Effect of Dynamic Social Distancing in Separate Division of Bangladesh

Shuchita Rahman
011 143 047

Abstract

Every 100 year throughout the history, a pandemic always ravaged humanity. In 1818 "Cholera", 1918 "Spanish Flu" and now Corona. Novel corona has proven the world that how much our health system is vulnerable in this modern age. From the beginning of this year researcher are trying to find every little aspect about this virus. Researcher tried to discuss about the situation about COVID-19 in Bangladesh. Still there is lack of data and information how division wise corona affecting Bangladesh. The motivation of this report is (i)gathering scattered data of different division in one place, (ii)learning how COVID-19 effecting Bangladesh in this division(Dhaka and Barisal),(ii)depending on the situation how to we should take precaution in different division of Bangladesh. I have collected data from 4th April to 10th May 2020 division wise. I have used extension of SEIR model to predict death for next 5 days. Then I am going to investigate how varying social distancing effect the division separately.
Keyword- COVID-19, SEIR model, Social distancing.

I. Introduction

The ongoing pandemic which broke the world's health system known as corona pandemic or COVID-19, caused by respiratory syndrome coronavirus (SARS-CoV-2).It was first discovered in December 13th , Wuhan China. Then the virus rapidly spread throughout China. It took WHO(World Health Organization)January 5th,2020 for declaring it as a pandemic. Till then there was already 60,0000 positive cases in China. Because of mutation this virus symptom varies changing from host to host. Researcher minimize down to this three common symptoms fever, cough and shorten of breathing. Other symptoms are sore throat, muscle pain, diarrhea,vomit etc. This virus mainly threaten to elderly and people whom have respiratory, diabetes, heart diseases. COVID-19 primarily transmitted from symptomatic people to other who are close contact through respiratory droplets, by direct contact with infected persons, or by contact with contaminated objects or surfaces.
This virus is found in Bangladesh in 3th March, 2020 from two returned individual from Italy. Government took 17 day before announcing whole nation lock down. But after 88 day lock down government reopen some of private and public institution. This strategy could be a guide in how government should take the lock down strategy in division wise to control spreading the virus.

3. Data

The data is I have used in this report is currently taken from COVID-19 traker of Bangladesh which resource is maintain by The John Hopkin University. For comparing prediction result I have used data of WHO's(World Health Organization) COVID-19 Situation Report of Bangladesh.

4. Methodology

In this section I will describe the procedure in details gradually before coming to a conclusion. First I have collected data of confirmed, infected, recovered and death number causes by COVID_19 from 5th April to 10th June of 8 division of Bangladesh. From the data I am choosing 2 division Dhaka, Barisal to do rest of the work. As I want to predict data(confirmed, infected, recovered and death) for next 5

day I trained my model to learn the parameter. Second, I have used extend SEIR model to predict data for next 5 days. Third, I brought a new parameter for social distancing to show how division wise it effect differently.

4.1 SEIR Model

The compartmental model SEIR is extension of SIR model. SEIR model is composed by four basic compartment, taken by certain 't' time.
S = Number of susceptible individual
E = Number of exposed individual
I = Number of Infectious individual
R = Number of Recovered individual
Hence it is based on four time function S(t), E(t), I(t), R(t). This function is normalized in a way that in any given time it will fulfill following equation where N is the constant total population,

$$N = S + E + I + R \qquad\qquad (i)$$

The model predict infection diseases which transmitted from human to human, an individual experienced long incubation duration where recovered confirmed lasting resistance.
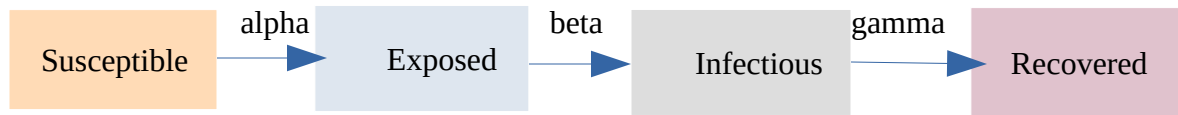
The infection rate, Beta, represents the probability of transmitting diseases between susceptible and infectious individual. Alpha(1/t_incubation), is the inverse rate of the incubation period. Gamma (1/t_infectious), is recovered rate. It can be represents by the set of differential equation.

$$\frac{dS}{dt} = \frac{-\beta \cdot I \cdot S}{N} \qquad\qquad (ii)$$

$$\frac{dE}{dt} = \frac{\beta \cdot I \cdot S}{N} - \alpha \cdot E \qquad\qquad (iii)$$

$$\frac{dI}{dt} = \alpha \cdot E - \gamma \cdot I \qquad\qquad (iv)$$

$$\frac{dR}{dt} = \gamma \cdot I \qquad\qquad (v)$$

There is one parameter which need to mentioned is Ro, it is sum up of infected individual who recovered from the virus and those who died in the virus. Following equation represents how dieases spreading can be related to the parameter ,beta and gamma.

$$R_0 = \frac{\beta}{\gamma} \qquad\qquad (vi)$$

4.2 SEIRD Model

Diseases model play an important role to understand the complex pattern of the disease. Modeling is the first step to understand what treatment and approaches can be most effective. From the dynamic of COVID-19 I have learn that after getting infected by the virus some individual sadly die. For this reason I have brought a new compartment D, death. This model is the extension of SEIR model. The population also divided in 5 compartment.

$$N = S + E + I + R + D \qquad \text{(viii)}$$

Here I am introducing to the new parameter ,delta. Death rate.

$$\frac{dD}{dt} = \delta I \qquad \text{(vii)}$$

Now the dynamic of this model value dependent on the setting of alpha, beta, gamma, and delta.

4.3 SEIRD Model with Dynamic Social Distancing

As we don't know anything about preventing COVID-19, many countries including Bangladesh used social distancing like avoiding large gathering, physical contact person to person, other efforts to reduce the spreading. From the statics of the world data we see China and Italy were able to stop spreading after taking this initiative. Hence, I am introducing to a new parameter rho, to understand how social can effect the virus spreading. The value of rho, will be constant term between 0 to 1. 0 indicates the ideal approach whole country is lock down and quarantined, where 1 considered as no one maintaining social distance. The introduction of , rho, will effect equation (ii) and (iii) where individual is contacted by exposed or infectious individual. So our final equation for SEIRD model is following

$$\frac{dS}{dt} = -\frac{\rho \cdot \beta \cdot S \cdot I}{N} \qquad \text{(ix)}$$

$$\frac{dE}{dt} = \frac{\rho \cdot \beta \cdot S \cdot I}{N} - \alpha \cdot E \qquad \text{(x)}$$

$$\frac{dI}{dt} = \alpha \cdot E - \gamma \cdot I \qquad \text{(xii)}$$

$$\frac{dR}{dt} = \gamma \cdot I \qquad \text{(xiii)}$$

 Hence the model is dependent on four parameter alpha, beta, gamma and rho.
Reason I have used the term dynamics because of the decision government has taken . After staying lock down for 88 days government have decided to open most of the private, public office. It will effect the parameter rho. Bangladesh is densely populated country where the population density is not divided equally. Capital city Dhaka has most densely area, with a density of 23,234 per square per kilometer where Barisal is lowest densely area, with a density of 10,514 per square kilometer.
So keeping, rho, value same for every division same is unreasonable.

As the time will pass more more shop in Dhaka will open and things will get worse. In the following of my experiment I will try prove that in some division of Bangladesh the social distancing should be maintained strictly, where other division it can be liberal.

5. Result

In the section I am going to discuss the result in two stage. In the first stage I applied SEIRD model to predict future data and show it's authentication. In second stage I applied different, rho, values for three division to show the scenario.

5.1 Modeling Dhaka and Barisal

I am going to run the experiment twice taking this two division Dhaka and Barisal. Important note Dhaka the is most densely populated division in Bangladesh, with 47,424,418 residence and Barisal lowest populated division, with 83,25,666 residence. It will be easy to show the by taking this two division.
From the recent information the incubation period is 5 days. Applying differential SEIR model I find the following data.

Table 1: Dhaka

Date	Confirmed	Recovered	Death
11-05-2020	6245	1566	129
12-05-2020	6741	1785	136
13-05-2020	7278	2021	143
14-05-2020	7859	2276	170
15-05-2020	9904	3170	180

Table 2: Barisal

Date	Confirmed	Recovered	Death
11-05-2020	140	2	16
12-05-2020	140	2	16
13-05-2020	140	2	16
14-05-2020	140	2	16
15-05-2020	140	2	16

From WHO's data of 15th May in Dhaka and Barisal confirmed and death cases 9988 ,180 and 158 and 19. Which is closer to our prediction data. This result show how division wise is effecting virus differently.

5.2 Applying Dynamic Social Distancing

Now I am going to use the parameter of last investigation for further query. For Dhaka alpha = .008, beta = 1.920 and gamma = 0.035.
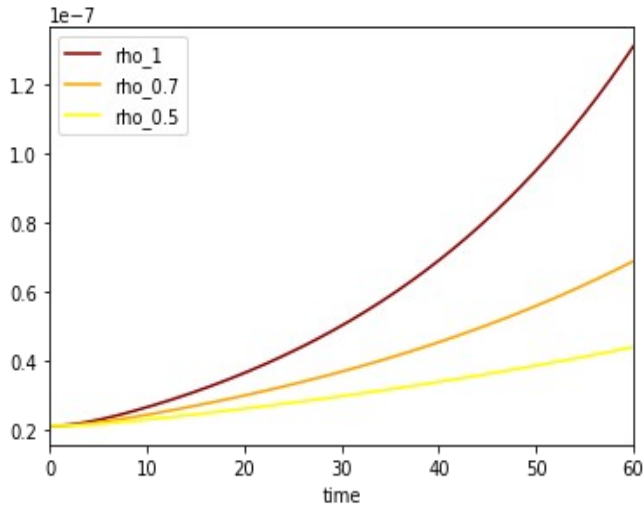
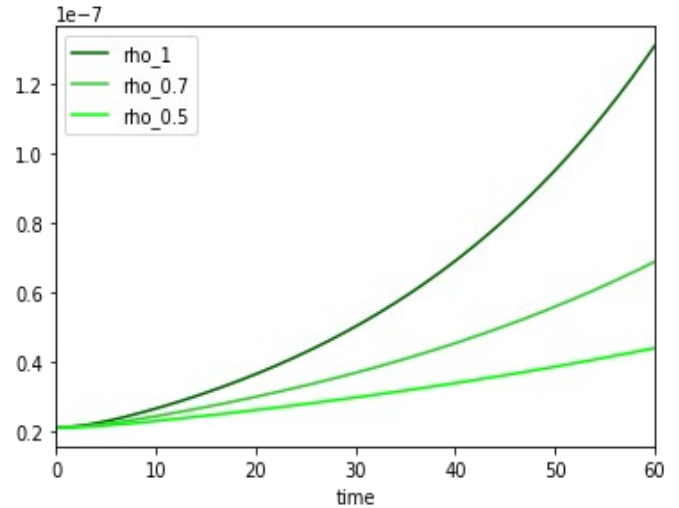Fig 1: Exposed individual in Dhaka for different rho's value

Fig 2: Infectious individual in Dhaka for different rho's value.

Again from last investigation we found parameter for Barisal alpha = 0.002, beta = 2.85 and gamma = 0.00
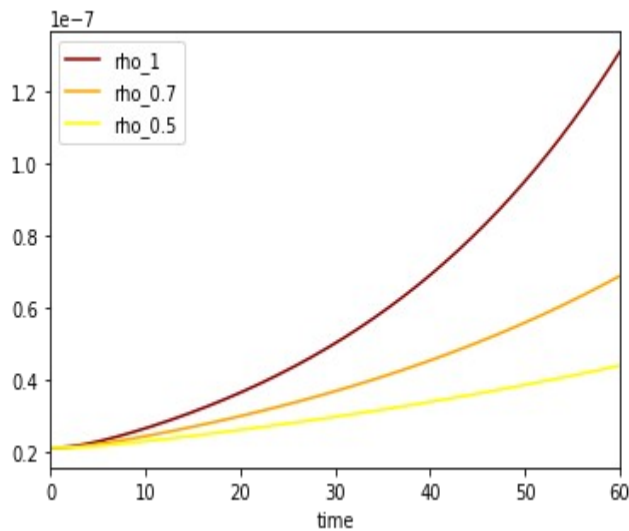

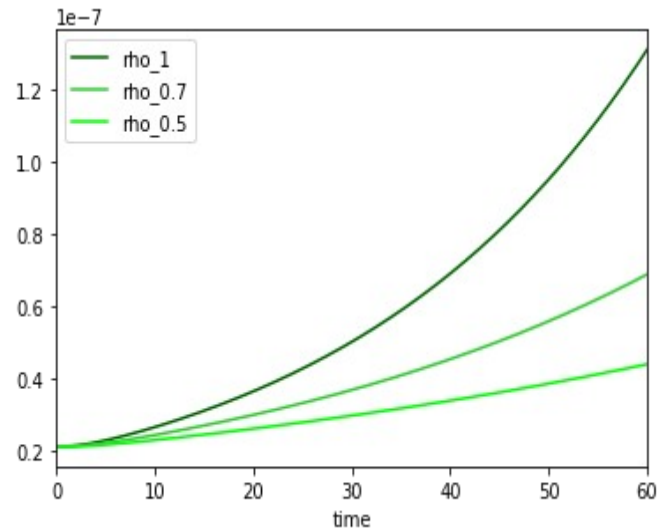Fig 3: Exposed individual in Barisal for different rho's value

Fig 4: Infectious individual in Barisal for different rho's value.

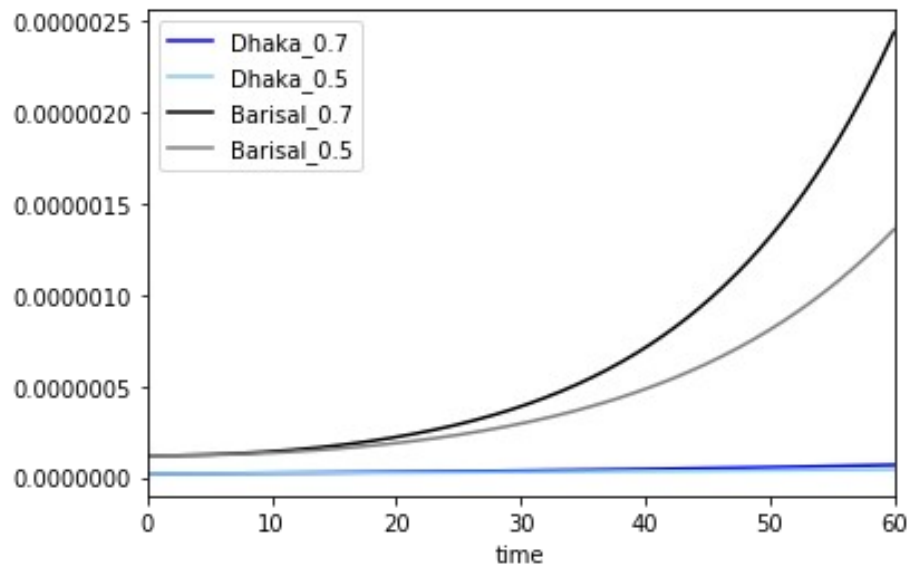To understand more accurately I am going to compare exposed individual of Barisal and Dhaka.

Fig 4 : Comparing exposed individual of Dhaka and Barisal division by applying social
0.5 and 0.7

6. Conclusion

This report show how division wise virus is effecting differently and taking same social distance approach for every division is unrealistic. Hence without opening full lock down all over Bangladesh division wise government should take separate strategy for each division.

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