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Analysis of Groundwater Quality in Al Zoroub and Al Buraimi, Oman Using Remote Sensing and GIS Technology

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Abstract:

In Oman, groundwater is the most significant source of water. As a result, the Sultanate of Oman has placed a high value on water resources in terms of their sources, efficiency, and ways to rationalize consumption. The study deals with groundwater quality analysis in Al Zoroub and in Al Buraimi city. In this research, the groundwater samples were collected from 20 groundwater monitoring wells. The spatiotemporal maps of various groundwater quality parameters were generated to detect the changes in the groundwater quality from the year 2018 to 2021 in Al Zoroub and Al Buraimi city. The results found that the pH value varies in the range of 7.30 to 8.52, Total Hardness (TH) 126.17 to 250.98 (mg/lit), Total Dissolved Solids (TDS) 195.87 to 460.17 (mg/lit) and Fluoride (F) 0.03 to 0.67 (mg/lit). The results show a slight increase in the groundwater quality parameter values but in permissible limits. The slight increase in the values in some of the areas may be due to urbanization and industrialization and over withdrawal of groundwater for agriculture, domestic water supply in the regions. Hence, the study suggests the authorities should develop a comprehensive water resources management strategies, industrial, urban developments and in the agricultural areas.

Key words: Groundwater quality, land use/ land cover, water level, spatiotemporal, urbanisation etc.

Introduction:

Water quality is important not only for human beings but also for animals and vegetation habitat. Groundwater is the main source of water in Oman (MRMEWR). Many factors such as lithology, soil, land use, domestic and industry waste and human activities lead to contamination of the groundwater. Therefore, groundwater quality is a matter of serious concern, it is necessary to keep physical and chemical parameters within its permissible limit. The increase in built-up area and population causing withdrawal of groundwater at various locations in Oman would lead to scarcity of water. Due to rapid increase in population and urbanization, and associated anthropogenic activities, in these regions, their groundwater resources are likely to be polluted by various sources (Khattak et al. 2012; Kata et al. 2014; Li et al. 2014; Mohammed et al. 2017). Moreover, the use of pesticides in agriculture, disposal of domestic and industry waste and dissolving of soil or rocks salts and minerals are linked to contamination of aquifers (Al-Shidi, 2014; Ammar et al. 2021). Many environmental causes, such as weathering and dissolving of soil or rocks salts and minerals, as well as human activity, have direct and indirect effects on groundwater quality resulting in pollution. Water quality parameters act as an indicator of contamination of groundwater. This technology provides a platform to build spatial information into a well- organized database and thus facilitates systematic handling of data to generate hydro-chemical information in a user desired format. (Kantharaja et al., 2012). In this study, the ground water quality data of the last 4 years was collected from 20 wells situated in Al Zoroub and in Al Buraimi. Here, Bicarbonate Alkalinity, Calcium (Ca++), Chloride (Cl), Magnesium (Mg++), Total Alkalinity, Total hardness (CaCO3), Total Dissolved solid, pH value, Fluoride (F), Sodium (Na) etc values are analysed in Geographical Information System (GIS) environment.

Study area:

This study is carried out in Al Zoroub and Al Buraimi city. The total 20 groundwater monitoring wells are situated in area as shown in Figure 1. Al-Zoroub is located near Khotom Ashiklla, south of Mahdah District, southeast of Al-Buraimi. The coordinates of the area are 395000N and 268000E (Figure 1).

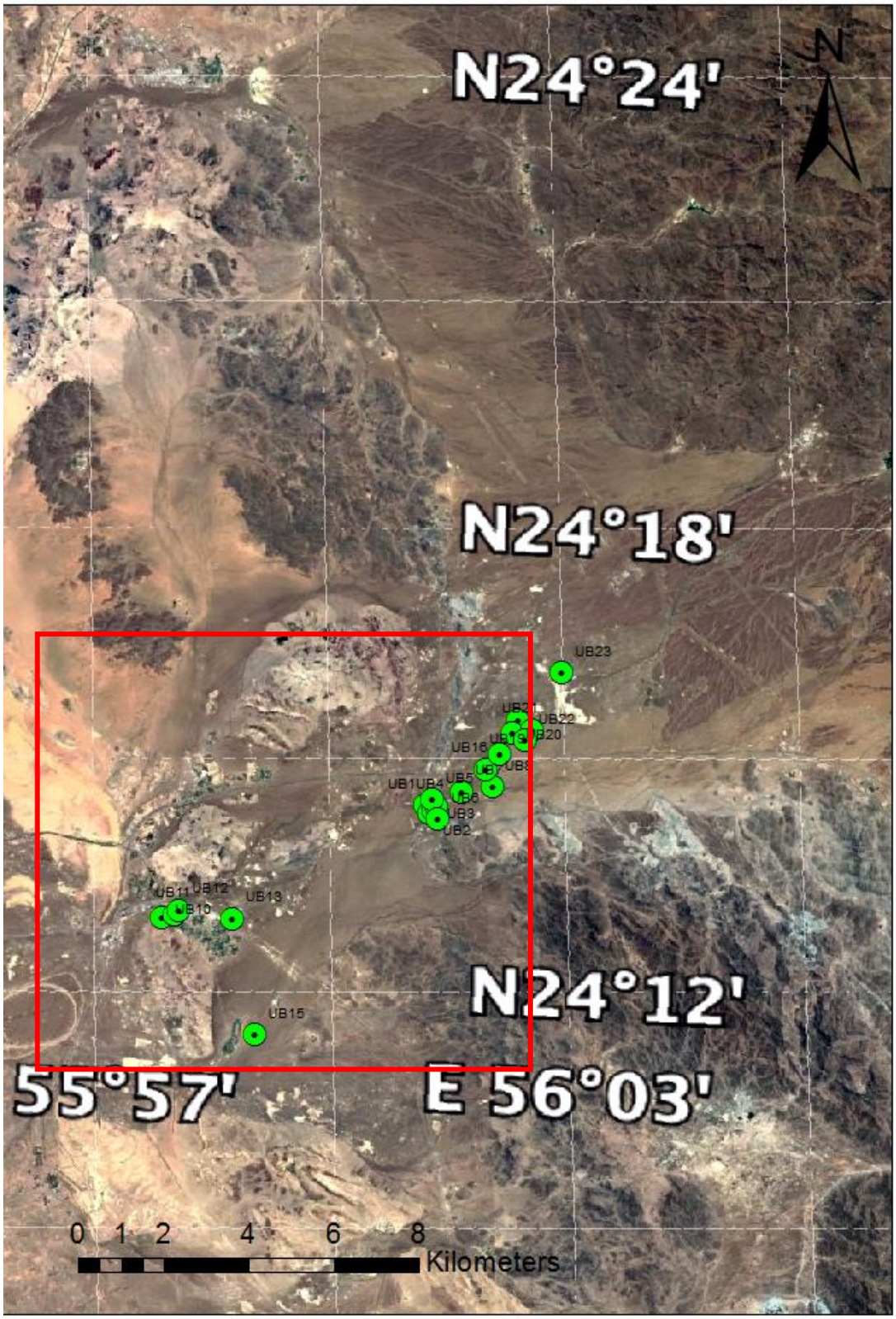

Figure 1: Location of the groundwater monitoring wells

Methodology adopted:

Groundwater samples were collected from 20 wells situated in Al Zoroub and Al Buraimi city. These samples have physical and chemical parameter like Bicarbonate Alkalinity, Calcium (Ca++), Chloride (Cl-), Magnesium (Mg++), Total Alkalinity, Total hardness (CaCO3), Total Dissolved solid (TDS), pH value, Fluoride (F), Sodium (Na) etc. In the first stage, the study area was finalised to collect the groundwater quality samples by selecting the 20 wells in the Al Zouroub and Al Buraimi area. The satellite image was captured from Google earth to locate the wells. Thereafter, image was georeferenced in the Arc GIS software and wells demarcated on the satellited image. The value of all parameters was attributed with respective wells. In the last stage, the (IDW) method of interpolation is applied to generate the thematic map in Arc GIS software. All thematic maps and graphs were generated which shows the trends of groundwater quality parameters with arial extent in the Al Zoroub and Al Buraimi region (Figure 2).

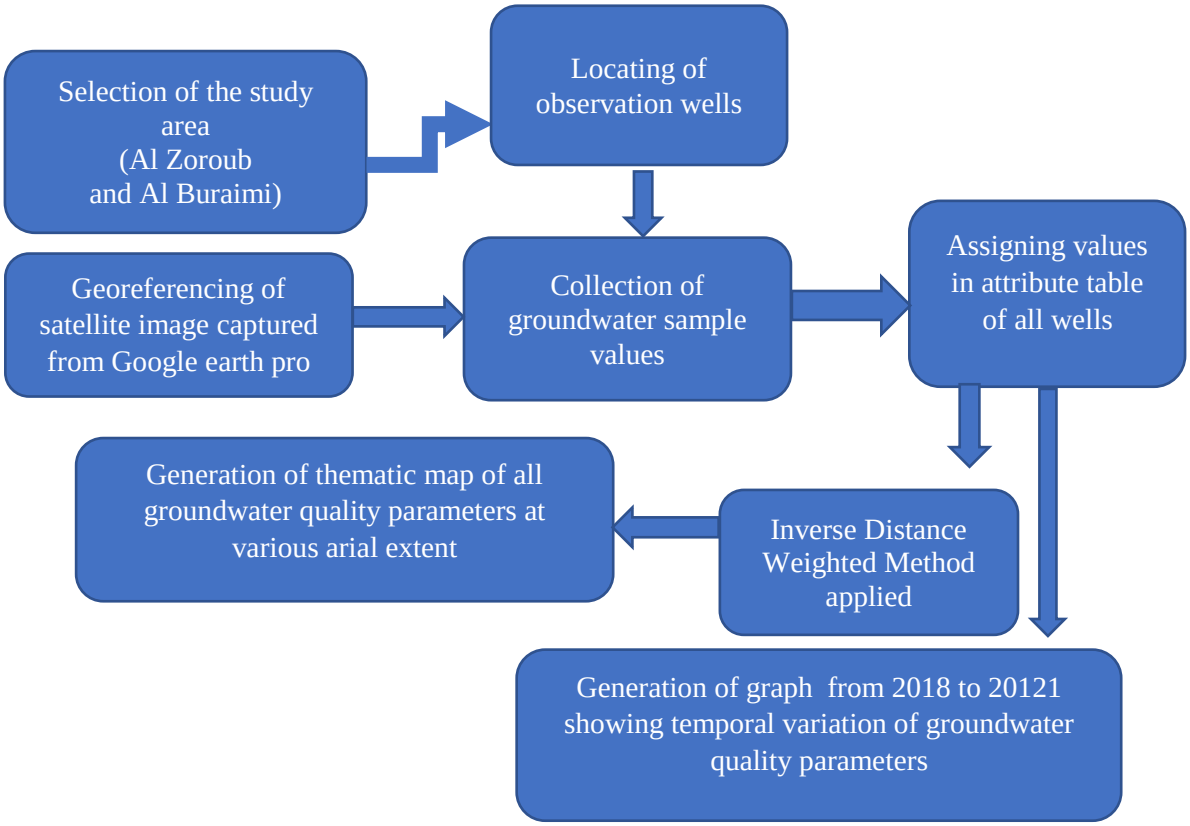

Figure 2: Methodology adopted for the study

Results and Discussion:

The spatial and temporal map of the groundwater quality parameters has been generated for the pH value, Total Hardness (CaCO3), Total Dissolved Solids (TDS), Fluoride (F) from the year 2018 to 2021 for Al Zoroub and Al Buraimi area. Also, the graph of temporal variation of 10 groundwater quality parameters is generated from 2018 to 2021. The pH value in 2018 and 2019 was in the range of 7.32 to 8.32 while it is slightly increased in the year 2021 from 7.94 to 8.51 on pH scale as shown in Figure 3.

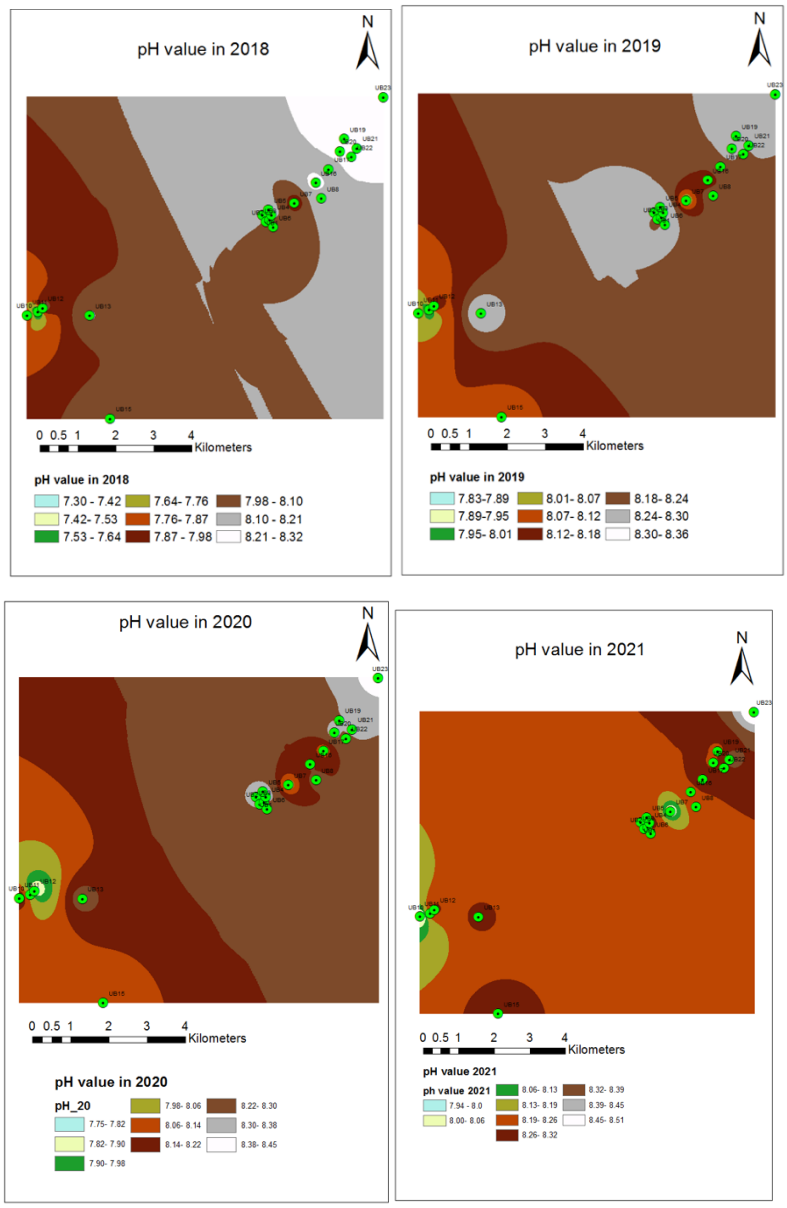

Figure 3. pH value over the study area from 2018 to 2021.

The value of total hardness was in the range of 126 to 234 mg/lit in the year 2018 but in the year 2021 it has increased up to 460 mg/lit at higher side as shown in Figure 4.

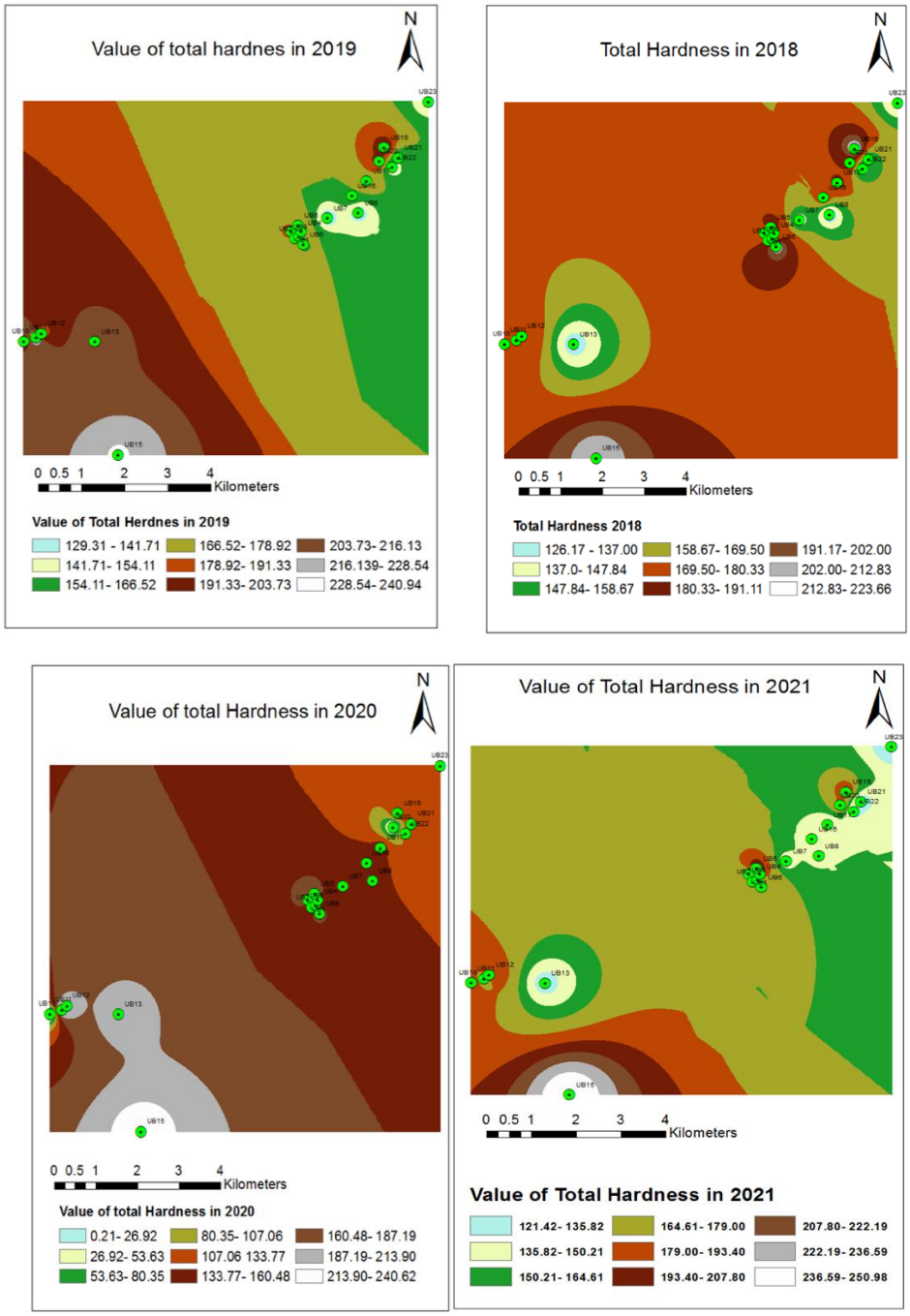

Figure 4. The value of total hardness over the study area from 2018 to 2021.

The value of total dissolved solids was in the range of 195 to 405 mg/lit in the year 2018 but it is increased up to 430 to 460 mg/lit in the year 2021 in the area as shown in Figure 5.

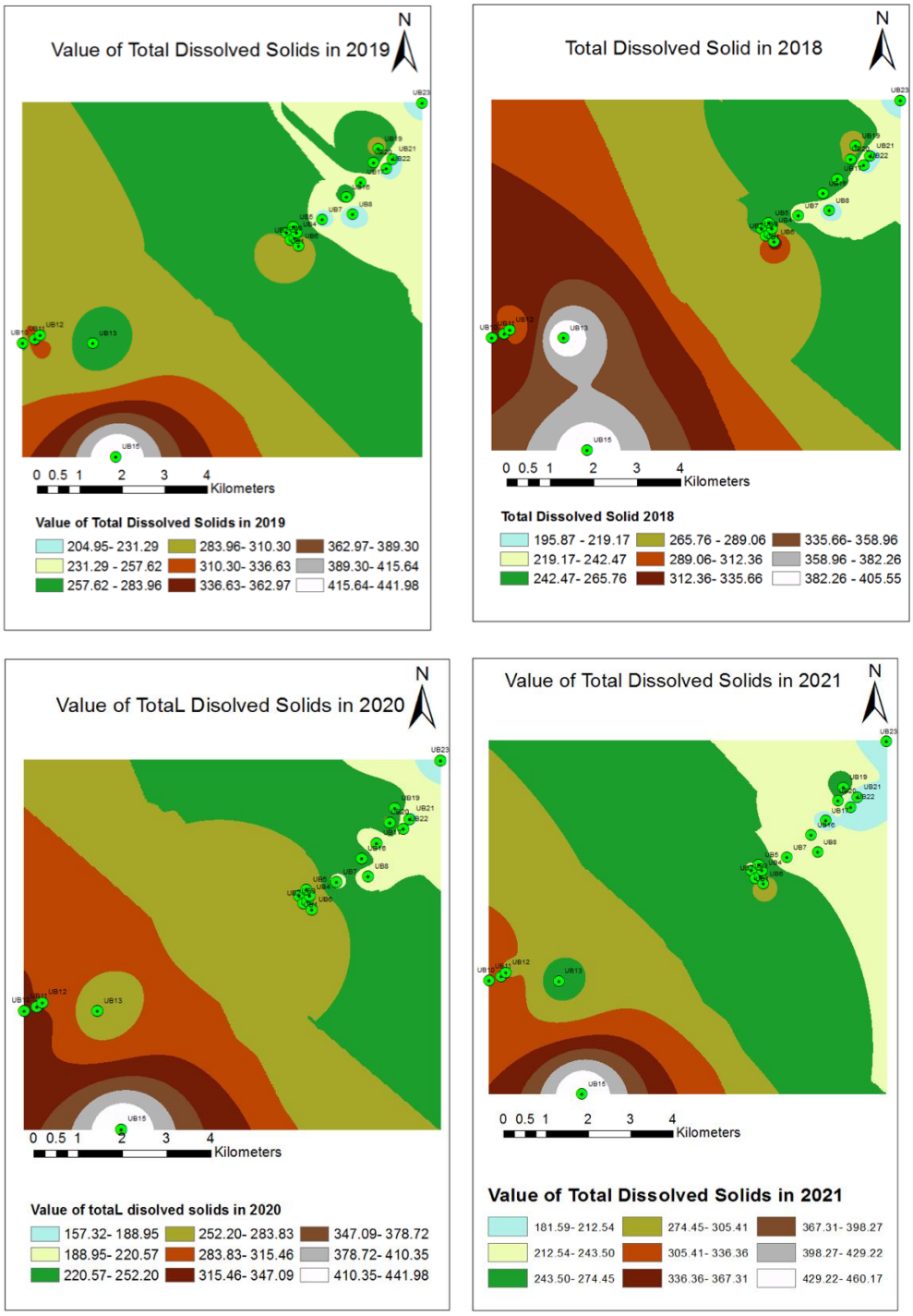

Figure 5. The value of total dissolved over the study area from 2018 to 2021

The value of fluoride was in the range of 0.03 to 0.32 in the year 2018 and changed in the range of 0.06 to o.67 mg/lit as shown in Figure 6.

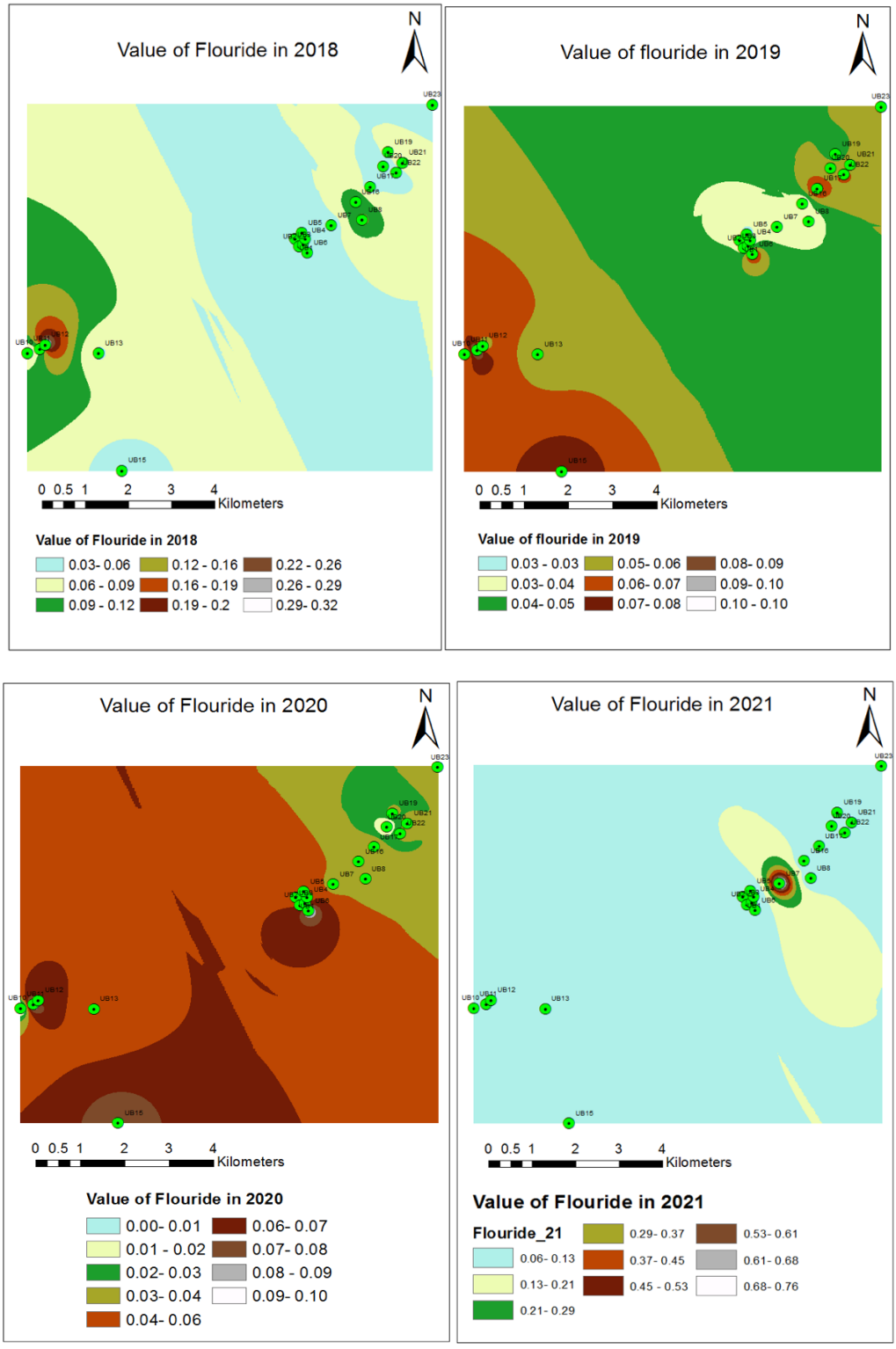

Figure 6. The value of fluoride over the study area from 2018 to 2021.

The Table 1 shows the comparison of the results from the year 2018 to 2021 in the study area.

Table 1 The comparison of the results from the year 2018 to 2021.

Sr.No.	Water quality Parameters	Values in year 2018		Values in year 2021		Desirable Limits per Oman Standard (OS 8/2012) (mg/lit)
		Lowest value (mg/lit)	Highest value (mg/lit)	Lowest value (mg/lit)	Highest value (mg/lit)	
1	pH (in scale)	7.30	8.32	7.94	8.52	6.5-8 (natural water) 6.5 – 8.5 (desalinated water) on pH scale
2	Total Hardness (TH)	126.17	223.66	236.59	250.98	500 (mg/lit) (Maximum)
3	Total Dissolved Solids (TDS)	195.87	405.55	181.59	460.17	1000 (mg/lit) (Maximum)
4	Fluoride (F)	0.03	0.32	0.06	0.67	1.5 (mg/lit) (Maximum)

Groundwater quality of different parameters in all wells:

The values of Bicarbonate Alkainity, Calcium (Ca++), Chloride (Cl-), Maganesiume (Mg++), Total Alkalinity, Total hardness (CaCO3), TDS, pH value, Fluoride (F), Sodium (Na) in the wells of code UB1, UB2, UB3, UB4, UB5, UB6, UB7, UB8, UB10, UB11, UB12, UB13, UB15, UB16, UB17, UB19, UB20,UB21, UB22, UB23 are given in the graph.

Conclusion:

The overall results shows that the values are increasing very slowly. The reason may be over withdrawal of water from ground in the study area. Also, the population, and urban development has increased in the region. It may be also concluded that, due to the disposal of domestic and industrial waste may increase the values of these quality parameters. Hence the pH value, Total Hardness (CaCO3), Total Dissolved Solids (TDS), Fluoride (F) from the year 2018 to 2021 has increased. It may be inferred that the stage has come where the Government of Oman must take decisions for further improving the groundwater quality to ensure quality under control in future.

Recommendations for future:

1. The various groundwater pollution sources must be identified all over the area.
2. Before disposal of industrial waste, quality parameters must be monitored.
3. Groundwater withdrawal must be restricted up to certain limit.

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