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Effects of Ground Water on Dampness of Building in Ede Township

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Abstract: Water plays a major role in the deterioration of masonry materials and often has a negative and devastating influence on buildings. The presence of groundwater is a common source for rising moisture contributing to dampness in masonry walls. This research investigates the effect of ground water on dampness of buildings in Ede Township. A randomly sampled questionnaire of one hundred (100) respondents was drawn from different affiliated locations represented in the study area. Visual investigations on wells were carried out to obtain necessary data, moisture content of the building was inspected and recorded with a wall moisture detector system. The result shows that the water level is high in both northern and southern region of Ede considering the depth of the wells, with worst scenario of a wells of depth as low as 2.80m, and water ooze from the floor of 59% of the building in the past years, which attest to the fact that the water table is extremely high. The results further showed that dampness is everywhere and majority of the buildings surveyed having maximum height of dampness of 2.06m during raining season. The study recommends that rise of water by capillary action through the walls of buildings can be controlled by incorporating damp proof membrane such as, asphalt, polythene of good quality which will serve as a barrier between sub-soil water and the walls and floors.

Keywords: Moisture, Dampness, Water Table, Wall Moisture Detector System, Ede Township.

1.0 INTRODUCTION

Dampness in building may occur due to bad design, faulty construction, use of poor quality of materials, poor soil characteristics, etc. Dampness does not only affects the life of the building but also creates unhygienic conditions for important items of work in the construction of a building (The constructor, 2021). Dampness, an indication of the moisture content of the air present in a space, it is an important factor which determines the quality of the air in relation to human health and comfort and more importantly, its effects on the structural integrity of building components (Hyvarinen *et al.*, 2002; Canadian Wood Council, CWC, 2000; King *et al.*, 2000). Dampness in buildings can arise from a number of different sources and can cause a variety of effects, such as wall staining, mold growth, impairment of air quality and respiratory problems in humans (Ahmed and Rahman, 2010; Trotman *et al.*, 2004; Riley and Cotgrave, 2005; CWC, 2000).
Dampness in building leads to building failure, when there is a defect in one or more elements of the building caused by inability of the material making up the components of such building elements to perform its original function effectively, which may finally lead to building collapse (Ayodeji, 2011). Dampness is one of the most serious building defects, just as serious as cracks on buildings; it defaces the building walls by spoiling paints and interior decoration. It also encourages mould and rots growth and reduces thermal insulation properties of buildings thereby exposing occupants to some health hazards. Capillary penetration of fluid from the ground up through concrete or masonry is known as rising damp and is governed by the shape and porosity of the construction materials through which this evaporation limited capillary penetration takes place (Liu *et al.*, 2018). The penetration of water is one of the most damaging defects that can occur in both old and modern constructions (Hetreed, 2008; Burkinshaw & Parrett, 2004). Ground water is an integral part of the water cycle and it interacts directly with the water present on the earth's surface. It is the water present beneath the earth's surface in soil pore spaces and in the fractures of rock formations which constitutes of 97% of global freshwater and it can be seen as an alternative source of water supply in cases of drought through their contributions to rivers, lakes, wetlands and swamps especially in the dry seasons which is of high significance. In most countries where surface water is polluted, ground water is an important source of drinking water.

Groundwater is an integral part of the water cycle (or hydrologic cycle), that is, the circulation of water throughout the various parts of the land, sea and air. This circulation includes all surface water (e.g. rivers, lake and oceans), the atmosphere and groundwater. The water cycle comprises three main phases: precipitation, migration and evaporation. About 99% of the world's liquid fresh water is ground water (Lall *et al.*, 2020). Although groundwater has several advantages, it is importance to analyze the negative effects it has. Groundwater can have a great toll on building structures and these may include flooding, swelling of clays, reduction in bearing capacity, hydrostatic uplift pressures, chemical attack, and cracks due to deferential settlement, dampness and difficulties during construction. The presence of groundwater is a common source for moisture rise contributing to rising damp in the masonry walls. The higher the groundwater table, the more severe the rising damp (Hetreed, 2008). Water table differs from one place to another depending on the geographical locations of buildings and the type of soils. This research is aimed at investigating the effect of ground water on dampness of buildings in Ede Township.

2.0 MATERIALS AND METHOD

Site Description: Ede is a town in Osun State, south-western Nigeria which lies on the coordinates 7°44′20″N and 4°26′10″E. It lies along the Osun river at a point on the railroad from Lagos, 180 kilometres (110 miles) south-west, and at the intersection of roads from Osogbo, Ogbomoso, and Ife. Ede has a total area of 330km^2 (130 sq mi) with an elevation of 269m (883ft), and a total population of 159,866 (Britannica, 2006; Wikipedia, 2021).

Data Collection: The study used physical inspection, moisture detector system, GIS and well-structured questionnaires to collect data. The questionnaire were developed and used to obtain necessary information about damped buildings in relation to their physical environment, and the moisture detector system was used to determine the percentage of moisture i.e moisture content of each buildings with respect to the moisture present in the soil, while the GIS application was used to produce the geographical details of the region.

Experimental Methods: In the survey, 100 questionnaires were administered randomly to the residents, 50 in each of the two local government areas in Ede town, and there was 100% response. Only the buildings with worse conditions were considered in this study. The field test to determine the moisture content of the building was carried out using the designed moisture detector system. Soil samples were also taken from the site to determine the moisture content of the soil in various locations in the study area according to ASTM2216.

3.0 RESULTS AND DISCUSSION

Sampled Respondents Result: The results obtained from the survey of respondents from 50 questionnaires distributed to each in both northern and southern region of Ede to inspect the effect of underground water on building dampness are presented below in Tables 1.

Table 1: Sampled Questionnaire Results

QUESTIONS	NORTHERN REGION		SOUTHERN REGION	
	YES	NO	YES	NO
Is your building damp?	46	04	45	00
Do water ooze from the floor during the past years?	20	25	37	12
Do you normally observe spring near your residence?	10	39	21	24
Is there water logged area near your residence?	18	32	20	25
Do you have any occurrence of flooding in your home within the past years?	09	41	21	24
Do you have any occurrence of flooding in your environment within the past years?	06	44	28	17
Is there any work that can abate dampness which has been carried out in your neighborhood?	07	43	23	22
If wall is made of hollow block, is the cavity filled?	08	10	00	00
Do you observe any form of crystalline salt on the wall?	17	33	03	42
Is damp proof membrane course installed in the building?	28	22	16	29
Does water dry off quickly from the soil after rainfall?	35	15	15	30
Does a wet cloth dry quickly in your residence?	43	07	45	00

Table 1 revealed that 44% & 74%, 20% & 47%, 36% & 44%, 18% & 47% and 12% & 62% of the buildings in northern and southern regions of Ede respectively experienced the followings: water ooze from the floor in the past years, springs near their residences, water logged area near their residence, flooding within their home within the past years and flooding within their environment within the past years. All these are pointer to the fact that water table is high. The southern region is more critical than the northern region. This also contributes to the causes of dampness in the region.

Table 2: Variation the Ground Water Level and Dampness Height at the Northern Region

Well S/N	Olorun Lomo Eru E			Adenike - Ijira Agbale Area			Bode - Oja Timi Axis			Sagba - Oke Gada Area		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
01	6.00	1.30	0.46	5.20	2.00	0.80	5.80	1.70	0.37	6.30	0.90	0.52
02	5.90	2.20	0.95	5.00	1.30	0.85	5.20	1.70	0.41	5.10	1.80	0.55
03	6.70	1.50	0.40	5.90	1.20	0.90	6.10	2.30	0.55	5.50	1.80	0.28
04	6.00	1.10	0.70	8.30	1.90	0.50	6.80	2.50	0.40	4.90	0.30	0.49
05	11.0	1.80	0.40	12.4	1.30	0.50	6.20	1.80	0.45	4.50	1.00	0.29
06	8.20	1.60	0.50	4.60	1.50	0.45	4.80	1.50	0.25	5.40	0.40	0.60
07	5.30	1.00	0.30	2.80	1.50	0.20	4.00	1.60	0.45	6.50	1.30	0.39
08	5.00	1.20	0.40	5.20	1.60	0.46	5.90	1.70	0.47	6.00	0.50	0.43
09	5.50	0.80	0.70	5.50	2.20	0.65	7.50	1.50	0.36	5.40	1.80	0.65
10	8.10	0.90	0.50	6.70	2.70	0.69	6.40	2.20	0.48	5.80	1.80	0.48

Where **A** *is Depth of Well (m),* **B** *is difference of Water Levels in well during Dry and Raining Season (m) and* **C** *is difference in height of dampness on wall during Dry and Raining Season (m).*

From table 2 above, the average depth of the well in the northern region is 6.1m with the lowest depth as low as 2.8m, which attest to the fact that the water table is high. The height of water in the well increases by 43% in the rainy season. i.e the water table is richly recharged during the rainy season in the region which increases the height of dampness on the wall by 58%. This makes the highest height of dampness on the wall 1.86m above the ground during the raining season against 0.76m during the dry season.

Table 3: Variation in the Ground Water Level and Dampness Height at the Southern Region

Well S/N	Ilori			Ogberin			Ajip			Arulogun		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
01	7.00	0.60	0.92	5.70	0.20	0.40	6.90	1.50	0.78	5.30	2.00	0.05
02	7.80	1.60	0.92	5.40	1.60	0.56	7.00	1.10	0.58	5.00	2.40	0.94
03	8.00	2.80	0.59	6.70	2.80	0.40	7.00	1.90	0.66	6.00	1.10	0.79
04	7.60	2.40	0.56	6.90	0.70	0.67	7.20	1.50	0.76	6.50	1.00	0.69
05	6.20	0.50	1.22	6.50	1.50	0.77	7.30	1.80	0.31	5.50	1.80	1.07
06	6.00	1.00	0.51	3.10	1.00	1.27	8.00	1.80	0.49	5.50	1.50	0.40
07	6.00	2.00	0.58	6.l0	1.40	0.82	7.50	3.10	0.49	6.20	1.40	0.94
08	5.30	1.70	0.72	6.10	2.20	1.03	7.80	3.30	0.72	6.00	1.00	0.35
09	6.00	2.50	0.74	6.10	1.60	0.59	7.60	2.40	0.37	5.60	1.00	1.38
10	6.20	1.60	1.13	5.80	0.70	0.64	8.10	2.90	0.61	4.50	1.20	0.78

Where **A** *is Depth of Well (m),* **B** *is difference of Water Levels in well during Dry and Raining Season (m) and* **C** *is difference in height of dampness on wall during Dry and Raining Season (m).*

Similarly, from table 3 above, the average depth of the well in the southern region is 6.4m with the lowest depth as low as 3.1m, which attest to the fact that the water table is high. The height of water in the well increases by 53% in the rainy season. i.e the water table is richly recharged during the rainy season in the southern region than in the northern region, which increases the height of dampness on the wall by 85%. This makes the highest height of dampness on the wall 2.06m above the ground during the raining season against 1.6m during the dry season. Tables 2 and 3 show that the dampness increases as the water table increased. The results obtained from using the designed wall moisture detector system (device) are shown in tables 4 and 5 below. Measurements are taken at 0.5m intervals from the ground level.

Table 4: Variation in Moisture Content Readings at the Northern region

Houses S/N	Olorun Lomo Eru E Readings (%)				Adenike - Ijira Agbale Readings (%)				Bode - Oja Timi Axis Readings (%)				Sagba - Oke Gada Readings (%)			
	A	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
01	0.57	0.01	0.00	0.00	0.91	0.75	0.28	0.00	0.72	0.75	0.00	0.00	0.72	0.78	0.00	0.00
02	0.68	0.76	0.72	0.00	0.84	0.45	0.01	0.00	0.64	0.54	0.01	0.00	0.92	0.72	0.05	0.00
03	0.74	0.00	0.00	0.00	0.68	0.32	0.03	0.00	0.75	0.21	0.00	0.00	0.76	0.28	0.00	0.00
04	0.92	0.79	0.04	0.00	0.65	0.52	0.00	0.00	0.85	0.62	0.00	0.00	0.87	0.71	0.20	0.00
05	0.88	0.63	0.00	0.00	0.74	0.22	0.05	0.00	0.79	0.55	0.21	0.00	0.68	0.32	0.00	0.00
06	0.63	0.68	0.61	0.02	0.88	0.01	0.00	0.00	0.52	0.18	0.01	0.00	0.64	0.68	0.00	0.00
07	0.08	0.00	0.00	0.00	0.62	0.35	0.00	0.00	0.91	0.32	0.01	0.00	0.57	0.18	0.00	0.00
08	0.83	0.88	0.00	0.00	0.78	0.64	0.40	0.00	0.74	0.18	0.03	0.00	0.62	0.48	0.00	0.00
09	0.87	0.96	0.21	0.00	0.83	0.62	0.05	0.00	0.82	0.01	0.00	0.00	0.84	0.95	0.69	0.00
10	0.90	0.00	0.05	0.00	0.85	0.54	0.13	0.00	0.62	0.25	0.15	0.00	0.57	0.59	0.01	0.00

Where **A, B, C** & **D** *are marked at heights 0.5, 1.0m, 1.5m and 2.0m respectively*

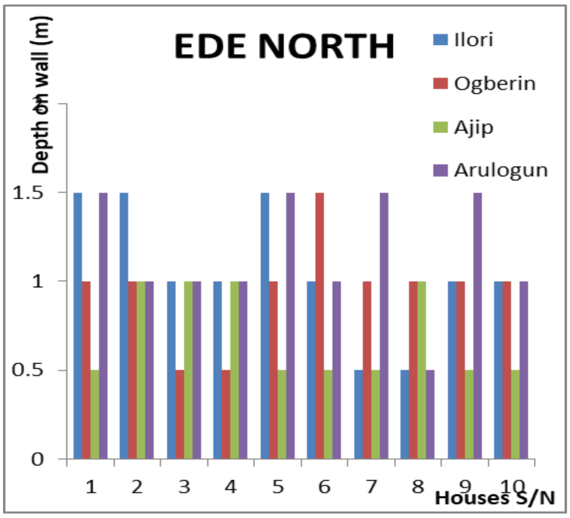
Table 4 shows that dampness rose to 0.50m in 14% of buildings, 1m in 59% of buildings, 1.5m in 23% of buildings and 2m high in 4% of the buildings respectively in the northern region. This indicates that the height of dampness in 96% of the buildings is 1.5m above the ground.

Table 5: Variation in Moisture Content Readings at the Southern Region

Houses S/N	Ilori Readings (%)				Ogberin Readings (%)				Ajip Readings (%)				Arulogun Readings (%)			
	A	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
01	0.68	0.72	0.63	0.00	0.75	0.76	0.00	0.07	0.54	0.06	0.00	0.00	0.78	0.79	0.20	0.00
02	0.75	0.76	0.86	0.01	0.60	0.56	0.02	0.00	0.36	0.15	0.00	0.00	0.32	0.33	0.00	0.00
03	0.79	0.83	0.00	0.00	0.81	0.00	0.00	0.00	0.73	0.53	0.00	0.00	0.46	0.20	0.00	0.00
04	0.60	0.54	0.00	0.00	0.53	0.01	0.00	0.00	0.85	0.56	0.00	0.00	0.56	0.01	0.00	0.00
05	0.99	0.98	0.17	0.00	0.73	0.70	0.00	0.00	0.65	0.00	0.00	0.00	0.89	0.70	0.32	0.00
06	0.31	0.13	0.00	0.00	0.91	0.83	0.56	0.00	0.60	0.01	0.00	0.00	0.67	0.30	0.00	0.00
07	0.79	0.09	0.01	0.00	0.43	0.21	0.00	0.00	0.80	0.00	0.00	0.00	0.62	0.70	0.30	0.00
08	0.54	0.01	0.00	0.00	0.68	0.58	0.00	0.00	0.48	0.20	0.00	0.00	0.52	0.00	0.00	0.00
09	0.69	0.65	0.00	0.00	0.99	0.97	0.02	0.00	0.50	0.06	0.00	0.00	0.50	0.53	0.20	0.00
10	0.77	0.65	0.02	0.00	0.65	0.33	0.00	0.00	0.91	0.02	0.00	0.00	0.69	0.23	0.00	0.00

Where **A, B, C** & **D** *are marked at heights 0.50m, 1.00m, 1.50m and 2.00m respectively*

Similarly, table 5 shows that dampness rose to 0.50m in 29% of houses in the study area, 1m in 49% of houses, 1.5m in 20% of houses and 2m high in 2% of the buildings respectively in the northern region. This indicates that 98% of the building is damped at 1.5m above the ground.



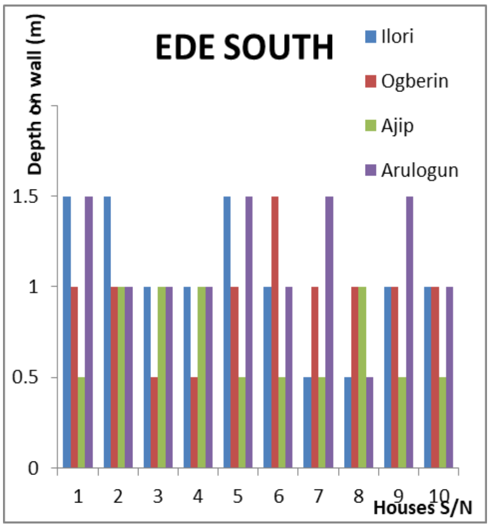


Figure 1a & 1b: Variation in the Level of Dampness on Walls in Ede North & South

1*(a)* **1*(b)***

Table 6: Variation in the Soil Moisture Content Values at the Southern Regions

S/N	Location	Northern Region e (N)	Longitude (E)	Moisture Content (%)	S/N	Southern Region e (N)	Latitude (N)	Longitude (E)	Moisture Content (%)
A1	Agbale – Poly road	007^0 43' 57"	004^0 25' 22"	7.48	**H1**	Ogberin	007^0 43' 30"	004^0 25' 43"	13.97
A2	Agbale – Poly road	–	–	8.75	**H2**	Ogberin	–	–	13.34
B1	Agbale – Poly road	007^0 44' 06"	004^0 25' 22"	6.96	**I1**	Ogberin	007^0 43' 31"	004^0 25' 37"	6.71
B2	Agbale – Poly road	–	–	13.58	**I2**	Ogberin	–	–	9.91
C1	Agbale – Poly road	007^0 44' 11"	004^0 25' 32"	12.63	**J1**	Ogberin (Poly Gate)	007^0 43' 33"	004^0 25' 26"	11.75
C2	Agbale – Poly road	–	–	13.81	**J2**	Ogberin (Poly Gate)	–	–	11.55
D1	Agbale – Poly road	007^0 44' 09"	004^0 25' 37"	10.38	**K1**	Ogberin (ABM)	007^0 43' 23"	004^0 25' 39"	12.75
D2	Agbale – Poly road	–	–	12.08	**K2**	Ogberin (ABM)	–	–	9.46
E1	Rhombay	007^0 43' 59"	004^0 25' 36"	13.62	**L1**	Ilori	007^0 43' 00"	004^0 25' 24"	7.93
E2	Rhombay	–	–	12.22	**L2**	Ilori - College	007^0 42' 57"	004^0 25' 22"	6.67
F1	Rhombay	007^0 43' 52"	004^0 25' 35"	14.02	**M1**	Wakajaye	007^0 43' 32"	004^0 26' 28"	17.32
F2	Rhombay	–	–	14.62	**M2**	Wakajaye	–	–	8.76
G1	Rhombay	007^0 43' 35"	004^0 25' 38"	12.32	**N1**	Ogberin - Agip	007^0 43' 25"	004^0 25' 37"	14.27
G2	Rhombay	–	–	13.57	**N2**	Ogberin - Agip	–	–	9.04
O1	Agbale – Ijira	007^0 43' 17"	004^0 24' 43"	11.70	**U11**	Owode	007^0 43' 46"	004^0 27' 16"	10.07
O2	Agbale – Ijira	007^0 43' 19"	004^0 24' 53"	13.69	**U12**	Owode	–	–	7.18
O3	Agbale – Ijira	007^0 43' 16"	004^0 24' 54"	15.90	**U21**	Oke Yidi	007^0 44' 34"	004^0 26' 22"	8.42
P1	Odo - Eja	007^0 44' 01"	004^0 25' 07"	7.048	**U22**	Oke Yidi	–	–	8.88
P2	Odo - Eja	–	–	8.69	**U31**	Abere Road	007^0 44' 32"	004^0 26' 30"	10.48
Q	Bode	007^0 44' 11"	004^0 25' 51"	15.04	**U32**	Abere Road	–	–	10.26
R	Oja Timi	007^0 44' 14"	004^0 26' 07"	8.17	**V1**	Adeleke University	007^0 42' 37"	004^0 25' 30"	9.78
S	Oke Gada Market	007^0 44' 45"	004^0 26' 09"	12.53	**V2**	Adeleke University	007^0 42' 35"	004^0 25' 30"	8.64
T	Oke Gada	007^0 45' 00"	004^0 26' 11"	10.50	–	–	–	–	–

Table 6 shows the variation in moisture contents value obtained in northern and southern regions with their coordinates. The natural moisture content of the soil in the northern region varies from one location to another with highest value of 15.90% at Ijira Agbale to the lowest value of 6.96% at Poly road, Agbale. Similarly, in the southern region, Wakajaye has the highest value of 17.32% and 6.67% at Ilori. The result revealed that soil at southern part retained more water than the soil at northern region as shown in Figure 3 and according to University of New South Wales the soil can be classified as sandy and sandy loam/loamy sand with sandy loam/loamy sand having highest percentage (Terra GIS, 2021). Figures 6 and 7 shows the variation in moisture content in various parts of northern and southern region of Ede.

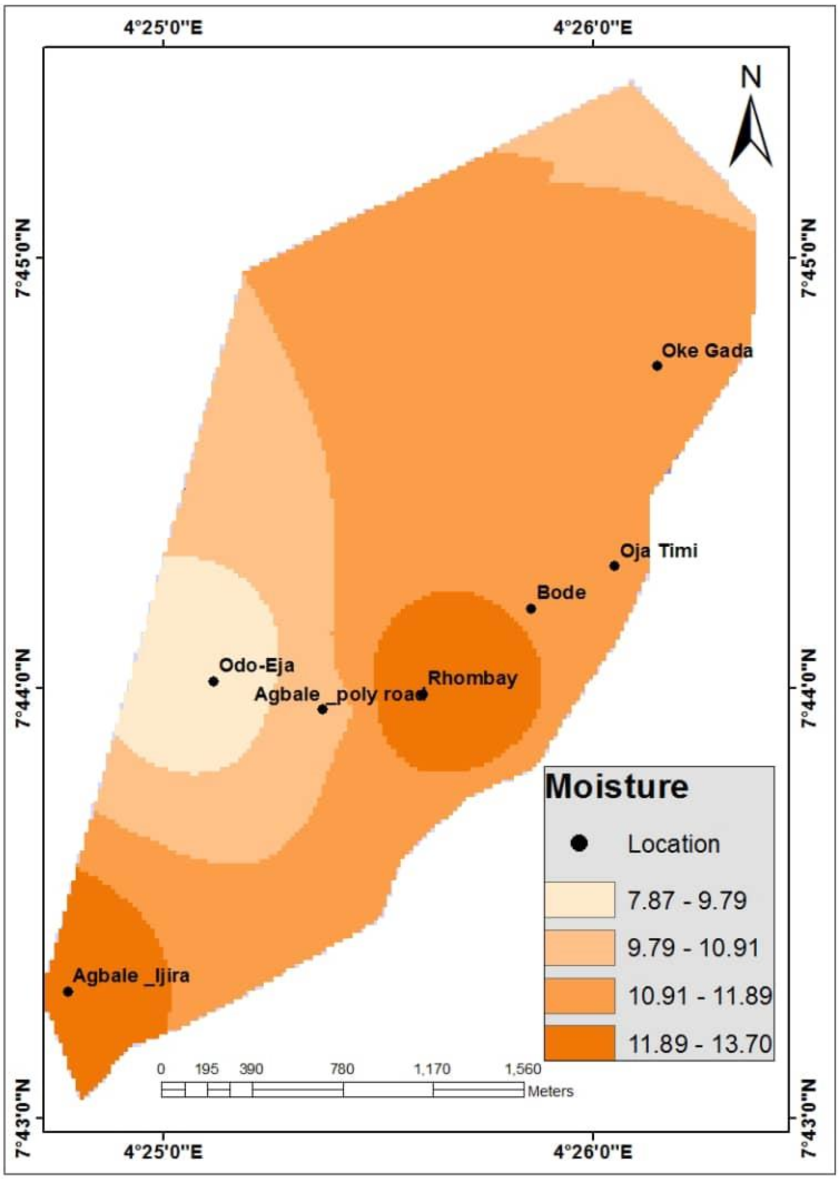


Figure 2: Variation in Moisture Content at Different Locations in Ede North

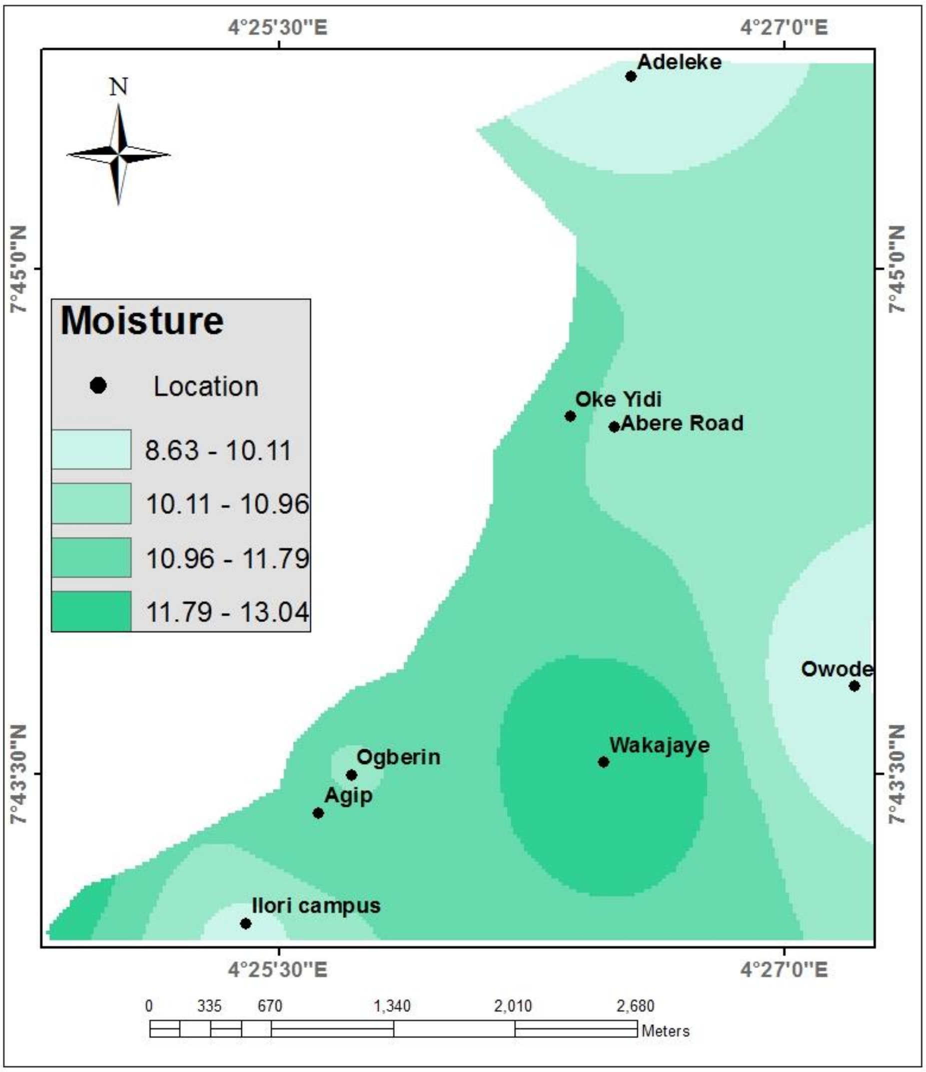


Figure 3: Variation in Moisture Content at Different Locations in Ede South

4.0 CONCLUSION

This study presented the effect of ground water on dampness of buildings in Ede Township**.** It can be concluded that water in the soil rises by capillary action up the wall of building causing damp. This is due to the closeness of the level of water table to the ground. This can be controlled by incorporating damp proof membrane such as, asphalt, polythene of good quality which will serve as a barrier between water from the ground and the walls and floors. Also, financial institutions such as the bank can offer loans to prospective building owners in order to help them achieve their objectives of implementing construction alternatives, stakeholders in building industry should sensitize people about the peculiarity of the area and collaborate with government and non-governmental organization to make sure that people do the needful during construction of their buildings.

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