Alternative Futures for the Syrian Refugee Crisis

1. Motivation and Outline

For many aid workers, the refugee migration from Syria to neighbouring countries and possibly on to Europe is considered the humanitarian crisis of our time. Millions of people have been displaced by the violence and thousands of people have died both in Syria and in transit to refugee camps in neighbouring countries. Refugee camps are crowded and conditions in the refugee camps desperate. Relocation services have been overwhelmed and there has been backlash from the accepting countries about the large number of refugees coming into their countries.

The driving factor of the problem is violence in Syria. In this paper, we will specifically examine the refugee crisis caused by the Syrian civil war and build a model based on data that was obtained from the UNHCR website (?). After finding the parameters for the model that provide a good fit of the model to the time-series data available, we will make a number of projections into the future to examine possible future courses of action that could be undertaken by the UNHCR.

In section 2, we will briefly describe why we think System Dynamics is ideally suited to the examination of the refugee crisis in Syria, neighbouring countries and Europe. In section 3, we will provide a visualization of the model with the important interactions highlighted. In section 4, we will find the parameters of the model that provide a good fit of the model to the data available from the start of the Syrian civil war in 2010 to the present. In section 5, we will discuss how the model can be used to make baseline projections of a possible future scenario created by the Syrian refugee crisis. In section 6, we will modify the model to consider alternative futures that might occur because of unsustainable situations we found in the baseline projection of the refugee crisis. In section 7, we will summarize our findings and discuss further work that needs to be done.

2. The System Dynamics Method

System Dynamics models use a perspective of Stocks and Flows. Stocks represent real-life objects that accumulate over time. Flows are the way the Stocks increase or decrease over time. A good way to think about Stocks is as water in containers and a good way to think of Flows is as pipes with taps that control the flow of water in and out of the containers. One System Dynamics expert describes the process of building a System Dynamics model as getting "the plumbing figured out" (Ref).

In the case of the refugee crisis, at any point in time, the people affected are in one of any number of containers (for example, in Syria or in refugee camps in neighbouring countries or having immigrated to a new country). The refugee crisis is causing problems because large numbers of people are being displaced (flowing) inside Syria trying to reach a safe haven and crossing (flowing) over international borders. Therefore, we felt that a System Dynamics approach, with its perspective of a system as number of physical objects in various containers connected by flows between the various containers, would be ideally suited to examine the refugee crisis and project how the crisis might develop over time. We call these projections "alternative futures in the refugee crisis".

3. The Baseline System Dynamics Model

Figure 1 shows the baseline System Dynamics model. In this case, people flow through the states from left to right in the figure. The initial population in Syria is assumed to be the population before the Syrian civil war started. On the far left is the net births, this is based on the difference between the births per year and the deaths from natural causes per year. If the net births is positive, it will increase the population in Syria all things being equal. The killings occur during protests and battles and is based on the impact of violence in Syria and the average population in a rebel enclave. Killings will decrease the population in Syria as long as the protests and battles are greater than zero. The net departures from Syria in the baseline model is assumed to be the refugees crossing the borders into neighbouring countries. In the baseline model, this is assumed to decrease the population in Syria and increase the population of refugees in neighbouring countries when the protests and battles are greater than zero.

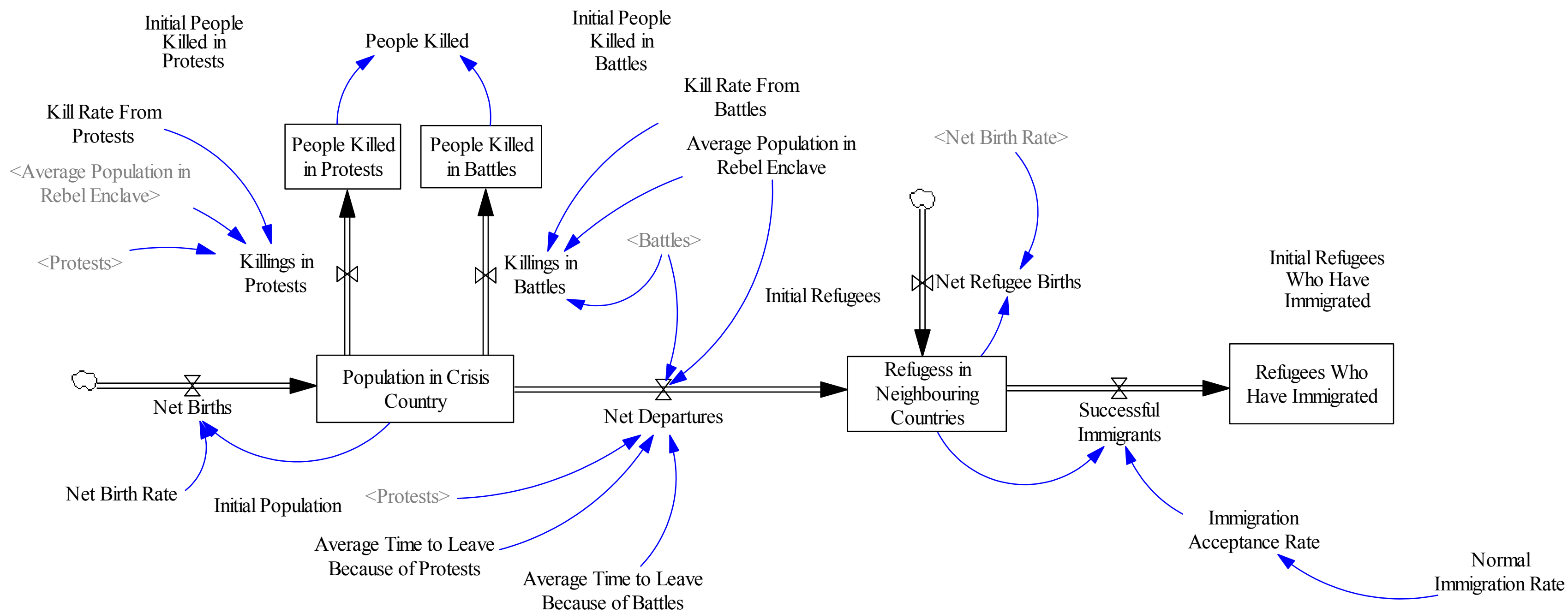

Figure 1: The Baseline Model of Population Flow

The refugees in the camps in the neighbouring countries will also have a positive net births that increases the number of refugees in the camps all things being equal. There are also a number of successful immigrants who will leave the refugee population in the neighbouring countries and become refugees who have immigrated. The number of successful immigrants is based on the number of refugees in the neighbouring countries and the normal immigration rate.

Figure 2 shows our baseline model of violence in the Syrian civil war. We assume there is an interaction between the anti-government protests and the on-going battles between the regime and rebel forces. There is an initial number of protests and a certain rate of contagion with the protests in one location encouraging protests in other locations. This will increase the number of protests all things being equal. There is then a regime response to the protests that increases the number of battles all things being equal. Based on the number of protests and the battles and the impact of violence, there is a quelling of the protests which reduces the number of protests all things being equal. Finally, there is a natural de-escalation rate that will reduce the number of battles.

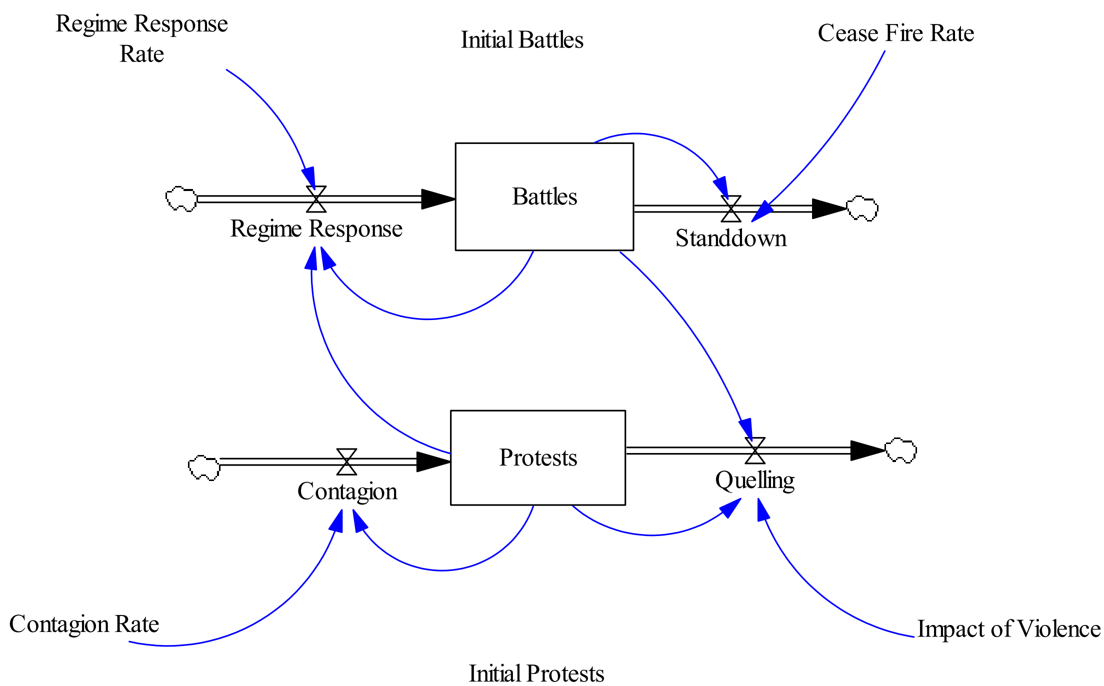

Figure 2: The Baseline Violence Model

4. Finding Parameters for the Baseline Model

We found a number of time-series data sets on the UNHCR website (Ref) and elsewhere (Ref) which we used to find the parameters of the model for the baseline case.

The first parameters we estimated were the contagion rate, the regime response rate, the impact of violence and the de-escalation rate. We assumed the initial number of protests was 50. Then we found a contagion rate of 1.37 protests/protest/year, a regime response rate of 0.00481 battles/(battles*protests)/year, an impact of violence of 0.0794 protests/(protests*battles)/year, and a de-escalation rate of 0.201 battles/battle/year provided a good fit to the violence data that was available for the period 2010 to 2018 (see Figure 3).

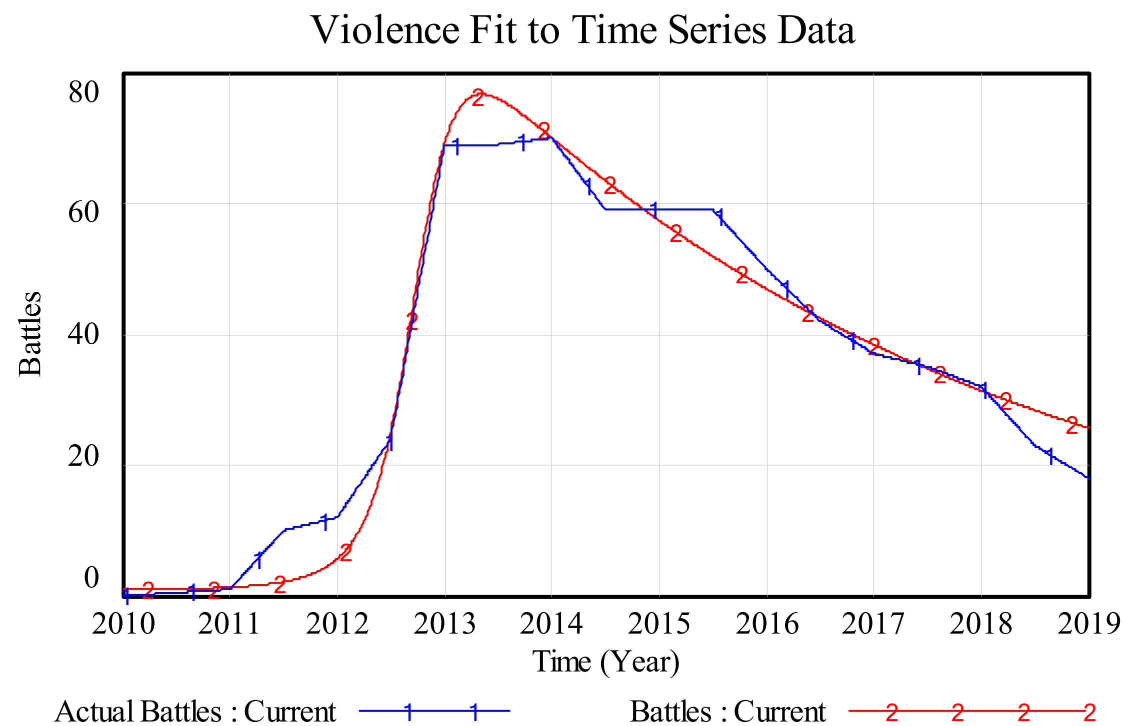

Figure 3: Fit of Violence Model to Time-series Data

For the population in Syria, we found data for 2010, 2015, 2016, 2017 and 2018. We estimated a net birth rate of 0.0241 people/person/year, a kill rate in protests 0.00161 people/person/protest/year, a kill rate in battles 0.0133 people/person/battle/year, average time to depart an enclave because of protests of 35.8 protest-years, average time to depart an enclave because of battles of 3.28 battle-years, assuming there were 65,000 people in an average enclave. With these values, we were able to find an interesting fit to the data (see Figure 4).

Notice that the population in the baseline model is increasing over the period 2010 to 2012. This is because the violence level is still relatively low and the net births is quite high. Since we do not have data for the period 2011 to 2014, we are not exactly sure what the population in Syria was in those years. However, the baseline model seems to fit the data that we do have for the period 2015 to 2018 quite well.

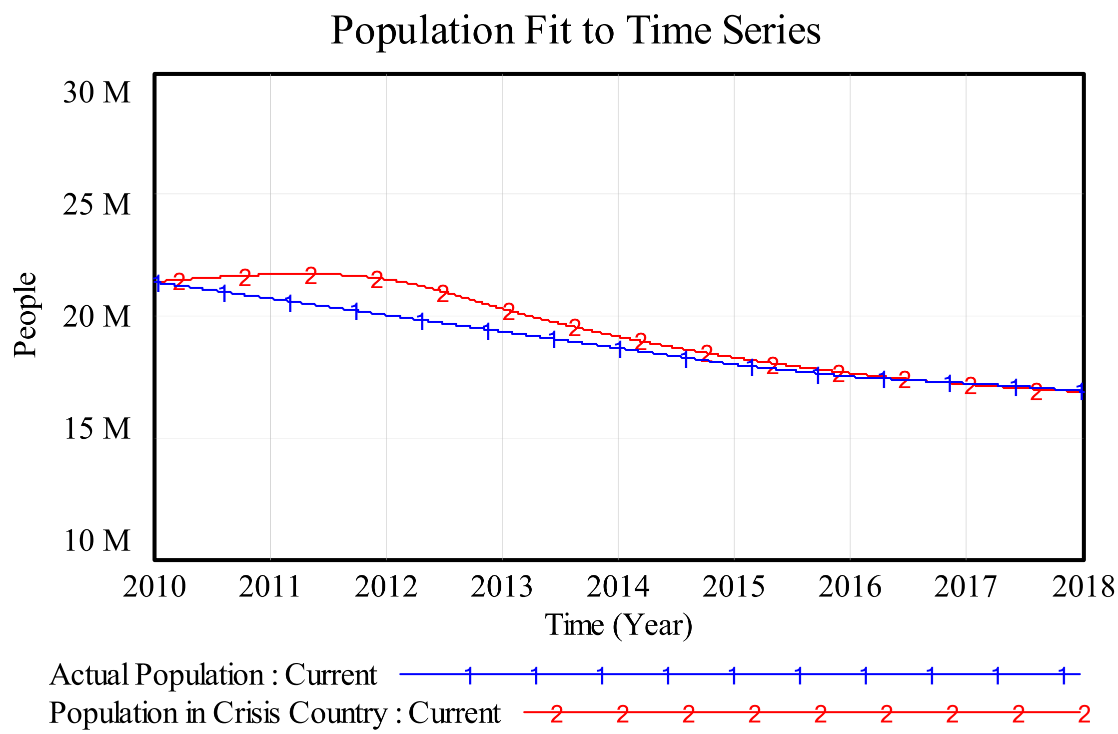

Figure 4: Population in Syria in the Baseline Model Fit to Time-series

We estimated a kill rate in protests 0.00161 people/person/protest/year, a kill rate in battles 0.0133 people/person/battle/year provided a good fit of the time-series data we found on people killed between 2010 and 2018 (see Figure 5).

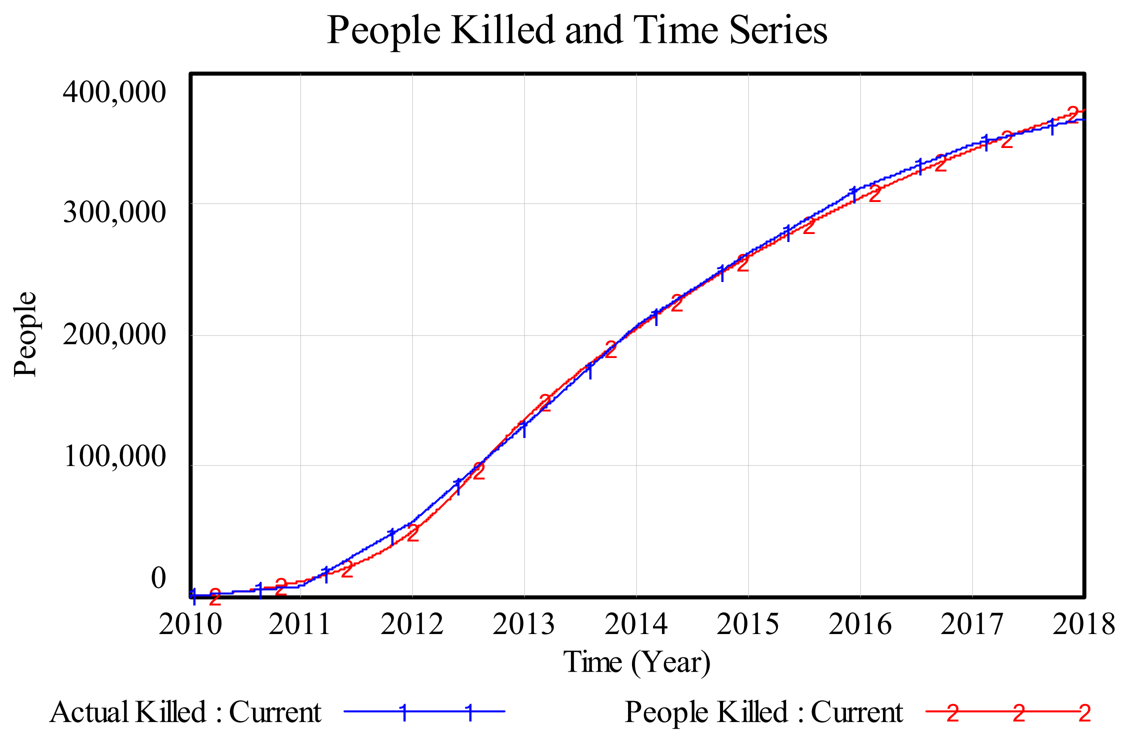

Figure 5: People Killed in Model Fit to Time-series

Estimates of average time to depart an enclave because of protests of 35.8 protest-years, average time to depart an enclave because of battles of 3.28 battle-years and an immigration acceptance rate of 0.0713 people/person/year provided a good fit for the refugee population time-series data (see Figure 6).

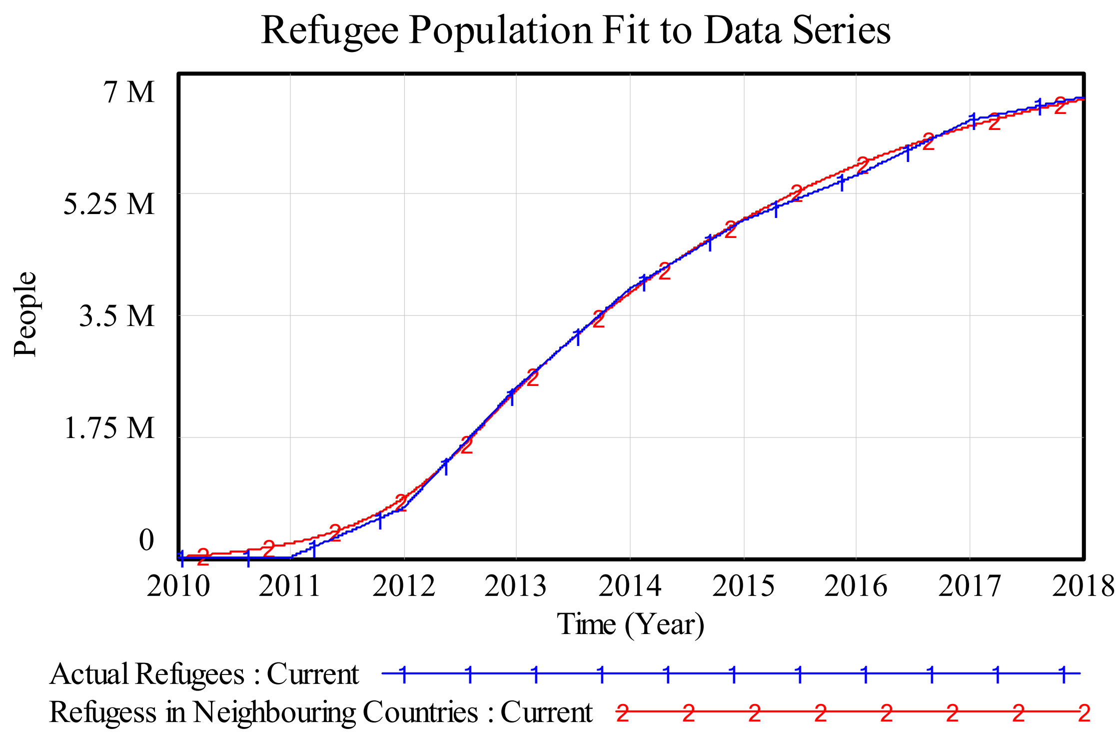

Figure 6: Refugees in Neighbouring Countries in Model Fit to Time-series

5. Projections Using the Baseline Model

Now that we have some confidence in the validity of the baseline model because it can be reasonably well fit to the available time-series data, we can attempt to make some projections into the future all things being equal. These projections are based on the assumption we have modelled "the plumbing" correctly and because of this we obtain curved projections rather than straight-line projections.

The first projection we will consider is the future of the violence in Syria. Figure 7 shows a projection of on-going battles projected into the future until 2035. The on-going battles are projected to decrease gradually and eventually drop to near zero by 2035.

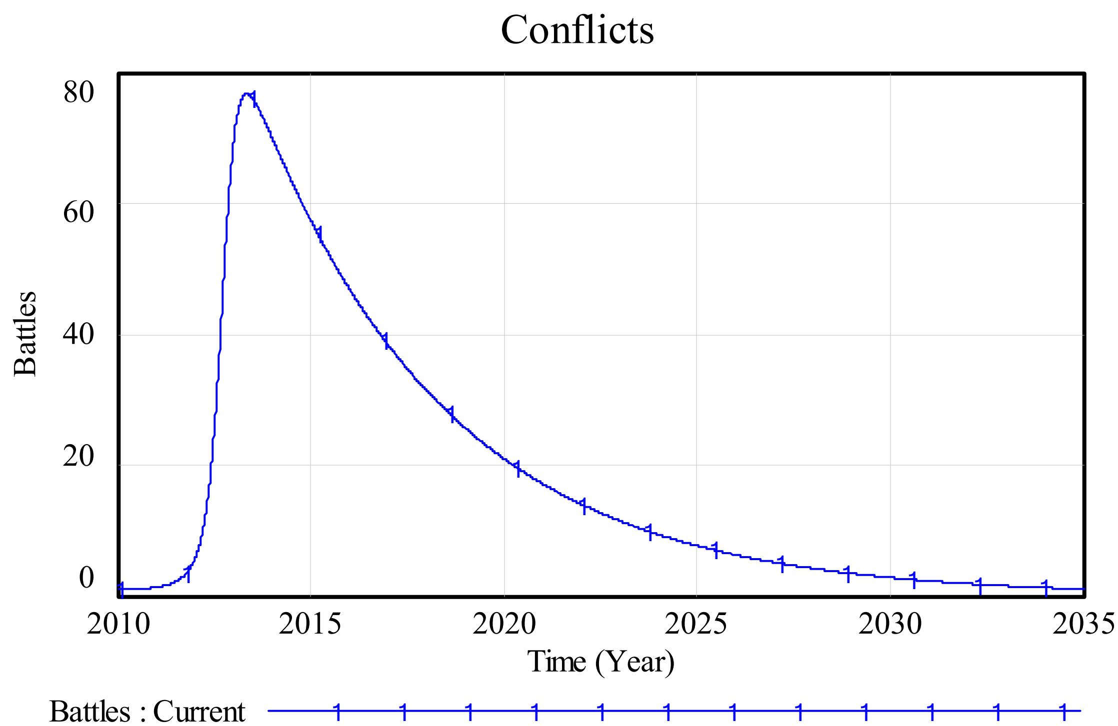

Figure 7: Violence Level Projections Using the Baseline Model

The population in Syria and the refugees in the neighbouring countries projected into the future by the baseline model are shown in Figure 8. We can see that the population in Syria will start to recover after 2020 as the violence level decreases and the net births begin to exceed the killings and the departures of refugees. The refugees in neighbouring countries is also projected to peak in 2020 and then start to decline as the immigration of refugees begins to exceed the refugees arriving in the neighbouring countries from Syria and the net births in the refugee camps. We can see that the number of refugees in the neighbouring countries is projected to be still over 5 million people until 2035 all things being equal.

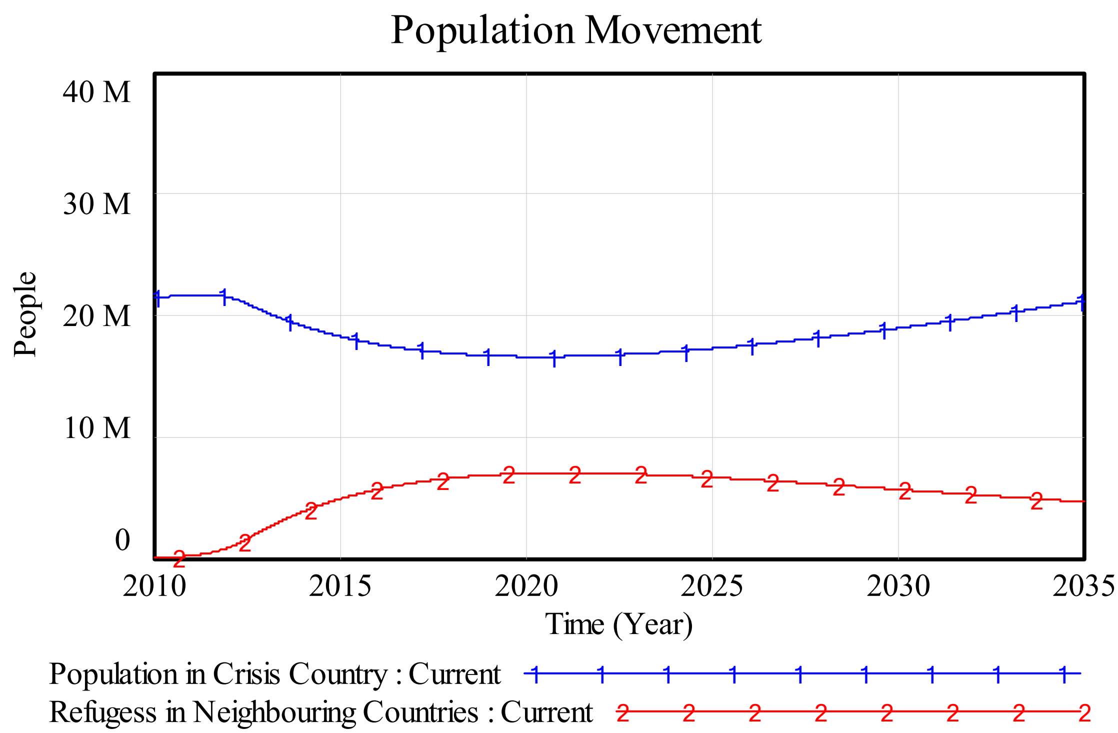

Figure 8: Projected Population Movement Using the Baseline Model

In the baseline model, the number of refugees who immigrate is projected to continue to increase up to 9 million people until 2035 with no end in sight (see Figure 9). This huge number of immigrants may not be sustainable. So we will consider two alternative futures to limit the number of immigrants.

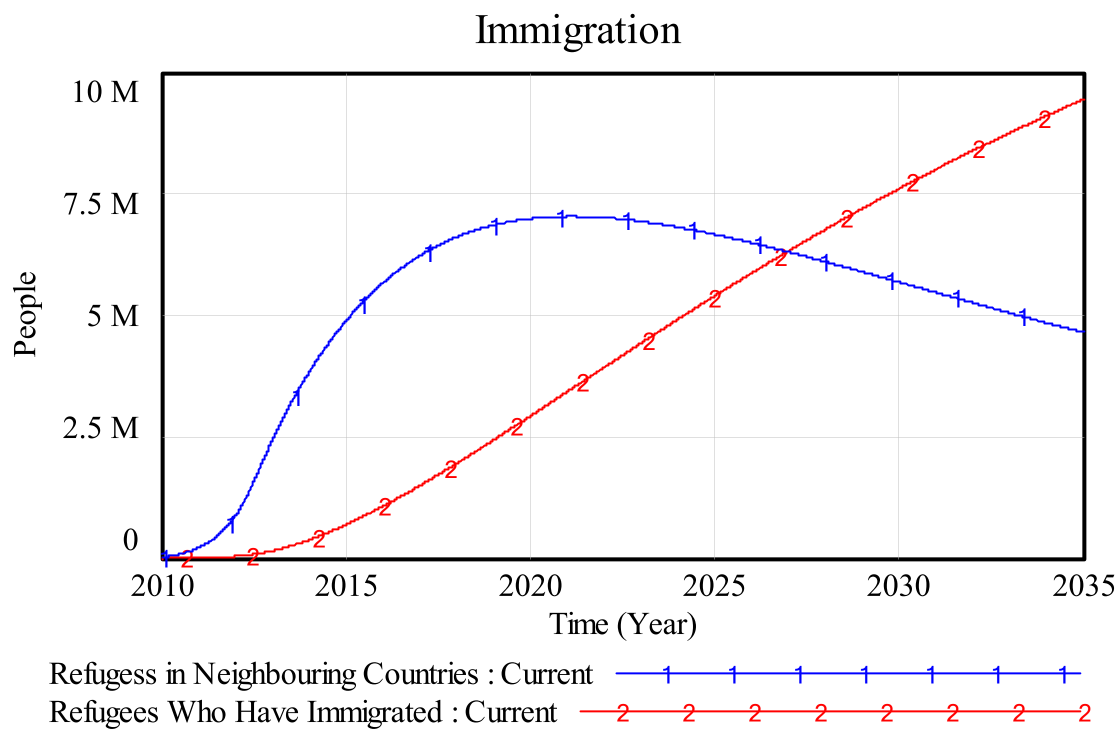

Figure 9: Projected Refugees in Camps and Immigrating Using the Baseline Model

6. Two Alternative Futures in the Refugee Crisis

The first alternative future we will examine is based on the assumption that the high and growing number of immigrating refugees is unsustainable. We can refer to this situation as compassion fatigue (Ref). In this case, there is a limit on the number of refugees that will be allowed to immigrate and thereby escape the refugee camps. The changes to the model are shown on the right hand side of Figure 10. Here we can see a compassion fatigue effect will apply once the number of refugees who have immigrated reaches the point at which the compassion fatigue starts to be a limiting factor, in this case at 2 million immigrants. Once that point is reached, the immigration rate will gradually be reduced, eventually to a very small amount, in this case just 5% of the original immigration rate.

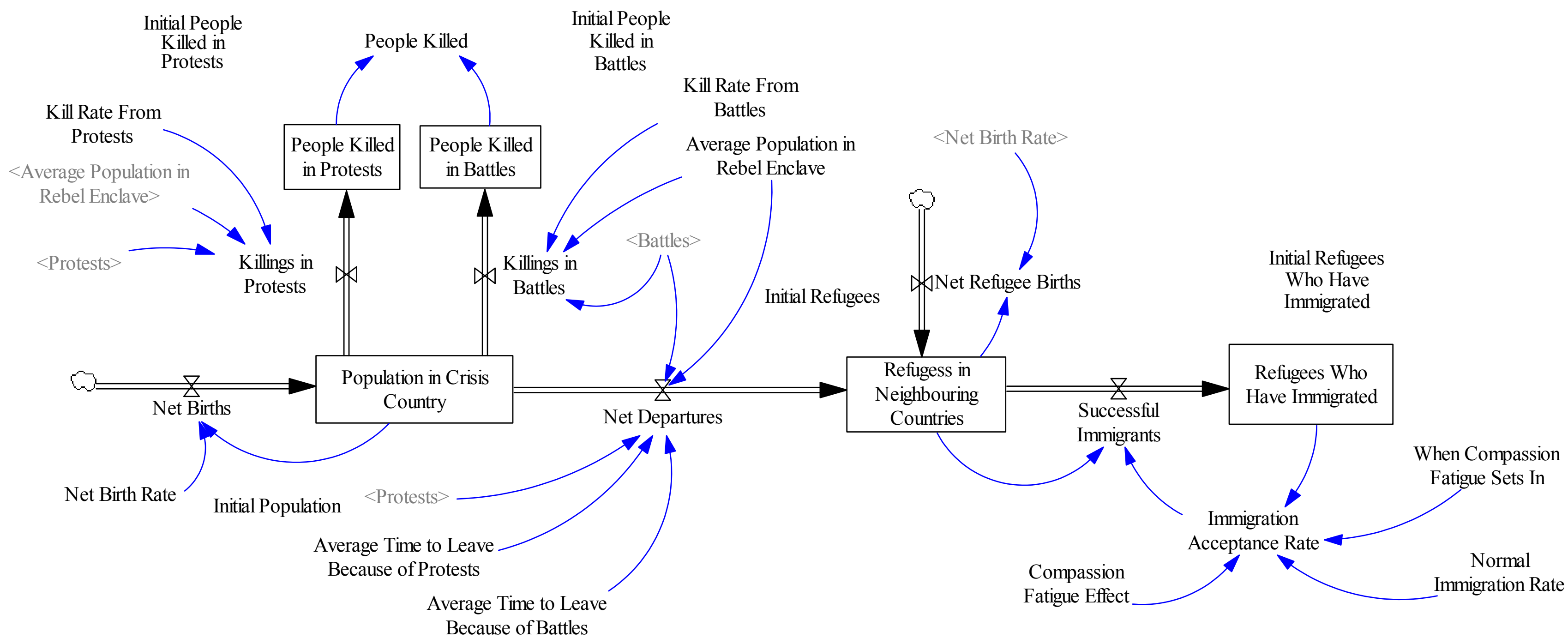

Figure 10: Revised Model to Include Compassion Fatigue

Figure 11 shows a projection of the impact of compassion fatigue on the refugees in the neighbouring countries and the refugees who have immigrated. We can see that the refugees who have immigrated stabilizes at around 4 million people while the refugees in the neighbouring countries continues growing up to 11 million because of the large number of births in the camps.

Although this compassion fatigue approach to the immigration rate may resolve the problem of overwhelming the countries willing to except refugees as immigrants, it leads to a serious humanitarian crisis of unsustainable refugee camps in the neighbouring countries.

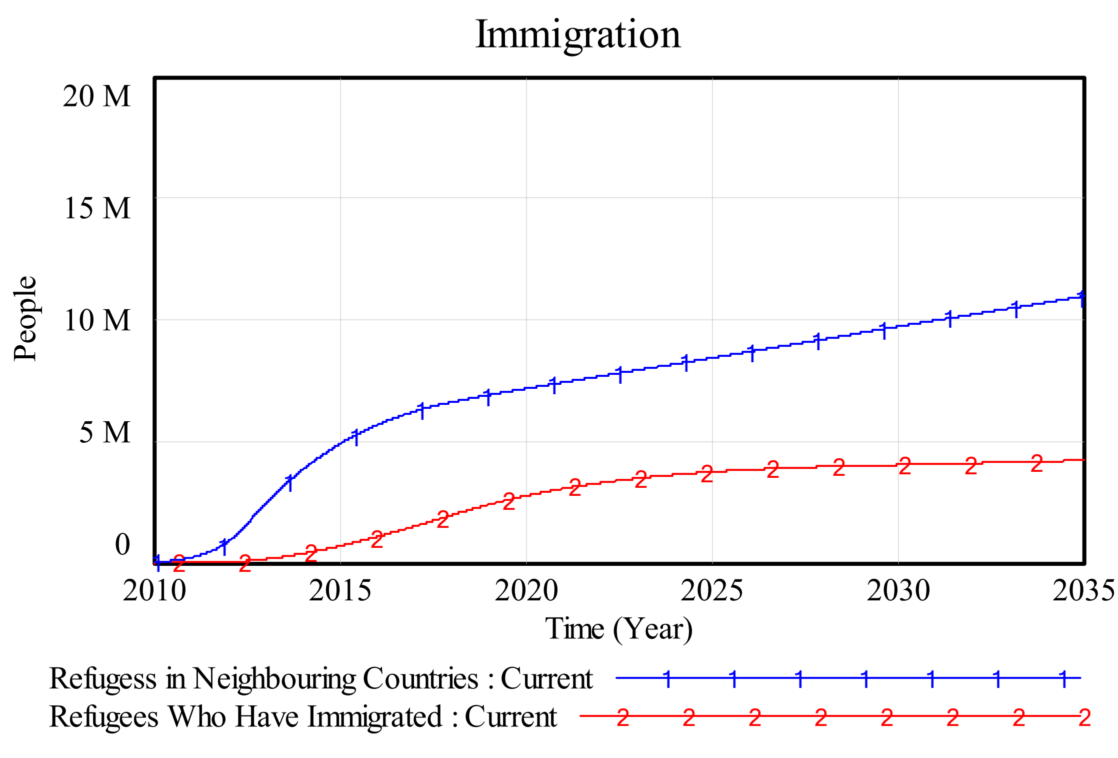

Figure 11: The Impact of Compassion Fatigue on the Refugee Populations

There is one more modification to the refugee crisis model that we would like to consider to possibly resolve the problems created by the refugees crisis and compassion fatigue, namely repatriation of the refugees (Ref). Assuming the refugees have left Syria to save themselves from the violence there, once the violence is reduced to a manageable level, it may be possible to repatriate the refugees in the neighbouring countries back to Syria. The compassion fatigue model will be modified to allow repatriation of the refugees from the neighbouring countries.

There are still a number of refugees in the neighbouring countries who would not be repatriated because they would risk their lives if they were sent back. So there is still a small number of refugees who will be relocated as asylum seekers to safe Western countries. However, the vast majority of refugees in the neighbouring countries would be repatriated if they could be ensured that their safety is guaranteed. In this case, we will assume the violence has been naturally reduced to a level where a cease fire between the rebels and the regime can be put in place and UN peacekeepers can be deployed to Syria to enforce the cease fire.

The peacekeeper model is shown on the right hand side of the revised Violence Model shown in Figure 12. In this case, once a desired violence level is reached, then the peacekeepers can begin to be deployed and they will be deployed based on the deployment rate and the redeployment rate until the number of peacekeepers reaches the desired number of peacekeepers in Syria.

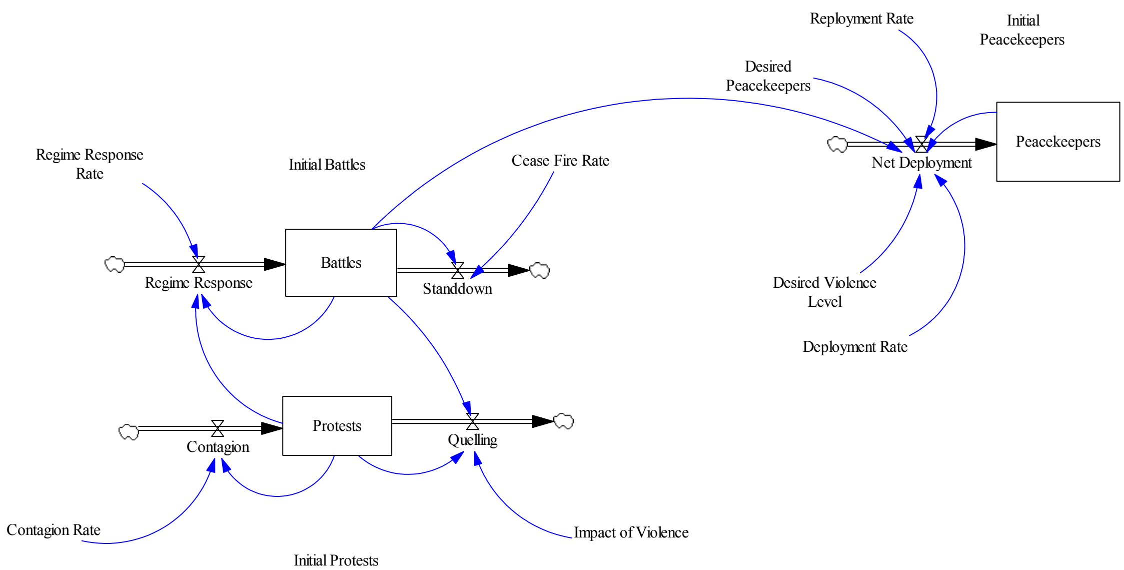

Figure 12: Revised Violence Model with the Deployment of Peacekeepers

Figure 13 shows the results of a deployment model for peacekeepers with a desired violence level of 5 battles at which time the peacekeeper deployment can begin, with a desired number of peacekeepers of 10,000 soldiers, and a deployment rate of 3.74 soldiers/soldier/year and a redeployment rate of 3.74 soldiers/soldier/year.

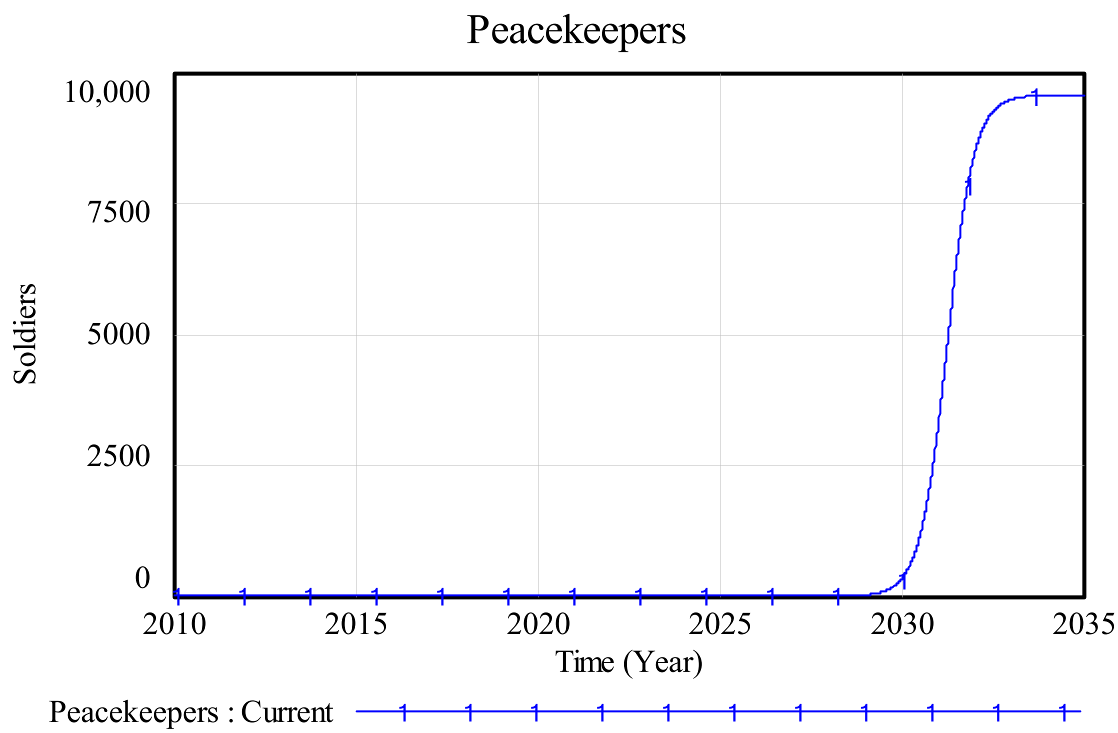

Figure 13: Projections from Peacekeeper Deployment Model

Then we will modify the refugee movement model to employ an average time to repatriate refugees from the neighbouring countries back to Syria that is based on the number of peacekeepers deployed compared to the desired number of peacekeepers in Syria (see Figure 14). The changes can be seen in the area where the net departures is calculated. So the net departures will be positive when the violence level is high and as the violence decreases, the peacekeepers can be deployed and the refugees can start being repatriated. So eventually the net departures becomes negative and there are more people returning to Syria than the number who are leaving Syria.

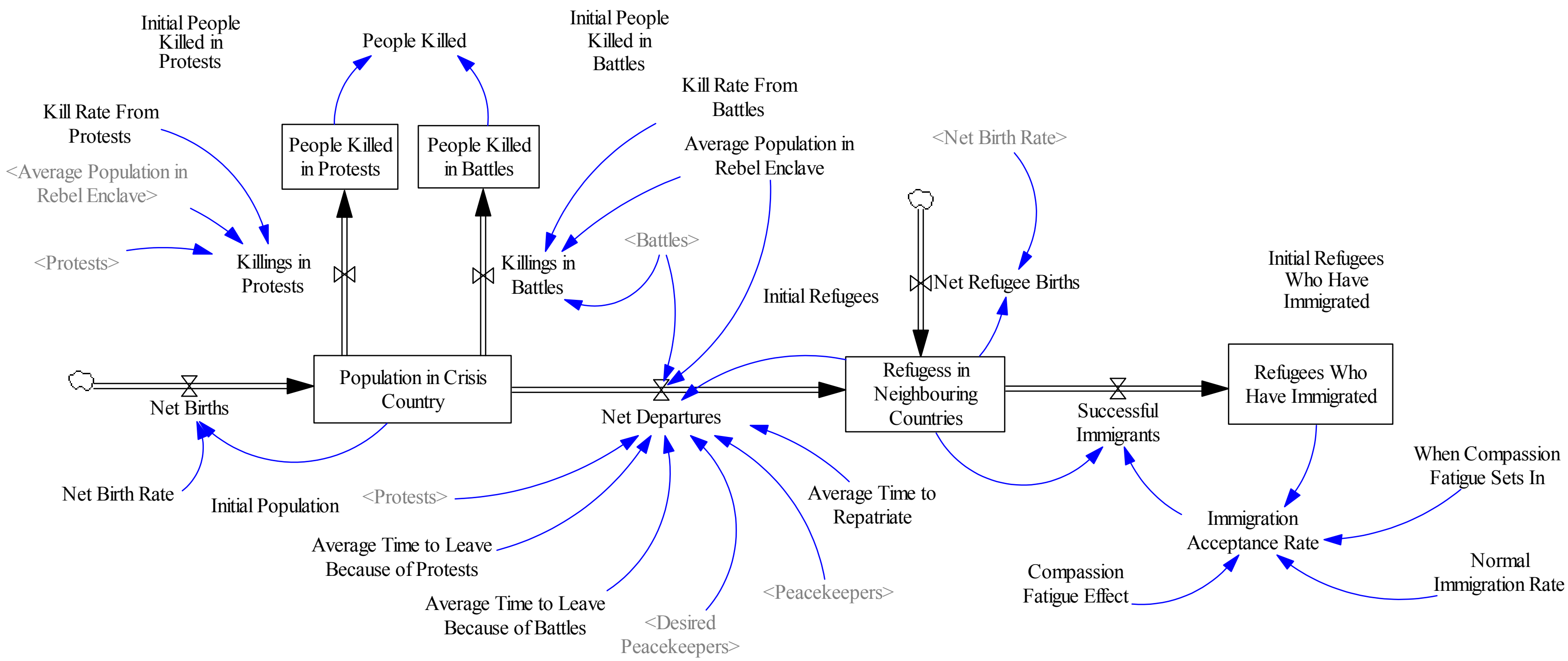

Figure 14: Revised Compassion Fatigue Model with Repatriation

In Figure 15, we can see the results of the repatriation revisions to the model. The projections would suggest that complete repatriation of the refugees to Syria from the neighbouring countries would take more than 5 years and would involve almost 10 million people being repatriated. This huge repatriation effort may not be realistic and may need to be phased over a longer period of time. However, the concept of repatriation would appear to resolve many of the problems of the refugees crisis in the neighbouring countries if it can be successfully implemented.

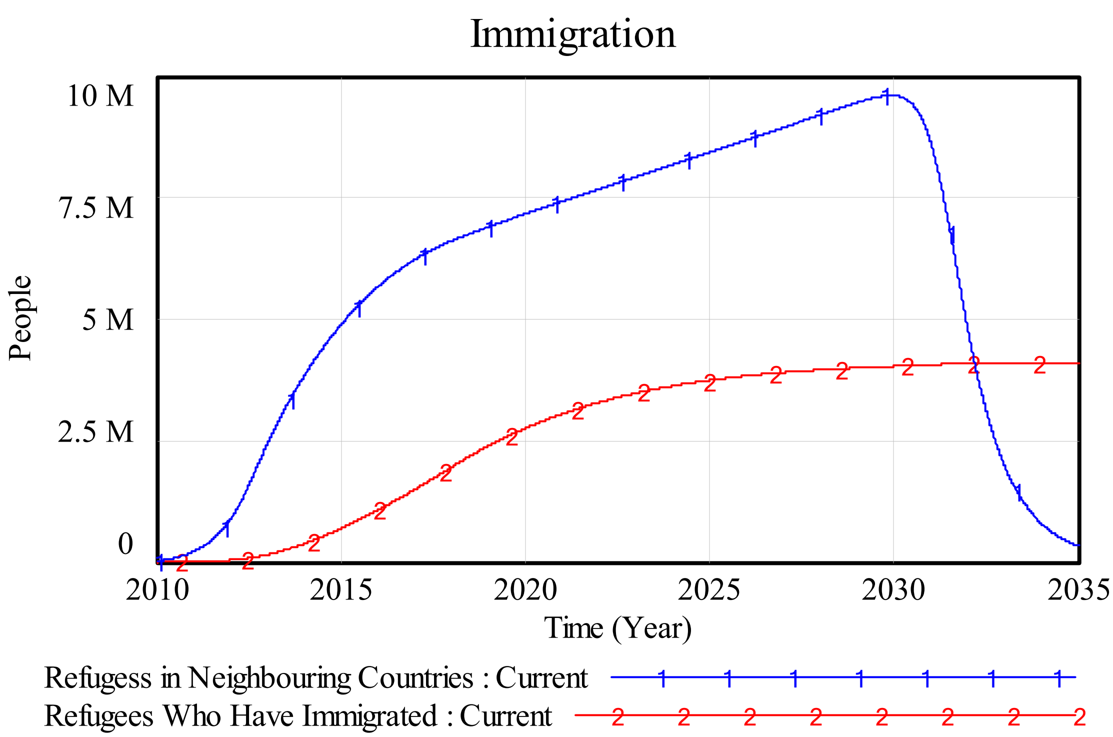

Figure 15: Projections from the Compassion Fatigue with Repatriation Model

Figure 16 shows the impact of the repatriation on the population in Syria. It would appear that the huge rapid increase in the population in Syria would be difficult to sustain without significant humanitarian aid through the UN and economic development aid from Western countries.

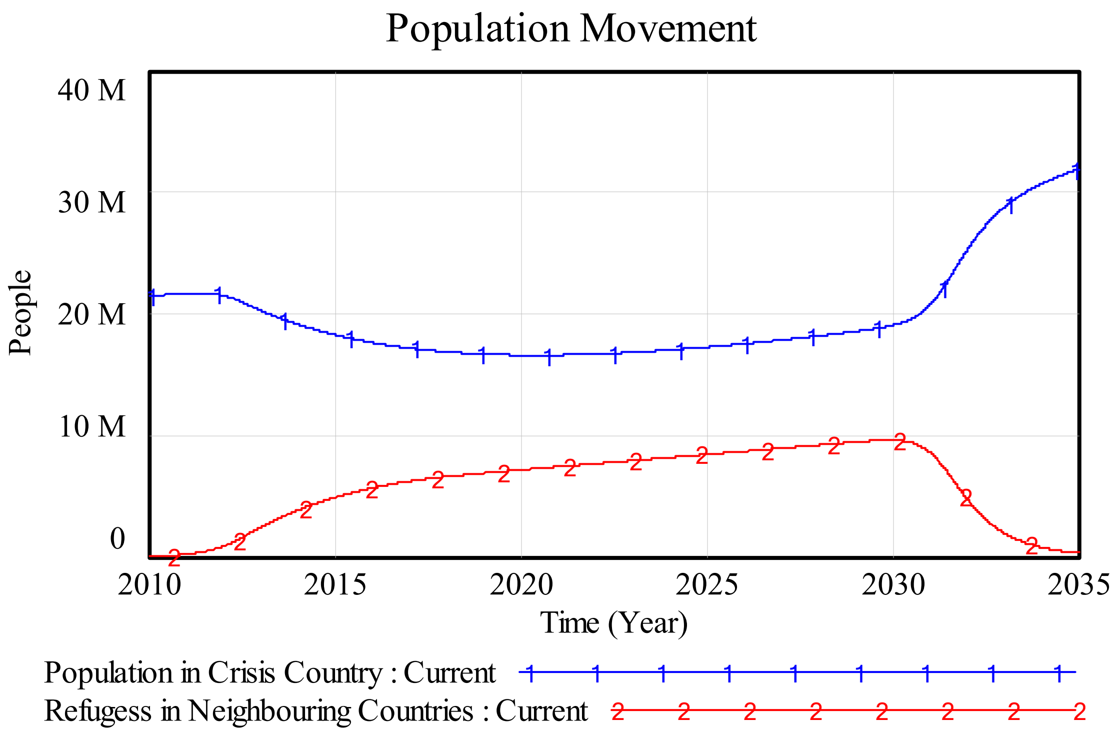

Figure 16: Impact of Repatriation on the Population in Syria and the Neighbouring Countries