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A Systemic Analysis of Terrorism in the West

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Research Question

"Through a Systemic analysis of Terrorism and Terror attacks in the west in the past 20 years, what recommendations can be made as regards the policies to reduce casualties?"

Introduction

The present thesis seeks to analyze and understand terrorism as a comprehensive process that, through various stages, transform a "normal" individual with some grievances into a radicalized agent ready and available to be recruited and trained to perform terror attacks that produce casualties. The goal of this analysis is to produce policy recommendations that may be used to reduce the number of casualties that terror attacks in the west produce. To this end, the analysis will be divided into two main sections. The first section, which spans the first 2 chapters, will focus on a careful study of key literature regarding terrorism. We conduct a deep analysis in order to construct a qualitative understanding of radicalization and terrorism, finding common points among what is analyzed and developing a strong overview and understanding of the topic. The specific division of chapters will be as follows: chapter one will focus on the analysis of two models which describe types of terror attacks, while the first part of chapter two will focus on radicalization and the second introduce the next section of the thesis. This second, and core, section of the thesis, which spans for the remaining chapters will focus on creating policy recommendations. In this section, we will use System Dynamics to construct a model based on our findings from the first section. System Dynamics will first be presented as a methodology and its core principles will be clarified, after which we will slowly translate our qualitative understanding gained in the first section into a quantitative Stock and Flow model. We will use this model as a tool to simulate various scenarios and produce policy recommendations that are best able to reach our stated goal of reducing casualties. The section will be divided as follows: chapter 3 will focus on the construction of the model, using principles of System Dynamics and the findings from the previous section. This construction will go through various stages, in order to fully transpose the research studied into an effective model. Chapter 4 will focus on simulations of the constructed model using the web-based program called "Silico"; from these simulations we will gain some insights regarding policy recommendations. After our policy recommendations we will move on to our conclusions, in which we will use all we have learned in order to argue the importance of utilizing System Dynamics in counter terrorism studies and policy.

1. Chapter 1

In this first chapter we will consider two contributions to the study of terror attacks. The first is that of Mitchel Silber, from his book "The Al Qaeda Factor", in which he analyzes 16 attacks carried out in the west and measures the degree of involvement Al Qaeda had in said attacks. The second input we shall consider is that of Alessandro Orsini, who, once again, analyzes attacks in the west; Orsini's focus, however, is on creating a classification of attacks based upon ISIS involvement and number of terrorists. After analyzing both models we will compare and contrast them in order to draw out the "points of interest" of the present thesis, using them as a springboard to continue our analysis.

1.1. The Al Qaeda Factor

The model developed by Silber[1] differentiates terror attacks based on what kind of contact the attackers had with Al-Qaeda, thus identifying three kinds of attacks: Command and Control, Suggested/Endorsed, Inspired. Rather than look at the single attacks in depth, work already done very effectively by Silber himself, we will focus on two elements of his analysis of the attacks that are of interest to us as we review them. These elements are the radicalization process of the terrorists and the degree of contact they had with Al Qaeda.

1.1.1. Command and Control

Command and Control plots are, as the name implies, attacks that are characterized by the direct involvement of Al-Qaeda. This means that the "Muscle" of the attack is not the "Brain"; Al-Qaeda higher ups and leaders make use of radicalized individuals and give them specific directions for the attack at all stages, starting from the selection of the target. Silber identifies 3 plots that can be classified as Command and Control:

1. The infamous coordinated attacks of 9/11/2001
2. The so called "Shoe Bombers' Plot" of 2001 (Paris-Miami)
3. "Operation Overt" of 2006 (UK-US)

In the case of the 9/11 attacks, the "Hub" in which the terrorists radicalized was the al Quds Mosque in Hamburg, a Mosque that was known for its radical rhetoric. After the group had formed the hub moved away from the Mosque and into a private flat. The "link-man" (an individual in contact with Al Qaeda that acts as a go between the terrorists and Al Qaeda) was Khalid al Masri, met by chance on a train in 1999, that put the

[1] Silber, M.D., 2011. The al Qaeda factor. In *The Al Qaeda Factor*. University of Pennsylvania Press.

cell into contact with Al-Qaeda. From here the men were trained and given a clear attack plan, as previously they only had vague ideas about carrying out an attack in Russia.

The "Shoe Bombers' Plot" was an attack that was supposed to be carried out on a flight from Paris to Miami. The attack failed due to the explosive device that was to be used not detonating. The Hub of radicalization was the Finsbury Park Mosque in England, that after being taken over by Abu Hamza, a radical that had had combat experience in Afghanistan and Bosnia, became a "radio tower" for radical Islam. In this case, there where multiple "Link-men" that frequented the Mosque and had connections with Al-Qaeda. These men had loose relationships with the attackers and pushed them to travel abroad to further study radical Islam and receive training.

"Operation Overt" was a plan to detonate multiple explosives on various flights from the UK to the US. There where multiple Hubs in which the terrorists radicalized, but a core for most of the attackers was membership in the Tabligh Jamaat group. This was not a radical group per-say, but believed in a strict adherence to the Islamic lifestyle. The link man was Rashid Rauf, whom it has been revealed worked in Al-Qaeda's external operations unit.

This process of contact with Al-Qaeda during radicalization is explained in general terms by both Silber and Bhatt in their theory regarding Radicalization[2] and, though it might seem outside of the scope of this thesis, is deceptively important in counter-terrorism policy planning. As we continue our analysis we will as such pay careful attention to it.

1.1.2. Suggested/Endorsed

The next type of attacks identified by Silber are Al Qaeda "Suggested/ Endorsed" plots. In such attacks, would be terrorists receive, as the name implies, either a suggestion or an endorsement to carry out an attack in the west from members of Al Qaeda. However, unlike in command and control plots, the attackers are left large or total discretion regarding methods and targets, as well receiving minimal to no training. In short, Al Qaeda is far less involved than in the first type of attack. Silber provides 7 examples of Suggested/Endorsed plots:

1. The Millennium Plot of 1999 (Los Angeles)
2. Operation Rhyme of 2004 (London)
3. Operation Crevice of 2004 (UK)
4. Operation Theseus of 2005 (London)
5. Operation Vivace of 2005 (London)
6. Operation Dagger of 2007 (Copenhagen)

[2] Silber, M.D., Bhatt, A. and Analysts, S.I., 2007. *Radicalization in the West: The homegrown threat* (pp. 1-90). New York: Police Department.

7. Operation Highrise of 2009 (New York)

In the case of the Millennium Plot, Ahmed Ressam was part of a cell of Algerian-Canadians that radicalized and travelled to the Middle East to receive training, however his entire original cell was arrested at varying times upon ending their training, leaving Ressam alone in organizing an attack that ultimately failed. The plot was very similar in the initial phases to the command and control plots seen before, with radicalization beginning in a hub in the west and then the attackers traveling to receive training. However, the terrorists were not given a specific target or strategy, only general knowledge on how to carry out a terror attack. As such, when his co-conspirators were caught, Ressam was on his own without guidance from Al Qaeda.

In Operation Rhyme the protagonist is Dhiren Barot, who frequented the earlier mentioned Finsbury Park Mosque where he began his radicalization process thanks to the sermons of Abu Hamza. In 1995 he and his cell began travel to southwest Asia in order to receive training and contact terrorists groups, notably Lashkar-e-Taiba and Al Qaeda. Once again, then, the initial phases of the plot are similar to all we have seen before; western radicalization followed by travel to receive training. After this point what is of interest to us, as we have noted, is contact with Al Qaeda; in Dhiren Barot's case what has been deduced from investigations following his arrest is that he maintained contact with Al Qaeda and put forward various attack proposals to its leaders. At the time of his arrest these attack "proposals" were laid out in detail in documents he had written. Silber deduces that Dhiren Barot likely presented these ideas to Al Qaeda leadership, seeking approval or support, however given that the conspirators did not have any of the materials needed to carry out any of the hypothetical attacks it is unlikely that the plots ever progressed outside of the planning phase.

In the case of Operation Crevice, the terrorists' radicalization process can be traced back to the Al Muhajiroun group. The group proposes a radical interpretation of Islam, and was the main catalyst that begun the radicalization of the would-be attackers. Unlike in Operation Rhyme, at the time of the arrests of the terrorists, materials for producing bombs were found, meaning that in practical terms the attack was further along in the "production chain". However, the final target was still unclear, with various locations across the UK being considered. In terms of contact with Al-Qaeda, between 2001 and 2004 the members of the cluster travelled to the middle east to receive training and first contacted the Terrorist group. After this the cluster began planning out an attack in the UK on the recommendation of Abu Munthir, the link man between the cell and the Al-Qaeda core that some members of the cell had met in the UK. Indeed, Abu Munthir told the cell that there was "no room for them" on the middle eastern front, and that they should thus focus their energies on carrying out an attack in the UK. However, the support of the Cell's link man never went beyond this initial suggestion and some general guidance.

Operation Theseus, otherwise known as the London Transit Bombings of 2005, were a series of coordinated blasts that hit the London Public Transport System. In terms of radicalization of the principal perpetrators, the Iqra Learning Center, a bookstore in the UK, served as the main hub. Here religious classes were held, political

discussions had and videos depicting western crimes on the Muslim world were shown. From here Mohammed Siddique Khan, the leader of the cell, travelled to the Middle East to train. After his return to the UK, he went to Pakistan to fight and planned to "martyr" himself, however his plans changed and he decided instead to focus on carrying out a terror attack in the UK. As regards Al-Qaeda involvement, Silber notes that the jury is still out on whether or not the leaders of the cell where actually recruited officially into the organization or not. However, it is certain that they received some degree of guidance from the group; as such it is to be considered an inspired plot unless future evidence reveals a higher degree of Al Qaeda involvement.

Operation Vivace refers to four failed bombing attempts on the London public transport system in 2005, just a few weeks after the events of Operation Theseus. Once again, the cell that carried out the attack had as their central node of radicalization the Finsbury Park Mosque, mentioned above multiple times already in various other attacks. Of this cluster, only one member, Muktar Ibrahim, travelled to outside the UK to receive training, first to Sudan and then to Pakistan. This second trip is what spurred the cell into action, as the preparations for the attack began shortly after it ended. While there is no hard evidence proving that Muktar Ibrahim was in contact with Al Qaeda, it is pointed out that he was in contact with Al Qaeda linked individuals in the UK, and it is as such likely that during his trips he received training and some guidance from the Terrorist Group.

Operation Dagger was a failed terror attack that would have taken place in Denmark, with the two terrorists involved being arrested om 2007. In terms of radicalization, not much can be said as not much has been disclosed by the Danish government; it is not easy to identify a clear "path" that the two terrorists took. It is noted, however, that in terms of contact with Al Qaeda, the two terrorists made frequent trips to Pakistan to visit their parents. These trips likely also allowed for contact, training and some guidance from Al Qaeda, as one trip seemed to be the catalyst for the attack, with the terrorist beginning preparations to carry it out as soon as they returned.

The final Endorsed Plot is Operation Highrise of 2009, a failed attack on the New York subway system that would have involved three coordinated bombings. Silber highlights how very little is known about the radicalization of the three terrorists, however he points to a trip that they took in 2008 to Pakistan as the point at which they linked up with Al Qaeda. The initial purpose of the trip was to travel to Afghanistan to join the Taliban in the fight against the US, however they ended up attending an Al Qaeda training camp where they were recruited into the organization. Upon their return in 2009 they began preparations for the attack after discussing it with Al Qaeda higher ups and receiving general guidelines from the group; the specifics were left to the three terrorists

1.1.3. Inspired

The final category of Plots that Silber identifies are the so called Al Qaeda "Inspired" Plots. In these plots, Al Qaeda has no involvement in the attack itself, meaning no guidance is provided as to the targets or methods. However, this does not necessarily mean that the terrorists never came into contact with Al Qaeda, nor does it

mean they never received training; it simply means that the attack itself has no connection to Al Qaeda. The attacks that Silber analyzes as "Inspired" plots are:

1. The Tradebom Plot of 1993 (New York)
2. The Madrid Train System Attack of 2004
3. The Hofstad Group Plots of 2004-5 (Netherlands)
4. Operation Pendennis of 2005 (Australia)
5. Operation Osage of 2006 (Canada)
6. The Lackawanna Cluster "Non-Plot" of 2002

The Tradebom plot of 1993 involved the detonation of a car bomb below Tower One of the World Trade center, with the intention of causing it to fall into Tower Two to cause widespread destruction; though it failed to topple the tower, it still caused 6 deaths and many injuries. Though the perpetrators did use an Al Qaeda bomb making manual, they did not have any other type of support from the group, nor did they formally join it. As such, the attack is classified as being an "Inspired" plot.

The attack on the Madrid Train System of 2004 involved 10 coordinated bombings on the train system of Madrid, causing 191 deaths. The main cause of radicalization of the attackers was Abu Dahdah, whom had connections with Al Qaeda connected individuals and preached violence and a radical interpretation of Islam in Spain. Following Abu Dahdah's arrest in 2001, his "followers" merged with another radical group and began to gravitate around Rabei Osman El Sayed Ahmed; this new group continued the radicalization process started by Abu Dahdah. While before his arrest Abu Dahdah facilitated travel for men who desired to fight in Afghanistan, none of the individuals linked to the 2004 attack traveled to receive training or fight abroad. Further, there was no evidence that the perpetrators received any guidance or training from Al-Qaeda, leading to the conclusion that the attack was an "Inspired" plot.

The Hofstad Group Plots were a series of plots that were elaborated by a cluster in the Netherlands known as the Hofstad Group: these plots were foiled by a series of arrests made between 2004-2005. In terms of radicalization, most members of the cluster began radicalizing as a result of their own research, but later on would meet at certain key locations, such as Mosques promoting a strict interpretation of Islam, where the group would coalesce and discuss. However, the group never travelled overseas to receive training, nor did it come into contact with Al Qaeda at any point. As such the plots were only inspired by, but otherwise had no connection to, Al Qaeda.

Operation Pendennis refers to the arrests of multiple individuals and the seizing of bomb making materials on the part of the Australian policy in Sydney and Melbourne in 2005. In terms of radicalization the "Ahlus Sunnah Wal Jamaah Association" was an organization in Australia promoting a fundamentalist and radical view of Islam, that served as the main vehicle of radicalization in this case. Some members of the cluster

travelled overseas to receive training and came into contact with Al Qaeda; however, the contact was not continued at the time in which the attacks began to be plotted out, thus making this an "Inspired" plot.

Operation Osage was a series of counterterrorism raids carried out in Toronto in 2006 by the Canadian Police that resulted in the arrest of 18 individuals that where plotting various possible terror attacks to be carried out in the City. Of these arrested individuals, only one had travelled to Pakistan to receive training, and only for a short while; none of the individuals had any contact with Al-Qaeda, much less did they receive any guidance from the group.

The final case examined by Silber is the so-called Lackawanna Cluster "Non-Plot" of 2002, in which individuals who had received training and had contact with Al Qaeda were arrested as a result of providing Material Support to the terrorist organization. However, these individuals were not planning any terror attacks at the time of their arrest, making this specific case not relevant to the present analysis.

As a result of the analysis of various terror attacks under this framework, Silber concludes that the role of Al-Qaeda in conducting attacks is on the decline and urges policymakers and governments to focus more on local counterterrorism initiatives.

1.2. Orsini's Model

The Model developed by Orsini[3] once again envisions three (and a half) categories of attacks, based on the type of "cells" that carry out the attack; in other words, the differentiation stems from the specific characteristics of the attackers. As such the three kinds of attackers are: cells directly commanded by ISIS leaders, autonomous cells and lone wolfs (trained or untrained). As we shall see, depending on who carries out the attack, the effects will be very different.

1.2.1. ISIS Controlled Cells

ISIS controlled cells are the first of the three types of possible attackers that Orsini envisions. As can be inferred from the name, these are cells that are under the direct guidance of ISIS and are, Orsini argues, the cells with the potential for the deadliest attacks. There are five reasons that ISIS led cells are so deadly[4], these being that the cells receive:

1. Money
2. Training

[3] Orsini, A., 2018. *L'ISIS non è morto*. Rizzoli.
[4] Orsini, A., 2019. Gli attentati dell'Isis in Europa occidentale. Un'interpretazione sociologica. *Democrazia e Sicurezza-Democracy and Security Review*, (3).

3. Weapons
4. Contact with other Terrorists
5. A strong motivation born from the perception of having the respect of ISIS leaders and the burden of carrying out an important mission.

An example of an attack carried out by an ISIS led cell that Orsini provides is the terror attack carried out in 2015 in Paris.[5] In this attack 9 terrorists carried out a coordinated attack divided into three groups of three in six different locations, killing 130 people. The specific cell that was responsible for the attack was the Brussels Islamic State terror cell, led by Abdelhamid Abaaoud, who was the main ISIS link-man.[6]

1.2.2. Autonomous Cells

The second type of attackers are Autonomous Cells, distinct from ISIS controlled cells, as can be inferred, due to the lack of a connection with ISIS. Orsini argues that these types of attacks are far less deadly than those led by ISIS controlled cells, using as an example a comparison between the Paris attacks, briefly explored above, and the 2017 Barcelona and Cambrils attacks[7]. It is pointed out how both attacks involved 9 terrorists, however the Barcelona attacks only caused 14 deaths, against Paris' 130.[8] Orsini notes how the vast difference in offensive capability of the two cells can be seen in two shortfalls of the Barcelona cell, namely in knowledge/training and tactics. Indeed, it is pointed out how the Barcelona cell committed three mistakes[9]:

1. They performed a test of the explosive device they planned to use in the same area they were storing the explosive materials;
2. They did not know how to produce suicide vests and wore fake ones;
3. Five of the attackers entered one car, allowing for one police officer to easily neutralize them.

These mistakes come down to a lack of training and tactical knowledge of the attackers, a shortfall that the Paris attackers (whom where in contact with ISIS) did not have.

1.2.3. Lone Wolves

The final type of possible Attackers are Lone Wolves, further differentiated into Trained and Untrained. Lone Wolves, while being the most unpredictable attackers, are also typically the least lethal as long as they are

[5] Ibid
[6] Van Vlierden, G., 2015. Profile: paris attack ringleader Abdelhamid Abaaoud. *CTC Sentinel*, *8*(11), pp.30-33.
[7] Aljazeera.com. 2017. *Barcelona and Cambrils attack: What we know so far*. [online] Available at: <https://www.aljazeera.com/news/2017/8/22/barcelona-and-cambrils-attacks-what-where-and-when> [Accessed 4 May 2022].
[8] Orsini, A., 2019. Gli attentati dell'Isis in Europa occidentale. Un'interpretazione sociologica. *Democrazia e Sicurezza-Democracy and Security Review*, (3).
[9] Ibid

Untrained. Trained Lone Wolves on the other hand, can be far more dangerous, as we shall see. Untrained Lone Wolves that have no involvement with ISIS usually commit a terror attack as a result of a life that is "unsatisfying", becoming what Orsini calls "Vocational Terrorists"[10] (We will explore this concept in more depth in the next chapter). As stated above, Untrained Lone Wolves will carry out attacks that are, usually, not very lethal; this is due to their lack of training and resources, forcing them to use whatever they have at their disposal as a weapon and to select targets that they can feasibly reach alone. Various examples are provided by Orsini of Untrained Lone Wolf attacks:

1. The 2016 Nice Truck attack, an outlier Untrained Lone Wolf attack with a high number of victims (86);
2. The 2017 Turku, Finland attack, in which there were only 2 deaths;
3. The Parsons Green train bombing of 2017 in London, which caused only injuries and no deaths;
4. The 2017 Marseille stabbing in France, in which 2 women were killed;
5. The 2017 Westminster attack, which caused 6 victims (including the terrorist);
6. The 2017 Surgut, Siberia Attack, in which only the terrorist was killed by the Police.

As can be seen from the list, save for the single outlier, Untrained Lone Wolves are usually unable to cause significant damage when carrying out an attack, due to the reasons above presented.

Trained Lone Wolves, however, are another story entirely, as they have the potential to cause far more victims, due to them having access to knowledge and/or materials that Untrained Lone Wolves do not. The example provided by Orsini in this case is that of the 2017 Manchester Arena Bombing. In this attack, a lone attacker, Salman Abedi, detonated an Improvised Explosive Device at the Manchester Arena, killing 22 people. What differentiates Abedi from the other lone wolve attackers is the fact that prior to the attack he had received training in Syria and/or Iraq as a result of trips he had made to these locations. The results of this training can be seen most clearly in the explosive used, as it was an unstable explosive that required specific knowledge to create and detonate effectively.

1.3. Comparison and Conclusions

As can be seen from the analysis of Orsini's Model, the main indicator of the lethality of a terror attack is whether or not ISIS played a role. Indeed, the types of attacks can be split into two categories:

1. Attacks with ISIS Involvement (ISIS led Cells and Trained Lone Wolves)
2. Attacks without ISIS Involvement (Autonomous Cells and Untrained Lone Wolves)

[10] Orsini, A. 2020, "What Everybody Should Know about Radicalization and the DRIA Model", *Studies in conflict and terrorism*, , pp. 1-33.

With the first category typically causing more damage than the second. We can thus find a parallel between Silber's Model, analyzed before, and Orsini's: while the two models focus on different terrorist organizations, with Silber's looking at Al Qaeda and Orsini at ISIS, both differentiate attacks based on the involvement the organization has in them. However, an extra step that is taken by Orsini is that to attach a different level of "lethality" to the types of attacks, with ISIS involvement typically causing more victims and damage.

The question that arises, then is whether or not this same consideration can be applied to the analysis carried out by Silber; do attacks with Al Qaeda involvement cause more victims and damage than those without? Answering this question is not easy, as many, if not most, of the attacks analyzed were stopped by authorities before they could be carried out. If, however, we look at the attacks that succeeded in each category identified by Silber we may be able to draw a conclusion. In terms of Command and Control Plots, the lethality of the 9/11 attacks is well known: 2996 deaths (including the Terrorists).[11] As regards Suggested/Endorsed plots the only one to succeed was the 2005 London bombings, causing a death toll of 56, including the 4 terrorists.[12] In terms of Inspired attacks, two plots succeeded with widely different results: the Tradebom plot of 1993 which caused 6 deaths, and the attack on the Madrid Train System of 2004, causing 191. Looking at the attacks, the first three show decreasing lethality as Al Qaeda involvement decreases, however the final attack is very lethal and as such breaks this pattern. However, even Orsini's model had such an exception, the 2016 Nice Truck attack, with 86 victims, far above the average for Untrained Lone Wolves; what is important is that the general pattern holds. In the case of Silber's analysis it is difficult to ascertain whether the general pattern holds even in light of this exception, given that most of the attacks analyzed did not succeed. However, reviewing the complexity of the plans, and the materials used, it can be reasonably held that a higher Al Qaeda involvement corresponds to more complicated plans and deadlier weapons. As such, it seems reasonable to conclude that, much like Orsini's model, a higher involvement of a larger Terrorist Group results in more lethal attacks.

This is an important conclusion in the context of this Thesis; indeed, the objective is to propose effective strategies to reduce victims of terror attacks, and we have discovered a key variable that can explain differences in lethality between attacks. However, the importance of contact with a terrorist group is not only important in terror attacks, but also in the process of radicalization that individuals may undergo. We will thus move to the second chapter, in which we will explore radicalization and the influence terror groups may have on this process.

[11] Morgan, Matthew J. (August 4, 2009*). The Impact of 9/11 on Politics and War: The Day that Changed Everything?.* Palgrave Macmillan. p. 222. ISBN 978-0-230-60763-7.

[12] The Independent. 2015. *7/7 bombings: Who were the 52 victims of the London terror attacks?*. [online] Available at: <https://www.independent.co.uk/news/uk/home-news/7-7-bombings-london-anniversary-live-the-52-victims-of-the-london-terror-attacks-remembered-10369569.html> [Accessed 4 May 2022].

2. Chapter 2

As we have seen through the review of two models for analyzing terror attacks in the previous chapter, a major descriptor of the lethality (amount of damage/number of victims) of a terror attack is the level of involvement a major terror group has in said attack. Silber considered the so called "Al Qaeda factor" in evaluating the involvement said terror group had in a large number of plots between the 1990s and the early 2000s, concluding that Al Qaeda's role is on the decline and urging policy makers to focus on local counterterrorism, as most of the plots came from terrorist that radicalized in the west. Our analysis further reveals that a higher level of Al Qaeda involvement also creates more lethal attacks. Orsini, on the other hand, categorizes terror attacks based on whether ISIS was involved and whether it is a single attacker or a cell. He concludes that ISIS involvement significantly raises the lethality of an attack, even if the attacker is a single terrorist.

However, the involvement of a terror group is not relevant only in a terror attack, but, as will be argued in the present chapter, it has a significant effect on radicalization as well. This will be argued by analyzing various different radicalization models and pointing to recurring concepts among them, before utilizing concepts from System Dynamics in order to tie what we have discovered thus far together.

While it may seem out of the scope of the present thesis to analyze Radicalization when focusing on terror attacks, it must be remembered that the objective is to propose policy solutions that will reduce the lethality of terror attacks; in an ideal world, if there were no terrorists there would be no terror attacks. As such, understanding what may drive individuals to become terrorists may well reveal insights that will help in reducing radicalization or its consequences.

2.1. Silber and Bhatt Model

The model developed by Mitchel Silber and Arvin Bhatt[13], alluded to in the previous chapter, is a radicalization model in which ideology plays a large role in the radicalization process. Silber and Bhatt focus on radicalization that takes place in western cities (thus the title of the paper "the homegrown threat"). This is in continuity with the conclusions reached in Silber's Book "The Al Qaeda Factor";[14] as has been explained, Silber notes that Al Qaeda involvement in terror attacks has been declining and urges policy makers to focus on local counterterrorism efforts. A radicalization model that focuses on the specific "type" of radicalization that the main perpetrators of terror attacks underwent in the attacks Silber studied is a logical contribution to this "invitation". The model envisions four steps in the radicalization process, that we will now look at one by one.

[13] Silber, M.D., Bhatt, A. and Analysts, S.I., 2007. *Radicalization in the West: The homegrown threat* (pp. 1-90). New York: Police Department.
[14] Silber, M.D., 2011. The al Qaeda factor. In *The Al Qaeda Factor*. University of Pennsylvania Press.

- Pre-radicalization: this is the starting point, when individuals come into contact with the jihadi or other terrorist ideology. There is no initial condition of relative deprivation that would spur radicalization. It is the terrorist ideology itself and a "cognitive opening" (that will be explained in the next step) that would push otherwise "normal" people to begin the radicalization process.
- Self-Identification: After a cognitive opening, individuals begin approaching the terrorist ideology, meeting with like-minded people and begin the process of changing their identity. The concept of "cognitive opening" refers to a catalyst that opens individuals to great change and is a crucial element. In this model, the cognitive opening will take the form of a great trauma to the individual in question, be it Economic, Political, Social or Personal. An example of an Economic trauma could be the loss of a job; a Political trauma could be the start of an international conflict; a Social trauma may be an inability to integrate into a new community following migration; finally, a personal trauma may be the death of a friend or family member. Whatever specific form it takes, this trauma will make the individual question their previously held beliefs, and begin looking for a "solution": something that will help them reorient themselves. At this stage the terrorist ideology can become a "beacon of salvation", offering a new way of life; as such it is clear that ideology plays a key role in this model, as without it the radicalization process may not even begin.
- Indoctrination: In this phase the individual will, as the name implies, be indoctrinated, usually with the assistance of a person well integrated into the terrorist organization. This "contact point" is important, and has been mentioned before by Silber in "The Al Qaeda Factor".[15] This person is the so called "Link man", who puts the radicalizing individual in contact with a Terrorist Group and will eventually facilitate his joining of said group. As the indoctrination continues (in a far more intense manner if a terrorist group is joined) the individual will become gradually more radical, and they will begin to believe that it is time for action. As such, in this phase the mental preparation to commit a terror attack begins.
- Jihadization: at this stage the radicalization process is complete, and the individual will accept that a terror attack is necessary. As such he will begin to plan a terror attack, alone or with others, by selecting a target, obtaining materials, creating a plan etc. This phase is much faster than the others and may in some cases last only a few days.

In this model there are three key points in the process that should be noted: first, in the "Self-Identification" phase we introduce the concept of a "cognitive opening", an element alluded to in the introduction of the chapter and that we will see again in the models to come. Second, it should be noted that "ideology" plays an important role in the radicalization process, as it is the main factor that will start radicalization after a cognitive opening. The final element is the "Link Man", found in the indoctrination phase; this is the contact point with a terrorist group that allows a radicalizing individual to access said group, furthering radicalization and

[15] Ibid

gaining access to the group's resources. For now, we should bear these three points in mind, as we will return to them after we are done analyzing all the radicalization models of interest to us.

2.2. DRIA Model

The DRIA model[16] developed by Alessandro Orsini is a sequential model. Similarly to that of Silber and Bhatt, it is focused, and does not attempt to explain all types of radicalization with a single model, but instead focuses on a specific type. In this case, the focus is on the radicalization of terrorists by vocation, or "Vocational Terrorists", introduced in the previous chapter. These are terrorists that make the terror ideology the most important aspect of their identity and dedicate all of their efforts to reinforcing it. This is done in order to respond to a perceived "need" of the terrorists; an interior, spiritual, need to give meaning to their lives and reduce "Existential Anxiety". As such, once again it can be seen that ideology plays a central role in the radicalization process, as we will see in more detail briefly. The name of the model (DRIA) is an acronym, with each letter representing a step in the radicalization process; we will now go through each step one by one.

- D – Disintegration of Social Identity: this is the starting point of the radicalization process, where an individual through some great event or trauma has his previous identity destroyed. This trauma leads to the "Cognitive Opening" that was explored in Silber and Bhatt's model. In the present model, the cognitive opening represents a turning point for the individual in question; given the destruction of what they believed to be "real" they seek new answers and a new way of life. At this stage there are many paths forward, and radicalization is but one of them. Indeed, individuals may choose to remain passive and not enact any change, or they may reinvent themselves in a "healthy" manner; embracing a radical ideology is just one of the many paths one may take at the crossroads of the first step. As such, once again ideology is at the forefront of the radicalization process, as it is the key in determining whether the process will even begin: indeed, if there is no terrorist ideology, or if the ideology is not "convincing" then radicalization under the DRIA model will not even begin.
- R – Reconstruction of Social Identity: at this step, individuals that come into contact with the Jihadi ideology may choose to use it as the basis for rebuilding themselves, as was said before. The Jihadi ideology is excellent at providing "lost souls" with a new purpose. Indeed, it is an ideology that gives a clear "mission" that is filled with meaning; the perfect remedy for people who have lost their sense of orientation and truth as a result of the first stage of the model, the Disintegration of Social Identity. During the process of reconstruction under a Jihadi Ideology, individuals will create a new "radical mental universe" for themselves, inspired by the radical ideology, that mutates their worldview into a

[16] Orsini, A. and Caillat, M., 2016. La radicalisation des terroristes de vocation. *Commentaire*, (4), pp.783-790.; Orsini, A. 2020, "What Everybody Should Know about Radicalization and the DRIA Model", *Studies in conflict and terrorism*, , pp. 1-33.; Orsini, A., 2011. *Anatomy of the red brigades: The religious mind-set of modern terrorists*. Cornell University Press.; Orsini, A., 2017. Il processo di radicalizzazione dei terroristi di vocazione. *Il processo di radicalizzazione dei terroristi di vocazione*, pp.163-173.

categorical "us-versus-them" mentality. This Mental Universe, Orsini explains, is based on seven "Cognitive Categories":

1. Radical Catastrophism: the world is irreparably corrupt.
2. Waiting for the End: the world is destined to end as a result of this corruption.
3. Obsession with Purity: one should shield oneself from the corruption of the world.
4. Identification of Evil: certain people are to blame for the current state of the world.
5. Obsession with Purification: these people deserve to die.
6. Exaltation of Martyrdom or Desire to be Persecuted: if these people persecute me, it is evidence that I am on the right path, as they are "impure".
7. Purification of the Means through the End: given that the objective is salvation of my soul, murder is acceptable.

These categories represent the worldview an individual radicalizing under this model will adopt, becoming "cognitively radicalized"

- I – Integration in a Revolutionary Sect: at this stage the now cognitively radicalized individuals will seek out likeminded people. Some will succeed in establishing contact with other radicalized individuals or with terrorist organizations and some will not. In the case of those that do not, they may still believe themselves to be a part of the organization through an imagined community, meaning they identify with the organization despite not having ever had contact. From this step we can see the groundwork for Orsini's model for terror attacks, based on what type of contact cognitively radicalized individuals will make. If they make contact with other radicalized individuals, but not a terror group they may evolve into an autonomous cell; if they contact a terror group they may evolve into either a trained lone wolf or a terror group (ISIS) led cell; if they are unable to establish any form of contact they may become untrained lone wolves.
- A – Alienation from the Surrounding World: the final stage in radicalization is crucial in enabling individuals to actually kill another human being. Alienation from the outside world is as simple as the name implies; the group into which an individual has integrated will forbid contact with the western world, which allows time for "traditional" morals to phase out and the radical ideology to fully mature. However, alienation may also be done on an individual basis, given that, as was seen in the previous step, it is not assured that a cognitively radicalized individual will succeed in establishing contact with others, be they radicals or a terror group. After sufficient alienation, individuals will now be able to kill others, and as such the radicalization process is complete.

The DRIA model is once again a more specific model, looking only at a certain type of radicalization; in this case that of terrorists by vocation. As with Silber and Bhatt, ideology plays a central role, as it is the key to beginning the radicalization process after the initial "disintegration". Furthermore, the cognitive opening is once again the necessary precondition to allow the ideology to be accepted and the radicalization to progress.

Finally, contact with a terror group is another common variable, however it is more elaborated in the case of the DRIA model, allowing for various outcomes depending on the type of contact established. Once again, we should keep these elements in mind as we move forward in our analysis.

2.3. Quintan Wiktorowicz's Model

The model developed by Quintan Wiktorowicz[17] is based on the participant observation of a specific radical group, al-Muhajiroun, in order to understand how it may turn "normal" people into radicals. Participant Observation, the research method used by Wiktorowicz, is a type of data collection in which the researcher fully immerses him or herself into the reality to be studied[18]. This is done for various reasons, but in Wiktorowicz's case the objective was to view radicalization from the point of view of the individual that radicalizes so as to understand the reasoning behind joining a radical Islamic movement. As a result of his analysis, Wiktorowicz concludes that individuals become radicalized and join terror groups as a result of an intense resocialization that said groups enforce; through this process individuals come to orient all their judgments based on the values the terror group imposes upon them through resocialization and isolation from other systems of judgment (the western world). The question is thus why individuals would approach these groups in the first place; the answer, according to Wiktorowicz, is to be found, once again, in a cognitive opening. There is not much new to say about the opening itself: individuals that have had their previous worldview destroyed will seek new truths, at which point the ideology of a terrorist group may come into play and begin the radicalization process. Wiktorowicz notes however, that in the case of al-Muhajiroun, the group attempts to initiate a cognitive opening through the showcasing of "shocking" material, designed to make individuals begin to question what they believe; this is an interesting insight to keep in mind, as we shall see.

Aside from this new addition of "induced" cognitive openings, we once again see the same familiar pattern; a cognitive opening allows a radical ideology to take hold, and individuals may come into contact with a terror group to further their radicalization. As such, we should move to the next section, in which we will take what we have learned in this chapter and the last and give an interpretation that will allow us to proceed.

2.4. Systemic Insight

Thus far we have looked at two models for interpreting and clarifying terror attacks, and three for mapping out the radicalization process. As regards the models for terror attacks, we have studied the "Al Qaeda Factor" by Silber and the model developed by Orsini; for radicalization we have viewed the model developed by Silber and Bhatt, that of Orsini and finally the model developed by Wiktorowicz. The analysis of the first two models

[17] Wiktorowicz, Q., 2005. *Radical Islam rising: Muslim extremism in the West*. Rowman & Littlefield Publishers.
[18] Spradley, J.P., 2016. *Participant observation*. Waveland Press.

revealed that the degree of involvement a larger terror group such as Al Qaeda or ISIS has in a terror attack will have a significant effect on the lethality of said attack, with higher involvement causing far more damage. Through consideration of the three models of radicalization, we have then noted three common elements: "Cognitive Openings", Radical Ideology, and contact with other radicals or terror groups. Currently our findings are somewhat disconnected, as such we should now organize our work, allowing the way forward to be clear.

The first step in this process is selecting a methodology with which we are to proceed; for the purposes of our research we shall use a Weberian Methodology.[19] Under this methodology it will be assured that the process to be carried out is repeatable, meaning that if one were to follow the steps of our research as we will take them the end results will be the same. Objectivity in the Weberian Methodology is obtained through the precise and correct use of a specific Method.[20] What is meant by this is that we must follow specific steps in a transparent manner in order to translate our intuition into tangible results. The question is thus what "steps" we will use in order to carry on; what is the best way to elaborate upon the preexisting research we have cited and analyzed in order to answer our research question?

In our case we will use what is known as "System Dynamics", which, given its importance in the present thesis, we shall spend some time presenting. System Dynamics was created by Professor Jay Forrester[21] and may be defined as a method or modeling technique used to frame and study complex systems. While its original inception was designed for the analysis of industrial processes, it was quickly realized that the model had the potential for much wider analysis, and may be applied in many different fields.[22] One of the most famous applications of System Dynamics can be found in the report "Limits to Growth",[23] in which System Dynamics was used to model how economic and population growth may progress in the future in the context of limited resources. Other fields in which System Dynamics has been used include International Security Studies, in particular regarding Risk Analysis of Terror threats,[24] policy development,[25] Environmental studies,[26] etc. Indeed, it is a tool that, since its inception, has been widely used with success across an array of topics, and is particularly useful in the context of the present thesis. The usefulness stems from the capacity of System Dynamics to highlight within complex systems a variety of elements useful to policy modeling. Two examples of such elements are: leverage points, parts of a system that with a low amount of change create

[19] Orsini, A., 2021. *Teoria sociologica classica e contemporanea.*
[20] Ibid
[21] Radzicki, M.J. and Taylor, R.A., 2008. Origin of system dynamics: Jay W. Forrester and the history of system dynamics. *US Department of Energy's introduction to system dynamics*.
[22] Ibid
[23] Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W., 2018. The limits to growth. In *Green planet blues* (pp. 25-29). Routledge.
[24] Ezell, B.C., Bennett, S.P., Von Winterfeldt, D., Sokolowski, J. and Collins, A.J., 2010. Probabilistic risk analysis and terrorism risk. *Risk Analysis: An International Journal*, *30*(4), pp.575-589.
[25] Sterman, J., 2002. System Dynamics: systems thinking and modeling for a complex world.
[26] Ford, A. and Ford, F.A., 1999. *Modeling the environment: an introduction to system dynamics models of environmental systems*. Island press.

large shifts in the system as a whole; feedback loops, which are situations in which one element may influence itself in an indirect manner after going through different stages of the system. The ability to identify such elements when attempting to create policies that aim to curb terrorism damages is invaluable, and as such utilizing System Dynamics will provide us with a great advantage in reaching the goal of the present thesis.

However the question is thus how exactly one "models" with System Dynamics? How are we to use this tool properly? This is a key question, as if we are to follow the Weberian Methodology we must ensure we are properly following the "rules" our method sets out for us, otherwise we risk losing objectivity. The basic procedure of system dynamics is divided into 6 steps, developed by the Founder of System Dynamics, Jay Forrester:[27]

1. Describe the System: at this stage we describe the system in general terms;
2. Convert description to level and rate equations: at this stage the model must be quantified, meaning variables must be inserted and made measurable;
3. Simulate the model: at this point the quantified model is simulated and the results analyzed. If it is necessary, we may return to steps 1 and/or 2 to adjust the model;
4. Design alternative policies and structures: at this stage we "toy" with the system, injecting policies and changing variables in order to reach a desired outcome;
5. Educate and debate: at this stage one puts the findings "out in the open" and gathers feedback;
6. Implement changes in policies and structure: finally, if the findings are sound, concrete policies may be implemented.

As one may have guessed, it is outside the scope of this thesis to reach the final step in this process, in which alternative policies are implemented. However, the other steps are well within our reach, and as such we will follow this procedure going forward.

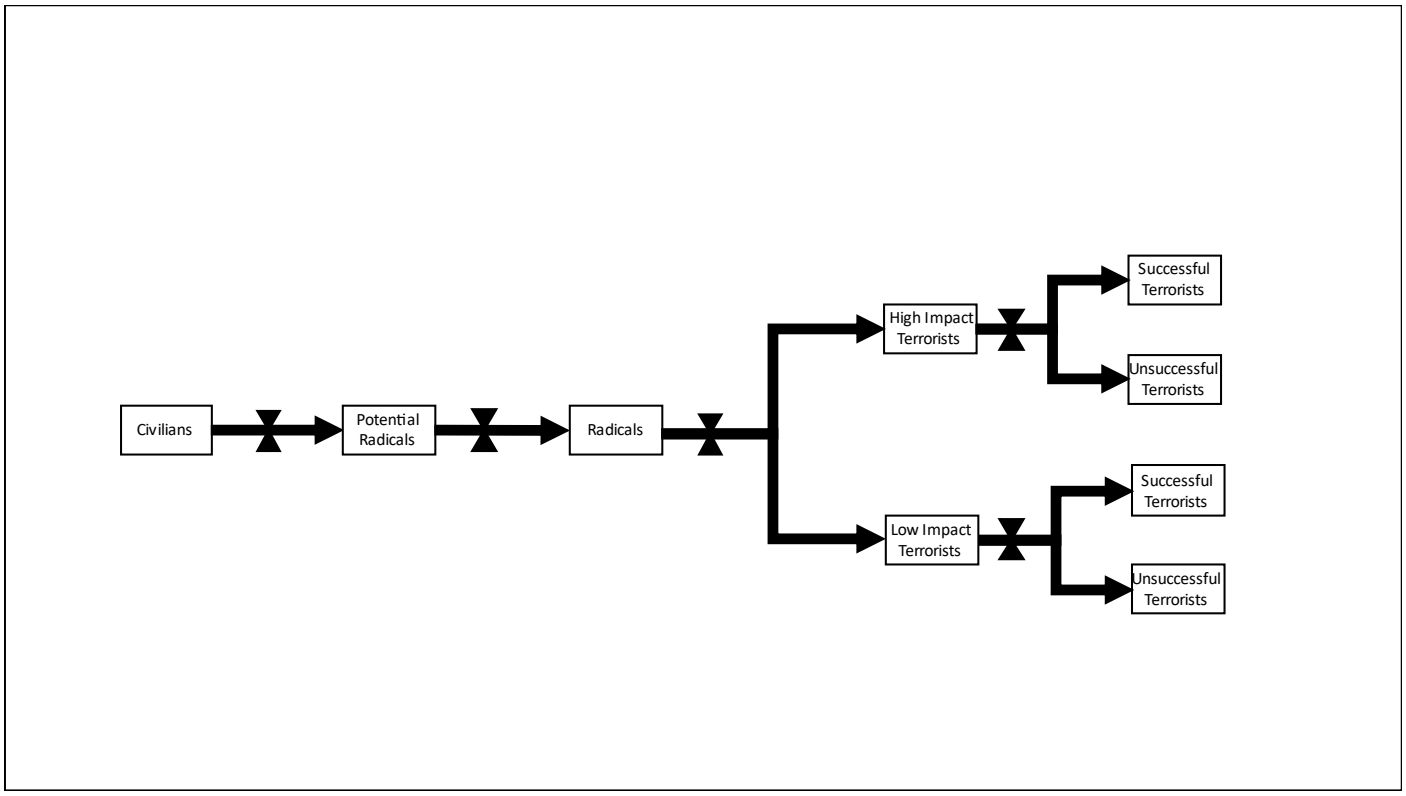
We will begin with the description of the system we wish to analyze, in this case that of terror attacks. In order to do this, we will create a basic, "not-yet-quantified" model on the basis of inputs from the five principal sources used thus far. The model structure we will use to construct this model is known in System Dynamics as a "stock and flow" diagram.[28] A stock and flow diagram, as the name implies, is divided into stocks, defined as any entity that accumulates or depletes over time, and flows, which are defined as the rate of change of stocks. In this first stage we will map out the general process we have deduced into a simple Stock and Flow and include the main variables. Once we have the basic structure of the system we can move on to step 2, in which we will insert and quantify all the relevant variables.

The first issue we face in constructing our model lies in the fact that a Stock and Flow model must have continuity; this means that the fundamental nature of our various stocks cannot change. In our case, this means

[27] Forrester, J.W., 1994. System dynamics, systems thinking, and soft OR. *System dynamics review*, *10*(2-3), pp.245-256.
[28] Meadows, D.H., 2008. *Thinking in systems: A primer*. chelsea green publishing.

we cannot have a stock of terrorists flow into a stock of terror attacks, as the former consists of people while the latter consists of actions. To solve this we will simply make sure all our stocks consist of people that flow into different states, starting from Civilians and ending in either Successful or Unsuccessful Terrorists (We will discuss the metrics under which to define success later). As such, we can present the first version of our model.

Figure 1, First draft of Stock and Flow Model. Source: Authors' Own Elaboration



The first stock is classified as "Civilians"; this comprises essentially all citizens of a given area of interest (A City, a State, a Continent, etc.) and represents the starting point of our model. From here, Civilians may flow into a stock of Potential Radicals; the people in this stock have, through the influence of some variables, become at risk of radicalization. The next stock that individuals will flow into, then, is that of radicals, as they become radicalized through the models we have analyzed. As we know from Orsini, this step is not guaranteed, as not all those that could begin radicalizing will; in the context of our model, some individuals may stop at the second stock. At this point our model will branch out: Radicals may move on to be either Low Impact Terrorists or High Impact Terrorists. This branch comes as a result of our findings from the first chapter, in which we determined that not all terrorists are created equal, and some have the potential for far more deadly attacks then others. At this point we have the final step, in which our two stocks of terrorists will either move to a stock of Successful Terrorists or Unsuccessful terrorists, depending on whether or not they carry out an attack and whether or not it succeeds. This final point is the point at which we join the radicalization process to terror attacks, and our ultimate objective will be to reduce the level of the "Successful Terrorist" stocks.

We have thus used our findings to create our basic model; we must now move on to step two, in which we will insert and quantify the variables that will influence our model after going through various stages of refinement. This shall be the focus of the next chapter.

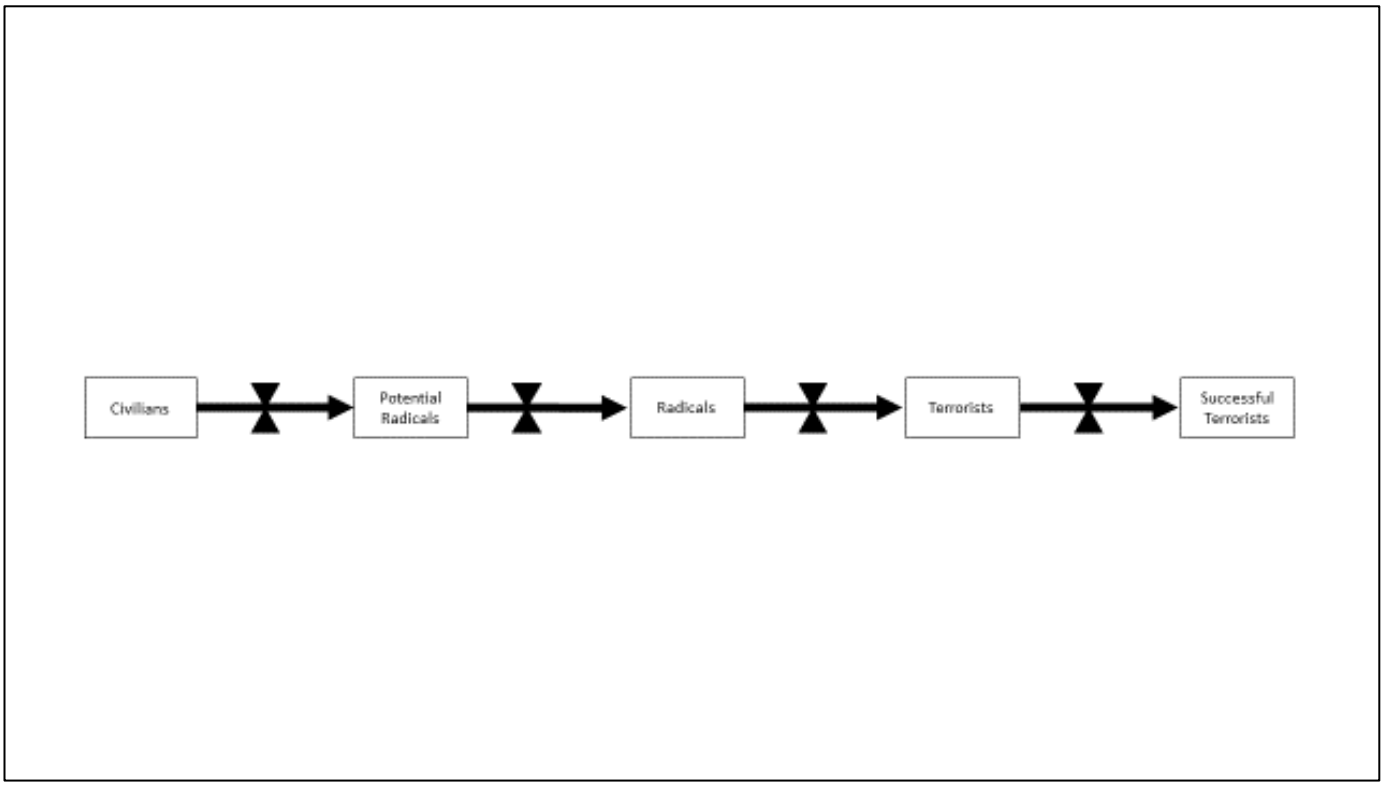
3. Chapter 3

With our basic model in hand, we have completed the first step of our process, namely the description of the System we are studying. The next step is arguably the most difficult: we must build upon this basic description and quantify our model. In order to proceed we will first identify the relevant flows and variables needed to flesh out our model, using our findings from the first and second chapters as a basis. After this, we will quantify all the variables and flows in a specific modeling software, in order to have a functional model.

3.1. Flows

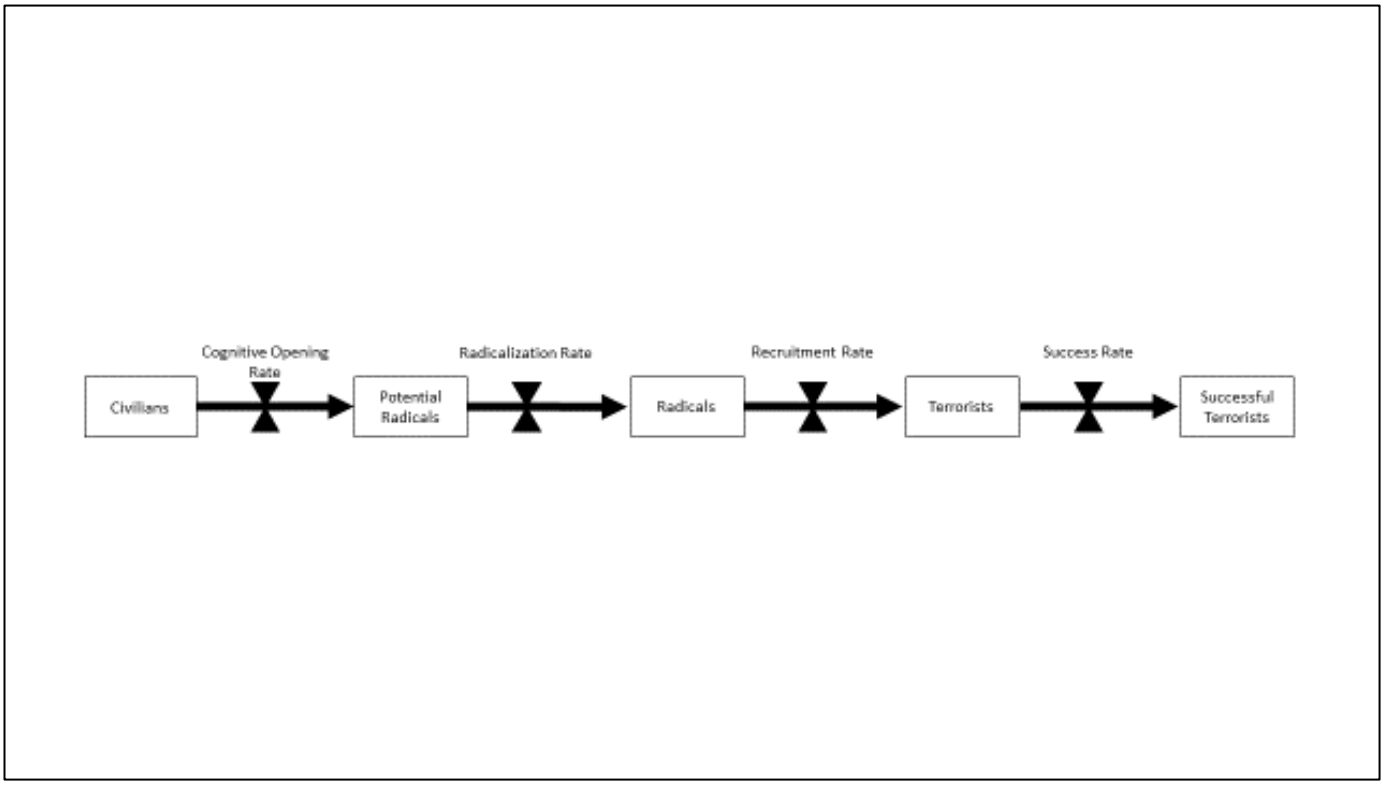
To take a step forward we must first take a step back; in order for our stock and flow to be calculable, it must be continuous, meaning it cannot "branch out". This means that we must remove the distinction between high and low impact terrorists we highlighted in our system description from the previous chapter. Please bear in mind that this is only a temporary measure, as we will recapture this nuance in another manner as we elaborate our model. With the branching removed our stock and flow now looks like this:

Figure 2, Second draft of Stock and Flow Model. Source: Authors' Own Elaboration



By removing the branches, we now have 5 stocks of interest: Civilians, Potential Radicals, Radicals, Terrorists and Successful Terrorists. The next step is defining the flows; said otherwise, we must now define the processes that allow one to move from one stock to another. By "naming" all of our flows, our model now changes as such:

Figure 3, Stock and Flow model with first draft of Flows. Source: Authors' Own Elaboration



We now have four rates that define the flows from one stock to the next, which we will now look at in some more detail:

1. Cognitive Opening Rate: drawing from the radicalization theories seen in the second chapter, we can define the flow of Civilians into Potential Radicals as being determined by the rate of cognitive openings. This means that the rate at which civilians are exposed to events that are traumatic enough to induce a Cognitive Opening (thus the name "Cognitive Opening Rate") will determine the value of our stock of Potential Radicals: people who have undergone a cognitive opening and are at risk of radicalization.
2. Radicalization Rate: once we are in the Potential Radical stock, the flow into the Radical stock is defined as the Radicalization Rate. This captures the process by which people that have undergone a cognitive opening may "absorb" a radical ideology and become a radical. Note that at this stage individuals are not yet defined as terrorists, as there is one more flow to cover before this stock is reached.
3. Recruitment Rate: the flow from the Radical stock into the Terrorist stock is defined as the Recruitment Rate. This measures the rate at which radicals are integrated into a Terror group, becoming "Official Terrorists". However, this rate also captures the rate at which radicals are *self-recruited*, meaning the rate at which radicals that do not come into contact with a Terror group nonetheless self-identify with one. This concept was presented in Orsini's DRIA model to radicalization, and allows us to measure a wider breadth of cases.

4. Success Rate: the final flow is rather self-explanatory; the flow from Terrorists to successful terrorist is measured by the rate of Successful Attacks carried out by Terrorists. As such, our current model does not measure attacks that are thwarted or fail; we will be creating a "worst case scenario" model, that will produce an estimate of the maximum potential damage that may be observed in a given time period.

We now have identified the "heart" of our model, now we must find the veins. This means identifying the variables that influence our model and where and in what manner they do so.

3.2. *Primary Variables*

We are now to add the variables that influence our model in order to understand what influences our flows. While this is a largely creative step, as it requires a fair amount of imagination to identify possible variables, it is grounded by the immovable requirement of measurability; in other words, we must be able to measure the variables we insert in the model. Fortunately, as we have conducted a thorough examination of previous research on the topic under examination, we have a large "database" from which to draw inspiration. As such, we will not be pulling variables out of a magician's hat, but identifying them in the bodies of work we have cited and analyzed. These first variables, which we will call Primary Variables, do not have to necessarily be measurable themselves, as their main purpose is to act as a logical go-between between our previous research and our eventual complete system. This means once all our primary variables have been found, we must then fully transpose our system from qualitative to quantitative.

The first flow that we will examine is the "Cognitive Opening Rate", which is described as the rate at which individuals experience an event that is traumatic enough to put them at risk of radicalization. From this description, the first variable that comes to mind is the "traumatic event" that triggers a cognitive opening. As we have seen, this traumatic event can come in many different forms, be they economic, social, personal, etc. While these events are easily quantifiable (an individual will experience a full number of events anywhere between 0 to infinity) they are not easy to measure. As such, inserting traumatic events as a variable in of itself would invite more issues than it would solve, as finding a way to accurately measure it as an individual variable is far too difficult. However, as we have seen, these traumatic events do not always sprout out from nowhere; other factors influence the likelihood of an individual to experience a traumatic event. As such, while we cannot measure the rate at which these events may occur, we can measure the conditions that may incentivize the occurrence of a traumatic event. We will detail how we shall create this measurement in the next section, where we will be setting up our final model.

The second flow is the "radicalization rate", described as the rate at which a potential radical will become radicalized. The main variable that will influence our rate of radicalization as seen in the first two chapters,

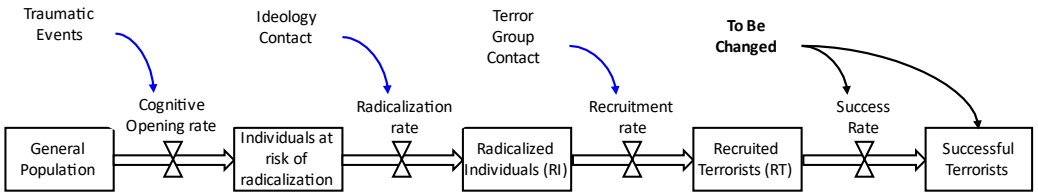
will be the rate of exposure to a Radical Ideology. Indeed, as we have seen, Ideology plays a key role in the radicalization process, acting as the catalyst that initiates radicalization. The next question, therefore, is whether or not we can measure the rate of exposure to a Radical Ideology. The key word here, is "exposure"; what we are interested in measuring is the rate at which an individual is exposed to a radical ideology. As such, we would be looking at the availability of a radical ideology in a given time period. As we shall see, we can use different sources to measure this variable so defined with sufficient confidence, focusing on online availability and physical availability.

The next flow is the recruitment rate, defined as the rate at which radicals are recruited by a terrorist organization. It is important to remember that this flow also includes individuals that come to identify with a terrorist group even if they do not come into contact with a recruiter or terror organization. However, this particular aspect could be impossible to measure, as individuals may not reveal this identification at all if they desire; as such, we will instead focus on actual recruitment by terror organizations. With this focus set, the main variable that influences our rate of recruitment is the rate of "contact with a terror group", as recruitment is impossible unless there is a communication established between the potential terrorist and the terror group. What we shall see, however, is that in our system this contact may occur both here and in the previous flow, that of radicalization, as the contact with the ideology implies contact with a terror group to some degree.

The final flow is the Success rate, defined as the rate of successful attacks carried out by terrorists. The main variable that will influence this rate will be training and funding, as both will likely increase the chances of success of any given terror attack. As we will see, this way this flow is represented in our model will need to undergo a significant modification in order to account for the different kinds of attacks. As we know, different types of attack exist based on the degree of involvement a larger terror group has; our current bare bone system, however, had to forgo this nuance in order to comply with the "rules" of System Dynamics. To remedy this, we will modify our final flow and stock in order to allow us to account for the different types of attacks.

With this we have identified our primary variables that make our flows tick and prepared the grounds for the modification of the final part of our model; the next task will be to turn this qualitative understanding into a series of quantitative variables that will take our model from a pure qualitative analysis to a system model in earnest.

Figure 4, Stock and Flow model with Primary Variables. Source: Authors' Own Elaboration



3.3. *Model Quantification and Completion*

We now have an understanding of what variables influence our model's flows thanks to the "translation" of the research we have reviewed into a more systemic lens. However, as was noted in the previous section, the variables we have identified are not all easily measurable, and served as a way to guide us in the creation of our final model. Our next step is to transform, shift and add variables until we have a model that can be simulated in order to produce tangible results. We will do this by going through our model in order, using all we have learned thus far in order to insert the most relevant, quantifiable variables that fill out the system. We will also modify our final section, as was mentioned, in order to better capture the difference among attack types. As a final disclaimer before beginning, we must bear in mind that our geographical focus will be the European area and as such we will be using data from this area. If one so desired, the focus could be changed to one or more specific European countries with the only requirement being to change data sources. Removing it from the European context altogether, however, would require some tweaking of the model in order to account for the specifics of the new focus.

3.3.1. *Cognitive Opening Rate Variables*

We will begin with the Cognitive Opening rate, influenced by Traumatic Events. This flow is perhaps the hardest to find measurable variables for, as it is a very "personal" flow. Indeed, as we have seen, Cognitive Openings are typically an event that affects a single individual on the basis of an event that is considered

traumatic to that specific person. As such, our best strategy in this case is to attempt to measure the context in which a Traumatic Event triggering a Cognitive Opening may occur. In this manner, while we are not able to find a direct influence on Cognitive Openings, we can measure how suited to triggering a Cognitive Opening an area may be. In order to conduct this measure we will use variables that will examine the context of the area in focus (In our case Europe) in terms of how they will affect they likelihood a Cognitive Opening will occur in said area. The first Variable we will use is the number of people in poverty in Europe;[29] this is the most "general" variable that will create our measure and serves to give us a general idea of how many people are in economic difficulty. This is useful to know, as given what we have seen economic difficulties may well trigger a Cognitive Opening[30], meaning that as poverty increases, so does the rate of Cognitive Openings

The next variable we will include is the quantity of first and second-generation immigrants living in the EU.[31] The reason for the inclusion of this variable is that immigrants are a group that is particularly vulnerable to undergoing a Cognitive Opening due to the discrimination and marginalization they often face. While measuring said discrimination would provide, in theory, a more direct influence on the Cognitive Opening Rate, it is in practice very difficult to measure. Measuring the amount of immigrants is therefore the "next best thing", as while we cannot measure discrimination, we can measure the group that is discriminated against. It follows logically that as the size of the group increases, the chance that an individual in said group is discriminated against increases; consequently the chance of a Cognitive Opening occurring will increase.

The final variable we can identify in the creation of our measure is related to education. We will measure the percentage of the studied population aged 20 to 64 that has obtained at most a lower secondary level of education.[32] The reasoning behind the selection of this variable is that a lower level of education means that an individual will be more vulnerable to a Cognitive Opening. This vulnerability is born not just from a lack of education, but also the marginalization that not attending a major "social forum" creates. As such, as the proportion of our population under study with a lower level of education increases, so does our Cognitive Opening rate.

A valid criticism that may be raised at this point is that the three variables we have selected to create our measure are not mutually exclusive, as there is the possibility of there being an overlap among them. Indeed, it is possible for one person to live in poverty, have low schooling, and be an immigrant, meaning we risk

[29] Ec.europa.eu. 2021. *Living conditions in Europe - poverty and social exclusion - Statistics Explained*. [online] Available at: <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Living_conditions_in_Europe_-_poverty_and_social_exclusion> [Accessed 29 August 2022].

[30] Orsini, A. 2020, "What Everybody Should Know about Radicalization and the DRIA Model", *Studies in conflict and terrorism*, , pp. 1-33.

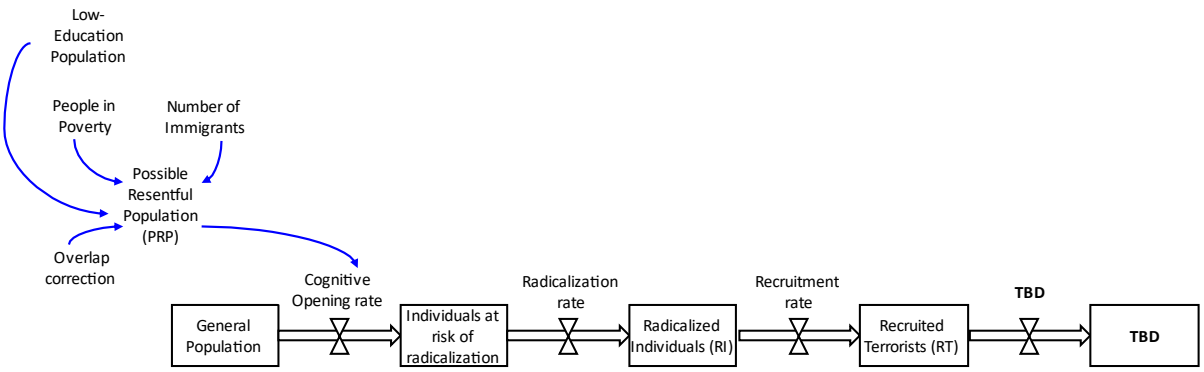
[31] Eurostat (2017). *First- and second-generation immigrants living in the EU*. [online] Available at: <https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/ddn-20170322-1> [Accessed 29 August 2022].

[32] Eurostat (2021). *Educational attainment level (ISCED11) distribution by sex, age, migration status and educational attainment level of parents (ISCED11F)*. [online] Available at: <https://ec.europa.eu/eurostat/databrowser/view/lfso_14beduc/default/table?lang=en>

counting one person three times. In order to account for this, we will include an "overlap correction" factor, that will remove a portion of the measured people, thus lowering the effect of the possible overlap.

Once we have summed our subset of the population and removed a portion with our correcting factor we will have our measure which we will call the "Possible Resentful Population" (PRP); the question is how we determine the rate of cognitive openings. Indeed, as we have said the PRP is looking at the contexts that may increase the likelihood of a Cognitive Opening, not the rate in of itself. In order to determine our rate, we will take the PRP and assume a normal Gaussian distribution; in this distribution the population under the bell curve represents those that, while at risk, will not experience a cognitive opening. The right extreme of the distribution, on the other hand, represent those that will experience a cognitive opening.

Figure 5, Stock and Flow model with Cognitive Opening Rate Variables. Source: Authors' Own Elaboration



3.3.2. *Radicalization Rate Variables*

Moving on we must now consider the radicalization rate, which as we have seen measures the rate at which individuals that have experienced a Cognitive Opening become radicals. As was seen in the research examined, the main factor that will push an individual to become a radical is the intervention of a Radical Ideology. As such, our selected variables in this flow will seek to measure the degree of availability that a given ideology has. In other words, we will seek to measure through what channels an individual may come into contact with a radical ideology. Before proceeding, we must as such set our focus; what ideology will we consider? Due to

the nature of the research we have seen up to this point, we will focus on the ideology of ISIS, as it is the most lethal terror group as of 2021.[33]

First and foremost, we will define the radicalization rate formula. While this may seem counterintuitive given it was the final step of our first part of model construction, the conditions are such that we can immediately define the rate. Similarly to the Cognitive Opening rate, we will assume a normal distribution of our Individuals at Risk of Radicalization and consider the right extreme. The reason behind this more "simple" method of defining the rate is to be found in the studied literature. As we have seen, individuals that have experienced a cognitive opening will naturally begin to seek a "new way of life". This is fundamentally different from how people in the "General Population" stock behave; the general population, if left alone, would not move into the stock of the population at risk. Only when we account for the subpopulation that is susceptible to a Cognitive Opening can we observe the rate. In the case of radicalization, on the other hand, given that our stock of people is already seeking an "exit" we can assume that a portion of them will turn to a radical Ideology and become radicalized. This base rate measures "physical" radicalization, meaning the radicalization that occurs through the interaction of an individual with an ideology through physical contact with it. We may further identify two main locations in which this type of radicalization occurs. The first is Mosques, in our case the number of them in our area of study.[34] The reasoning behind this choice is that, as we have seen, especially when considering "The Al-Qaeda Factor",[35] Mosques can act as a starting point to come into contact with a radical ideology. Note that this does not imply that Mosques are spreading extremist messages; the link to the radicalization rate in this case is slightly more indirect. Indeed, Mosques are a location in which individuals may come into contact with Islam; if the individual in question has undergone a cognitive opening (which in our model is a requirement to be in our potential radical stock) then there is the risk that they become "overzealous". As such, in our model, Mosques act as a springboard that may lead individuals to more radical ideologies.

The second location in which physical radicalization primarily occurs is prison. [36] The reason for the selection of this location is that prisons are a prime location in which individuals may come into contact with people that are in some way connected to a terror group,[37] consequently coming into contact with a terror ideology. As such, as the population in prison increases, so too does the chance that someone in prison encounters a radical ideology and becomes radicalized.

[33] IEP. 2022. *Global Terrorism Index | Countries most impacted by terrorism*. [online] Available at: <https://www.visionofhumanity.org/maps/global-terrorism-index/#/>
[34] Allievi, S., 2014. *Mosques in Western Europe - Stefano Allievi*. [online] Stefano Allievi. Available at: <https://stefanoallievi.it/anno/mosques-in-western-europe/> [Accessed 22 August 2022].
[35] Silber, M.D., 2011. The al Qaeda factor. In *The Al Qaeda Factor*. University of Pennsylvania Press.
[36] Eurostat. 2020. *Prisoners by age and sex - number and rate for the relevant sex and age groups*. [online] Available at: <https://ec.europa.eu/eurostat/databrowser/view/crim_pris_age/default/table?lang=en> [Accessed 23 August 2022].
[37] Europol. 2022. *European Union Terrorism Situation and Trend report 2022 (TE-SAT) | Europol*. [online] Available at: <https://www.europol.europa.eu/publication-events/main-reports/european-union-terrorism-situation-and-trend-report-2022-te-sat> [Accessed 23 August 2022].

Having clarified what factors constitute our base rate of radicalization, and its implicit enhancers, we will now identify the external variables that influence this rate. In this case the variables will flow into what we will call the "Digital Contact", so named due to the nature of variables inside it; these are variables that increase the likelihood an individual may encounter a radical ideology in the digital sphere, a major area where "modern" radicalization occurs. This means that they will increase the percentage of our normal distribution of "At Risk" population that will enter into the radicalization rate formula. As such, rather than defining the formula, the variables that affect our radicalization rate will change the quantity of individuals that will "move".

The first variable we will consider comes from the activities of the "Al Hayat Media Center", which is a media wing of ISIS focused on creating publications that target a Western audience.[38] The journals published by this group are typically only accessible through the dark web,[39] leading us to add another enhancing factor besides the number of publications made. In this case we will also consider the share of the population that has used specific software to access the dark web.[40] This is due to the fact that they will be the population that could reasonably be expected to find and consume radical material, both published by ISIS or not, on the dark web. As such, we will consider that a portion of the dark web users will come into contact with these publications and become radicalized.

Exiting the Deep Web, but remaining online, we have the amount of pro ISIS twitter accounts that exist [41] and the amount of Terrorist Propaganda that has been removed from Facebook.[42] Both are another measure of the exposure that individuals may receive regarding Terror ideology, as they give us an idea regarding the amount of terrorist propaganda that is easily accessible online. Furthermore, both areas have seen an intensification in focus from ISIS in recent years, signaling that they merit inclusion.

With the inclusion of these variables, we have identified the relevant enhancing factors that affect the radicalization rate. However, as we will see, some will have an influence on other parts of our system, most notably the recruitment rate. As such, we shall now turn to said rate, to clarify what is meant.

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[38] Maragkos, K. E. and Maravelakis, P. E. (2022) *'Extracting Primary Emotions and Topics from the Al-Hayat Media Centre Magazine Publications, Using Topic Modelling and Lexicon-Based Approaches'*, Social Science Computer Review. doi: 10.1177/08944393211061272.

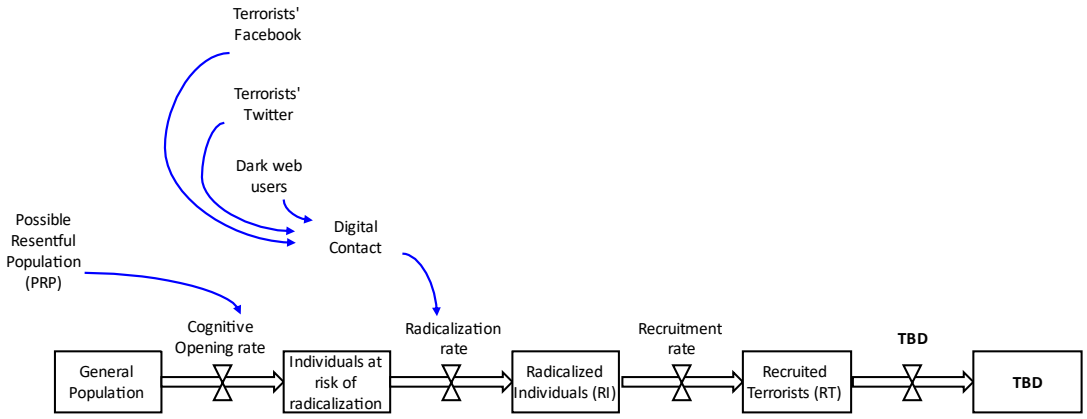
[39] Ibid

[40] CIGI. (2019). *Share of internet users who have used technologies that allow access to the dark web as of February 2019, by region*. *Statista*. Statista Inc.. Accessed: August 22, 2022. https://www.statista.com/statistics/1015238/dark-web-access-technology-usage-by-region/

[41] McCarthy, N. (2015). *ISIS Is Expanding Its Reach On Twitter*. *Statista*. Statista Inc.. Accessed: August 26, 2022. https://www.statista.com/chart/3308/isis-is-expanding-its-reach-on-twitter/

[42] Facebook. (2022). *Global number of content containing terrorist propaganda removed by Facebook from 4th quarter 2017 to 1st quarter 2022 (in millions)*. *Statista*. Statista Inc.. Accessed: August 30, 2022. https://www.statista.com/statistics/1013864/facebook-terrorist-propaganda-removal-quarter/

Figure 6, Stock and Flow model with Radicalization Rate Variables. Source: Authors' Own Elaboration



3.3.3. *Recruitment Rate Variables*

The recruitment rate is defined as the rate at which radicals join a terrorist group. Note that this recruitment also includes the "self-recruitment" explained in Orsini's DRIA model:[43] this means that it includes the rate at which individuals that do not come into contact with a specific group nonetheless identify with it and "imagine" themselves to be a part of it. We will account for this specificity when we reach the final part of our model that, as we have mentioned, requires modification, so for now we will ignore it and consider only recruitment that happens in terror organizations. Furthermore, our recruitment rate will be system driven, meaning the formula will be a result of other forces in the system that we will detail later. Indeed, it is difficult to discuss this rate in a vacuum, as we have done up until this point; this is a good sign, as it indicates our model is nearing completion and the various loops and connections will begin to emerge. This element of interconnectedness is what will allow us to theorize possible policy action in the future, as we will see.

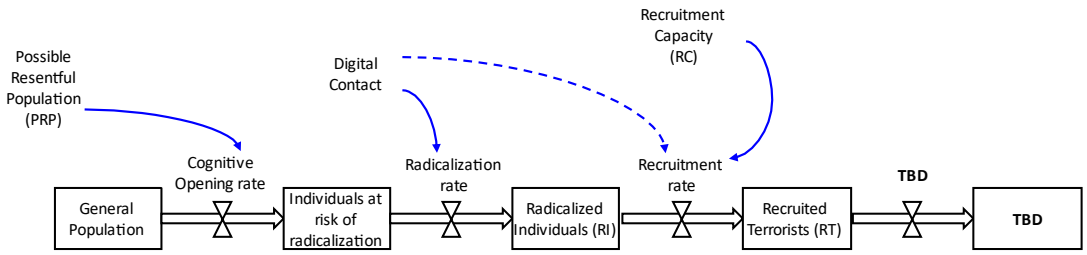
Before getting too far ahead of ourselves, however, we can name one factor that will influence the recruitment rate, namely the Recruitment Capacity (RC). The Recruitment Capacity is not the same as the Recruitment Rate; while the latter measures the rate at which individuals that are radicalized become recruited terrorists, the former represents the maximum rate that the terror organization can support. Put otherwise, the recruitment

[43] Orsini, A. and Caillat, M., 2016. La radicalisation des terroristes de vocation. *Commentaire*, (4), pp.783-790.; Orsini, A. 2020, "What Everybody Should Know about Radicalization and the DRIA Model", *Studies in conflict and terrorism*, , pp. 1-33.; Orsini, A., 2011. *Anatomy of the red brigades: The religious mind-set of modern terrorists*. Cornell University Press.; Orsini, A., 2017. Il processo di radicalizzazione dei terroristi di vocazione. *Il processo di radicalizzazione dei terroristi di vocazione*, pp.163-173.

rate will be constrained by the RC: if the rate is ever higher than the capacity, the actual rate will be reduced to the RC value. We will clarify how the RC is measured when carrying out the final adjustments to our model.

The other variables that would influence the recruitment rate we have already discussed, as they are the same Factors that affected the radicalization rate (Number of Prisoners, Dark Web users, Terrorists' social media, etc.). Indeed, those factors increased not only the chance of contact with a terror ideology, but also of contact with a terror group itself. As such, the influence on the recruitment rate is already "internalized" in the system by the effect on the Radicalization Rate. If the radicalization rate increases, so too does our stock of Radicals; if this stock increases this means the pool of available radicals that the terrorists may seek to recruit will be large enough for them to meet their Recruitment Capacity

Figure 7, Stock and Flow model with Recruitment Rate Variables. Source: Authors' Own Elaboration



3.3.4. *Preparation Rate and Combat Force Definition*

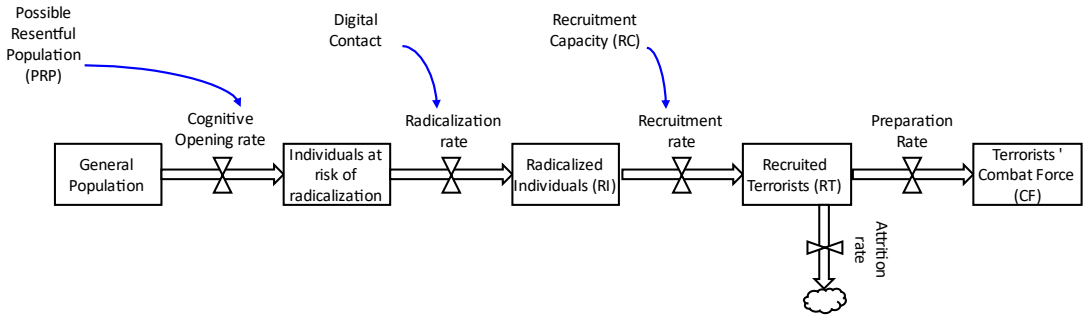
The time has now come to discuss the changes that must be made to the final portion of the model in order to complete it. Our stock of Recruited Terrorists (RT) will remain the same, what will change is the flow and final stock. Our final flow will change from the "Success Rate" to the "Preparation Rate" and the final Stock will become Combat Force (CF). This change may, on its own, make it seem like attacks are completely excluded from our model, but this is not the case; they will be present, but in a different manner. We will clarify what this means soon, for now, however, we will focus on defining our changed Stock and Flow.

Our Preparation rate measures the rate at which a terrorist organization can train, equip and direct its recruited terrorists. Once this process is complete, the recruited terrorists will become part of the terror group's Combat

Force (CF), meaning the number of terrorists that are able to carry out highly lethal attacks. The Preparation Rate is once again System driven, meaning that it will be defined on the basis of other variables, as we will see when analyzing the completed model. Once again, however, the Preparation Rate is constrained by a Preparation Capacity, that like the Recruitment Capacity before it, limits the rate based on the maximum that can be achieved. Once again, this Capacity will be defined later, as it is defined by the same variable that defines the Recruitment Capacity.

However, the preparation rate is not the only flow that draws out the recruited terrorists. There will be another flow, called the Attrition Rate, that measures the rate at which, for whatever reason, recruited terrorists are not trained and carry out an attack. This could be due to arrests, death, changes of heart, etc. This rate will be set in an arbitrary manner, using once again real-world data as an anchor to create a judgment. The rate will flow out of our stock of recruited terrorists, but after this flow we are not interested in measuring what happens to those terrorists that "don't make it"; as such we will not add a stock, but simply account for the outflow caused by the Attrition Rate.

Figure 8, Stock and Flow model with adjusted final section. Source: Authors' Own Elaboration

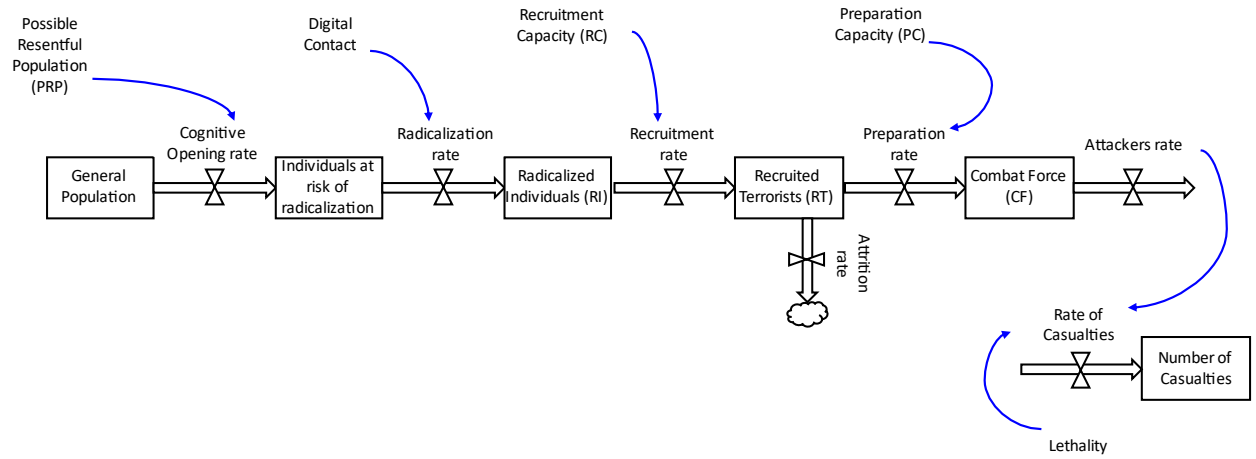


3.3.5. *Model Adjustments*

We have as such defined all our stocks, flows, and done a first round on our variables; our changes, however, have caused us to no longer measure attacks but only radicalization, recruitment and preparation. This is quickly fixed, and doing so will allow us to finish our model in earnest. The first objective is to measure attacks; however we must choose how we wish to measure them. Our ultimate objective is to reduce the number of casualties caused by terrorists' attacks, both deaths and injuries; it would make sense, therefore, to use this as our measure. Indeed, if we measure the number of casualties, we will be able to produce a system that, once filled out correctly, will estimate the number of casualties a territory could expect from terrorism over a given time period. This would make for a powerful tool, and as such it is how we will proceed. As may be recalled from our introduction to System Dynamics, however we cannot have a flow of terrorists going into a flow of casualties, as they are not comparable; they are measures of two different sets of individuals that are not connected. The solution to this issue is quite straightforward; we will measure casualties through an independent stock and flow. We will imagine our Number of Casualties as being filled by a flow defined as the Rate of Casualties; this rate will be defined on the basis of a new outflow from our CF Stock, defined as the Attackers Rate, or rather the number of CF that will carry out an attack per year. This rate will be combined with a new variable, called "Lethality" which measures, on average, how many casualties one trained terrorist can produce. We will define this variable using Europol data,[44] comparing the number of terrorists in ISIS led attacks against the number of casualties produced.

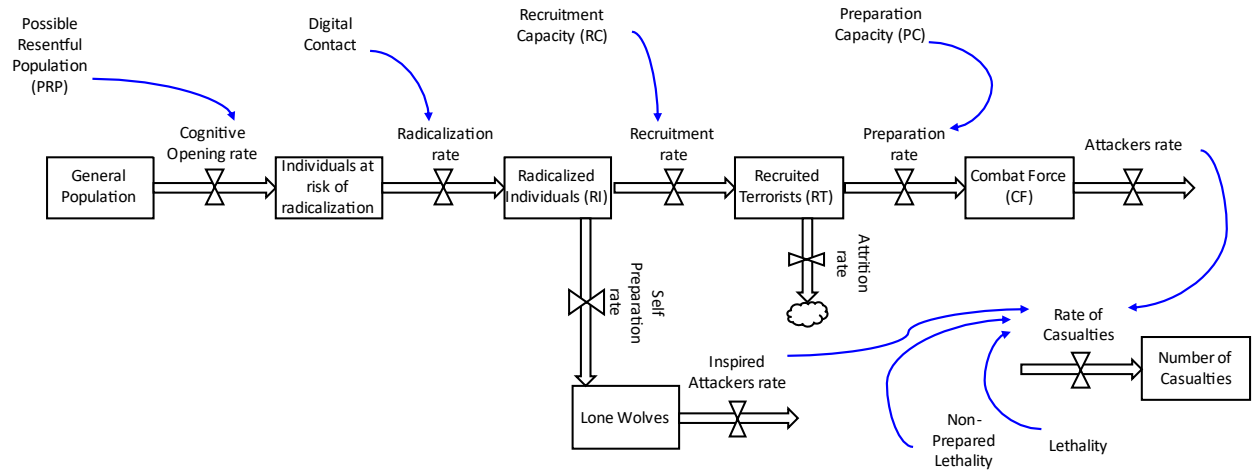
[44] Europol. 2022. *EU Terrorism Situation & Trend Report (TE-SAT) | Europol*. [online] Available at: <https://www.europol.europa.eu/publications-events/main-reports/tesat-report> [Accessed 17 September 2022].

Figure 9, Stock and Flow model with Casualties factored in. Source: Authors' Own Elaboration



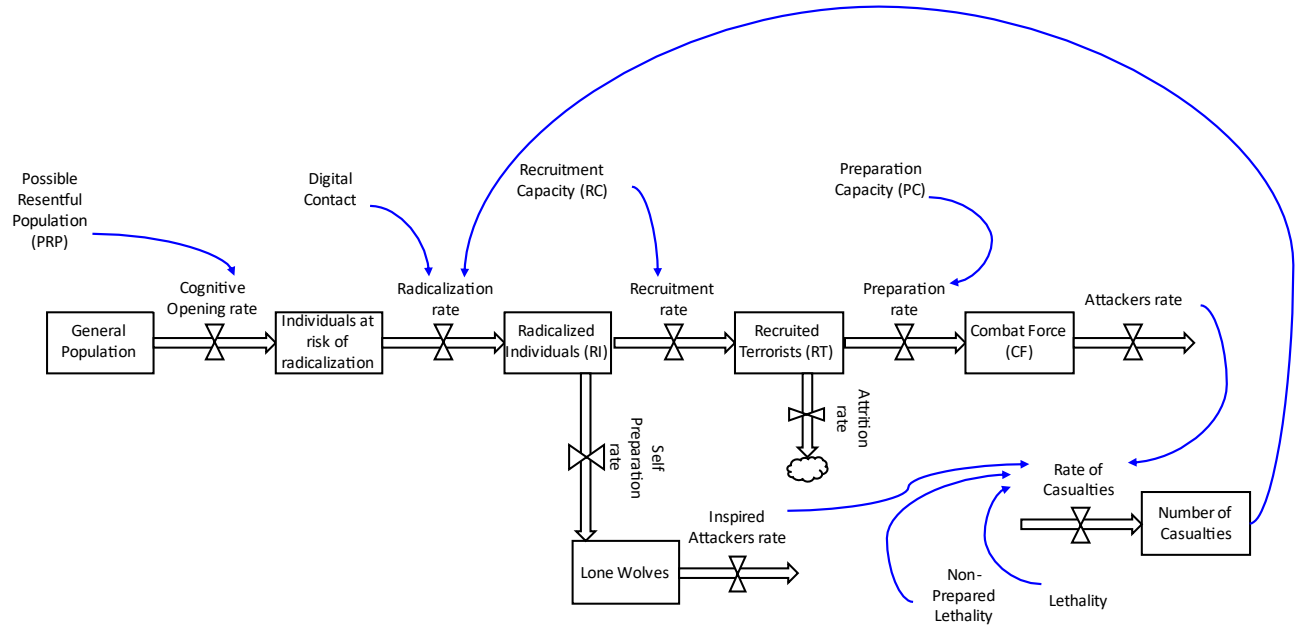
But what of untrained lone wolves and autonomous cells? As we have seen they may "self-recruit", but they will not be trained by a terror group and as such cannot pass through the Preparation Rate. In order to account for them (and therefore all types of attacks) we will create a new stock called "Lone Wolves" that will be fed from our stock of Radicalized individuals through a flow called "Self-Preparation rate". This rate is defined as a small portion of our Radicalized Individuals stock and measures the rate at which individuals who have self-recruited will arm themselves for an attack. From our lone wolf stock, we will have an outflow of "Inspired Attackers", which will measure the rate at which lone wolves will carry out attacks every year. This flow will affect our Rate of Casualties, together with a new variable called "Non-prepared Lethality" which measures the casualties that lone wolves are able to produce on average; this will be calculated in the same way as the Lethality variable, only checking for lone wolf attacks rather than ISIS led attacks. In this way we are measuring the "self-recruits" and any other individuals that split from our main path and conduct an attack on their own terms.

Figure 10, Stock and Flow model with Lone Wolves factored in. Source: Authors' Own Elaboration



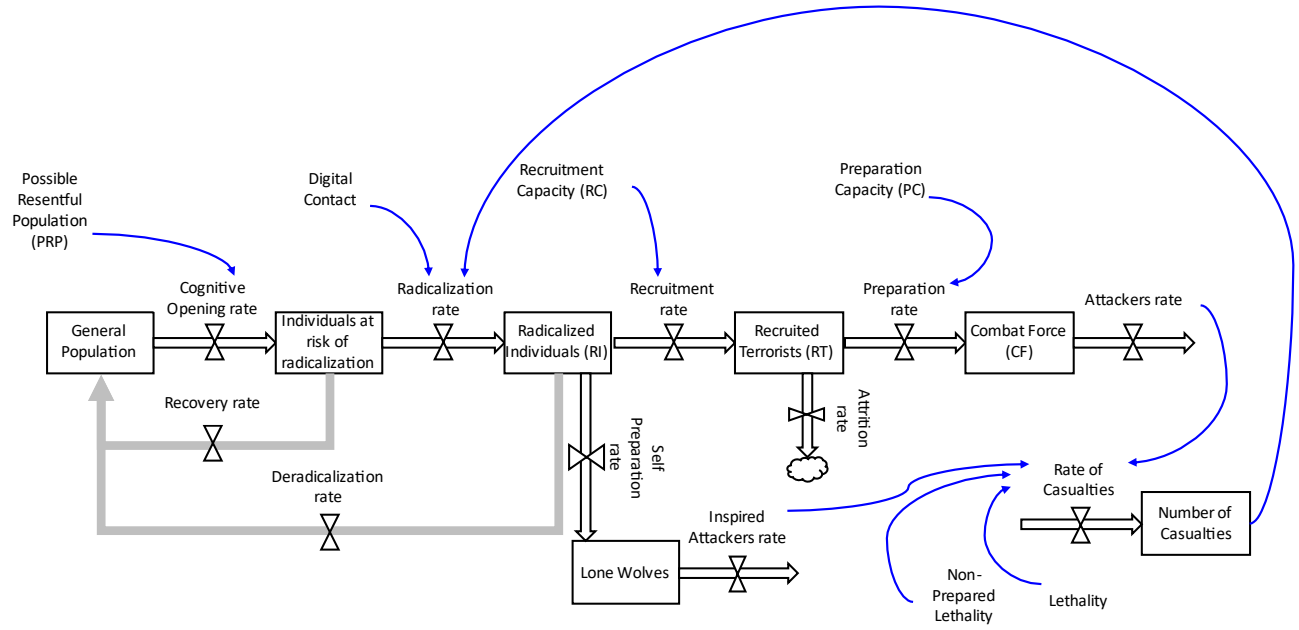
With our Rate of Casualties fully defined, we will insert a feedback loop in our system; as we have seen, successful terror attacks become material for terrorists groups that can be used as propaganda, increasing their "prestige", or may be used as material to induce cognitive openings. To account for this, we will allow for our radicalization rate to grow as the number of casualties grow, signifying that the more success the group has, the better their capacity to influence and radicalize vulnerable individuals.

Figure 11, Stock and Flow with Casualties feedback loop. Source: Authors' Own Elaboration



Next, we will include two new outflows for our At-Risk and Radicalized stock, which will measure the rate at which individuals in these stocks "Recover" and return to the general population. These will be defined as a small portion of our stock value and are included to stop the model from implying that all of a general population will slowly become terrorists; if there are no outflows in our model, and the only path is forward, then our model will imply that the fate of every individual in it is to be a terrorist. To avoid this, we will include outflows.

Figure 12, Stock and Flow model with new Outflows. Source: Authors' Own Elaboration

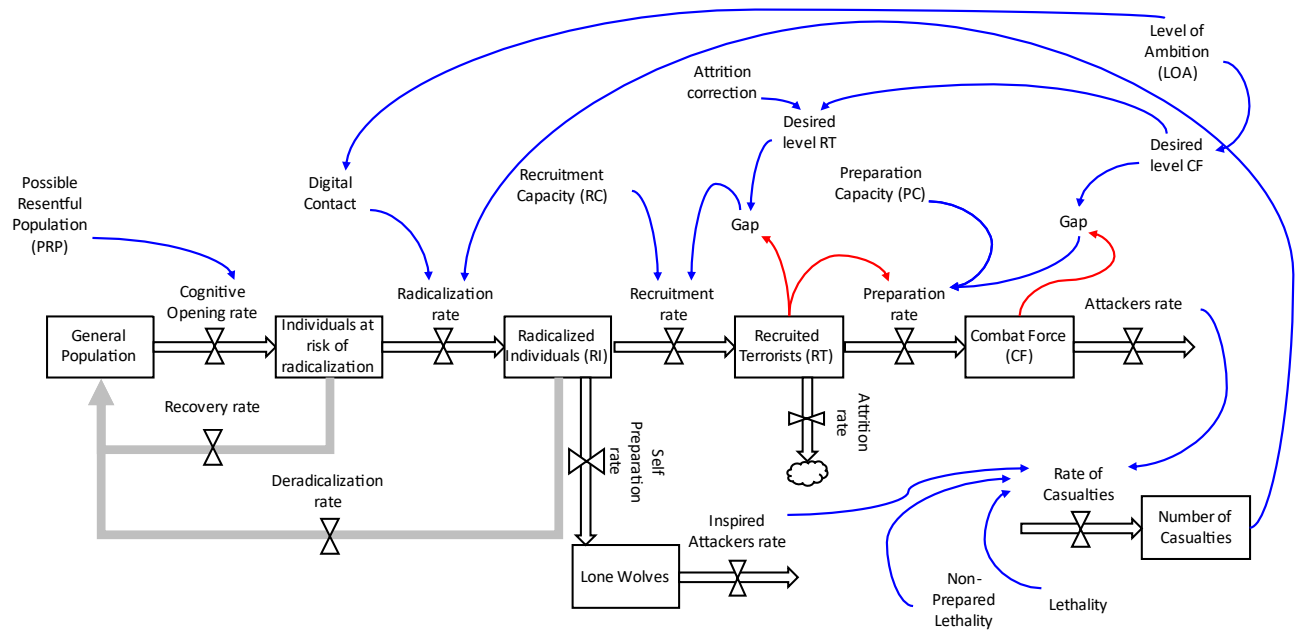


Our model is now almost fully complete, we are missing only what we may consider the "engine" of the system. To clarify what this means, let us point out an interesting aspect of the model we have constructed. The model can be divided into two parts, based on whether the individuals moving through the Stocks are being "pushed" or "pulled". Indeed, the flows of Cognitive openings and Radicalization are "push" flows, in the sense that individuals pass through them due to the system. If, for example, we ignored terrorism altogether, this first section of the model still holds; even without ISIS or any other terror group, individuals would experience traumas and possibly become radicals due to other influences. The second part of the model, on the other hand, is made up of "pull" flows, as without terror groups it would no longer exist. Indeed, the recruitment rate and preparation rate hinge on there being a group that creates them; if, in our model, there were no ISIS then there would be no recruitment or training occurring. Further, these rates are created by the pull of a terror group; they recognize the existence of a stock of radicalized individuals, and seek to recruit and train them. With this understanding we can thus finish our model, by placing ourselves in the shoes of terrorists that seek to maximize the number of casualties.

The goal of terrorists inside of this system is to maximize casualties; in order to do this there are two paths; either increase the amount of Lone Wolves or increase Combat Force. As we have seen in the second chapter, Untrained Attackers will typically cause less casualties, as such the best strategy would be to maximize CF. As such, we have a new variable to insert into the model, the terrorist's Level of Ambition (LoA), meaning the amount of casualties they would like to reach in a given time period. This LoA will create a correspondent level of CF that is needed; as such the LoA will create a new variable to insert, the desired level of CF-The

logic is simple: if the terrorists want to reach a certain number of casualties, they will need a certain level of CF, meaning that they will need to compare their CF to the one they have and adjust accordingly. If the stock of CF is lower than the desired level of CF then this means that they must prepare more recruits. However it is not just the Preparation rate that is influenced by the LoA, as if they wish to reach a certain level of CF they will need a certain number of recruits as well, meaning there will also be a Desired Level of Recruited Terrorists (RT) that will create a gap between the Recruitment rate and the stock of RT. This desired level, moreover, will have to account for the Attrition Rate we identified, meaning that to reach a desired level of RT there will need to be a degree of "over-recruitment" to account for the Attrition Rate. As such, the desired level of RT will also include a variable called "Attrition Correction" which will counteract the Attrition Rate. Finally, the LoA will also influence and increase the digital propaganda activity of the terror group, measured through our "Facebook and Twitter" variables. In this way the ambition will also seek to increase the total of radicalized individuals, therefore increasing the amount of lone wolves, as they are defined as a portion of this stock.

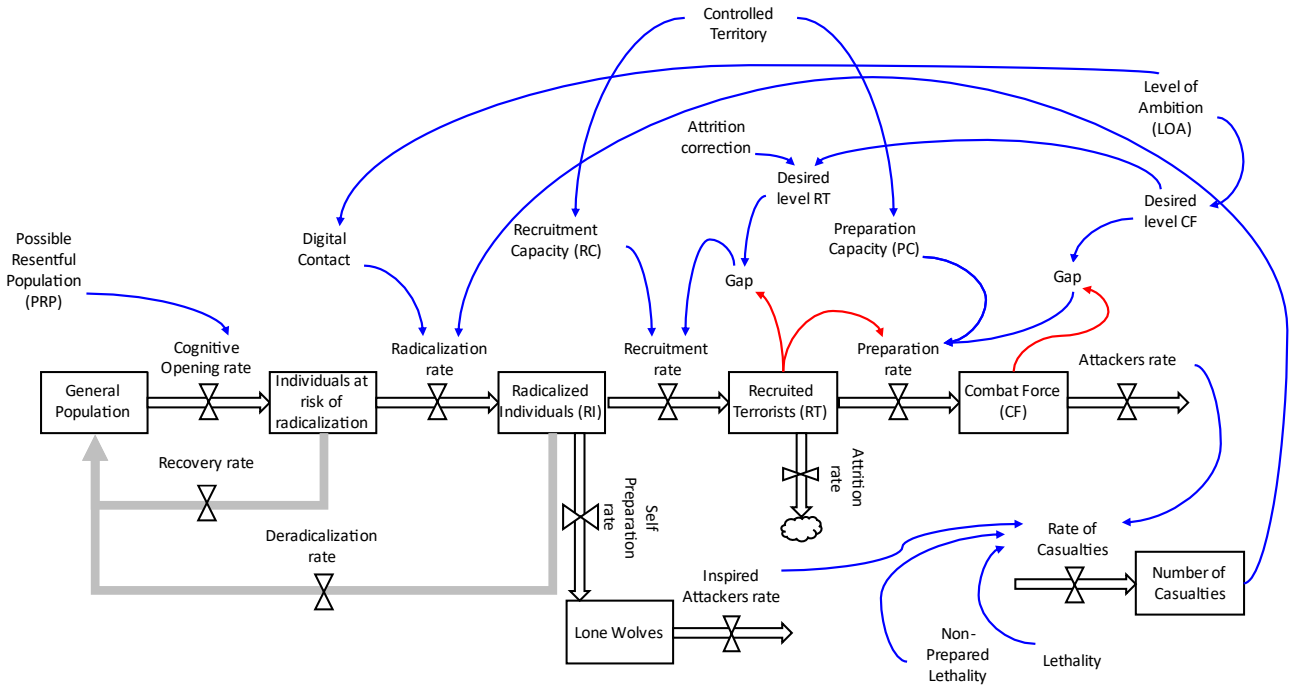
Figure 13, Stock and Flow model with Level of Ambition and Desired Levels. Source: Authors' Own Elaboration



The final element we must include is the variable that will define the Preparation and Recruitment capacity of the terrorist group. These capacities, logically, will be constrained by the power of the group; a larger and richer group will be able to recruit and prepare more terrorists than a smaller one. In order to measure this "size" we will include a "Controlled Territory" variable, defined as the amount of territory a terror group (In

our case ISIS) controls.[45] As the controlled territory increases, so will the capacities of the terror group, allowing for them to sustain a higher level of ambition.

Figure 14, Final Stock and Flow model. Source: Authors' Own Elaboration



With this final addition our model is now complete, and we have fully translated the research we have analyzed into a Stock and Flow model. The next step will be the most interesting, as it is now time to run simulations with the model and begin exploring possible policy interventions.

4. Chapter 4

The program we will be using to simulate our model is known as "Silico", a web based program available online at the domain "Silico.app". The reasoning behind the selection of this program was twofold. Firstly, it was selected due to the clarity it provides; while there are other programs with more functionality, they may often result unintuitive unless one has a deep understanding of the platform. The second, and main, reason is that, due to the online nature of the program, the simulated model may be accessed by anyone who has the address. This is important due to the fact we are following a Weberian method; in order for our work to be repeatable it is important we allow our model to be openly accessed and analyzed. A link to the model on the program is provided here:

[45] Wilson Center. 2019. *Timeline: the Rise, Spread, and Fall of the Islamic State*. [online] Available at: <https://www.wilsoncenter.org/article/timeline-the-rise-spread-and-fall-the-islamic-state> [Accessed 19 September 2022].

https://silico.app/@thomasdeangelis22/test?s=x_nSJGZJT9G-7aEgoeBJKA

Anyone is open to view and modify it, as it is an exact copy (not the original) of the model used to produce the simulations that will follow.

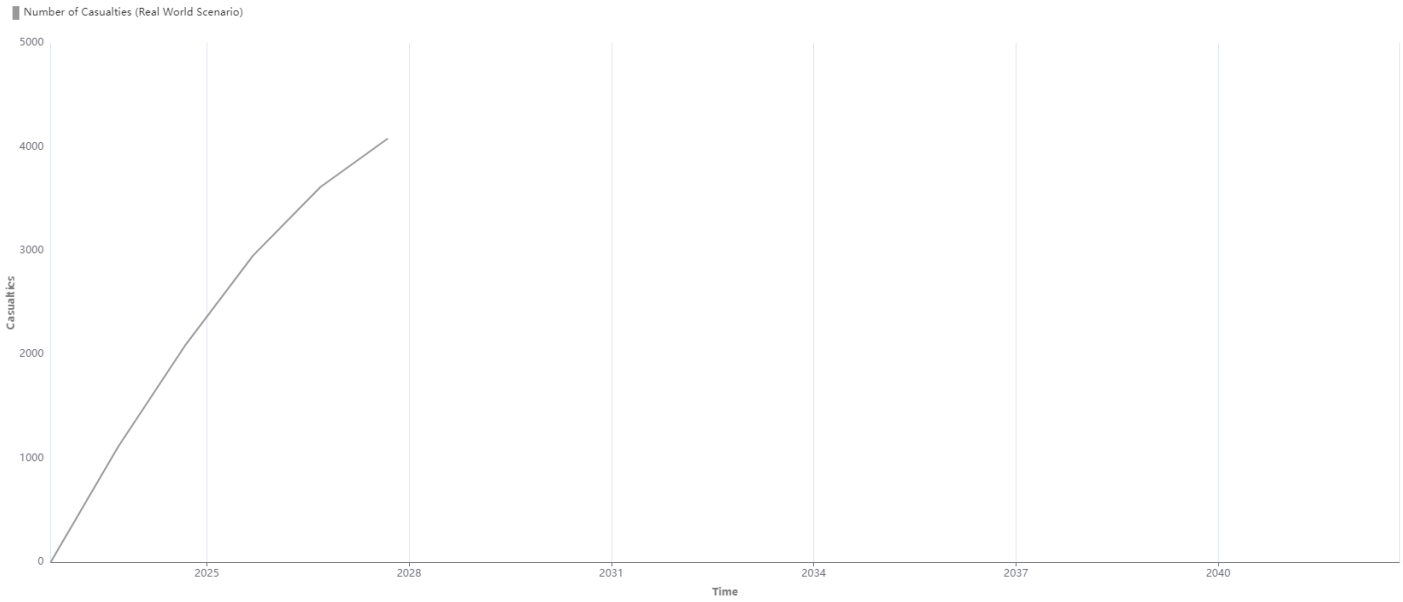
Before simulation we will clarify what assumptions and conditions we will use, so as to ensure that the results we will obtain are understood in the correct context. First, while the model was constructed using data from ISIS and Al-Qaeda, it has been designed in such a way as to be independent from these groups; as such simulations may be made considering different terror groups, real or hypothetical. Next, we will assume our general population stock to remain constant, given that we are not analyzing the possible inflows it may have (for example the birth rate). While this is not reflective of reality, we are not interested in understanding the demographic factors that contribute to a given population size: as such we will assume the stock will remain constant and not decrease as it is drained. The second clarification regards the time measurement we will use: we will run simulations over a period of 20 years, with each "tick" of our system representing 1 year. A "tick" of our system will allow the whole system to flow once, meaning that every 1 tick will cause all flows to activate and drain and/or populate their respective stocks. This means every tick will represent a full run through of our model, and we will run the model 20 times; in other words we will observe how the model behaves year by year over a period of 20 simulated years. Next, we will assume the level of ambition of the terrorists to remain constant, at 1000 casualties per year. This means that the "goal" of the system is to output a total of 20000 casualties over its simulation period, however it is not a given that it will reach this number. Another assumption we will make is that all the attacks carried out by terrorists will succeed. As such, we are effectively creating a "worst case scenario" in all our simulations, as we are not taking into account the capacity of different security bodies to halt attacks once they have been planned. The numbers we will obtain may as such result exaggerated compared to reality, as not all attacks will be successful. Finally, we will input initial values into our stocks in order to assume that the system has already been operational. If we did not input these initial values the system would assume that in the first tick there are no at risk individuals, radicalized individuals, recruited terrorists, etc. This is not reflective of reality, as we are assuming that the dynamics we are seeking to understand are an on-going process, and are not concerned with understanding the start-up of the model.

4.1. "Real-World" Scenario

Before this baseline simulation, however, we must check whether or not our model is descriptive of reality; in other words if we input data that has been observed in the past, is our outcome reflective of the actual past observed outcome? In order to do this we will run a shorter simulation, spanning over 5 years in order to mimic the years 2014 to 2019, during which ISIS steadily lost its territory, going from 100000 square kilometers in

2014 to just 4000 in 2019.[46] We will factor this change in territory into our model, and then check our results against the actual observed number of casualties over the time period. We will obtain this information from the yearly Europol reports[47] that track terrorist activity year by year. According to these reports there were roughly 3141 total casualties between 2014 and 2019; we must now run our model for a 5-year simulation, accounting for the territory change and see if our results are in line. The results of this simulation are as follows:

Figure 15, Real World Scenario Casualties. Source: Silico.app, based on Authors' Own Elaboration



Running the simulation yields a total of 4080 casualties over 5 years, only 939 casualties away from the real numbers. In order to understand this result we must recall that our model is assuming an 100% success rate for attacks and that it will depict a linear path of casualties: these two factors combine to make the model overestimate values slightly, with the effect being more noticeable over shorter spans of time. Understanding this allows us to determine that the model is adequately describing the number of casualties, meaning it is descriptive of reality. This knowledge allows us to also assert that it is predictive; if inputting historical data yields results that are in line with historical outcomes, than we know that we can use the model to simulate future scenarios. As such, we may confidently proceed to our baseline simulation, keeping in mind our earlier clarified assumptions.

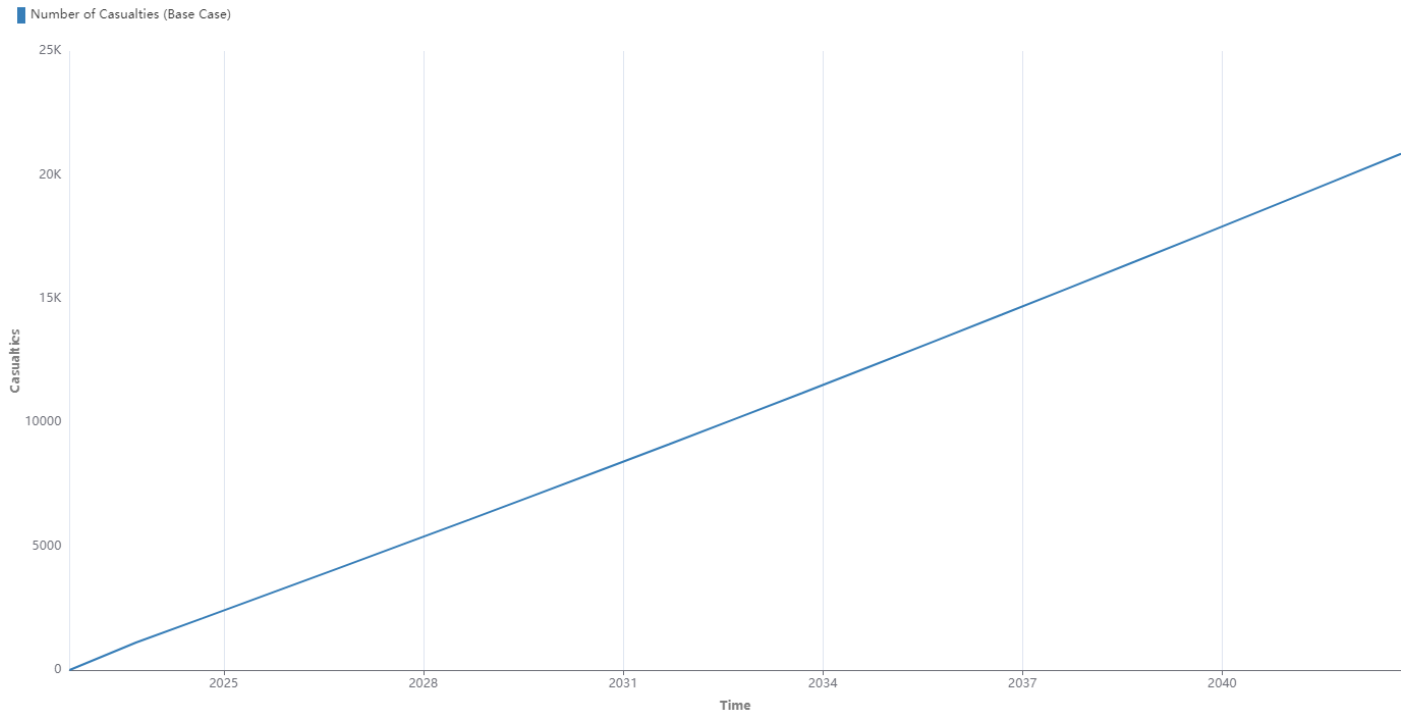
4.2. Baseline Simulations

It is now time to set our baseline simulation. This simulation will be the one that we will use as a basis to compare all our planned policy interventions. The results obtained in this first run of the model will be what

[46] Ibid.
[47] Europol. 2022. *EU Terrorism Situation & Trend Report (TE-SAT) | Europol*. [online] Available at: <https://www.europol.europa.eu/publications-events/main-reports/tesat-report> [Accessed 17 September 2022].

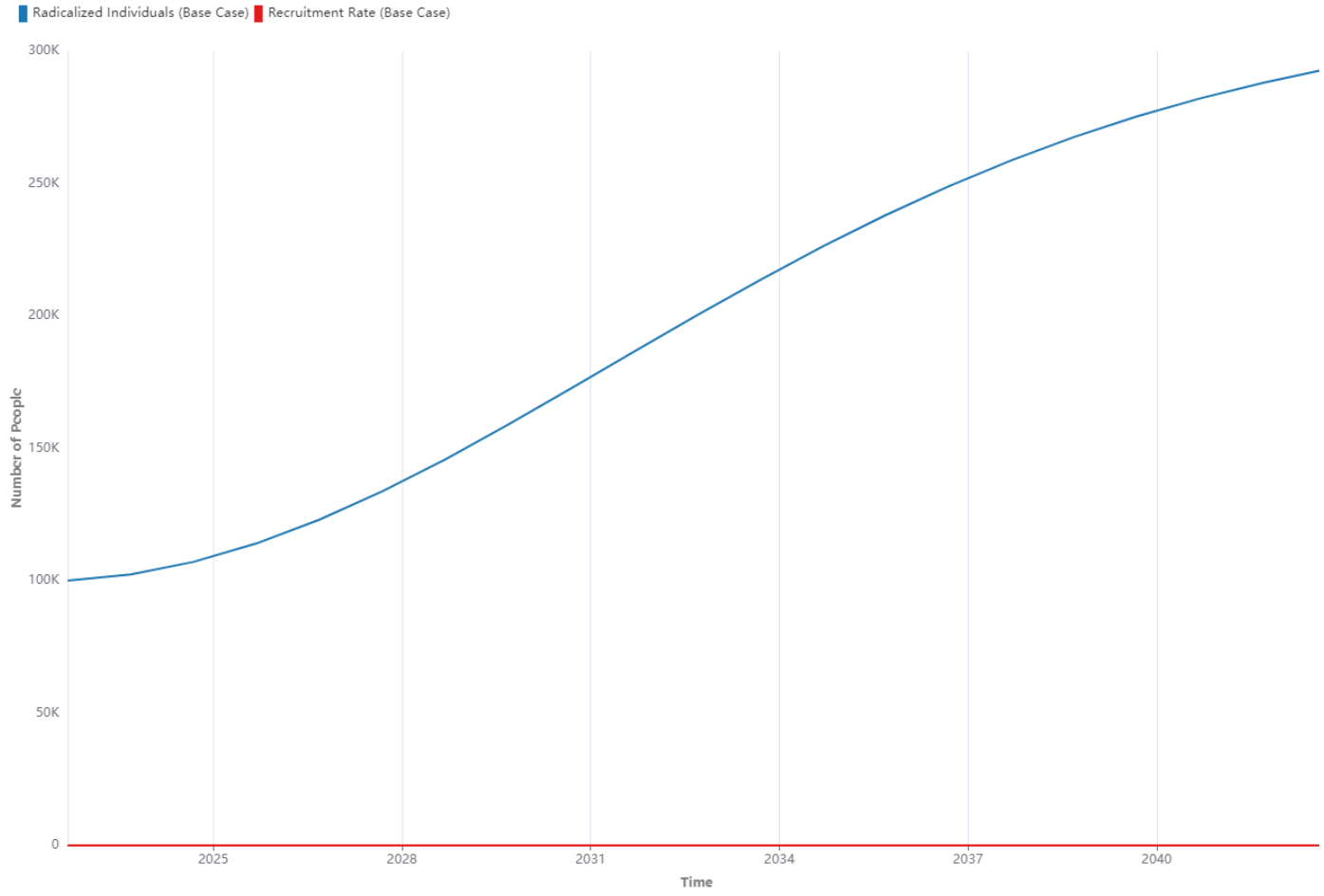
we will compare our future simulations (that will have policies integrated into them) against. In this first simulation we will assume our terror organization to have 100,000 square kilometers of territory under their control for the duration of the simulation; in other words the terror organization will be at their peak performance. Our baseline simulation yields the following results:

Figure 16, Baseline Casualties. Source: Silico.app, based on Authors' Own Elaboration



Over the course of the simulation a total of 20850 casualties are observed, growing yearly at a constant rate. It should be noted that the trend of a constant yearly growth is not indicative of reality; in a real world scenario some years may have no casualties while others have far more; the model is predicting a trend, not the specific pattern. However, while the specific pattern is not fully accurate, the general trend is, and as such we can begin drawing some conclusions. First, it can be noted that our large terror group has reached its set goal, even obtaining an extra 850 casualties. This is not terribly surprising as we have simulated them having a large amount of territory for the duration of the simulation. As such, we have assumed that no action has been taken against them and they have had ample land (and therefore resources) available to them in order to prepare their attacks. A second observation may be made if we compare the recruitment rate against our stock of radicalized individuals:

Figure 17, Baseline Radicalized Individuals and Recruitment Rate. Source: Silico.app, based on Authors' Own Elaboration



In the above graph the blue line represents the trend of radicalized individuals, while the red one that of the recruited terrorists. A first observation is that the trend of the radicalized individuals stock; as can be seen it follows a slight "S" curve, in which it slowly accelerates its growth before beginning to reach a plateau. This occurs because, as we have seen, the number of casualties will increase our radicalization rate; as such, after the first few ticks of the simulation our casualties grow, causing the radicalization rate to grow and give the stock an S shape. Focusing instead on the recruitment rate, as can be seen, the two values are hardly comparable. The radicalized individuals will number in the tens of thousands, while the recruited individuals number in the tens. As such, we can see a fundamental asymmetry between the needs of the terrorist group and the availability of radicalized individuals. Indeed, the supply is far larger than the demand, given that terrorists do not require a large amount of trained attackers to reach their desired casualties. This would seem to suggest that as long as the terrorist group is large enough and, as such, able to train its needed quantity of prepared attackers, they will always have enough supply to reach their goals. This could be a key element in planning out possible policy action, and as such merits testing. As such, we will run a new baseline simulation in which we will imagine that we are able to completely remove the digital propaganda that increases radicalization and set a deradicalization rate of 90%. In so doing, we will greatly reduce the quantity of radicalized individuals that will be produced during our simulation period. In this way we will be able to

confirm whether our suspected asymmetry of supply and demand is real. Running the simulation yields the following results:

Figure 18, Radicalized Individuals and Recruitment Rate with maximum reduction of Radicalized Individuals. Source: Silico.app, based on Authors' Own Elaboration

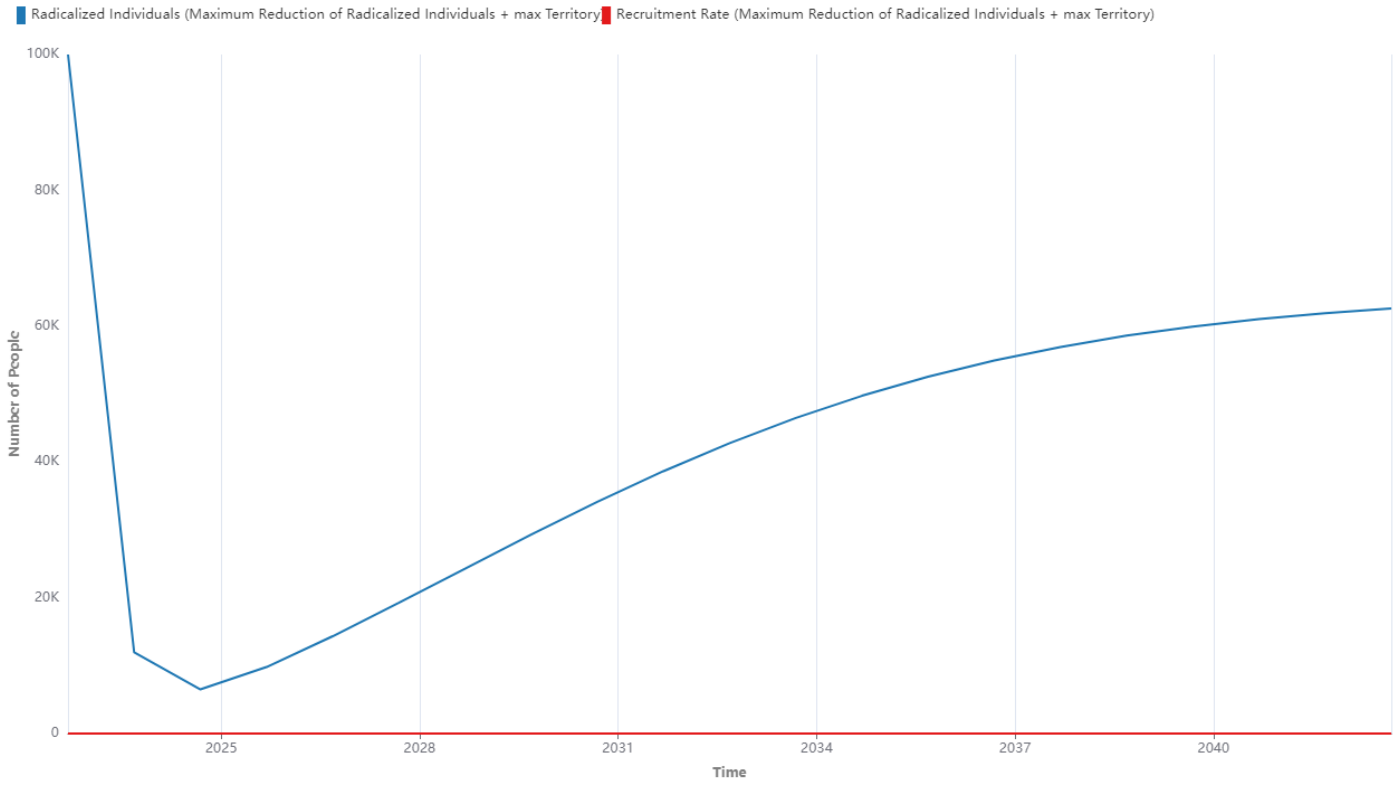
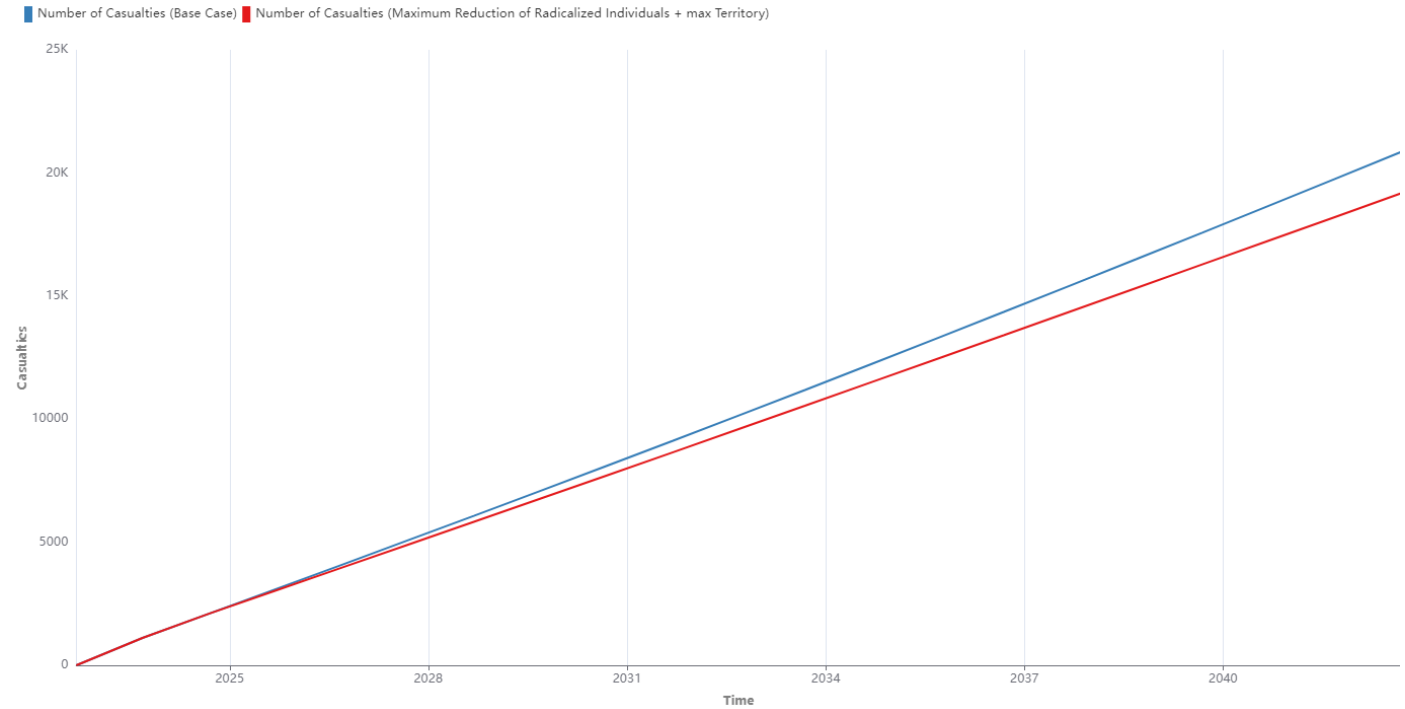


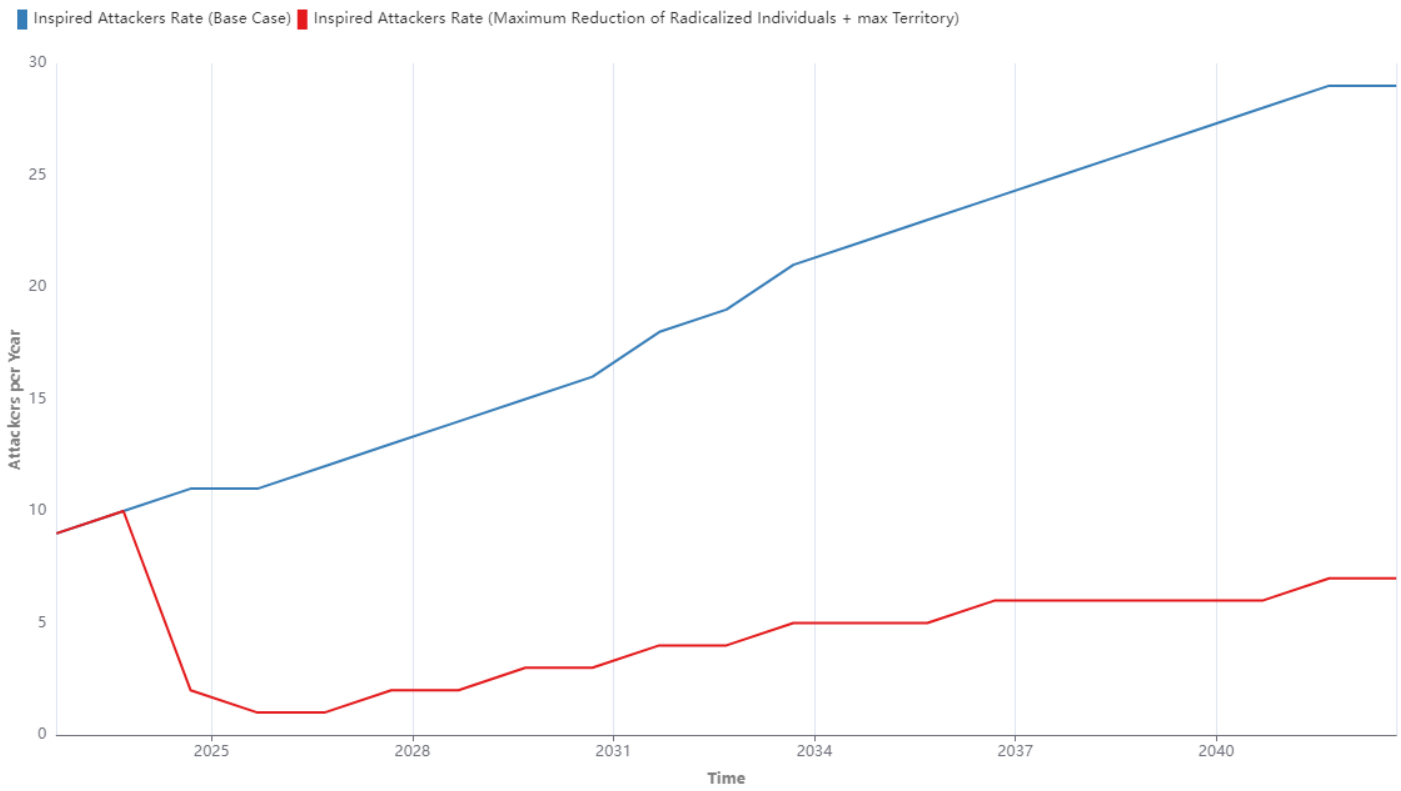
Figure 19, Casualties with maximum reduction of radicalized individuals. Source: Silico.app, based on Authors' Own Elaboration



As can be seen, even if the stock of radicalized individuals were to be dramatically reduced, the supply will still outweigh the demand. Furthermore, the total number of casualties will not deviate significantly from the

base case, reaching a total of 19170, roughly 1000 less than the base scenario. However the fact that there has been any variation at all is noteworthy. We know that the terrorist group produced the same amount of attackers over the simulation given that their recruitment demand was always met; we also did not vary the lethality of the terrorists, so why did the total number of casualties decrease? The answer lies in the lone wolves. Indeed, while reducing the radicalized individuals did not have an effect on our terror group, it did reduce the rate of lone wolf attacks, as can be seen in the graph below:

Figure 20, Inspired Attackers Rate with maximum reduction of Radicalized Individuals. Source: Silico.app, based on Authors' Own Elaboration

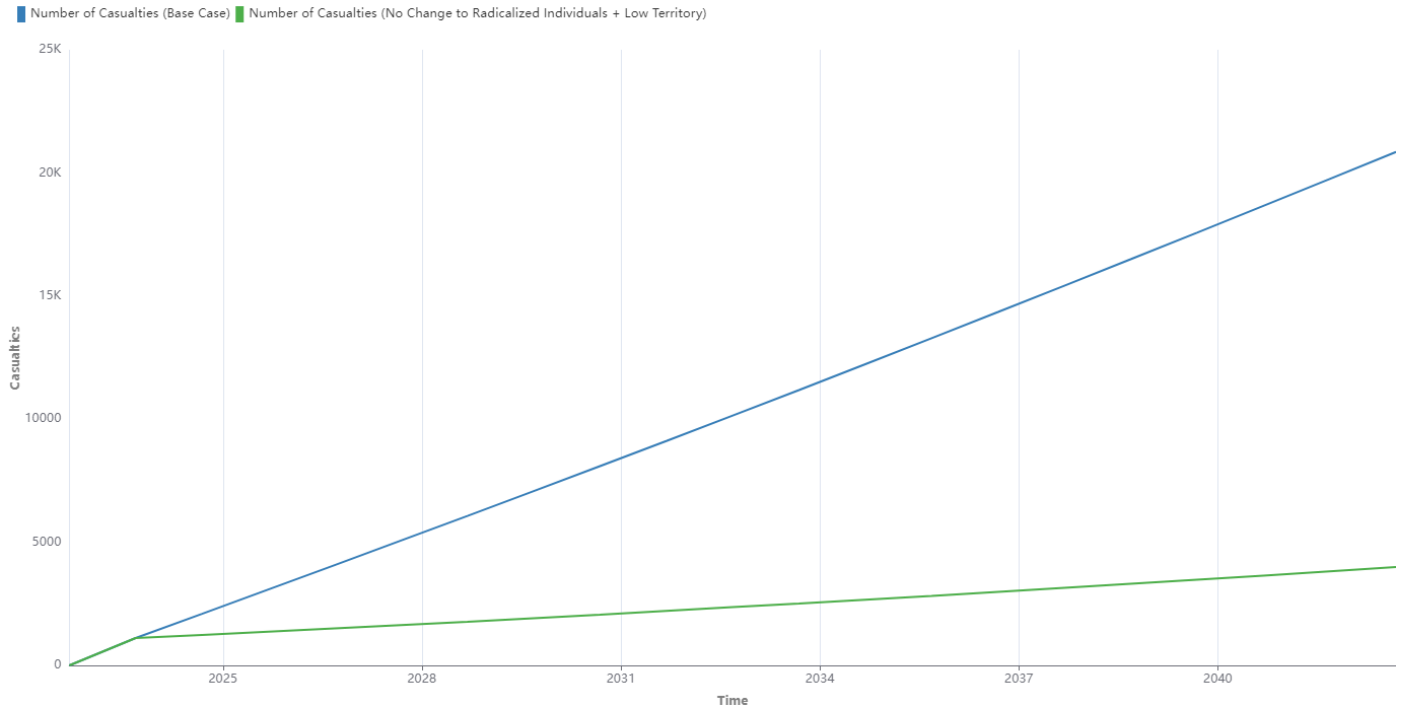


As can be seen, the quantity of lone wolf attacks per year drops considerably if the stock of radicalized individuals is reduced, meaning that their contribution to the total number of casualties will also be reduced, explaining the variation observed above. The reduction in lone wolves attacks occurs because, as explained when constructing the model, we define the rate of self-preparation (meaning the rate with which radicalized individuals prepare themselves for an attack without the involvement of a terror group) as being a small percentage of our total radicalized individuals. As such, if said stock drops, so too does the self-preparation rate and, as a consequence, the inspired attacker rate. This is another interesting factor to consider in policy planning, which we will explore further later.

We have so far concluded that as long as the terror group is large enough and able to prepare its attackers, no amount of feasible reduction to the stock of radicalized individuals will be able to curb the number of casualties. The question that arises, then, is what if the terror group had less territory under its control? As we have seen, the controlled territory is important, as it is both a source of income and provides training grounds. As such, it is worthwhile to investigate what effect a smaller amount of territory will have on our casualties.

We will run a new simulation, this time reducing the amount of controlled territory to a tenth of the baseline, only 1000 square kilometers, in order to investigate this issue. The results are as follows:

Figure 21, Casualties with maximum reduction of Controlled Territory. Source: Silico.app, based on Authors' Own Elaboration



The results are dramatic: the total number of casualties drops to 3966, a significant departure from our baseline. The scope of the change made to the territory is similar to that we made to the radicalized individuals stock in the last simulation, however the results are much more pronounced. It is clear to see that the controlled territory of a terrorist organization (and as a consequence their funds, training camps, weapon supplies, etc.) are crucial in determining their capacity to do damage in the West. Furthermore, the reduction in casualties will cause a drop in the radicalization rate, as a consequence also reducing the attacks carried out by lone wolves.

As such we have concluded our round of baseline simulations, and have gained some important insights for our policy modeling. The first observation is an important one, as we have determined that there is a large asymmetry between supply and demand in terms of the recruitment needs of a terror organization. Due to the strategies employed by terrorists in their attacks against the west (Suicide bombing etc.), they do not need a large amount of combat force, meaning a relatively low demand. On the other hand, the radicalized individuals that may become terrorists will always number far higher than the demand, meaning that terrorist organizations that are “large” enough will never have a lack of possible recruits. Furthermore, we have seen that the size of a terror group in terms of territory controlled is crucial in determining the amount of damage they may inflict on the west. This may seem like an obvious statement, however what is interesting here is to understand the mechanics behind this relationship and use it to understand past and future dynamics. We will explore this notion as we begin to plot out possible policy interventions.

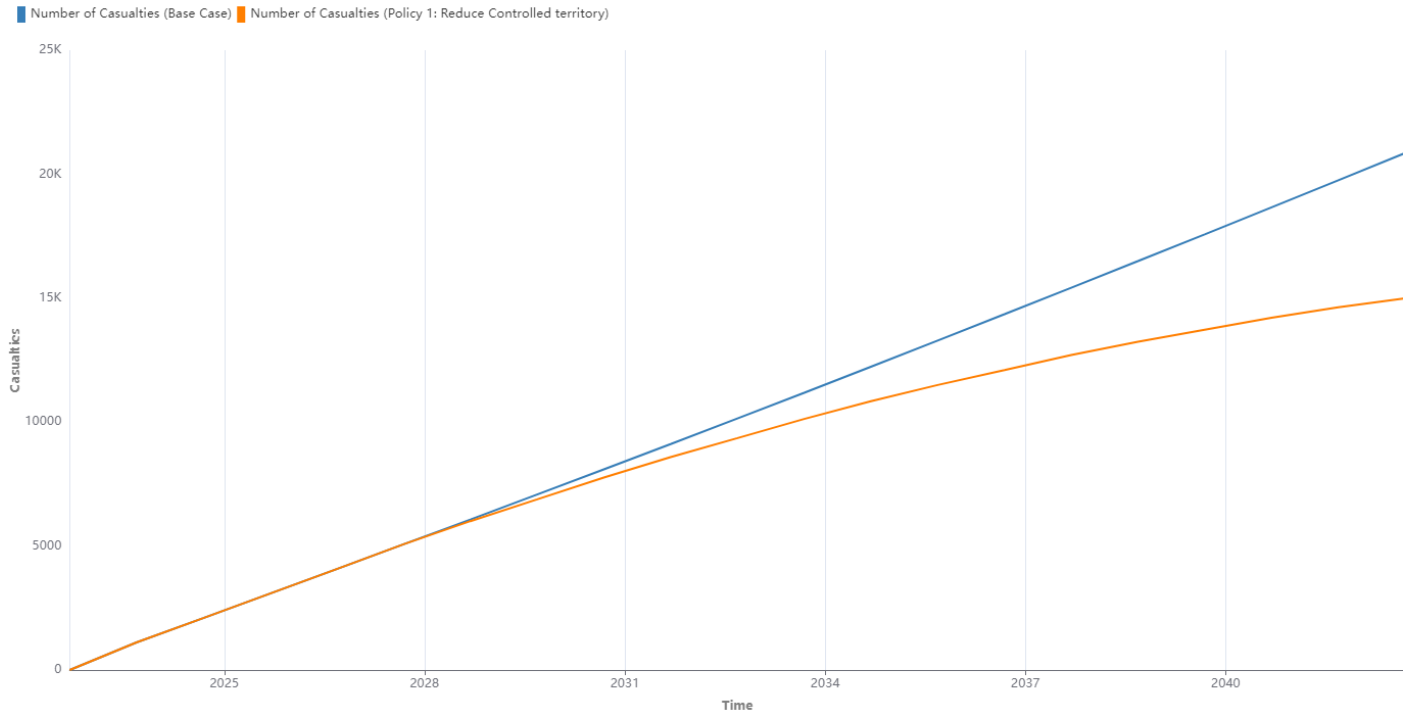
4.3. Policy Modeling

We will now start to model possible policy solutions, using the insight gained from our baseline simulations. The main difference from our baseline simulations will be that we will be implementing more realistic adjustments to the model, meaning we will make smaller adjustments more spread out over time in order to simulate policy interventions. Our baseline simulations have provided us with two main scenarios in which to model policies: the first is if the terror group is large, and the second is if it is small. These two scenarios will entail different strategies, and as such we must investigate possible policies for both.

4.3.1. Large Terror Groups

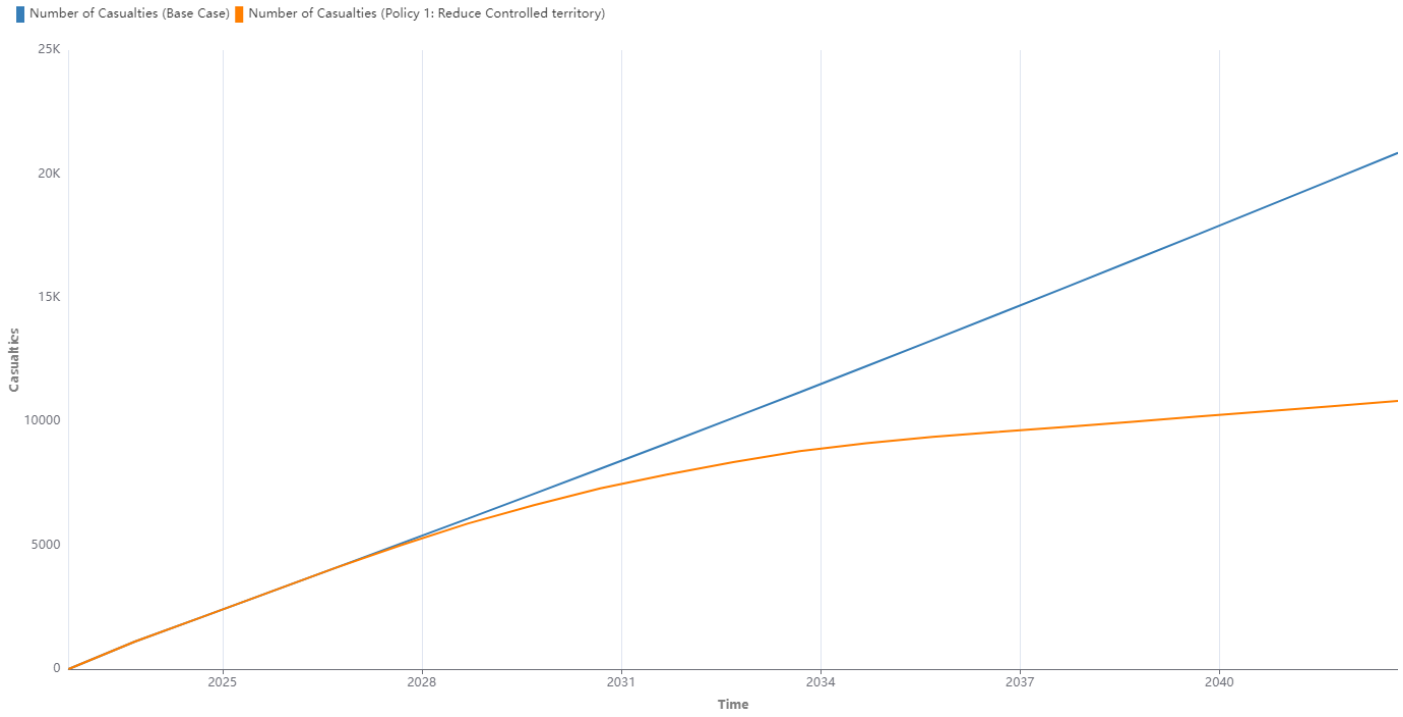
We will begin by considering the scenario in which the terrorist group has a large amount of territory under its control, signifying that it is relatively powerful. As we have seen from our baseline simulation, the territory controlled is a major descriptor of the number of casualties, as such we will imagine a policy aimed at reducing the controlled territory. We will modify our territory variable in order to implement a reduction of the territory over time and compare the result against our baseline in order to determine the efficacy of the policy. However, we will prevent the territory from going bellow 1000 square kilometers, assuming that our policy is unable to fully "eradicate" the terrorist group. We will assume our policy to begin at the second year of simulation, in order to account for a startup time, after which we will reduce the controlled territory by 5000 square kilometers per year. Our results are as follows:

Figure 22, Casualties with Territory Reduction Policy. Source: Silico.app, based on Authors' Own Elaboration



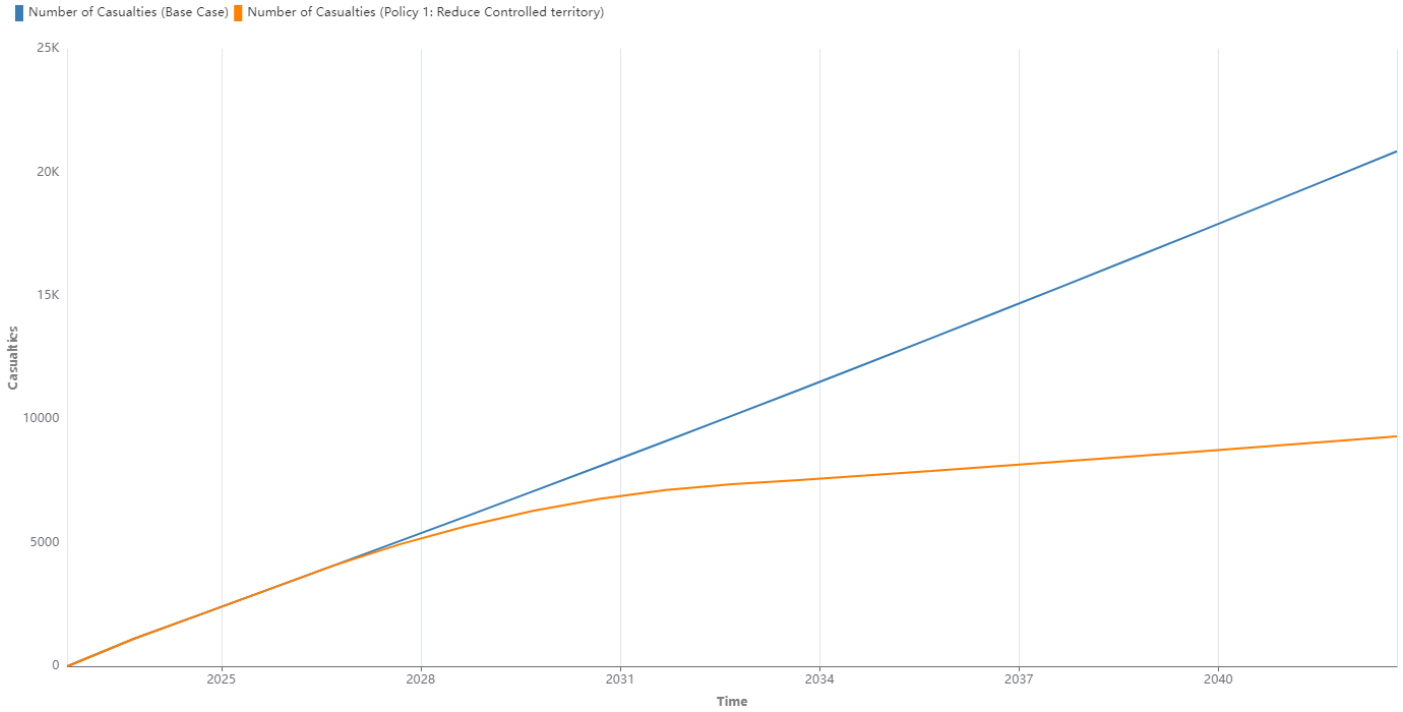
As we can see, the policy will succeed in reducing the number of casualties over the simulation period, however the results are not observable until roughly 2031 and will only result in a reduction of roughly 5000 casualties by 2042. As such a more aggressive policy may be required; let us imagine that we are able to double our territory reducing capacity, how will our results change?

Figure 23, Casualties with Second Territory Reduction Policy. Source: Silico.app, based on Authors' Own Elaboration



As we can see, doubling our efforts will increase the overall reduction to roughly 10000, double our previous result. However, note that the 2 year delay once again causes the results to not be significant until approximately 2031. We have seen that doubling our efforts will double the results; does this mean there is a direct proportionality? Let us triple our efforts and see if the relationship holds:

Figure 24, Casualties with Third Territory Reduction Policy. Source: Silico.app, based on Authors' Own Elaboration



As we can see it does not, as casualties will only drop a further 1000 as compared to the previous simulation, suggesting diminishing returns. However, these diminishing returns are due to the fact we have assumed an inability to fully eradicate the terror group, what if we remove this limit and run our three scenarios again?

Figure 25, First Territory Reduction Policy with no Limits. Source: Silico.app, based on Authors' Own Elaboration

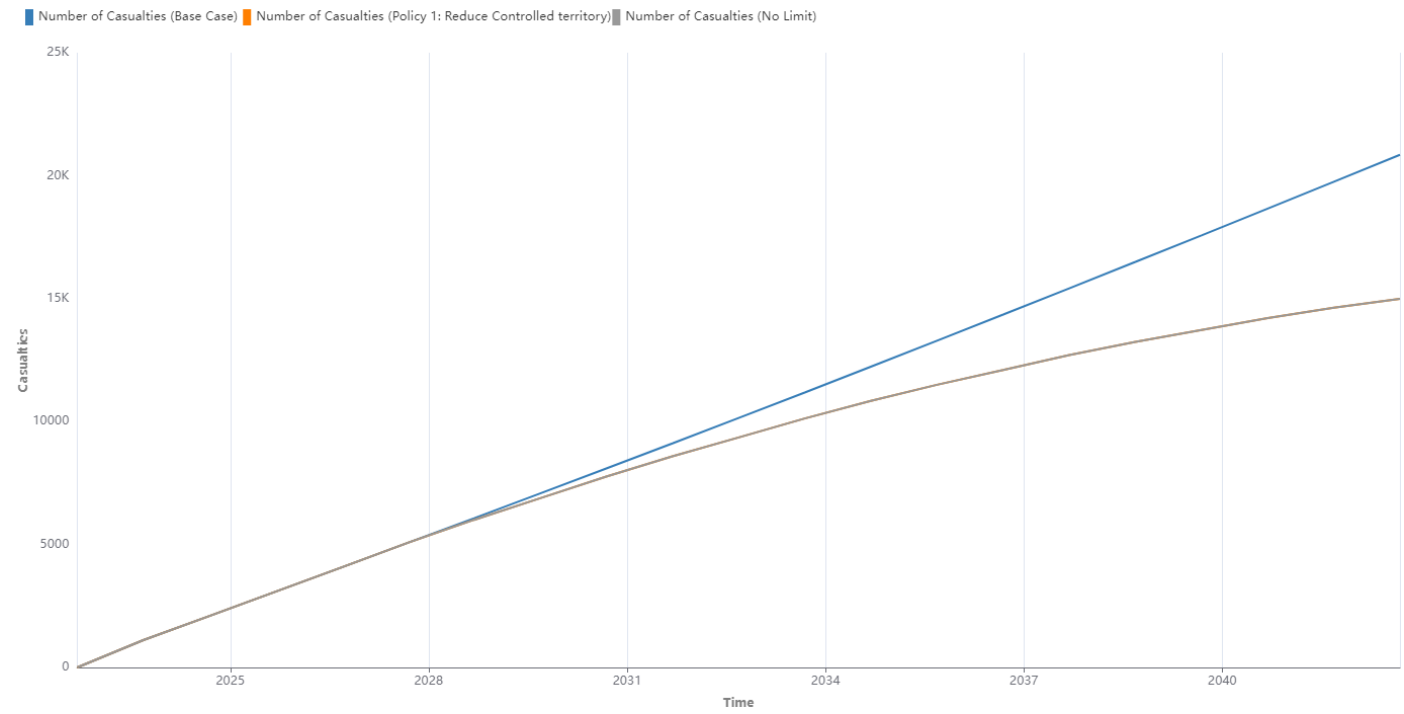


Figure 26, Second Territory Reduction Policy with no Limits. Source: Silico.app, based on Authors' Own Elaboration

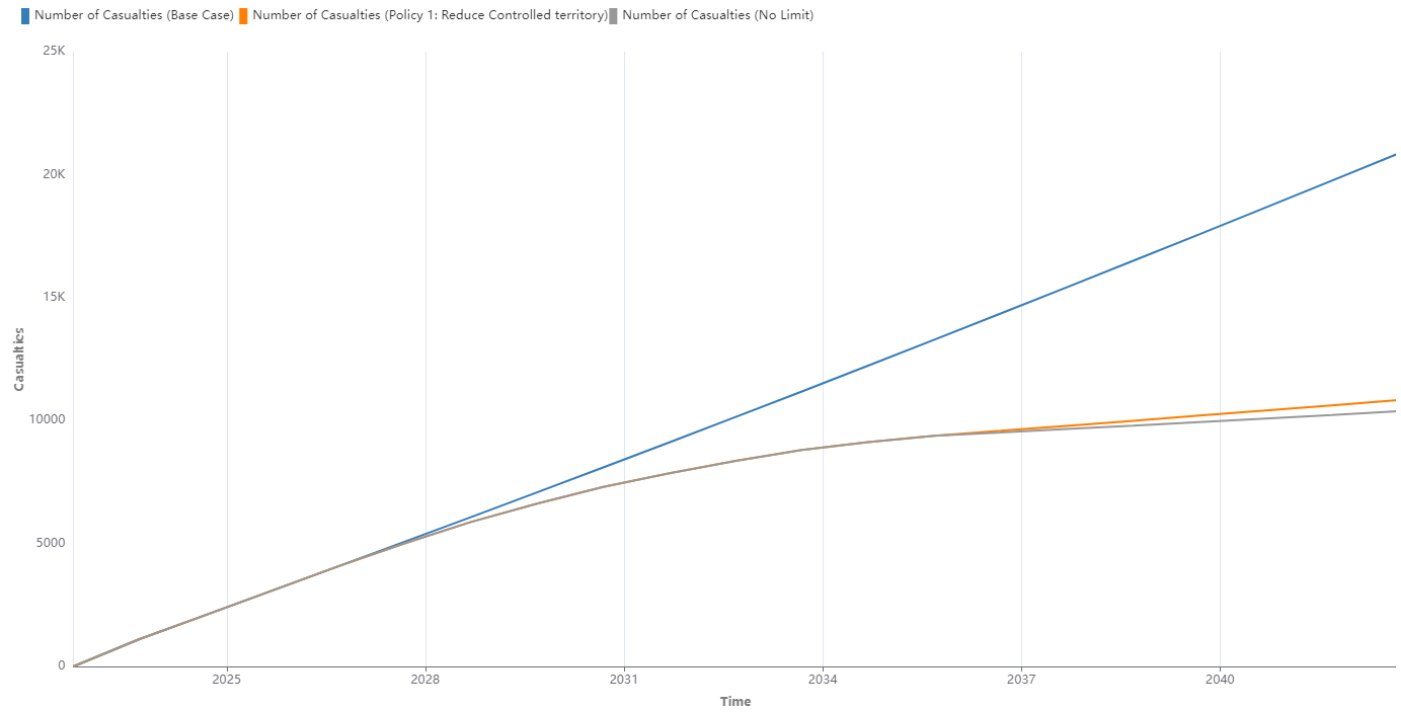
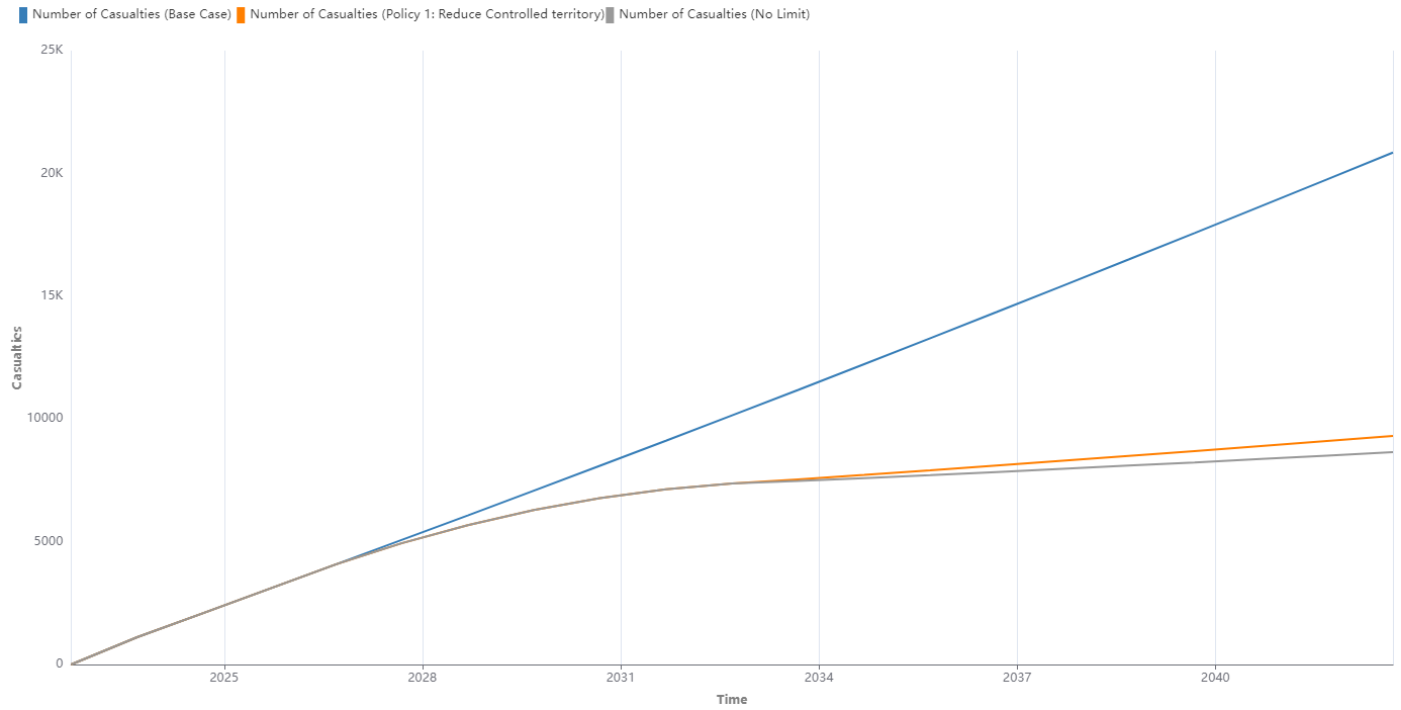


Figure 27, Third Territory Reduction Policy with no Limits. Source: Silico.app, based on Authors' Own Elaboration



As we can see, removing the limit has not resulted in a significant change to our results, signifying that the diminishing returns are not due to our imposed floor, but are inherent in the system itself.

Translating our results into practical terms, we have found that policies aimed at reducing the controlled territory of a terrorist organization will be successful, however they will have diminishing returns. In the case of our system the cutoff point occurs at circa 10000 square kilometers reduction per year, after which more aggressive policies will not yield proportional results. This suggests that there is a minimum amount of

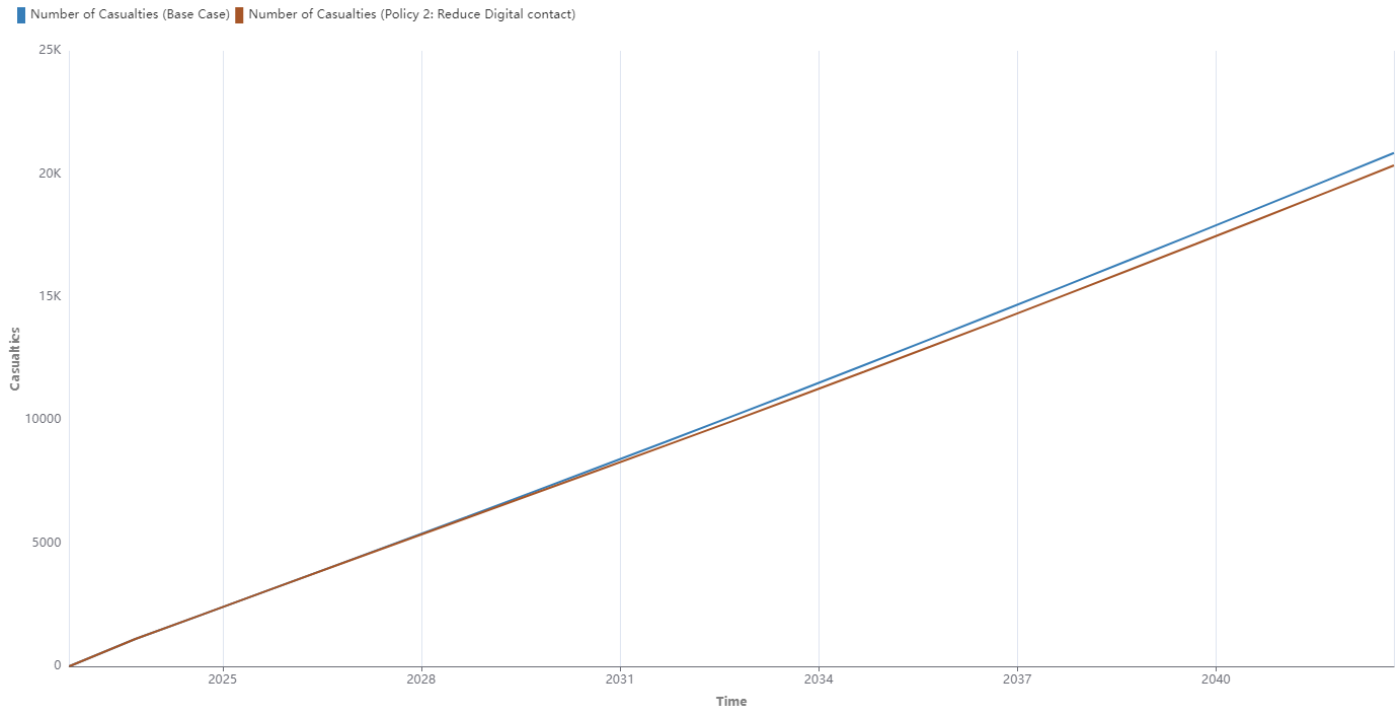
territory a group requires in order to produce effective casualties; once this quantity is reached there is little point in continuing to reduce the controlled territory. As such, policies aiming at reducing controlled territory should factor this in and attempt to determine where this cutoff point is and plan around it, in order to use resources efficiently.

However, reducing controlled territory may imply military action abroad and may not always be feasible due to a variety of factors. Furthermore, military action may increase resentment from foreign population and cause retaliatory attacks. While this may be an interesting aspect to factor into the system, it has been constructed focusing on western radicalization and is not equipped to calculate this spillover. Expanding the system with more data in the future, however, may allow for this aspect to be calculated. Until then, however, it is good practice to recommend a "next-best" policy, if reducing territory is unfeasible or there is reason to believe the spillover effect may be significant. As such, we will investigate where in the system it is best to act if we are unable to pursue the first policy.

During our baseline simulation we already determined that it is near impossible to affect a terrorist group's effectiveness if we act on the "left" side of the model, as the supply will always outweigh the demand. However, actions on the left will reduce lone wolf attacks and as such will produce results. Our first step, therefore, is to envision a realistic policy that targets lone wolves and compare it against our baseline. After this we will look for another point upon which we can act in the right side of the model in alternative to the controlled territory and decide which of the two policies is best.

We will begin with a policy that aims at reducing the digital propaganda capacity of the terror group until it is null; we will imagine this process to take a total of 2 years, in order to match the delay, we inserted in our first policy. The results are as follows:

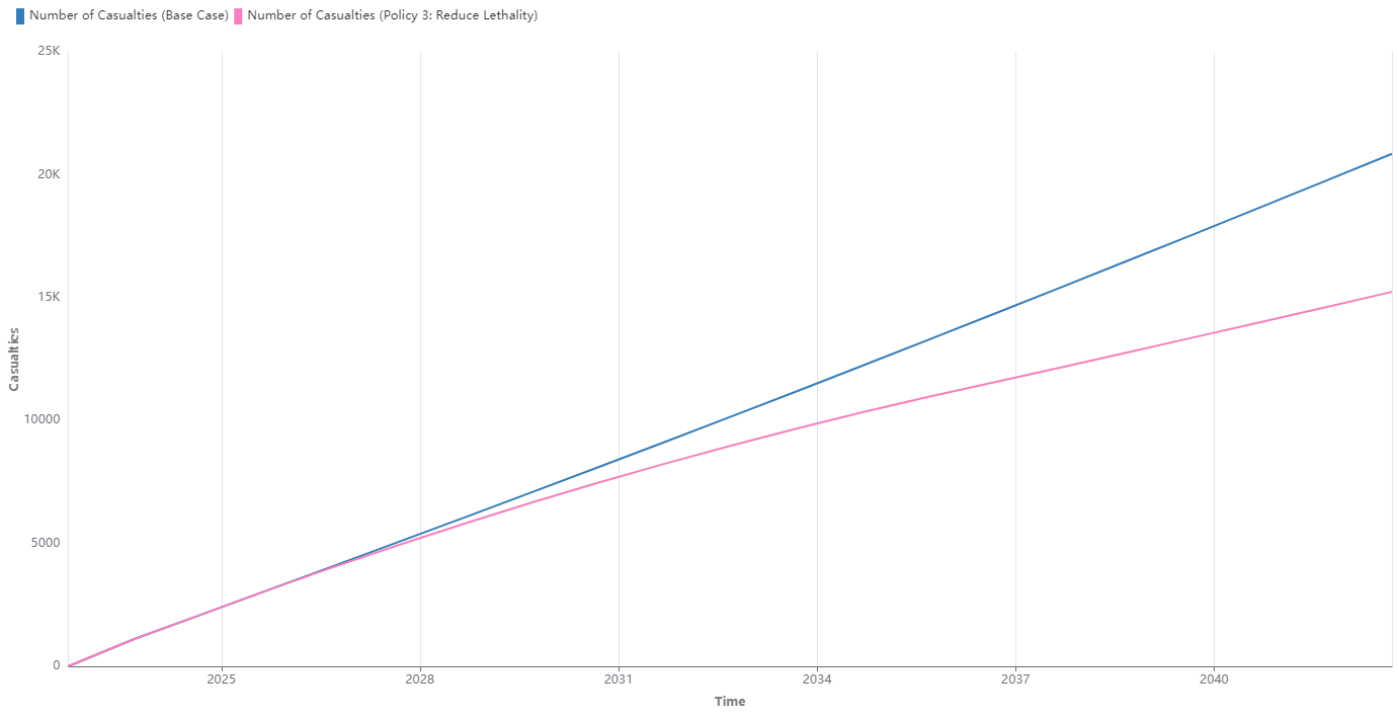
Figure 28, Casualties with Digital Contact Reduction Policy. Source: Silico.app, based on Authors' Own Elaboration



As we can see, there is no significant change in the casualties observed, in line with the results obtained during our baseline simulations. As such it is clear that while the terror group is large, removing their propaganda capacity is not enough.

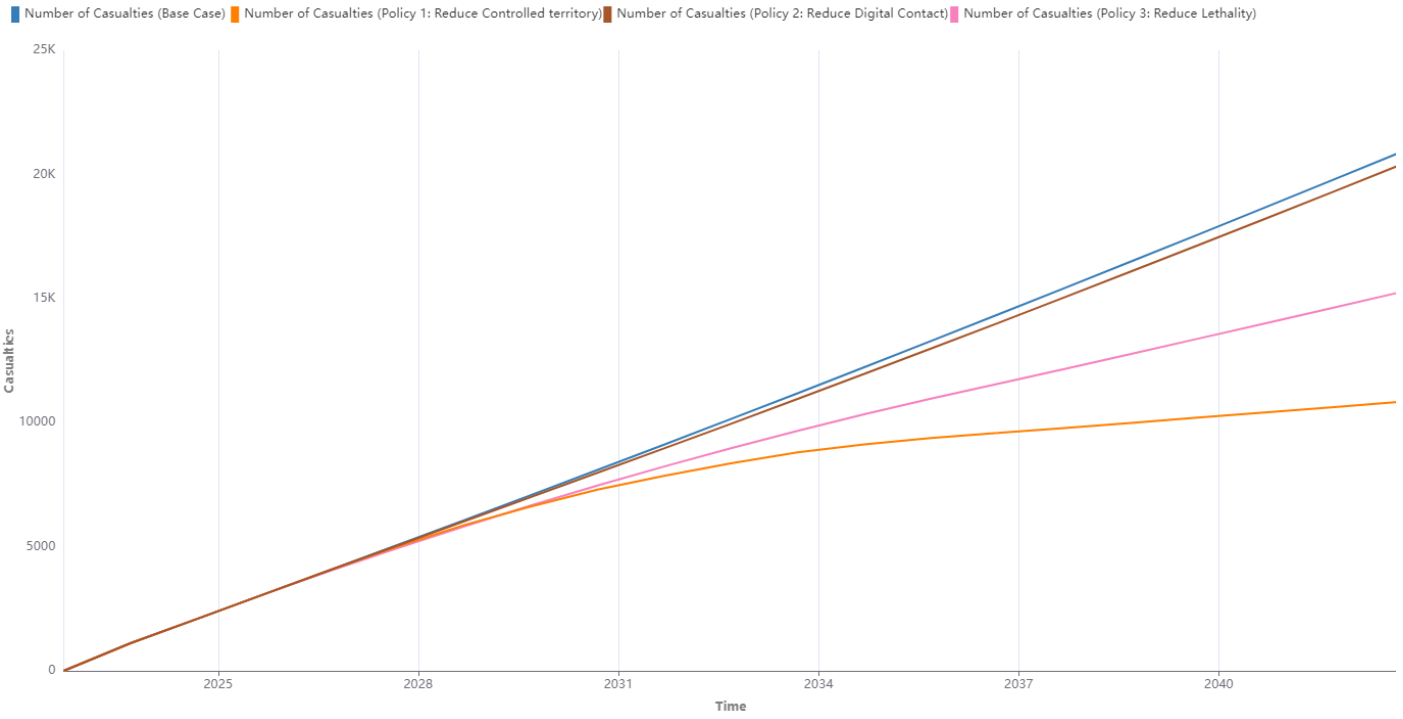
Let us now investigate another policy that seeks to target the terror group directly that does not, however, change their controlled territory. There are many variables that could produce results, however we must select the one that is most realistically targetable by policy action. In order to identify this variable, we must remember that our system is assuming the worst case scenario, meaning it is assuming all terror attacks will succeed. As such, we cannot envision reducing the success rate of attacks, as the results would not be consistent with previous simulations. An alternative, however, is imagining a reduction of the lethality of trained terrorists. As we can recall, our base line lethality was calculated using real world figures, and measures how many casualties one terrorist is able to produce on average. Policies that reduce lethality would entail improving the response to attacks, assuming that the attack allows for it. Indeed, if the attack has multiple actors and phases, improved terror response capacity would allow for a reduction of victims. If, on the other hand, the attack is a single phase attack, such as a suicide bombing, than the response will do little to reduce the victims. To reflect this limit to our policy we will imagine that only half of the lethality can be shaved off, with the other half representing the lethality of attacks that do not allow for a response. Once again, we will implement a 2 year delay to account for policy startup, and after that we will reduce the lethality of attacks by 3 per year, stopping once we reach half lethality. The results of this simulation are as follows:

Figure 29, Casualties with Lethality Reducing Policy. Source: Silico.app, based on Authors' Own Elaboration



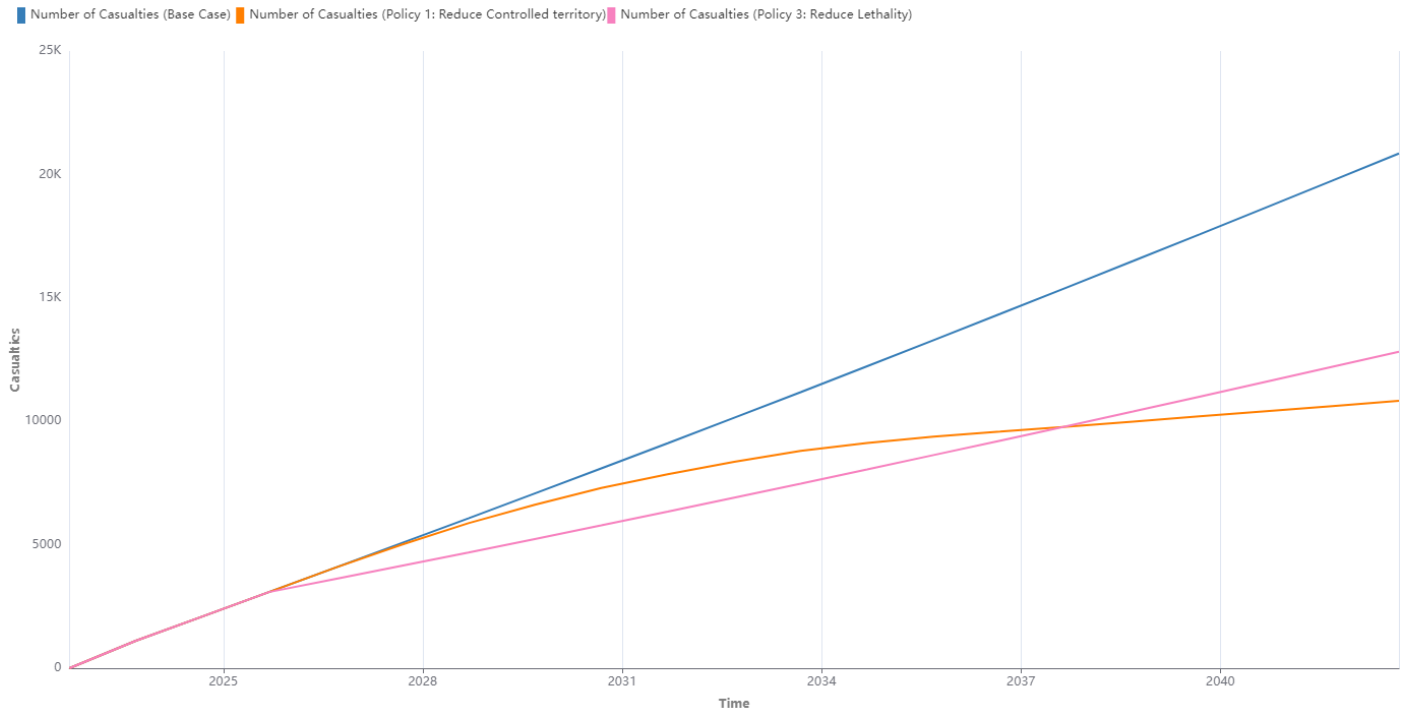
As can be seen, the results are noticeable: over the 20-year period we are able to reduce the number of casualties by roughly 5000, a number that is the same as our low intensity territory removal policy. The question that arises from this observation, then, is how the policy compares to our best territory removal policy and the digital contact reduction policy. The results of the comparison are as follows:

Figure 30, Policy Performance comparison. Source: Silico.app, based on Authors' Own Elaboration



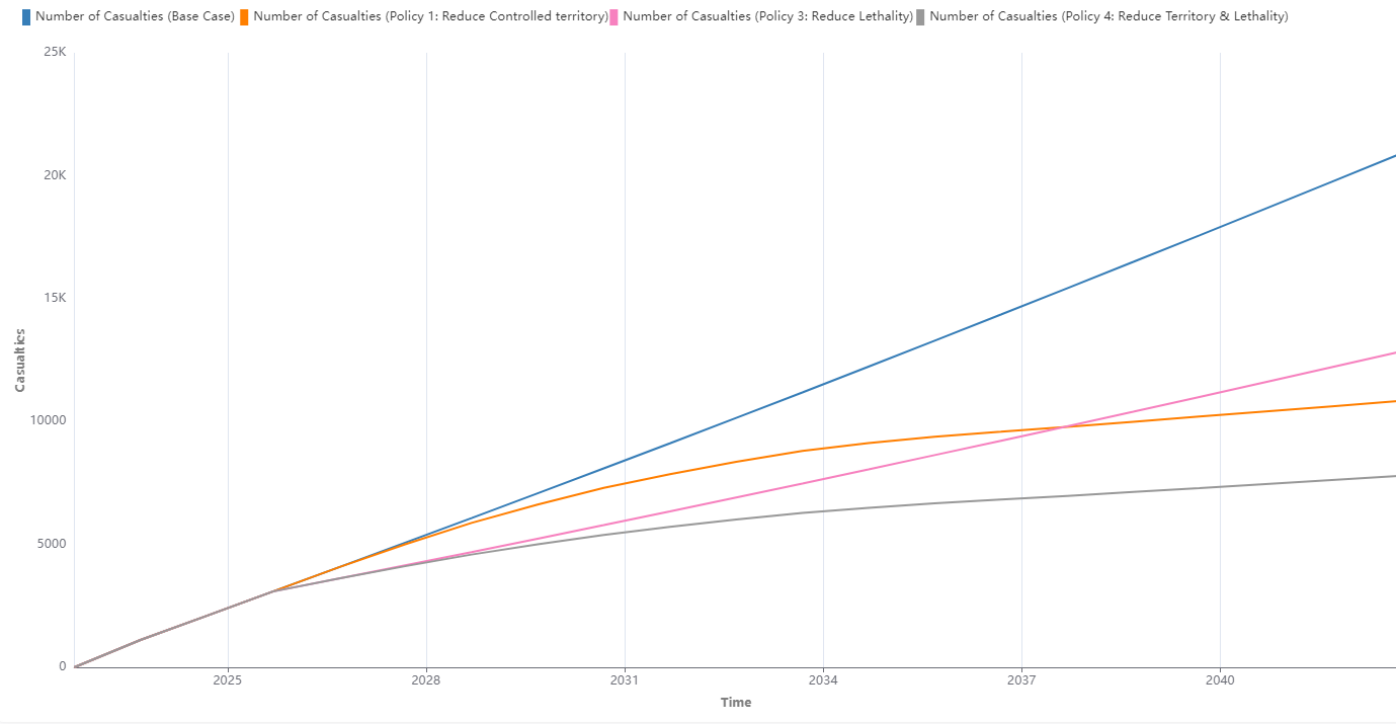
The results demonstrate that reducing the lethality, while not being as effective as reducing the territory, produces far better results than simply removing digital contact. But what if we allow for a more aggressive lethality reduction policy? Will it produce better results than our territory removal policy? Let us imagine that we can instantly reduce lethality to half after the two-year delay through a particularly intense policy and find out:

Figure 31, Comparison of Instant Lethality Reduction Policy and regular Territory Reduction Policy. Source: Silico.app, based on Authors' Own Elaboration



These results merit investigation. As can be seen, an aggressive lethality reduction policy will initially be more effective in reducing casualties than a territory reduction policy; however, after a certain point in the simulation the trend inverts, and the territory reduction policy will yield better results. This occurs because while the number total attackers is lower, the reduction of lethality is more noticeable than that of territory. However, once territory reduces to a point in which the number of attackers is very low, the higher lethality of the territory reduction policy is offset by the higher number of attackers in the lethality reduction policy. In order to better understand let us look at a snapshot of the final year of simulation: policy 1 will see 1 terrorist carrying out an attack with a lethality of 66 for a total of 66 casualties; policy 3, on the other hand, will see 14 attackers carrying out an attack/s with a lethality of 33 for a total of 462 casualties. In other words, it is more efficient, over longer periods of time, to reduce the number of attackers rather than the damage they can do. However, in the shorter term, improving response capacity to attacks in order to reduce lethality will allow for better casualties reduction than targeting the terror group's territory. As such, one final policy that we may imagine is one that integrates both insights. The results of this policy are as follows:

Figure 32, Combined Policy Performance comparison. Source: Silico.app, based on Authors' Own Elaboration



As could have been expected, this combined policy is the most effective, reducing our total casualties to 7788. Indeed, this policy acts in two parts, short-term and long; initially the response to attacks is bettered in order to combat the immediate effects, deviating the trend of casualties from our base case; after this, the reduction of territory will follow through, pushing the casualties down further and in a more effective manner.

We have thus reached the conclusion of our first scenario for policy modeling, in which we are acting against a large terrorist group. We have discovered that the best courses of action, ranked by effectiveness, are as follows:

1. Reduce the controlled territory of the group while improving terror attack response capacity
2. Reduce the controlled territory of the group
3. Improve attack response capacity

These policies will all reduce the number of casualties, however the first two will also change the trend of casualties, allowing for more long-term effects. If we consider these policies we may notice, that we are not suggesting revolutionary new strategies; indeed, these policies have been employed in the past, both versus Al-Qaeda and ISIS, and have indeed been successful. The original contribution being made, however, is understanding why these policies are successful; it is one thing to see that something works, it is another to understand why. In our case, we can see that reducing the territory of a group is effective specifically because it is limiting their preparation capacity. By removing their territory (and thus funding) they are unable to train and prepare new terrorists, leading to a decrease in their capacity to do damage. If this specific mechanism did not exist, this relationship would not hold, and reducing their territory would have little effect. However, it may soon be that this relationship will not be as pronounced, as new communication technologies may allow

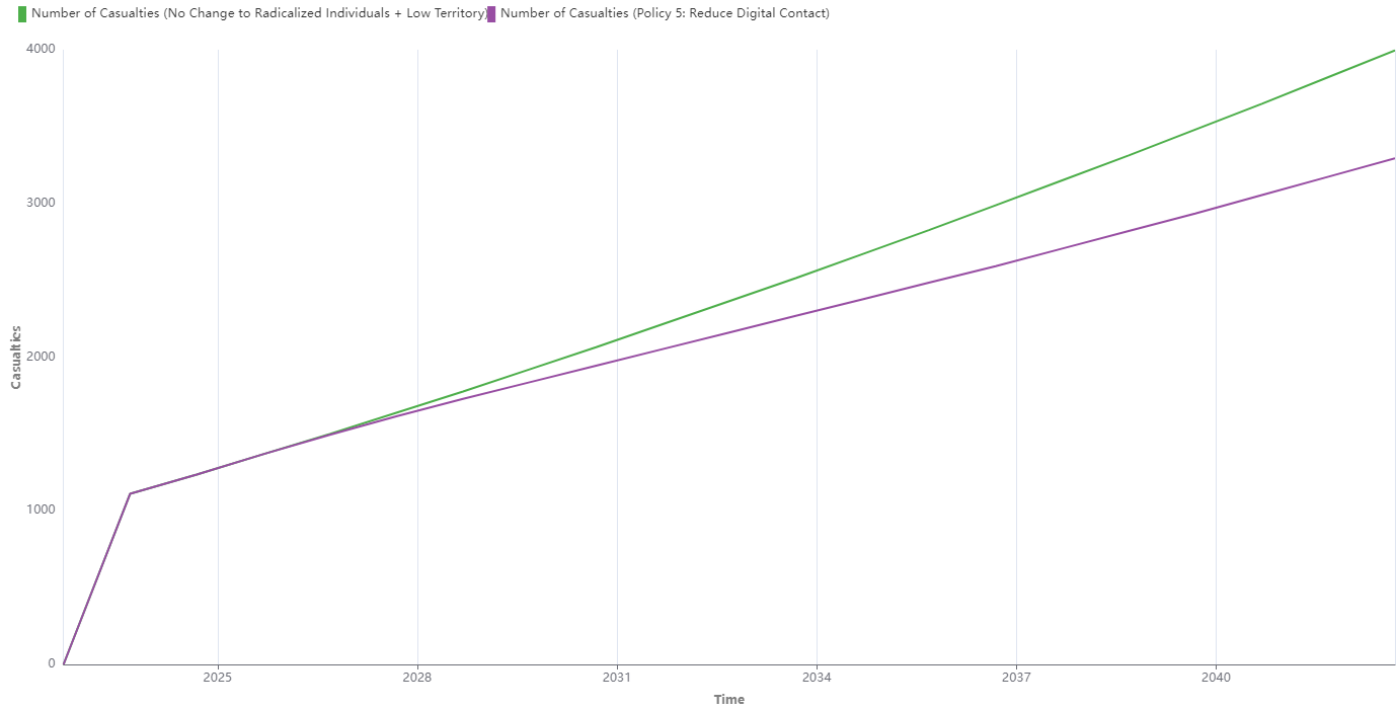
for recruitment and training to occur without the need for large amount of funds or territory. Indeed, the policies suggested above have been used and they have succeeded, yet terror attacks continue, only following a new paradigm. Lone wolf attacks seem to be the premier strategy used by terror groups that do not have a lot of territory; instead of training highly lethal operatives terror groups seek to use the over-supply of radicalized individuals in another way. If they cannot recruit them, they can push them to carry out attacks on their own, intensifying their digital propaganda and outreach and supplying them with knowledge on how to carry out attacks. In other words, rather than transforming a select few into highly effective soldiers, they can push the radicalized individuals to take up arms independently, knowing that there is a large supply of them. As such, while it is useful to know how to combat large terrorist groups, we must now consider how to combat smaller groups that use lone wolf attacks as their main weapon.

4.3.2. Small Terror Groups

Lone wolves, as we have highlighted, are the modus operandi of "modern" terror groups. Lone wolves are a strategy that take advantage of the asymmetry between supply and demand, but in a different way. Instead of highly training a few, terror groups seek to keep the stock of radicalized individuals high so that they will produce more lone wolf attackers over time. As such, the main policy goal we must pursue is that of reducing the stock of radicalized individuals, consequently lowering the casualties.

Our simulations in this case will use the baseline scenario in which we envisioned a small terror group with only 1000 square kilometers of territory, otherwise leaving everything else the same. To begin, we will use a policy attempted before when considering large terror groups, namely that of reducing the digital contact a terror group is able to make. The conditions will be the same as before, with the only difference being the size of the terror group. The results are as follows:

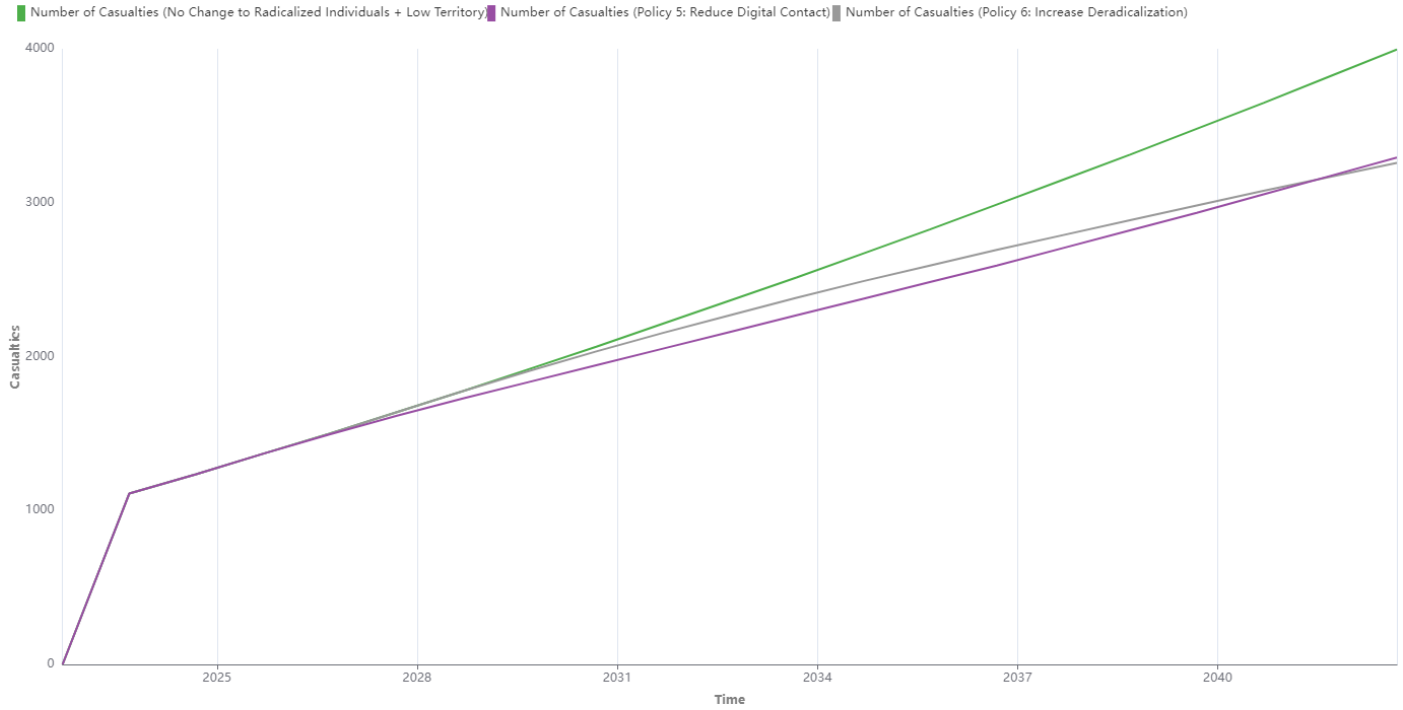
Figure 33, Casaulties with Digital Contact reduction Policy (Small Terror Group). Source: Silico.app, based on Authors' Own Elaboration



As can be seen, when dealing with smaller numbers the effect of the policy is more pronounced, reducing the casualties from 3996 to 3294: a reduction of 702 casualties. When considering a large terror group this number would not be significant, but with lone wolves the lethality is lower, thus are the casualties lower, meaning changes that were once small are now, in relative terms, large. As such we have found one avenue to decreasing lone wolf attacks through the digital contact that terror groups carry out, but we must test other policies in order to have a full view.

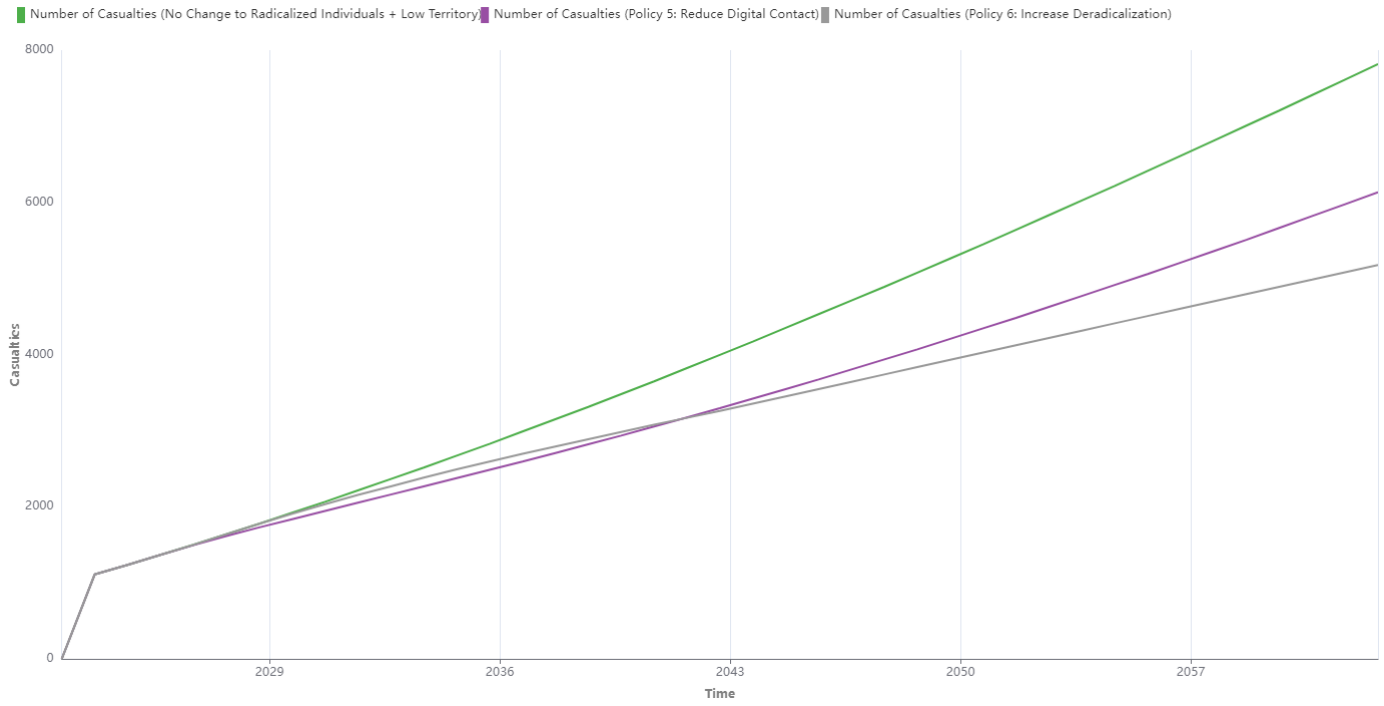
The next strategy we will test is increasing the deradicalization rate. The deradicalization rate, as we may recall, is defined as the natural rate at which individuals move away from their radical views, set at a low 20% of the radical stock per year. The reason for this value was based on the literature reviewed, that pointed to deradicalization being a rare and difficult occurrence. However, we may imagine a policy aimed at increasing deradicalization over time, through outreach programs, monitoring of at-risk individuals and other such initiatives. To integrate a policy of this type into our system, we will insert our usual 2-year delay, after which we will increase deradicalization by 5% each year, stopping once we reach a deradicalization rate of 90%. We will compare these results against our digital contact removal policy and our baseline. The results are as follows:

Figure 34, Casualties with Deradicalization increasing Policy (Small Terror Group). Source: Silico.app, based on Authors' Own Elaboration



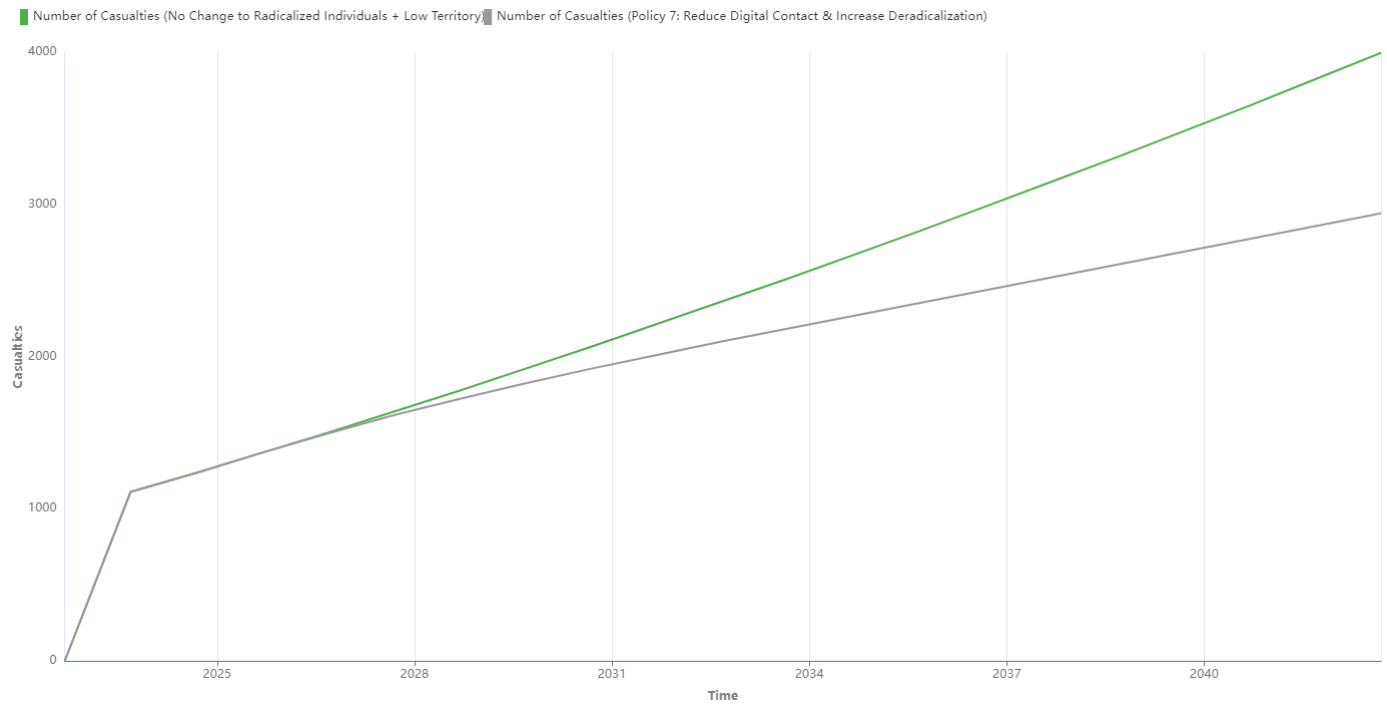
As we can see, the digital contact policy will be slightly more effective that the deradicalization policy initially, but near the end of the simulation the trend will invert. In total casualties will be reduced by 738, a number that is practically identical to our digital contact policy. However, the trend inversion that is seen as the end merits further investigation; we will extend our simulation by a further 20 years for this scenario, in order to determine whether the trend holds:

Figure 35, Policy Comparison (Small Terror Group). Source: Silico.app, based on Authors' Own Elaboration



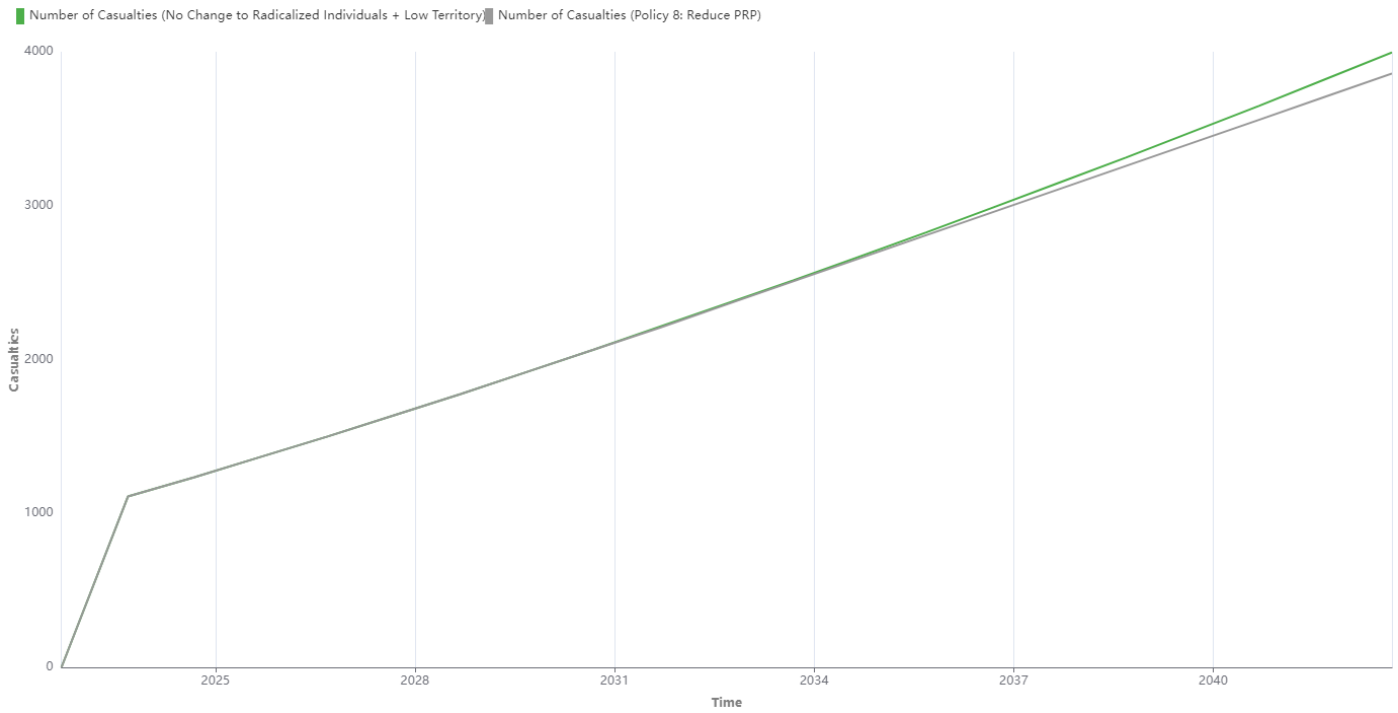
As we can see, increasing the simulation time does indeed confirm our initial intuition; in the long run, a deradicalization policy will be more effective than a policy that removes the digital propaganda capacity of terror groups. This mirrors our discovery regarding a lethality reduction policy versus a territory reduction policy made in the previous section. We once again have a situation in which a policy's effectiveness depends on the amount of time that has passed. As we did in that scenario, let us now imagine a policy that combines both actions:

Figure 36, Casualties with combined Policy (Small Terror Group). Source: Silico.app, based on Authors' Own Elaboration



As expected, this policy will outperform both its single components, reducing casualties by 1056 over the simulation period, and is as such our best option so far. The next area of investigation regards the effectiveness of acting further upstream in the simulation. Indeed, we do not need to act upon the direct influences of the radicalized individual stock, but may imagine policies that act in other areas, such as that of the cognitive opening rate. The issue with these policy plans, however, is that they will act upon a much larger population and will be less specific; indeed, we cannot reduce the rate of cognitive openings directly, as we have seen, but we may imagine policies that reduce the Possible Resentful Population. We will test an aggressive policy in this regard, that after a 2-year delay will seek to reduce the resentful population by 10% per year, stopping at a 50% reduction. A policy of this type is somewhat unrealistic, as we are essentially suggesting the reduction of poverty, low education and discrimination and racism by 50%; the purpose of this first policy is not to be realistic, however, but to determine whether such reforms could feasibly produce results. The results are as follows:

Figure 37, Casualties with PRP reduction Policy (Small Terror Group). Source: Silico.app, based on Authors' Own Elaboration



As can be seen, even an aggressive and unrealistic policy that aims at reducing the number of individuals that undergo a cognitive opening will produce limited results, reducing casualties by only 128 over the simulation period. As such it is not worthwhile to pursue any further investigation in this direction, as the effort required for policies of this type are not proportional to the return obtained.

With this we have concluded our investigation into small terror groups, and have found that the following three policies are best, listed in order of effectiveness:

1. Censor digital terror propaganda and implement deradicalization programs
2. Implement deradicalization programs
3. Censor digital terror propaganda

Of these, the first two will produce better results in the long run as compared to the third, however all three policies will succeed in reducing casualties by a notable amount. Policies that would seek to create more structural reforms that remove the conditions for radicalization produce very little return for the amount of effort, and as such are not recommended if the goal is to reduce casualties. Furthermore the lethality of lone wolves is very low, save for outliers, meaning that the improved attack response policy that seeks to reduce lethality would not produce worthwhile effects either. As such, the best way to combat lone wolves is to remove the material that radicalizes individuals while attempting to re-integrate radicals into the general population. The second element of this policy is the most complicated to implement, but is still feasible and will produce results; the first element on the other hand requires less “effort” and will produce effects in the short term, as such it is a good “next-best’ policy. With this we have concluded our investigations using our

model, and have produced a total of 6 proposed policies, dependent on the size of the terror group. We will now move to conclude and discuss our findings as a whole.

Conclusion

With our simulations concluded and our policy recommendation made, it is time to take stock of what we have learned and draw conclusions. We have utilized a breadth of literature and data regarding terrorism in the west in order to construct a model that may describe the issue in practical, numerical terms. The model was constructed using System Dynamics, a methodology that focuses on the mapping of complex systems into quantified models that may be analyzed. This model produced important findings, and it shall be argued that, going forward, System Dynamics is an important tool that will allow for counter terrorism strategy to become faster in its deployment and more efficient in its results.

First and foremost we have discovered that there is a clear supply and demand dynamic in terms of terror attacks; there is a supply of radicals and a demand for terrorists, both trained and lone wolves. There is a large asymmetry between the supply and demand, as the need for terrorists numbers in the tens, while the supply of radicals in the thousands. This asymmetry is worse when dealing with a large terror group, so much so that, if the group is large enough, they will have no issue in taking advantage of frustrated western populations. In this scenario, policies that seek to reduce this malcontent will not be able to compensate the asymmetry in the system, meaning that the best solution is a direct approach, either through targeting the terror group itself, or through improving the capacity to respond to attacks.

On the other hand, if the terror group is small and unable to take advantage of the stock of radicals directly, it will rely on lone wolf attacks; this type of attack has been the main one perpetrated against Europe in recent years, as highlighted by Europol, and consists in the independent action of a radical that is “egged on” by a terrorist group. To this end, to push for more lone wolf attacks a terror group will have to intensify its propaganda activity in order to push these individuals over the edge, allowing for them to attack the west without having to actually send any trained terrorists in. The key to making these kinds of attacks work lie in the necessity for the terror group to have a large audience; they need to be able to reach a large amount of people, in the hopes that at least 1 in 10000 is fragile enough that their message will push him or her to action. As such, lone wolf attacks are reliant on the internet and new communication technologies, and their rise is largely due to these technologies. However, lone wolf attacks are triggered on the “supply” side of the model, meaning they occur before the asymmetries inherent in the system are active; in other words, reducing radicalized individuals in this case will have a more noticeable effect on the casualties, meaning that policies that seek to limit radicalization or increase deradicalization will be far more effective.

What is interesting to note is that our findings match the observed reality. Aside from the "real-word" simulation conducted to prove our model as descriptive, we can observe that the model is able to match the historical evolution of terrorism in the west. Indeed, when groups such as Al-Qaeda and ISIS were at their peak in terms of size, the attacks perpetrated were carried out by trained operatives that produced large quantities of casualties. Consider as an example 9/11 for Al Qaeda, or the November 2015 Attacks for ISIS; both these attacks occurred at points of high territorial extension of the respective groups, were carried out by a relatively large number of operatives and produced catastrophic damage. On the other hand, as the groups have lost power, these types of attacks have phased out, and we have seen an increase in lone wolf strategies. This evolution is consistent with what our model predicts: large groups will output many trained operatives, small groups will be noticed through lone wolf attacks. At this point it may be argued that the system is not producing any worthwhile information; it reflects reality, and when the policies suggested were pursed in the past (such as the reduction of Al-Qaeda territory through the War on Terror) the results were positive. In this sense, it seems that the policy suggestions are redundant; this is not the case. What is important to the model and the policy recommendations is not that the outcomes are close to reality; what is important is why we observe these reality matching outcomes. Indeed, we can deduce that lower territory will equal less attacks, but our model can tell us why this happens, due to the decrease in the preparation capacity of the terror group. We can observe how easy it was for terror groups to recruit western citizens to their cause, but the model can tell us why this occurred, due to the fundamental asymmetry between supply and demand. We can observe how lone wolf attacks increased, but the model will tell us why this happened, thanks to the digital propaganda made through new communication avenues of terror groups that have seen their preparation capacity gutted. As such, the policy suggestions are not born out of mere historical study; they are made through the thorough examination of history to construct a model that is able to place what we know in a new light, telling us exactly how terrorism "ticks" and how our interventions will affect the issue.

However, the contribution of our model is not limited to these policy suggestions; due to how it is constructed, it may be used as a predictive tool as well, allowing us to anticipate how many casualties we may expect. We are able to do this thanks to the way the model functions; given that all its values are interconnected, a change in one value may precede a change in another. As such if we are able to observe that one element of the system is on an upwards trend, we are able to predict how the rest of the system will react. Through the identification of these "locations" in the model, we are able to insert a collection of indicators and warnings that are able to signal to us when a change in the system is about to occur before it happens. A few practical examples will help understand what is meant: in our system the digital propaganda activity of a terror group is connected to their ambition; if they wish to increase casualties they will intensify their online efforts. As such, if we observe a heighted online activity of a terror group it may be understood as a warning bell that said group raised their level of ambition, meaning we may expect an intensification in their activity. As another example, if we notice that many citizens are being recruited by a terror group we can deduce that their recruitment capacity is high;

it follows then, that they have a large enough amount of territory to sustain this capacity, meaning their preparation capacity is high and we may expect more trained terrorist attacks. If we observe the controlled territory of a terror group to be low, we may expect more lone wolf attacks; vice-versa, if we observe an increase in lone wolf attacks we can deduce that our stock of radicals is very large and/or a terror group is carrying out intense propaganda activity. These are just some of the ways the system may be used as a predictive tool, allowing us to anticipate changes in our expected casualties before they happen. If the model is used in this way, this anticipatory quality may be used to implement counter policy before we even observe any change, allowing us to be more effective by sidestepping the usual delay between observing an outcome and planning a strategy.

It is clear how such a tool can be useful to our stated goal of creating policies that aim to reduce the casualties caused by terrorism, and it must be recalled that the model used in the present thesis is still somewhat limited in scope. If the findings here are expanded upon, more data is collected, and the model is expanded its "power" will increase, allowing for more accurate predictions and thus more accurate policy proposals. In this sense the present thesis has provided a taste of what contributions a systemic approach to terrorism may make; further evolution of the model created and the creation of new ones, focusing on specific aspects of the issue will allow for counter terrorism policy to become more efficient, quicker to design, and more focused on key leverage points. As such, as the present thesis has argued, System Dynamics could become a great asset to counter terrorism studies and policy planning and going forward it should be further implemented and expanded upon in order to further leverage all the advantages that have been presented.

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Summary

The Present thesis seeks to propose policy solutions to the issue of terrorism in the west through the use of a Stock and Flow Model constructed using the System Dynamics methodology. It is structured in two sections, the first focusing on reviewing literature in order to gain an understanding of the issue at hand and the second on constructing and simulating a stock and flow model. Through these simulations, policy proposals may be made on the basis of which variations to the system produced the best results.

The first chapter focuses on analyzing two works regarding terror attacks: The Al-Qaeda Factor, by Mitchel Silber and the model for analyzing terror attacks developed by Alessandro Orsini, which focuses on ISIS rather than AL-Qaeda. Beginning with the Al-Qaeda factor, the book is analyzed while focusing on two key elements: the radicalization process of terrorists and their contact with Al-Qaeda. The analysis follows the division of the book, focusing on three types of attacks: Command and Control plots, which, as the name implies, are attacks that are characterized by the direct involvement of Al-Qaeda; "Suggested/ Endorsed" plots in which terrorists receive either a suggestion or an endorsement to carry out an attack in the west from members of Al Qaeda; "Inspired" Plots, in which Al Qaeda has no involvement in the attack itself, meaning no guidance is provided as to the targets or methods.

After the analysis of these attack types, the focus is shifted to Orsini's Model, which envisions three categories of attacks, based on the type of attacker: ISIS controlled cells, which are terrorists under the direct command and control of ISIS; Autonomous cells, which are terrorists that lack a connection to ISIS; Lone Wolves, that may be trained or untrained depending on whether or not they have received training from ISIS.

After this analysis, the two models are compared and an initial conclusion is drawn. It is highlighted how in both models the major descriptor behind the difference in damage caused by a terror attack is the degree of involvement a terror group has in the attack. The more involvement there is, the more damage is typically caused. It is noted that there are outliers to this rule, with some attacks with no ISIS or Al-Qaeda involvement causing a large amount of damage, however the general pattern holds. This will be an important element in the later construction of the Stock and Flow model.

The second chapter continues the literature analysis, this time shifting the focus away from attacks and toward the radicalization process that terrorists undergo. To this end, various different authors are considered, beginning with a radicalization model developed by Mitchel Silber and Arvin Bhatt. This model envisions radicalization as being divided into four steps: Pre-radicalization, which is the starting point from which the process begins, after a cognitive opening; Self-Identification, in which a cognitive opening (A trauma or significant event that opens an individual to the possibility of radical change) pushes a person to self-identify with a terrorist ideolog; Indoctrination, in which the individual is indoctrinated and recruited into a terror group through a "link man" from the terror group; Jihadization, in which the individual plans and prepares a terror attack. Of this model the elements that are highlighted are the concept of a cognitive opening, the importance of a terror ideology and the figure of the 'Link man".

The next model that is analyzed is the DRIA model, developed by Orsini. This model also bases itself upon four steps, from which the name is drawn through an acronym. The first step is the Disintegration of Social Identity, the starting point of the radicalization process, where an individual through some great event or trauma has his previous identity destroyed. This trauma leads to the "Cognitive Opening" that was explored in Silber and Bhatt's model. The second step is the Reconstruction of Social Identity, where individuals that come into contact with the Jihadi ideology may choose to use it as the basis for rebuilding themselves after the cognitive opening. The next step is the Integration in a Revolutionary Sect, where the now cognitively radicalized individuals will seek out likeminded people. Some will succeed in establishing contact with other radicalized individuals or with terrorist organizations and some will not. In the case of those that do not, they may still believe themselves to be a part of the organization through an imagined community. The final step is the Alienation from the surrounding world, during which the group into which an individual has integrated will forbid contact with the western world, which allows time for "traditional" morals to phase out and the radical ideology to fully mature. After the presentation of the model it is noted how the three elements found in the previous model reappear, namely the cognitive opening, terror ideology and terror group contact.

The final model analyzed is that of Quintan Wiktorowicz, which states that individuals become radicalized and join terror groups as a result of an intense resocialization that said groups enforce. The question is thus why individuals would approach these groups in the first place; the answer, according to Wiktorowicz, is to be found, once again, in a cognitive opening. It is further noted

how terror groups may induce a cognitive opening through the showcasing of shocking and violent material, a detail that will be used in the model.

The pattern of radicalization that emerges from the three models is that a cognitive opening will induce a terror ideology to take hold and radicalize. Combining this insight with that from the first chapter, the second half of the second chapter focuses on introducing System Dynamics and creatin an initial "combination" of it with what has been learned from the literature.

System Dynamics is a method or modeling technique used to frame and study complex systems. The basic procedure of system dynamics is divided into 6 steps, developed by the Founder of System Dynamics, Jay Forrester:

7. Describe the System: at this stage we describe the system in general terms;
8. Convert description to level and rate equations: at this stage the model must be quantified, meaning variables must be inserted and made measurable;
9. Simulate the model: at this point the quantified model is simulated and the results analyzed. If it is necessary, we may return to steps 1 and/or 2 to adjust the model;
10. Design alternative policies and structures: at this stage we "toy" with the system, injecting policies and changing variables in order to reach a desired outcome;
11. Educate and debate: at this stage one puts the findings "out in the open" and gathers feedback;
12. Implement changes in policies and structure: finally, if the findings are sound, concrete policies may be implemented.

It is noted how the final step is outside the scope of the present thesis, as such it will be excluded, however the first five are able to be followed. As such, the remainder of the chapter focuses on the first step, the general description of the system.

The model used is a stock and flow model, which is divided into stocks, defined as any entity that accumulates or depletes over time, and flows, which are defined as the rate of change of stocks. Using this model a first draft of the model is created, which has a stock of civilians, which flows into a stock of potential radicals, which then flows into a stock of radicals. From here the model splits between high and low impact terrorists, depending on the degree of contact with a terror group. From here there is a final split into successful and unsuccessful terrorists.

This basic model represents the end of the second chapter, with the third focusing on the refinement and completion of the model.

The first step is the removal of the distinction between high and low impact terrorists, postponing the nuance until a more refined solution is elaborated. The next step is the definition of a first draft of flows, that are as follows:

5. Cognitive Opening Rate: drawing from the radicalization theories seen in the second chapter, we can define the flow of Civilians into Potential Radicals as being determined by the rate of cognitive openings.
6. Radicalization Rate: once we are in the Potential Radical stock, the flow into the Radical stock is defined as the Radicalization Rate.
7. Recruitment Rate: the flow from the Radical stock into the Terrorist stock is defined as the Recruitment Rate. This measures the rate at which radicals are integrated into a Terror group, becoming official "Terrorists".
8. Success Rate: the flow from Terrorists to successful terrorist is measured by the rate of Successful Attacks carried out by Terrorists.

With the definition of a first draft of flows, the next step is understanding the primary variables that drive them. As all the construction up till this point, this step will lean heavily on the analyzed literature. Three primary variables are defined for the first three flows, while the final flow (and stock) are highlighted as needing further modification in order to regain the earlier abandoned nuance. These three variables are: Traumatic Events for the Cognitive Opening Rate; Ideology Contact for the Radicalization Rate; Terror Group Contact for the Recruitment Rate.

As such the model is ready to be fleshed out with quantifiable variables and a better construction of the final section; this process spans for the remainder of the third chapter. To proceed, each flow is analyzed and the primary variable is translated into a more "Systemic" set of variables that may be measured when inserting them into the modelling software.

Starting with the Cognitive Opening Rate, we will use variables that will examine the context of the area in focus (In our case Europe) in terms of how they will affect they likelihood a Cognitive Opening will occur in said area. The first Variable we will use is the number of people in poverty in Europe; the next variable we will include is the quantity of first and second-generation immigrants living in the EU; the final variable we can identify in the creation of our measure is related to education. We will measure the percentage of the studied population aged 20 to 64 that has obtained at most a lower secondary level of education. These combined variables will

indicate the likelihood that a portion of the population may undergo a cognitive opening, due to the heighted possibility of trauma in these groups. These variables are as such combined into the "Possible Resentful Population" (PRP) with the addition of an overlap correction, and use it to better define the Cognitive Opening Rate.

The next rate which is considered is the Radicalization Rate; in this case the variables will flow into what we will call the "Digital Contact", so named due to the nature of variables inside it; these are variables that increase the likelihood an individual may encounter a radical ideology in the digital sphere, a major area where "modern" radicalization occurs. The first variable we will consider comes from the activities of the "Al Hayat Media Center", which is a media wing of ISIS focused on creating publications that target a Western audience. The journals published by this group are typically only accessible through the dark web, leading to another enhancing factor besides the number of publications made. In this case we will also consider the share of the population that has used specific software to access the dark web. Exiting the Deep Web, but remaining online, we have the amount of pro ISIS twitter accounts that exist and the amount of Terrorist Propaganda that has been removed from Facebook. Having considered the influences on radicalization that are in the digital sphere, we consider those in the physical one, these being the number of Mosques in the area of study and the number of prisoners. All these digital and non-digital variables help measure the likelihood of contact with a terror ideology.

Next the Recruitment rate is examined, which is constrained by the Recruitment Capacity (RC). The Recruitment Capacity is not the same as the Recruitment Rate; while the latter measures the rate at which individuals that are radicalized become recruited terrorists, the former represents the maximum rate that the terror organization can support. The other variables that would influence the recruitment rate we have already discussed, as they are the same Factors that affected the radicalization rate (Number of Prisoners, Dark Web users, Terrorists' social media, etc.). Indeed, those factors increased not only the chance of contact with a terror ideology, but also of contact with a terror group itself. As such, the influence on the recruitment rate is already "internalized" in the system by the effect on the Radicalization Rate.

Next the final part of the model is refined through the definition of the Preparation Rate and Combat Force, which replace the final flow and stock respectively. The Preparation rate measures the rate at which a terrorist organization can train, equip and direct its recruited terrorists. Once this process is complete, the recruited terrorists will become part of the terror

group's Combat Force (CF), meaning the number of terrorists that are able to carry out highly lethal attacks. The Preparation Rate is once again System driven, meaning that it will be defined on the basis of other variables, as we will see when analyzing the completed model. Once again, however, the Preparation Rate is constrained by a Preparation Capacity, that like the Recruitment Capacity before it, limits the rate based on the maximum that can be achieved. However, the preparation rate is not the only flow that draws out the recruited terrorists. There will be another flow, called the Attrition Rate, that measures the rate at which, for whatever reason, recruited terrorists are not trained and carry out an attack.

After this the final skeleton of the model is ready, and the final adjustments are made. First the Number of Casualties stock is introduced. Said stock is filled by a flow defined as the Rate of Casualties; this rate will be defined on the basis of a new outflow from our CF Stock, defined as the Attackers Rate, or rather the number of CF that will carry out an attack per year. This rate will be combined with a new variable, called "Lethality" which measures, on average, how many casualties one trained terrorist can produce. Next, we reintroduce lone wolves and autonomous cells through the use of a Lone Wolves stock, fed from our stock of Radicalized individuals through a flow called "Self-Preparation rate". This rate is defined as a small portion of the Radicalized Individuals stock, and measures the rate at which individuals who have self-recruited will arm themselves for an attack. From the lone wolf stock, we will have an outflow of "Inspired Attackers", which will measure the rate at which lone wolves will carry out attacks every year. This flow will affect our Rate of Casualties, together with a new variable called "Non-prepared Lethality" which measures the casualties that lone wolves are able to produce on average. Next, to account for induced cognitive openings, we will allow for our radicalization rate to grow as the number of casualties grow, signifying that the more success the group has, the better their capacity to influence and radicalize vulnerable individuals. After this two new outflows for our At-Risk and Radicalized stock are introduced, which will measure the rate at which individuals in these stocks "Recover" and return to the general population. At this point, before continuing, it is noted how a structure has emerged from the model. The model can be divided into two parts, based on whether the individuals moving through the Stocks are being pushed or pulled. Indeed, the flows of Cognitive openings and Radicalization are "push" flows, in the sense that individuals pass through them due to the system. If, for example, we ignored terrorism altogether, this first section of the model still holds; even without ISIS or any other terror group, individuals would experience traumas and possibly become radicals due to other influences. The second part of the

model, on the other hand, is made up of "pull" flows, as without terror groups it would no longer exist. Indeed, the recruitment rate and preparation rate hinge on there being a group that creates them; if, in our model, there were no ISIS then there would be no recruitment or training occurring. From this observation, a new variable is introduced, the terrorist's Level of Ambition (LoA), meaning the amount of casualties they would like to reach in a given time period. This LoA will create a minimum level of CF that is needed; as such the LoA will create a new variable to insert, the desired level of CF. However it is not just the Preparation rate that is influenced by the LoA, as if they wish to reach a certain level of CF they will need a certain number of recruits as well, meaning there will also be a Desired Level of Recruited Terrorists (RT). The desired level of RT will also include a variable called "Attrition Correction" which will counteract the Attrition Rate. Finally, the LoA will also influence and increase the digital propaganda activity of the terror group, measured through our "Facebook and Twitter" variables. The final element inserted into the model is a "Controlled Territory" variable, defined as the amount of territory a terror group (In our case ISIS) controls. As the controlled territory increases, so will the capacities of the terror group, allowing for them to sustain a higher level of ambition.

With all these additions the model is now complete, and as such the final chapter may begin, in which the model is transferred onto a modelling software and simulations are run in order to produce policy recommendations. The program used to simulate the model is known as "Silico", a web based program available online at the domain "Silico.app". The reasoning behind the selection of this program was twofold. Firstly, it was selected due to the clarity it provides; while there are other programs with more functionality, they may often result unintuitive unless one has a deep understanding of the platform. The second, and main, reason is that, due to the online nature of the program, the simulated model may be accessed by anyone who has the address; this means that there is full transparency regarding how the model is constructed. Before simulation, important assumptions and conditions of the model are clarified. First, we assume our general population stock to remain constant, given that we are not analyzing the possible inflows it may have (for example the birth rate). The second clarification regards the time measurement used: we run simulations over a period of 20 years, with each "tick" of our system representing 1 year. A "tick" of our system will allow the whole system to flow once, meaning that every 1 tick will cause all flows to activate and drain their respective stocks. This means every tick will represent a full run through of our model, and we will run the model 20 times; in other words we will observe how the model behaves year by year over a period of 20 simulated years. Next, we will

assume the level of ambition of the terrorists to remain constant, at 1000 casualties per year. Another assumption we will make is that all the attacks carried out by terrorists will succeed. As such, we are effectively creating a "worst case scenario" in all our simulations, as we are not taking into account the capacity of different security bodies to halt attacks once they have been planned. The numbers we will obtain may as such result exaggerated compared to reality, as not all attacks will be successful. Finally, we will input initial values into our stocks in order to assume that the system has already been operational.

After these clarifications, a first simulation is run in order to test the capacity of the model to describe historical reality. In order to do this we run a shorter simulation, spanning over 5 years in order to mimic the years 2014 to 2019, during which ISIS steadily lost its territory, going from 100000 square kilometers in 2014 to just 4000 in 2019. We will factor this change in territory into our model, and then check our results against the actual observed number of casualties over the time period. The result of the simulation is only 939 casualties above the historic value, which, when the assumptions of the model are considered, is within range. As such we are able to define the model as descriptive of reality, and therefore able to be predictive of the future.

After confirming the model's validity, baseline simulations against which to test policy intervention are run. The first baseline assumes a terror organization to have 100,000 square kilometers of territory under its control; the resulting casualties are 20850, following a steadily growing upwards trend. It is further noted that the trend of the radicalized individuals stock can be seen to follow a slight "S" curve, in which it slowly accelerates its growth before beginning to reach a plateau. This occurs because the number of casualties will increase our radicalization rate; as such, after the first few ticks of the simulation our casualties grow, causing the radicalization rate to grow and give the stock an S shape. Focusing instead on the recruitment rate, as can be seen, the two values are hardly comparable. The radicalized individuals will number in the tens of thousands, while the recruited individuals number in the tens As such, we can see a fundamental asymmetry between the needs of the terrorist group and the availability of radicalized individuals. This asymmetry is tested through another baseline simulation that completely removes the digital propaganda that increases radicalization and sets a deradicalization rate of 90%, greatly reducing the amount of radicals in the model. Through this simulation it is highlighted how even if the stock of radicalized individuals were to be dramatically reduced, the supply will still outweigh the demand. Furthermore, the total number of casualties will not deviate significantly from the base case, reaching a total of 19170, roughly

1000 less than the base scenario. This reduction is due to a change in the quantity of lone wolves attack per year, which drops considerably if the radicalized individual stock is drained. Finally, the importance of the size of a terror group is tested through a baseline in which the terror group has 1000 square kilometers of territory under its control, which causes the total number of casualties drops to 3966, a significant reduction. As such these baselines are used in order to begin testing policy interventions in two scenarios: one with a large terror group and one with a small terror group. In the case of a large terror group various policies are tested to varying degrees of success, such as reducing controlled territory, removing digital contact, or reducing lethality. These policies are tested in various scenarios, in combination and isolated in order to determine the most effective. The conclusion of this process sees three policies as being most worthwhile, ranked in descending order of effectiveness:

4. Reduce the controlled territory of the group while improving terror attack response capacity
5. Reduce the controlled territory of the group
6. Improve attack response capacity

These policies will all reduce the number of casualties, however the first two will also change the trend of casualties, allowing for more long-term effects. These policies have been employed in the past, both versus Al-Qaeda and ISIS, and have indeed been successful. The original contribution being made, however, is understanding why these policies are successful; it is one thing to see that something works, it is another to understand why. This point is further stressed in the conclusions.

Next, simulations are run in order to identify policies that reduce casualties in the scenario in which there is a small terror group, in this case with 1000 square kilometers of territory. Once again the same simulation procedure is followed, with some policies being re-tested in the new scenario to check for a change in results. Tested policies include the removal of digital contact, the increase of deradicalization, and the reduction of the Possible Resentful Population. After testing different variations and combinations of the policies the three most effective policies are identified as:

4. Censoring digital terror propaganda and implementing deradicalization programs
5. Implementing deradicalization programs
6. Censoring digital terror propaganda

In a similar pattern to the first scenario, the best policy is a combined one, with its components being the best performers among the tested policies. With the policy recommendations made, the thesis moves to its conclusion, in which all that has been learned is summed up and further considerations are made.

First and foremost it has been discovered that there is a clear supply and demand dynamic in terms of terror attacks; there is a supply of radicals and a demand for terrorists, both trained and lone wolves. There is a large asymmetry between the supply and demand, as the need for terrorists numbers in the tens, while the supply of radicals in the thousands. This asymmetry is worse when dealing with a large terror group, so much so that, if the group is large enough, they will have no issue in taking advantage of frustrated western populations. In this scenario, policies that seek to reduce this malcontent will not be able to compensate the asymmetry in the system, meaning that the best solution is a direct approach, either through targeting the terror group itself, or through improving the capacity to respond to attacks.

On the other hand, if the terror group is small and unable to take advantage of the stock of radicals directly, it will rely on lone wolf attacks. To this end, to push for more lone wolf attacks a terror group will have to intensify its propaganda activity in order to push these individuals over the edge, allowing for them to attack the west without having to actually send any trained terrorists in. The key to making these kinds of attacks work lie in the necessity for the terror group to have a large audience; they need to be able to reach a large amount of people, in the hopes that at least 1 in 10000 is fragile enough that their message will push him or her to action. However, lone wolf attacks are triggered on the "supply" side of the model, meaning they occur before the asymmetry inherent in the system are active; in other words, reducing radicalized individuals in this case will have a more noticeable effect on the casualties, meaning that policies that seek to limit radicalization or increase deradicalization will be far more effective.

Further, the importance of the ability of the model to describe mechanisms of the terrorism system is underlined. Indeed, we can deduce that lower territory will equal less attacks, but the model can tell us why this happens, due to the decrease in the preparation capacity of the terror group. We can observe how easy it was for terror groups to recruit western citizens to their cause, but the model can tell us why this occurred, due to the fundamental asymmetry between supply and demand. We can observe how lone wolve attacks increased, but the model will tell us why this happened, thanks to the digital propaganda made through new communication avenues of terror groups that have seen their preparation capacity gutted. As such, the policy suggestions

are not born out of mere historical study; they are made through the thorough examination of history to construct a model that is able to place what we know in a new light, telling us exactly how terrorism "ticks" and how our interventions will affect the issue.

The contribution of our model is not limited to these policy suggestions; due to how it is constructed, it may be used as a predictive tool as well, allowing us to anticipate how many casualties we may expect. We are able to do this thanks to the way the model functions; given that all its values are interconnected, a change in one value may precede a change in another. As such if we are able to observe that one element of the system is on an upwards trend we are able to predict how the rest of the system will react.

It is clear how such a tool can be useful in creating policies that aim to reduce the casualties caused by terrorism, and it is recalled that the model used in the present thesis is still somewhat limited in scope. If the findings were to be expanded upon, more data collected, and the model expanded its "power" would increase, allowing for more accurate predictions and thus more accurate policy proposals. As such, it is argued that System Dynamics could become a great asset to counter terrorism studies and policy planning and should as such be further implemented and expanded upon in order to further leverage all the advantages that have been presented.