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Effects of Soil Drainability on the Dampness of Buildings in Ede Township

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Abstract: Despite the lasting qualities of buildings, all buildings, be it old or modern types of construction are susceptible to natural and man-made mechanisms of deterioration. Of all defects associated with buildings, moisture is the most common and frequent, and this contributes to more than 50% of all known building failures. This research investigates the effect of soil drainability on dampness in buildings in Ede Township. Quantitative method and field test were used, one hundred (100) questionnaires were administered to residents of the study area, and double ring infiltrometer equipment was used to determine the rate at which water infiltrates into the soil according to ASTM D3385-03 standard test method. The study shows that 84% of the buildings surveyed were damped and 57% of the damped buildings became dampened a year after construction. Despite the fact that 44% of the buildings have damp proof membrane installed, yet most of them became damped due to poor workmanship. The infiltrometer and moisture content test confirmed that the two soil types found in the study area include sandy and sandy loam. However, the sandy loam has the greater percentage. It can also be inferred that water rises easily in the soil due to porous nature of some parts of the soil and some parts are cohesive in nature and they have the ability to hold water which will later infiltrate the soil through capillary action. Undersetting and saw slotting, rectifying plumbing leakages, using approved waterproof chemical injection, and application of admixtures were the main measures recommended to avert the occurrence of dampness in buildings.

Keywords: Moisture, Dampness, Drainability, Infiltrometer, Quantitative method.

1.0 INTRODUCTION

Dampness is the wetting of structural elements through moisture rise by capillary action. Damp occurs when there is excess unwanted moisture in the air that has no way of escaping. Dampness in buildings can cause a number of problems, including the destruction of timber, blocks, bricks, ineffective insulation due to cold bridging, the increased risk of mold growth, wall staining, impairment of air quality and respiratory problems in humans (Ahmed and Rahman, 2010; Hyvarinen et al., 2002; Trotman, et al., 2004; Riley & Cotgrave 2005; CWC, 2000; King et al., 2000).

Any building or plumbing problems that allow water/moisture into the property can lead to damp problems. The most common factors that allow moisture into properties include leaking roof, rainwater penetration in exterior walls, failed damp proof course, ground water intrusion into basements and crawl spaces, plumbing problems such as a leaking washing machine or dishwasher, condensation and indoor moisture sources such as poor ventilation(Ahmed & Rahman, 2010; Riley & Cotgrave, 2005; Trotman et al., 2004). Excess indoor moisture can be caused by steam when cooking, drying clothes inside the home and perspiration caused through showering and bathing.

Damp problem can be a serious concern in any building, whether as a home-owner or renter. At best, it can be a nuisance and makes the building cold, unwelcoming and unhealthy, and at worst, it can indicate structural or weatherproofing issues. Damp problems tend to be at their worse during the rainy season however, if left unresolved damp can be an issue all year round. Spot the signs of damp on walls and ceilings, walls may be wet whilst ceilings will look stained and discoloured. Basically, the affected areas are colder than the rest of the wall creating a dew-point on the walls where the moisture from the ambient air within the building condenses more readily than the higher temperature surroundings. Some major forms of dampness include rising damp, condensation damp and penetrating damp (Halim et al., 2012).

Rising damp only happens at ground floor levels as the moisture drawn up the wall comes from the soil in the ground. It is often confused with damp caused by condensation. Rising damp signs include; decaying skirting boards, crumbling plaster and tide marks on walls, and general damage on external walls such as crumbling mortar and white salt stains (Envirovent, 2021).

Soil is a product of several factors: the influence of climate, relief (elevation, orientation, and slope of terrain), organisms, and the soil's parent materials (original minerals) interacting over time (Gilluly, 1975). It continually undergoes development by way of numerous physical, chemical and biological processes, which include weathering with associated erosion (Ponge, 2015). Soil texture affects the water content and drainage ability of soils. This is because texture controls the nature of soil pores, i.e. the voids or spaces between the mineral particles in a clay soil. For instance, there are many minute pores or micro pores between the tiny clay particles. Being small, they tend to retain water but to exclude air. As a result, clay soils are prone to drain poorly and to become waterlogged. By contrast, sandy soils are dry soils.

Soil's ability to allow water movement into and through the soil profile influences the rate of rising damp. This is the infiltration rate which allows the soil to temporarily store water, making it available for uptake by plants and soil organisms. Water entering too slowly may lead to ponding on level fields or erosion from surface runoff on sloping fields while an infiltration rate that is too high can lead to nitrate-nitrogen or pesticide leaching, if they are not managed correctly. A measure of how fast water enters the soil, typically expressed in inches per hour but recorded in minutes for each inch of water applied to the soil surface is termed as infiltration rate (Smith, 2021). This research investigates the effect of soil drainability on dampness in 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 double ring infiltrometer, GIS and well structured questionnaire to collect data. The questionnaires were developed and used to obtain necessary information about damped buildings in relation to their physical environment, and the double ring infiltrometer was used to determine the rate at which water infiltrates into the soil, while the GIS application was used to produce the geographical details of the region.

Experimental Methods: A survey of one hundred (100) questionnaires were administered and distributed to residents fifty (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 rate at which water infiltrates into the soil was carried out using the double ring infiltrometer equipment according to ASTM D3385-03 standard test method and DIN 19682. The standard set consists of pairs of inner and outer rings, a driving plate, an impact absorbing hammer, measuring bridges and measuring rods with floats. The purpose of the outer ring is to have the infiltrating water act as a buffer zone against infiltrating water straining away sideways from the inner ring. Samples were also taken from the site to determine the moisture content of various locations in the study area.

3.0 RESULTS AND DISCUSSION

Tables 1 and 2 shows the results obtained from the survey of respondents from 50 questionnaires distributed in each of the two local government areas of Ede town to inspect the general causes of dampness. 82% and 80% of the buildings have been over 4 years and 50% and 46% of the respondents have owned or lived in the building for over 4 years in the northern and southern regions respectively. This shows that the buildings were susceptible to dampness attacks because studies have shown that the age of buildings is very significant to any dampness study and the older the building the more susceptible it is to dampness (Halim and Halim, 2010; Ahmed and Rahman, 2010).

Table 1: Sampled Questionnaire Results at the Northern Region of Ede Metropolis

QUESTIONS	None	< 1	1 – 3	4 – 6	7 – 9	10 – 13	14 – 16	17 – 19	> 20
How long have you owned/lived in the property? (in years)	–	–	25	16	05	04	–	–	–
How old is the property?(in years)	–	02	07	11	08	09	05	03	05
When did you first notice the problem, dampness?(in years)	14	08	18	05	04	01	–	–	–

In order of appearance of dampness on the walls of the buildings, 56% and 58% of the buildings in northern and southern regions of Ede respectively became damped a year after construction. Thus, 57% of the buildings were damped a year after construction.

Table 2: Sampled Questionnaire Results at the Southern Region of Ede Metropolis

QUESTIONS	None	< 1	1 – 3	4 – 6	7 – 9	10 – 13	14 – 16	17 – 19	> 20
How long have you owned/lived in the property? (in years)	–	05	22	18	04	01	–	–	–
How old is the property?(in years)	–	04	06	15	12	06	03	02	02
When did you first notice the problem, dampness?(in years)	–	21	24	03	01	01	–	–	–

Table 3 shows that 96% and 72% of buildings were damped in northern and southern region of Ede respectively. In the northern region, 32% of the houses have damp proof membrane installed, yet most of the buildings still remained damped, 68% of the buildings have dampness pronounced in areas where the sanitary fittings were buried in the wall than other parts which is as a result of poor workmanship.

Table 3: Degree of Dampness in Selected Buildings in Ede North and South

Questions	Northern region			Southern region		
	YES	NO	NO IDEA / NONE	YES	NO	NO IDEA / NONE
Is your building damp?	48	02	–	36	14	–
Do you have water leakage in your house during the last 2 years?	40	10	–	16	34	–
Do you have a proper drainage system in your house?	37	13	–	29	21	–
How about your area, do you have a proper drainage system?	36	14	–	20	30	–
Is there sanitary appliances? (Sewer/Waste pipe, Water pipes, etc)?	46	04	–	44	06	–
If yes, is the area more damped than other areas?	34	16	–	23	21	–
Do you have occurrence of flooding in your house within the last 2 years?	34	16	–	10	40	–
Is damp proof membrane course installed in the building?	16	34	–	28	22	–
Do you have any water body near your residence that could influence dampness in your home?	38	12	–	17	33	–
Does the soil easily drain water?	32	14	–	28	18	04

Similarly, in the southern region, despite the fact that 56% of the buildings have damp proof membrane installed, most of the buildings were damped, although not as critical as the northern region. The sampled respondents confirmed that 46% of buildings have their area of sanitary appliances fittings more damped than other areas of their buildings. This also contributes to the causes of dampness in the region, although the installation of the damp proof membrane helped in controlling the dampness problems.

Table 4: Variation in Water Infiltration Rate at Northern Region

Cumu-lative Time	Agbale (Poly Area)			Agbale (Odo-Eja)			Agbale (Ijira)			Rhombay			Bode – Rhombay			Rector's Market		
(min)	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Start 0	–	–	00	–	–	00	–	–	00	–	–	00	–	–	00	–	–	00
05	16	3.2	16	26	5.2	26	24	4.8	24	28	5.6	28	30	6.0	30	30	6.0	30
10	11	2.2	27	14	2.8	40	18	3.6	42	27	5.4	55	24	4.8	54	29	5.8	59
15	17	3.4	44	13	2.6	53	16	3.2	58	13	2.6	68	12	2.4	66	14	2.8	73
20	07	1.4	51	11	2.2	64	13	2.6	71	11	2.2	79	10	2.0	76	13	2.8	86
25	08	1.6	59	07	1.4	71	08	1.6	79	12	2.4	91	10	2.0	86	11	2.2	97
30	08	1.6	67	08	1.6	79	07	1.4	86	11	2.2	102	10	2.0	96	12	2.4	109
35	09	1.8	76	12	2.	91	14	2.8	100	10	2.0	112	09	1.8	105	11	2.4	111
40	08	1.6	84	11	2.0	102	13	2.6	113	10	2.0	122	10	2.0	115	11	2.4	122
45	10	2.0	94	11	2.2	113	10	2.0	123	11	2.2	133	10	2.0	125	10	2.0	132
50	09	1.8	103	09	1.8	122	10	2.0	133	10	2.0	143	09	1.8	134	09	1.8	141

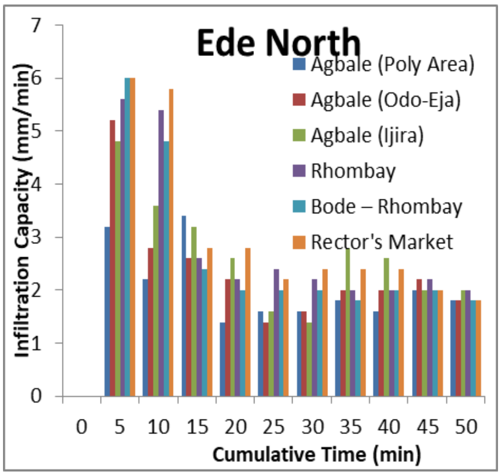
Where **A** *is Infiltration (**mm**),* **B** *is Infiltration Capacity (**mm/min**) and* **C***is Cumulative Infiltration (**mm**).*

Tables 4 and 5 shows the variation in the water filtration rate at northern and southern regions. The results show that 64% and 56% of respondents in northern and southern regions respectively claimed that the soil does not drain water easily according to Table 3 which is an indication that water does not easily percolates. Tables 4 and 5 show that after 30 minutes at most locations, there is stable or near stable infiltration rate in the soil. Also, at 15 minutes, after a depth of about 45mm – 65mm, the rate of infiltration tends to be almost equal. This indicates that at that depth of 45mm – 65mm, the soil is more cohesive. That is, the soil has some cohesive content which has ability to retain more water, thus reducing the rate at which the water enters the soil. According to Beleta et al. (2013) and Carina (2014), the soil in the study area can be classified as sandy and sandy loam/loamy sand with sandy loam/loamy sand having higher percentage. From the above it can be deduced that if rain falls more than an hour, the area will be muddy and if rain continues without good drainage system in place, it will increase the rate at which erosion is generated which might lead to flooding in the nearest future. The variation in water infiltration rate is shown below in Figures 1a and 1b respectively.

Table 5: Variation in Water Infiltration Rate at the Southern Region

Cumulative Time (min)	Ogberin – Agbale			Ogberin – Poly Gate			Ogberin			ABM – Ilori			Wakajaye			Wakajaye – Rhombay		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Start 0	–	–	00	–	–	00	–	–	00	–	–	00	–	–	00	–	–	00
05	15	3.0	15	26	5.2	26	28	5.6	28	29	5.8	29	30	6.0	30	31	6.2	31
10	19	3.8	34	21	4.2	47	24	4.8	52	26	5.2	55	26	5.2	56	27	5.4	58
15	16	3.2	50	16	3.2	63	17	3.4	69	17	3.4	72	16	3.2	72	15	3.0	73
20	11	2.2	61	11	2.2	74	11	2.2	80	12	2.4	84	13	2.6	85	12	2.4	85
25	09	1.8	70	11	2.2	85	10	2.0	90	11	2.2	95	11	2.2	96	11	2.2	96
30	10	2.0	80	10	2.0	95	11	2.2	101	11	2.2	106	09	1.8	105	08	1.6	104
35	09	1.8	89	09	1.8	104	11	2.2	112	09	1.8	115	08	1.6	103	06	1.2	110
40	09	1.8	98	11	2.2	115	10	2.0	122	07	1.4	122	07	1.4	110	05	1.0	115
45	09	1.8	107	09	1.8	124	10	2.0	132	05	1.0	127	07	1.4	117	06	1.2	121

*Where **A** is Infiltration (**mm**), **B** is Infiltration Capacity (**mm/min**) and **C** is Cumulative Infiltration (**mm**).*



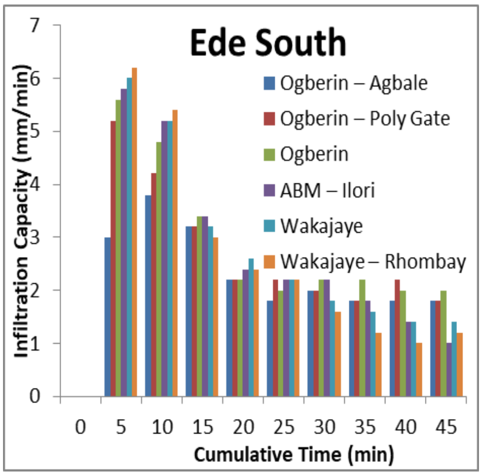


Figure 1a & 1b: Variation of infiltration rates at different locations in Ede North & South

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

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 varies from one location to another with highest value of 13.97% at Agbale Polytechnic road to the lowest value of 6.67% at Rhombay. The result revealed that soil at northern part retained more water than the soil at southern region and according to University of New South Wales the soil can be classified as sandy and sandy loam or loamy sand with sandy loam or loamy sand having highest percentage (TerraGIS, 2021). Figures 2 and 3 shows the level of dampness in various parts in northern and southern regions of Ede.

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

Northern Region					Southern Region				
S/N	**Location**	**Latitude (N)**	**Longitude (E)**	**Moisture Content (%)**	**S/N**	**Location**	**Latitude (N)**	**Longitude (E)**	**Moisture Content (%)**
A1	Agbale – Poly road	007043' 57"	004025' 22"	7.478414	**H1**	Ogberin	007043' 30"	004025' 43"	13.97
A2	Agbale– Poly road	–	–	8.750148	**H2**	Ogberin	–	–	13.34
B1	Agbale– Poly road	007044' 06"	004025' 22"	6.958737	**I1**	Ogberin	007043' 31"	004025' 37"	6.71
B2	Agbale– Poly road	–	–	13.58066	**I2**	Ogberin	–	–	9.91
C1	Agbale– Poly road	007044' 11"	004025' 32"	12.63307	**J1**	Ogberin (Poly Gate)	007043' 33"	004025' 26"	11.75
C2	Agbale– Poly road	–	–	13.81172	**J2**	Ogberin (Poly Gate)	–	–	11.55
D1	Agbale– Poly road	007044' 09"	004025' 37"	10.38427	**K1**	Ogberin (ABM)	007043' 23"	004025' 39"	12.75
D2	Agbale – Poly road	–	–	12.07699	**K2**	Ogberin (ABM)	–	–	9.46
E1	Rhombay	007043' 59"	0040 25' 36"	13.62385	**L1**	Ilori	007043' 00"	004025' 24"	7.93
E2	Rhombay	–	–	12.21659	**L2**	Ilori - College	007042' 57"	004025' 22"	6.67
F1	Rhombay	007043' 52"	004025' 35"	14.02208	**M1**	Wakajaye	007043' 32"	004026' 28"	17.32
F2	Rhombay	–	–	14.62148	**M2**	Wakajaye	–	–	8.76
G1	Rhombay	007043' 35"	004025' 38"	12.31515	**N1**	Ogberin - Agip	007043' 25"	004025' 37"	14.27
G2	Rhombay	–	–	13.57431	**N2**	Ogberin - Agip	–	–	9.04
O1	Agbale – Ijira	007043' 17"	004024' 43"	11.70364	**U11**	Owode	007043' 46"	004027' 16"	10.07
O2	Agbale – Ijira	007043' 19"	004024' 53"	13.69305	**U12**	Owode	–	–	7.18
O3	Agbale – Ijira	007043' 16"	004024' 54"	15.90326	**U21**	OkeYidi	007044' 34"	004026' 22"	8.42
P1	Odo - Eja	007044' 01"	004025' 07"	7.047934	**U22**	OkeYidi	–	–	8.88
P2	Odo - Eja	–	–	8.690077	**U31**	Abere Road	007044' 32"	004026' 30"	10.48
Q	Bode	007044' 11"	004025' 51"	15.04235	**U32**	Abere Road	–	–	10.26
R	OjaTimi	007044' 14"	004026' 07"	8.167378	**V1**	Adeleke University	007042' 37"	004025' 30"	9.78
S	OkeGada Market	007044' 45"	004026' 09"	12.5328	**V2**	Adeleke University	007042' 35"	004025' 30"	8.64
T	OkeGada	007045' 00"	004026' 11"	10.49989	–	–	–	–	–

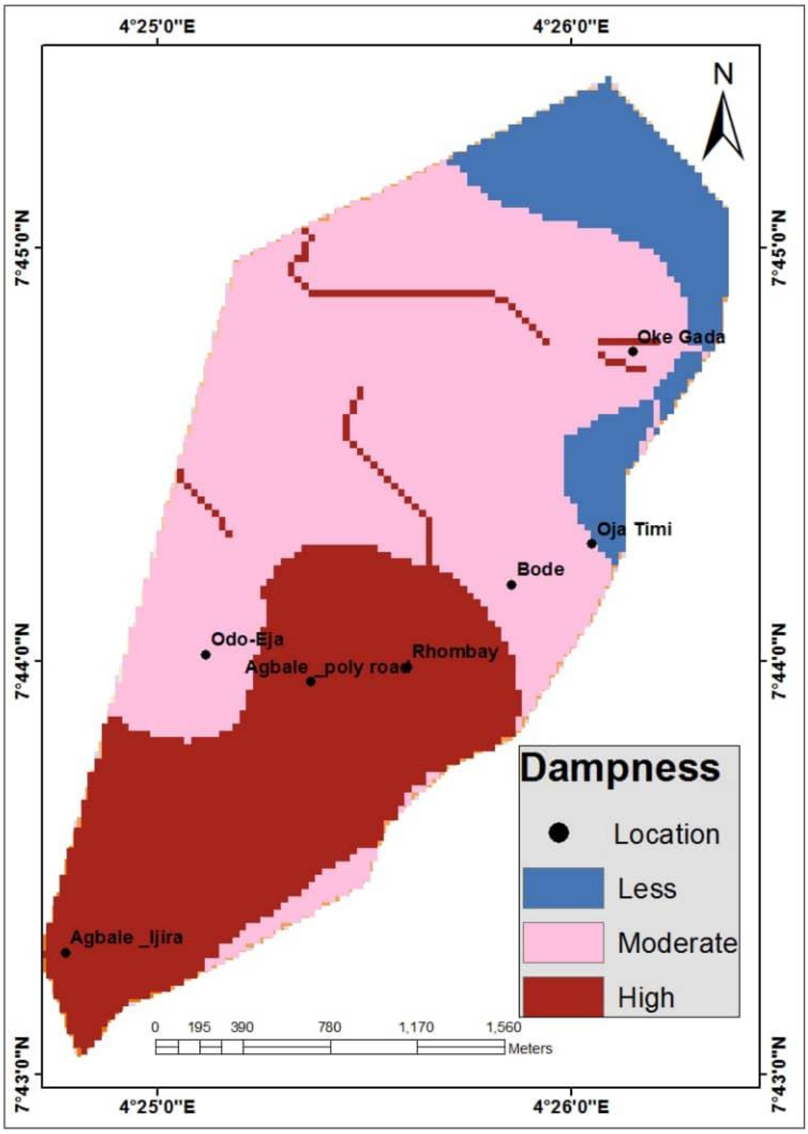


Figure 2: Soil Map Showing Dampness Rates at Different Locations in Ede Northern Region

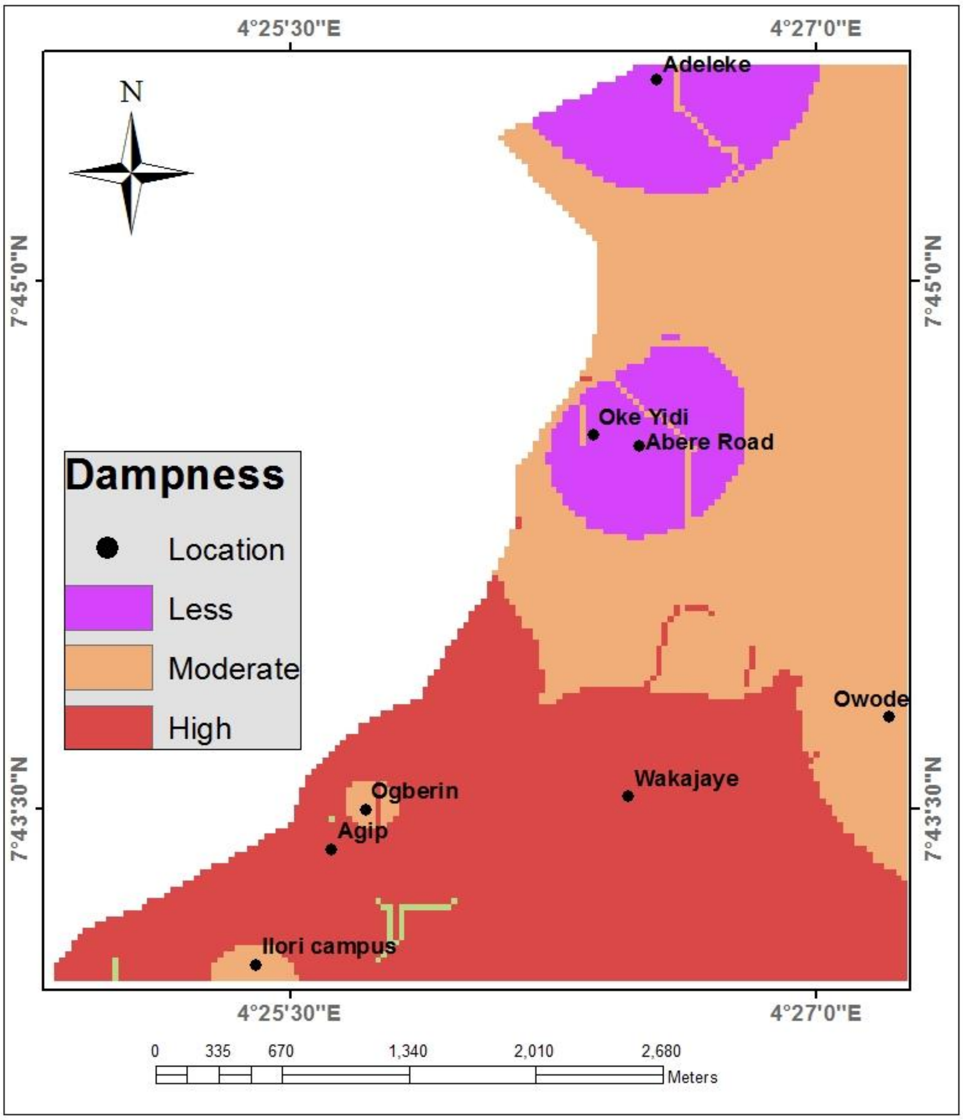


Figure 3: Soil Map Showing Dampness Rates at Different Locations in Southern Region

4.0 CONCLUSION

It can be concluded that water in the soil rises by capillary action up the wall of building causing damp which will cause it to saturate thereby causing the wall to be susceptible to discoloration and finally crack results. The results showed that 84% of the buildings surveyed were damped and most of it occurred just one year after construction. It was also discovered that the majority of respondents were ignorant of the facts that rising dampness can be controlled by incorporating damp proof membrane such as, asphalt, polythene which will prevent water from infiltrating the building and other construction alternatives. Stakeholders in building industry should sensitize people regularly on how to prevent and cure dampness; government should invest in the construction of good surface water drainage systems to prevent flooding.

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