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A GIS-Based Spatial Variations Analysis of Water Quality in Domestic Wells in The Buttala Area, Sri Lanka

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Abstract

Water quality can be identified as the main agent of human health. Different approaches and techniques can be used to analyze groundwater quality. Among them, Geographical Information Systems (GIS) is one of the approaches that can be utilized to analyze water quality levels in a spatial context and it provides more powerful tools that can be interpreted the spatial variation of the water quality parameters over the geographical space. Accordingly, the study was conducted to analyze spatial variations of the water quality in drinking wells in the Buttala Divisional Secretariat (DSD) which is an agricultural area in the dry zone. The methodological procedure is extremely important in this type of research thus, the spatial Multi-Criteria Decision Analysis (MCDA) procedure was used. Multi-criteria analysis has been widely applied to solve decision-making problems related to the environment, and natural resource management. In the study, Analytic Hierarchy Process (AHP) and MCDA integrated approach were used to visualize the spatial patterns of the water quality in the study area and to formulate the water quality index map. To generate the water quality index map, pH value, turbidity, electrical conductivity (EC), florid, and nitrate of 48 water samples were collected from the domestic well and tube wells from 10 Grama Niladari Divisions (GND) in Buttala DS. The ArcGIS 10.3 software was used for spatial analysis like Inverse Distance Weighting (IDW) and kriging. The results revealed that 11.2% of the water of the drinking wells in the study area has a good fitness level, while 68.7% of wells show a moderate quality level. Out of the total samples is shown that 18.5% of wells had a poor-quality level, and 1.2% was found to be very poor for drinking purposes. And also, 0.4 % of the area is unsuitable for drinking. The study shows that geospatial techniques are more effective for studying the water quality in any area in an accurate decision support tool.

Keywords: Buttala, GIS, Groundwater, IDW, Kriging, Water quality

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INTRODUCTION

Aquatic resources are an essential resource for the survival of the human, plant, and animal life. More than three-quarters of the Earth's surface is water. Out of total water volume, only about 1% of the water can be used by humans for their drinking purposes. Because about 70% of the world's total freshwater is from glaciers and groundwater. Thus, the amount of water that can be used by animals, including humans, is invaluable. The water, which is constantly circulating on earth, evaporates, evaporates from the open surface, evaporates from vegetation, and precipitates into surface water (Dhanapala, 2014).

About 500000 km3 of water evaporates from the oceans each year and 90% of it falls into the ocean. The remaining 10% is landlocked. Evaporated water from the ground returns to the ground (Dhanapala, 2014). Located in the tropics, Sri Lanka receives adequate annual rainfall and is the main source of freshwater resources. Sri Lanka has an average annual rainfall of 1900 mm and an annual water maximum of 124659 m3 with a median annual rainfall between 900 – 5000 mm (Dhanapala,2014). That puts about 130m3 billions of water on the ground (Dhanapala, 2014). People living in the wet zone use shallow water frequently for their daily and daily water needs but the people of the dry region use deep water. Water conservation is an important factor in the use of water for domestic purposes to meet water quality and quantity. Water pollution affects water quality through various activities as agriculture. Urbanization, industrial wastewater disposal, inefficient land use, and agrochemicals in agriculture are among the major modalities of groundwater pollution (Muralitharan and Kthiresan, 2018). Decreasing the amount of fluoride in water also affects humans as fluoride can cause cavities, as well as high levels of fluoride, can lead to browning and breakage. If the amount of fluoride in the water exceeds 4 milligrams per liter, older people may develop osteoporosis. This situation has been reported in Kandy and Kalutara districts in Sri Lanka. The fluoride level also affects leprosy (Dhanapala, 2014). Although the quantity of water is often considered, there is a lack of concern about the quality as the study of the physical properties of the drinking water is essential and timely relevance. GIS can be identified as a computer-based system for presenting various information through electronic media using computer technology. The GIS system operates integrating five components like hardware, software, data, procedures, and operators. Remote sensing is the process of identifying and monitoring the physical characteristics of an object, area, geographical phenomenon over a vast area simultaneously by using the tools and techniques that are not directly connected to the said object or phenomenon as photographing from a satellite orbiting in space or from an aircraft.

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Water quality can be studied by integrating remote sensing data with Geographical information systems (Balakrishnam,2011). Muralitharn and Palanivel have conducted research to assess the groundwater quality in the coal region of the Karur district in Tamilnadu. The groundwater samples were taken from 32 locations during pre-monsoon and post-monsoon zones to collect information of the water quality variables as pH, TDS, No3, Ca, Mg, Na, K, Cl, So4, Co3, Hco3, F. Accordingly, it has been concluded that the quality of water deteriorates greatly during the post-monsoon period (Muralitharn and Palanivel 2018). Zaidi conducted a study on water quality management using RS and GIS tools in 2012. The study aims to demonstrate the ability to integrate RS and GIS technology into water quality assessment. Here GIS maps for water quality variables were prepared according to the terrain, soil cover, elevation, water content, and total maximum daily water load were used to prepare a quality index map. These tools are considered to be more reliable and up-to-date for changes in water quality (Zaidi,2012). El-Sayede and Omran used GIS tools as kriging interpolation to assess the quality of irrigated water Darb Elba in SouthWestern Egypt. The analysis was performed using 36 samples to determine variables of pH, Ec, Na, Ca, Mg, B, Cl, Hco3, Sodium Adsorption Ratio (SAR), Soluble Sodium Percentage (SSP), Residual Sodium Cahbonate (RSC). The study concluded that the two villages used in the study had good water quality but the water quality of the two villages was very poor (El-Sayede and Omran,2012). Ashwani et al., conducted a GIS survey to assess the groundwater quality in the western Bokaro coal region of India. According to the results obtained from the GIS analysis, the water quality index (WQI) ranges from 21 to 131, and as a whole, the study shows that groundwater of the area is suitable for drinking purposes (Ashwani, et al,2014). Soumya et al, researched to assess the quality of groundwater using GIS in Chhattisgarh, India. Based on the 67 villages 145 water samples were collected pH, chloride, calcium, nitrate, hardness, and TDS. With the help of Arc GIS, various spatial data layers have been deployed. Based on the results of the analysis carried out in this manner, only 18 of the 67 villages have received satisfactory results. The water of the 28 villages is unfit for drinking purposes and the water quality of other villages is very poor (Soumya et al.,20115). Karantaka et al., conducted a case study to analyze the water quality variations using GIS technology in Bhadravati taluk. Here the twelve physical and chemical parameters are taken into account. The research has shown that most of the sample sites are suitable for drinking purposes and some sample sites are unsuitable due to agricultural and industrial disposals (Karantaka et al.,2012). In their study, Fatima et al. tried to formulate a water quality index of rural areas in Western Lahore, Pakistan. The area has been

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zoned and 72 water samples have been monitored.As a whole result concluded that water in this area is unfit for human consumption Thus, good water quality management practices are essential for the area (Fatima et al.,2006). Alssger et al. researched the deterioration of the water quality of the Kuala Terangganu Nerus River in Malaysia. Land use has degraded the water quality of the Neras River and its past and current status have been studied using a GIS and geo-statistical approach. Analysis has concluded that the river to be somewhat third class (Alssger et al., 2018). Tiber and Janos conducted a GIS-based water quality assessment in Hungaria. Results revealed that aquatic hazards have been identified in the part of the river, and these maps have been shown to provide strength to assess the consequences of any pollution (Tiber and Janos,2006).

Mahagmage and Padmalal have conducted a study on groundwater quality in the Kelani Ganga Basin, Sri Lanka to map the spatial variations of the water quality using GIS. Accordingly, 72 sample sites were selected and water parameters were analyzed using GIS. At present, 90% of the sites are exposed to high levels of COD and BOD, 70% of the samples are contaminated with complete coliform bacteria and 45% of the samples are contaminated with mucous coliforms. Based on these, research has concluded that a management plan is needed to protect water resources as the Kelani River basin tends to become more polluted (Mahagamage and Padmalal,2014). Mahagamage and Padmalal have conducted another research on groundwater quality and microbial pollution in the Jaffna peninsula. In the study 40 water samples were taken and such as water temperature, pH, hardness, DO, TDS, EC, COD, TP (Total phosphate) variables were calculated and analyzed using GIS. There, the inverse distance weighted interpolation of Arc GIS was used to map the water quality variables and 38% of the samples showed positive results. It has been found that the drinking water standards provided for COD by SLS and WHO mainly in sample sites are non-existent (Mahagamage and Padmalal, 2019).

As a dry area main livelihood of the people in the Buttala Divisional Secretariat (DS) is farming including cultivating crops such as sugarcane, vegetables, maize, bananas, etc. Therefore, agro-chemicals have to add groundwater more predominantly. The majority of the inhabitants in the study area consume water in domestic wells. The study was carried out to find out the spatial variations of household drinking water quality in the Buttala DS in the Monaragala District, using geospatial technology upon the research questions as what are the spatial variations of water quality in the domestic wells of the study area? which geospatial strategies can be used to analyze the water quality variations of domestic wells and how water quality

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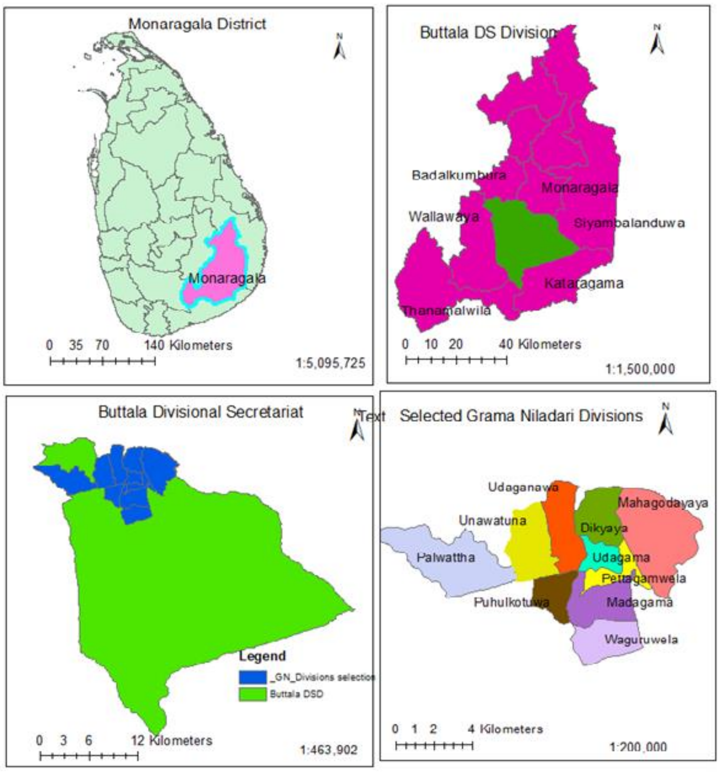
levels can be categorized through geospatial technology? In that way, through the study, it was expected to identify the spatial variations of the water quality levels in domestic wells in the ten selected GN divisions of the study area under five categories as unsuitable, very poor, poor, moderately good, and good water quality using different GIS tools and techniques applied in the same context. So, modeling and analysis of water quality parameters were done using the GIS-MCDA technique. The water quality index map was prepared through GIS- MCDA using test results of the water samples regarding the selected quality parameters.

RESEARCH METHODOLOGY

Study Area Description

Buttala Divisional Secretariat is one of the 11 Divisional Secretariat Divisions in the Monaragala District of the Uva Province. It is located between North latitudes 6 41 'and 6 81' and east longitudes between 80 13 'and 81 47' with an area of 698.77km^2. It is bordered by Badalkumbura Divisional Secretariat in the North, Monaragala in the East, Hambantota Divisional Secretariat in the East, Wellawaya Divisional Secretariat in the West, Kataragama and Thanamalwila and Kataragama Divisional Secretariats from South as Figure1.

Figure 1: Location of the study area in the spatial context



Source: Sri Lankan survey department digital data layers, 2015

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There are 128 Grama Niladhari divisions in the DS and 128 villages. Due to its historical and archaeological value, the location of the Pelwatta Sugar Company, and its reputation for gem mining, the area is well known in Sri Lanka (Resource profile, 2018/2019). Agriculture is the main occupation of most of the people in the DS. The height of the study area varies from 300 to 2300 feet and half of the plains are less than 500 feet in total. There are six types of soil in the DS and one-third of the area is brownish-brown and sticky and reddish-brown can be seen on high and medium slopes. The depth of soil to a pan, which impedes rooting, is 1 to 1.5 m. Water tolerance of the soil is relatively low and water dependence is low. The DS is divided into two climatic zones. Accordingly, about 95% of the area belongs to the lowland dry zone climate. Most of the land in the study area is under sugarcane cultivation and it is 13398.8 acres (Resource profile, 2018/ 2019). Monaragala District, which belongs to the dry zone, uses mostly groundwater for agriculture and drinking purposes. Monaragala District is one of the less densely populated districts with having a density of 80 persons per sq km. Currently, a large number of families benefit from the National Water Supply and Drainage Board Buttala Unit it is about 2733 households. It accounts for 40% of the total water requirement of families in the area

Nature of Data

The digital data related to the administrative boundaries of the study area was retrieved through the Sri Lanka Survey Department's 1: 10000 scale digital data layers,2015 database. And the GPS samples related to the water quality variables in domestic wells were obtained from 48 wells in ten selected GNDs using CT Droid Sri Lanka GPS app as Table 1 and2.

Table1: Coordinate values of sample locations in the study area

GND name	No	X Coordinate	Y coordinate	source
	1	555702.99	476084.13	Domestic well
	2	556062.06	472886.04	Domestic well
	3	555081.10	476121.03	Tube well
Mahagodayaya	4	556902.91	474330.78	Domestic well
	5	553561.36	474811.33	Domestic well
	6	552707.78	476234.65	Domestic well
	7	552712.65	475021.55	Domestic well
	8	552791.91	476891.61	Domestic well
Dikyaya	9	553534.36	474811.33	Domestic well
	10	551347.89	476241.51	Domestic well
	11	553182.49	473860.14	Domestic well
	12	552991.00	473446.05	Domestic well
	13	552360.72	473346.05	Domestic well
Udagama	14	552035.97	474366.58	Domestic well
	15	552363.62	472345.91	Domestic well
	16	553633.03	474334.03	Domestic well
Pettagamwela	17	553731.17	473427.45	Domestic well
	18	551611.19	471080.43	Tube well

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	19	552777.34	471780.63	Domestic well
	20	552983.38	471348.97	Domestic well
	21	552999.87	471004.40	Domestic well
Medagama	22	551308.34	470821.98	Domestic well
	23	552838.61	470788.041	Domestic well
	24	552998.31	468913.41	Domestic well
	25	551611.10	468807.17	Domestic well
	26	553645.87	469100.41	Domestic well
waguruwela	27	552048.18	469189.12	Domestic well
	28	552901.19	469381.99	Domestic well
	29	550191.49	471281.99	Domestic well
	30	550219.15	470308.11	Domestic well
	31	551001.01	470318.91	Domestic well
Puhulkotuwa	32	550901.93	471321.81	Domestic well
	33	551158.19	472561.12	Domestic well
	34	551118.62	473292.52	Domestic well
	35	551037.10	474366.58	Domestic well
	36	550521.66	473911.72	Domestic well
Udaganawa	37	549798.31	475343.90	Domestic well
	38	549999.91	477128.81	Domestic well
	39	549364.88	475666.77	Domestic well
	40	548790.70	475967.70	Domestic well
	41	550099.67	472800.58	Domestic well
Unawatuna	42	549121.41	472571.61	Domestic well
	43	547989.99	473967.12	Domestic well
	44	547793.09	472342.64	Domestic well
	45	546370.62	471939.51	Domestic well
	46	545668.98	473730.17	Domestic well
Pelwatta	47	543631.90	474125.81	Domestic well
	48	543991.89	471831.71	Domestic well

Source: CT Droid based field sample survey,2021

Table2**:** GN divisions of Sample survey

No	GN no	Name	Extend (km²)
1	140/2	Mahagodayaya	19.57
2	140/3	Dikyaya	6.36
3	140	Udagama	1.54
4	140/1	Pettagamwela	2.39
5	142	Medagama	7.25
6	142/1	Waguruwela	6.6
7	142/3	Puhulkotuwa	5.6
8	140/A	Udaganawa	7.11
9	142/ A /1	Unawatuna	8.63
10	143	Pelwatta	15.48

Source: Resource profile, Buttala DS, 2018/2019

To obtain the opinions of water quality variables semi-structured questionnaire survey was done for nine selected respondents including water engineers, hydrologists, geologists, university academics. The questions in the semi-structured questionnaire were systematically aimed at obtaining the views of experts regarding water quality in the study area. Since the study only focused on ten selected GN divisions to analyze the spatial variations of the water quality levels in domestic wells field-based GPS survey was conducted to collect water samples from 48 domestic wells. Inverse Distance weighting (IDW) interpolation tool used in Arc GIS environment to predict the spatial variations of five quality parameters upon the sample results taken from domestic wells because the weights are

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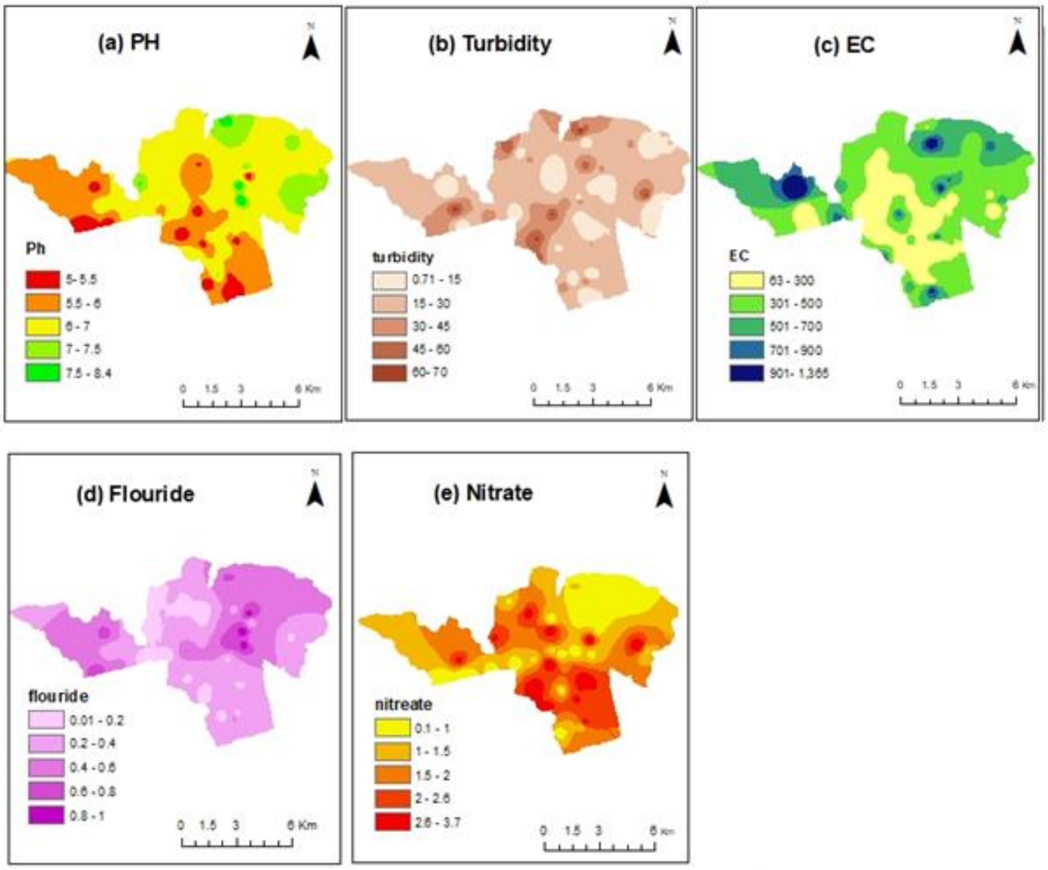
proportional to the distance with increasing the distance. And also, IDW is the most popular interpolation technique utilized to predict spatial variations over the surface based on sample data.

The pH value, which is considered as a quality parameter that determines the number of constituents present in water, ranges from 0 to 14. Accordingly, out of the 48 sample sites in the study area, 56% have a pH value ranges between 4.9 - 6.5 and only 44% of the sample sites have a range of 6.5-8.5. As a whole, the acidity is higher as the pH value is less than 6.5 in the study area. The distribution of the PH values is divided into five classes (Figure 2).

Figure 2: IDW interpolated maps of (a) pH, (b) Turbidity, (c) EC, (d) Florid (e) Nitrate



Source: Water sample results-2021

The most common pH range in the study area is between 4.99-6.30, indicating that the overall acidity of the drinking water. The electrical conductivity (EC) was measured to determine the ion concentration in the water and the higher the ion content, the higher the electrical conductivity. The electrical conductivity is measured in us/cm or s/cm The electrical conductivity of the calculated samples in the study area ranges from 64 - 1365, with 46% of the sample sites spreading in the value range between 63 - 292, and

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about 25% of the samples having an electrical conductivity above 750 us / cm. Thus, low salinity and moderate salinity water can be identified in domestic wells in the study area. Florid, a compound that can enter the water through natural processes, affects dental health. Excess fluoride and osteoporosis can cause kidney disease and fluoride levels can lead to tooth decay. The florid level in drinking water is 1ppm, according to WHO standards. In the study area, it was low, i.e., levels below 1 ppm could be detected at each sample site NO_3 is a compound that occurs naturally when N_2 combines with O_2 or O_3. N_2 is essential for all living things, but the presence of high levels of NO_3 in drinking water is dangerous to health. NO_3 levels in the sampled wells in the study area ranged from 0.10 mg / l to 3.7 mg / l. Accordingly, the highest percentage of the study area is represented by the class interval between 1.6-2.0. Thus, it was clear that in the study area high concentrations of nitrates did not exist. In this way, the variations of water quality were mapped and analyzed according to the water quality levels according to the water sample results.

Spatial Analysis Procedure

Quality variable mapping was created using GPS coordinates of the 48 water samples obtained in the study area and the results obtained for each water sample. Arc GIS 10.3 IDW interpolation tool was used to prepare quality variance between sample points. In the mathematical field of numerical analysis, interpolation involves the processing of new data points with a range of known data points. (Mitas & Mitasova, 1999). It is often necessary to calculate the correlation between the points when there are several data points obtained by sampling. That is, the value of that function must be estimated for an intermediate value of the independent variable. One such method is Kriging. Kriging is a multifunctional process that involves statistically analyzing data, modeling variability models, creating surfaces, and exploring variance surfaces. The entire spatial analysis procedure of the study is shown in Figure 3. The Spatial analysis began with collecting 48 water samples and then those coordinate values were transformed into the Sri Lankan national grid using kandawala datum through the project transformation tool in the Arc GIS. Here, the Inverse Distance Weighting (IDW) interpolation method was used as Kriging to calculate the interrelationships between the well locations where the quality variables were calculated. water quality index was calculated based on the resulted water quality parameter maps for each parameter. The final composite index map was also prepared integrating five water quality maps. To obtain the index levels for each criterion map and final map judgments of nine expertise taken through a semi-structured questionnaire. Considering the score values given for each quality variance category (Table3). The sub-criterion

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map and the composite map were prepared and the score values for the attribute value ranges for sub-criteria were obtained from the experts' opinions using said questionnaire and AHP procedure (Table 4 and 5). To perform GIS analysis IDW, vector to raster, raster to vector conversion, calculate geometry tools were used during the spatial analysis procedure.

Table 3: Water quality score for attribute values for each sub criteria.

Code	Sub Criteria	Attribute Value	Water quality score
	PH value	5 – 5.5	0
A		5.6 – 6	5
		6.1 – 7	7
		7.1 – 7.5	7
		7.6 - 8.4	1
B	Electrical Conductivity (μs/ cm)	63 – 300	7
		301 – 500	5
		501 – 700	5
		701 – 900	3
		901 - 1365	1
C	Turbidity (N.T.U.)	0 – 15	1
		16 – 30	0
		31 – 45	0
		46 – 60	0
		61 - 70	0
D	Florid (mg/l)	0 – 0.2	7
		0.21 – 0.4	5
		0.41 – 0.6	3
		0.61 – 0.8	1
		0.81 – 1	0
E	Nitrate (NO_3) (mg/l)	0.1 – 1	7
		1.1 – 1.5	5
		1.6 – 2	3
		– 2.6	1
		2.7 – 3.7	0

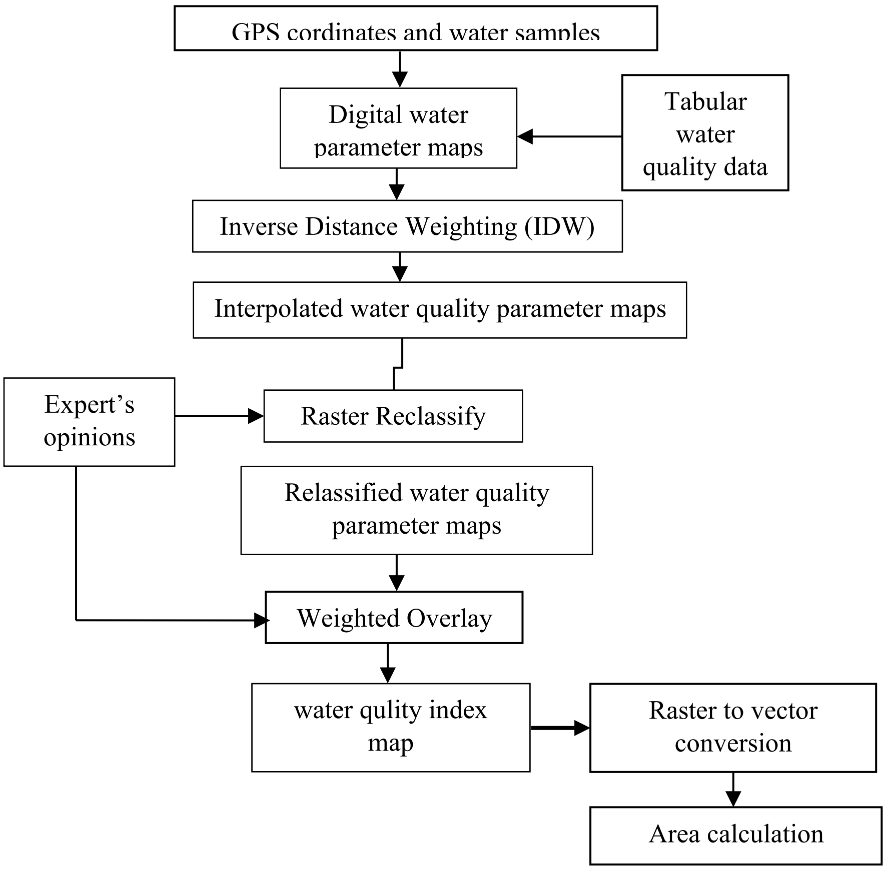

Figure 3: Flow diagram of the spatial analysis procedure

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Table 4: AHP based weights for water quality variables

	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert6	Expert8	Expert9	average
PH	0.2240	0.1768	0.1760	0.1977	0.1771	0.2545	0.1971	0.1643	0.4959	0.2292
EC	0.0322	0.0310	0.0298	0.0475	0.0272	0.2382	0.1027	0.0337	0.0902	0.0702
Tubidity	0.1472	0.1445	0.3941	0.5036	0.4018	0.1903	0.2480	0.1858	0.1113	0.2585
Florid	0.5118	0.4649	0.3020	0.2892	0.3092	0.1993	0.3126	0.5358	0.1417	0.3407
Nitrate	0.0845	0.1147	0.0978	0.0971	0.0842	0.1172	0.1392	0.0785	0.1607	0.1082
Total										1.0068

Table 5: Final weights and % assigned for each criterion maps

parameter	weight	%
PH	0.2292	23 **%**
EC	0.0702	07 **%**
Tubidity	0.2585	26 **%**
Florid	0.3407	34 **%**
Nitrate	0.1082	11 **%**
Total	**1.00**68	100 %

The water quality equation was constructed based on the selected water quality variables in the study of data, such as pH, turbidity, electrical conductivity (EC), nitrate (NO3), and florid (F). It can be shown as following equation and the quality level as in Table 7.

$$WQI = SIph + SIec + SIno_3 + SIf + SI\ Turbidity$$

WQI - Water Quality Index
SIph - Subindex of PH value
SIec - Subindex of Electrical Conductivity
SI no_3 - Subindex of Nitrate
Sif - Subindex Florid
SI Turbidity - Sub index of Turbidity

RESULTS

The pH, which is an important criterion for water quality, ranges from 5.0 to 8.4 according to water sample testing. Upon the reclassified maps it was categorized into 5 classes as unsuitable, very low quality, low quality, moderate, and good as Figure5. EC was ranged from 0-1365 in the study area with showing good quality between 0-300, moderate between 300-700, poor between 700-900, and very poor between 900-1365. The turbidity was ranged from 0-70 upon the results of the sample test and experts' opinions in the study area as above 15 <are unsuitable and very low between 0-15, so it was clear that the majority of water in the area is unfit for drinking purposes according to the turbidity. The florid level ranges from 0-1, as good quality. Between 0–0.2, moderate between 0.2–0.4, low between 0.4–0.6, very low between 0.6–0.8, and between 0.8–1.0 as unsuitable for drinking. The nitrate content of the samples in the study area ranged from 0 –3.7, showing a good quality between 0-1, moderate 1.0–1.5, low quality 1.5–2.0, and a very low from 2.0–2.6, and 2.6– 3.7 as unsuitable level. According to the results generated from the GIS techniques regarding water quality in domestic drinking water in the study area, 68.7% (55 sq km) out of the total area having moderate quality,11.2% (9

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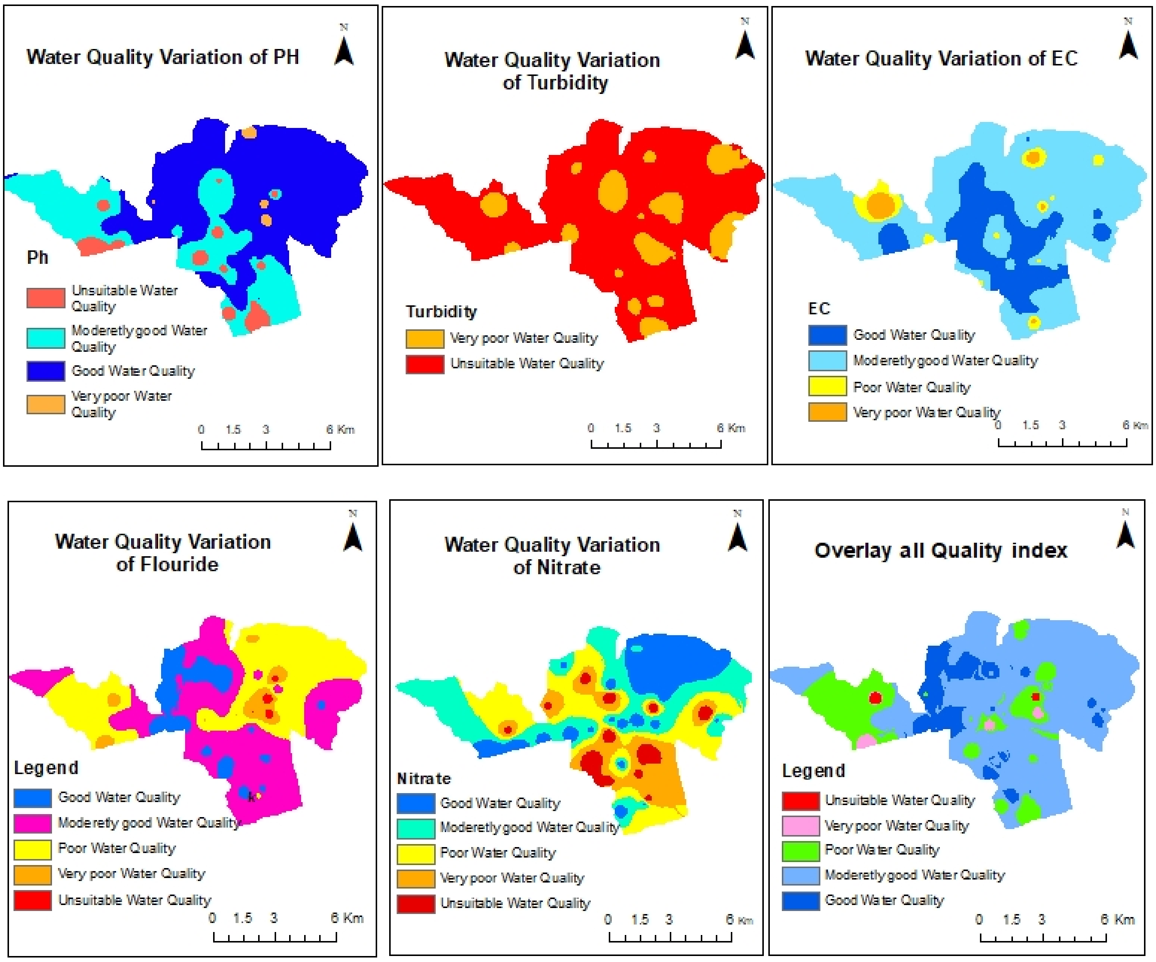
sq km) is good quality. And 19.7% (15.8 sq km) of the area is the poor and very poor category. 0.4% of the total land area is unsuitable for drinking as Table 8.



Source: Water samples results and expert's opinions-2021

Figure 5: Water quality levels for pH, Turbidity, EC, Florid, Nitrate and water quality index map

Table **6:** water quality variations of the study area

GN division	Sample No	PH	Turbidity	Electrical Conductivity	Nitrate	Florid
Mahagodayaya	1	7.16	0.65	769	0.7	0.44
	2	7.05	1.55	154	103	0.3
	3	6.41	33	331	0.5	0.5
	4	7.22	63.4	262	3.7	0.15
	5	7.2	1.21	620	0.9	0.31
Dikyaya	6	7.45	1.1	1176	0.1	0.5
	7	6	54	332	0.1	0.34
	8	8	39.4	241	0.7	0.51

	9	7.32	33.1	315	0.5	0.89
	10	7.12	70	602	1.3	0.71
Udagama	11	8.05	2.9	993	3.6	1
	12	8.45	28	221	0.6	0.94
	13	6.19	3	307	0.9	0.69
	14	6.12	44	157	0.5	0.61
Pettagamwela	15	6.54	41	299	0.4	0.81
	16	5.65	2.18	88	2.1	0.11
	17	4.99	0.71	735	0.8	0.21
	18	6.1	9.4	154	1.2	0.41
Madagama	19	6.34	21	341	0.5	0.4
	20	6.25	7.44	134	3.4	0.22
	21	6.13	3.24	766	3.7	0.3
	22	5.11	32.4	89	2.1	0.11
	23	5.11	8.45	203	1.7	0.1
Waguruwela	24	6.51	22.6	101	2.8	0.4
	25	4.99	1.52	964	1.9	0.31
	26	5.1	36.42	587	0.5	0.29
	27	5.08	45.14	90	0.9	0.47
	28	7.15	0.96	89	1.2	0.11
Puhulkotuwa	29	6.01	2.47	436	3	0.15
	30	5.03	62.35	136	3.6	0.17
	31	6.54	58.24	782	3.1	0.31
	32	6.35	20.84	93	2.9	0.13
	33	5.11	61.7	782	3.7	0.41
Udaganawa	34	6.01	20.5	365	0.8	0.33
	35	5.57	0.95	89	3.7	0.1
	36	5.61	5.12	185	2.4	0.31
	37	6.01	33.1	89	3.1	0.11
	38	5.45	1.44	465	0.4	0.01
Unawatuna	39	6.91	0.86	424	1.7	0.23
	40	6.31	58.34	421	0.9	0.19
	41	7.01	33.9	90	0.9	0.61
	42	5.9	0.96	93	0.5	0.12
	43	7.53	19.66	538	2.7	0.11
Pelwatta	44	6.97	33.7	769	0.8	0.11
	45	5.31	2.18	88	0.1	0.5
	46	5.37	1.1	1365	1.6	0.67
	47	6.41	63.4	63	2.8	0.21
	48	4.99	33	331	0.3	0.7

Source: Laboratory test results, 2021

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Table 7: Water quality levels as land extent and % in the study area

Quality level	Extent (km²)	%
Unsuitable	0.4	0.4
Very Poor	1.0	1.2
Poor	14.8	18.5
Moderate	55.0	68.7
Good	9.0	11.2
Total	**80.2**	**100**

Source: GIS-based area calculation results, 2021

As the whole water quality in the Pelwatta Grama Niladari division (GND) is low. The reason behind this should be studied further to find out the relationship with another physical and socio-economic background especially land-use practices in the study area. A good quality level can be identified in the Yudaganawa, Dikyaya, Mahagodayaya, and Medagama GNDs.Unawatuna Grama Niladhari Division has the highest water quality in the area. Thus, geospatial methods are the high capability to assess the water quality effectively and efficiently.

CONCLUSION AND DISCUSSION

Geospatial technologies are more effective than traditional approaches in modeling the spatial distribution of water quality in any area since GIS provides a set of tools for water quality analysis and spatial modeling. This study is limited to ten Grama Niladhari Divisions of Buttala Divisional Secretariat. Thus, it can be used as a useful guide for water-related rural development programs, strategies in the study area. Since only five water quality parameters were used for this study when conducting other research, it may be more effective and accurate if able to measure and analyze other water quality variables in addition to these five variables.

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