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On The Principle of Parsimony Perspective of Uncertainty Analysis: ODE Numerical Stimulation

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Abstract
In this study, we have applied a numerical method to calculate the effect of the principle of parsimony assumption on the uncertainty analysis index by a 1-norms error value provided a multiplicative random perturbation of 0.01 is applied on the initial condition values of x(0) = 1, y(0) = 1. We will expect this alternative method of calculating the effect of the principle of parsimony on the basis of a probabilistic assumption on the initial data to complement and move the frontier of knowledge in numerical simulation. The novel result that we have obtained that we have not seen elsewhere are presented and discussed quantitatively.
Keywords and phrases: Principle of parsimony, uncertainty analysis, 1-norms error analysis, random perturbation, initial data, numerical simulation.

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I. Introduction

Since a mathematical model is not an exact quantification of a real life problem, it is imperative to look at the effect a fluctuating random perturbation on a specific dynamical system. Due to the inevitability of an experimental error, there are three (3) popular fundamental error analysis techniques, namely, 1-norms error, 2-norms error and the infinity-norms error, which can be subjected to three (3) levels of random-perturbation such as the additive random perturbation on the initial condition boundaries. For the purpose of this pioneering study, the 1-norm error value specifies the trend of uncertainty analysis in the event of a low multiplicative random perturbation which is an extension of the research contribution of Nafo (2010), Ekaka-a, (2009); Ekaka-a et al (2012), Nafo et al (2014), Koot (2003), Ekaka-a and Nafo (2012), Nafo et al (2013).

II. Mathematical Formulations

Following Nafo (2016) and Ekaka-a (2009), we have considered the following non-linear dynamical system of first order differential equations, having the following mathematical structure.

$$\frac{dx}{dt} = \alpha_1 x - \beta_1 x^2 - \gamma_1 xy + c_1. \quad (1)$$

$$\frac{dy}{dt} = \alpha_2 y - \beta_2 y^2 - \gamma_2 xy + c_2 \quad (2)$$

where c_1 and c_2 are called positive control terms on the specified dynamical system with the initial condition $x(0) = x_o > 0$ and $y(0) = y_o > 0$. For the purpose of this dynamical system, x(t) defines the biomass of the first specie in the non-artic eco-system (Pielou, 1977).
y(t) defines the biomass of the second yeast specie in the eco-system. In this Lotka-Volterra system
α_1 and α_2 define the intrinsic growth rates of the two yeast species
β_1 and β_2 define the intra-species coefficients
γ_1 and γ_2 define the inter-species coefficients of the first and second yeast species whereas the notation t defines the length of the growing season in the unit of months.
For the purpose of this important study, we have considered the following parameter values (Pielou, 1977).
$\alpha_1 = 0.1$, $\beta_1 = 0.0014$, $\gamma_1 = 0.0012$, $\alpha_2 = 0.08$, $\beta_2 = 0.001$, $\gamma_2 = 0.0009$,
$c_1 = c_2 = 0.1$, c_1 and $c_2 = 0.5$, $c_1 = c_2 = 1.5$

III. Method of Analysis

To solve and analyse this proposed challenging problem on the effect of the principle of parsimony on the over-simplicity of model parameterization on the uncertainty analysis, we have applied the computationally efficient method of ODE45 numerical simulation. When the new uncertainty analysis values are smaller than the original uncertainty values in the absence of a zero random perturbation, the depletion effect can be calculated by using a simple mathematical expression which is defined by

$$UA\ (\%) \ = \left[\frac{UA\ (old\ ) - UA\ (New\ )}{UA\ (Old\ )} \right] \tag{3}$$

where the notation UA, signifies Uncertainty Analysis differentiated into UA(old) and UA (New), provided UA(old) > UA(New) and UA(old) $\neq$ 0

IV. Results

The full results of this study are presented as shown in Table 1.1 – Table 3.4.

Table 1.1: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 1, $c_1 = c_2 = 0.1$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	31.238996284803083	5.963455367778963	80.910220951368970
2.	31.238996284803083	4.674605879208924	85.035992076726899
3.	31.238996284803083	7.033332065425164	77.485409578134608
4.	31.238996284803083	5.444596029834834	82.571155679276799
5.	31.238996284803083	6.171187128369148	80.245245166947754
6.	31.238996284803083	4.654108695618921	85.101606168175721
7.	31.238996284803083	7.060238012460946	77.399280219846375
8.	31.238996284803083	7.337518712087993	76.511669436519327
9.	31.238996284803083	5.180202384100039	83.417513364153550
10.	31.238996284803083	5.828420165896544	81.342485806011922
11.	31.238996284803083	7.202109132673357	76.945132721255234
12.	31.238996284803083	5.989178645533467	80.827877467858855
13.	31.238996284803083	5.923538410602186	81.038000207824140
14.	31.238996284803083	6.740763711010377	78.421958088680412
15.	31.238996284803083	6.949688936937436	77.753161869934118
16.	31.238996284803083	7.325156904222553	76.551241155638408
17.	31.238996284803083	6.309789896942187	79.801560077614496
18.	31.238996284803083	4.738112406488534	84.832699606313881
19.	31.238996284803083	6.769145769695212	78.331103509275636
20.	31.238996284803083	7.882299450198250	74.767757010065097

Table 1.2: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 2, $c_1 = c_2 = 0.1$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	31.238996284803083	6.059562767932654	80.602568940793830
2.	31.238996284803083	6.046255448662326	80.645167362167584
3.	31.238996284803083	5.352992923909408	82.864388871183124
4.	31.238996284803083	5.622336770958633	82.002184962345453
5.	31.238996284803083	5.994051142932310	80.812279984013912
6.	31.238996284803083	5.242886230247156	83.216854400672034
7.	31.238996284803083	6.964751055719848	77.704946112151475
8.	31.238996284803083	5.209316632019906	83.324314953889555
9.	31.238996284803083	7.335552551944067	76.517963365191051
10.	31.238996284803083	6.690196548122163	78.583830008082685
11.	31.238996284803083	7.014293947747126	77.546353014039099
12.	31.238996284803083	5.661126205848903	81.878015048124681
13.	31.238996284803083	6.035509249545032	80.679567312215013
14.	31.238996284803083	6.760862408360785	78.357619602362973
15.	31.238996284803083	5.639030896103750	81.948744944641561
16.	31.238996284803083	7.221690487499369	76.882450314152621
17.	31.238996284803083	7.180848607518866	77.013190366131738
18.	31.238996284803083	7.247596221752262	76.799522764186818

19.	31.238996284803083	5.750406333699026	81.592218004467583
20.	31.238996284803083	6.297572414998442	79.840669791103252

Table 1.3: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 3, $c_1 = c_2 = 0.1$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	31.238996284803083	5.170731593615821	83.447830568963440
2.	31.238996284803083	6.084721339824403	80.522033152568184
3.	31.238996284803083	7.339023860228110	76.506851265902085
4.	31.238996284803083	6.101735479420761	80.467568727907278
5.	31.238996284803083	5.614877061361175	82.026064441472926
6.	31.238996284803083	5.831609809713733	81.332275350502698
7.	31.238996284803083	5.584440701847864	82.123495099090164
8.	31.238996284803083	7.667535892798079	75.455242470360275
9.	31.238996284803083	6.196064610044633	80.165609184252659
10.	31.238996284803083	5.243056066656011	83.216310732727948
11.	31.238996284803083	4.884424613308266	84.364335624687143
12.	31.238996284803083	5.536465849433441	82.277068702982689
13.	31.238996284803083	5.150419161860718	83.512853246292494
14.	31.238996284803083	5.254705034164967	83.179020906247118
15.	13.238996284803083	5.962102663815024	80.914551128790833
16.	31.238996284803083	6.639990356242379	78.744546413379638
17.	31.238996284803083	4.846151670949221	84.486852180629299
18.	31.238996284803083	4.828049362250742	84.544799972976548
19.	31.238996284803083	5.280032812561243	83.097943466481240
20.	31.238996284803083	5.213339923712211	83.311435885510960

Table 1.4: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 1, $c_1 = c_2 = 0.1$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	31.238996284803083	4.585654403979694	85.320737061547362
2.	31.238996284803083	4.643895378000177	85.134300296775848
3.	31.238996284803083	6.031637516270722	80.691961222822812
4.	31.238996284803083	5.289575657524019	83.067395606121792
5.	31.238996284803083	5.046989165820466	83.843945817568766
6.	31.238996284803083	5.204724251101916	83.339015749254813
7.	31.238996284803083	5.697369063735747	81.761997050758765
8.	31.238996284803083	5.839747850508969	81.306224446942792
9.	31.238996284803083	6.682851785469956	78.607341527419749
10.	31.238996284803083	6.755189216232475	78.375780211867138
11.	31.238996284803083	6.566779541621452	78.978903541737637
12.	31.238996284803083	5.641883591748899	81.939613103083218
13.	31.238996284803083	6.542284441490318	79.057315472478990
14.	31.238996284803083	6.081084790043074	80.533674210904920
15.	31.238996284803083	5.742111113202073	81.618772060242364
16.	31.238996284803083	6.626818077224311	78.786712553731832
17.	31.238996284803083	6.085244949112306	80.520357012646372
18.	31.238996284803083	5.979599433693052	80.858541743218680
19.	31.238996284803083	5.049673756680775	83.835352100805807
20.	31.238996284803083	6.401749865603496	79.507184522705771

Table 2.1: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 1, $c_1 = c_2 = 0.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	30.960533092550310	18.646314644044381	39.773922534521745
2.	30.960533092550310	20.415783977640984	34.058680719055815
3.	30.960533092550310	19.464570089224079	37.131024097554629
4.	30.960533092550310	18.877138055114884	39.028381718475387
5.	30.960533092550310	18.612543983840919	39.882999016191199
6.	30.960533092550310	19.844729010558719	35.903141747472894
7.	30.960533092550310	19.526397171363545	36.931327658366563
8.	30.960533092550310	18.803850895852449	39.265093273290539
9.	30.960533092550310	19.552670218475232	36.846467856265775

10.	30.960533092550310	18.040018188597049	41.732210699764025
11.	30.960533092550310	17.636094936900125	43.036849901193392
12.	30.960533092550310	19.321815459298136	37.592109924142967
13.	30.960533092550310	18.670680825754324	39.695221752344942
14.	30.960533092550310	18.445694866620123	40.421908074126456
15.	30.960533092550310	18.039333353296431	41.734422662001784
16.	30.960533092550310	18.087125784215552	41.580057003063501
17.	30.960533092550310	18.574090176067468	40.007201683046134
18.	30.960533092550310	18.773223960080927	39.364015781116770
19.	30.960533092550310	20.068455112140700	35.180524662963407
20.	30.960533092550310	19.928902268759458	35.631268979813754

Table 2.2: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 2, $c_1 = c_2 = 0.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	30.960533092550310	17.828404463660611	42.415705794321539
2.	30.960533092550310	19.060695946574782	38.435504680760339
3.	30.960533092550310	19.623723193643645	36.616972534088944
4.	30.960533092550310	18.668980289672682	39.700714345371559
5.	30.960533092550310	19.487934127152478	37.055560158162642
6.	30.960533092550310	18.859865375208443	39.084171067627757
7.	30.960533092550310	20.582563279147379	33.519997160191231
8.	30.960533092550310	19.574676486411384	36.775389403351646
9.	30.960533092550310	19.591331349816112	36.721595551175582
10.	30.960533092550310	19.076673544310250	38.383898341529338
11.	30.960533092550310	17.967163243818380	41.967526237002623
12.	30.960533092550310	18.872840678141806	39.042261896055763
13.	30.960533092550310	19.758121555033483	36.182876774212716
14.	30.960533092550310	19.100793629109880	38.305992432327038
15.	30.960533092550310	20.056901754794662	35.217841066112868
16.	30.960533092550310	19.304294291877628	37.648701867725251
17.	30.960533092550310	19.689175780961442	36.405566008490240
18.	30.960533092550310	19.688126827394157	36.408954043070104
19.	30.960533092550310	18.393194320491553	40.591480561691931
20.	30.960533092550310	18.848655233687563	39.12037891161859

Table 2.3: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 3, $c_1 = c_2 = 0.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	30.960533092550310	18.603983398022770	39.910649011081659
2.	30.960533092550310	19.150697565333946	38.144806783246359
3.	30.960533092550310	18.390737513690013	40.599415847541806
4.	30.960533092550310	19.220767243262401	37.918487431060157
5.	30.960533092550310	19.111953191363625	38.269947955249123
6.	30.960533092550310	18.751561231633268	39.433984629466060
7.	30.960533092550310	17.455536898185624	43.620037658893686
8.	30.960533092550310	19.053434933624487	38.458957161144284
9.	30.960533092550310	19.294894775753058	37.679061539170419
10.	30.960533092550310	19.280787561108799	37.724626693368791
11.	30.960533092550310	19.183977908750681	38.037313984859296
12.	30.960533092550310	17.874546439083836	42.266670972197211
13.	30.960533092550310	18.724605431370062	39.521049668632621
14.	30.960533092550310	18.416815952863814	40.515184613228612
15.	30.960533092550310	18.131465339701958	41.436843850519061
16.	30.960533092550310	18.352593753233933	40.722617086816527
17.	30.960533092550310	19.282253409185863	37.719892123480463
18.	30.960533092550310	19.126070470561693	38.224350293361752
19.	30.960533092550310	19.037445443258605	38.510601912602809
20.	30.960533092550310	20.557116253613579	33.602188979879003

Table 2.4: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 4, $c_1 = c_2 = 0.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	30.960533092550310	18.096845618429114	41.548662730282388
2.	30.960533092550310	19.477999322052888	37.087648769395180
3.	30.960533092550310	18.668218710736674	39.703174183300476
4.	30.960533092550310	18.205535476728414	41.197603341303548
5.	30.960533092550310	17.878075020957105	42.255273940167044
6.	30.960533092550310	19.518884104512424	36.955594252319138
7.	30.960533092550310	18.577506959129032	39.996165752071207
8.	30.960533092550310	19.640327917584159	36.563340628298178
9.	30.960533092550310	19.668361026616420	36.472795969559712
10.	30.960533092550310	18.682324515229908	39.657613583775053
11.	30.960533092550310	18.905824526944091	38.935726751122417
12.	30.960533092550310	19.655022076707844	36.515879691240798
13.	30.960533092550310	18.845162680233663	39.131659574788891
14.	30.960533092550310	19.740164227678584	36.240877478855680
15.	30.960533092550310	19.860398720512897	35.852529860696478
16.	30.960533092550310	19.165617640878224	38.096616154552471
17.	30.960533092550310	20.052166527878544	35.233135463344219
18.	30.960533092550310	20.026247012611918	35.316853386382377
19.	30.960533092550310	19.201492968423786	37.980741768803625
20.	30.960533092550310	18.919661772313773	38.891033575690585

Table 3.1: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 1, $c_1 = c_2 = 1.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	16.408872501594871	18.783585928361909	14.472130407108871
2.	16.408872501594871	18.499152541163046	12.738718271867908
3.	16.408872501594871	18.313135225602288	11.605079653232304
4.	16.408872501594871	19.183028966578227	16.906441711419966
5.	16.408872501594871	17.967492990737327	9.498644644785708
6.	16.408872501594871	18.148401529558662	10.601149029555296
7.	16.408872501594871	17.760386795592243	8.236484827741887
8.	16.408872501594871	17.980941516129576	9.580603508144186
9.	16.408872501594871	18.610341580798650	13.416333626760801
10.	16.408872501594871	17.637317930106789	7.486470678546126
11.	16.408872501594871	18.828377268163209	14.745100654131917
12.	16.408872501594871	18.069454786284595	10.120026738755650
13.	16.408872501594871	18.135958189500407	10.525316030931867
14.	16.408872501594871	18.195975040386465	10.891074561143034
15.	16.408872501594871	17.754235266319604	8.198995784713238
16.	16.408872501594871	17.745704996866490	8.147010071177556
17.	16.408872501594871	17.885290214658582	8.997679230673585
18.	16.408872501594871	17.728191843761010	8.040280293712485
19.	16.408872501594871	17.795648556697014	8.451379306941133
20.	16.408872501594871	19.215853611518881	17.106483761460048

Table 3.2: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 2, $c_1 = c_2 = 1.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	16.408872501594871	18.353999872399626	11.854119596673673
2.	16.408872501594871	18.079509014621500	10.181299859964483
3.	16.408872501594871	17.729287954621501	8.046960282604983
4.	16.408872501594871	19.274866524362551	17.466124028260431
5.	16.408872501594871	18.624852484117248	13.504766901607612
6.	16.408872501594871	19.631597513332476	19.640136831000245
7.	16.408872501594871	18.368512571944358	11.942563818196637
8.	16.408872501594871	17.896324678681864	9.064926166879653
9.	16.408872501594871	17.695761640918604	7.842642077928592
10.	16.408872501594871	18.937569837399565	15.410548991461267
11.	16.408872501594871	17.587380306199719	7.182137617866813

12.	16.408872501594871	18.773241432579912	14.409088319476151
13.	16.408872501594871	17.952003532519292	9.404247798100908
14.	16.408872501594871	17.586667604592300	7.177794226159978
15.	16.408872501594871	17.426016698631752	6.198745202865212
16.	16.408872501594871	17.651594372537904	7.573475086860755
17.	16.408872501594871	18.175167668522228	10.764268945082488
18.	16.408872501594871	17.662620716671540	7.640672538316148
19.	16.408872501594871	18.513870290557751	12.828412121297688
20.	16.408872501594871	18.017884074578916	9.805741209992679

Table 3.3: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 3, $c_1 = c_2 = 1.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	16.408872501594871	18.275133129505839	11.373484849306834
2.	16.408872501594871	17.899559129421966	9.084637763394207
3.	16.408872501594871	17.645543382618818	7.536598757189126
4.	16.408872501594871	18.476852059492558	12.602813250555075
5.	16.408872501594871	18.541622864926662	12.997543634545867
6.	16.408872501594871	18.039452719224098	9.937186223311452
7.	16.408872501594871	18.920830023798551	15.308532149052464
8.	16.408872501594871	18.669542181060557	13.777117710226333
9.	16.408872501594871	18.334098188059833	11.732833479435218
10.	16.408872501594871	17.827756440667809	8.647053226448243
11.	16.408872501594871	18.375675131464366	11.986214346405154
12.	16.408872501594871	19.187512461150490	16.933765310721668
13.	16.408872501594871	18.595824387997084	13.327862022144728
14.	16.408872501594871	18.743946320671281	14.230556175321924
15.	16.408872501594871	18.098419874625439	10.296547632181010
16.	16.408872501594871	18.177011032082252	10.775502889156616
17.	16.408872501594871	18.076299992726174	10.161743233541708
18.	16.408872501594871	17.688125920122623	7.796107980017602
20.	16.408872501594871	18.470847943054046	12.566222580245903
21.	16.408872501594871	18.373158595477495	11.970877911883974

Table 3.4: ODE 45 numerical quantification of uncertainly that is vulnerable to a small 0.01 multiplicative random noise intensity on the initial condition boundaries, principle of parsimony scenario 4, $c_1 = c_2 = 1.5$.

Example	1-norms error value with a zero random noise intensity	1-norms error value with a 0.01 multiplicative random noise intensity	Depletion Effect (%)
1.	16.408872501594871	18.253728996764863	11.243042414953740
2.	16.408872501594871	17.778166398476493	8.344838420485825
3.	16.408872501594871	18.122589491568661	10.443843657187440
4.	16.408872501594871	18.269064192478574	11.336499145220978
5.	16.408872501594871	18.384852017114898	12.042140709716470
6.	16.408872501594871	19.180514138637008	16.891115686179813
7.	16.408872501594871	18.308531044071110	11.577020555748728
8.	16.408872501594871	18.859835785635369	14.936817162801860
9.	16.408872501594871	17.937222018002490	9.314165347186837
10..	16.408872501594871	18.635749838249950	13.571178253951549
11.	16.408872501594871	18.594750813143911	13.321319373629004
12.	16.408872501594871	18.779887016684480	14.449588263051934
13.	16.408872501594871	17.376890971705091	5.899360056677463
14.	16.408872501594871	18.040082690809221	9.941025436426564
15	16.408872501594871	18.788382277768342	14.501360626345248
16.	16.408872501594871	18.807971546605827	14.620742801053360
17.	16.408872501594871	18.290354910911628	11.466250402846903
18.	16.408872501594871	18.918612880814926	15.295020294515174
19.	16.408872501594871	18.185217633476412	10.825516084111740
20.	16.408872501594871	18.415077943874604	12.226345485253407

V. Discussion of Results

When the random noise perturbation value of 0.01 and the positive control value of 0.1 are specified, the analysis values which were calculated using the 1-norms error definition ranges within 80.91 to 85.1 approximately for scenario 1 (Table 1.1).

Irrespective of the variations of the control terms and the effect of a random noise perturbation, this study has clearly shown that an increase in the control parameter values tend to decrease the depletion pattern of the uncertainty analysis values thereby demonstrating that the increase in the control parameter values can attempt to decrease the level of depletion. For instance, when the control parameter values c_1 and c_2 are increased to 0.5, the depletion effect ranges within 3.4 to 4.3 scenario 1 (Table 2.1).

Furthermore, when the control parameter values c_1 and c_2 are increased to as high as 1.5, a more significant decrease in the depletion effect of as low as within 11.2 to 14.2 is observed, scenario 4 (Table 3.4).
Hence in this context, the paper can be considered as a useful intervention strategy in the construction of ODE 45 numerical simulation.

VI. Conclusion and Further Research

We have used the principle of parsimony assumption in a numerical method to quantify the percentage effect of 1-norms error value of 0.01 multiplicative random noise intensity. Our results show that in the event of the application of 1-norms error value on the initial condition boundaries of our model equations, increasing the values of the parameters c_1 and c_2 yields a significant result of low depletion effect.
The application of much higher random perturbation of $c_1 = c_2 > 1.5$ is an extension of this work.

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