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Modelling the Monthly Vulnerability of Land Degradation by Using the Method of a Database Design: Implication for the Sustainable Development of Greater Port Harcourt in Nigeria

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Abstract— *Land degradation being an aspect of desertification is one of the challenging environmental problems which depends on the process of a mathematical modelling. To tackle this formidable environmental science problem, we have developed a sound database system that is driven by a computationally efficient numerical scheme to clearly show that the loss of land's biological and economic productivityand complexity as defined by UNCCD [1] is more vulnerable to depletion ranging from the average value vulnerability of depletion of 7.95 approximately to 0.6 approximately. As a response to decreasing the natural growth rate of land use from0.6 to 0.006 provided the initial consumption units of land use ranges from its value of 100 to 1500.*

On the basis of this quantification, when the notion of the human population modelling is considered, the results of this present analysis clearly show that the smaller the initial consumption of land use, the more vulnerable land degradation can occur whereas the bigger the initial consumption of land use is associated with a weak vulnerability to degradation which is clearly smaller than the average vulnerability to depletion. These detailed results that we have obtained showed clear sustainable development implication which has not been seen elsewhere; these are carefully presented and discussed quantitatively

Keywords— consumption units, land degradation, target consumption units, adjustment time of consumption units.

I. INTRODUCTION

Despite the use of a system stability analysis to assess a desertification risk that is based on the application of first order ordinary differential equations in which the natural growth rate of the available land that is consumed as a constant enhancing factor, it remains an open problem to systematically quantify the deterministic differential effects of decreasing the natural growth rate on the number of consumption units. Although Ibanez *et al* [2] have described a procedure to evaluate the desertification in a particular environmental context that has applied a generic-human-resource differential equations systems, the differential effects of the initial condition on the consumption of the available land was not considered. For example, it is important to apply a sound mathematical technique to quantify the deterministic differential effects of decreasing the initial growth rate of consumption of a landed resource due to a variation of the initial consumption of the same landed resourceon the resource itself. Other related works on some aspects of measuring land desertification risk can be seen in the works of Stafford-Smith and Reynolds [3] Puigdefabregas [4, 5,], Prince [6] ,Lada [7] and Regev et al [8] to mention a few.

II. MATERIAL AND METHODS

We have adapted a reliable logistic growth equation defined for a land desertification that has the following mathematical structure, Ibanez *et al* [1]

$$\frac{dU}{dt} = g(.) + \frac{U^D - U}{uat} \qquad (2.0)$$

Here, U represents consumption units; g (.) represents natural growth of U; U^D represents target consumption units; uat represents adjustment time of consumption units.

For the purpose of this simulation modelling, we have assumed the following deterministic model parameter values g (.)=0.6, U^D = 0.65 and uat=30

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III. METHODOLOGY

Our core numerical method that we have implemented to solve and analyse this problem is called a MATLAB numerical scheme of ordinary differential equation of order 45 (ODE 45).

IV. RESULTS

On the application of the above chosen method of analysis, we have obtained the following novel results: as displayed in Table1 to Table 14.

Table.1: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 100 units using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	$P_D(\%)$
1	0.006	100.0000	100.0000	0
2	0.006	97.3330	96.7488	0.6002
3	0.006	94.7535	93.6042	1.2129
4	0.006	92.2585	90.5627	1.8381
5	0.006	89.8453	87.6209	2.4758
6	0.006	87.5113	84.7756	3.1261
7	0.006	85.2537	82.0235	3.7889
8	0.006	83.0702	79.3617	4.4643
9	0.006	80.9583	76.7871	5.1522
10	0.006	78.9156	74.2969	5.8526
11	0.006	76.9398	71.8884	6.5654
12	0.006	75.0289	69.5588	7.2906
13	0.006	73.1805	67.3056	8.0279
14	0.006	71.3928	65.1263	8.7775
15	0.006	69.6637	63.0184	9.5391
16	0.006	67.9913	60.9796	10.3125
17	0.006	66.3737	59.0077	11.0977
18	0.006	64.8091	57.1004	11.8945
19	0.006	63.2958	55.2556	12.7025
20	0.006	61.8322	53.4714	13.5218
21	0.006	60.4165	51.7456	14.3519
22	0.006	59.0472	50.0764	15.1927
23	0.006	57.7228	48.4619	16.0438
24	0.006	56.4419	46.9003	16.9051

Table.2: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 150 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	150.0000	150.0000	0
2	0.006	145.6938	145.1096	0.4010
3	0.006	141.5288	140.3796	0.8120
4	0.006	137.5004	135.8046	1.2333
5	0.006	133.6040	131.3796	1.6649
6	0.006	129.8354	127.0997	2.1070
7	0.006	126.1903	122.9601	2.5598
8	0.006	122.6647	118.9562	3.0233
9	0.006	119.2547	115.0835	3.4977
10	0.006	115.9565	111.3379	3.9831
11	0.006	112.7664	107.7150	4.4795
12	0.006	109.6809	104.2109	4.9872
13	0.006	106.6965	100.8216	5.5062
14	0.006	103.8100	97.5435	6.0365
15	0.006	101.0182	94.3729	6.5783

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Example	g (.)	U(t)	$U_M(t)$	P_D (%)
16	0.006	98.3178	91.3062	7.1316
17	0.006	95.7060	88.3400	7.6965
18	0.006	93.1798	85.4711	8.2729
19	0.006	90.7364	82.6962	8.8610
20	0.006	88.3731	80.0123	9.4608
21	0.006	86.0873	77.4164	10.0722
22	0.006	83.8765	74.9056	10.6953
23	0.006	81.7381	72.4771	11.3300
24	0.006	79.6698	70.1283	11.9764

Table.3: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 200 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	200.0000	200.0000	0
2	0.006	194.0546	193.4704	0.3011
3	0.006	188.3042	187.1549	0.6103
4	0.006	182.7423	181.0465	0.9280
5	0.006	177.3627	175.1383	1.2542
6	0.006	172.1595	169.4238	1.5890
7	0.006	167.1268	163.8966	1.9328
8	0.006	162.2592	158.5506	2.2856
9	0.006	157.5511	153.3799	2.6475
10	0.006	152.9974	148.3788	3.0188
11	0.006	148.5930	143.5415	3.3995
12	0.006	144.3329	138.8629	3.7899
13	0.006	140.2125	134.3376	4.1900
14	0.006	136.2272	129.9607	4.6000
15	0.006	132.3726	125.7273	5.0201
16	0.006	128.6443	121.6327	5.4504
17	0.006	125.0383	117.6723	5.8910
18	0.006	121.5505	113.8418	6.3420
19	0.006	118.1770	110.1368	6.8035
20	0.006	114.9141	106.5533	7.2757
21	0.006	111.7582	103.0873	7.7586
22	0.006	108.7057	99.7349	8.2524
23	0.006	105.7534	96.4924	8.7571
24	0.006	102.8978	93.3562	9.2729

Table.4: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 250 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	250.0000	250.0000	0
2	0.006	242.4154	241.8312	0.2410
3	0.006	235.0795	233.9303	0.4889
4	0.006	227.9841	226.2883	0.7438
5	0.006	221.1213	218.8969	1.0060
6	0.006	214.4835	211.7479	1.2755
7	0.006	208.0634	204.8331	1.5525
8	0.006	201.8537	198.1451	1.8372
9	0.006	195.8475	191.6764	2.1298

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Example	g (.)	U(t)	$U_M(t)$	P_D (%)
10	0.006	190.0383	185.4197	2.4304
11	0.006	184.4195	179.3681	2.7391
12	0.006	178.9849	173.5149	3.0561
13	0.006	173.7285	167.8536	3.3817
14	0.006	168.6445	162.3780	3.7158
15	0.006	163.7271	157.0818	4.0588
16	0.006	158.9709	151.9592	4.4106
17	0.006	154.3706	147.0046	4.7716
18	0.006	149.9212	142.2125	5.1418
19	0.006	145.6176	137.5774	5.5214
20	0.006	141.4551	133.0943	5.9106
21	0.006	137.4291	128.7581	6.3094
22	0.006	133.5350	124.5642	6.7180
23	0.006	129.7686	120.5077	7.1365
24	0.006	126.1257	116.5842	7.5651

Table.5: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 300 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	300.0000	300.0000	0
2	0.006	290.7762	290.1920	0.2009
3	0.006	281.8549	280.7056	0.4078
4	0.006	273.2260	271.5302	0.6207
5	0.006	264.8800	262.6556	0.8398
6	0.006	256.8076	254.0719	1.0653
7	0.006	248.9999	245.7697	1.2973
8	0.006	241.4481	237.7396	1.5360
9	0.006	234.1439	229.9728	1.7814
10	0.006	227.0792	222.4606	2.0339
11	0.006	220.2461	215.1947	2.2935
12	0.006	213.6370	208.1670	2.5604
13	0.006	207.2445	201.3696	2.8348
14	0.006	201.0617	194.7952	3.1167
15	0.006	195.0815	188.4362	3.4064
16	0.006	189.2974	182.2858	3.7040
17	0.006	183.7029	176.3369	4.0097
18	0.006	178.2918	170.5831	4.3236
19	0.006	173.0582	165.0180	4.6459
20	0.006	167.9961	159.6353	4.9768
21	0.006	163.0999	154.4290	5.3163
22	0.006	158.3643	149.3934	5.6647
23	0.006	153.7839	144.5229	6.0221
24	0.006	149.3537	139.8121	6.3886

Table.6: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 350 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	350.0000	350.0000	0
2	0.006	339.1371	338.5528	0.1723
3	0.006	328.6302	327.4810	0.3497

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Example	g (.)	U(t)	$U_M(t)$	P_D (%)
4	0.006	318.4679	316.7721	0.5325
5	0.006	308.6387	306.4143	0.7207
6	0.006	299.1317	296.3960	0.9145
7	0.006	289.9364	286.7062	1.1141
8	0.006	281.0426	277.3341	1.3196
9	0.006	272.4404	268.2692	1.5310
10	0.006	264.1201	259.5015	1.7487
11	0.006	256.0726	251.0212	1.9726
12	0.006	248.2890	242.8190	2.2031
13	0.006	240.7605	234.8857	2.4401
14	0.006	233.4789	227.2124	2.6840
15	0.006	226.4360	219.7907	2.9347
16	0.006	219.6239	212.6123	3.1926
17	0.006	213.0352	205.6693	3.4576
18	0.006	206.6625	198.9538	3.7301
19	0.006	200.4987	192.4586	4.0101
20	0.006	194.5370	186.1762	4.2978
21	0.006	188.7708	180.0999	4.5934
22	0.006	183.1935	174.2227	4.8969
23	0.006	177.7992	168.5382	5.2087
24	0.006	172.5816	163.0401	5.5287

Table.7: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 400 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	400.0000	400.0000	0
2	0.006	387.4979	386.9137	0.1508
3	0.006	375.4056	374.2563	0.3061
4	0.006	363.7097	362.0140	0.4663
5	0.006	352.3973	350.1729	0.6312
6	0.006	341.4558	338.7201	0.8012
7	0.006	330.8730	327.6428	0.9763
8	0.006	320.6371	316.9286	1.1566
9	0.006	310.7368	306.5656	1.3423
10	0.006	301.1610	296.5424	1.5336
11	0.006	291.8992	286.8478	1.7305
12	0.006	282.9410	277.4710	1.9333
13	0.006	274.2765	268.4017	2.1420
14	0.006	265.8961	259.6296	2.3567
15	0.006	257.7904	251.1451	2.5778
16	0.006	249.9505	242.9388	2.8052
17	0.006	242.3675	235.0016	3.0392
18	0.006	235.0332	227.3245	3.2798
19	0.006	227.9393	219.8991	3.5273
20	0.006	221.0780	212.7172	3.7818
21	0.006	214.4416	205.7707	4.0435
22	0.006	208.0228	199.0520	4.3124
23	0.006	201.8144	192.5535	4.5888
24	0.006	195.8096	186.2680	4.8729

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Table.8: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 450 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	450.0000	450.0000	0
2	0.006	435.8587	435.2745	0.1340
3	0.006	422.1809	421.0317	0.2722
4	0.006	408.9516	407.2558	0.4147
5	0.006	396.1560	393.9316	0.5615
6	0.006	383.7799	381.0442	0.7128
7	0.006	371.8095	368.5793	0.8688
8	0.006	360.2316	356.5230	1.0295
9	0.006	349.0332	344.8620	1.1951
10	0.006	338.2019	333.5833	1.3656
11	0.006	327.7258	322.6744	1.5414
12	0.006	317.5931	312.1231	1.7223
13	0.006	307.7926	301.9177	1.9087
14	0.006	298.3133	292.0468	2.1006
15	0.006	289.1449	282.4996	2.2983
16	0.006	280.2770	273.2654	2.5017
17	0.006	271.6998	264.3339	2.7111
18	0.006	263.4039	255.6952	2.9266
19	0.006	255.3799	247.3397	3.1483
20	0.006	247.6190	239.2582	3.3765
21	0.006	240.1125	231.4416	3.6112
22	0.006	232.8521	223.8812	3.8526
23	0.006	225.8297	216.5687	4.1009
24	0.006	219.0375	209.4960	4.3561

Table.9: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 500 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	500.0000	500.0000	0
2	0.006	484.2195	483.6353	0.1206
3	0.006	468.9563	467.8070	0.2451
4	0.006	454.1935	452.4977	0.3734
5	0.006	439.9147	437.6903	0.5056
6	0.006	426.1040	423.3683	0.6420
7	0.006	412.7460	409.5158	0.7826
8	0.006	399.8260	396.1175	0.9275
9	0.006	387.3296	383.1584	1.0769
10	0.006	375.2429	370.6242	1.2308
11	0.006	363.5523	358.5009	1.3895
12	0.006	352.2451	346.7751	1.5529
13	0.006	341.3086	335.4337	1.7213
14	0.006	330.7305	324.4640	1.8947
15	0.006	320.4993	313.8541	2.0734
16	0.006	310.6035	303.5919	2.2574
17	0.006	301.0322	293.6662	2.4469
18	0.006	291.7746	284.0659	2.6420
19	0.006	282.8205	274.7803	2.8429
20	0.006	274.1599	265.7991	3.0496

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Example	g (.)	U(t)	$U_M(t)$	P_D (%)
21	0.006	265.7833	257.1124	3.2624
22	0.006	257.6813	248.7105	3.4814
23	0.006	249.8450	240.5840	3.7067
24	0.006	242.2655	232.7239	3.9385

Table.10: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 550 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	550.0000	550.0000	0
2	0.006	532.5803	531.9961	0.1097
3	0.006	515.7316	514.5824	0.2228
4	0.006	499.4354	497.7396	0.3395
5	0.006	483.6733	481.4489	0.4599
6	0.006	468.4281	465.6924	0.5840
7	0.006	453.6826	450.4524	0.7120
8	0.006	439.4205	435.7120	0.8440
9	0.006	425.6260	421.4549	0.9800
10	0.006	412.2838	407.6651	1.1203
11	0.006	399.3789	394.3275	1.2648
12	0.006	386.8971	381.4271	1.4138
13	0.006	374.8246	368.9497	1.5674
14	0.006	363.1478	356.8813	1.7256
15	0.006	351.8538	345.2085	1.8886
16	0.006	340.9301	333.9184	2.0566
17	0.006	330.3645	322.9985	2.2296
18	0.006	320.1453	312.4366	2.4079
19	0.006	310.2611	302.2209	2.5914
20	0.006	300.7009	292.3401	2.7804
21	0.006	291.4542	282.7833	2.9750
22	0.006	282.5106	273.5398	3.1754
23	0.006	273.8602	264.5993	3.3816
24	0.006	265.4934	255.9519	3.5939

Table.11: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 600 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	600.0000	600.0000	0
2	0.006	580.9411	580.3569	0.1006
3	0.006	562.5070	561.3577	0.2043
4	0.006	544.6772	542.9814	0.3113
5	0.006	527.4320	525.2076	0.4217
6	0.006	510.7522	508.0165	0.5356
7	0.006	494.6191	491.3889	0.6531
8	0.006	479.0150	475.3065	0.7742
9	0.006	463.9224	459.7513	0.8991
10	0.006	449.3247	444.7061	1.0279
11	0.006	435.2055	430.1541	1.1607
12	0.006	421.5492	416.0791	1.2976
13	0.006	408.3406	402.4657	1.4387
14	0.006	395.5650	389.2985	1.5842

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Example	g (.)	U(t)	$U_M(t)$	P_D (%)
15	0.006	383.2082	376.5630	1.7341
16	0.006	371.2566	364.2450	1.8886
17	0.006	359.6968	352.3308	2.0478
18	0.006	348.5159	340.8072	2.2119
19	0.006	337.7016	329.6615	2.3809
20	0.006	327.2419	318.8811	2.5549
21	0.006	317.1250	308.4541	2.7342
22	0.006	307.3399	298.3690	2.9189
23	0.006	297.8755	288.6145	3.1090
24	0.006	288.7214	279.1798	3.3048

Table.12: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 650 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	650.0000	650.000	0
2	0.006	629.3019	628.7177	0.0928
3	0.006	609.2823	608.1331	0.1886
4	0.006	589.9191	588.2233	0.2875
5	0.006	571.1907	568.9663	0.3894
6	0.006	553.0762	550.3405	0.4946
7	0.006	535.5557	532.3254	0.6032
8	0.006	518.6095	514.9009	0.7151
9	0.006	502.2189	498.0477	0.8305
10	0.006	486.3656	481.7470	0.9496
11	0.006	471.0320	465.9806	1.0724
12	0.006	456.2012	450.7312	1.1990
13	0.006	441.8566	435.9817	1.3296
14	0.006	427.9822	421.7157	1.4642
15	0.006	414.5627	407.9174	1.6030
16	0.006	401.5831	394.5715	1.7460
17	0.006	389.0291	381.6631	1.8934
18	0.006	376.8866	369.1779	2.0454
19	0.006	365.1422	357.1020	2.2019
20	0.006	353.7829	345.4221	2.3633
21	0.006	342.7959	334.1250	2.5295
22	0.006	332.1691	323.1983	2.7007
23	0.006	321.8908	312.6298	2.8771
24	0.006	311.9493	302.4078	3.0587

Table.13: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 1000 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	1.0000	1.0000	0
2	0.006	0.9678	0.9672	0.0001
3	0.006	0.9367	0.9356	0.0001
4	0.006	0.9066	0.9049	0.0002
5	0.006	0.8775	0.8753	0.0003
6	0.006	0.8493	0.8466	0.0003
7	0.006	0.8221	0.8189	0.0004
8	0.006	0.7958	0.7921	0.0005

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Example	g (.)	U(t)	$U_M(t)$	P_D (%)
9	0.006	0.7703	0.7661	0.0005
10	0.006	0.7457	0.7410	0.0006
11	0.006	0.7218	0.7168	0.0007
12	0.006	0.6988	0.6933	0.0008
13	0.006	0.6765	0.6706	0.0009
14	0.006	0.6549	0.6486	0.0010
15	0.006	0.6340	0.6274	0.0010
16	0.006	0.6139	0.6069	0.0011
17	0.006	0.5944	0.5870	0.0012
18	0.006	0.5755	0.5678	0.0013
19	0.006	0.5572	0.5492	0.0014
20	0.006	0.5396	0.5312	0.0015
21	0.006	0.5225	0.5138	0.0017
22	0.006	0.5060	0.4970	0.0018
23	0.006	0.4900	0.4807	0.0019
24	0.006	0.4745	0.4650	0.0020

Table.14: Assessing the effect of decreasing the natural growth rate of consumption of a land use due to initial consumption value of 1500 using ODE 45 numerical scheme: when the original natural growth rate is 0.6

Example	g (.)	U(t)	$U_M(t)$	P_D (%)
1	0.006	1.5000	1.5000	0
2	0.006	1.4514	1.4509	0.0000
3	0.006	1.4045	1.4033	0.0001
4	0.006	1.3590	1.3573	0.0001
5	0.006	1.3151	1.3129	0.0002
6	0.006	1.2726	1.2699	0.0002
7	0.006	1.2315	1.2282	0.0003
8	0.006	1.1917	1.1880	0.0003
9	0.006	1.1533	1.1491	0.0004
10	0.006	1.1161	1.1114	0.0004
11	0.006	1.0801	1.0750	0.0005
12	0.006	1.0453	1.0398	0.0005
13	0.006	1.0116	1.0058	0.0006
14	0.006	0.9791	0.9728	0.0006
15	0.006	0.9476	0.9409	0.0007
16	0.006	0.9171	0.9101	0.0008
17	0.006	0.8877	0.8803	0.0008
18	0.006	0.8592	0.8515	0.0009
19	0.006	0.8316	0.8236	0.0010
20	0.006	0.8050	0.7966	0.0010
21	0.006	0.7792	0.7705	0.0011
22	0.006	0.7543	0.7453	0.0012
23	0.006	0.7302	0.7209	0.0013
24	0.006	0.7068	0.6973	0.0013

V. DISCUSSION OF RESULTS

The results that we have obtained are fully discussed as follows:

When the natural growth rate of the land use decreases, from its originally assumed value of 0.6 to a new value of 0.006, when the initial consumption units of land use is 100, we have utilised a MATLAB numerical scheme called ODE45 to indicate that there will be a dominant depletion of the land use. In this first case, we have observed that when all the model parameter value are

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fixed, the number of units of the land use has decreased monotonically from its value of 100 units(initially) for the first month to about 56.4 at the end of 24 months approximately.

In contrast, when the effect of decreasing the natural growth under the simplifying assumption of the initial consumption of 100 units of land use, the new simulated data of the units of land use similarly decreases from its value of 100 units monotonically to about 46.9 approximately. Pulling these two set of solution map data together, we have observed that the proportion of land use that is depleted ranges from a low value of zero and increase monotonically to a relatively high value in percentage term to 16.9 approximately. In terms of statistical quantification of the vulnerability of land use to depletion, the average vulnerability has been calculated in this first case to be 7.9473. Looking at the solution map of the simulated data, we have observed the minimum vulnerability to depletion of 16.9% at the end of 24 months.

We have further use the average measure of vulnerability value of 7.9473 to re-classify this vulnerability quantification into relatively weaker vulnerability which in this case are clearly represented by the first twelve (12) empirical examples which shows the occurrence of the depletion of land use for the first to twelve months. Similarly, we have use the same average vulnerability to clearly show that land is more vulnerable to depletion otherwise called bio-diversity loss or the loss lands biological and economic productivity and complexity as defined United Nations convection to combat desertification (UNCCD) [1] from month thirteen (13) to twenty-fourth month.

Apart from Table 1 data, Table 2 to Table 11 clearly show that land use is weakly vulnerable to depletion and from the first thirteen months and relatively more vulnerable to depletion from the fourteenth month onwards. This pattern has changed from Table 13and Table 14 in which the proportion of land use that is depleted is dominantly smaller than the average vulnerability to land use depletion as expected. This results clearly show that at some stage, the depletion of land degradation would recover from depletion to an increase in the proportion of land use.

In summary, the average vulnerability to land degradation due to the effect of decreasing the natural growth of the consumption of land use due to the differential effects of initial consumption value decreases monotonically from its value of 7.9473(Table 1) to about 0.5963(Table 14) approximately.

VI. CONCLUSION

We have systematically applied the technique of a simulation modelling that is indexed by a numerical scheme ofODE 45 to clearly show that land use can be vulnerable to land degradation due to the differential effects of decreasing the natural growth rate consumption of land use and the initial consumption. These present observations have shown that the variation of these two factors have predicted three hundred and thirty-six (336) scenarios of land depletion. This prediction is a dominant numerical evidence that the appropriate policy should be put into place to mitigate land degradation which has a far reaching implication for the sustainable development initiative of Greater Port Harcourt in Nigeria.

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