IDENTIFICATION OF GROUND WATER POTENTIAL ZONES USING GEOGRAPHIC INFORMATION SYSTEMS (GIS) WITH SPECIAL REFERENCE TO PUTHUHAPUWA GRAMA NILADHARI DIVISION

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Abstract

The objectives of the study were to identify the water scarcity in the Study area and to identify the ground water potential zones by generating a map of the groundwater potential zones in the study area using GIS as a solution. The study identified that people in the area are facing physical water shortages and the generated groundwater potential zone map identified 112095m² of area has a good groundwater potential, 683700m² of landscape shows a moderate groundwater potential and 229066 m² of area has a very low groundwater potential level. GIS is very efficient and effective software in identifying ground water potential zones and in case of inadequate use of water from surface water sources, it is advisable to use ground water sustainably as a solution to water shortages.

Keywords: *GIS, Groundwater Potential Zones, Reclassify, Water Scarcity, Weighted Overlay*

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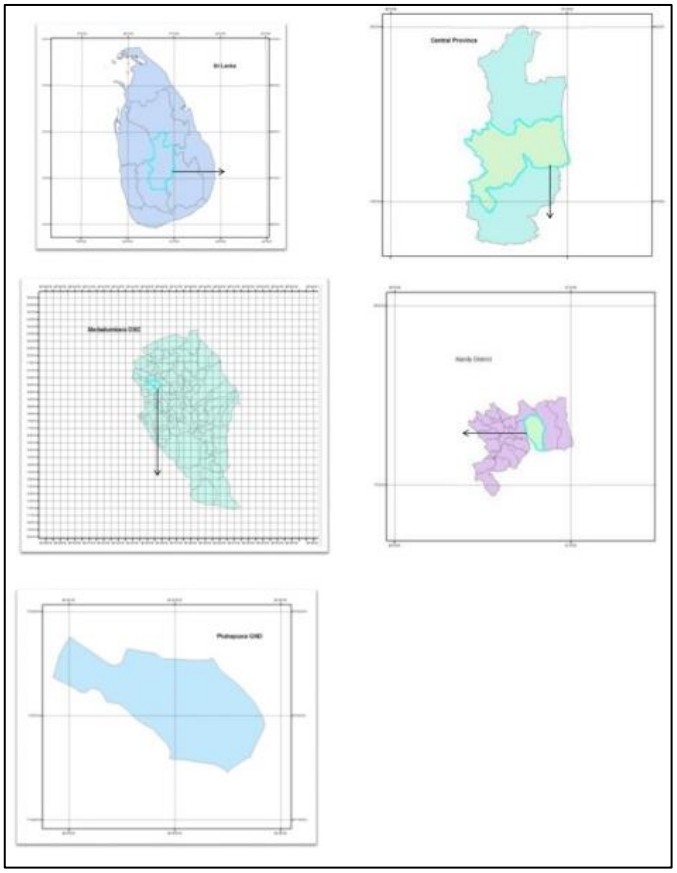
Introduction

Remote sensing and GIS play an important role in groundwater exploration and assessment and are widely used in groundwater studies related identification, monitoring, assessment, conservation and various other fields [1]. Through this study, as a solution to the shortage of water in the surface water sources in the area, the groundwater potential zone map has been created using Geographical Information System to identify the groundwater potential zones and its validity has been confirmed using GPS technology. Puthuhapuwa Grama Niladhari Division can be identified as one of the 93 Grama Niladhari Divisions of the Medadumbara Divisional Secretariat Division in the Kandy District of the Central Province of Sri Lanka.

Figure 1:

Map of the study area

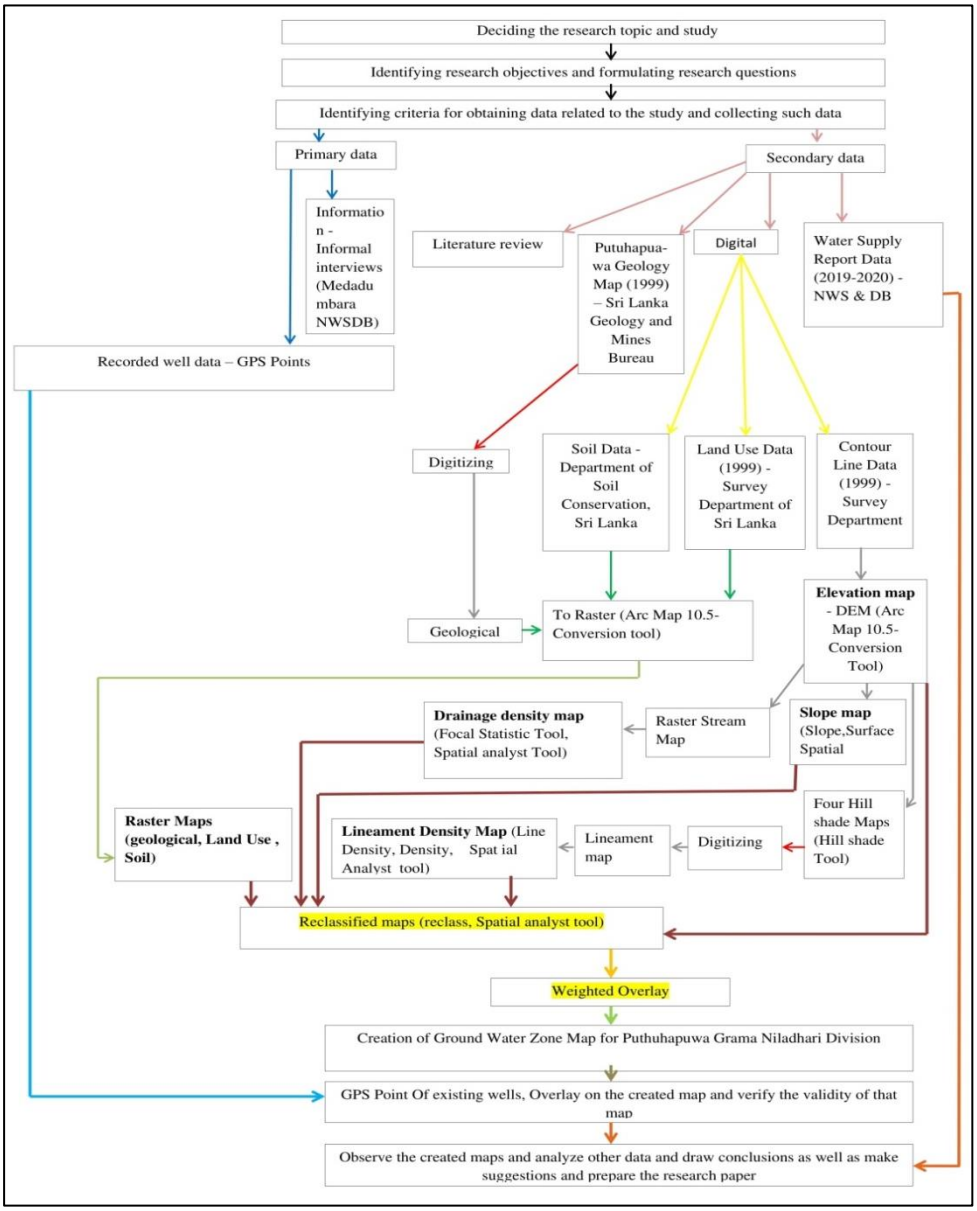


Source: 1:50000 Digital data of the Survey Department of Sri Lanka, 1998

Material and Methods

Figure 2:

Methodology of the study



Source: Created by author

Generating reclassified maps

The thematic maps were then generated separately as reclassification maps by adding weights to each subclass of thematic maps, as shown in Table 1, using Reclassify tool in GIS.

Table 1:

Weights assigned to subclasses of factors affecting groundwater potential zones in the study area

Factors (Theme Map)	Subclasses	Contribution to groundwater creation	Weight
Geology	Quartzite	good	3
	Marble	Very good	4
	Charnockytic biotite gneiss	Moderate	2
	Alkaline feldspar granite	Weak	1
Soil	Reddish brown latasolic	good	2
	Immature brown loamy	Moderate	1
Slope	0^o – 6.459029703^o	Very good	5
	6.459029704^o – 15.76003247^o	Good	4
	15.76003248^o – 23.51086812^o	Moderate	3
	23.51086813^o – 39.27090059^o	Weak	2
	39.2709006^o – 65.88210297^o	Very Weak	1
	(m^{-m2})		
Lineament density	0 – 0.005154734	Very good	1
	0.005154734 – 0.013283354	Good	2
	0.013283354 – 0.021213715	Moderate	3
	0.021213715 – 0.03013537	Weak	4
	0.03013537 – 0.050556049	Very Weak	5
Elevation	600 – 658.0392157 m	Very good	5
	658.0392158 – 695.6862745 m	Good	4
	695.6862746 – 730.1960784 m	Moderate	3
	730.1960785 – 763.1372549 m	Weak	2
	763.137255 – 800 m	Very Weak	1
Land use	Home garden	Good	6
	Paddy	Very good	7
	Coconut	Moderate	4
	Shrubs	Weak	3
	Tea	Very Weak	2
	Cemeteries	Very Very weak	1

	Open forest	Good	5
	(m^{-m2})		
Drainage density	1 – 52	Very good	5
	52.00000001-120	Good	4
	120.0000001-204	Moderate	3
	204.0000001-302	Weak	2
	302.0000001- 432	Very Weak	1

Source: Created by author

Weighted Overlay

The thematic maps reclassified by Weighted Overlay Tool in GIS were weighed in percentages according to their contribution (impact) to the creation of groundwater potentials and each reclassification maps were integrated.

Table 2:

Percentage of weights assigned to factors affecting groundwater potential zones in the study area

Factors (Reclassified Theme Map)	Impact On Ground water Formation	Satti's Scale (Fractions)	Satti's Scale (Decimal)	Impact (%) = (Satti's Scale / Collection) * 100 (Rounded To the Nearest Decimal Place)
Geology	High	1	1	36
Soil		1/2	0.5	18
Slope		1/3	0.33	12
Lineament Density		1/3	0.33	12
Elevation		1/4	0.25	9
Land Use		1/5	0.2	7
Drainage Density	Law	1/6	0.16	6
			Total=2.58	Total = 100

Source: Created by author

The percentage of constituents affecting the ground water potential zones was calculated based on Satti's analytical hierarchy process [2].

Confirmation of the validity of the groundwater potential zone map of the study area

Obtained from the existing water harvesting wells as GPS Points by Smart phone, the extracted GPS Point and the created groundwater potential zones were retrieved on the map.

Results and Discussion

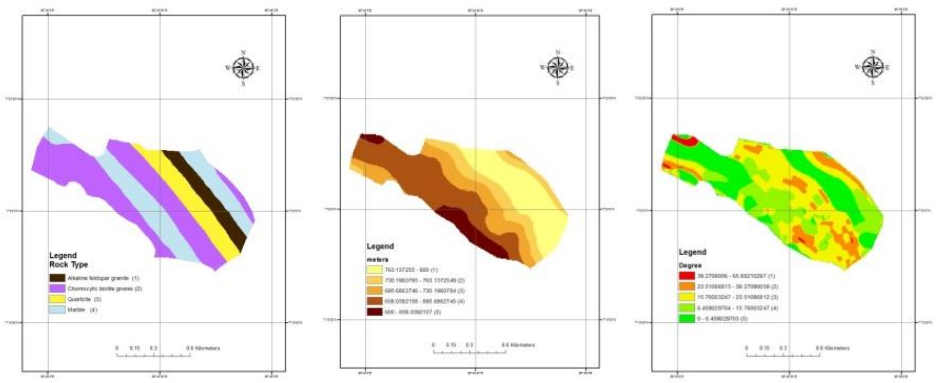
Water scarcity in the study area

According to the information obtained by the Medadumbara Water Supply and Drainage Board, this area is facing a water problem because the piped water supply to this area is not continuous.

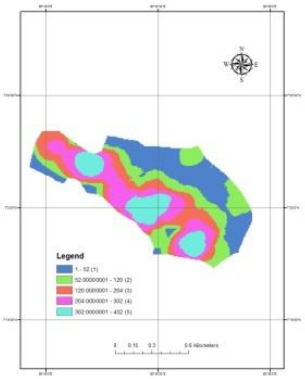
Factors influencing the formation of groundwater potential zones in the study area

Figure 3:

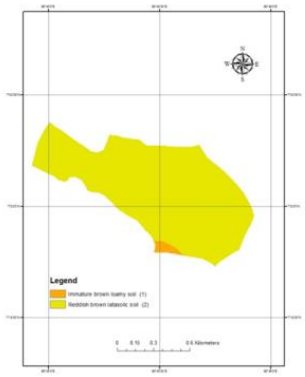
Factors influencing the formation of groundwater potential zones in the study area



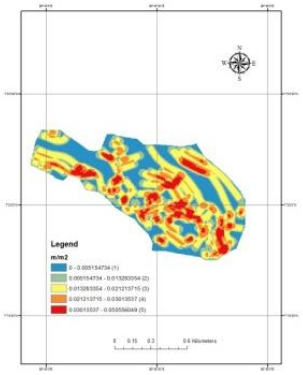
(a)Geology (b) Elivation (c)Slope



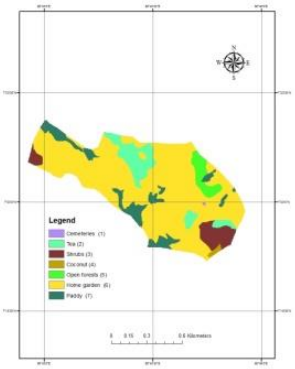
(d) Drainage Density



(e) Soil Type



(f)Lineament Density



(g) Land Use

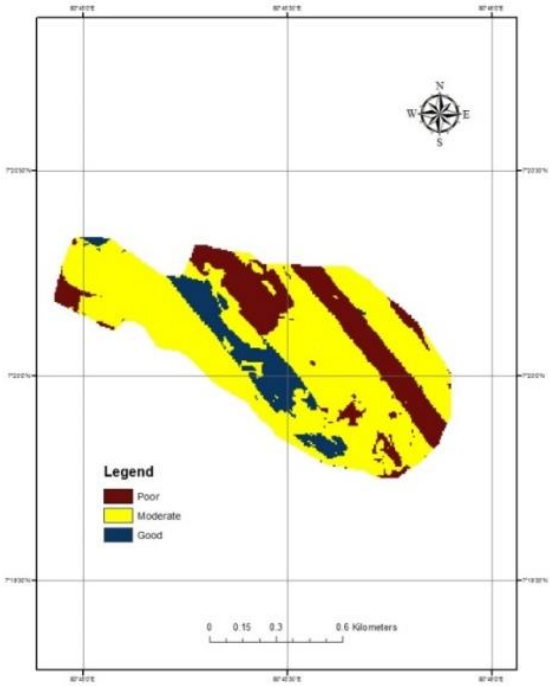
Note. Geology (a), elevation (b), slope (c), drainage density (d), soil type (e), lineament density (f), and land use (g) factors have led to the creation of groundwater potential zones in the study area. (7 reclassification thematic maps were created using GIS based on the sub-characteristics of each of these factors contributing to the creation of groundwater potential zones.)

Source: Putuhapuwa Geology Map of Sri Lanka, Geological Survey and Mines Bureau, Digital Data of the Survey Department of Sri Lanka, 1999

Groundwater potential zones

Figure 4:

Groundwater potential zones of the study area (h)



Source: Created by author

(h) reveals three groundwater potential zones in the area as good, moderate, and poor.

Table 4:

Areas of land belonging to groundwater potential zones

Ground water potential zones	M^2 * Count of pixel	Area (m^2)
Good	53 * 2115	112095 m^2
Moderate	53 * 12900	683700 m^2
Poor	53 * 4322	229066 m^2

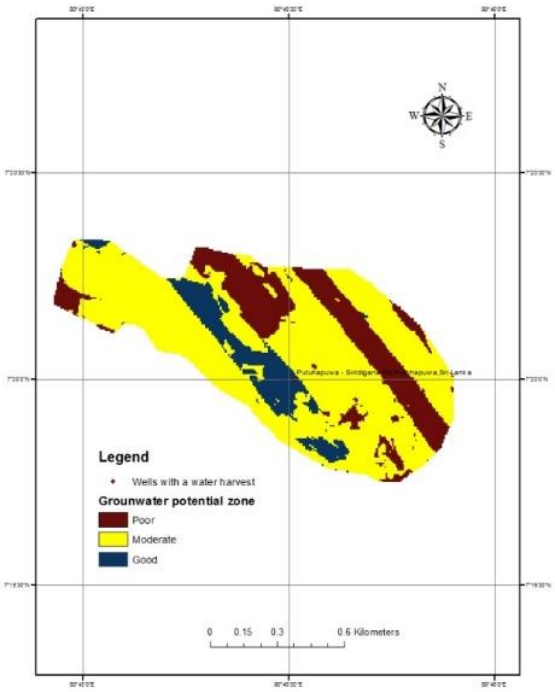
Note. *The areas belonging to each zone are identified on the basis of the arrangement of pixels representing each zone in the map attribute table.

Source: Created by author

Check the validity of the created map

Figure 5:

Wells in the groundwater potential zones of the study area (i)



Source: Created by author

According to the (i), the groundwater potential zone map created has high validity and accuracy because the well with existing water yield in the area is located in the good groundwater potential zone map of the groundwater potential zone map.

Conclusion and Recommendations

A long-term solution to water scarcity in the area is to develop a system to sustainably extract water from the identified groundwater potential zones in the study area by the responsible agencies. Geographic information system technology was a very efficient and useful tool for identifying groundwater potential zones in this area, and based on that, suitable locations for withdrawing groundwater could be identified with high accuracy, so it can be used in identifying groundwater potential zones with high efficiency and accuracy. GIS can be used as a tool. Accordingly, GIS works as an efficient

tool that provides highly accurate results with less time and cost in identifying groundwater potential zones, so this geographic information system technology is very suitable in identifying groundwater potential zones.

References

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