
```

format long
clear

type choleraData.m

totalPop = 10000000;

%no class division
high= 0;
mid = 0;
low = 10000000;
disp('*****')
disp('*****')
disp('*****')
disp('*****')
disp('**0 high, 0 mid, 1 low **')
data(1,:,:,:) = choleraData(high,mid,low);

clear
clf
totalPop = 10000000;

%relatively large class sizes
high= totalPop*.1;
mid = totalPop*.3;
low = totalPop*.6;
disp('*****')
disp('*****')
disp('*****')
disp('*****')
disp('**.10 high, .30 mid, .60 low **')
data(2,:,:,:) = choleraData(high,mid,low);

clear
clf
totalPop = 10000000;

%half of the relatively large class sizes
high= totalPop*.05;
mid = totalPop*.15;
low = totalPop*.8;
disp('*****')
disp('*****')
disp('*****')
disp('*****')
disp('**.05 high, .15 mid, .80 low **')
data(2,:,:,:) = choleraData(high,mid,low);

clear
clf
totalPop = 10000000;

```

```

%wikipedia numbers (circa 1980)
high= totalPop*.02;
mid = totalPop*.05;
low = totalPop*.93;
disp('*****')
disp('*****')
disp('*****')
disp('*****')
disp('**.02 high, .05 mid, .93 low **')
data(2, :, :, :) = choleraData(high, mid, low);

clear
clf
totalPop = 10000000;

% half wikipedia numbers because its GDP is about half of what it was
%wikipedia numbers (circa 1980)
high= totalPop*.01;
mid = totalPop*.025;
low = totalPop*.965;
disp('*****')
disp('*****')
disp('*****')
disp('*****')
disp('**.01 high, .025 mid, .965 low **')
data(2, :, :, :) = choleraData(high, mid, low);

clear
clf
totalPop = 10000000;

%very small class sizes
high= 10000; %.001 percent
mid = 100000; %.01 percent
low = 9890000; %.998 percent
disp('*****')
disp('*****')
disp('*****')
disp('*****')
disp('**.001 high, .01 mid, .998 low **')
data(3, :, :, :) = choleraData(high, mid, low);

function data=choleraData(high, mid, low)

    time = 4000;           %time in days
    timex = [0:1:time];    %time array

    Narr= [high;mid;low]; %population

    initS = [Narr(1)*.999;Narr(2)*.999;Narr(3)*.999]; %initial
    suseptible pop

```

```

initI = [Narr(1)*.001;Narr(2)*.001;Narr(3)*.001]; %initial infected
pop
initR = [Narr(1)*0;Narr(2)*0;Narr(3)*0]; %initial recovered
pop
initB = [0;0;0]; %initial bacteria
in water

N = sum(Narr) ;

Lambda = [.0000638356;.0000638356;.0000638356]; %birth rates
mu= [.0000210958;.0000210958;.0000210958]; %mortality rate
beta = 10^-8*[1 1 1; %human to human
1 1 1;
transmission rate
1 1 1];
epsilon = [.0002739726;.0002739726;.0002739726]; %loss of immunity
rate
lambda = 10^-8* [1;1;1]; %water to human
transmission rate
gamma = [.2;.2;.2]; %recovery rate
alpha = [.0005;.0005;.0005]; %disease induce
mortality
xi = [7;7;7]; %shedding rate
delta = [.33;.33;.33]; %bacterial death
rate

flist = @(Y) [Lambda(1)*Narr(1)-mu(1)*Y(1)-beta(1,1)*Y(1)*Y(2)-
beta(1,2)*Y(1)*Y(6)-lambda(1)*Y(1)*Y(4)+epsilon(1)*Y(3),...
beta(1,1)*Y(1)*Y(2)+beta(1,2)*Y(1)*Y(6)+lambda(1)*Y(1)*Y(4)-
(gamma(1)+mu(1)+alpha(1))*Y(2),...
gamma(1)*Y(2)-mu(1)*Y(3)-epsilon(1)*Y(3),...
xi(1)*Y(2)-delta(1)*Y(4),...
Lambda(2)*Narr(2)-mu(2)*Y(5)-beta(2,2)*Y(5)*Y(6)-
beta(2,1)*Y(5)*Y(2)-beta(2,3)*Y(5)*Y(10)-
lambda(2)*Y(5)*Y(8)+epsilon(2)*Y(7),...

beta(2,2)*Y(5)*Y(6)+beta(2,1)*Y(5)*Y(2)+beta(2,3)*Y(5)*Y(10)+lambda(2)*Y(5)*Y(8)-
(gamma(2)+mu(2)+alpha(2))*Y(6),... %6
Im
gamma(2)*Y(6)-mu(2)*Y(7)-epsilon(2)*Y(7),...
xi(2)*Y(6)-delta(2)*Y(8),...
Lambda(3)*Narr(3)-mu(3)*Y(9)-beta(3,3)*Y(9)*Y(10)-
beta(3,2)*Y(9)*Y(6)-lambda(3)*Y(9)*Y(12)+epsilon(3)*Y(11),...
beta(3,3)*Y(9)*Y(10)+beta(3,2)*Y(9)*Y(6)+lambda(3)*Y(9)*Y(12)-
(gamma(3)+mu(3)+alpha(3))*Y(10),...
gamma(3)*Y(10)-mu(3)*Y(11)-epsilon(3)*Y(11),...
xi(3)*Y(10)-delta(3)*Y(12)];

init = [initS(1) initI(1) initR(1) initB(1) initS(2) initI(2) initR(2)
initB(2) initS(3) initI(3) initR(3) initB(3)];
h=1;
steps=time;

```

```

freq=1;

out = RKStage5( flist ,init, 1, time, 1);

totS = out(:,1)+out(:,5)+out(:,9);
totI = out(:,2)+out(:,6)+out(:,10);
totR = out(:,3)+out(:,7)+out(:,11);
totB = out(:,4)+out(:,8)+out(:,12);
totals = [totS totI totR];
endTotal = totals(time, :, :, :);
totals = [totS totI totR, totB];


hold on
a1 = plot(timex,totS,'m--');
M1 = 'susceptible pop';

a2 = plot(timex,totI, 'k-.');
M2 = 'infected pop    ';

a3 = plot(timex,totR , 'b');
M3 = 'recovered pop  ';


xlabel('Time in Days'),ylabel('Total People'), title('SIWR GDP
STRUCTURED MODEL total')
legend([a1; a2; a3], [M1; M2; M3]);
snapnow
hold off
clf


hold on
a1 = plot(timex,out(:,1),'m--');
M1 = 'susceptible pop';

a2 = plot(timex,out(:,2), 'k-.');
M2 = 'infected pop    ';

a3 = plot(timex,out(:,3) , 'b');
M3 = 'recovered pop  ';


xlabel('Time in Days'),ylabel('Total People'), title('SIWR GDP
STRUCTURED MODEL high')
legend([a1; a2; a3], [M1; M2; M3]);
snapnow
hold off
clf
hold on
a1 = plot(timex,out(:,5),'m--');
M1 = 'susceptible pop';

a2 = plot(timex,out(:,6), 'k-.');
M2 = 'infected pop    ';

```

```

a3 = plot(timex,out(:,7) , 'b');
M3 = 'recovered pop  ';

xlabel('Time in Days'),ylabel('Total People'), title('SIWR GDP
STRUCTURED MODEL mid')
legend([a1; a2; a3], [M1; M2; M3]);
snapnow
hold off
clf
hold on
a1 = plot(timex,out(:,9),'m--');
M1 = 'susceptible pop';

a2 = plot(timex,out(:,10), 'k-.');
M2 = 'infected pop  ';

a3 = plot(timex,out(:,11) , 'b');
M3 = 'recovered pop  ';

xlabel('Time in Days'),ylabel('Total People'), title('SIWR GDP
STRUCTURED MODEL low')
legend([a1; a2; a3], [M1; M2; M3]);
snapnow
hold off
clf
hold on
a1 = plot(timex,out(:,4),'m--');
M1 = 'bacteria high ';

a2 = plot(timex,out(:,8), 'k-.');
M2 = 'bateria mid  ';

a3 = plot(timex,out(:,12) , 'b');
M3 = 'bateria low  ';

xlabel('Time in Days'),ylabel('Total bacteria'), title('bateria
differences')
legend([a1; a2; a3], [M1; M2; M3]);
snapnow
hold off

peaksinfected = [max(out(:,2)); max(out(:,6)); max(out(:,10))]
peakTotInfected = max(totI)
peaksbacteria = [max(out(:,4)); max(out(:,8)); max(out(:,12))]
peakTotBateria = max(totB)
sumtotals = sum(totals,1)
data = out;
end

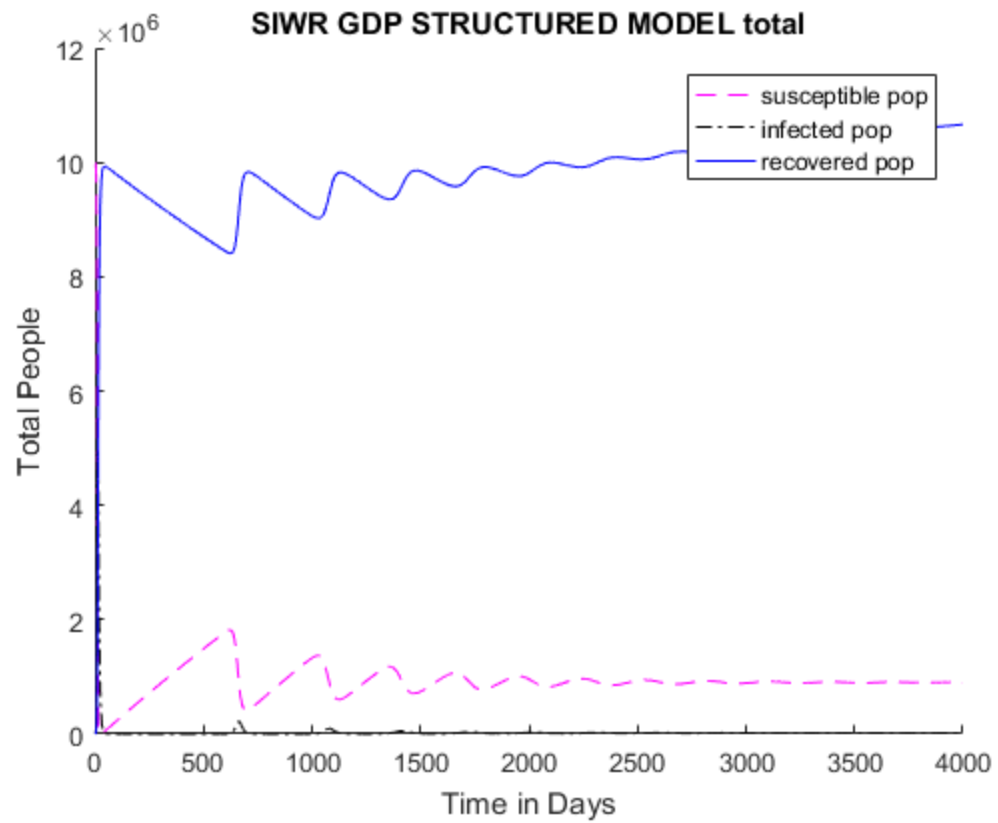
```

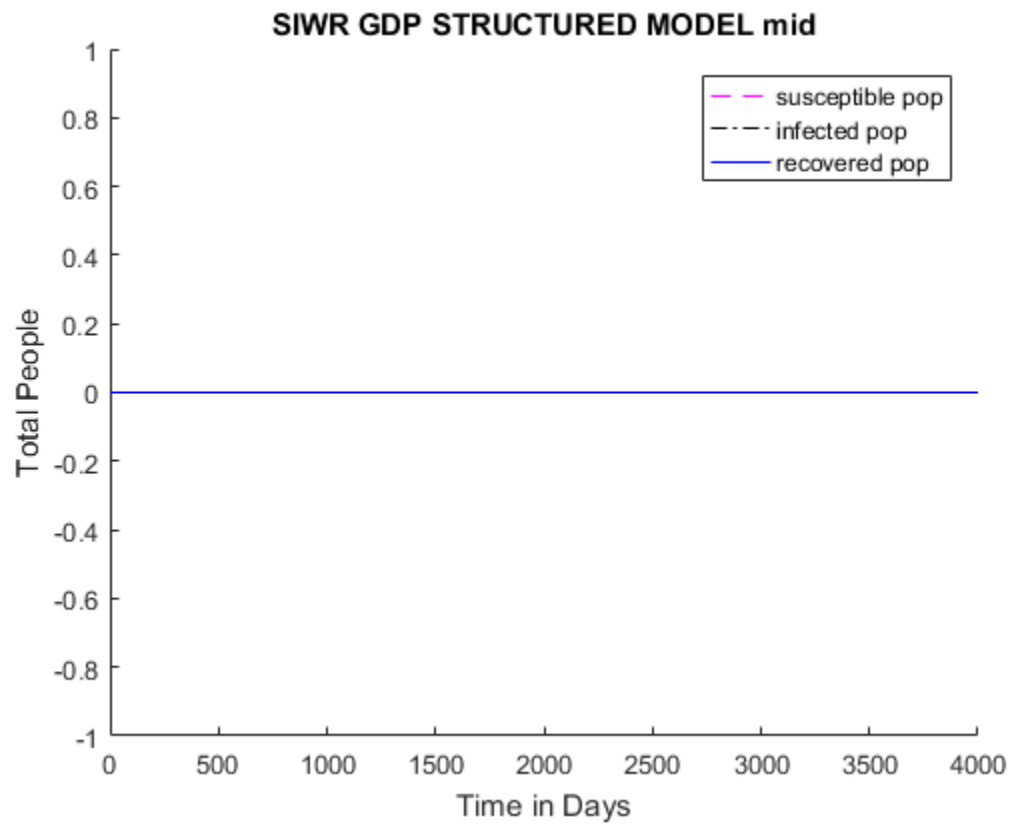
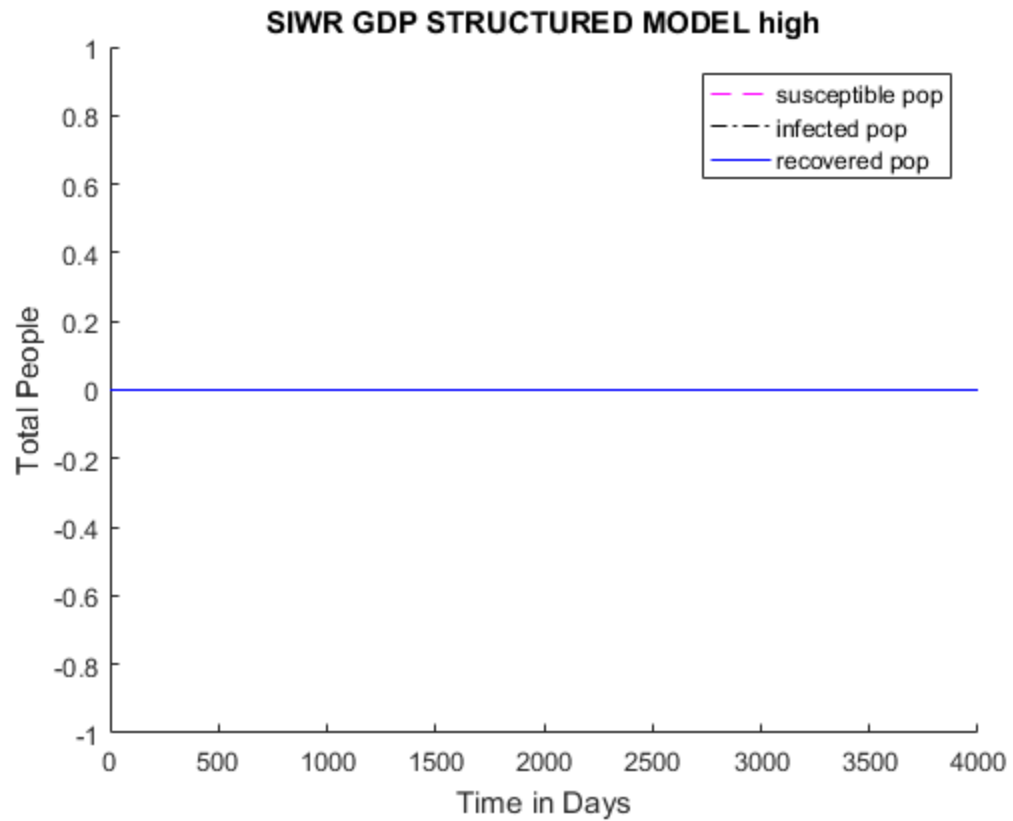
```
*****
*****
*****
*****
**0 high, 0 mid, 1 low **
```

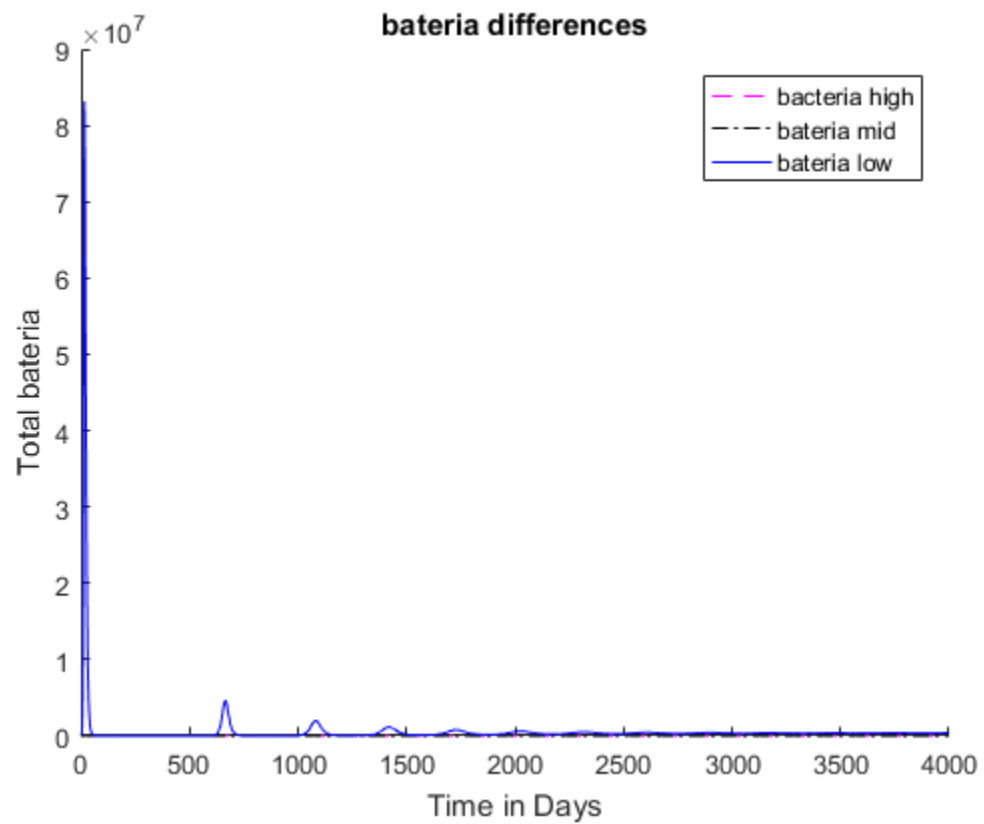
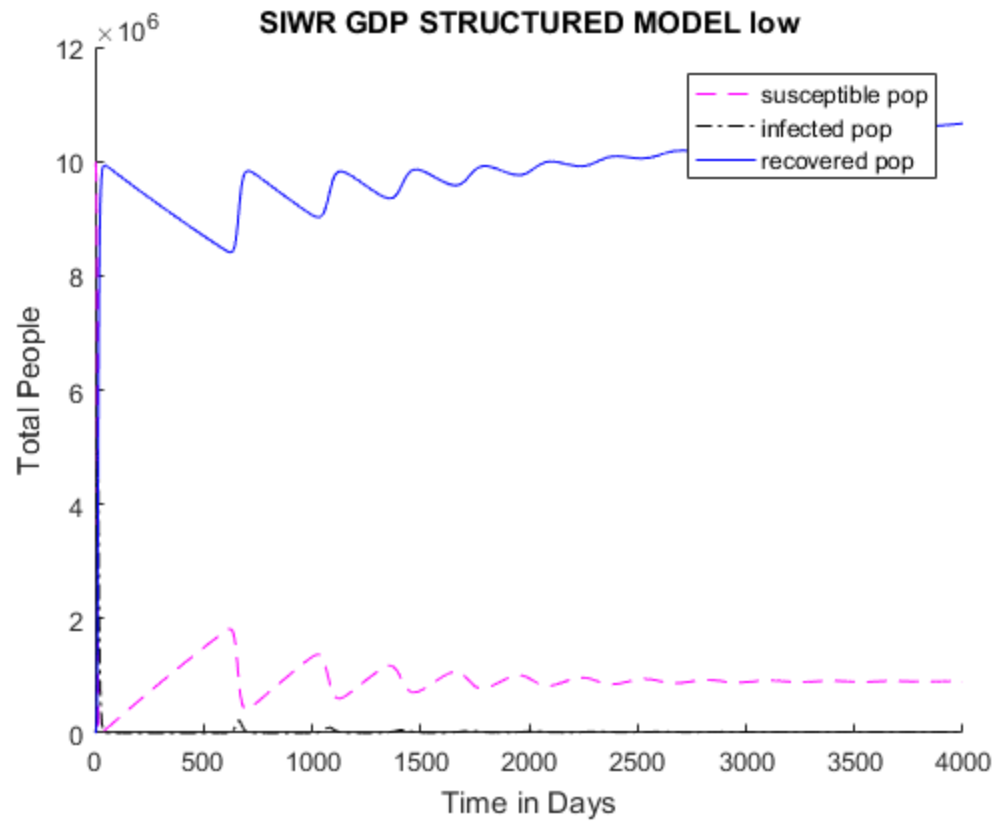
endTotal =

1.0e+07 *

0.090563015774060 0.001793722864237 1.066297786081869







peaksinfected =

1.0e+06 *

0

0

4.944829188698199

peakTotInfected =

4.944829188698199e+06

peaksbacteria =

1.0e+07 *

0

0

8.315093765709698

peakTotBateria =

8.315093765709697e+07

sumtotals =

1.0e+10 *

Columns 1 through 3

0.375026590441960 0.011133880652528 3.932509123824096

Column 4

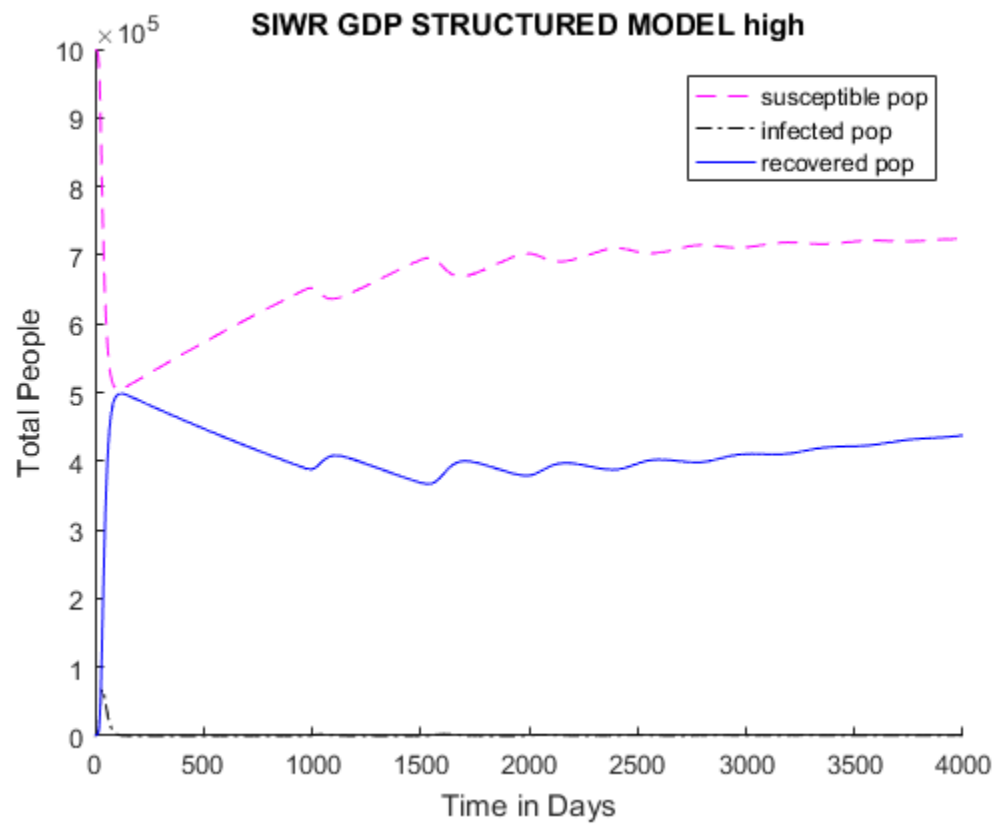
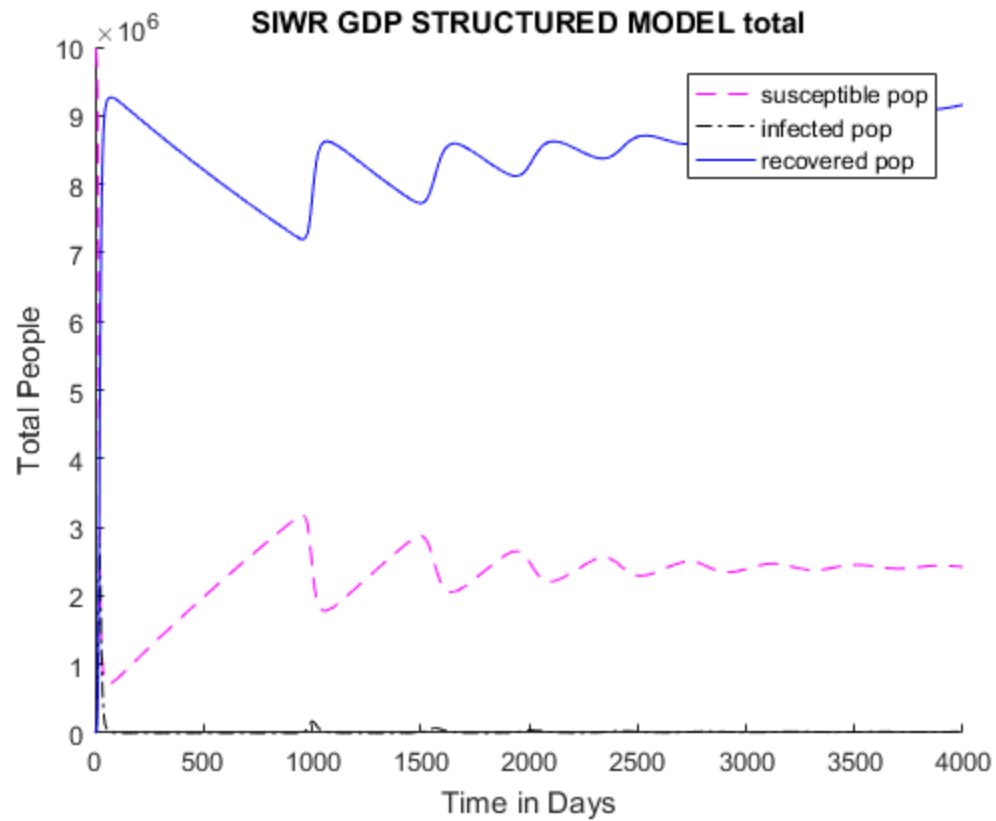
0.236054480483046

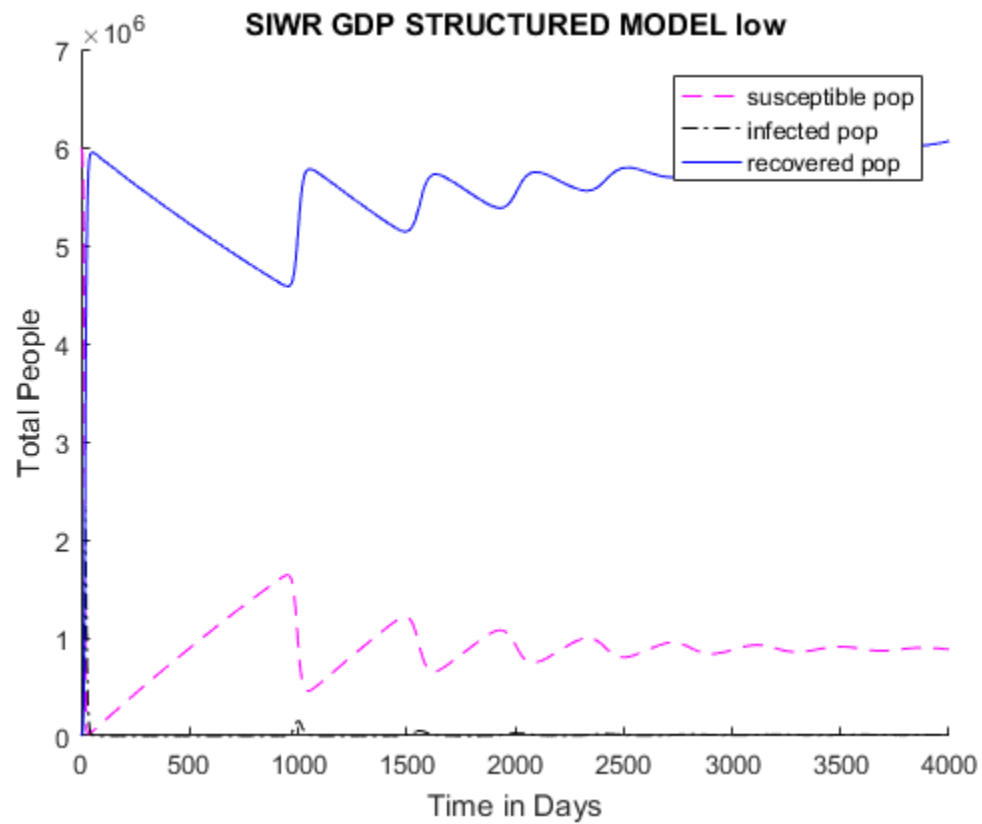
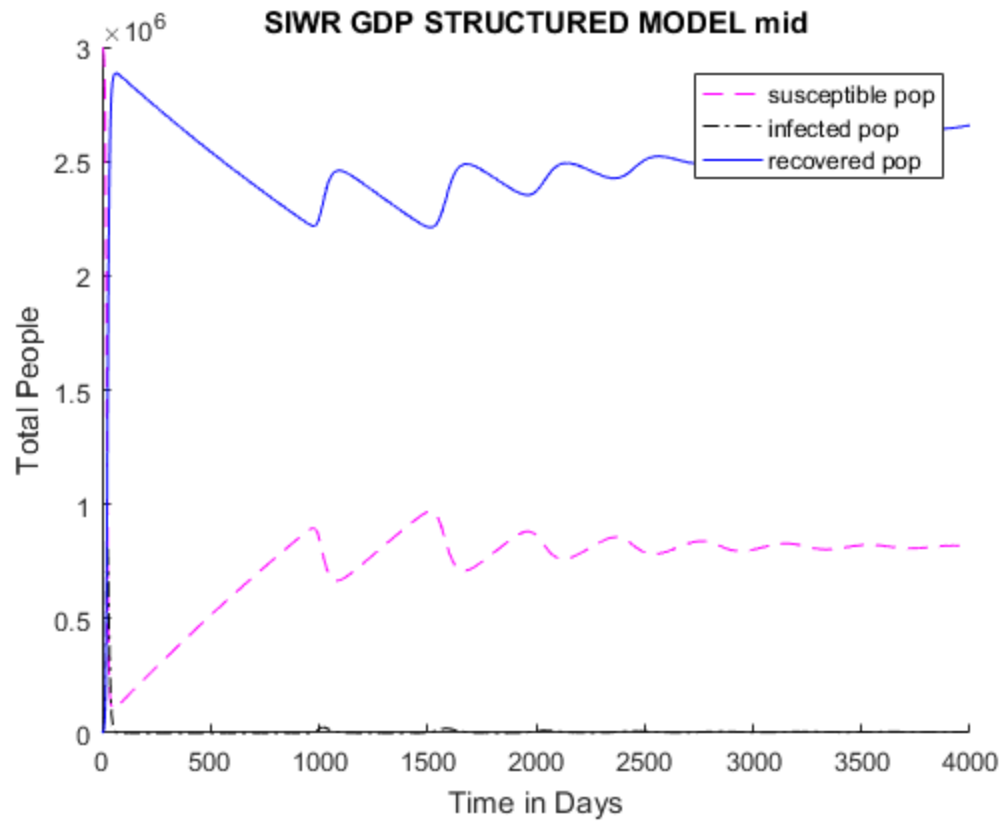
** .10 high, .30 mid, .60 low **

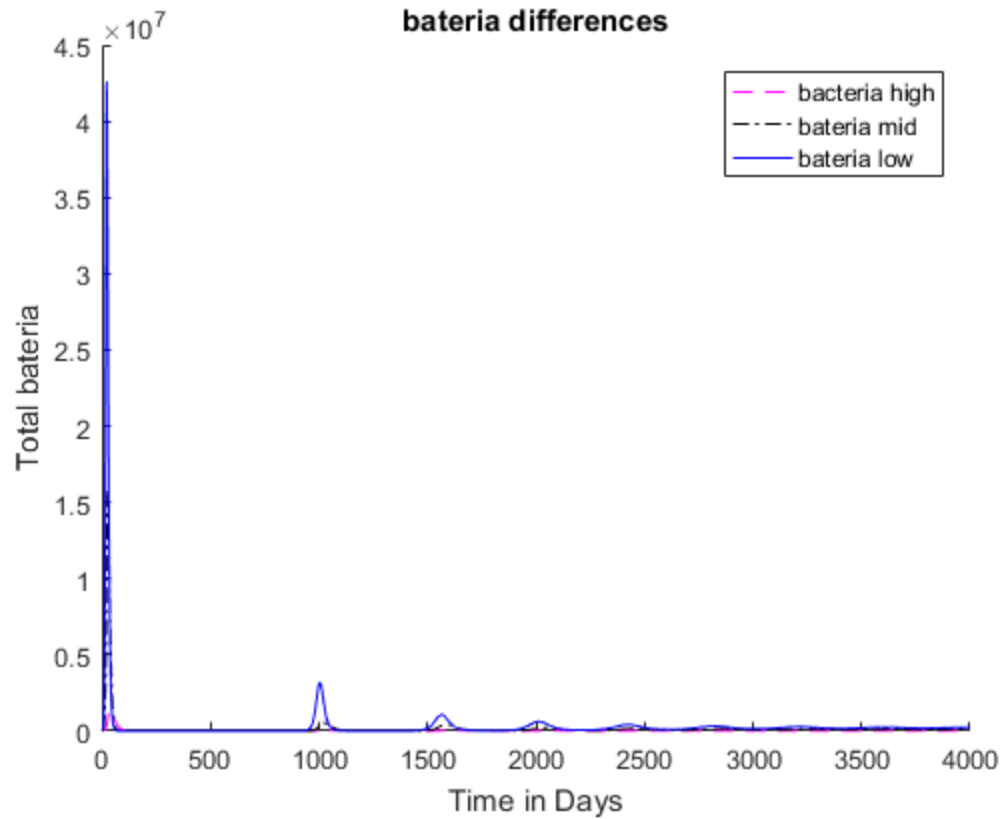
endTotal =

1.0e+06 *

2.420882826733923 0.016819501546443 9.156231588905921







peaksinfected =

```
1.0e+06 *  
  
0.067917473668894  
0.821192822937815  
2.359546785383043
```

peakTotInfected =

```
2.940456504012959e+06
```

peaksbacteria =

```
1.0e+07 *  
  
0.140031440293971  
1.589670143204681  
4.260611685577143
```

peakTotBateria =

```

5.461416758181212e+07

sumtotals =

1.0e+10 *

Columns 1 through 3

0.928517805610794    0.009569627970718    3.382634822585470

Column 4

0.202874029326887

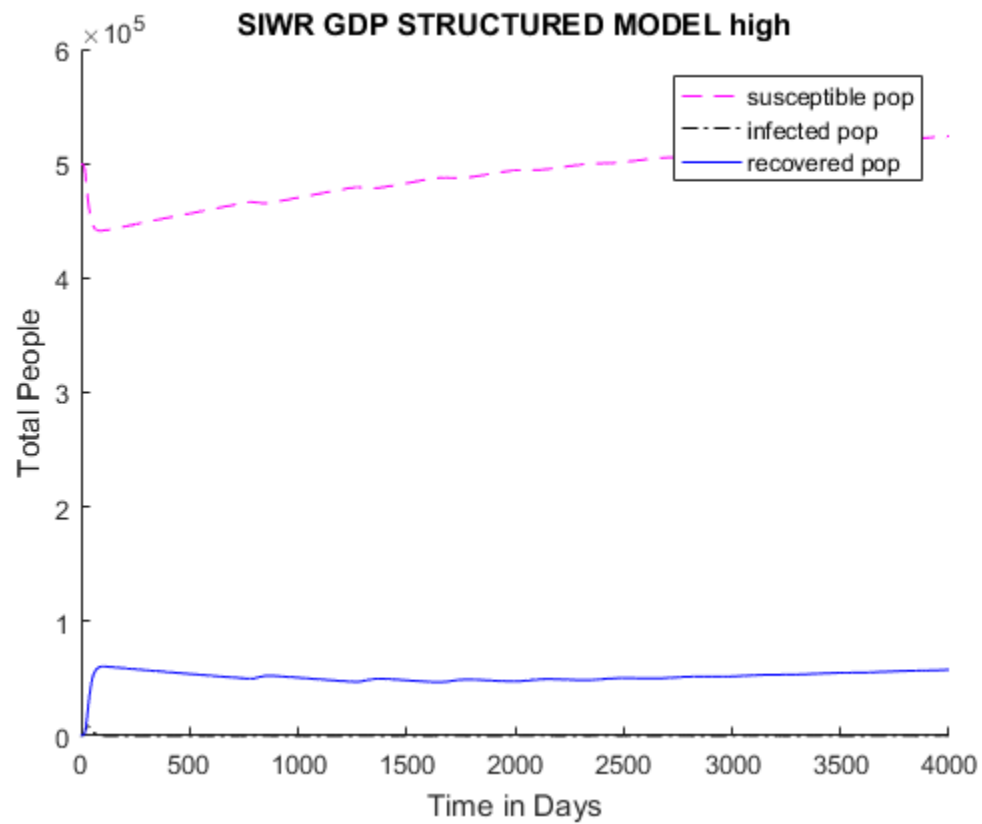
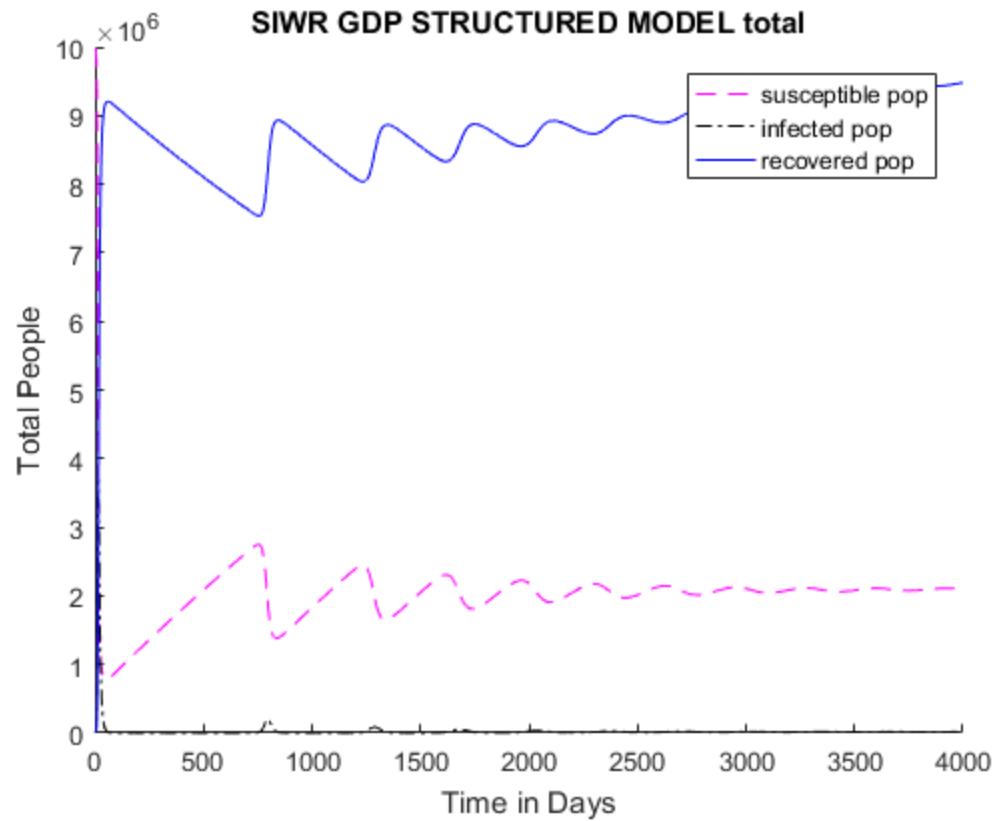
*****
*****
*****
*****
** .05 high, .15 mid, .80 low **

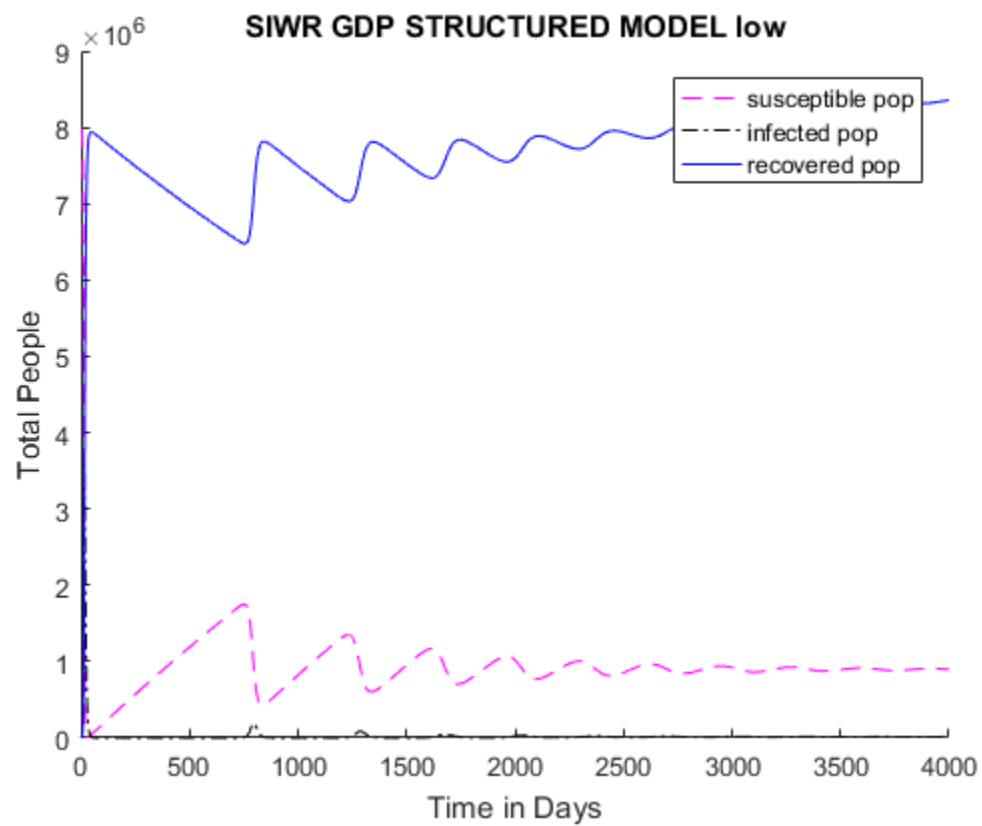
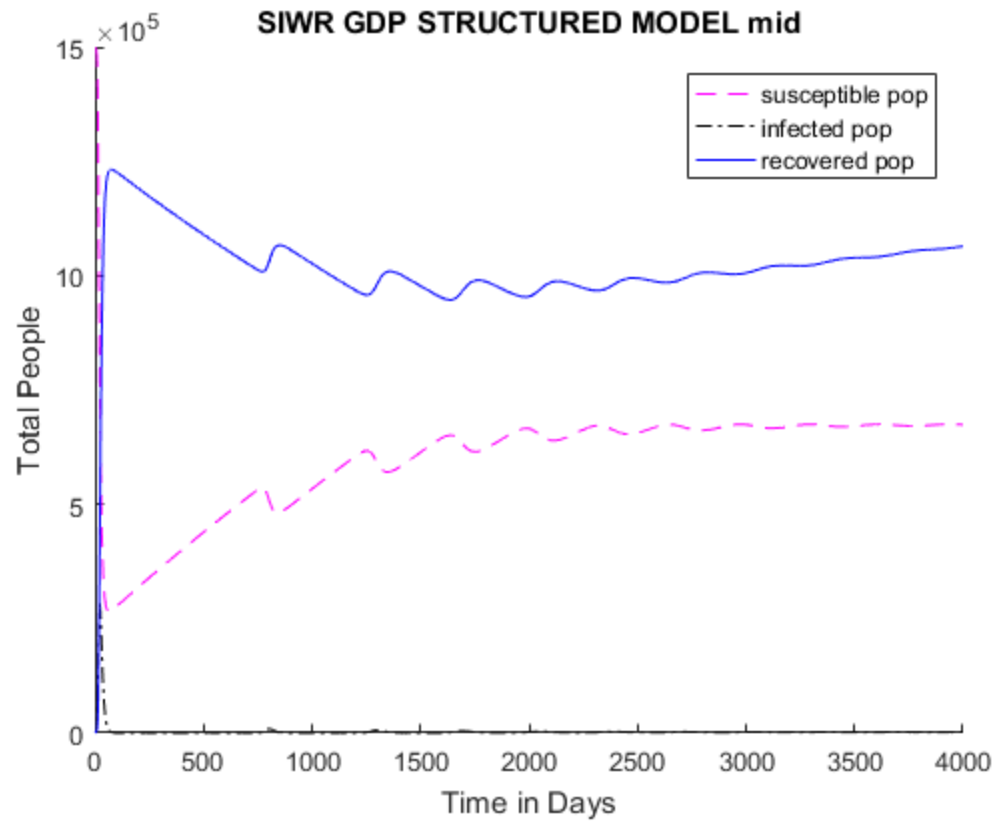
endTotal =

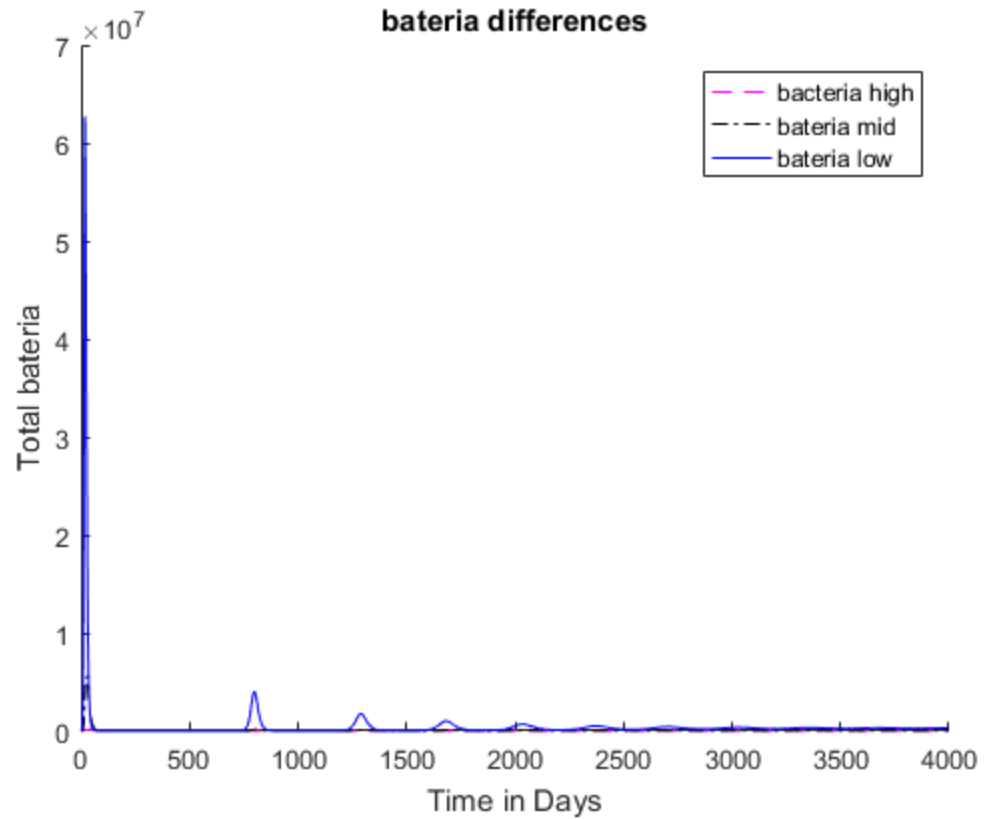
1.0e+06 *

2.094951408025820    0.017011233273980    9.480359073804605

```







peaksinfected =

1.0e+06 *

0.008816988369344

0.281728216890578

3.626079478553209

peakTotInfected =

3.817378432970925e+06

peaksbacteria =

1.0e+07 *

0.018145460298082

0.557481002193472

6.272403400247898

peakTotBateria =

```

        6.619098006926050e+07

sumtotals =

    1.0e+10 *

Columns 1 through 3

    0.806168764716969    0.009910920105086    3.504194522257431

Column 4

    0.210114644947729

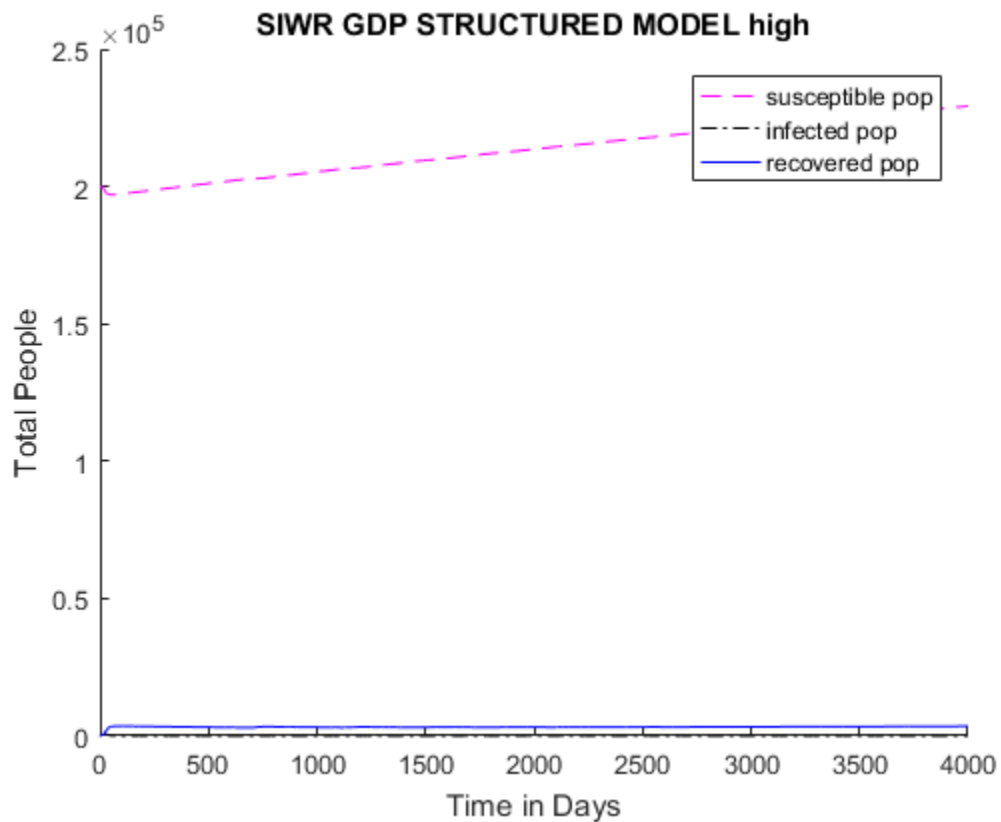
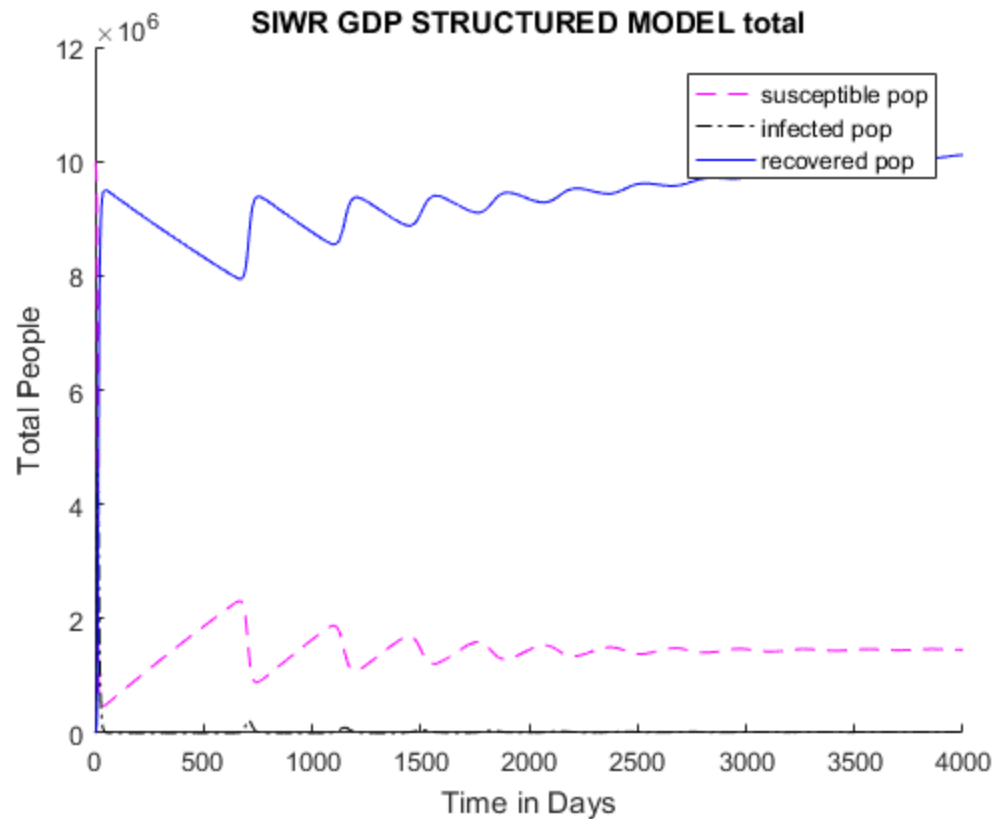
*****
*****
*****
*****
** .02 high, .05 mid, .93 low **

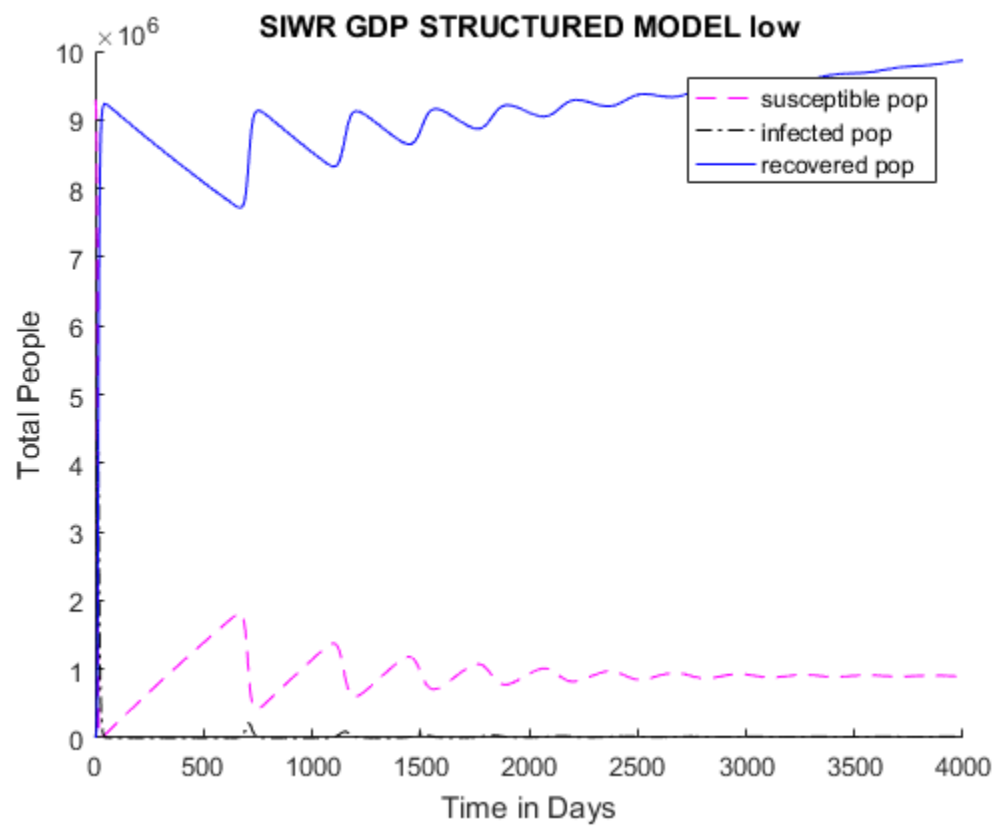
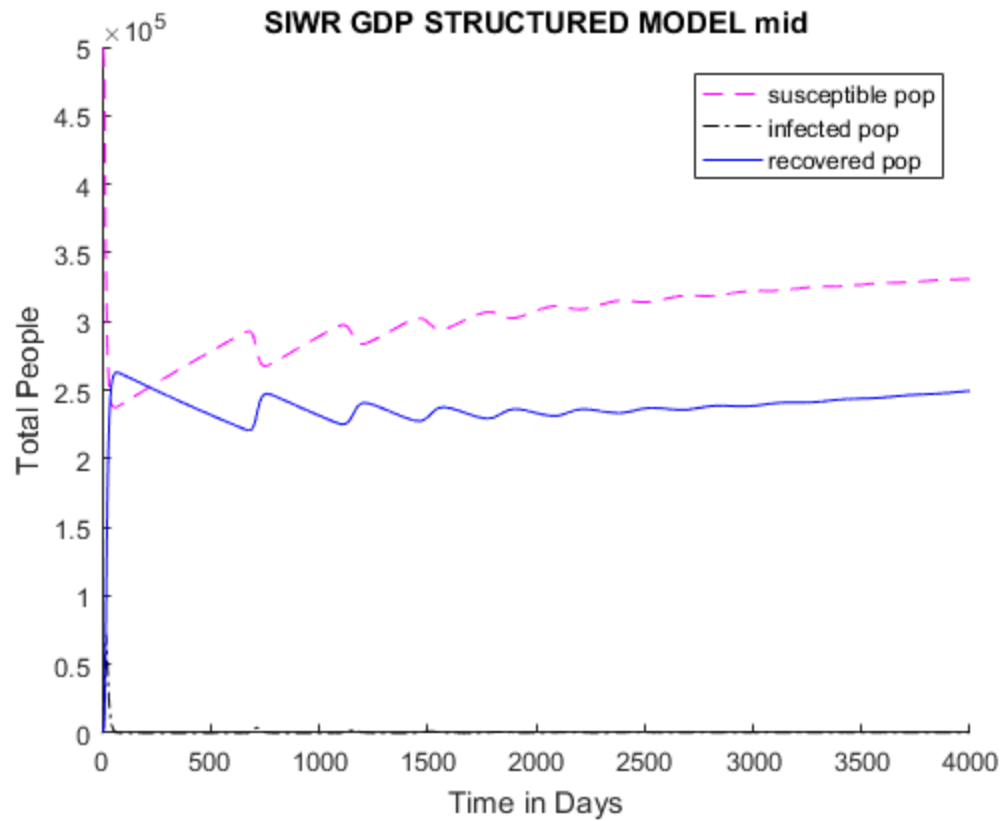
endTotal =

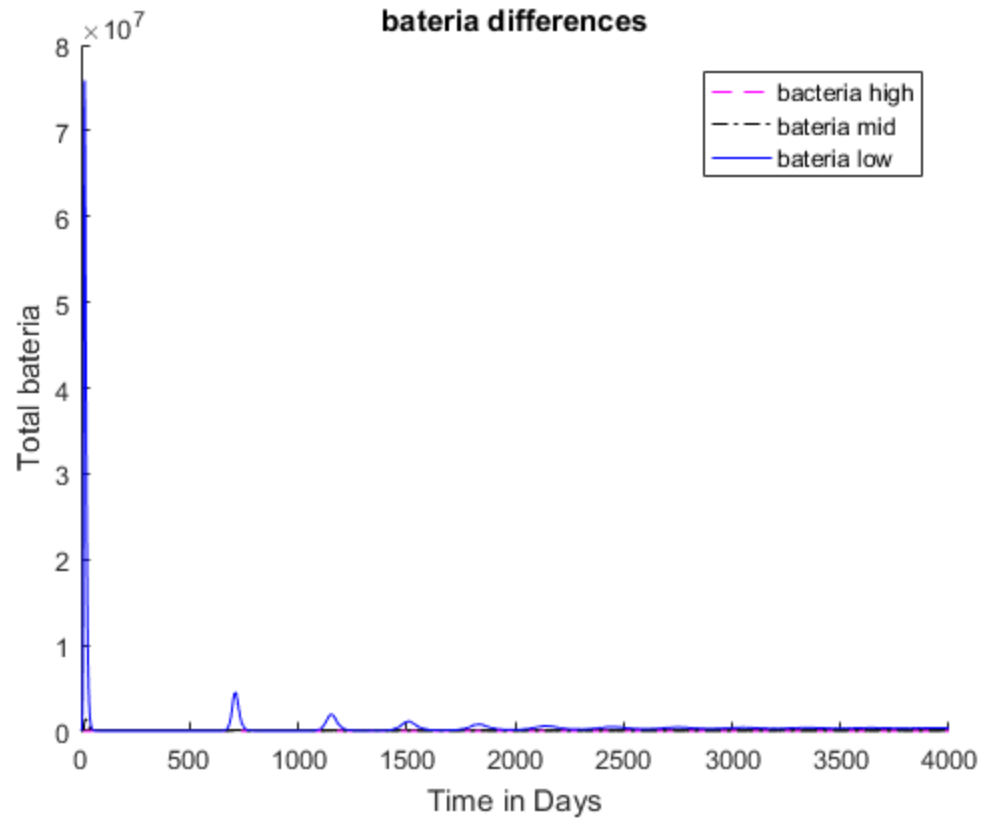
    1.0e+07 *

    0.145644004293144    0.001688843742462    1.011593138763367

```







peaksinfected =

```
1.0e+06 *  
  
0.000667596012186  
0.073068530618906  
4.502213391036292
```

peakTotInfected =

```
4.554858057688616e+06
```

peaksbacteria =

```
1.0e+07 *  
  
0.001341331780158  
0.138403510917662  
7.587883466007529
```

peakTotBateria =

```

7.697721717903395e+07

sumtotals =

1.0e+10 *

Columns 1 through 3

0.581209969453745    0.010558176785462    3.727676332585323

Column 4

0.223847457018637

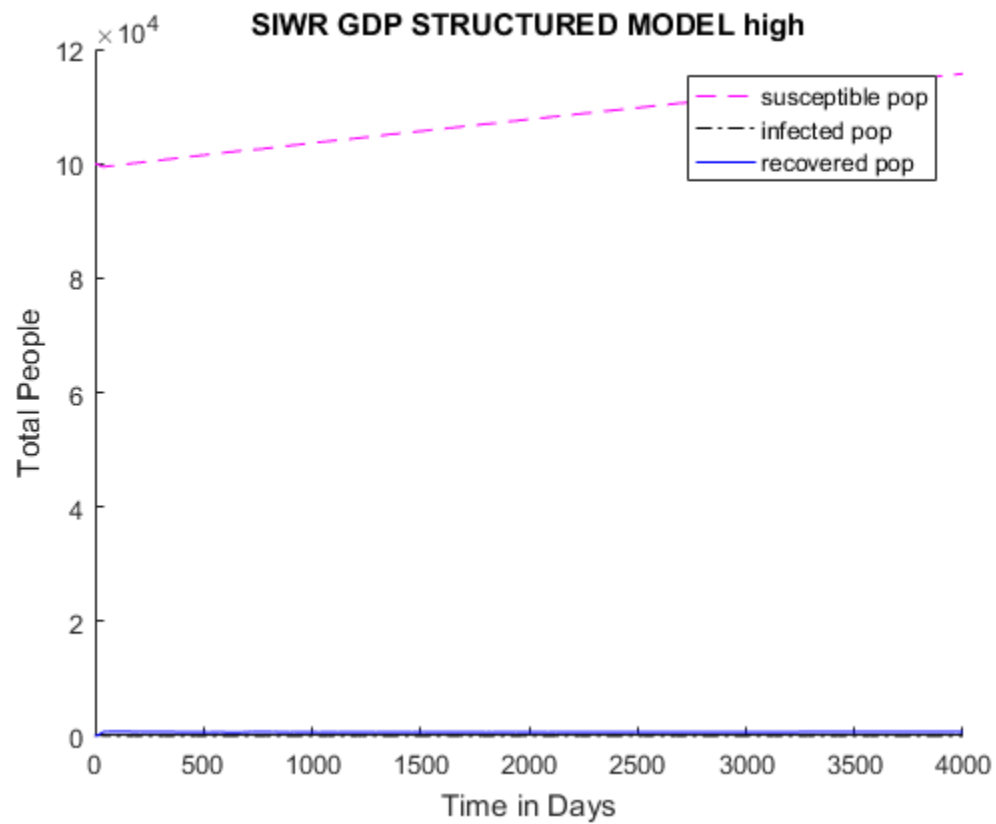
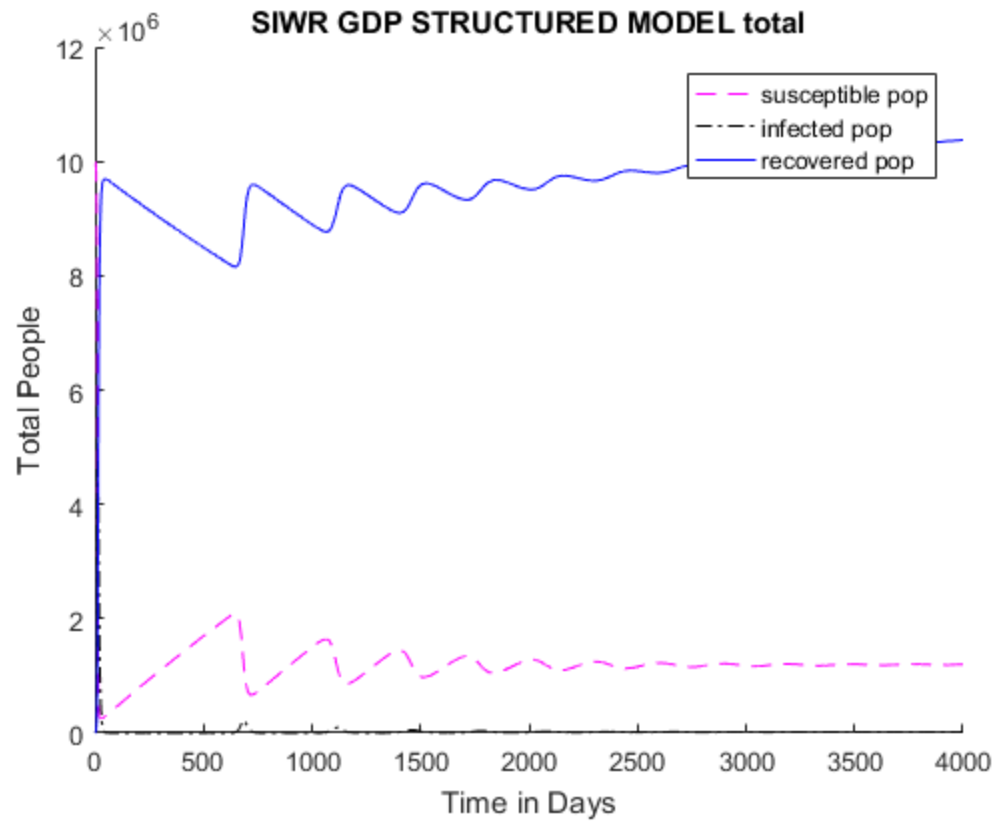
*****
*****
*****
*****
** .01 high, .025 mid, .965 low **

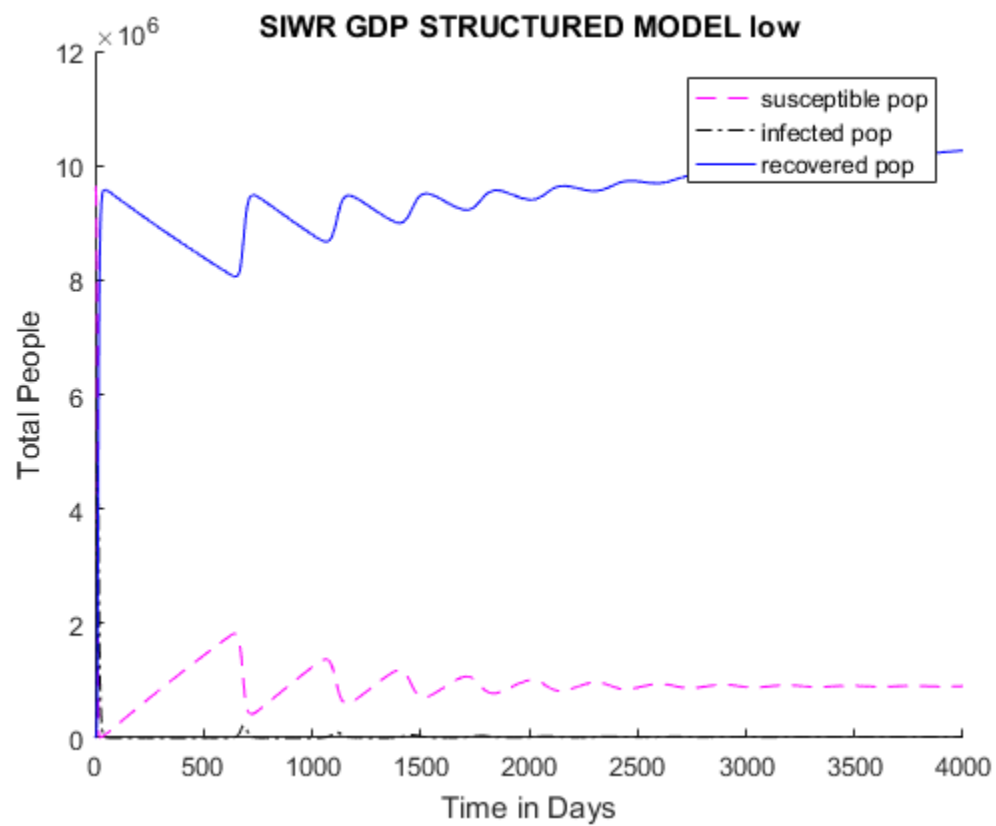
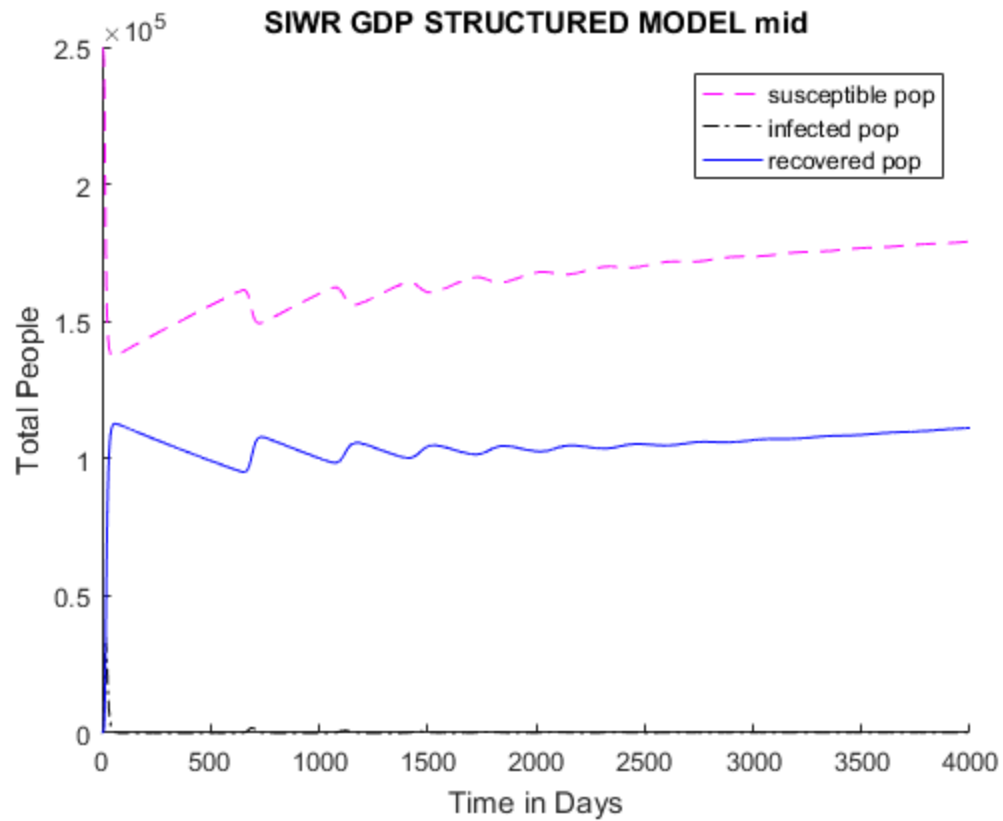
endTotal =

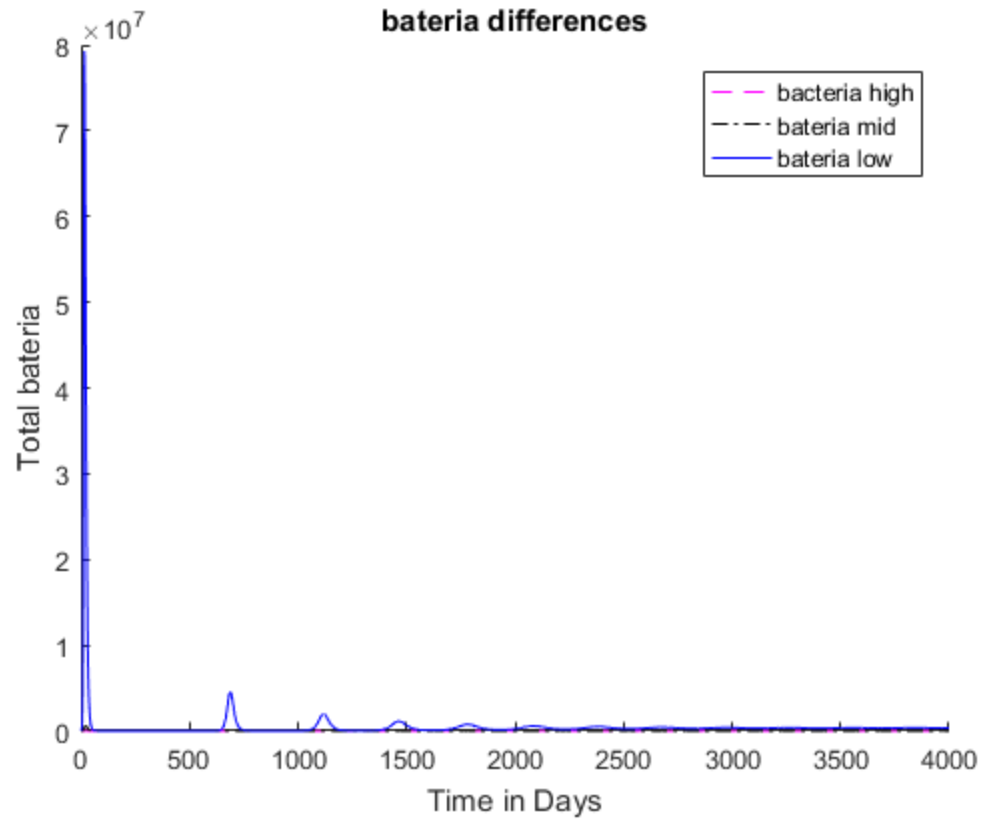
1.0e+07 *

0.119867533197427    0.001669371749249    1.037261525677357

```







peaksinfected =

```
1.0e+06 *  
  
0.000146912539753  
0.035038961361686  
4.750344324113678
```

peakTotInfected =

```
4.778113097825803e+06
```

peaksbacteria =

```
1.0e+07 *  
  
0.000291460958341  
0.065287263840008  
7.930701307236657
```

peakTotBateria =

```

7.979467809699981e+07

sumtotals =

1.0e+10 *

Columns 1 through 3

0.484213121601452    0.010828575468534    3.824038995024929

Column 4

0.229585398793901

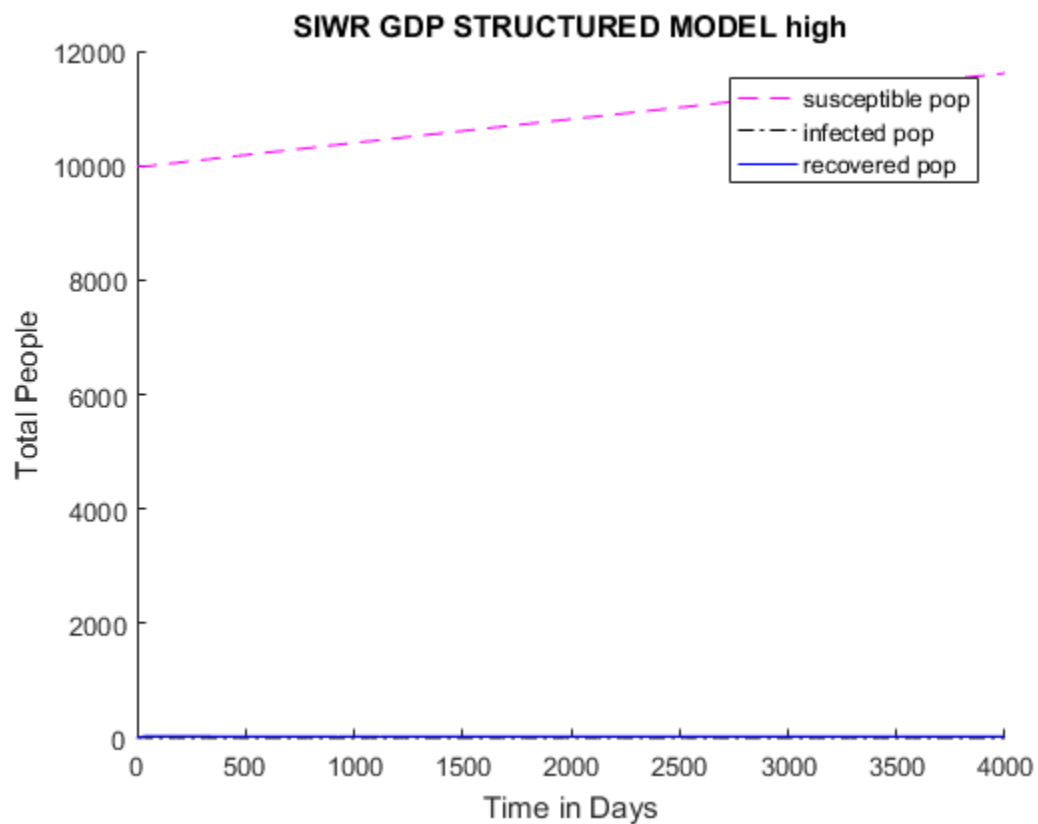
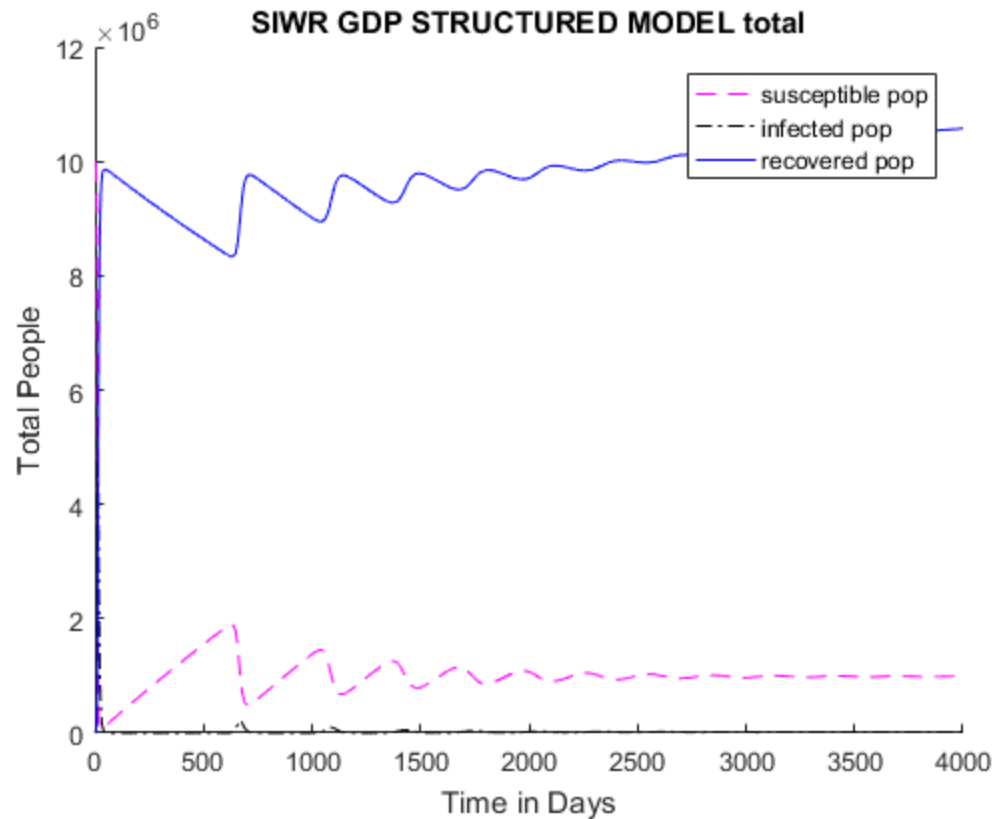
*****
*****
*****
*****
** .001 high, .01 mid, .998 low **

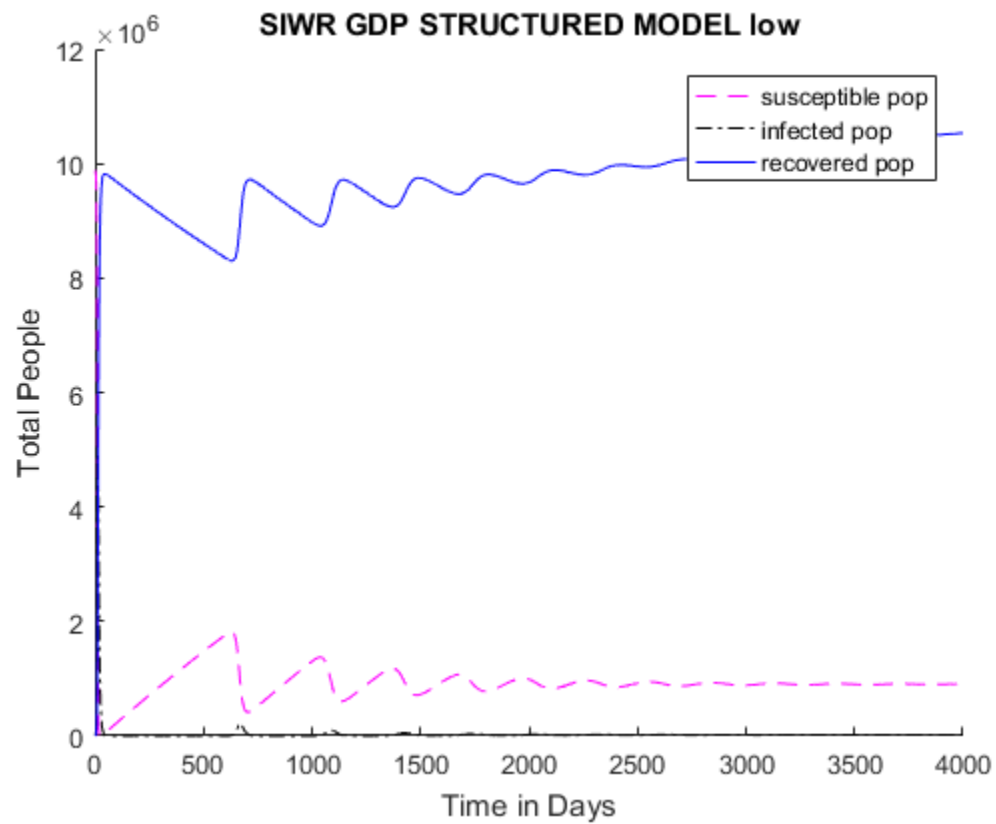
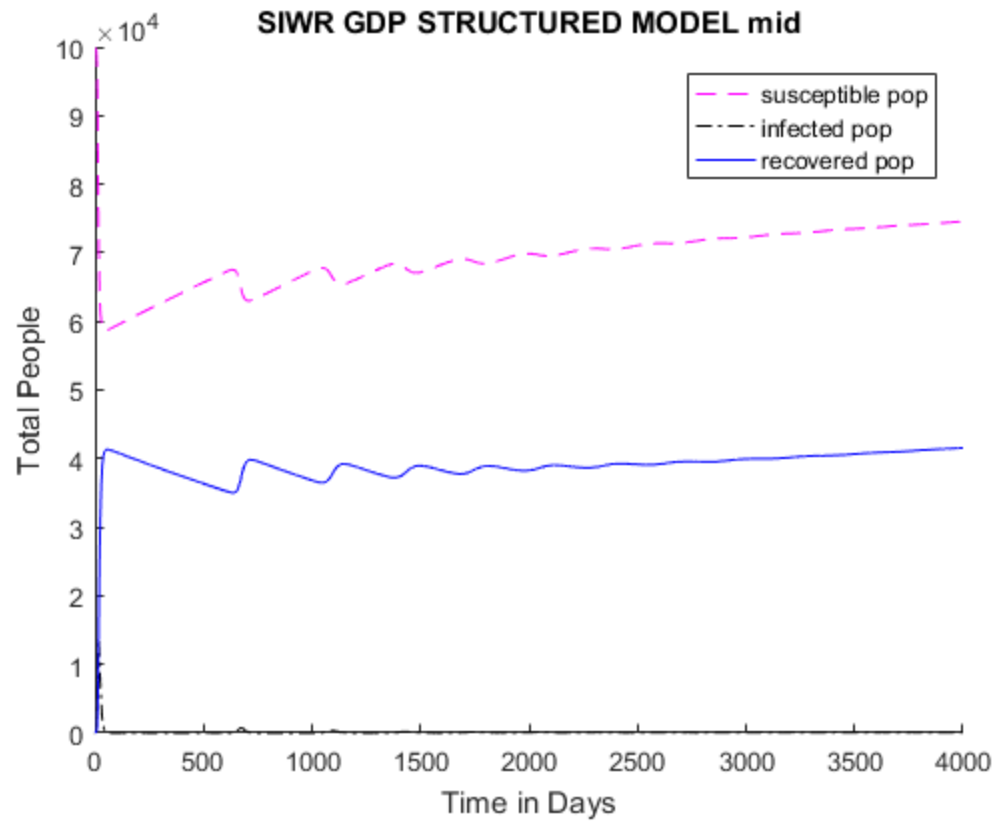
endTotal =

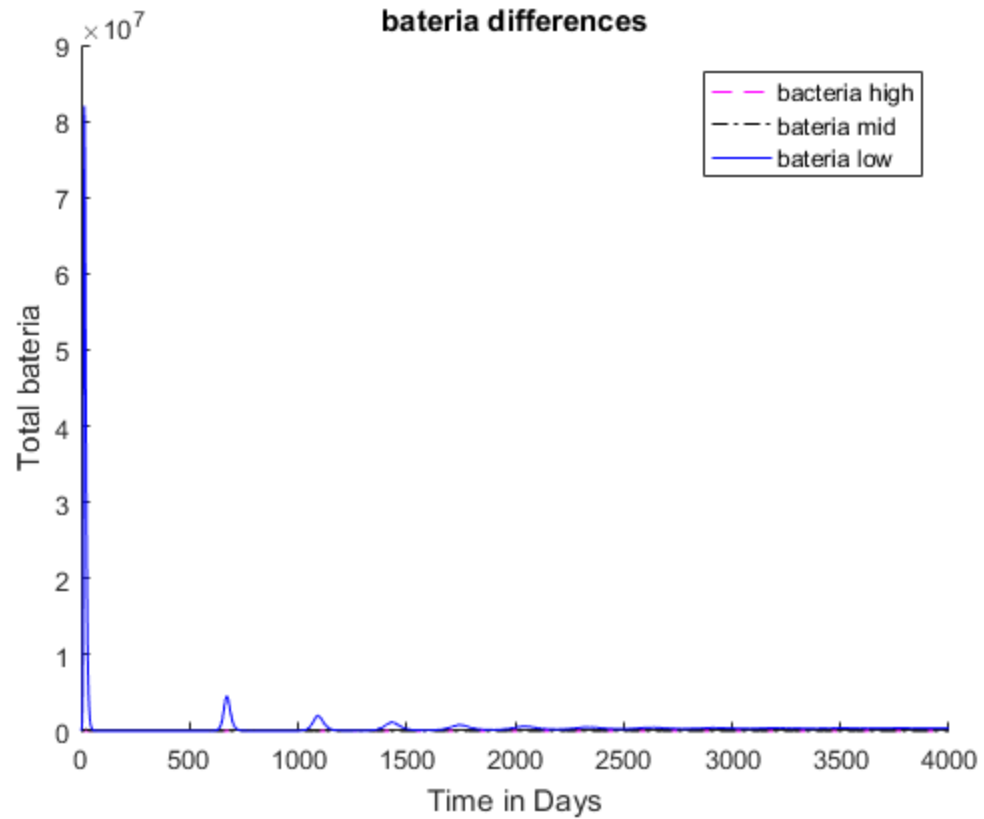
1.0e+07 *

0.099295214334032    0.001756078361977    1.057645733688068

```







peaksinfected =

```
1.0e+06 *  
  
0.0000100000000000  
0.013720499708631  
4.889239337894802
```

peakTotInfected =

```
4.900715477278180e+06
```

peaksbacteria =

```
1.0e+07 *  
  
0.000010803675642  
0.025386185038388  
8.199384008718283
```

peakTotBateria =

8.219380407503963e+07

sumtotals =

1.0e+10 *

Columns 1 through 3

0.406983468960104 0.011043756049680 3.900762708702136

Column 4

0.234144916613294

Published with MATLAB® R2016b