Determination of Groundwater Flow Direction in Amai Kingdom, Ukwuani Local Government Area of Delta State, Nigeria.

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ABSTRACT

A study was carried out in the five clans of Amai Kingdom, Ukwuani Local Government Area of Delta State using the Global Positioning System (GPS) and meter tape to determine the groundwater flow pattern of the area. Readings of depth to water level, elevation above mean sea level, and longitudes and latitudes was measured from a total of 54 hand dug wells within the five clans. GPS was used to measure the longitudes, latitudes, and elevations above mean sea level in the five areas in Amai. The values obtained showed that the longitude ranges between 006°10ˈ58.9ˈˈ_006°14ˈ39.0ˈˈE, latitude ranged from 05°44ˈ06.3ˈˈ_05°45ˈ30.0ˈˈN, and the elevation above mean sea level ranges between 9-39m. The values for depth to water level obtained ranges between 0.61-2.31m. The water elevation contour map, the static water level map and the 3-Dimensional framework map of the study location revealed that the groundwater flow direction is toward the South-Western part of the region.

Based on the flow direction or pattern of the aquifer in Amai Kingdom, dumpsites should be sited in the South-Western part of the area and not in north, east in other to minimize groundwater contamination. Boreholes can therefore be sited in the north and Eastern portion. This study will guide both individuals and Government in future groundwater exploration and exploitation decisions.

(Keywords**:** groundwater, flow direction, boreholes, static water level, dumpsites, Amai)

INTRODUCTION

Water is of fundamental importance to plants and animals particularly man. It is very vital in maintaining life processes and growth (Oseji et al., 2005). Potable water is not commonly found and its provision limits the setting up of villages and towns to places where supply exists (Shankar, 1994 and Huisman, 1966). Groundwater is commonly understood to mean water occupying all the voids within a geologic stratum. (Deborah et al, 1996).It is not usually static but flows through the rock. Groundwater therefore, is which which exist below the Earth's surface, within saturated layers of sand, gravel, and pore-spaces in sedimentary or crystalline rocks, while freshwater is the water from the zone that is not invaded (Tyson, 1993).

The depth to water table can be determined by digging a hole progressively deeper into the ground, the depth at which water begins to seep into the hole indicates that the surrounding material is saturated with water and this marks the height of the local water where there is no surface water (Buddemeier and Schloss, 2000).

Groundwater flow is very slow compared to surface water movement. However, groundwater, like surface water, flows 'downhill' in the direction determined by the slope of the water table. Groundwater flow is therefore, from high hydraulic head [high water level] to low hydraulic head [low water level] (Buddemeier and Schloss, 2000). Hence, the determination of groundwater flow direction and pattern is necessary to ensure that land use activities in the recharge area will not pose a threat to the quality of the water (Freeze and Cherry, 2002.). The absence of information regarding groundwater flow direction in the study area informed the decision to carry out this research in order to plan properly future land use activities.

LOCATION

Amai is located in Ukwani Local Government area of Delta State, Nigeria. The study area, Amai, is within the Sombriero Warri deltaic plain

deposit invaded by mangrove and located within longitude: 06° 50′ E and latitude: 05° 45′ N, it is bounded on the west by Umuebu, to the east by Ogume, the South by Ezionum and Obiaruku in the Northern portion as shown in Figure 1.

The study area is well drained by Okumeshi stream which runs in East-Westerly direction and has its source from Ethiope river channels which run across part of Amai.

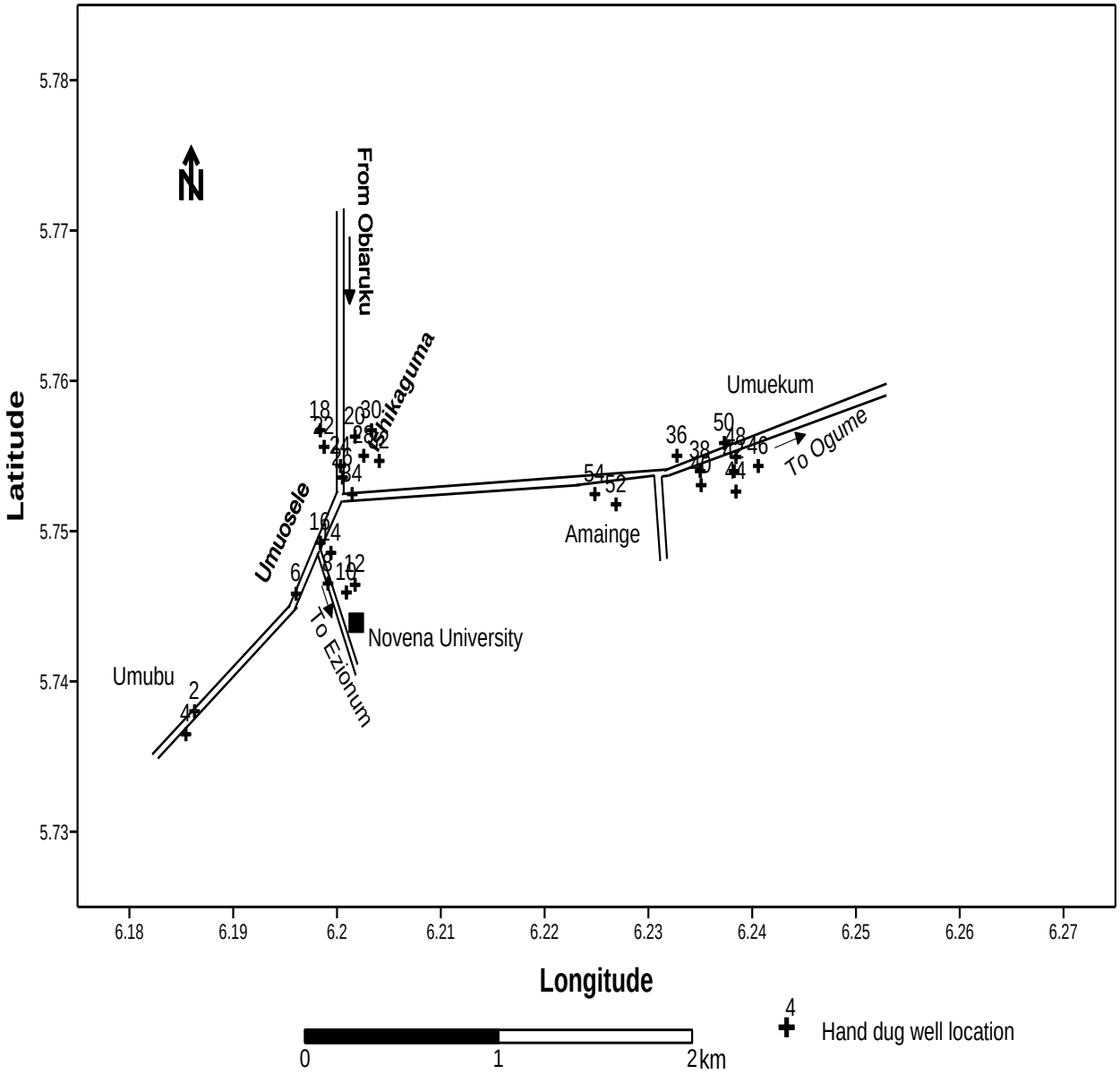

Figure 1: Sample Location/Map of Study Area.

Field Procedures and Records

The field methods involved measurement of certain information from hand dug wells in five areas of Amai (Umubu, Umuosele, Ishikaguma, Umuekum, and Amainge). The information obtained include depth to water level in hand dug wells, elevation above mean sea level, latitudes, and longitudes of the well locations.

The Global Positioning System (GPS) Garmin 76CSx was used to measure the longitude, latitude, and the surface elevations with respect to the mean sea level at different well locations. A meter tape was used to measure the depth to water level in all the wells. All elevations were taken with respect to the mean sea level. The surface elevations at different points vary due to topographic variations (Buddermeier and Scholoss, 2000).

The surface elevations at different points vary due to topographic variations, the true water levels were obtained by subtracting the measured depths to the water level in the hand-dug wells from the surface elevation to get uniform water level otherwise known as the elevation of the water level (Buddemeier and Schloss 2000) and hence reduce topographic variations This uniform water level coincides with the static water level in the case of an unconfined aquifer while it is the piezometric surface if the aquifer is confined (Buddermeier and Schloss, 2000).

Let DHDW=Depth from the surface of the Earth to the water level in the hand dug wells.

E= surface elevation with respect to mean sea level.

Therefore Swl =E-Dwl,

where Swl is the static water level and otherwise could be known as Uniform or True water level.

The static water level was used to generate the contour map of the study area making sure that none of the values collides with each other. (Buddermeier and Schloss, 2000).

Table 1: Field Records obtained from Hand-Dug Wells in Amai Umubu.

s/no	GPS Location	(N) Latitude	(E) Longitude	Evaluation (m)	DHDW (m)	SWL (m)
1	Amai Umuebu	05°44' 13.7"	006°11' 11.2"	39	1.66	37.34
2		05°44' 13.1"	006°11'09.1"	56	1.28	54.72
3		05°44' 08.6"	006°10'58.9"	27	1.82	25.18
4		05°44'06.3"	006°11'05.9"	20	1.81	18.19
5		05°44'19.0"	006°11'16.6"	22	1.32	20.68

Table 2: Field Records obtained from Hand-Dug Wells in Amai Umuosele.

s/no	GPS Location	(N) Latitude	(E) Longitude	Elevation (m)	DHDW (m)	SWL (m)
1	Umuosele	05°44'46.1"	006°11'46.8"	28	2.31	25.69
2		05°44'55.2"	006°11'55.0"	29	1.76	27.24
3		05°44'49.1"	006°11'58.8"	14	0.7	13.3
4		05°44'51.7"	006°12'00.8"	31	1.22	29.78
5		05°44'46.6"	006°12'05.4"	22	0.95	21.05
6		05°44'47.6"	006°12'07.5"	21	1.34	19.66
7		05°44'48.5"	006°12'08.8"	27	1.95	2.05
8		05°44'54.1"	006°12'14.8"	20	0.71	18.29
9		05°44'57.7"	006°11'59.6"	23	0.86	22.14
10		05°45'05.9"	006°11'57.4"	24	1.23	22.77
11		05°45'00.4"	006°11'55.8"	21	0.61	20.39
12		05°45'00.9"	006°11'58.1"	21	0.61	20.39

Table 3: Field Records obtained from Hand-Dug Wells in Amai Ishikagwuma.

S/No	GPS Location	Latitude (N)	Longitude (E)	Elevation (m)	DHDW (m)	SWL (m)
1	Ishikagwuma	05°45'32.0"	006°11'55.8"	20	1.91	18.09
2		05°45'32.7"	006°11'57.7"	13	1.81	11.19
3		05°45'30.3"	006°12'08.5"	15	1.17	13.83
4		05°45'27.9"	006°11'58.4"	9	1.72	7.28
5		05°45'27.3"	006°11'57.2"	9	1.39	7.61
6		05°45'22.3"	006°11'58.1"	19	2.21	16.79
7		05°45'22.2"	006°12'03.4"	23	0.87	22.13
8		05°45'17.7"	006°12'07.8"	22	1.33	20.67
9		05°45'18.6"	006°12'04.0"	17	1.00	16.00
10		05°45'25.3"	006°12'12.4"	29	1.90	27.1
11		05°45'25.1"	006°12'12.0"	29	2.07	26.93
12		05°45'29.1"	006°12'14.1"	21	2.00	19.00
13		05°45'31.9"	006°12'14.7"	25	1.67	23.33
14		05°45'35.6"	006°12'16.9"	35	0.98	34.02
15		05°45'23.3"	006°12'17.6"	24	1.25	22.75
16		05°45'13.0"	006°12'16.2"	23	0.72	22.28
17		05°45'13.9"	006°12'07.6"	17	0.08	16.92

Table 4: Field Records obtained from Hand-Dug Wells in Amai Umuekum.

S/No	GPS Location	Latitude (N)	Longitude (E)	Elevation (m)	DHDW (m)	SWL (m)
1	Umuekum	05°45'25.0"	006°14'08.6"	23	1.66	21.34
2		05°45'22.4"	006°14'18.6"	27	1.60	25.4
3		05°45'20.5"	006°14'17.4"	23	1.58	21.42
4		05°45'21.4"	006°14'15.2"	40	1.25	38.75
5		05°45'16.7"	006°14'18.5"	20	2.03	17.97
6		05°45'13.4"	006°14'23.4"	25	0.56	24.44
7		05°45'20.6"	006°14'29.8"	25	2.11	22.89
8		05°45'18.6"	006°14'31.9"	26	1.82	24.18
9		05°45'14.9"	006°14'30.7"	17	0.83	16.17
10		05°45'17.6"	006°14'39.0"	21	1.69	19.31
11		05°45'21.9"	006°14'38.9"	18	0.71	17.29
12		05°45'22.2"	006°14'37.6"	11	1.98	9.02
13		05°45'24.3"	006°14'30.4"	27	1.26	25.74
14		05°45'30.0"	006°14'24.5"	23	1.13	21.87
15		05°45'28.6"	006°14'26.2"	20	1.85	18.15
16		05°45'25.4"	006°14'20.6"	9	1.10	7.9

Table 5: Field Records obtained from Hand-Dug Wells in Amainge.

S/No	GPS Location	Latitude (N)	Longitude (E)	Elevation (m)	DHDW (m)	SWL (m)
1	Amainge	05°45'11.3"	006°13'45.8"	23	1.61	21.39
2		05°45'12.0"	006°13'50.4"	23	1.47	21.53
3		05°45'13.9"	006°13'37.8"	22	1.48	20.52

RESULTS AND DISCUSSION

The values of the static water levels were contoured on the map of Amai Kingdom by joining equal values of static water levels and making sure that none of the lines overlapped or cut across each other. This was improved upon with the aid of Surfer 8 computer package as shown in Figure 2.

The contoured maps (Elevation maps), depth to water level map, map of static water level, and 3-D map showing flow direction, as displayed in Figures 2 to 5, all revealed the same trend (South Western) in the groundwater flow direction.

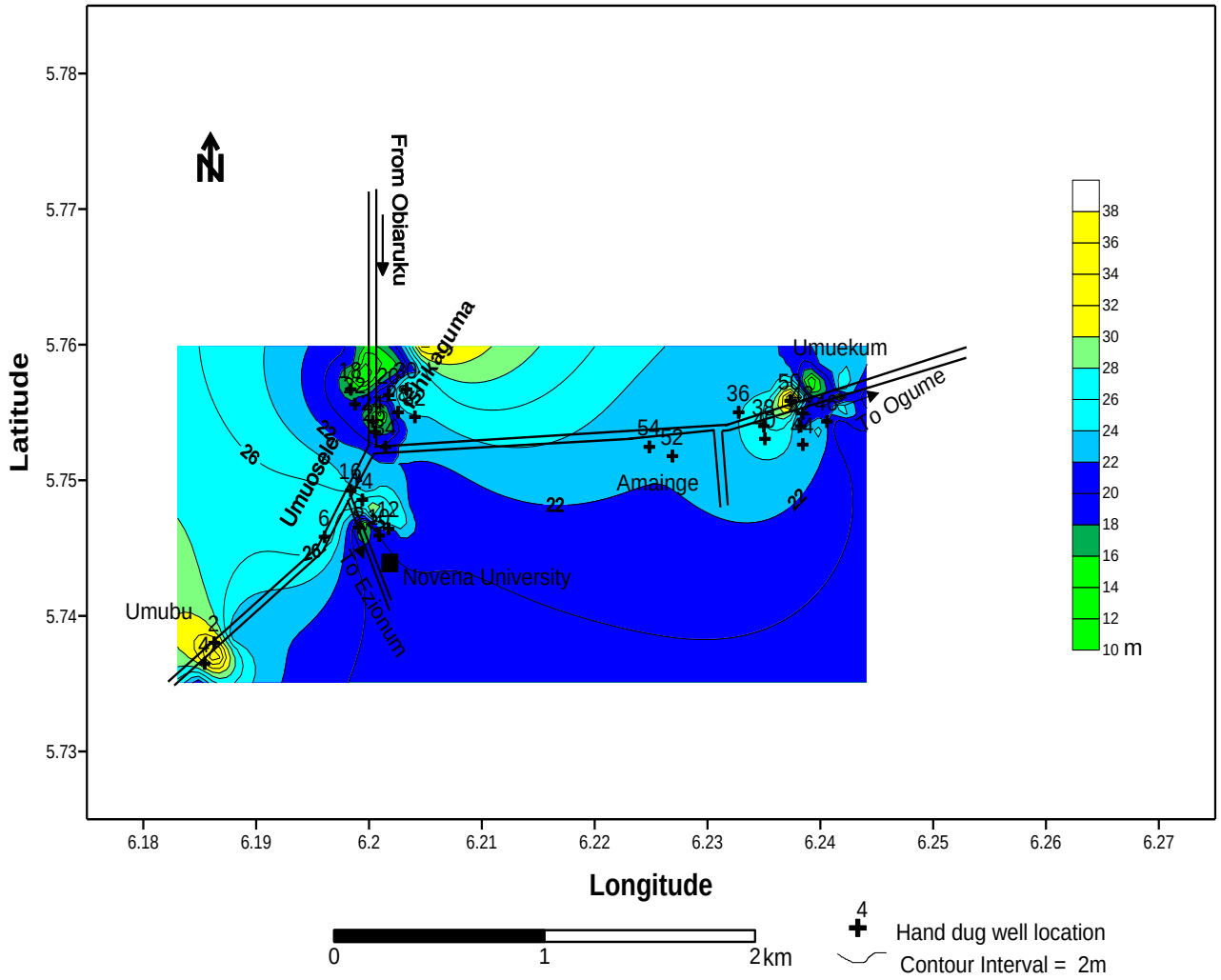

Figure 2: Contour map of Study Area Showing Elevation above Mean Sea Level

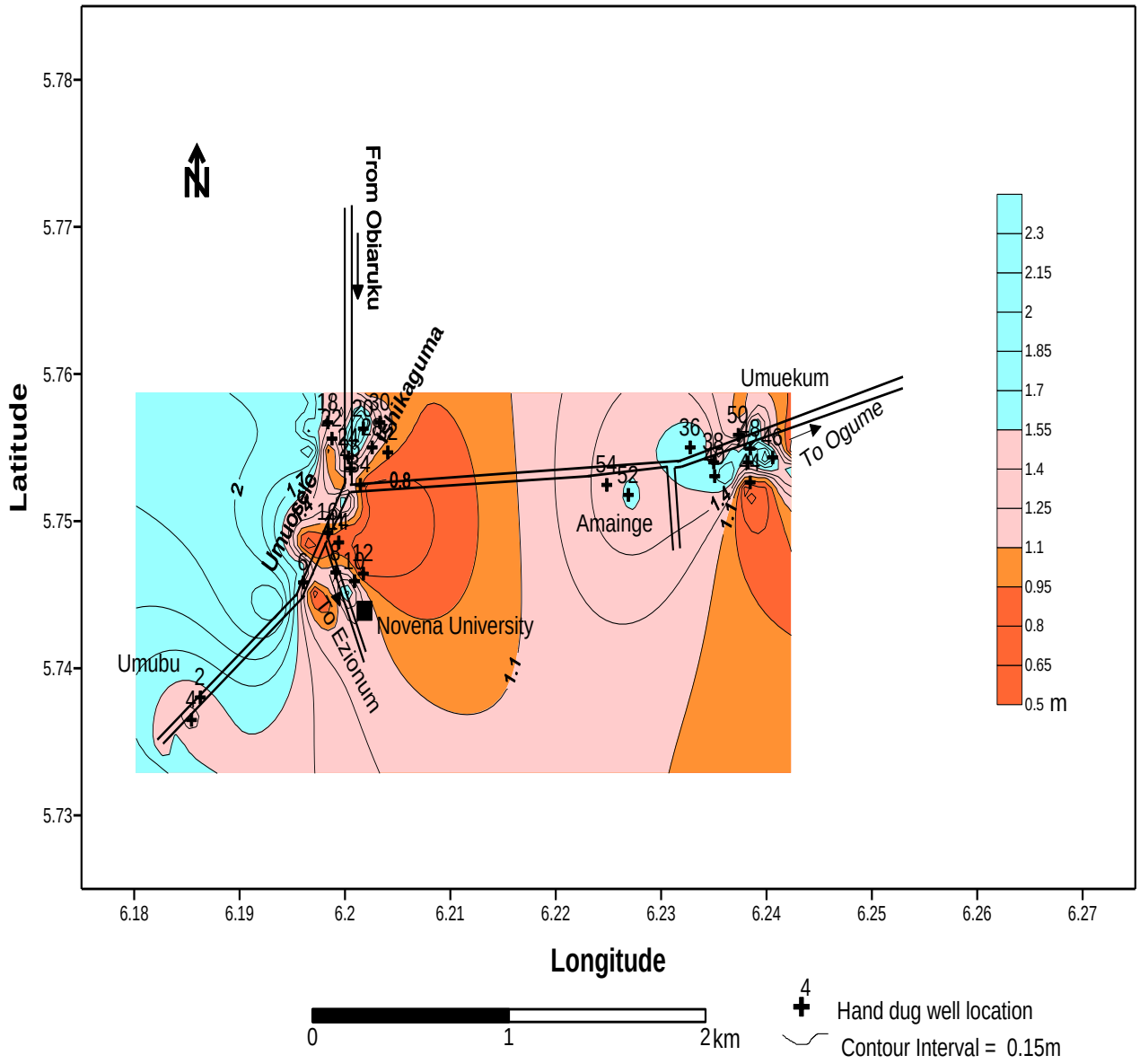

Figure 3: Contour Map of Study Area Showing Depth to Water Level.

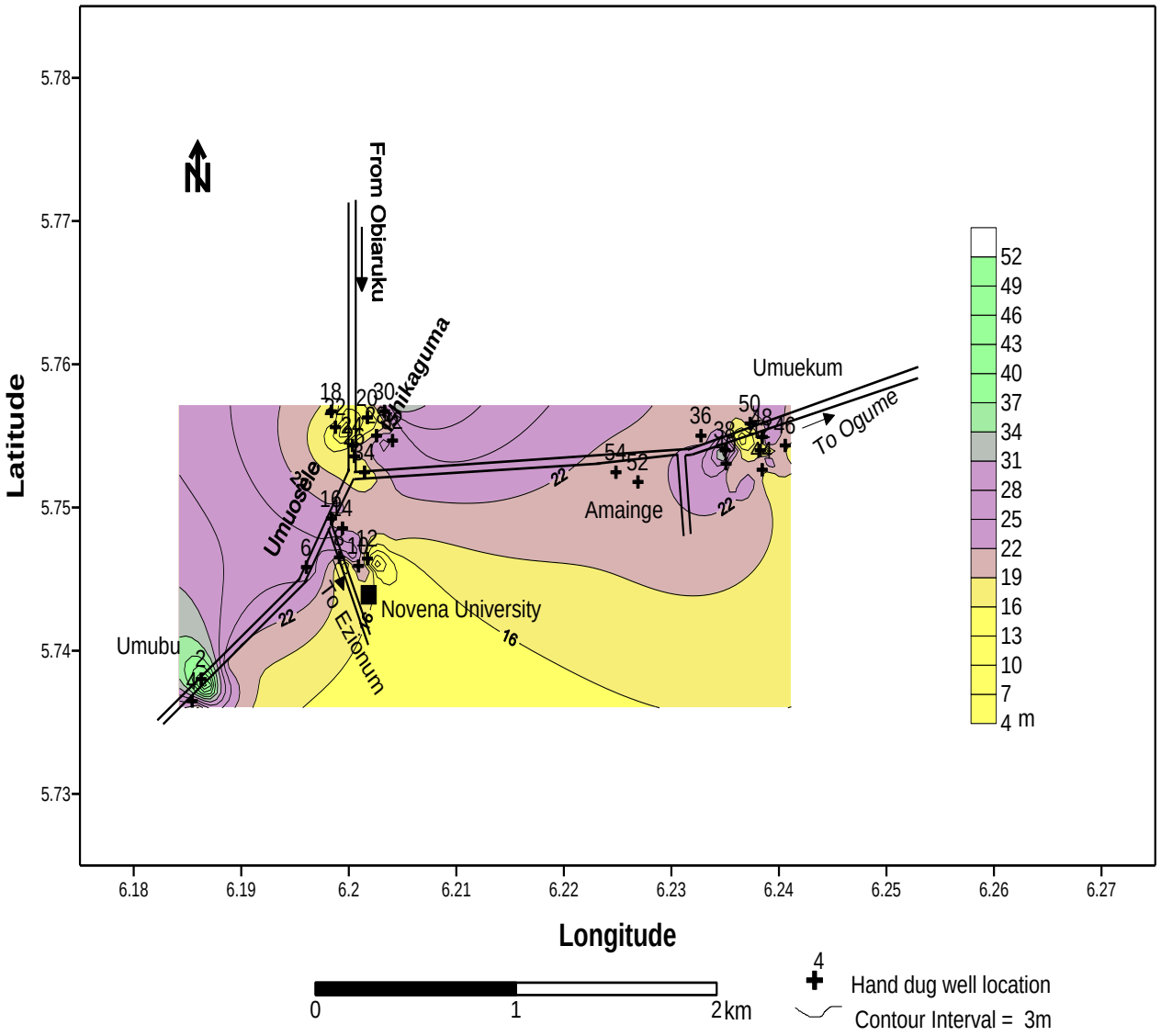

Figure 4: Contour Map Showing Groundwater Flow Direction.

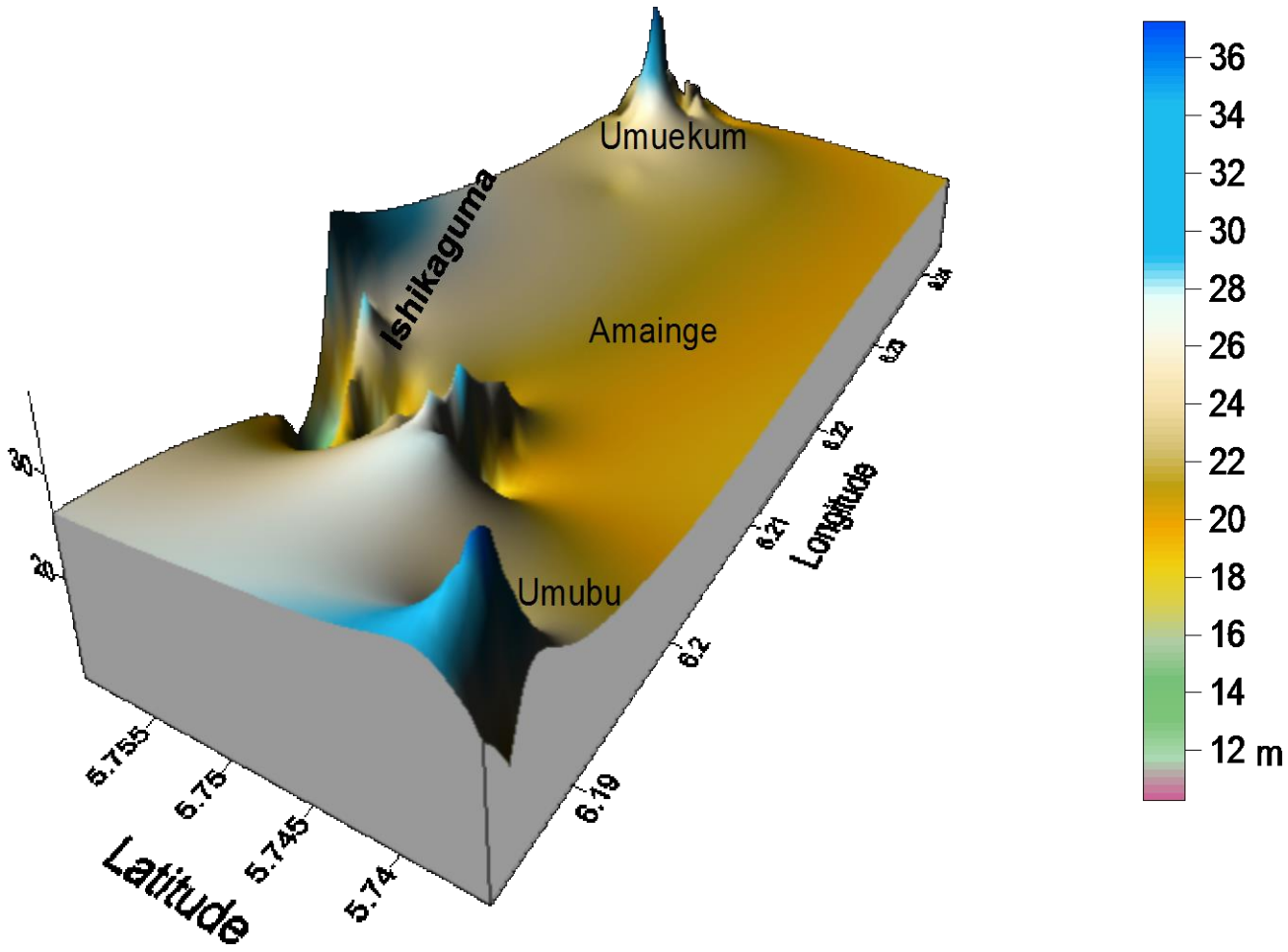

Figure 5: Wire Frame of Amai Kingdom Showing Groundwater Flow Direction in Three Dimensions using Suffer 8 Computer Program.

CONCLUSIONS

The water elevation contour map of Amai Ukwani Local Government Area revealed that groundwater flow direction is toward the South-western part of the region. The determination of groundwater flow enables one to know that groundwater definitely can act as carriers of soluble soil pollutants. This can also assist authorities of government in case of citing infrastructures that may interfere with groundwater resources.

RECOMENDATION

Based on the pattern of the aquifer system and the groundwater flow direction, it is recommended:

- Dumpsites should be sited within the South-Western parts of the region and not in the north, west, and eastern regions in order to minimize groundwater contamination by dumpsites
- Borehole for potable water should not be cited at the South Western portion to avoid pollution of drinking water sources.

The research paved the way to show the flow system in Amai Ukwani Local Government Area. It also created an avenue on where the dumpsites areas could be sited to minimize groundwater contamination. Therefore it is appeared that the recommendation made be taken seriously.

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