



Mapping of Water and Soil Quality Parameters in the Gampaha-Ihalagama East and Eldeniya East Grama Niladhari Divisions, Sri Lanka

P.E.P.S. Deraniyagala ^{a*}, H.M.D.S.D. Heenkenda ^a
and R.C.L. De Silva ^a

^a University of Kelaniya, Kandy Road, Dalugama, Kelaniya 11600, Sri Lanka.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JGEESI/2024/v28i5771

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/115848>

Original Research Article

Received: 08/02/2024

Accepted: 12/04/2024

Published: 23/04/2024

ABSTRACT

Water and soil are important natural resources, and the study of their distribution is of great interest. The Grama Niladhari Divisions, Ihalagama-East and Eldeniya-East, located in the Gampaha district, are selected as the study areas, and this is done as a pilot study. Different water and soil quality parameters are investigated followed by the construction of contour maps. As water quality parameters, pH, conductivity, phosphate content, nitrate content, and Ca²⁺ hardness were determined, and as soil quality parameters, pH, nitrate, organic matter, water-soluble Na⁺ and K⁺, extractable Na⁺ and K⁺, and water-soluble Ca²⁺ ion contents were determined. The pH of water samples lies within the range of 4.41 – 7.11 and 3.79 – 7.18 in the Ihalagama-East and Eldeniya East divisions, respectively. Almost all the samples have acidic pH values, with some falling below the lower limit of the WHO guidelines for safe drinking water (6.5 – 8.5). Conductivity values vary

*Corresponding author: E-mail: pasinduderaniyagala11@gmail.com;

from 52.0 – 277.0 $\mu\text{S}/\text{cm}$ and between 54.0 – 403.0 $\mu\text{S}/\text{cm}$, respectively, which is below the WHO permissible level of 1500 $\mu\text{S}/\text{cm}$. The phosphate content varies from 1.374 – 3.986 mg/L in Ihalagama-East and water-soluble phosphate was not detected in Eldeniya-East, indicating a very low range and suggesting that the water samples are less contaminated with phosphate-containing substances. Considerably high values in the range of 1.24 – 279.00 mg/L for Ihalagama-east and 59.5 mg/L – 168.0 mg/L for Eldeniya-East, are obtained for the nitrate content where most of them are beyond the safe level of drinking water, 50 mg/L. The soil pH in all the samples falls within the acidic range, varying from 2.99 – 6.73 in Ihalagama-East and 3.07 – 6.68 in Eldeniya-East. Most of the soil samples contain high nitrate contents, indicating significant contamination. The percentage soil organic matter content varies between 0.60% and 13.27% in both areas. Many fertile agricultural soils typically have an organic matter content ranging from 3% – 6% revealing that most of the samples are beyond the standard levels. The distribution of water-soluble and extractable cations does not exhibit a wide range. According to the findings, though two Grama Niladhari Divisions are selected, they also display a huge variation. This reveals the importance of mapping to address contaminations, effects of natural disasters which lead to changes in the studied water and soil quality parameters.

Keywords: Distribution; mapping; soil; water; WHO.

1. INTRODUCTION

Water and soil are two main natural resources which play an important role in maintaining the natural environmental balance. Water is a precious natural resource to which the life of every living being is connected with. When considering the nature of water, it can be either freshwater or marine water. Freshwater systems are what is important for life, and they can be either surface water or groundwater. Due to population growth, urbanization, and industrialization in the century, especially in developed countries such as India, and China, the availability of surface water has become insufficient for day-to-day needs, thus the usage of groundwater has also increased [1]. Therefore, the quality of these water sources should be assessed for the well-being of living populations. Rivers, streams, lakes, and reservoirs are some of the surface water sources where their quality has been affected by anthropogenic activities and natural phenomena. Climate changes such as droughts and floods, and natural processes such as weathering and erosion affect the quality of surface water, but direct impacts are caused by circumstances linked to human activities. Due to the increase in population, agricultural activities, water consumption, contaminations from sewage discharges, and industrial and recreational processes have been drastically increased which led to degradation of water quality which will further cause adverse effects on human health and natural environment [2,3]. Dug wells and tube wells are used to obtain groundwater and with the high demand for

groundwater currently, over-extraction of it has become a serious concern. This leads to problems such as seawater intrusion and depletion of water storages. Therefore, groundwater quality parameters may be affected giving rise to critical issues [4].

Soil is a complex mixture of organic and inorganic materials that forms the uppermost layer of the Earth's crust having conditions for normal plant growth. It is a combination of minerals, water, air, organic matter, and microorganisms that interact to create a unique environment for plant growth. Soil is an essential natural resource that supports plant growth, provides habitats for many living organisms, and plays a crucial role in the cyclization of nutrients and water between the atmosphere, land, and water bodies. Different types of soil have different properties, including texture, nutrient content, and pH level, which can influence the types of plants that can grow in them. Soil is a vital component of sustainable agriculture and ecosystem management, and its preservation and restoration are crucial for maintaining the health of the Earth [5].

Due to the importance of the two natural resources, water and soil, constant investigation of water and soil quality parameters must be done regularly. For such investigation, it is essential to have maps of quality parameters which cover an entire country or an area to get a better understanding of the distribution of those. These maps can then be used as a reference which can be used for future studies and to

address environmental issues raised due to industrial activities, agricultural processes, and any other anthropogenic or natural phenomena. Unfortunately, a recent study regarding the mapping of water and soil quality parameters in Sri Lanka has not been identified, and the available maps found on Sri Lankan information are also outdated, thus revealing the need of such a database.

When considering mapping of water and soil quality parameters in Sri Lanka, according to literature, it is not an area that has been studied to a greater extent. Research related to mapping of groundwater quality parameters has been conducted previously by Dissanayaka and Weerasooriya, and has been published as "Hydrogeochemical Atlas of Sri Lanka" in 1993. This team had collected 500 samples from dug wells across the entire island, but the number of samples has been limited, especially in the Northern province, due to issues of inaccessibility. Determination of each parameter has been done using available standard procedures. The resulting work included contouring maps for 15 water quality parameters [6]. As an example, when considering the map of distribution of nitrate ions in groundwater in the 1993 study, there are large areas having a single value of the parameter. About six ranges are selected to construct the contour map and the distribution of parameters throughout the entire country is covered by these six regions. This may not be practically possible, and the major drawback of this study would be the limited number of sampling sites which is therefore addressed in the current study.

Through this research, it is planned to evaluate some selected water and soil quality parameters in the Gampaha-Ihalagama East and Eldeniya-East Grama Niladhari Divisions and to construct maps using the obtained results. Though the smallest administration unit is studied, this research is planned to highlight the importance of mapping as a pilot study and to expand this to the entire country.

2. MATERIALS AND METHODS

$\text{FeSO}_4 \cdot (\text{NH}_4)_2 \cdot 6\text{H}_2\text{O}$ was purchased from HIMEDIA (Mumbai, India). KNO_3 and conc. H_2SO_4 were purchased from Riedel de Haen (Germany, Seelze). HCl , conc. NH_4OH and glacial acetic were purchased from Merck (Mumbai, India). $\text{K}_2\text{Cr}_2\text{O}_7$ was purchased from Central Drug House (India, Delhi). NH_4Cl was purchased from Srlichem (Mumbai, India).

$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ and phosphoric acid were purchased from Daejung (South Korea, Siheung-si). KCl and diphenylamine were purchased from Fluka (Switzerland, Buchs) and NaF was purchased from Fischer scientific (USA, New jersey).

Laboratory instruments used to conduct this research project were; pH meter, conductivity meter, spectrophotometer (Agilent Technologies Cary 60 UV-Vis) to measure absorbance values, nitrate ion selective electrode (Thermo Scientific Orion Star A214) to measure the nitrate content, flame photometer (Jenway-pfp7, UK) to measure cation contents, orbital shaker (mrc, UK) to homogenize samples, electrical balance (KERN EW 2200-2NM) and analytical balance (Kern, ALJ 250-4AM, Germany) for mass measurements and hot plate for heating purposes.

2.1 Study Area

The Grama Niladhari Divisions, Ihalagama-East and Eldeniya-East located in the Gampaha district, Sri Lanka, were selected as the study area. One-hundred-fourteen (114) randomly selected sampling sites (58 in Ihalagama-East and 56 in Eldeniya-East) were chosen for the analysis. Water samples were collected from surface and groundwater sources, and soil samples were collected from each site close to the water source. The two study areas and the sampling sites are illustrated in Fig 1. and Fig. 2.

2.2 Sample Collection and Pretreatment

Water samples (1 L) from selected sampling sites were collected into polypropylene bottles which were previously washed with distilled water and air-dried. Before filling samples, these bottles were rinsed with the samples to be collected. Then the bottles were filled with samples [7].

A clean plastic spade was used to collect soil from selected sampling sites. About 2 inches of the soil surface was removed and then soil samples (~800 g) were collected into labeled polythene zip-lock bags. Samples were dried in air, and dried samples were ground using a mortar. Ground samples were sieved through a 2 mm sieve and used for further analysis [7].

2.3 Water Analysis

Determination of pH was done using the pH meter. First, it was calibrated using standard

buffer solutions of pH=4, pH=7, and pH=10. recorded. All pH readings were duplicated
Then, pH of water samples was measured and [7].

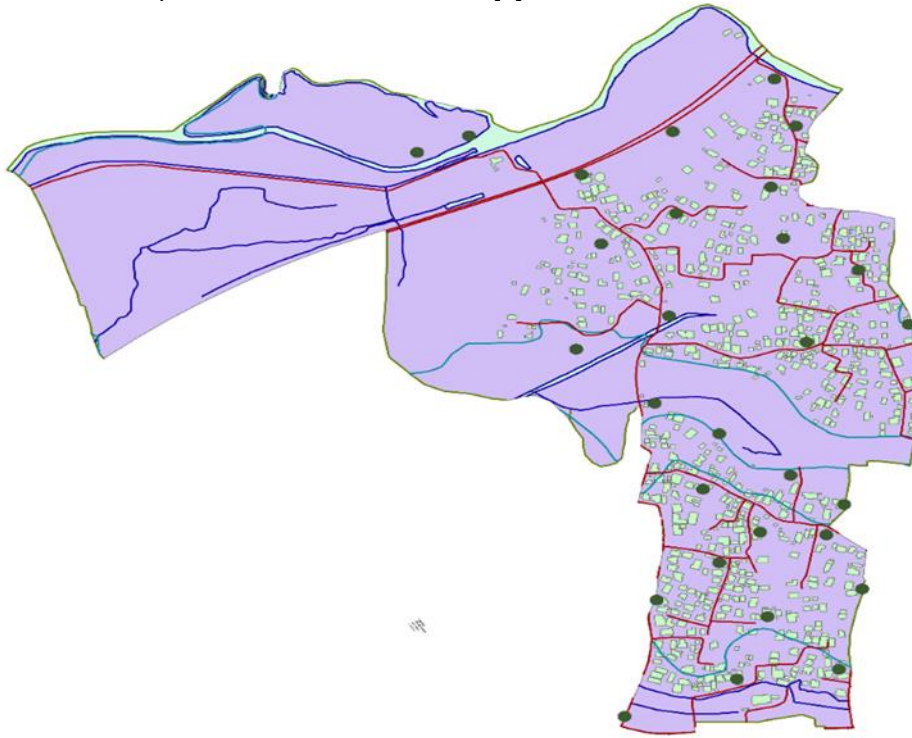


Fig. 1. Ihalagama-East (study area) with sample sites



Fig. 2. Eldeniya-East (study area) with sample sites

Conductivity determination was done using the conductivity meter. It was calibrated using standard solutions. Then, the conductivity of water samples was measured and recorded. All conductivity readings were duplicated [8].

Determination of the phosphate content was done using a colorimetric method, the yellow method. For this, 5.00, 10.00, 15.00, 20.00 and 25.00 cm³ aliquots of phosphate standard solution (50 mg/dm³) were transferred to a series of volumetric flasks (50.00 cm³). Ammonium molybdate solution and ammonium metavanadate solution were mixed to prepare the coloring agent. The coloring agent (10.00 cm³) was added to each flask and was mixed well. Each solution was distilled up to the mark with deionized water and was allowed to stand at room temperature for about 20 min. The absorbance of solutions was measured at 470 nm using the spectrophotometer. A blank was also carried out. A calibration curve was plotted using the obtained absorbance values for absorbance against concentration (mg/dm³). Water samples (10.00 cm³) were transferred into volumetric flasks (50.00 cm³) and the coloring agent (10.00 cm³) was added to each flask. Each solution was mixed well and was allowed to stand at room temperature for about 20 minutes. Absorbance of samples was measured at 470 nm using the spectrophotometer. The phosphate content was determined using the calibration curve plotted [9].

Determination of the nitrate content in water was done using the nitrate ion selective electrode. The meter was calibrated using standard nitrate solutions having concentrations of 10, 70, 130, 190, 250 ppm. Water samples (25.00 cm³) were transferred into 50.0 cm³ beakers and the ionic strength adjuster (ISA) (0.5 cm³) was added to each sample. Then nitrate content of the water samples was determined using the calibration curve. Readings were duplicated [10].

The Ca²⁺ hardness was determined using the flame photometer. First, it was calibrated using the standard Ca²⁺ (50 mg/dm³) solution. Then the Ca²⁺ ion content in water samples was determined.

2.4 Soil Analysis

Soil pH determination was done using the pH meter. Pretreated soil sample (10.00 g) was placed in an Erlenmeyer flask (250.0 cm³), and CaCl₂.2H₂O (0.01M, 35.00 cm³) was added. The

sample was kept for 30 minutes without shaking to allow the absorption of CaCl₂.2H₂O into soil and then stirred for 10 seconds. The suspension was shaken for 30 minutes in the orbital shaker and filtered under gravity. The pH of this soil solution was measured using the calibrated pH meter [7].

Soil nitrate content determination was done using the nitrate ion selective electrode. Pretreated soil sample (10.00 g) was placed in an Erlenmeyer flask (250.0 cm³), and nitrate extracting solution (50.00 cm³) was added. This was shaken for 10 minutes in the orbital shaker and was filtered under gravity. Nitrate-extracted soil solution (25.00 cm³) was transferred into a beaker (50.0 cm³) and ISA (0.50 cm³) was added. The nitrate content of the soil solution was measured using the calibrated nitrate ion selective electrode [10].

Soil organic matter content was determined using a titrimetric method. Pretreated soil sample (1.00 g) was placed in an Erlenmeyer flask (500.0 cm³). K₂Cr₂O₇ (1 N, 10.00 cm³) and conc. H₂SO₄ (20.00 cm³) were added to it and was allowed to stand for 30 minutes. The solution was diluted to 200.0 cm³. NaF (0.2 g) and diphenylamine (0.4 cm³) were added, and the solution was titrated against FeSO₄.(NH₄)₂.6H₂O (0.5 N) to a brilliant green color endpoint. A blank was run simultaneously without the soil sample [11].

Water-soluble cation (Na⁺, K⁺) content determination was done using the flame photometer. First, it was calibrated using standard Na⁺ (50 mg/dm³) and standard K⁺ (50 mg/dm³) solutions. Pretreated soil sample (2.50 g) was placed in an Erlenmeyer flask (250.0 cm³) and deionized water (100.00 cm³) was added. It was shaken in the orbital shaker for 1 hour. The solution was filtered under gravity. Na⁺ and K⁺ ions were determined separately using the flame photometer [12].

Soil extractable cation (Na⁺, K⁺) content determination was done using the flame photometer. First, it was calibrated using standard Na⁺ (50 mg/dm³) and standard K⁺ (50 mg/dm³) solutions. Pretreated soil sample (5.00 g) was placed in an Erlenmeyer flask (250.0 cm³) and NH₄OAc solution (1 N, 25.00 cm³) was added to it. It was shaken in the orbital shaker for 30 minutes. The solution was filtered under gravity. The final volume of each solution was brought up to 25.00 cm³ using NH₄OAc solution (1 N). Each solution was diluted 10-fold. Then,

Na⁺ and K⁺ ions were determined separately using the flame photometer [12].

Water-soluble Ca²⁺ determination was done using the flame photometer. First, it was calibrated using the above-mentioned standard Ca²⁺ (50 mg/dm³) solution. Pretreated soil sample (2.50 g) was placed in an Erlenmeyer flask (250.0 cm³) and deionized water (100.00 cm³) was added. It was shaken in the orbital shaker for 1 hour. The solution was filtered under gravity. Ca²⁺ ion content was determined using the flame photometer [12].

3. RESULTS AND DISCUSSION

According to the results obtained from this analysis, the pH values of surface and groundwater samples are in between the range of 3.79 – 7.18. This pH distribution is illustrated in Fig 3. and Fig 14. As per WHO guidelines, the accepted pH range for drinking water is 6.5 – 8.5 [13]. The selected study areas belong to the wet zone of Sri Lanka where the pH lies within a range of 4.0 – 7.8 and all the results obtained are accepted accordingly⁴. Almost all the samples have acidic pH values while some of them are close to the neutral pH value of 7.0. When considering the geology and aquifer type of the study areas, they consist of fractured metamorphic acid rocks, base rock, and laterite Cabook aquifers. The control factors of this slightly acidic behavior are the interaction with less soluble metamorphic acid rocks which is lower in acid buffering capability and dilution by heavy annual rainfall [4].

In this study the conductivity values vary from 52.0 to 403.0 μS/cm, and this variation is shown in Fig 4. and Fig 15. Since WHO permits a limit of 1500 μS/cm as the safe level of conductivity in drinking water, all these obtained values can be considered as acceptable values in terms of drinking purposes [8].

When considering the nitrate ion concentration values obtained, they lie within the range of 1.24 – 279 mg/L, which is a considerable distribution within the sampling areas. Fig 5. and Fig 16. explain this variation. In the previous study, this variation was observed approximately in the range of 1 – 40 ppm [6]. Due to the high sensitivity of the electrochemical method used, it was able to detect smaller concentrations as well. Only 3 samples were below the detection limit of nitrate ion levels. According to WHO guidelines, the maximum permissible nitrate concentration of drinking water is 50 mg/l [14].

According to the results, areas near agricultural lands and urbanized locations have a considerably high nitrate levels which exceed the accepted value.

Total hardness includes both Ca²⁺ hardness and Mg²⁺ hardness. In this study, Ca²⁺ hardness was determined using the flame photometer and a qualitative experiment was done to determine the presence of Mg²⁺ ions in water samples. Since negative results were obtained for the qualitative analysis, it can be stated that Mg²⁺ hardness is below the detection limits and is of very low concentrations or Mg²⁺ is not present in the samples. The Ca²⁺ hardness values obtained are in the range of 0 – 59.93 mg CaCO₃/L according to the sensitivity of the instrument. This distribution is shown in Fig 6. and Fig 17. About 11% of samples did not give measurable values as their Ca²⁺ concentrations are too low to be detected. According to the classification of water, based on hardness, all the samples collected within the study area can be classified as soft water with minimum hardness [15]. The permissible limit of calcium in drinking water is 180 mg CaCO₃/L and all the obtained values are below this maximum level [16]. In the previous study, the total hardness was determined, and the maps constructed highlight that the total hardness distribution in groundwater is approximately in the range of 50 – 850 ppm, which is significantly different from the values obtained from the current study [6].

In this study, soil pH values vary from 2.99 to 6.73, and all the values are acidic pH values. The National Resources Conservation Service of the United States Department of Agriculture states that an acceptable range for soil pH is between 6 and 7 [17]. Fig 7. and Fig 18. explain the soil pH distribution.

This study reveals that the nitrate ion content of the respective samples varies between the range of 0.39 – 217.00 mg/L, which is illustrated in Fig 8. and Fig 19. The amount of nitrate required in the soil for specific crops varies from crop to crop, but in general, the level should not fall below 10 mg/L and should not exceed 50 mg/L. Only about 17% of the samples are between these accepted levels. About 79% of samples have nitrate values higher than 50 mg/L and other remaining samples have nitrate values lower than the accepted value in Ihalagama-East. However, soil nitrate content of Eldeniya - East's all samples exceeded the acceptable value.

3.1 Ihalagama-East

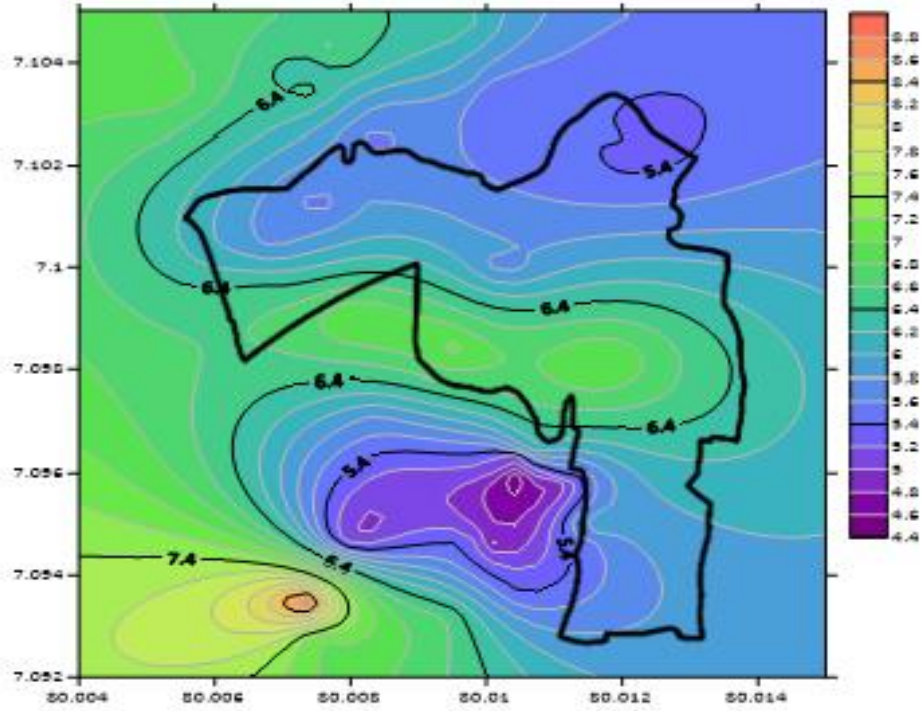


Fig 3. Distribution of pH of water samples

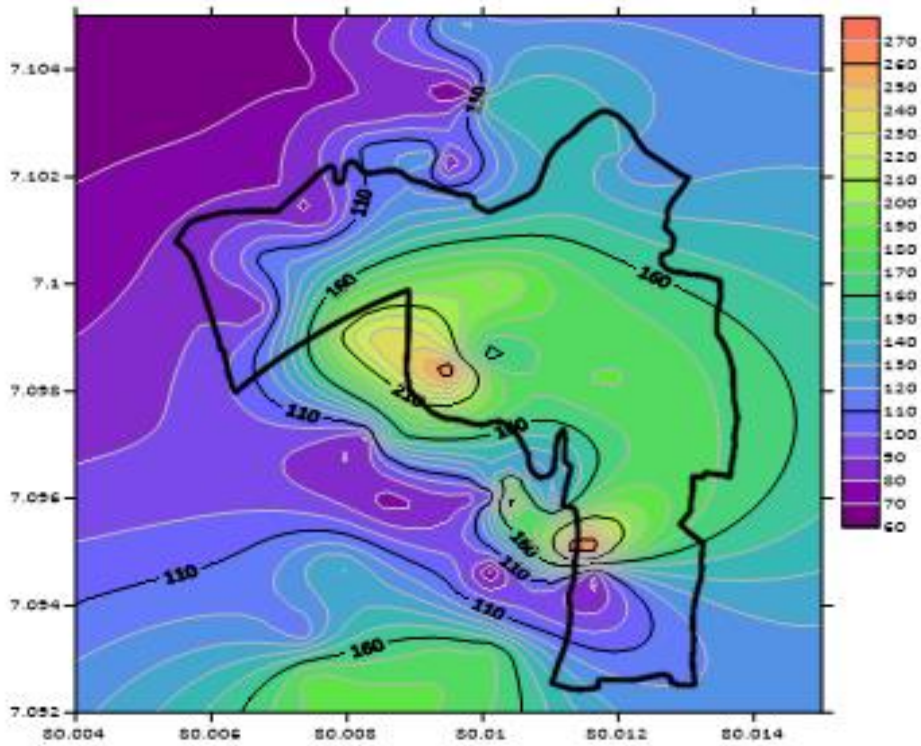


Fig. 4. Distribution of conductivity in water samples

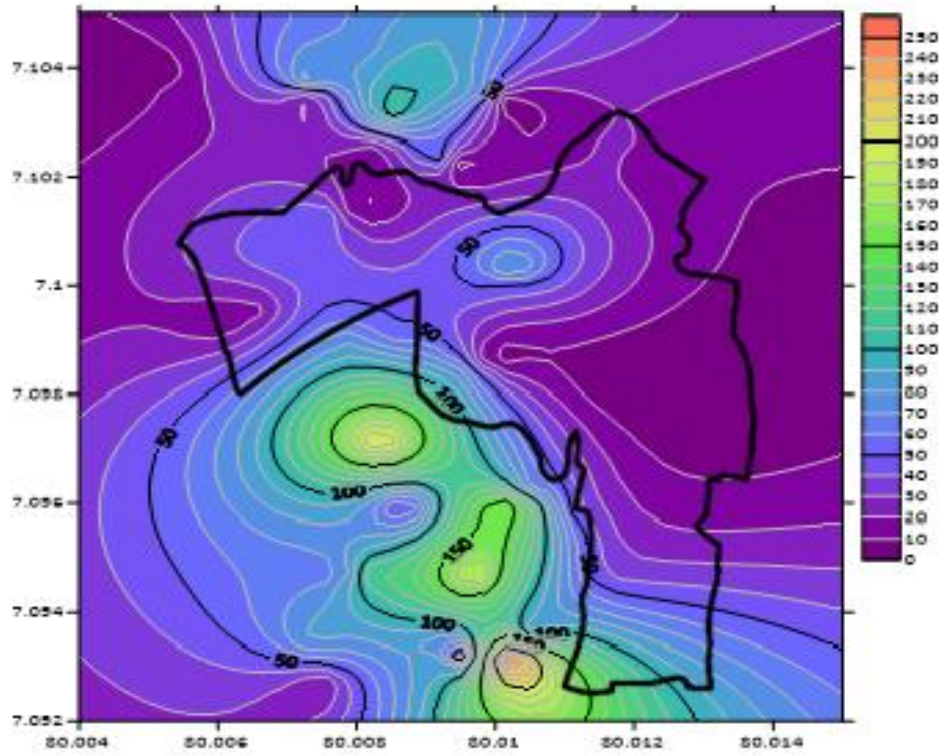


Fig. 5. Distribution of nitrate ion content in water samples

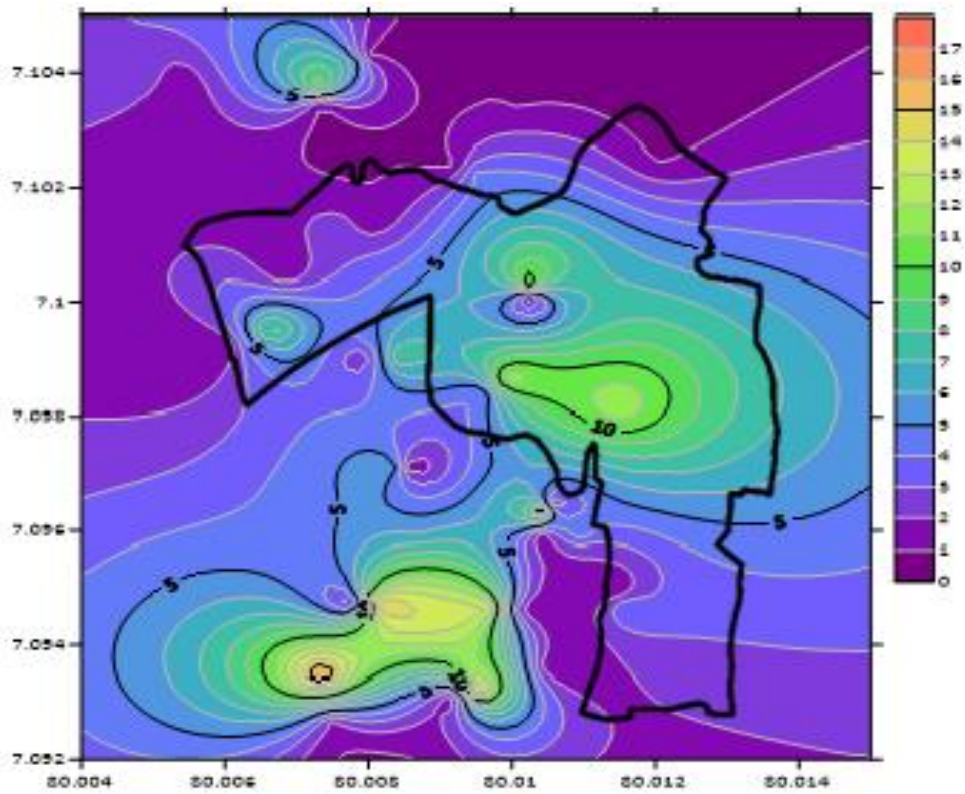


Fig. 6. Distribution of Ca^{2+} hardness in water samples

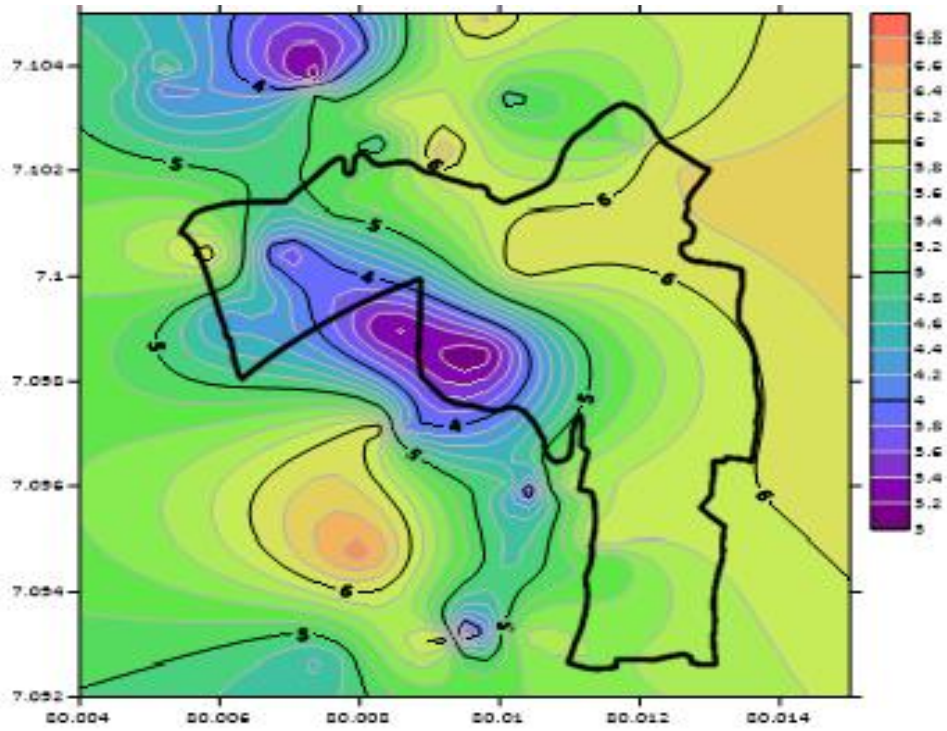


Fig 7. Distribution of soil pH of samples

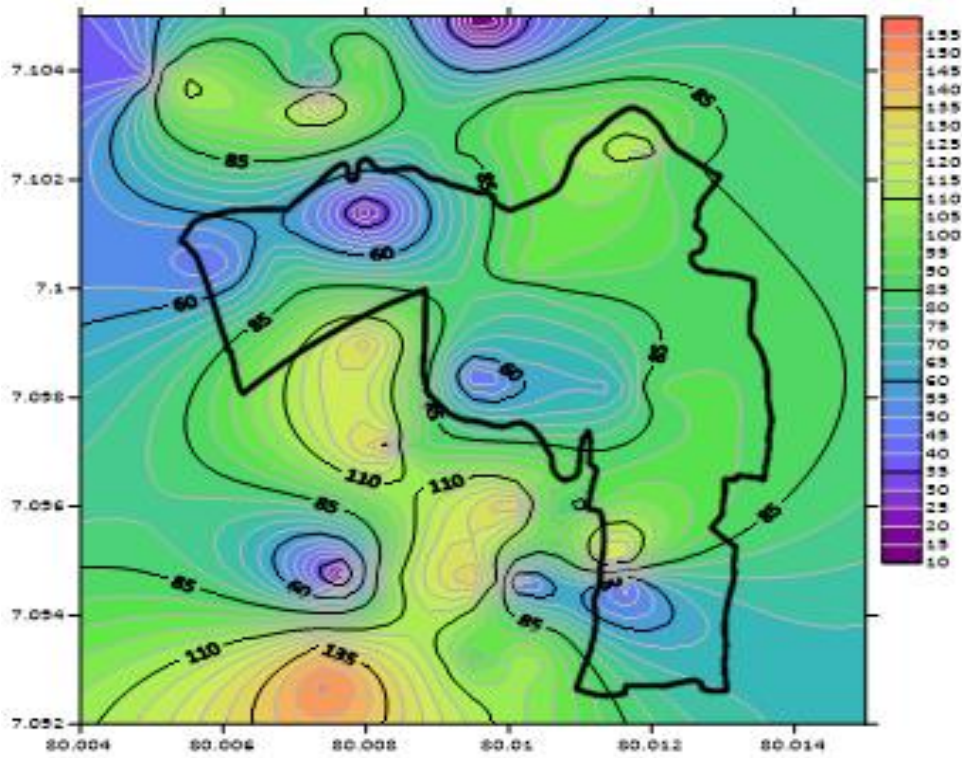


Fig 8. Distribution of soil nitrate content of samples

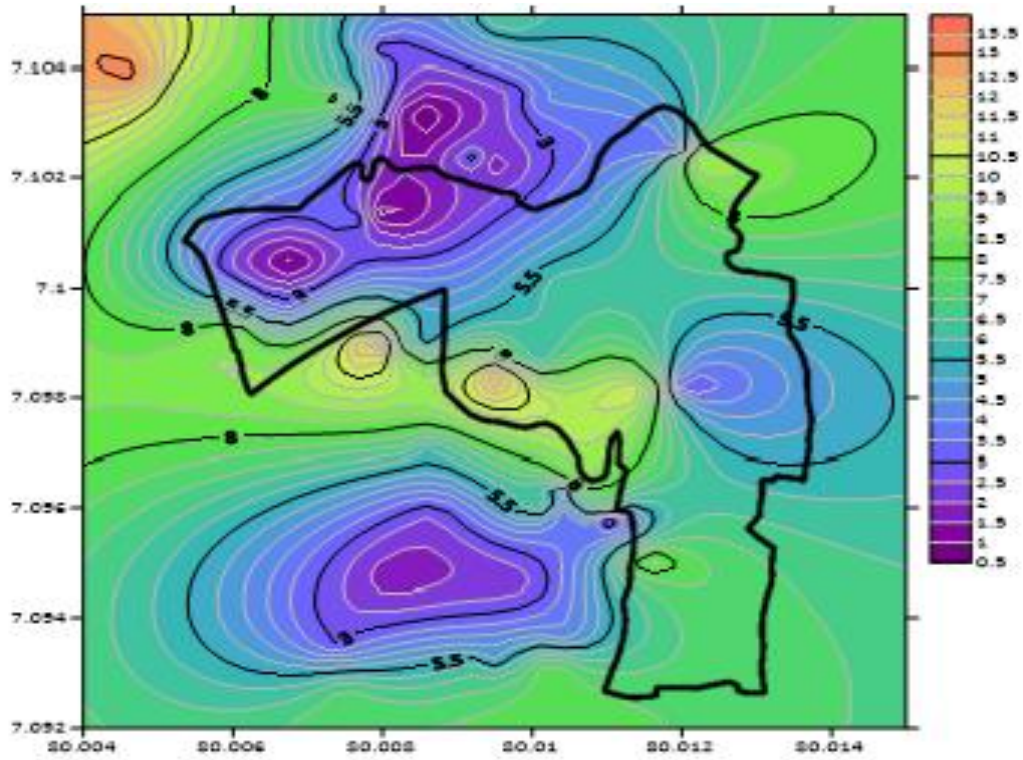


Fig. 9. Distribution of soil organic matter content of samples

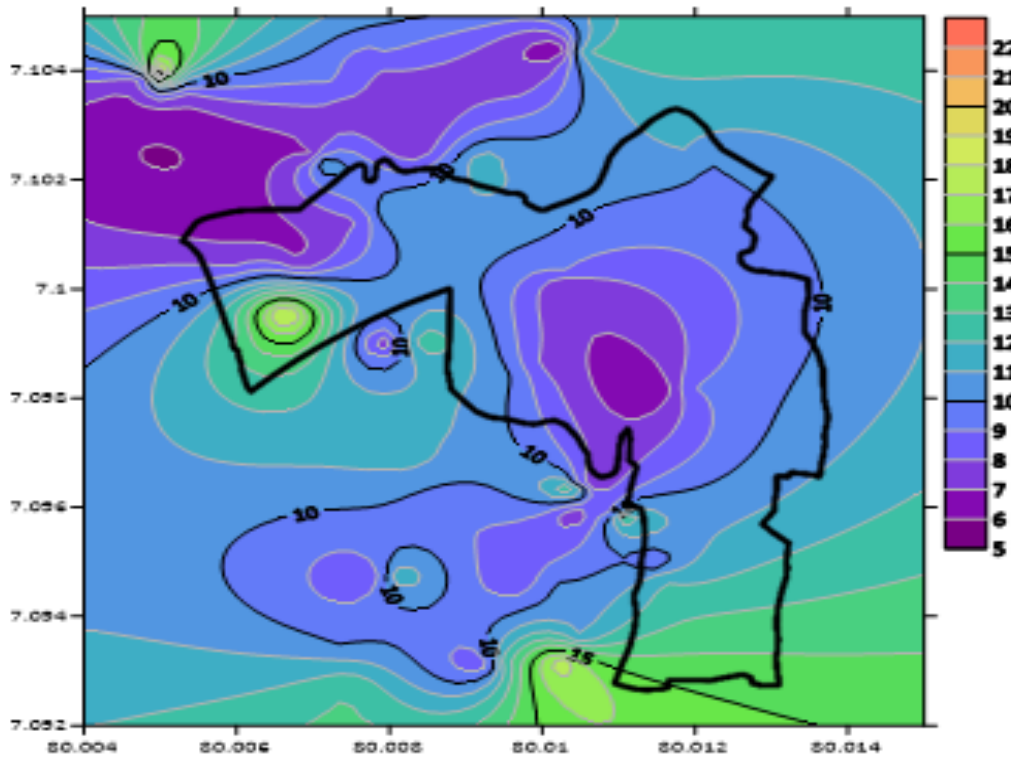


Fig. 10. Distribution of water soluble Na⁺ content of samples

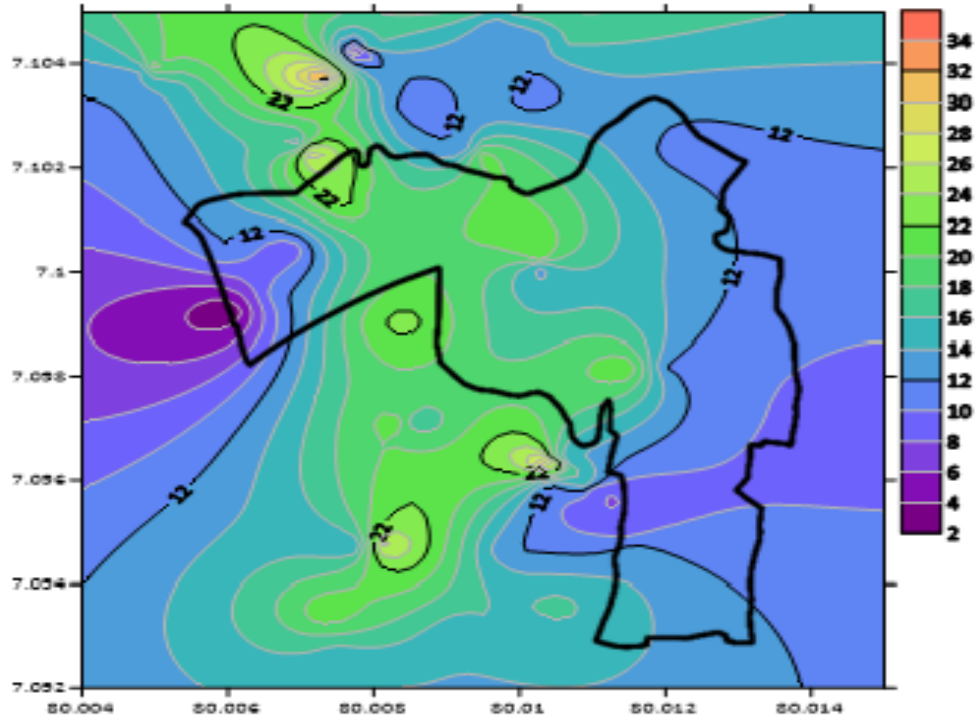


Fig. 11. Distribution of soil extractable Na^+ content of samples

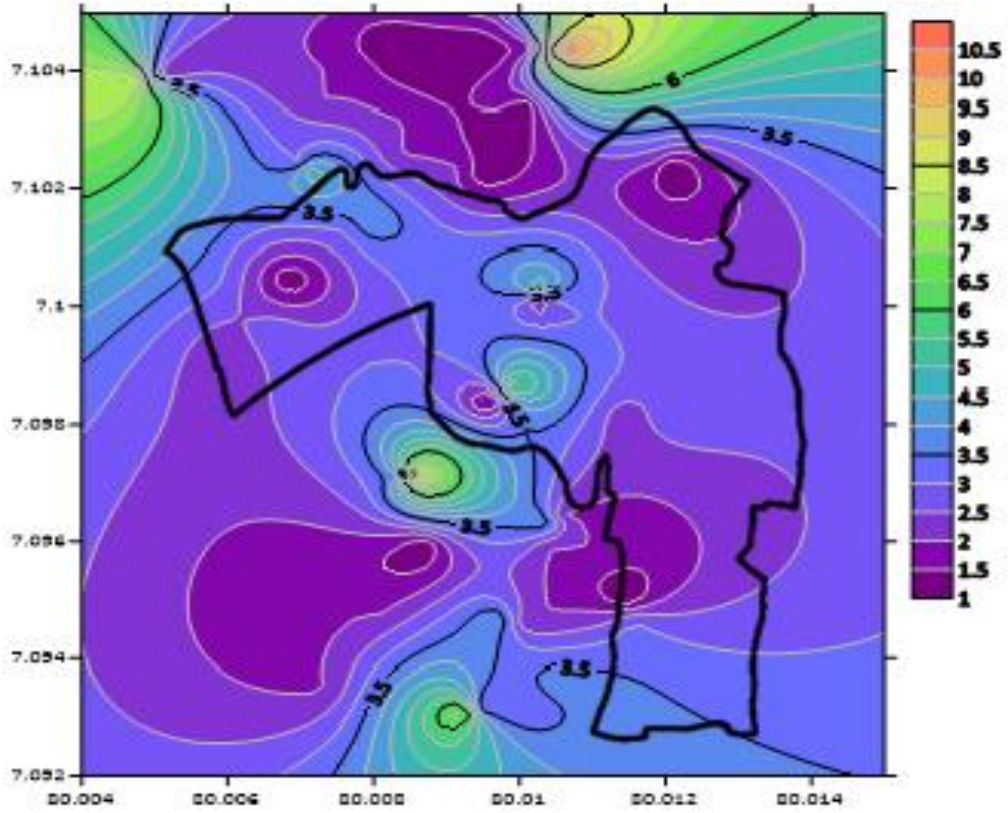


Fig. 12. Distribution of water soluble K^+ content of samples

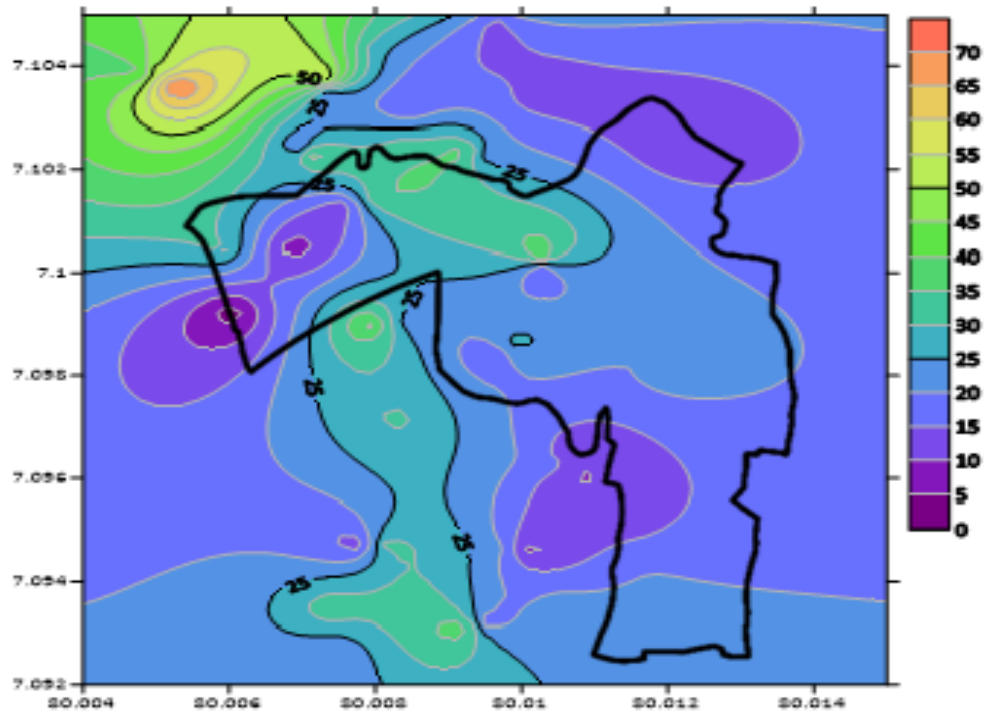


Fig 13. Distribution of soil extractable K⁺ content of samples

3.2 Eldeniya-East

located in the Gampaha district.

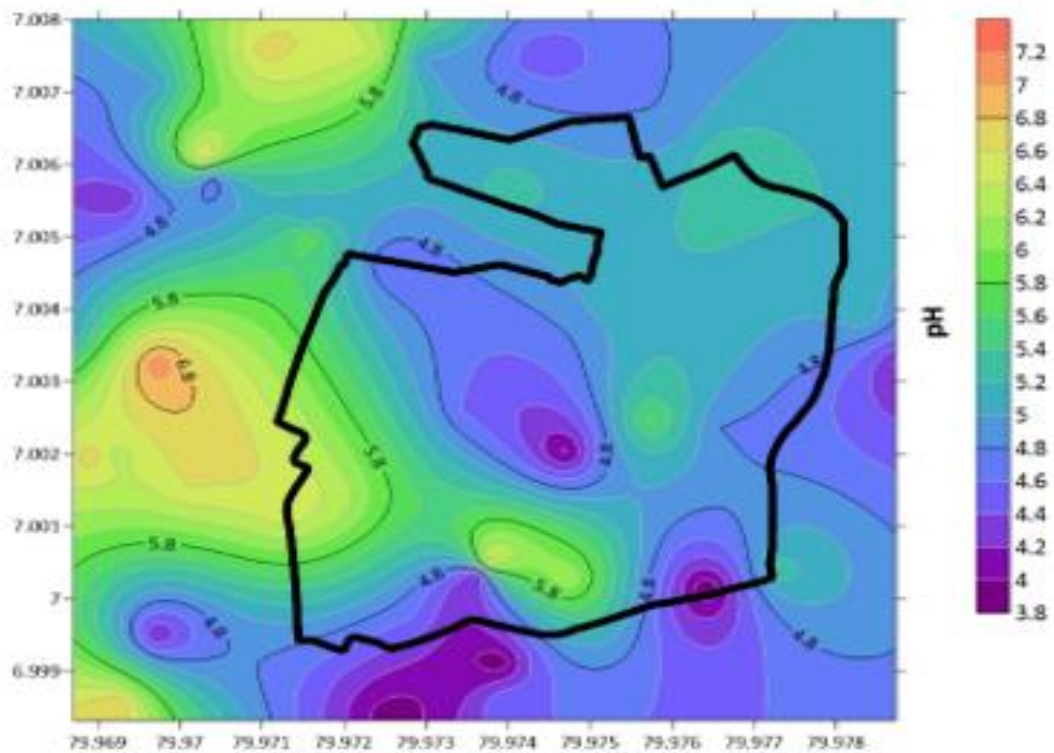


Fig 14. Distribution of pH of water samples

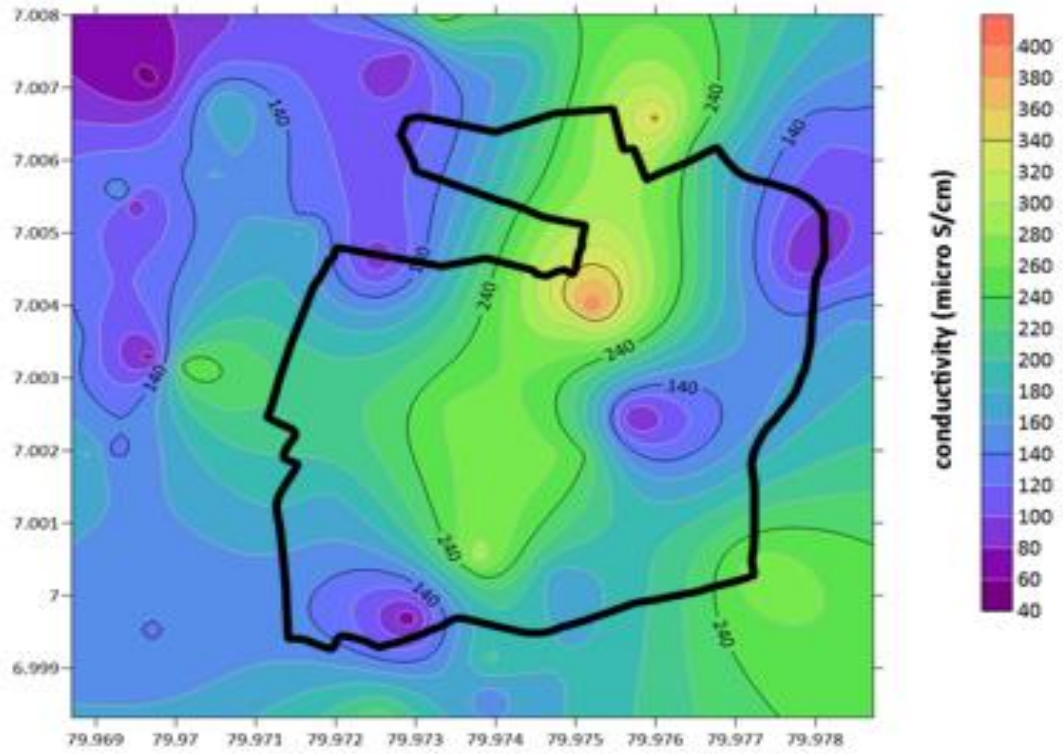


Fig. 15. Distribution of conductivity of water samples

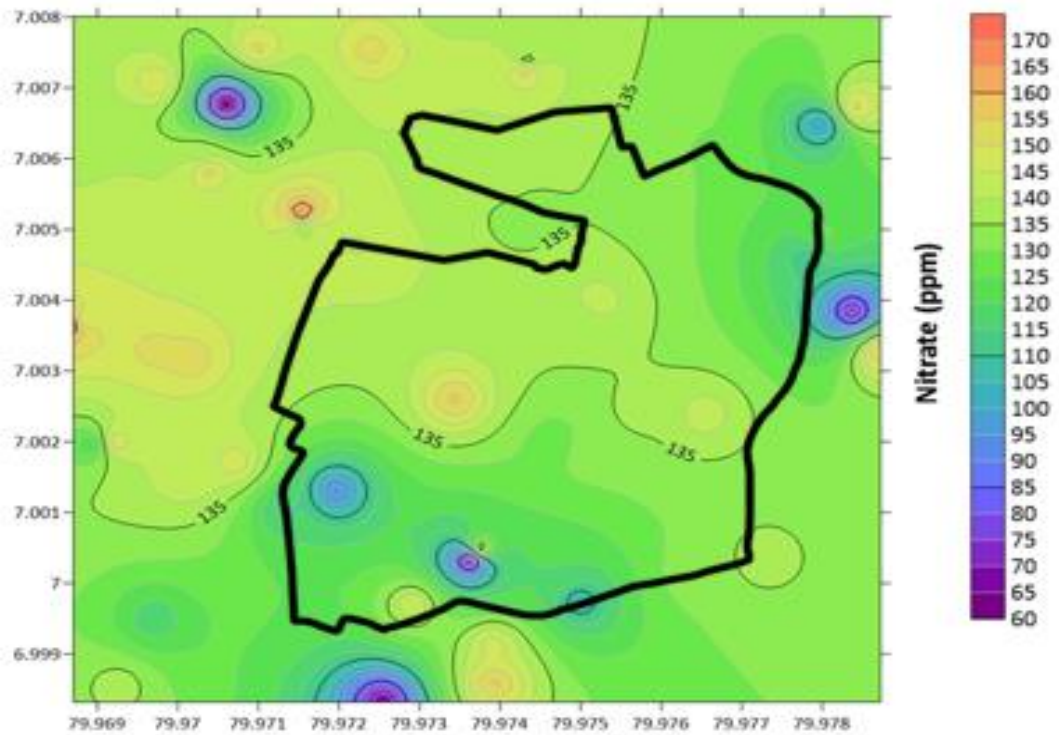


Fig. 16. Distribution of nitrate ion content in water samples

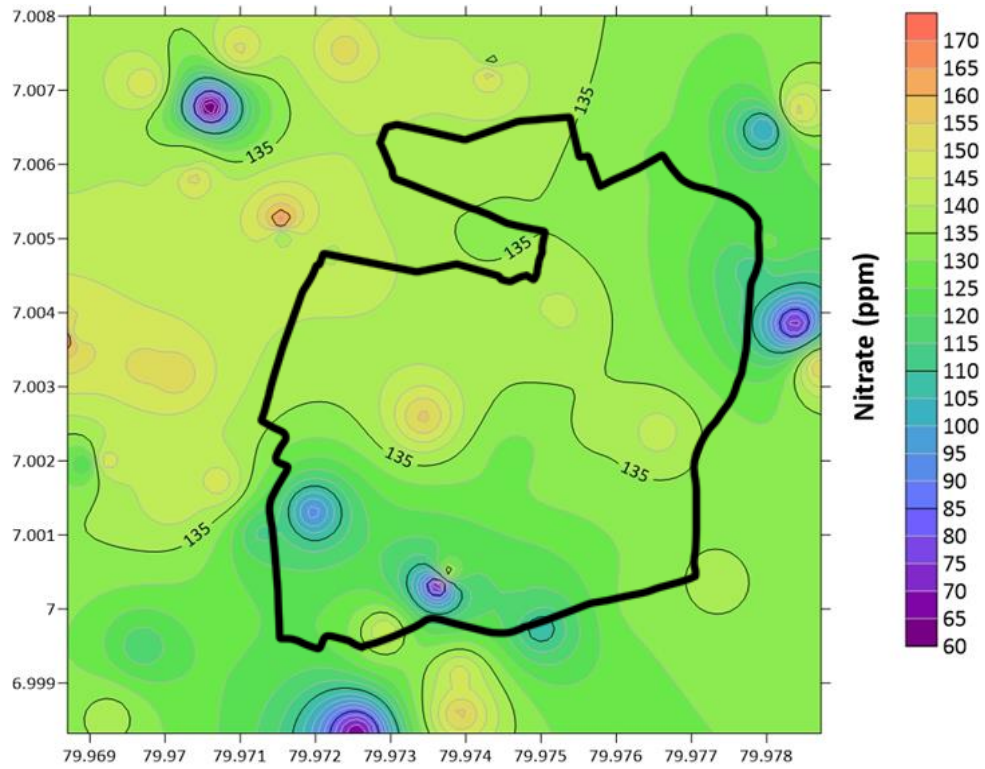


Fig. 17. Distribution of Ca^{2+} hardness in water samples

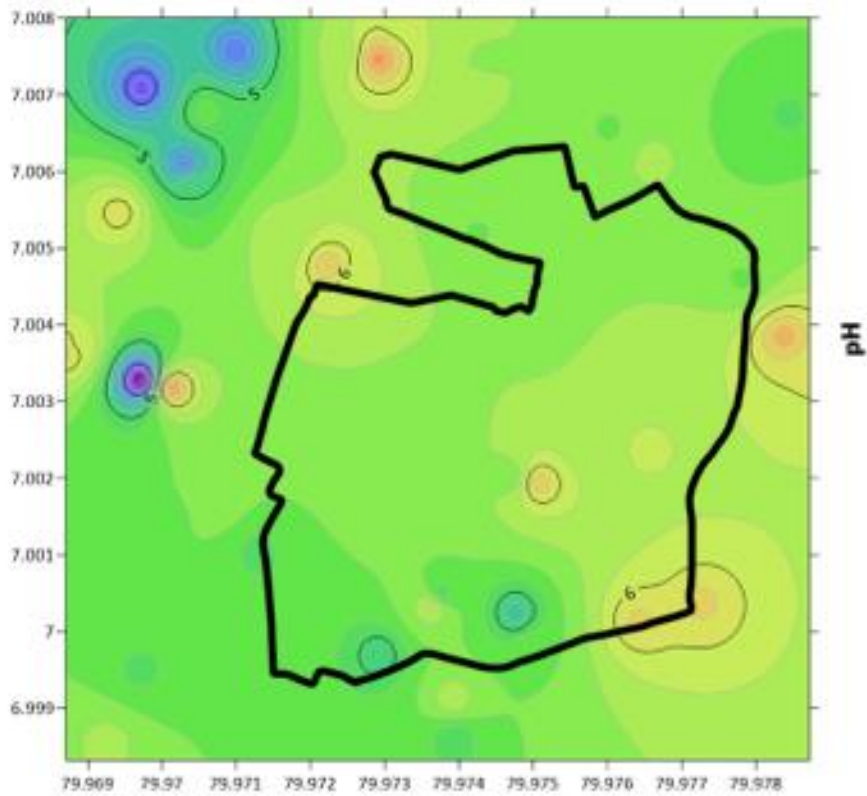


Fig. 18. Distribution of Soil soil pH of samples

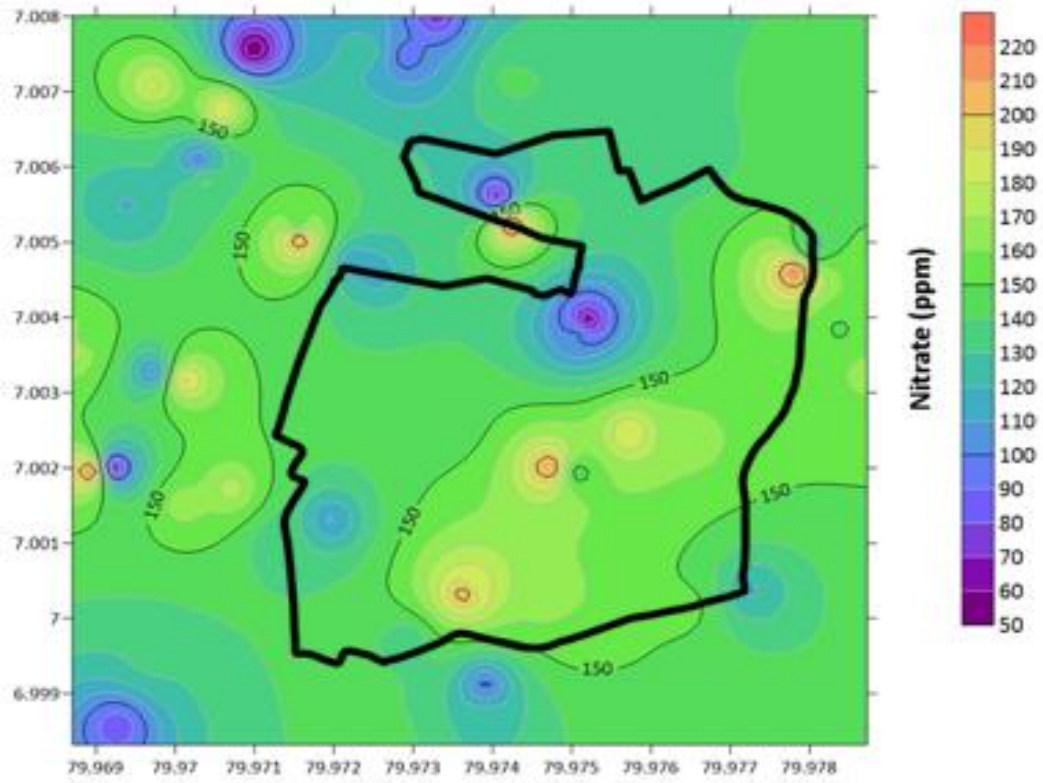


Fig. 19. Distribution of soil nitrate content of samples

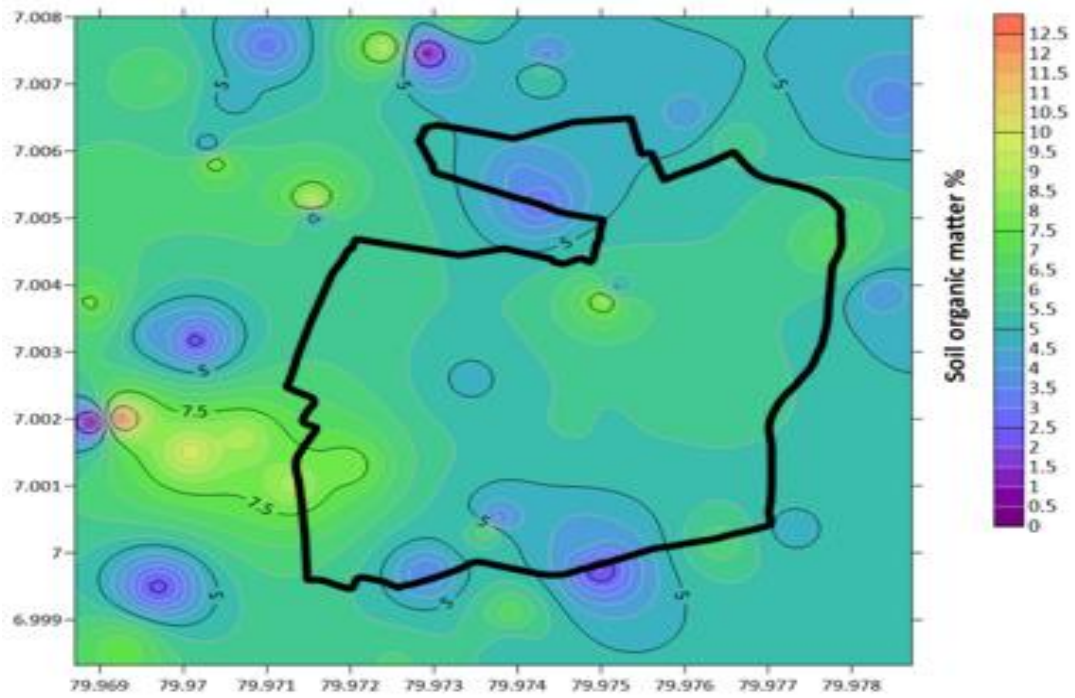


Fig. 20. Distribution of soil organic matter content of samples

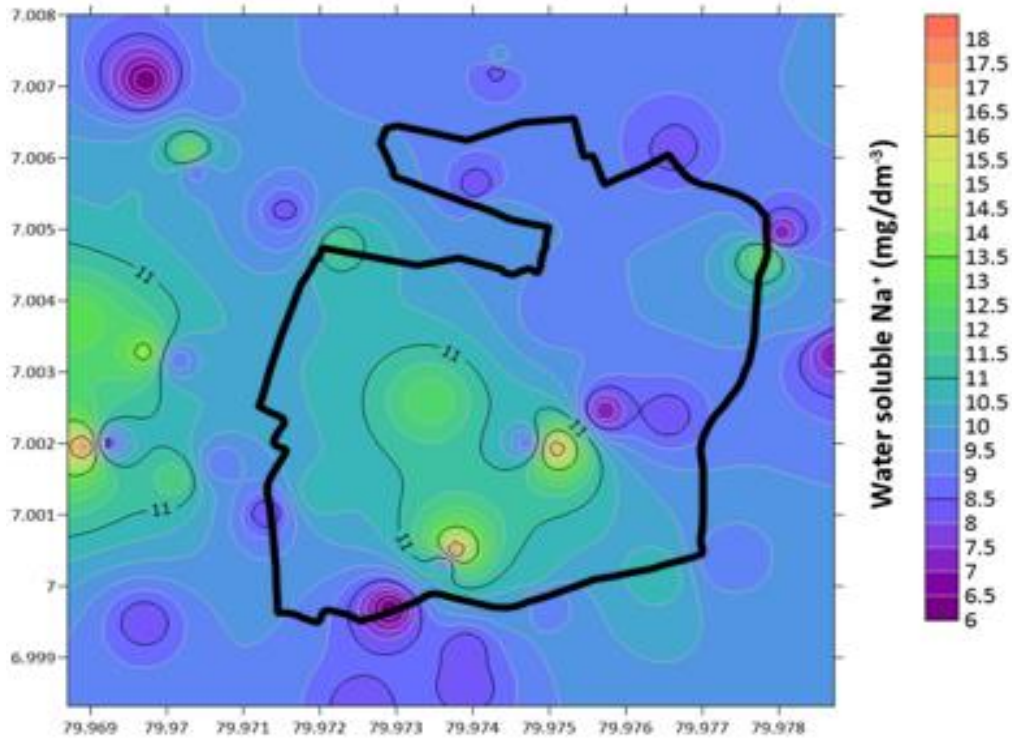


Fig. 21. Distribution of water soluble Na^+ content of samples

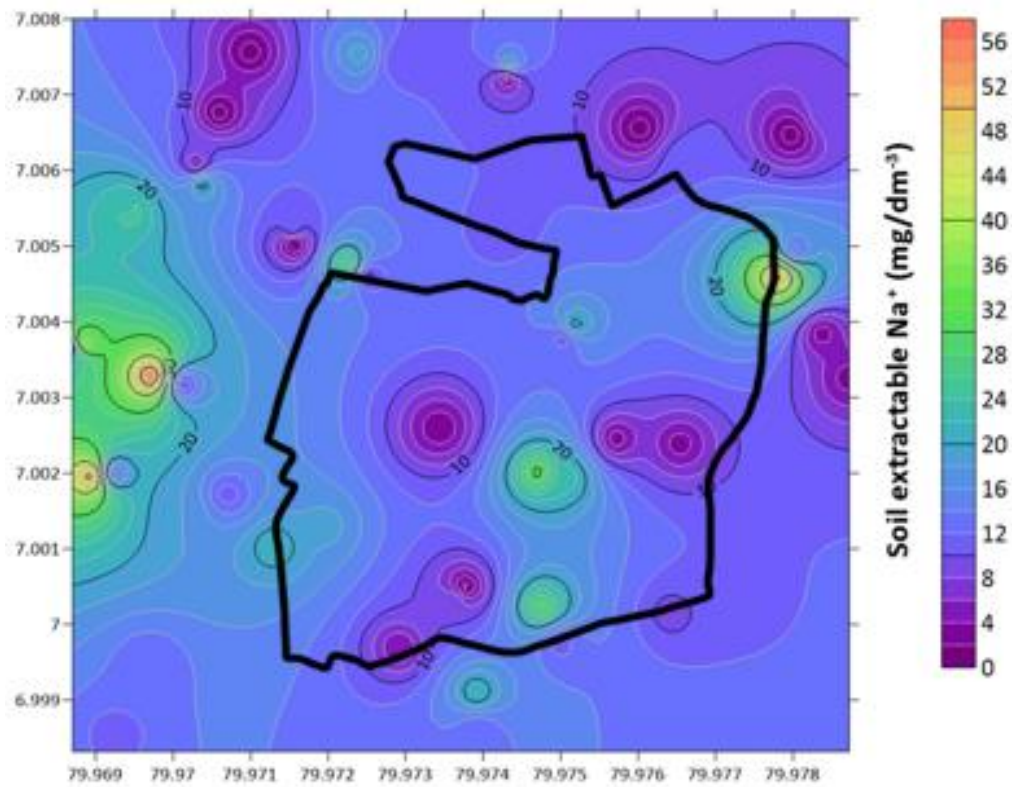


Fig. 22. Distribution of soil extractable Na^+ content of samples

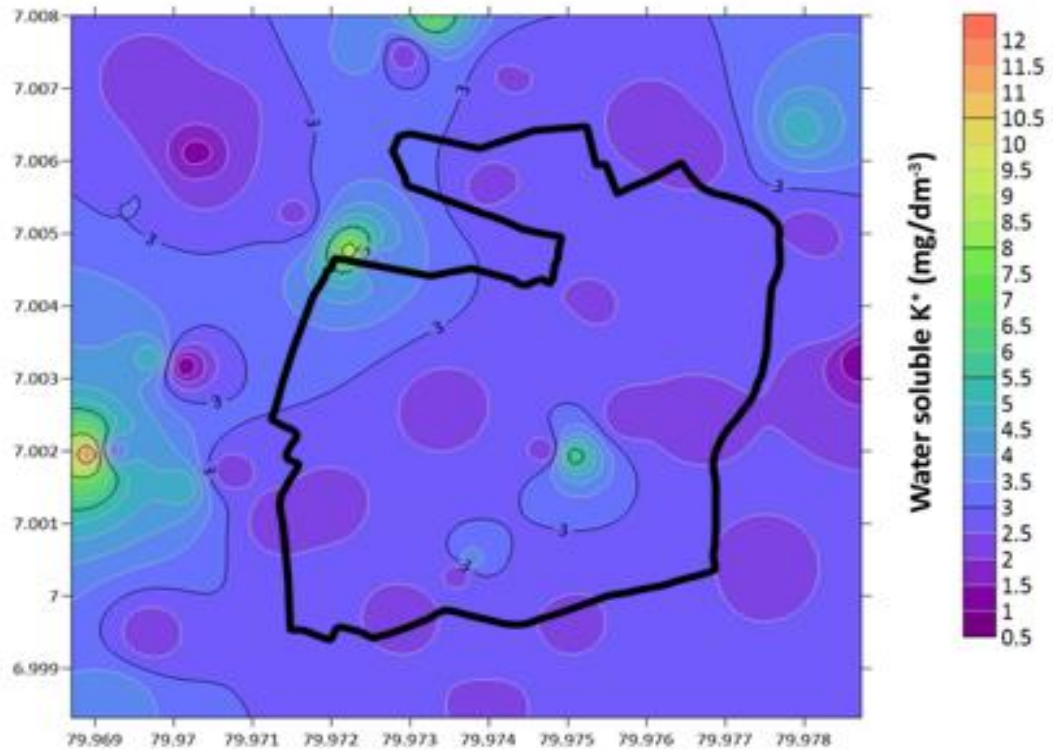


Fig. 23. Water soluble K^+ content

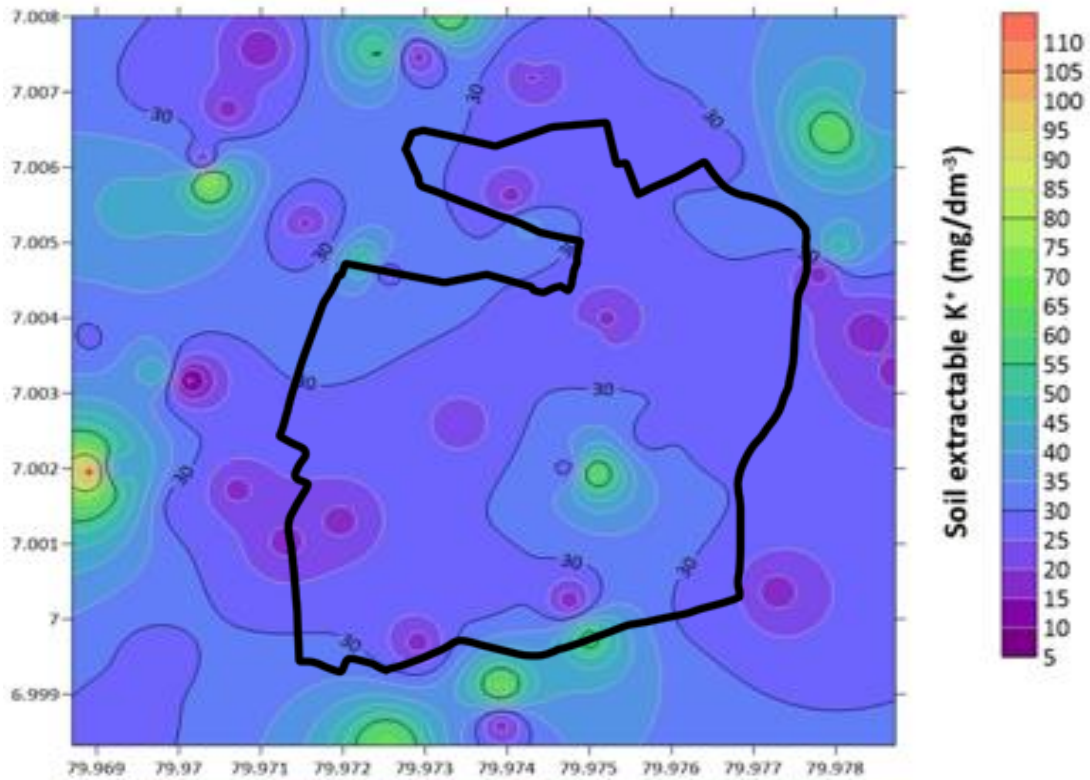


Fig. 24. Distribution of soil extractable K^+ content of samples

According to the results obtained, percentage soil organic matter content varies between 0.60% and 13.27% in both areas. Fig 9 and Fig 20 explain this variation. The majority of fertile agricultural soils typically has an organic matter content ranging from 3% to 6%. Therefore, only a few samples are under the accepted range, and most of the samples have a higher organic matter content in Ihalagama-East. This may be due to natural phenomena as well as anthropogenic activities. However, half of the soil samples of Eldeniya-East are within the accepted range.

In this study, water-soluble sodium ion content varies from 6 to 22 mg/L, and extractable sodium ion content varies from 1 to 56 mg/L. This variation is highlighted in Fig 10 and Fig 21, and Fig 11 and Fig 22, respectively. The sodium ion content in soil can be determined as water-soluble, exchangeable, extractable, and mineral forms. Extractable sodium refers to the form of sodium that is readily available and can be determined using the ammonium acetate extraction method, and exchangeable sodium is determined by calculating the difference between the extractable sodium and the soluble sodium forms [6]. When considering the results obtained, water-soluble potassium ion content is in the range of 1-12 mg/L and extractable potassium content in the range of 2 – 108 mg/L. Fig 12 and Fig 23 show the distribution of the water-soluble ion content and Fig 13 and Fig 24 show that of the extractable ion content.

In the study areas, the water-soluble calcium content varies from 1 to 8 mg/L which is comparatively a low range. About 71% of the samples did not contain calcium ions in detectable levels. According to the soil type of the area, the amount of calcium varies. The higher the clay content in soil, the higher the calcium content. Since the soil is more of sand form in the study areas, it may be a reason for low calcium contents [18].

4.CONCLUSION

The variation of water and soil quality parameters in the Gampaha Ihalagama-East and Eldeniya-East Grama Niladhari Divisions is of considerable magnitudes. This fact is clear when considering the distribution of parameters in the contour maps constructed. This variation shows a significant difference when comparing the maps constructed in the previous study of which,

though the entire country was considered, a minor variation is observed. In contrast, in this study, even though two Grama Niladhari Divisions are studied, a significant variation is observed. If this pilot study is expanded to construct more detailed maps, it would be very useful as a reference for future studies and for routine analysis. This indicates the need of mapping the entire country with the help of respective authorities including the National Water Supply and Drainage Board, the Central Environmental Authority, and government and nongovernment educational institutes.

CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented and published in the conference: Proceedings of 11th Ruhuna International Science & Technology Conference. University of Ruhuna, Matara, Sri Lanka, January 24, 2024.

Web Link of the proceeding: https://www.researchgate.net/publication/377774185_Mapping_of_Water_and_Soil_Quality_Parameters_in_the_Gampaha_Ihalagama_Grama_Niladhari_Division

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tirkey P, Bhattacharya T, Chakraborty S. Water quality indices- important tools for water quality assessment: Int. J. Adv. Chem. 2013;1(1):15–28.
2. Simeonov V, Stratis JA, Samara C, Zachariadis G, Voutsas D, Anthemidis A, Sofoniou M, Kouimtzis . Assessment of the Surface Water Quality in Northern Greece. Water Res. 2003;37(17):4119–4124. Available:[https://doi.org/10.1016/S0043-1354\(03\)00398-1](https://doi.org/10.1016/S0043-1354(03)00398-1)
3. Delpla I, Jung AV, Baures E, Clement M, Thomas O. Impacts of climate change on surface water quality in relation to drinking water production. Environ. Int. 2009;35(8): 1225–1233. Available:<https://doi.org/10.1016/j.envint.2009.07.001>
4. Indika S, Wei Y, Cooray T, Ritigala T, Jinadasa KBSN, Weragoda SK, Weerasooriya R. Groundwater-based drinking water supply in Sri Lanka: Status

- and perspectives. *Water (Switzerland)* 2022;14(9):1–24.
Available: <https://doi.org/10.3390/w14091428>
5. Bünemann EK, Bongiorno G, Bai Z, Creamer RE, De Deyn G, de Goede R, Flesskens L, Geissen V, Kuyper TW, Mäder P, Pulleman M, Sukkel W, van Groenigen JW, Brussaard L. Soil quality – a critical review. *Soil Biol. Biochem.* 2018;120:105–125.
Available: <https://doi.org/10.1016/j.soilbio.2018.01.030>
 6. Dissanayake CB. The hydrogeochemical atlas of Sri Lanka. *Ecol. Landsc. Manag. Sri Lanka.* 1993;491–504.
 7. Buurman P, Lagen B Van, Velthorst EJ. *WfM Manual For*; 1996.
 8. Rusydi AF. Correlation between Conductivity and total dissolved solid in various type of water: A review. *IOP Conf. Ser. Earth Environ. Sci.* 2018;118 (1).
Available: <https://doi.org/10.1088/1755-1315/118/1/012019>
 9. Kibria K, Islam MA, Hossain MZ, Billah SM. Calibration of yellow colour spectroscopic method of phosphorus determination for wavelength, working range and time. *Khulna Univ. Stud.* 2019;41–46.
Available: <https://doi.org/10.53808/kus.2019.16.1and2.1901-1>
 10. Alahi MEE, Mukhopadhyay SC. Detection methods of nitrate in water: A review. *Sensors Actuators, A Phys.* 2018;280: 210–221.
Available: <https://doi.org/10.1016/j.sna.2018.07.026>
 11. Poudel S. Organic matter determination (Walkley-Black Method). TUDelft 2020;2–6.
Available: <https://doi.org/10.13140/RG.2.2.2043.00807>.
 12. Central N, Publication R. Recommended chemical soil test procedures. *Program* 1998;221(221).
 13. Jain CK, Sharma SK, Singh S. Assessment of groundwater quality and determination of hydrochemical evolution of Groundwater in Shillong, Meghalaya (India). *SN Appl. Sci.* 2021;3(1):1–14.
Available: <https://doi.org/10.1007/s42452-020-03993-4>.
 14. Ward MH, Jones RR, Brender JD, de Kok TM, Weyer PJ, Nolan BT Villanueva CM, van Breda SG. drinking water nitrate and human health: An updated review. *Int. J. Environ. Res. Public Health* 2018;15(7), 1–31.
<https://doi.org/10.3390/ijerph15071557>.
 15. Bisergaeva RA, Sirieva YN. Determination of calcium and magnesium by atomic absorption spectroscopy and flame photometry. *J. Phys. Conf. Ser.* 2020;1691 (1).
<https://doi.org/10.1088/1742-6596/1691/1/012055>.
 16. Sarala CPRB. Assessment of groundwater quality parameters in and around Jawaharnagar , Hyderabad. *Int. J. Sci. Res. Publ.* 2012;2(10):1–6.
 17. NRCS,USDA SQ. I. Soil quality test kit guide; U.S. Departments of Agriculture. 1999, No. August.
 18. Abeyasinghe AMDU. Island Wide construction raw material survey report on Matara District Island wide construction raw material survey report on the on Matara District. 2018;1–33.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/115848>