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USING GEOGRAPHIC INFORMATION SYSTEMS TO ANALYZE ACCESSIBILITY IN THE WEST BANK

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USING GEOGRAPHIC INFORMATION SYSTEMS TO ANALYZE ACCESSIBILITY IN THE WEST BANK

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Abstract

With the recent failure of another highly publicized peace negotiation, the Israeli-Palestinian conflict remains a polarizing and contentious geopolitical crisis. Following the Israeli victory in the Six Day War of 1967, the West Bank and its substantial Palestinian population have lived under Israeli occupation. In response to the First Palestinian Intifada (uprising), lasting from1987 to 1993, the Israeli military imposed varying degrees of regulations to limit Palestinian mobility within the West Bank. The mobility constraints, most notably in the form of checkpoints, roadblocks, and physical obstructions, dramatically increased in volume and scale during the Second Intifada from 2000 to 2005. With the completion of the Israeli-West Bank security barrier in 2006, the mobility restrictions within the West Bank remain severely impaired, contributing to economic stagnation. This study aims at assessing how the current policies resulting from the political response to the ongoing Israeli-Palestinian conflict impact the mobility and access of both the Palestinian and Israeli populations in the West Bank. The concept of accessibility was introduced as a mechanism from which to measure, evaluate and compare the effects of these mobility constraints implemented by the Israeli military. The Network Analyst extension of ArcMap 10.1 was utilized to simplify accessibility into a workable framework, enabling it to be interpreted and analyzed. Using spatial data collected from a variety of human rights organizations and international bodies, two separate network datasets were generated to simulate the transportation networks for the Palestinian and Israeli populations within the West Bank. The security barrier, roadblocks and roadgates were integrated into the network as barriers inhibiting access, as the

crossing of a checkpoint represented an impedance of 15 minutes. Once constructed, Service Area Analysis and Closest Facility Analysis were conducted for each network using the mobility conditions that represented a worst case scenario, the current situation and a best case scenario. The results concluded that the Israeli mobility restrictions are responsible for increasing inter-city travel between major Palestinian cities by nearly 65%. Despite being able to bypass the vast majority of Israeli imposed mobility constraints, the degree of accessibility afforded to Jewish settlers is comparable to that of the Palestinian population. However, this is primarily due to geographic isolation away from major activity centers within Israel.

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I. Introduction

"I am convinced that peace will come to Israel and its neighbors because the tens of millions of Arabs need peace just as much as we do. An Arab mother who loses a son in battle weeps as bitterly as any Israeli mother." Golda Meir, 1969 (MSU Denver 2013).

Since its inception in1948, the state of Israel has remained a perpetually divisive geopolitical subject that continues to divide international opinion and contribute to an extensive array of implications throughout the Middle East. The story of Israel is a tale of extremes: at one end displaying the most admirable aspects of human nature, and at the other highlighting the most deplorable. To some, the story of Israel evokes strong feelings of hope, optimism, courage, and faith. To others, it arouses feelings of hatred, violence, remorse and shame. Placed in an unstable region at the crossroads of three major world religions, the land of Israel is shaped by its complex history where millennia of strife and conflict continue to unfold.

The Israeli-Palestinian conflict is an intense and polarizing crisis that remains a staple of Western media. European and American news outlets are quick to report the latest suicide bombing, United Nations ruling or Israeli reprisal attack. If death and controversy occur, the world will hear about it and debate which side is right or wrong. A succession of American presidents has persistently promoted highly publicized negotiations between Israeli and Palestinian political officials, promising that each particular round of talks will yield a peaceful resolution to the conflict. In spite of all this

political discussion and media attention, the conflict remains unresolved and continues to affect the everyday lives of ordinary Israelis and Palestinians. The world will never know how the conflict impacts an Israeli teenager girl, who is forced to leave her home and family, shipped off to a military training camp in the desert as soon as she graduates high school. Likewise, the world will never feel the plight of a Palestinian farmer, cut off from his ancestral lands by an Israeli-built wall, forced to wait hours every morning and evening at a crowded checkpoint to simply tend his crops.

The western world falsely perceives this conflict in terms of explosions and body counts, not by how it impacts the lives of ordinary people. Through this thesis, I aim to present the Israeli-Palestinian conflict on a personal level, studying how the political response to the conflict impacts the daily cycles of life experienced by people on both sides. Specifically, I focus on how transportation issues impact life in the West Bank. I relate the Palestinian-Israeli conflict to elements of transportation planning by introducing the concept of accessibility, and show how accessibility is impacted by the conditions of the West Bank's transportation network, including how this is affected by Israeli security restrictions. Quantifying the broad notion of accessibility into a workable framework that enables it to be readily network interpreted, analyzed and compared in the context of the security situation and travel restrictions in the West Bank is the central objective of this study.

The following literature review will provide background information regarding the origin of the conflict, pertinent historical events, recent developments and the current state of affairs. Further sections will convey the political and economic nature

surrounding this conflict, establishing a platform from which to frame the research questions and objectives this study will cover. Lastly, academic concepts and analysis techniques that can be used to quantify the geopolitical aspects of the conflict will be explained and discussed in order to develop a mechanism that can be utilized to answer the research questions. Due to the polarizing nature and deep-seated emotions attached to the Israeli-Palestinian conflict, this thesis aims to avoid bias or any politicized commentary. However, touching on certain volatile and hotly debated issues is unavoidable.

II. Literature Review

1. Background

The history of Israel is riddled with ethnic and religious upheaval, international conflicts and near perpetual bloodshed, all contributing to a deep-seeded hatred between divided groups. In the aftermath of World War I (1914-1918), the triumphant Western Allies partitioned the vast Middle Eastern lands previously held by the defeated Ottoman Empire. The area which now constitutes the modern state of Israel fell into British hands, administered as the Mandate of Palestine from the early 1920s until the conclusion of the Second World War in 1945. Britain relinquished control over the region in 1947, leaving the United Nations with the arduous task of orchestrating a peaceful transition to a sovereign state (Dolphin 2006). The United Nations presented a plan to partition Palestine on religious lines, bestowing the Jewish minority control over 58% of the former British mandate and Arab majority control over the remaining 42% of the land. In May of 1948 when the British Mandate officially ended, Jewish leaders immediately declared the establishment of the state of Israel within the confines of the UN partition. Arab nations reacted swiftly, as the Arab Palestinians and the nations of Lebanon, Jordan, Syria, Egypt, and Iraq moved to eradicate the

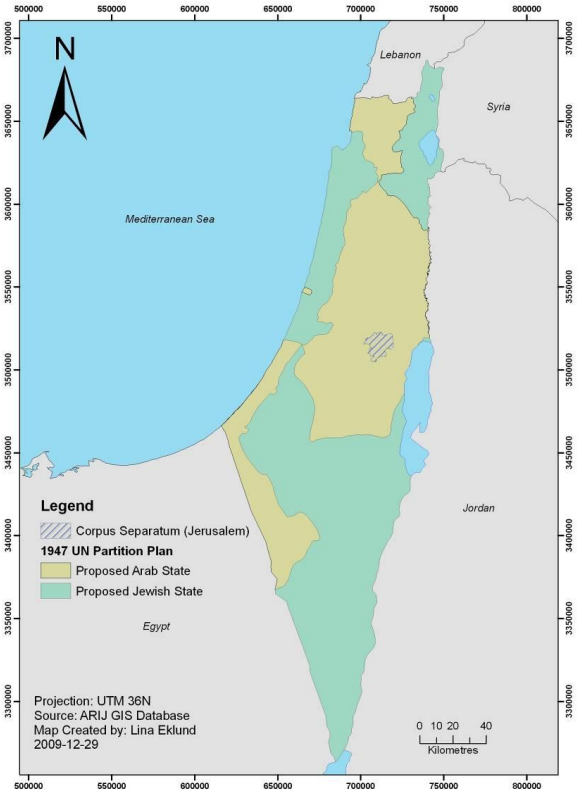


Figure 1: United Nations Partition Plan, 1947 (Eklund 2010)

newly created Jewish state (Dolphin 2006). Prevailing over seemingly overwhelming Arab forces, Israel successfully repelled the Arab onslaught, solidifying its sovereignty and international recognition. The Israel War of Independence (or, as Palestinians put it, "The Catastrophe,") resulted in the flight or expulsion of (the question is hotly debated) of nearly 80% of the Palestinian population from inside the Israeli borders (Dolphin 2006). The Arab Palestinians failed to defeat the Jewish minority. At the conclusion of the war in 1948, the United Nations officially recognized the sovereignty of the Jewish state in Palestine.

Over the course of the following 25 years, Israel emerged victorious in three wars, against several alliances of Arab states. The pivotal Six Day War of 1967 witnessed the Israeli army thoroughly defeat a military alliance of Egypt, Jordan and Syria. In the aftermath of the Israeli victory, the previously-Arab held Arab enclaves of the West Bank, Gaza Strip, East Jerusalem, and the Golan Heights have remained under Israeli occupation since the conclusion of the war (Dolphin 2006). Citing the need to protect its own citizens, Israeli forces have instituted policies to limit the movement of Palestinians within the Occupied Territories and into Israel since the Six Day War. These policies have become increasingly more stringent through the four decades of occupation, shaped considerably by the onset of two Palestinians uprisings, widely referred to the as the First and Second Intifada. The cycle of violence between Israel and Palestine reached an apogee with the onset of the First Intifada, lasting from 1987 to 1993. Seeking ways to prevent Palestinian militants from entering into Israel, the Israeli Security Forces (ISF) tightened its grip over the Palestinian territories, completely sealing off the West Bank and Gaza Strip from the Israeli border (Dolphin 2006). Within the Occupied Territories, Israel Security Forces first employed a series of checkpoints and roadblocks at major crossing points, funneling the flow of Palestinian travelers into regulated corridors where they could be easily searched. The checkpoints may have proven to be effective in curtailing the violence against Israeli citizens,

which dropped dramatically, though this may be the result of other factors like the adoption of nonviolence by the PLO. However, they greatly impeded the flow of Palestinian workers and commerce (Le More 2005).

To stem the violence of the First Intifada, Palestinian leader Yasser Arafat and Israeli Prime Minister Yitzhak Rabin met in Washington DC under the mediation of then-President Bill Clinton to hatch a peace agreement. In September of 1993, the talks yielded an agreement between the Palestinian and Israeli delegations, culminating in the signing of the Oslo Peace Accords, ending the violence of the First Intifada. The Oslo Accords divided the West Bank into three political entities: Area A, Area B and Area C. Comprising 17% of the West Bank, Area A is fully under Palestinian security and political authority with very little Israeli military interference. Palestinian authorities possess civil control over Area B, encompassing roughly 24% of the West Bank, with the Israeli Army operating to provide security. Constituting nearly 60% of the West Bank, Area C is under full Israeli authority, containing Jewish settlements, closed military zones and a highly regulated Palestinian transportation network. The Oslo Accords created lofty expectations on both sides of the conflict. Palestinians assumed that the Oslo agreements would spell an end to Israeli occupation, ushering in a new age of self-determination, greater freedoms, and, ultimately, a state of their own.

The Oslo Accords only quelled the hostilities for a short time. Palestinian hope for a new beginning quickly vanished as the peace agreements did little to curb Israeli dominance over their daily lives. Seven years after the signing of the Accords, Israel had retained control over nearly 60% of the West Bank, 20% of the Gaza Strip and all of East Jerusalem. Israel From 1993 to 2000, the amount of Israeli settlers increased nearly 117% in the Gaza Strip and 46% in the West Bank. The exchange of hostile rhetoric between the two sides only served to reinforce Israel's military (Eklund 2010). Ultimately, the changes promised under the Oslo Accords failed to materialize, leading many Palestinians to lose faith in the diplomatic process and resort to confrontation as a means to achieve their demands of self-government. By the turn of the twentieth century, the situation in the Occupied Territories had become increasingly volatile. The diplomatic process reached an impasse in 2000 as the two sides failed to find common ground during negotiations at Camp David. Shortly after the unsuccessful negotiations, the two sides

Source: **Origins and Evolution of the Arab-Zionist Conflict, Israel: A History, The Question of Palestine and Graphic News**

Figure 2: Map showing the progression of the political borders defining the State of Israel and Palestinian control areas between 1947 and the present day (The Independent Online).

engaged in a series of provocations which exposed their underlying resentment and the situation digressed to violence (More 2005).

3. Existing Conditions: Israel

"*Israel was not created in order to disappear – Israel will endure and flourish. It is the child of hope and home of the brave. It can neither be broken by adversity nor demoralized by success. It carries the shield of democracy and it honors the sword of freedom*". John F. Kennedy, 1960 (Jewish Virtual Library, 2013)

Through 60 years of perpetual violence, Israel has become a prosperous first world nation, boasting among the highest standard of living in the Middle East. Roughly three quarters of Israel's 8 million people are Jewish, with Arabs constituting the vast majority of the remaining 25% (The World Factbook). Israel is often cited as the most stable democracy in the region, and has been strongly supported since its inception by the United States. The nation also possesses a diversified and highly specialized economy excelling in fields such as electronics, communication technology, pharmaceuticals and medical equipment. The military is among the strongest and most influential institutions within Israel, maintaining a technological superiority over its Arab neighbors (Dolphin 2006). With a history of violence and its position within an unstable region surrounded by numerically superior enemies, the Israelis have become accustomed to living under a persistent threat of war. They have learned from the harsh lessons of history that they must always be prepared to fight for their nation's survival.

4. Existing Conditions: Palestine

In stark contrast to the economic prosperity of Israel, the Occupied Palestinian Territories continue to suffer from high levels of poverty and unemployment. Ever since the creation of Israel in 1948, the Palestinians have witnessed a land they used to call home systematically taken over by Israel military superiority. Once spread out across the modern state of Israel, the Palestinian people who are not Israeli citizens are now forced to inhabit two small enclaves. Through four decades of military occupation, the West Bank and Gaza strip have existed in a constant state of conflict between Palestinian militants and the ISF. The three and a half million Palestinian civilians always find themselves trapped within the violence, bearing the brunt of Israeli reprisals for militant attacks (Tawil-Souri 2011). Despite decades of international talks, the creation of a sovereign Palestinian state has yet to be realized, leaving the future of the Palestinian people in the hands of Israeli politicians and soldiers. In 2005 Israel dismantled all of settlements and ended its permanent military presence in the Gaza Strip, though the borders of the territory largely continue to be controlled by Israel. Moreover, the majority of the West Bank remains under Israeli occupation as settlements continue to be constructed on Palestinian territory (McIntyre, 2009).

5. Mechanisms of Control

5.1 Obstructions, Checkpoints and Roadblocks

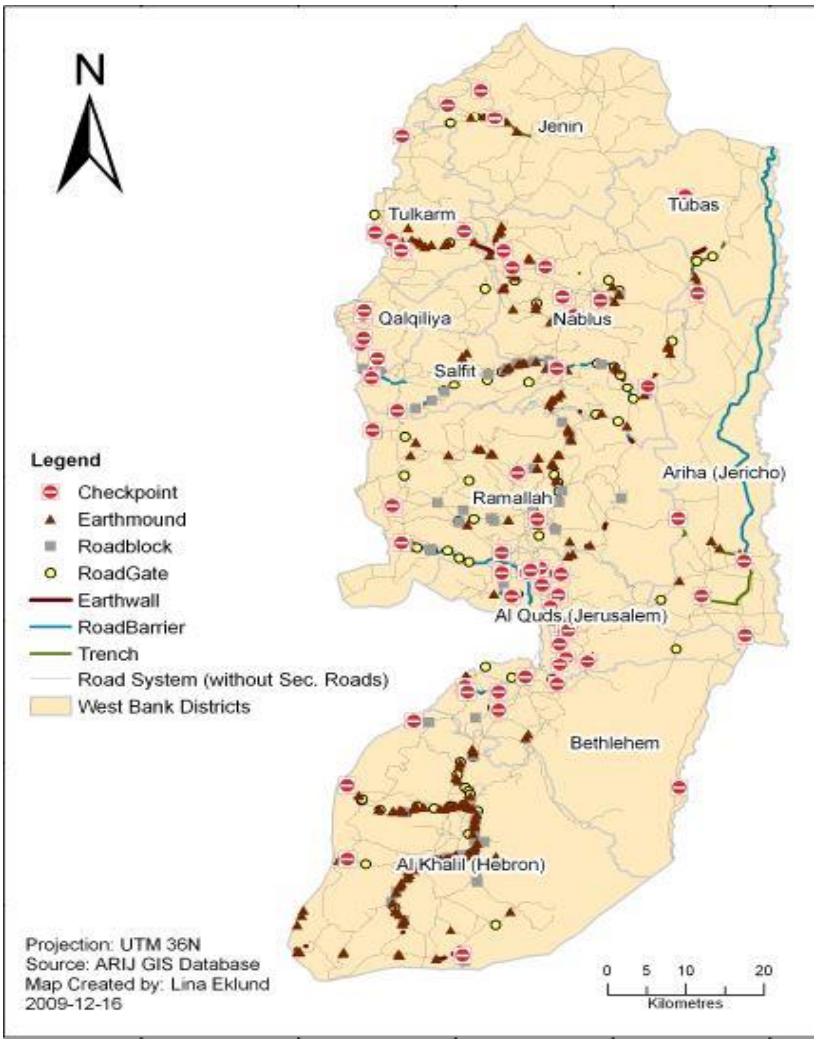


Figure 3: Israeli Obstructions in the West Bank (Eklund, 2010).

"Palestinian life is scattered, discontinuous, marked by the artificial and imposed arrangements of interrupted and confined space by the dislocation and unsynchronized rhythms of disturbed time" (Braverman 2011).

Mobility in the West Bank is restricted by Israeli measures designed to thwart terrorism. The ISF employs widespread physical obstructions strategically placed to limit Palestinian access to main roads, systematically channeling travelers to checkpoints (B'tselem 2007). Dirt mounds, concrete blocks, gates, trenches, and other physical impediments block vehicular access on Palestinian roads. The amount, type and severity of these obstructions vary, but they have slowly increased to include nearly 455

identifiable restrictions as of July 2007 (B'tselem 2007). In this study, the physical obstructions of any type are referred to as "roadblocks," since their function is to inhibit movement along certain Palestinian roadways. In addition to roadblocks, adjustable gates can be opened or closed at the ISF's discretion to permit or inhibit vehicular access along segments of Palestinian roadways. These adjustable entry points are identified as "roadgates."

In addition, since the beginning of the Israeli military occupation of the Palestinian territories in 1967, the ISF has utilized a system of staffed checkpoints to monitor and limit Palestinian movement. In early 2007, the ISF operated 80 checkpoints with 37 serving as the last inspection line before entry into Israel and the remaining checkpoints located inside the West Bank. Six of the checkpoints are designated to handle the movement of goods (B'tselem 2007). Forty-seven permanent checkpoints are located within the West Bank to regulate the internal movement of Palestinians. There is no standardized procedure to process people passing through the checkpoints. Typically, Palestinians are required to form a single-file line and are processed one at time by showing their identification card or crossing permit to an Israeli soldier or border guard employee. Only people who meet the requirements associated with each checkpoint are granted passage through it. Requirements for passage are not uniform across every checkpoint but vary in accordance with the locational importance and traffic volumes associated with each individual crossing point. For example, checkpoints positioned along the security barrier regulating the flow of Palestinian workers into Israeli are designated as the most important; therefore the passage requirements are the most

stringent. Checkpoints located along the rural peripheries of the West Bank which handle small volumes of travelers will possess minimal requirements for passage (B'tselem7 2007).

The severity of restrictions is difficult to quantify as it constantly fluctuates with the political climate surrounding the conflict and, furthermore, there is no comprehensive procedure utilized by the ISF for its checks. Recently the ISF began instituting what is referred to as "flying checkpoints" where army vehicles randomly set up a checkpoint between two permanent checkpoints and inspect all vehicles and pedestrians along the particular roadway (B'tselem 2007). In 2006, there was an average of nearly 136 flying checkpoints established per week, adding additional delay for Palestinian travelers who have already had to wait to be processed through permanent checkpoints. The unpredictability of the flying checkpoints further complicates internal trade within the West Bank while limiting access to vital goods and services. Palestinian workers must factor the additional delay a flying checkpoint may potentially have when commuting to and from places of employment. The B'tselem report also points out numerous cases of unprovoked ISF violence committed against Palestinians at checkpoints.

5.2 The Settlements

Following the Israeli triumph in the Six Day War of 1967, a succession of Israeli governments has allowed the establishment of Jewish civil communities within the Occupied Territories (Mcintyre, 2009). A hotly contested and highly controversial subject, the settlements continually receive condemnation from the international community and left-of-center Israelis. In spite of widespread disapproval, the

proliferation of Jewish settlements in the West Bank persists unabated, receiving political and military support from the Israeli government (Al Jazeera, 2013). The convergence of several facets of Israeli society encourages the settlements: proponents of the "Greater Israel" Zionist ideology seek to expand Israel to the Jordan River, military elements view the settlements as an opportunity to impede Palestinian movement and improve Israeli security, and politicians see the settlements as a land-grab technique that strengthens Israel's position in future peace talks (Mcintyre, 2009). The legality of the settlements is a speculative issue with no transparent answer, although there is almost unanimous agreement among the nations of the world that the all settlements are an illegal breach of international law. In accordance with the Oslo peace talks, the former settlements within the Gaza Strip are universally accepted as illegal, and have since been dismantled by the Israeli government in 2005. However, the settlements in the West Bank and East Jerusalem are classified as illegal under international law but are legitimized by the Israeli legal system (McIntyre, 2009).

Since the construction of the first Israeli settlement in July 1967, the number of Israelis inhabiting the West Bank has gradually increased to an estimated 500,000 people (Al Jazeera, 2013). The Oslo Accords failed to explicitly forbid the encroachment of Israeli settlers in the West Bank and the number of settlers has tripled in the two decades following the peace agreement (Al Jazeera, 2013). Despite serving as a significant roadblock to the peace process, the construction of settlements continues unabated as the current Israeli government under Prime Minister Benjamin Netanyahu encourages their construction.

5.3 The Permits

Since the outbreak of the First Intifada, the ISF has implemented a policy requiring all Palestinians to obtain a personal entry permit in order to gain entry into Israel from the Occupied Territories. These policies quickly progressed, becoming increasingly rigid even after the end of hostilities in the latter part of the 1990s. The advent of the twenty-first century coincided with the eruption of the Second Intifada, bringing even harsher restrictions against Palestinian movement (B'tselem 2007). Palestinians were confronted with a sophisticated scheme of permits required for accessing employment, visiting family members, picking up groceries, and traveling to mosques. The majority of permits allow a limited number of Palestinian laborers and merchants to gain access into Israel during daylight hours and to return to their homes in the Occupied Territories at night. There are limitations on the number of permits given to Palestinian vehicles based upon a checkpoint's capacity to inspect the vehicles, their passengers and the goods they carry (B'tselem 2007).

Lacking transparency or a clear procedure, the process of issuing of permits begins with a visit to a District Coordination Office (DCO) within the West Bank. These Palestinian DCOs will file a request for a permit with an Israeli DCO on behalf of a Palestinian resident. In accordance with the discretion of the Israeli DCO, a Palestinian may be given or denied their requested permits based on unspecified criteria. If rejected, there is little indication of the reasoning and a complete lack of a process for the Palestinian to launch a meaningful appeal (B'tselem 2007).

5.4 The Security Barrier

In June of 2002, the Israeli government began construction of a separation barrier between the West Bank and Israel with the intention of preventing terrorists from accessing Israel proper (Braverman 2010, p. 268). Stretching 723 kilometers, the barrier consists of electronic fences, barbed wire and trenches along either side, spreading out to an average width of 60 meters (B'tselem 2007). In many urban areas, the Israelis opted to constructed 8-meter high concrete walls. The barrier functions as an impassible physical obstruction separating the West Bank from Israel, directing the movement of people and goods to specific checkpoints (Braverman 2010). The barrier also encloses a large area extending between the Separation barrier and the Green Line (the pre-1967 border) that has become a fully closed military area manned by the ISF. Identified as the "Seam Zone" by the Israeli military, this enclave extends the entire length of the Separation barrier and is accessible to Israeli citizens and permitted foreigners but all Palestinians are prohibited from entering (B'tselem 2007).

Figure 4: Example of the separation barrier (BBC News, 2003).

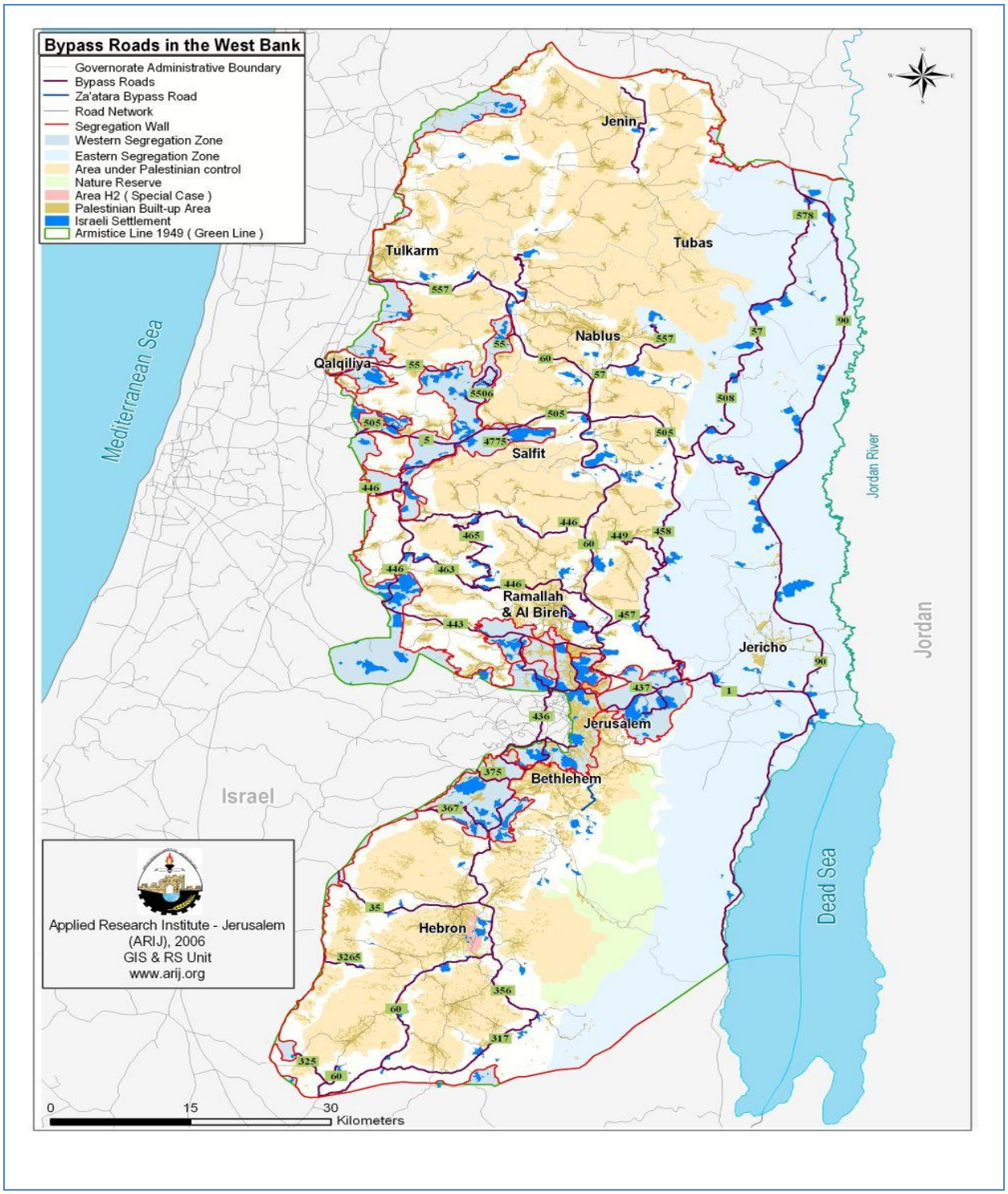
The official purpose of the barrier is to inhibit the entry of Palestinian militants looking to commit violent acts against Israeli citizens, and ultimately prevent the breakout of a wider conflict (B'tselem 2007). Yet the route of the barrier has been a hotly contested subject, with some suggesting possible ulterior motives for the building of the barrier. The barrier separates the large majority of Jewish settlements from the Palestinian population while establishing territorial contiguity between these settlements

and Israel (B'tselem 17). A mere 20% of the barrier lies along the Green Line, as the vast majority of route snakes through the West Bank, penetrating as much as 22 kilometers into Palestinian territory (B'Tselem 2006).

Figure 5: The current political situation in the West Bank, highlighting Israeli Settlements (National Borders Identities Conflict)

While providing linkage between Israel proper and the Israeli settlements, the barrier separates Palestinians from their families, communities, farmland, places of employment, emergency services, and religious establishments. Critics of the wall classify it as an elaborate scheme, enabling Israel to permanently secure its hold on much of the West Bank and denying future generations of Palestinians access to critical natural resources and economic opportunity. In many instances, Palestinian communities are becoming systematically encircled by arrangements of Israeli settlement on one side and the barrier on another. The security barrier completed encirclement of the 43,000 Palestinian residents of Qalqiliyah, while providing space for the expansion of settlements and construction of Israeli-only roads (Sorkin 2005).

Figure 6: The separation of Israeli and Palestinian roadways in the West Bank (Applied Research Institute of Jerusalem, 2006)



5.5 Separation of Infrastructure

The Israeli military occupation essentially enforces a separation of infrastructure throughout the West Bank. Vehicles with Palestinian license plates are restricted to travel only on certain designated roadways that are regulated through the checkpoint system. Nearly 311 kilometers of roadway are designated for use only by Jewish settlers, Israeli citizens and ISF forces, who and are not subjected to routine checks (B'tselem 2009). The separate road network has reinforced Israeli power over many of the Jewish settlements within the West Bank, providing secure connectivity between the settlements and Israel. Bypassing the expansive arrangement of roadblocks and checkpoints, this Israeli-only transportation network enables direct and uninterrupted travel throughout the West Bank and Israel (B'tselem 2007).

6. Adverse Effects of Israeli Policies on Access

"Nothing is transparent… it is never clear who will pass and who will not… The reasons [for prohibiting Palestinian from passing] are so numerous and the use of them changes so much, that uncertainty becomes the ultimate system of control within the framework of the certainty of the occupation… Not only is the arbitrariness deliberate, the inefficiency of the system is built in too." Exert from a Machsomwatch and Physicians For Human Rights-Israel report (Tawil-Souri 2011)

The establishment of a sovereign Palestinian state has long been identified as an effective mechanism to achieve peace, gaining support from the international community

over the past decades (LeMore 2005). But in recent years the prospects of a Palestinian nation have dimmed, due primarily to the continuation of stringent Israel military occupation of the West Bank. With nearly 3.5 million Palestinians virtually trapped inside the Occupied Territories, LeMore contends that a full-fledge humanitarian crisis emerged throughout much of the Second Intifada (LeMore, 2005). The Palestinian economy has not recovered from its devastation during Second Intifada, as Israeli policies continue to inhibit the flow of Palestinian workers into Israel. The maze of internal checkpoints and the encroachment of the security barrier have destroyed the geographical contiguity of Palestine while connecting isolated Jewish settlements to Israel (LeMore, 2005).

With little control over its internal transportation network, external borders, airspace, and natural resources, Israel has severed every potential avenue of trade for the Palestinian areas of the West Bank (Le More, 2005). A transportation network that efficiently facilities the movement of goods and people between geographic locations is a fundamental necessity for encouraging and sustaining economic development. The quality of transportation within a nation serves as an accurate assessment to gauge its level of modernization. In addition, the transport sector functions as a chief source of gross domestic product. For example, the transport sector and its related activities accounted for a fifth of the GDP in the United States in 2005 (Atawi, 2008).

Transportation can be identified as an intermediate service, providing a means to an end (Gannon and Liu, 1997). It is impossible for a transportation network to solely instigate economic development and reduce poverty, yet transport functions in a vital

complementary role, establishing a fundamental framework that activates and harmonizes economic activity. Transportation increases economic efficiency, lowering the cost of moving goods, enabling businesses to lower their capital costs, which, in turn, diminish the prices consumers pay for goods and services. An efficient transportation network also contributes to a reduction in transport cost for individuals, improving the access populations have to economic opportunities. This is particularly important for low-income populations. The following text, taken from a Gannon and Lui (2007) publication that investigated the role transportation plays in alleviating poverty, explains the linkage between transportation and economic development:

> "Under competitive conditions, significant predicable consequences will result [from better transportation]. These include lower market prices for final products (both rural products and consumer products), spatial extension of the market (due to the transport-induced changes in production and consumption patterns), higher personal mobility, and stimulation of socio-economic activities. In general, this dynamic process can be expected to benefit all income groups in society in the form of real income effects and increased opportunity" (Gannon and Lui 2007).

The role transportation plays in stimulating economic growth is well established by both professionals and academics alike. Transportation networks expedite interaction between economic activities, serving to directly decrease the

cost of production by reducing the amount of capital required to accrue the raw materials, labor, energy, technology and knowledge necessary for production (Gannon and Lui 2007). Heightened efficiency allows for products to be shipped and delivered at a lower price, enabling regional and international trade to take place while allowing employment and production to benefit from scale economies. Gannon and Lui conclude that transportation investment is often an overlooked mechanism that plays an indirect yet crucial role in expanding employment opportunities to disadvantaged groups and reducing overall poverty rates.

As reflected in the findings of Gannon and Lui (2007), a transportation network improves the economic outlook of impoverished groups by increasing their access to opportunities, lowering the overall transport expenditure and reducing the costs of essential goods and services. The goal of any transportation network is to improve people's lives, enhancing their access to employment, family members, public services, commercial amenities, entertainment venues, etc. Investing in transportation improvements goes hand in hand with making social services successful by making them accessible to all people within the community, extending social justice for all members of society. Likewise, transportation systems increase the degree of access businesses have to raw material, labor, technology and other vital facets of production that are spatially distributed. Policies that limit access by increasing the cost and impedances associated with travel generate a myriad of adverse implications that detract from

the dynamic processes necessary for economic activity to take place (Gui and Luis 2007). The offsetting of these processes complicates production, presenting difficulties that must be overcome by more costly measures. As previously highlighted, limiting accessibility increases the capital costs incurred by businesses, which ultimately raising the prices consumers pay for goods and services.

The mobility restraints instituted by the ISF severely hamper the ability for the Palestinian transportation network to facilitate the efficient movement of people and goods, thereby eliminating a vital component of economic development. The positive economic impacts a functional transportation system could provide the West Bank are thwarted by these mobility constraints carried out by the ISF. The doubling of transportation costs in the West Bank since 2000 can be primarily attributed to the mobility restrictions and impedances that obstruct the movements of goods and raw materials between economic activities (Atawi 2007). Without an efficient transportation network, the capital costs of production and freight incurred by businesses skyrockets, forcing venders to increase the price consumers pay for goods and services. With a higher cost of living and economic stagnation, the West Banks's most impoverished groups are further marginalized.

Similar to their relationship with economic development, transportation networks also play a complementary role in facilitating the successful implementation of social services such as health care, education and community

development. Investment in social services is rationalized by creating a new class of human capital that can expand the tax base, which contributes to increasing the revenue taken in by national, regional or municipal government (Gui and Luis 2007). Providing education, training and services to impoverished groups enhances their skillset and economic value, increasing their likelihood of finding and sustaining employment, thereby earning a taxable income. However, this process cannot take place if these marginalized populations cannot access social services, educational facilities or employment centers. A functional transportation network can serve to connect these groups to social services that are vital to improve their economic, social and political position.

7. Framing the Research Question

"*Palestinian life is scattered, discontinuous, marked by artificially and imposed arrangements of interrupted or confined space by dislocations and unsynchronized rhythms of disturbed place"* (Tawil-Souri 2011).

Despite ongoing international efforts to create a sovereign nation, Palestine remains entrenched in state of internal turmoil, with a poverty rate of nearly 30%, unemployment levels nearing 25%, political infighting and persistent violence (Atawi 2008). The transportation policies carried out by Israel isolate Palestine, fragmenting its population and creating conditions that discourage outside investment. The development of an effective transportation system that facilitates the movement of people and goods

between the two nations is a critical factor in the long-term viability of a Palestinian state. An accessible and contiguous transportation network between the West Bank and Israel is a critical component to promote economic development within the future state of Palestine. Atawi believes without a doubt that the severe restriction of movement has been a primary cause for the deterioration of the Palestinian economy since the conclusion of the Second Intifada.

As previously discussed, the current restrictions placed on Palestinian movement by the ISF continue to cause economic turbulence within Palestine, adversely affecting the everyday lives of its people. With such limitations placed on the movement of goods and people, the economic opportunities available to Palestinians are severely limited. The stringency of Israeli policies has undermined the functionality of the transportation system within the West Bank, severing crucial connectivity that facilitates economic activity. Other aspects of life are affected as well. If a Palestinian desires access a major Palestinian city within the West Bank to find employment, they are forced to take an indirect route and wait in line at a checkpoint, limiting the time they can spend looking for a job, at the grocery store, visiting with family or partaking in religious activities.

While Jewish settlers and Israeli citizens are provided with an efficient method to reach desired destinations outside of their home surroundings, Palestinians must navigate a through a variety of barriers that dramatically increase their travel time and limit the destinations they can reach.

Accessibility is also a problem for many Jewish settlers. The accessibility of Jewish settlements is highly dependent upon their geographic position within the West

Bank. Larger settlements are generally close to Israel proper, near the security barrier and Green Line. However, many smaller settlements are located deep inside Palestinian territory. Although not impeded by the mobility constraints, Jewish settlers there must travel greater distances to activity centers and desirable destinations that lie beyond the security barrier in larger settlements or inside major Israeli cities. If a Jewish settler in an isolated settlement wishes to access a major city in order to find employment, the Israeli-only transportation network confronts him or her with minimal constraints, yet the geographic isolation of the settlement requires a lengthy travel time.

The uproar over current Israeli policies within the Occupied Territories is in large part a question of accessibility. The ability to reach a destination is an important feature of everyday life for all people and when this ability is limit or curtailed, it begins to diminish quality of life (Eklund and Martensson 2010). Hours spent waiting in line at a checkpoint are not only frustrating, but they begin to eat away at one's capacity to complete activities that are necessary for the function of daily life. Not possessing the ability to reach jobs, schools, family members, hospitals, etc. has detrimental effects on individuals, families and communities (Eklund and Martensson 2010). Unquestionably, accessibility is a vital necessity that enables society to function properly and economic activities to be undertaken. By taking away or severely limiting accessibility, Israeli policies have undermined the ability of Palestinian families, communities, businesses, religious institutions and government to function. For Israeli settlers, the need to live in remote locations like the Jordan Valley has also resulted in inaccessibility.

The objective of this study is to assess how the current policies resulting from the political response to the ongoing Israeli-Palestinian conflict are impacting the mobility and access of both the Palestinian and Israeli populations in the West Bank. Accessibility will be quantified using spatial modeling techniques and applications available in Geographic Information System (GIS) software. Data required for the analysis consists of pertinent socio-economic data for the population subsets, land use and transportation characteristics, and the spatial distribution of desirable destinations. Modeling software can incorporate the real-life dynamics that factor into travel decisions, replicating limitations, time constraints, distance considerations and transport modes. Once calculated, accessibility measurements can be applied to analyze how the travel limitations have impacted the current transportation system in the West Bank.

8. Defining Accessibility

Accessibility has been the subject of a vast array of definitions throughout the years, with no prevailing consensus on what it precisely means. As stated by Gould (1969) "accessibility is a slippery notion … one of those common terms which everyone uses until faced with the problem of defining and measuring it" (Makri and Folkesson, 1999). Although it is a term frequently used throughout transportation planning, accessibility remains a very vague subject that is difficult to quantity and measure. Vandebulcke, Steenbergen and Thomas (2009); Geurs and van Bee (2004); Borazacchielo and Koomen (2010); Paez, Scott and Morency (2012); Makri and

Folkesson (1999); and Miller and Wu (2000) all stress the lack of consensus regarding the definition, conceptualization, components and evaluation techniques of accessibility.

The popular work of Handy and Niemeier (1997) evaluates accessibility as being determined by the spatial distribution of potential destinations, the ease of reaching each destination, as well as the magnitude, quality and character of the activities found there (Vandenbulcke, Steenbergen and Thomas 2009 et al pg. 3). For the purposes of this paper, the work of Liu and Zhou (2002) provides the most concise interpretation of accessibility, defining the term as "the relative ease by which locations of activities, such as work shopping and health care can be reached from a given location." Despite being the subject of a diverse set of definitions, academic publications agree that accessibility depends on the linkage between transportation and land use, encompassing spatial distribution of desired destinations and characteristics of the individuals. Accessibility serves as a barometer to measure the efficiency and effectiveness of transportation system, while shaping transportation and land use planning (Liu and Zhou 2002)

In order to simplify the broad concept of accessibility into a workable framework, the term can be understood by three questions: "who/ where", "what" and "how." Who or where summarizes accessibility as an extension of people and places. "What" refers to the opportunities available at a location that satisfy the needs or desires of the traveler, such as employment opportunities, commercial land uses, etc. "How" summarizes the factors that must be overcome in order to reach a desired locale. These factors can include distance, travel time, cost or other dynamics that might inhibit or deter access (Halden, Jones and Wixey 2003).

9. Components of Accessibility

Geurs and van Bee (2004) derived four components of accessibility that best relate to the question this thesis is attempting to answer. These components include land use, transportation, temporal factors and individual factors. The land use component takes into account "the amount, quality and spatial distribution of opportunities supplied at each destination" as well as demand for these opportunities (Geurs and van Bee 2004). The transportation component depicts the transportation system by measuring the disutility taken on by an individual in traveling between an origin and destination depending upon their travel mode. This component takes into consideration the amount of time spent, monetary cost, and effort undertaken by the individual. The temporal component is replication of the time constraints impeding travel, including the times an individual is able to make the trip as well as the availability and conditions of travel at certain times of the day (Geurs and van Bee 2004). Lastly, the individual component assesses certain financial, physical, mental and situational attributes of the individual traveling. These characteristics influence the abilities, needs and opportunities of a person to complete the journey to a desired destination (Geurs and van Bee 2004).

The components of accessibility presented by Geurs and van Bee (2004) can be synthesized to accurately depict the mobility constraints confronting Palestinians and Jewish settlers within the West Bank. Land uses most demanded by Palestinians include commercial and industrial space; economic centers; schools; religious sites; health care locations; agricultural lands; natural resources (primarily water); entertainment venues;

recreational amenities; and tourist sites (B'tselem 2007). Palestinian accessibility is highly dependent upon the availability, location and characteristics of infrastructure that is necessary to effectively facilitate movement from origin to destination. In addition, the amount of time and effort necessary to complete the journey will be greatly impacted by the location, waiting time, and capacity associated with checkpoints and roadblocks (Eklund 2010).

In complete contrast, transportation issues associated with Jewish settlers will not be complicated by the ISF security measures, as this group utilizes a largely separate transportation system. The accessibility of settlers will likely be determined by the safety of each route (occurrences of violence), mode type and distance from destination. The majority of settlements provide schools, minor health care facilities, recreational amenities and religious sites for their residents (Mcintyre 2009), meaning the potential destinations desired by Jewish settlers are not as extensive as the Palestinian populations. Yet, many settlements exist deep inside the West Bank surrounded by a substantial Palestinian majority, isolated from many facets of Israeli society and economic activity. Therefore, it is necessary for the Jewish population to travel significant distances to employment opportunities, commercial centers, entertainment opportunities, and cultural amenities found within the borders of Israel proper.

The immobility of Palestinians is greatest during peak commuting hours, when checkpoints become flooded with workers attempting to get to and from their places of employment (Eklund and Martensson 2011). This is likely the feature most influencing the temporal component of accessibility. Curfews imposed by the ISF will also limit the

time Palestinians are able to partake in their desired activities. The transportation system used by the Israeli settlers is likely to experience a limited amount of congestion during peak travel periods. In addition, their temporal constraints will likely be affected by the arrival of darkness due to safety concerns.

When applied to the Palestinian people, the individual components of accessibility will be tied to spatial distribution of desired destinations as well as availability of transportation modes. With soaring unemployment and high poverty levels, it can easily be determined the needs of Palestinians include employment, social services, food, clean water, etc. But individual opportunities and abilities will be difficult to quantity due to the limited amount of socio-economic data available. The individual accessibility of Jewish settlers in isolated settlements will be less limited by a lack of transportation opportunities. However, their point of origin within the West Bank is situated far away from the location of desired destinations, such as employment centers, hospitals and retail venues that are in Israel proper. This high degree of spatial distribution may serve to limit the individual accessibility of settlers.

10. Measurements of Accessibility

Before diving into the murky world of accessibility measurement, the proper type of accessibility must be decided upon. Accessibility can either measure individual accessibility or place accessibility (Makri and Folesson 1999).

Place or location accessibility measures take into account land use patterns and transportation systems. In accounting for land use patterns, place accessibility measures

the spatial distribution of destinations as well as the amount and attractiveness of activities found at these destinations. In accounting for transportation systems, place accessibility measures the barriers, such as cost and time, of reaching the destination (Makru and Folesson 1999). As a majority of past studies have approached accessibility from this perspective, place-based accessibility can be gauged by a variety of measurement techniques that have been applied to a diverse range of study areas and populations (Geurs and van Bee 2004). The major limitation of place based accessibility measurements is their inability to differentiate between varying degrees of individual access, assuming that all people within similar area or socioeconomic status share the same level of accessibility (Makri and Folesson 1999).

Individual or person based accessibility attempts to analyze accessibility on a personal level. Interpreting accessibility from an individual viewpoint, this measurement approach takes into account the constraints, needs, mobility and opportunities experienced by a single person within a study area (Geurs and van Wee 2004, p. 134). This type of measurement has the potential to be very useful in relating accessibility to real life social conditions. However, the evaluation techniques utilized to measure individual accessibility are extremely complex, highly theoretical, limited to small areas and require access to state-of-the art applications. Furthermore, the data requirements are very complex and require data that is difficult to find (Geurs and van Bee 2004, p. 136).

Due to the availability of data, flexibility, and relative simplicity, the analysis of Palestinian accessibility is best approached utilizing place-based measurements. In

addition, the lack of socio-economic data and lack of access to the most up-to-date modeling applications virtually eliminates the usage of individual-based measurements.

10.1 Place Based Location Measurements

There are four primary methods for measuring placed-based accessibility. These methods include distance measures, cumulative opportunity measures, gravity measures and utility measures (Vandenbulcke, Steenberghen and Thomas 2009; Geurs and van Bee 2004; Lui and Zhu 2004). The main components and operations of these four methods are summarized below.

10.2 Distance-based measurements

Classified as the simplest form of place-based accessibility, distance measurements measure the distance from a point of origin to the location of desirable destinations (Makri and Folkesson 1999). As the chief component of measurement, the distance can be described in a variety of ways, including average distance, weighted area distance or distance to the closest destinations. Weighted distance takes into account the desirability and opportunities placed on each destination (Makri and Folkesson 1999).

10.3 Cumulative-Opportunity Measurements

Cumulative-opportunity measurements are also referred to as "Opportunity-based measurements" in Lui and Zhu (2004). This type of measurement analyzes accessibility based upon the amount or configuration of opportunities and destinations reachable within a specified travel distance, time or cost from a point of origin. Opportunity based measurements are ideal to interpret the various destinations and opportunities available to people within a specific area (Makri and Folkesson 1999). In simple terms, this measurement technique is employed to locate the nearest opportunities and destinations from an origin and map their distances. More sophisticated analysis methods enable accessibility to be measured based upon the number or orientation of destinations and opportunities reachable within a specified distance, time or cost (Lui and Zhu 2004). These are then summed to give an overall measure of accessibility. The spatial distribution of places can be expressed through weighting the destinations and opportunities based upon the travel costs they incur. For example, destinations can be weighted by their proximity to an origin, with the weight of each feature lowered as they increase in distance from the origin (Makri and Folkesson 1999).

$$A_i = \begin{cases} \sum_j M_j, & \text{if } d_{ij} \leqslant L, \\ 0, & \text{if } d_{ij} > L, \end{cases}$$

Figure 7: Cumulative Opportunity Equation (Lui and Zhu 2004)

Potential drawbacks associated with the cumulative-opportunity method revolve around determining how to calibrate the cut-off travel distance or time. The cut-off area attempts to realistically determine the travel or time limitation an individual would not

overcome to reach a destination opportunity. Prior to calibrating the various destinations and opportunities into the model above, a particular distance, time or cost must be identified as the defining limitation, determining the parameters assigned to a particular variable in the cumulative-opportunity model (Lui and Zhu 2004). The accessibility measurement generated by the model is highly influenced by the cut-offs. Despite its importance, there is no preferred mechanism to accurately calculate cut-off values (Makri and Folkesson 1999).

10.4 Gravity Measurements

Gravity-based measurements of accessibility have the longest history of usage, and have been employed in a variety of applications dating back to the first attempts to quantify the vague concept of accessibility. In assessing spatial interaction, gravity models evaluate the likelihood of potential interaction between two locations. The prospects of interaction are positively influenced by the attractiveness of the destinations and negatively influenced by the barriers, restriction and cost associated with traveling between the two locations (Liu and Zhu 2004). The influence of phenomena varies inversely with the distance between them (Geurs and van Bee 2004). Gravity models are regularly employed to measure the possibility of interaction between socioeconomic groups at different activity centers and offer various avenues of interpretation in determining the influence a destination or socioeconomic group has compared to others. Most specifically to the objectives of this study, gravity models can be used to measure

$$A_i = \sum_j \frac{M_j \mathrm{f}(d_{ij})}{D_j},$$

Figure 8: Gravity Model Equation (Lui and Zhu 2004)

the accessibility of population groups in different locations relative to one another (Liu and Zhu 2004).

10.5 Utility Measurements

Derived from concepts of microeconomics, a utility-based method analyzes accessibility as a set of various transportation choices available made by a traveler (Geurs and van Bee 2004). From an economic perspective, utility refers to the amount of satisfaction or fulfillment an individual experience when they consume a good or service. When choosing a destination, an individual compares the amount of utility he or she can receive at location and will most likely choose to travel to the destination where utility can be maximized. Utility measurements in accessibility assign each possible destination a utility value that is formulated based upon certain attributes. These attributes may include the barriers to travel, socioeconomic data of individuals in a study area, amount of activities at each destination, etc. (Makri and Folkesson need date, p. 6). Accessibility is measured as a function of the likelihood an individual will choose to travel to a particular destination compared to all other choices.

$$A_p = \ln \sum_{q \in C_p} \exp u_{pq} ,$$

Figure 9: Utility Based Equation (Lui and Zhu 2004)

11. Comparison of Accessibility Measurements

Distance measurements are a standard procedure, incorporating basic concepts of land use and transportation planning, such as assessing opportunities available given maximum travel time. The processes it entails are relatively basic and are easily interpreted. Due to the simplicity of distance measurements, they fail to take into consideration how transportation and land-use characteristics impact accessibility (Geurs and van Bee 2004).

Gravity models possess a high degree of practicality as they can be computed using readily available land use and transportation data. With a long history of usage, there exists a vast myriad of past studies that have utilized gravity models in variety of capacities. Most appealingly, gravity models can be employed to gauge social and economic opportunities afforded to different socio-economic groups. Gravity models fail to take into account temporal factors (beyond distance) that may limit access to various destinations as well as excluding attributes of particular groups or individuals when considering their desire to access potential destinations (Geurs and van Bee 2004).

Utility-based measurements bridge the gap between place and individual accessibility, and are considered an effective mechanism to quantify social and economic contributors to accessibility. They can be calibrated various ways, taking into account the importance of socio-economic and temporal factors to find the most accurate simulation of the actual considerations groups or individuals contemplate when comparing destination (Makri and Folkesson 1999). Despite being the most potentially informative

analysis method, the data and technology required to formulate utility based measurements are much more advanced then distance and gravity measurements, and thus this method may not be feasible in many cases (Geurs and van Bee 2004).

11.1 Discussion of Limitations

Distance measurements are one-dimensional in their analysis. The simplicity and the transparent method by which they are evaluated are positive aspects of distance measurements, particularly considering the limited amount of socio-economic and transportation data available on the West Bank and Israel. However, they are one-dimensional in their analysis, failing to merge critical aspects of accessibility. Utility measurements would be ideal for this thesis, but there are considerable data and technology requirements that are simply not available. The complexities of a utility model cannot be incorporated in an ArcMap 10.2 application or transportation model. The analytics of gravity-based measurements are straightforward, integrated into AutoCAD traffic modeling capabilities, but the spatially referenced socio-economic data necessary to calibrate a gravity model is likewise not available. Gravity models are much wider in their scope then distance-measurements, amalgamating attributes of both transportation and land use in their synthesis. Unlike utility measurements, however, they fail to replicate the real-life decision-making process undertaken by people when determining their most desirable destinations.

12. GIS and Accessibility

The synthesis of accessibility measurements requires the integration of various socio-economic characteristics into a geographic framework using software that that possesses the computation abilities to calibrate large quantities of spatial data (Liu and Zhu, 2003). Researchers are increasingly utilizing the capabilities of Geographic Information Systems (GIS) to measure and analyze accessibility through a variety of methods (Delafontaine, Neutens and van de Weghe, 2011; Liu and Zhu, 2003; Luo and Wang, 2003; Eklund 2009, Eklund and Martensson, 2012; Eklund and El-Atash, 2012; Vadenblucke, Streenberghen and Thomas, 2009; Naude, de Jong and van Teeffelen, 1999; de Jong and Tillema, 2005; Makri and Folkesson, 1999). With the growing abundance of spatially referenced digital data published online, coupled by the bourgeoning analytical abilities available on geospatial software, GIS is quickly becoming an integral tool in quantifying accessibility through a variety of mechanisms (Luo and Wang, 2003).

GIS capabilities used to measure accessibility are provided through dedicated packages and extensions, compatible with the latest ArcGIS software developed by the Environment Systems Research Institute (ESRI). Placed-based accessibility techniques work the best with the ArcGIS interface, supporting simple distance-measurements as well as more complex mechanisms such as gravity models and utility-based measurements (Delafontaine, Neutens and van de Weghe, 2011). Individual-based measurements are the least amenable to the current ArcGIS software due to the intricacies of their calculation and substantial data requirement. Prior studies have

successfully calibrated individual-based measurements into ArcGIS software through the custom-design of tools developed through programming methods (Delafontaine, Neutens and van de Weghe, 2011).

13. Summary of Prior Studies

Previous studies have employed and adapted GIS capabilities to quantify accessibility through a diverse array of methods. Naude and de Jong (1999) developed a mechanism that integrated the FlowMap tool extension with the spatial modeling software AccessMap to measure the geographic accessibility between rural markets centers and villages along the Wild Cost of South Africa.

Dissatisfied with the capabilities of the Network Analyst extension, Liu and Zhou (2004) developed their own GIS tool, Accessibility Analyst, to overcome these deficiencies. The Accessibility Analyst tool allows users to tailor accessibility measurements to their own needs, enabling the selection of various measurement techniques as with specified parameters. Liu and Zhou performed a case study using Accessibility Analyst to examine the accessibility provided to residents by the Singapore MRT rapid transit system along highly populated corridors.

Similar to the methods utilized by Liu and Zhou (2004), Delafontaine, Neutens and van de Weghe (2011) developed the PrismMapper tool kit that can be embedded into ArcGIS software as a project template, affording users access to a variety of pre-programmed accessibility measurements. PrismMapper attempts to bridge the gap between individual-based and location-based measurements by introducing a simplified

interface that allows users to customize parameters, load necessary data and incorporate aspects of temporal constraint.

Luo and Wang (2003) examine spatial accessibility to health care facilities throughout the ten-county Chicago metropolitan area, comparing a gravity-based method to a costume-built spatial decomposition method. Each method was calibrated using separate modeling software prior to being incorporated into ArcGIS.

Using ArcGIS capabilities, de Jong and Tillema (2008) computed origin-destination distances using Delauney networks in Eindhoven, Netherlands and Dar es Salaam, Tanzania to enhance the accuracy of the digital road networks in each city. The enhanced roadmaps were then tested for accuracy using known distances and travel speeds between activity centers.

Vadenblucke, Streenberghen and Thomas (2009) measured accessibility in Belgium based upon travel times to urban centers, employment, airports and rail-stations, incorporating a variety of time, distance and activity constraints. The construction of OD matrices in Network Analyst provided the framework from which to calculate minimum travel times to certain activity centers during peak and off-peak hours. Various cluster analysis methods, including ascending hierarchical method, measured the degree of accessibility afforded to each Belgium commune.

Using the Network Analyst route analysis tool, Eklund and El-At rash (2012) determined the quickest route between Bethlehem and Ramallah in the West Bank, taking into account the travel speeds, the distribution of roadblocks, average wait time at checkpoints and the restrictions in place along Palestinian designated roadways. In

similar fashion, Eklund and Martensson (2012) used various Network Analyst functions service area analysis to determine the traveling times to health care facilities throughout the entire West Bank, while also utilizing the closest facility analysis tool to calculate distance and travel times to each hospital in all 668 West Bank communities.

14. Determining the Optimal Analysis Technique

In spite of the extensive literature that presents methods to quantify accessibility using ArcGIS software, there is a critical absence of a single preferred process. The analytical techniques selected in each study are highly influenced by the availability of geospatial technology, modeling software and, most critically, spatial data. Due to the limitations in both software and data, the most sophisticated measurement techniques cannot be undertaken in this project, eliminating the usage of individual-based measurements as well as complex modeling programs that operate independently from ArcGIS. The simplification of accessibility into a workable framework that establishes an effective mechanism that enables it to be readily interpreted and analyzed is a central issue confronting this study. Therefore, it is necessary to ascertain to the most applicable methods employed by previous studies. The following section highlights the analytical processes of prior publications that are most relatable to the aspirations of this study.

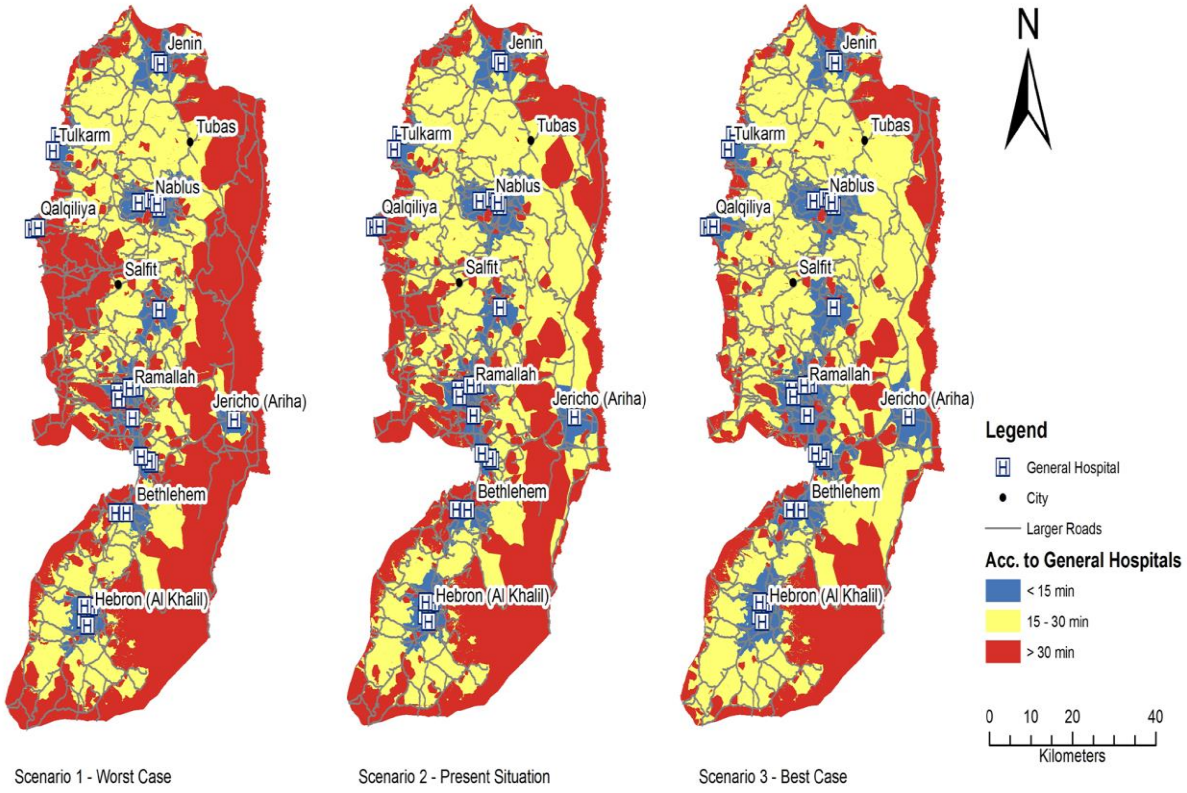
14.1 ArcGIS Network Analyst

Lina Eklund has been involved with three previous studies (Eklund and Martensson 2012; Eklund 2010; Eklund and El-Atash 2012) that directly examine how Israeli policies have influenced Palestinian accessibility within the West Bank. Each

study utilized the analytical capabilities in the Network Analyst extension of ArcGIS, while incorporating the same spatial data this study will be utilizing with very comparable research designs. Each study proposed and analyzed accessibility based upon three scenarios; the worst-case scenario, the present-day scenario and the best-case scenario. Eklund and Martensson (2012) and Eklund (2010) each studied access to health care facilities as Eklund and El-Atash (2012) assessed mobility conditions along the principal route connecting Bethlehem and Ramallah. Each of the studies was conducted on-site in the West Bank, enabling them to overcome data deficiencies by gathering information through in-situ methods, including interviews, surveys and first-hand exposure. Being on location offered an optimal scenario for the collaboration with various Arab Universities, non-profit agencies and advocacy groups as well as a number of Israeli government agencies. All three studies collected field data to record road speeds and conducted interviews to ascertain the temporal delays at major checkpoints along highly diverse corridors. Spatial data that geographically projected population characteristics, political boundaries, Israeli barriers (checkpoints, roadblocks, etc.), road networks and hospital locations were gathered from the Applied Research Institute in Jerusalem. Once a network database was developed in Network Analyst, the studies conducted their evaluation techniques.

Eklund and El-Atash (2012) used the route analysis tool in Network Analyst to determine the quickest path between the important population and economic centers of Bethlehem and Ramallah for each of the three scenarios outlined above. Once travel times for each scenario were ascertained, the synthesized routes were mapped and their time and distances were compared. Although lacking in sophistication, the capabilities of route analysis proved to be an effective tool in evaluating how the Israeli occupation has impacted the mobility of Palestinian populations. Although only employing a single

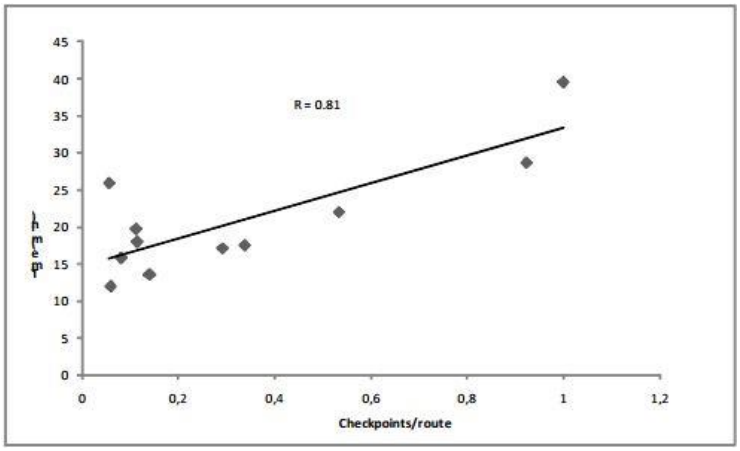
Figure 10: Resulting maps generated by the Service Area Analysis (Eklund, 2010)



mechanism to quantify accessibility, the route analyst tool proved to be very useful, producing easily discernible results that can be understood by individual possessing little to no prior knowledge of transportation planning.

Eklund and Martensson (2012) utilized the service area analysis and closest facility analysis processes in ArcGIS 9.2 version of Network Analyst. The service area analysis calculated travel times to each general hospital in the West Bank and the closest facility analysis calculated the travel times and distance separating all 668 Palestinian communities from the health care facilities. Each analysis technique produced discernible results that were interpreted and examined through the construction of maps and charts. Eklund and Martensson (2012) assigned accessibility values for major communities to examine and compare the variation in accessibility that exists throughout the West Bank. The amount of content relating to the discussion and interpretation of results is rather minimal as the study only encompasses seven pages including a reference section.

Figure 11: Sample scatter plot illustrating the correlation between the number of checkpoints per route with travel times (Eklund 2010).



Boasting over 100 pages of content, the Eklund (2010) study is a very extensive and in-depth accessibility study of the West Bank. In essence, Eklund (2010) is a synthesis of the Eklund and Martensson (2012), and Eklund and El-Atash (2012) studies that expands and intensifies the scope of analysis. Aside from using the route analysis, service area analysis and closest facility analysis processes, Eklund (2010) conducted various statistical tests to determine the relationship between multiple accessibility factors. For

each of the three scenarios, Eklund estimated the average travel time to health care facilities from each of the 11 Palestinian political divisions. Using these values, Eklund developed correlation plots, portraying the relationship between average travel time to hospitals and factors that include distance, the number of checkpoints per route, amount of barriers per route, and population density. Furthermore, due to the incorporation of defective terrain data acquired from the Applied Research Institute of Jerusalem, Eklund investigated the relationship between road speed and topology, conducting T-tests for each of the six road classes to determine how elevation influenced travel speed. The results were displayed on a correlation plot, proving that slope does not significantly impact travel speeds. Furthering her assessment, Eklund derived P-values using the sample T-tests results for the six road classes, proving that developed areas have a greater impact than slope on travel speeds.

14.2 The Prism Mapper Application

Despite the positive aspects of the three previous studies, the analytical processes they rely upon possess significant deficiencies. Introduced in 1998 by ESRI, the Network Analyst extension is the principal toolset available on ArcGIS to conduct transportation analysis. The analytical capabilities of Network Analyst are generally limited to distance-based accessibility measurements, although gravity and utility-based techniques can be integrated using independent modeling software (Delafontaine, Neutens and van de Weghe, 2011). Network Analyst features can compute the shortest pathway between two locations, maximum travel distance, nearest facilities and service areas. This toolkit is readily available, very user-friendly and requires only a modest amount of spatial data to

perform its processes. The analytical limitations of Network Analyst are well documented, as its procedures assume all locations and activities are directly positioned adjacent to the transportation network. It also fails to integrate crucial socio-economic features of a study area into its analysis while possessing no mechanism to measure the demand and desirability of locations (Liu and Zhu, 2004).

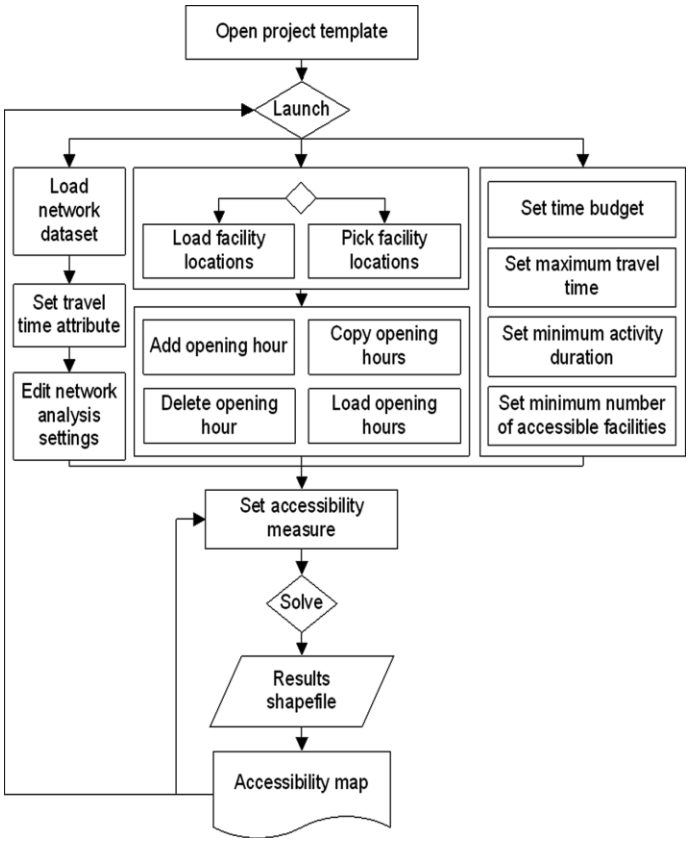


Figure 12: A flow map presenting the processes and capabilities of PrismMapper (Delafontaine, Neutens and van de Weghe, 2011).

The PrismMapper extension, introduced by Delafontaine, Neutens and van de Weghe (2011), is a very intriguing and potentially advantageous tool. Delafontaine, Neutens and van de Weghe (2011) present PrismMapper as a handy GIS toolkit for measuring and mapping accessibility, bridging the gap between placed-based and individual-based accessibility measurements. PrismMapper is designed to improve the accuracy of analysis through the incorporation of the temporal preferences that make individual-based measurements more realistic and practically applicable. Despite offering increased analytical capabilities, PrismMapper is designed to emulate the comprehensive and user-friendly aspects of place-based measurements. The toolkit is embedded into the ArcGIS desktop as a project template so it can be integrated to function with the existing tools in ArcMap. In addition to its GIS component, PrismMapper possesses a computational module (CM) that is coded to calculate and map various accessibility measurements. The input data requirements are modest and relatable to that of Network Analyst, requiring the development of a network dataset, a travel time attribute layer, the location of facilities, a time budget, maximum and minimum travel time and the selection of an accessibility measurement. Delafontaine, Neutens and van de Weghe (2011) provide a case study to illustrate the

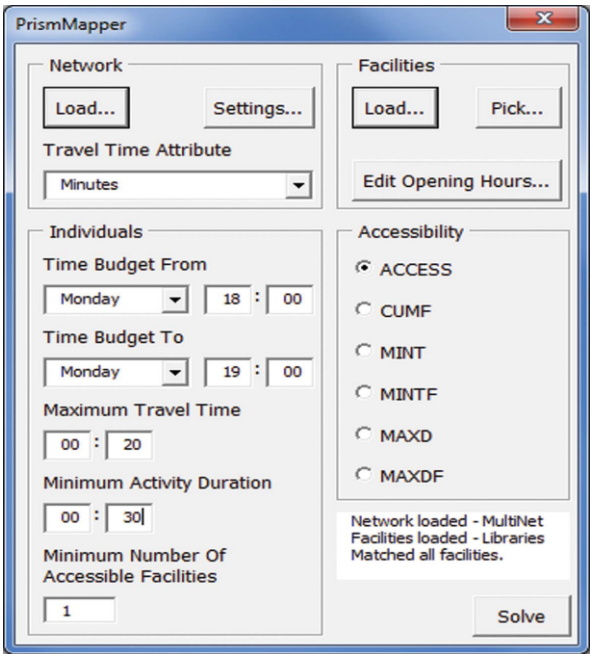
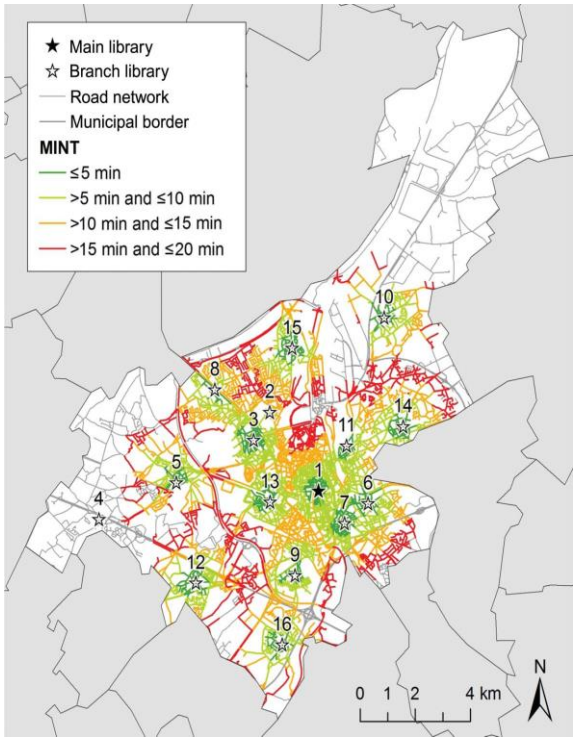


Figure 13: The PrismMapper interface (Delafontaine, Neutens and van de Weghe, 2011).

application of PrismMapper, measuring accessibility to public libraries in Ghent, Belgium. Once the necessary input data is loaded into the interface and the desired parameters are selected, the toolkit can automatically generate a variety of accessibility maps based upon alternative scenarios of impedance. In this particular case study, accessibility maps are produced to portray individual constraints, such as mobility resources (including cars, transit, and taxis), mobility resources and activity duration, as well as place-based constraints, including location and opening hours (Delafontaine, Neutens and van de Weghe, 2011).

Figure 14: Sample accessibility map measuring minimum travel time produced by PrismMapper.



From reviewing the work of Delafontaine, Neutens and van de Weghe (2011), PrismMapper is a very impressive tool that enables the utilization of several complex accessibility measurements in an extremely user-friendly interface. Surprisingly, the data requirements are not overly burdensome, and are feasible given the data and technology limitations confronting this study. The computational module is pre-programmed to contain model algorithms that produce accessibility measurements that include space-time paths, space-time prisms, reverse space-time prisms, minimum and maximum distance, minimum and maximum travel time. However,

many of the accessibility maps PrismMapper is capable of generating are difficult to interpret and serve little practical purpose beyond examining the variation in accessibility between group population groups. The capabilities of PrismMapper are ideal for measuring accessibility across the distribution of public schools in a first-world municipality, accounting for individual-based constraints such as opening and closing hours, time budgets and desired duration of activity. However, although impressive, the capabilities of PrismMapper will have difficulty quantifying the various constraints that limit Palestinian mobility in a functional and interpretable framework. PrismMapper does not contain a method to input crucial data pertaining to the impedances encountered by Palestinians, such as wait times at checkpoints, prohibited roadways, etc. Furthermore, obtaining the PrismMapper extension was problematic. Delafontaine, Neutens and van de Weghe (2011) provide a website where PrismMapper can be accessed but not downloaded.

Fahui Wang has published many studies over the past decades that utilize GIS technology to measure accessibility in a number of ways. I have cited this particular study (Luo and Wang, 2002) previously in the literature review, as it contains a variety of useful definitions, concepts and examples. The most appealing aspect of this study is that it uses a gravity model to measure accessibility to health care in the Chicago region, outlining the processes and explaining how each variable in the gravity function was assigned. The most difficult aspect of the gravity model is determining how to measure the travel-friction coefficient. Luo and Wang (2002) introduce an augmented gravity formula that was previously developed by Wang to evaluate job accessibility.

Unfortunately, the study does not go into explicit detail of how the gravity model was merged into an ArcMap interface, or display the step-by-step operations used to determine particular measurements. However, Luo and Wang are very explicit on how they came up with the travel-friction coefficient and the augmented gravity-model is an intriguing development in measuring accessibility to jobs.

III. Methodology

1. Introducing the Methods

1.1 Discussion of Data and Analytic Limitations

As previously expressed in the literature review, although accessibility is a widely used term throughout transportation planning, it remains a very vague subject that is difficult to define, quantify and measure. Past academic studies and journal publications are in agreement regarding the overall concept of accessibility, but the consensus stops at this point. The lack of transparency regarding the definition, components, evaluation techniques, and necessary data for evaluating accessibility is widely documented and emphasized. Simplifying accessibility into a workable framework that establishes an effective mechanism that enables it to be readily interpreted and analyzed is a central issue confronting this study.

With the absence of a single preferred process in prior studies, selecting the optimum measurement is highly dependent upon the availability of geospatial technology, modeling software and spatial data. Due to the limitations in both software

and data, the most complex and developed processes of accessibly measurements simply cannot be undertaken in this project. The four fundamental components of accessibility defined by Geurs and van Bee (2004) included land use, transportation, temporal and individual features. Obtaining the necessary data in the correct spatial format to satisfy each of these components is an extremely arduous endeavor that is dependent upon the cooperation of various Israeli and Palestinian governmental agencies. Due in part to the contentious and highly polarizing political issues surrounding this study, correspondence and collaboration with the necessary government institutions could not be done.

The four publications that measure accessibility in the Occupied Territories (Eklund and Martensson 2012; Eklund 2010; Eklund and El-Atash 2012; Aldwaik 2007), discussed in the literature review and cited in the reference section, had the luxury of conducting their research on-site in the West Bank and Israel. This enabled each to overcome the data deficiencies by gathering information through in-situ methods, including interviews, surveys and first-hand exposure. Being on-location offered an optimal scenario for the collaboration with various Arab universities, non-profit agencies and advocacy groups as well as a number of government agencies. These studies were also conducted under the supervision of known academics that possesses a keen familiarity with the language, culture and history of Israel and Palestine. Unfortunately, this study failed to enjoy any of these advantages, which diminished the potential extent and accuracy of the analysis.

1.2 Establishing a Framework

Through the development of a GIS-based accessibility model, this study aimed to assess how the current policies resulting from the political response to the ongoing Israeli-Palestinian conflict have impacted the mobility of the both the Palestinian and Israeli populations in the West Bank. The populations of Palestinian localities and Israeli settlements, various Israeli obstructions, the dual road networks, travel speeds, distances and other dynamics that impact mobility were integrated into a Geographic Information System (GIS) interface to model, evaluate and compare accessibility through a variety of mechanisms. Due to the limitations confronting this study, the analytical capabilities available in the Network Analyst extension of ArcMap 10.1 served as the optimum platform from which to assess the mobility conditions in the West Bank. Three prior studies (Eklund 2010; Eklund and Martensson 2012; Eklund and El-Atash 2012) successfully employed the capabilities of Network Analyst and other GIS processes to measure and evaluate Palestinian accessibility to healthcare facilities in the West Bank. This study employed a similar research design, but widened the scope of analysis to include centers of economic activity and connections between Palestinian cities and Jewish settlements. Furthermore, this study introduced a new dynamic by evaluating the accessibility of Jewish settlers in the West Bank. This provided an entirely new analytical perspective, allowing the highly restricted travel conditions endured by the Palestinians to be compared with the relatively unregulated mobility but spatial isolation experienced by many Jewish settlers.

Through the transportation modeling capabilities provided in Network Analyst, the study investigated and analyzed the following research questions:

- What is the difference between the experiences of Palestinian residents compared to that of Jewish settlers?
- What destinations (activity centers) can be reached within a set time frame from population centers?
- Which routes between major population centers afford the highest level of efficiency and least amount of cost?
- To what level is accessibility affected by the limitations and barriers to mobility implemented by the Israeli Security Forces and the fact that the Jewish and Arab populations in the territories do not interact?
- How would accessibility be impacted if these limitation and barriers did not exist?
- What factors impair the movement of Jewish settlers to and from activity centers within Israel?

To relate the research objectives and questions to the analytical processes, three scenarios were developed to compare accessibility in its current state with two extreme cases. Each accessibility analysis was calibrated in accordance with the three scenarios.

1. "Worst-Case" Scenario 1: the transportation network is completely closed and travel is virtually impossible. All checkpoints, roadblocks, road-gates, and crossing points are closed, making destinations inaccessible for Palestinians in the West Bank, while security concerns make travel too risky for the isolated pockets of Jewish settlers.

2. "Present-status" Scenario: the current mobility restrictions and impedances are applied. For the Palestinian situation, roadblocks and road-gates are closed as the appropriate delays at checkpoints are simulated. The mobility of Israeli settlers is limited by geographic isolation and the inability to access Palestinian population centers.
3. "Best Case" Scenario: travel conditions on the transportation network are at their most ideal, representing the absence of any roadblocks, checkpoints, and infrastructure separation. However, this situation is made more realistic by taking into account the divisions that still permeate through the West Bank despite the absence of military conflict. Therefore, Palestinians mobility is still restricted by the Security Barrier and Israeli settlers cannot access Palestinian activity centers despite their close proximity.

1.3 Data Collection

GIS data was collected primarily through sources and spatial data accessed through the Harvard Geospatial Library (HGL). The Harvard Geospatial Library is an extensive catalog and repository of spatial data that is compatible with Geographic Information Systems. The HGL Portal displays the GIS data in a web-based mapping environment where datasets and layers can be viewed, accessed and downloaded. The GIS datasets and layers provided by HGL come from a variety of sources, including national government agencies, international organizations, activist groups, and non-profit organizations. The GIS data used in this project was accessed and downloaded through the HGL Portal and was generated by the following sources: the United Nations Office

for the Coordination of Humanitarian Affairs, Beteslem (the Israeli Information Center for Human Rights in the Occupied Territories), Shalom Achshav (Israel's Peace Now activist organization) and the Israeli Central Bureau of Statistics. The following highlights the layers and their sources that were utilized for the accessibility analysis:

- Palestine Governorate Boundaries 2004: B'tselem Israeli Organization
- West Bank Checkpoints 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Roadblocks 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Road Regimes 2008: Shalom Akhshav (Peace Now Organization),
- West Bank Road Gates 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Earth Mounds 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Road Barriers 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Partial Checkpoints 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Trenches 2008: United Nations Office for the Coordination of Humanitarian Affairs
- West Bank Earth Walls 2008: United Nations Office for the Coordination of Humanitarian Affairs

- Israeli Controlled Roads West Bank 2003: Shalom Akhshav (Peace Now Organization),
- Israeli Security Barrier 2010: Shalom Akhshav (Peace Now Organization), based on information from the Israeli Ministry of Defense
- Israeli Roads West Bank 2008: Shalom Akhshav (Peace Now Organization)
- Israeli Border Towns: Shalom Akhshav (Peace Now Organization)
- Israeli and Palestinian Population West Bank 2006: Shalom Akhshav (Peace Now Organization)
- Palestinian Territories 2008: Shalom Akhshav (Peace Now Organization)
- Israeli Annexed Land 2007: Shalom Akhshav (Peace Now Organization)
- West Bank Major Roads 2008: Shalom Akhshav (Peace Now Organization)
- Israeli/Palestinian Roads 2008: Shalom Akhshav (Peace Now Organization)
- Israeli Political Borders: Israeli Central Bureau of Statistics
- Israeli Palestinian Localities 2003: Shalom Akhshav (Peace Now Organization)
- Israeli/Palestinian Municipalities 2008: Lishkah ha-merkazit li-statisticah, Central Bureau of Statistics, 2008 Israeli Census
- Israeli Block Groups: Central Bureau of Statistics, 2008 Israeli Census
- West Bank Population 2006: Shalom Akhshav (Peace Now Organization)
- Average waiting times at major permanent checkpoints and road-gates: B'tselem Israeli Organization

2. Network Analyst

2.1 Conceptualization of Network Analyst

Transportation networks are portrayed in by Network Analyst through the process of linear modeling (Hamm 2010). The linear model is a system of interconnected elements that are oriented based upon the configurations of two basic elements: edges and junctions. Edges are the line segments that connect the junctions, representing the traversable routes available in the network. Junctions connect the edges, facilitating movement through the network (ArcGIS Help 10.1). For the purposes of this study, the streets served as the edges the network as intersections dictated the junctions.

NAME	TYPE	ONE_WAY	SPEED	Shape_Length	Minutes
RESERVE	DR		35	437.134562	0.141927
EMILY	LN		35	653.754941	0.212258
ANNA	WAY		35	1002.718009	0.325558
EMILY	WAY		35	328.850651	0.10677
OTTER CREEK	PUMP *		30	1803.766897	0.683245
BLUME	DR		30	225.015545	0.085233
BLUME	DR		30	419.300857	0.158826
BLUME	DR		30	1845.730508	0.69914
VERNICE	DR		30	123.420078	0.04675
TRADITIONS	DR		30	723.176271	0.27393
BURNIDGE	WAY		30	611.902737	0.231781
TRADITIONS	DR		30	255.905388	0.096934
TRADITIONS	DR		30	139.885384	0.052987
CLUBHOUSE	CIR		30	1681.785013	0.63704
TRADITIONS	DR		30	567.193564	0.214846
TRADITIONS	DR		25	855.419906	0.388827
TRADITIONS	DR		25	1623.59049	0.737996
TRADITIONS	DR		30	351.502557	0.133145

Table 1: Specifying impedance data within an attribute table (Hamm 2010).

The construction of a network in Network Analyst is based on the concept of dynamic segmentation, where each data feature stored in a tabulated format (spreadsheet) is geographically displayed onto a map (Hamm 2010). For this to take place, the lines (representing the edges) and points (representing the junctions) must possess a spatial reference in their attribute table. In addition, the attribute table must contain a unique mechanism to identify the different elements (edges and junctions) within the network (Hamm). Geospatial technology achieves dynamic segmentation through the employment

of polylines. Possessing the necessary spatial referencing and identification criteria, each polyline signifies the individual segments that make up the network. When practically applied, the polylines essentially represent the segments of roads between intersections.

In the real world, transportation networks are extremely heterogeneous, with each segment of roadway exhibiting different characteristics and dynamics. Speeds, distances, and impedances all vary from each segment to the next. Network Analyst accounts for this variation by enabling the user to attaching unique attributes to each polyline segment. These attributes can be viewed as the properties of the network elements (edges and junctions) that the dictate the traversibility throughout the network (ArcGIS Help 10.1). These attributes can include speed limits, travel time, restrictions, degree of incline, etc. that exist along a particular polyline. Utilizing the individual characteristics of the polylines, Network Analyst offers a variety of analysis techniques that can be applied to measure accessibility.

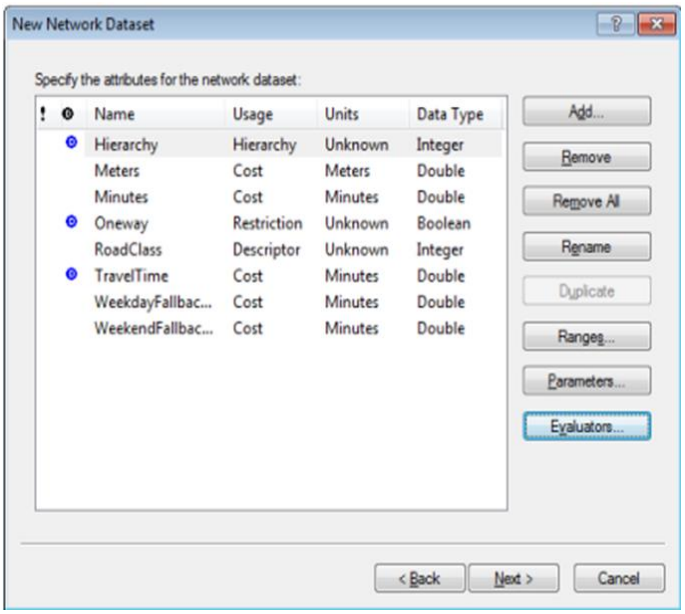


Figure 15: Defining the Network Attributes in Network Analyst (Source: ESRI Online ArcGIS Help 10.1).

2.2 Designing a Network Dataset

All analysis capabilities available through Network Analyst require the development of a network dataset. A network dataset provides the fundamental framework that enables Network Analyst to examine any transportation system. Network

datasets are conceived from the interconnection of the previously discussed network elements (edges and junctions) which constitute the basic structure of the network. Once the necessary spatial data is converted into network elements, the connectivity of the transportation network is derived from the alignment of edges and the arrangement of junctions along various routes. Network attributes define the properties of the network elements, expressing the costs, restrictions, speeds and temporal characteristics of each road segment (ESRI ArcGIS Resources Help 10.1).

2.3 Overview of Analysis Techniques

The primary analysis capabilities of Network Analyst can be categorized as routing functions that determine the optimal course of travel based upon the characteristics of the transportation network being studied (Curtin). In configuring the ideal route between an origin and destination, routing functions find the pathway with the least amount of cost. Travel cost is calculated as a function of the distance, time and impedance a traveler experiences while traversing the transportation network. The attributes of each polyline define the distance, time and impedance associated with each segment of the network. Therefore, when determining the best route, Network Analyst selects the configuration of interconnected polylines that possess the lowest cost (Curtin).

The four primary routing functions integrated into Network Analysis include Service Area Analysis, Original Destination (OD) Matrices, Closest Facility Analysis and Time-Dependent Analysis.

- **Service Areas Analysis** creates a buffer polygon around a destination that encompasses all areas that can access the destination within a set amount of time or distance. In doing this, Service Areas show how accessibility varies with impedance. For example, the service area analysis function can be applied to show what areas can reach a health care facility in twenty minutes.

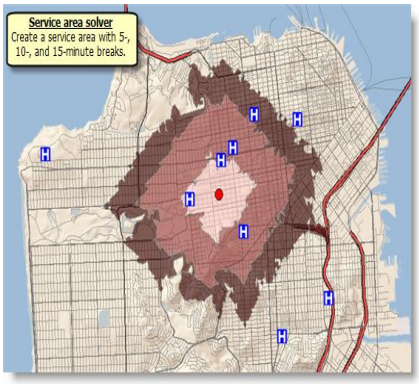


Figure 16: The output generated through service area analysis (ESRI Online ArcGIS Help 10.1).

- **Origin Destination (OD) Matrices** find and measure the route with the least travel cost between multiple destinations and origins, determining the most efficient pathway that possesses the least amount of impedance incurred along each route (ESRi Online ArcGIS Help 10.1). An OD table is produced from the analysis, ranking each route based upon the amount of cost it requires to travel from the origin to multiple destinations (ESRI ArcGIS Resources Help 10.1).

Table 2: Example of the output table produce by the OD Matrices ((ESRI ArcGIS Resources Help 10.1).

ObjectID	Shape	Name	OriginID	DestinationID	DestinationRank	Total_Time
133	Polyline	Buffalo - Detroit	5	2	5	252
134	Polyline	Milwaukee - Milwaukee	6	6	1	0
135	Polyline	Milwaukee - Chicago	6	1	2	98
136	Polyline	Milwaukee - Indianapolis	6	7	3	265
137	Polyline	Milwaukee - Detroit	6	2	4	355
138	Polyline	Milwaukee - Cleveland	6	3	5	419
139	Polyline	Indianapolis - Indianapolis	7	7	1	0
1	yline	Indianapo Columbus		9	2	

- **Closest Facility Analysis** finds shortest and most cost-effective route between points of origin and the location of desired destinations. It can build upon the results of the Service Area Analysis, providing more detailed output of potential routes within the maximum-distance or time buffer zones. Friction Values can be calibrated into the analysis, accounting for various impedances, such as stop lights, congestion, and restricted access that may occur along each route (ESRI ArcGIS Resources Help 10.1). It should be noted that the analytic functions of Closest Facility Analysis and OD Matrices are very similar, yet they generate a difference output. The Closest Facility Analysis output reflects the true shape of the route between two destinations, while OD Matrices generates straight lines connecting the locations in order to reduce the computational time. The analytical value of OD Matrices is primarily found in its detailed output table, but it fails to display the true route of the pathways it generates.

Figure 17: Routes generated by Closest Facility Analysis (ESRI ArcGIS Resources Help 10.1).

3. Data Preparations

3.1 Checking Data Accuracy

Prior to utilizing any of the Network Analyst capabilities, the accuracy of the spatial data was assessed and corrections were made when required. The geographical

orientation of the roadblocks, checkpoints, the separation barrier, earth mounds, trenches, Palestinian localities, Jewish settlements, roadways, and political borders was compared to the latest aerial photography made available from the Landsat satellite (Eklund 2010). The correct arrangement of the various mobility impedances, the transportation network, population centers and political boundaries maximized the accuracy of the accessibility measurements. Features that were placed incorrectly would have yielded imprecise results, adversely impacting the accuracy of this study.

3.2 Matching the Data Up

In order to construct a functional network dataset, it was necessary for all components of the spatial data within the source layers to be touching or physically share a border. As the spatial data was collected from a variety of sources, the data failed to precisely line up. The points that represented the checkpoints, road blocks and road gates did not intersect the road layer or the separation barrier. Prior to building the network dataset, all checkpoints, roadblocks and road gates had to be placed on the closest line segment of the road layer or the separation barrier. This was done by using the editing tool which allowed for each point that represented a checkpoint, roadblock or road gate to be highlighted and moved to the adjacent line segment. If the point was not directly adjacent to a line segment then it was attached to the closest line segment of either the road network or separation barrier.

3.3 *Differentiating* between the Israeli and Palestinian Road Networks

As previously discussed, there are considerable disparities between the mobility conditions afforded to Jewish settlers and Palestinians within the West Bank. Rather than

create a hierarchical system of roadways within the same network dataset, these differentiations were distinguished by creating a separate network dataset for each group. In the attribute table of the road layer, a new fields "Classification" was added to denote the differences in allowable uses within the road network. Using the "Select by Location" tool, the line segments within the master roads layer that are the same as the Israeli roads layer were selected, and given the title "Bypass" under the "Classification" field. These line segments classified as "Bypass" identified all Israeli controlled roads within the Palestinian network dataset. Once selected within the attribute table, the "Bypass" segments were exported out as a new dataset to be used as the base road-layer for the Israeli network dataset.

In constructing the Palestinian road network, the remaining line segments not identified as "Bypass" within the master road network were either classified as "Urban" or "Regional." Using the "Select by Location" tool, the line segments that were completely enclosed within the boundary of a Palestinian locality and were not previously classified as "Bypass" were designated as "Urban." The remaining line segments that are not contained within an identifiable municipal boundary as well as not previously classified as "Bypass" were designated as "Regional" in the "Classification" field. The Israeli road layer does not contain the "Urban" and "Regional" line segments, only the segments classified as "Bypass."

3.4 Speed Limits

Due to the lack of data available, generalizations were made when assigning speed limits to each road classification. In addition to the "Classification" field discussed

above, the new field "Speed" was added to road layer's attribute table. Using the "Select by Attribute" tool, the line segments identified as "Bypass" under the "Classification" field were highlighted and assigned the value of 50 miles per hour within the "Speed" field. The same process was utilized to select out the "Urban" and "Regional" classifications. Urban roadways were assigned the value of 35 miles per hour and Regional roadways assigned the value of 45 miles per hour.

3.5 Distance

As distance, identified as the length of each line segment, is to be used as an impedance for each network dataset, the field "Length" was added to the road layer's attribute table. In order to correspond with the "Speed" field, the distance of each segment was calculated in miles using the "Calculate Geometry" tool.

3.5 Travel Time

The new field "TravelTime" was added to the road layers attribute table in order to calculate the time it would take an automobile to travel across the entire length of the line segment. The values within this field

Table

Palestinian Road Network

OBJECTID *	Shape *	LENGTH	Classification	Speed	Length	Travel_Time
31706	Polyline	11105.328075	Regional	45	6.900517	9.20069
31289	Polyline	11079.846152	Regional	45	6.884683	9.179578
31541	Polyline	10982.309715	Regional	45	6.824077	9.09877
29884	Polyline	8486.1705	Urban	35	5.273051	9.039517
32448	Polyline	10797.790017	Regional	45	6.709422	8.945896
31200	Polyline	10643.892137	Regional	45	6.613795	8.818393
20456	Polyline	10582.835713	Regional	45	6.575856	8.767808
32574	Polyline	10573.263789	Regional	45	6.569908	8.759878
32488	Polyline	10504.596649	Regional	45	6.527241	8.702988
29287	Polyline	11658.97719	Bypass	50	7.244538	8.693446
32439	Polyline	11629.064426	Bypass	50	7.225951	8.671141
31233	Polyline	10459.500283	Regional	45	6.499219	8.665626
32619	Polyline	10347.185963	Regional	45	6.42943	8.572574
31409	Polyline	10214.498358	Regional	45	6.346982	8.462643
31234	Polyline	10122.807935	Regional	45	6.290009	8.386678
17173	Polyline	10116.457753	Regional	45	6.286063	8.381417
32442	Polyline	11197.393939	Bypass	50	6.957724	8.349269
30499	Polyline	10065.546338	Regional	45	6.254428	8.339237
32433	Polyline	11176.032459	Bypass	50	6.944451	8.333341
29998	Polyline	10016.747426	Regional	45	6.224106	8.298808
14060	Polyline	7788.008142	Urban	35	4.839234	8.29583
29663	Polyline	11058.418074	Bypass	50	6.871369	8.245642
30545	Polyline	9921.842366	Regional	45	6.165135	8.22018
30032	Polyline	9879.332164	Regional	45	6.13872	8.18496
32436	Polyline	10956.704516	Bypass	50	6.808167	8.1698
6246	Polyline	9791.243271	Regional	45	6.083984	8.111979
30394	Polyline	9624.063848	Regional	45	5.980104	7.973472
31299	Polyline	9571.855939	Regional	45	5.947664	7.930218
31793	Polyline	9533.212621	Regional	45	5.923652	7.898202
20463	Polyline	9467.921846	Regional	45	5.883082	7.844109

0 (1 out of 32727 Selected)

Palestinian Road Network

Table 3: Fields added to the attribute table prior to building the network dataset

were configured by entering the equation “Length * 60 / Speed” into the field calculator. The values denote how long it will take the travel across the line segment in minutes, considering its length and speed limit assigned to each segment. The graphic above highlights the final attribute table once the edits described in the above sections were concluded.

3.6 Identifying Palestinian Origins and Destinations

Taking into account the populations, commercial activity, economic importance and spatial distribution throughout the West Bank, the eight major Palestinian cities of Bethlehem, Hebron, Jenin, Jericho, Nablus, Qalqiliya, Ramallah and Tulkarm were chosen for the analysis. The map on the right displays the proximity of these cities within the West Bank.

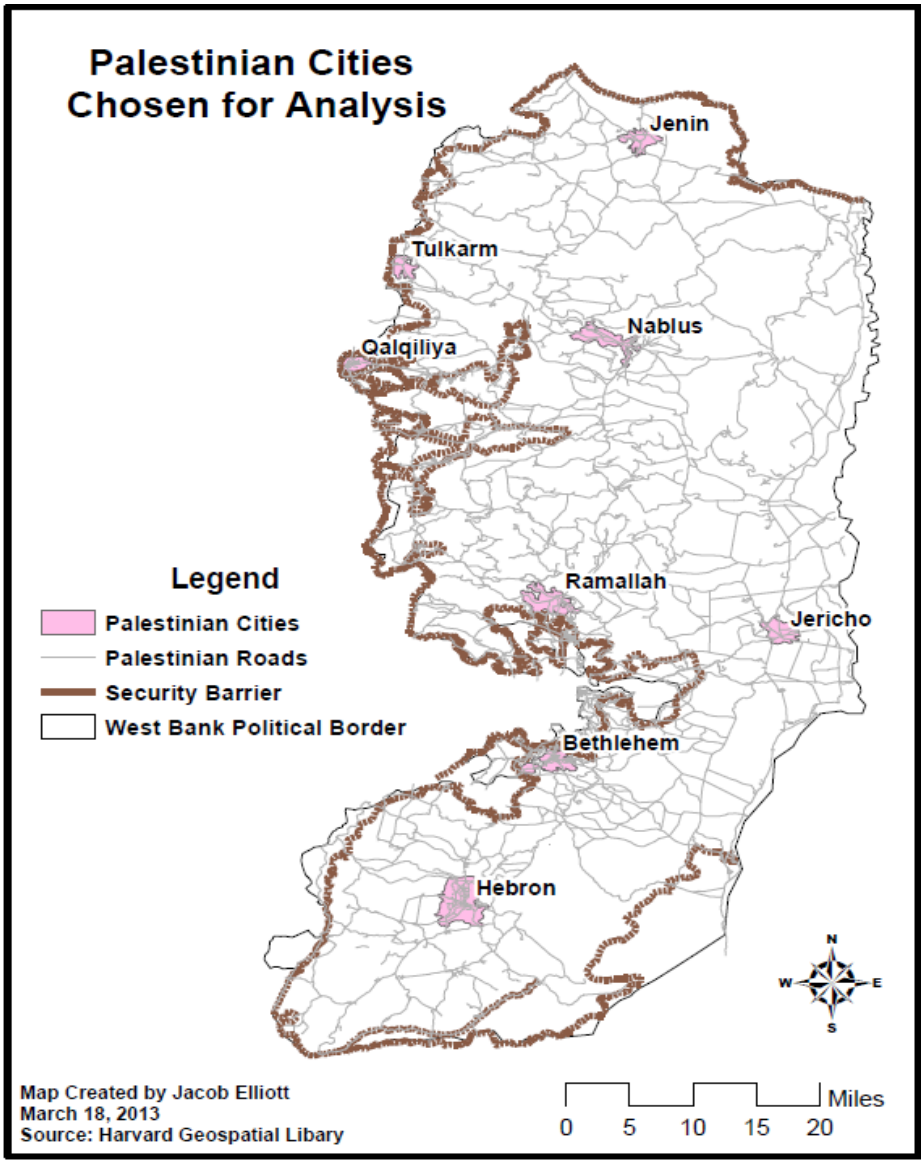


Figure 18: Palestinian Cities chosen for analysis

3.7 Identifying Israeli Settlements and Destinations

Eight isolated Jewish settlements were selected based upon their relative isolation within the West Bank, distance from major Israeli cities and proximity to Palestinian populations. The settlements of Elon Moresh, Hamra, Homesh, Netiv Hagedud, No'omi, Noqedim, Qalya and Qiryat Arba were chosen for analysis.

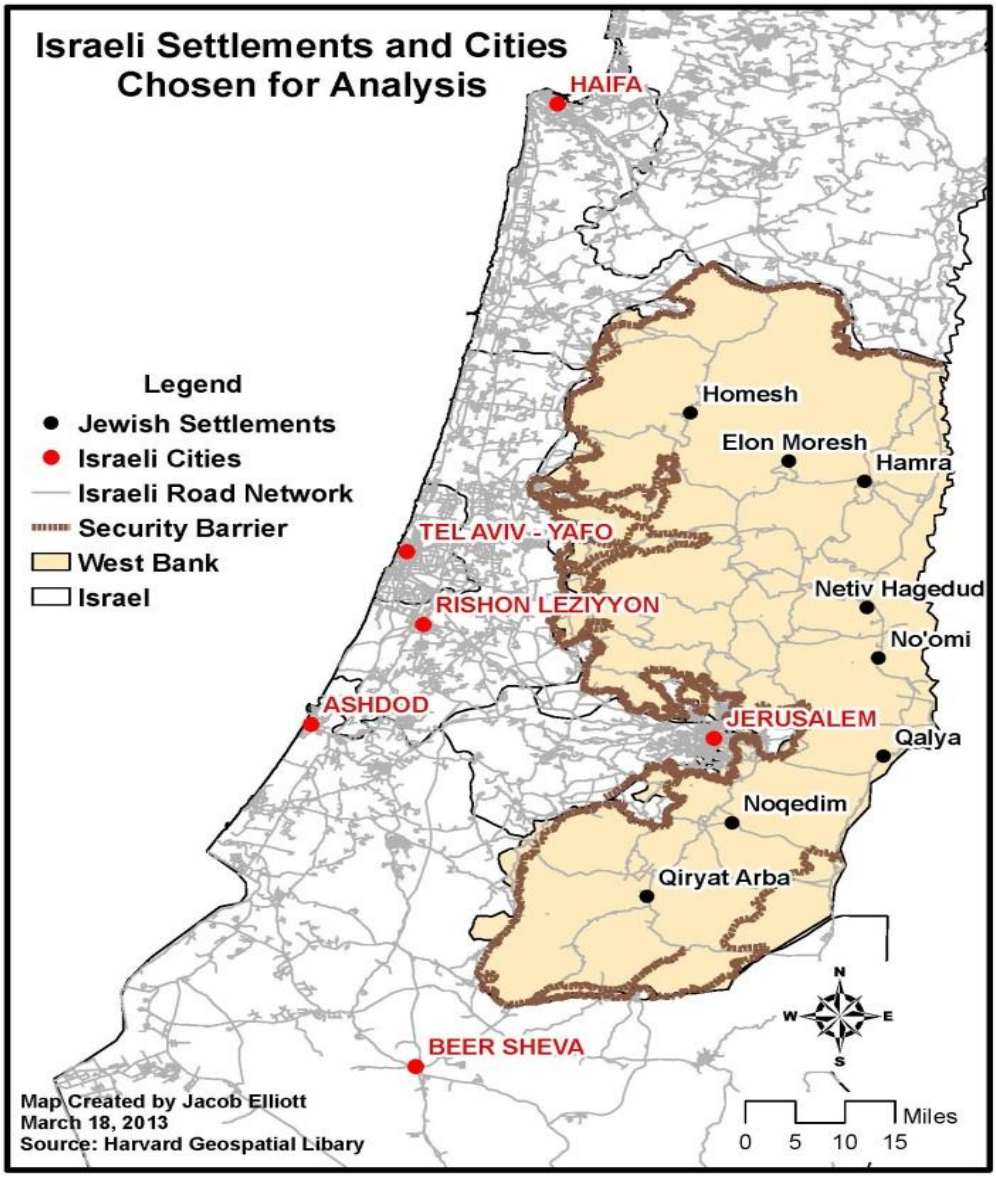


Figure 19: Israeli settlements and cities chosen for analysis.

4. Research Design

4.1 Organization of Procedures

The flowchart below depicts the research design that was utilized to achieve the objectives of this study. It portrays the organization of the aforementioned processes, categorizing their relationship by illustrating the order in which the procedures will take place. Once the network dataset was fully designed, the analytical capabilities of Network Analysis were implemented. Accessibility was measured by using Service Area Analysis and Closest Facility Analysis. Each analysis technique was conducted for each of the three scenarios outlined, covering specified Palestinian population centers and Jewish settlements.

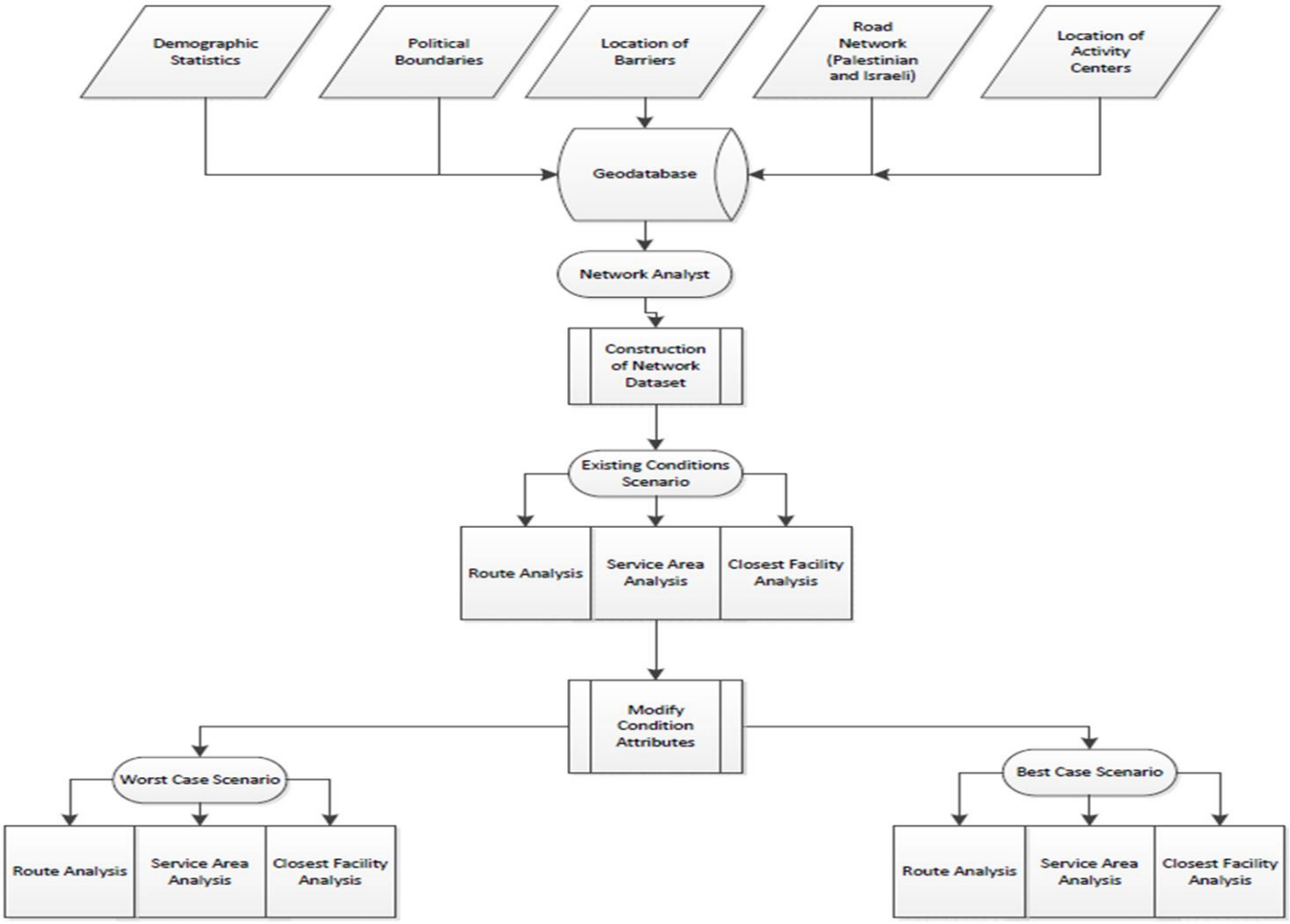


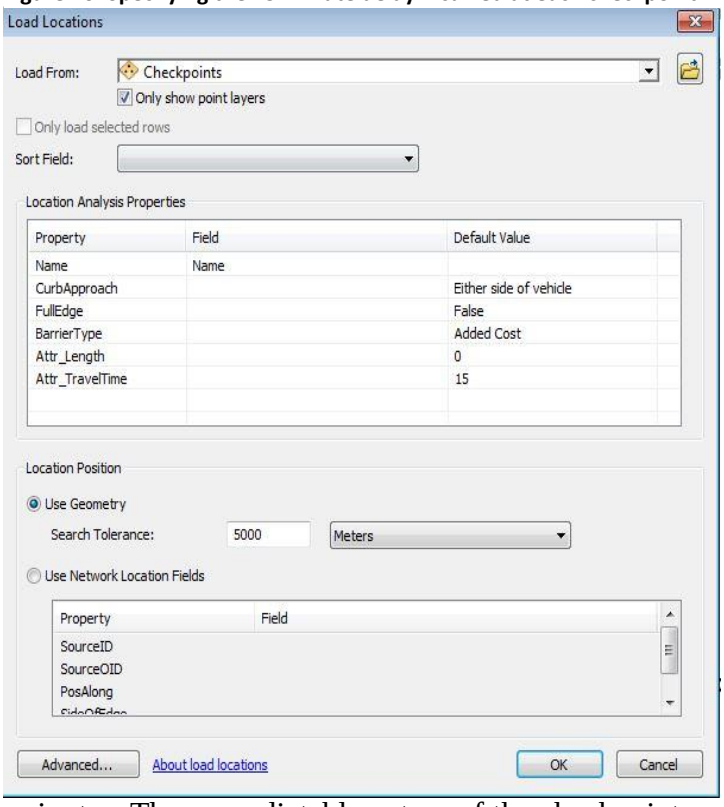
Figure 20: Research design outlining the processes that will be used in this study

4.2 Service Area Analysis

Service Area Analysis created buffers around Palestinian localities and major Jewish settlements showing the maximum distance a person from each perspective population center can travel within 15 minutes, 30 minutes and 45 minutes. Polygons corresponding to the three timeframes emanate from each population center, demonstrating how accessibility is impacted by increased impedance for each of the three scenarios of mobility restriction (ESRI ArcGIS Resources Help 10.1). The Service Area Analysis was run separately for each of the three scenarios, generating a polygon for each

of the 15 minute, 30 minute and 45 minute time intervals. Travel Time was used as the impedance. Under Scenario 1 (Worst Case), the service area was modeled with each of the roadblocks, road gates and checkpoints impassible as well as access to "Bypass" segments restricted for the Palestinian network dataset. In Scenario 2 (present day), all roadblocks and road gates were assigned as restrictions and passage through each checkpoint added an additional 15 minutes penalty to the Travel Time, as seen in the graphic to above. As cited by B'tselem, the average wait time at each checkpoint is fifteen minutes. The unpredictable nature of the checkpoint regime makes the estimation of actual wait time at each individual checkpoint nearly impossible to predict, therefore a 15-minute delay was universally applied to every checkpoint. In Scenario 3 (best case), all roadblocks, road gates, and checkpoints do not factor into the model, as these do not pose any mobility restrictions within the West Bank. The security barrier represents a restriction under each scenario, limiting travel to within the West Bank.

Figure 20: Specifying the 15-minute delay incurred at each checkpoint



The graphic below depicts an example of the process used to generate the service areas for Bethlehem. In the Network Analyst Toolbar, an individual service area was selected to analyze each of the eight Palestinian cities. As seen in the Network Analyst Toolbar to the left of the graphic, the location of the city was loaded into the "Facility" category. The locations of the roadblocks and roadgates layers were loaded into the "Point Barriers" category as Restrictions and the checkpoints placed as an Added Cost of "15" to the Travel Time. Additionally, the Security Barrier was loaded into the "Line Barriers" category as a restriction. Once the analysis was run and the service areas created, the polygons were exported into the geodatabase and the same process was utilized to for the remaining scenarios under different conditions.

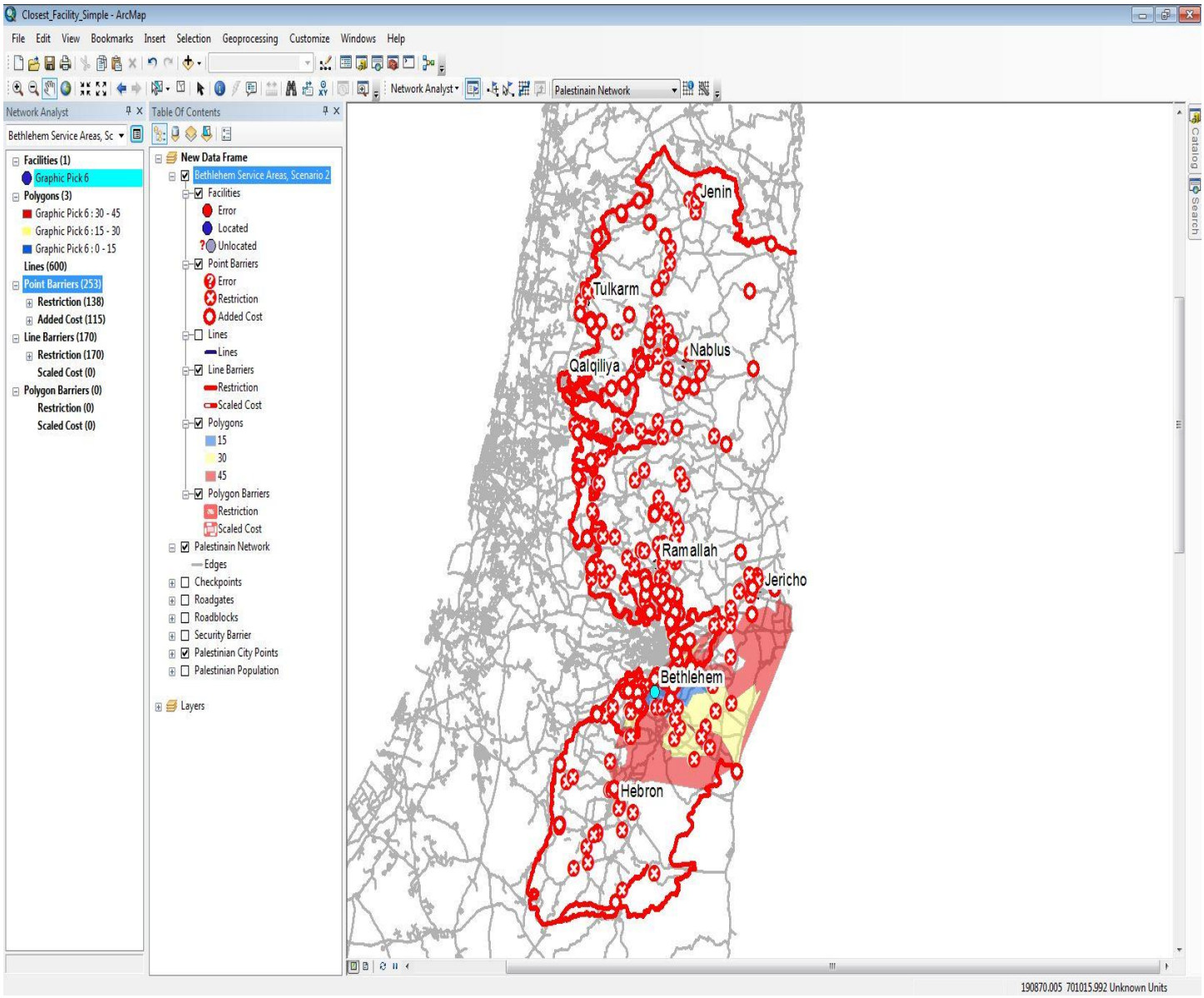


Figure 21: Example of the Closest Facility Analysis for Bethlehem

4.3 Closest Facility Analysis

The Closest Facility Analysis function was utilized to find the least-cost route between each Palestinian city as well as between every isolated Jewish settlement and the 5 major Israeli cities. Additionally, Closest Facility Analysis was run to generate routes between the eight isolated Jewish settlements and the five most-populous settlements that are afforded territorial contiguity with Israel due to the security barrier. Although not offering the same scale and diversity of economic opportunities and desired activities found in major Israeli cities, the 5 principal settlements are in closer proximity to the isolated settlements, extending limited educational, health care, commercial and recreation opportunities. The primary function of the least-cost routes connecting the isolated settlements and major settlements is to add an element of reality in evaluating the accessibility attributes of the isolated Jewish settlers. The long distance separating the isolated settlements from major Israeli cities makes them less attractive and only accessed for certain activities and destinations, primarily employment, major health care centers, and higher education. Deterred by the long trip in hostile territory, the daily needs of the isolated settlers is likely to be fulfilled at the nearest possible destination, which, in this case, are the larger settlements situated across the security barrier.

This process is described in the graphic below. Unlike the Service Area Analysis, the Closest Facility Analysis was run once for Scenario 2 and Scenario 3 using Travel Time as the impedance. The heightened mobility constraints associated with Scenario 1 (Worst Case) turn every checkpoint function as an impassible restriction, making inter-city travel impossible As depicted in the graphic below, routes were generated between

"Facilities" and "Incidents" as the restrictions (roadblocks, roadgates and the security barrier) and costs (checkpoints) were loaded into their respective categories depending upon the scenario being simulated. For the analysis of the Palestinian network, the same locations of the eight cities were loaded into both the "Facilities" and "Incidents" categories to generate routes between each. For the analysis of the Israeli network, the locations of the settlements were loaded into the "Facilities" category as the six major Israeli cities were used as the "Incidents," producing routes between each category.

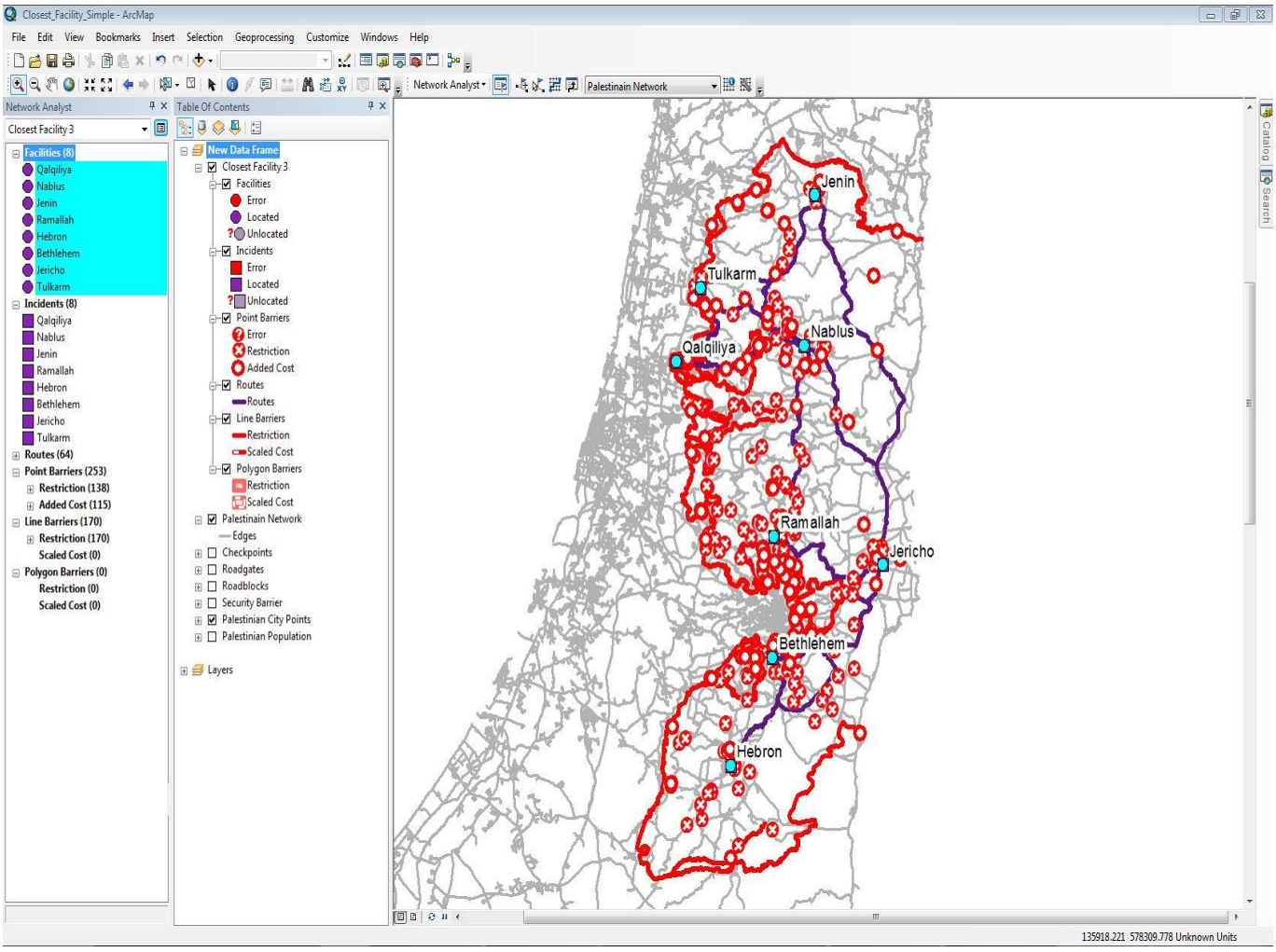


Figure 22: Generating least-cost routes using Closest Facility Analysis

Once run, each least-cost pathway generated by the Closest Facility Analysis is contained within the "Routes" output, which can be found in the above graphic inside the ArcMapTable of Contents. The "Route" output was exported to the geodatabase once the Closest Facility Analysis was run for each of the scenarios.

4.4 Analysis Techniques

As each of the three scenarios was evaluated using the Service Area Analysis and Closest Facility Analysis tools, myriad charts and maps was generated and synthesized to assess and compare the accessibility conditions of the Palestinian and Jewish populations of the West Bank. Interpretation of these results provided answers to the primary objectives and questions confronting this study.

The polygons exported from the Service Area Analysis were used to produce maps displaying the buffer areas that represent the maximum distance a Palestinian or Israeli can travel within the three specified timeframes under the each scenario. The spatial extent of these buffer areas provided an ideal way to measure the differences in accessibility afforded to Palestinians compared to that of the Jewish settlers. Furthermore, the populations within each buffer zone were calculated and compared as a mechanism to measure the amount of accessibility afforded Palestinian city or Israeli settlement under each scenario.

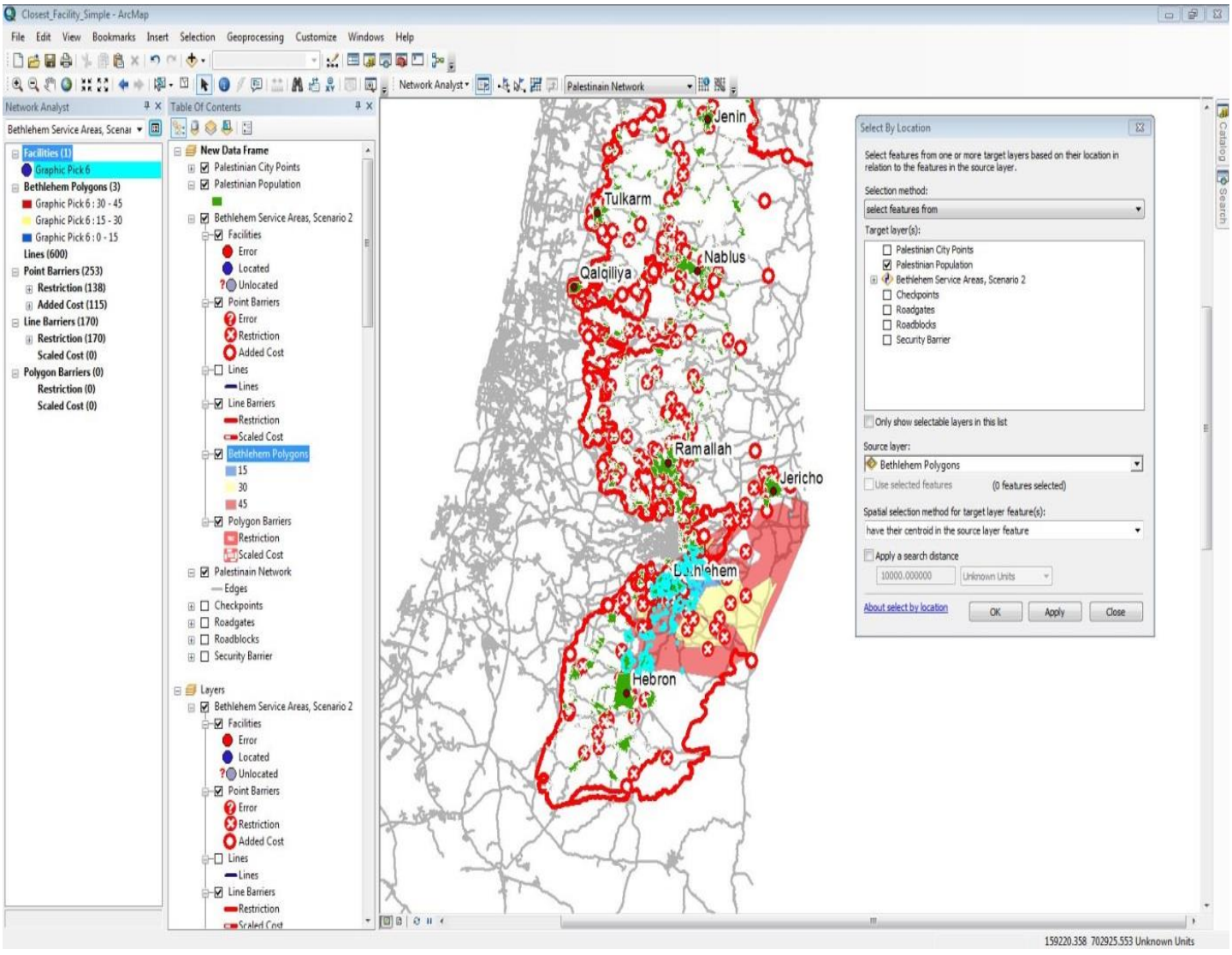


Figure 23: The processed used to calculate the population within each service area

The graphic below highlights the process used to determine the population accessible within each service area. Using the "Select By Location" tool, all Palestinian localities that lie within the service area polygon were selected. The total population can be ascertained by opening the Palestinian Population dataset's Attribute Table, viewing the selected features, and highlighting the 2006_Population column.

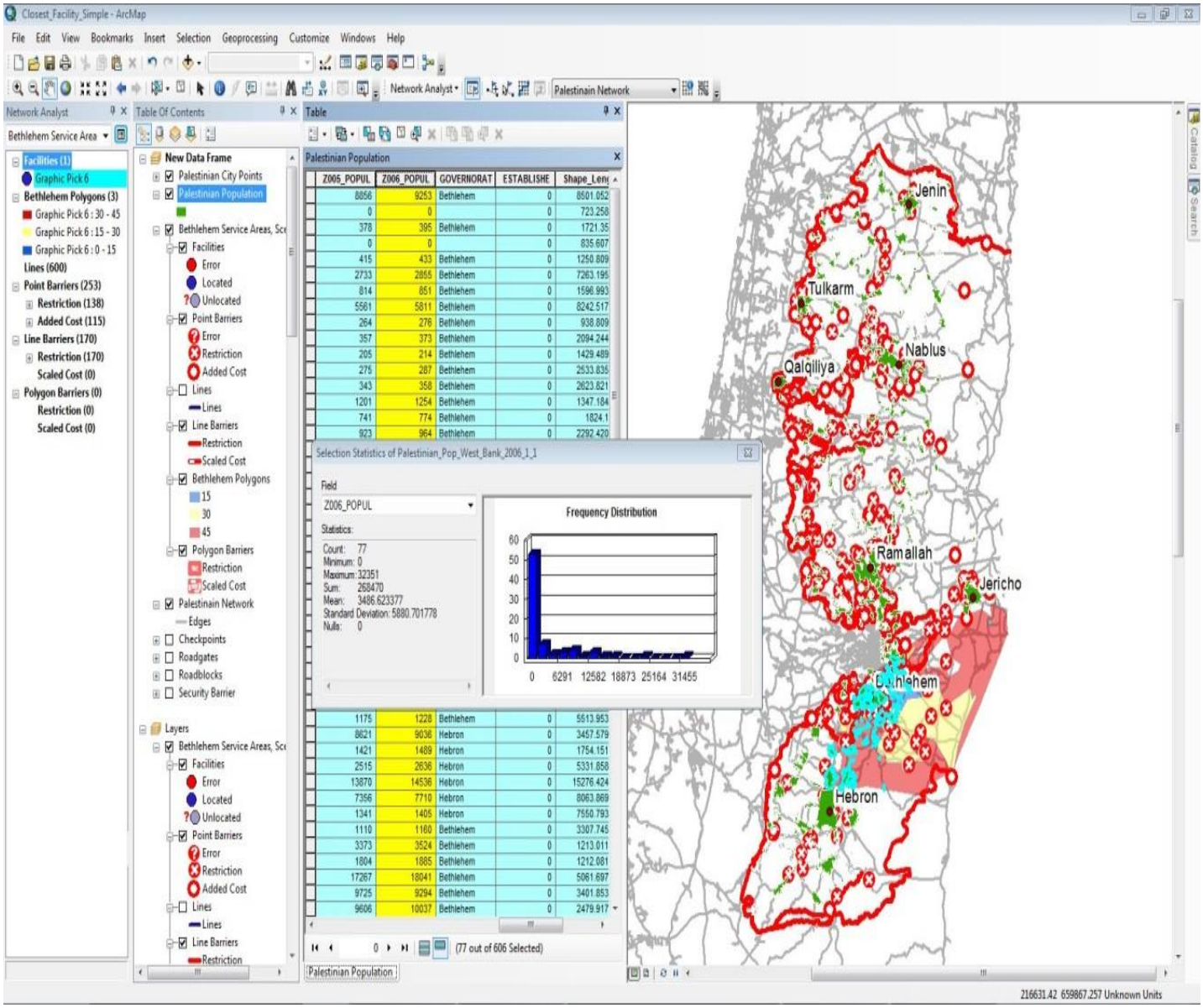


Figure 24: Determining the total population of the selected features the Attribute Table

IV. Results

1. Palestinian Service Area Analysis

The following section summarizes the results from the Service Area Analysis for each Palestinian city, providing maps, figures and a brief summary of the findings.

1.1 Bethlehem

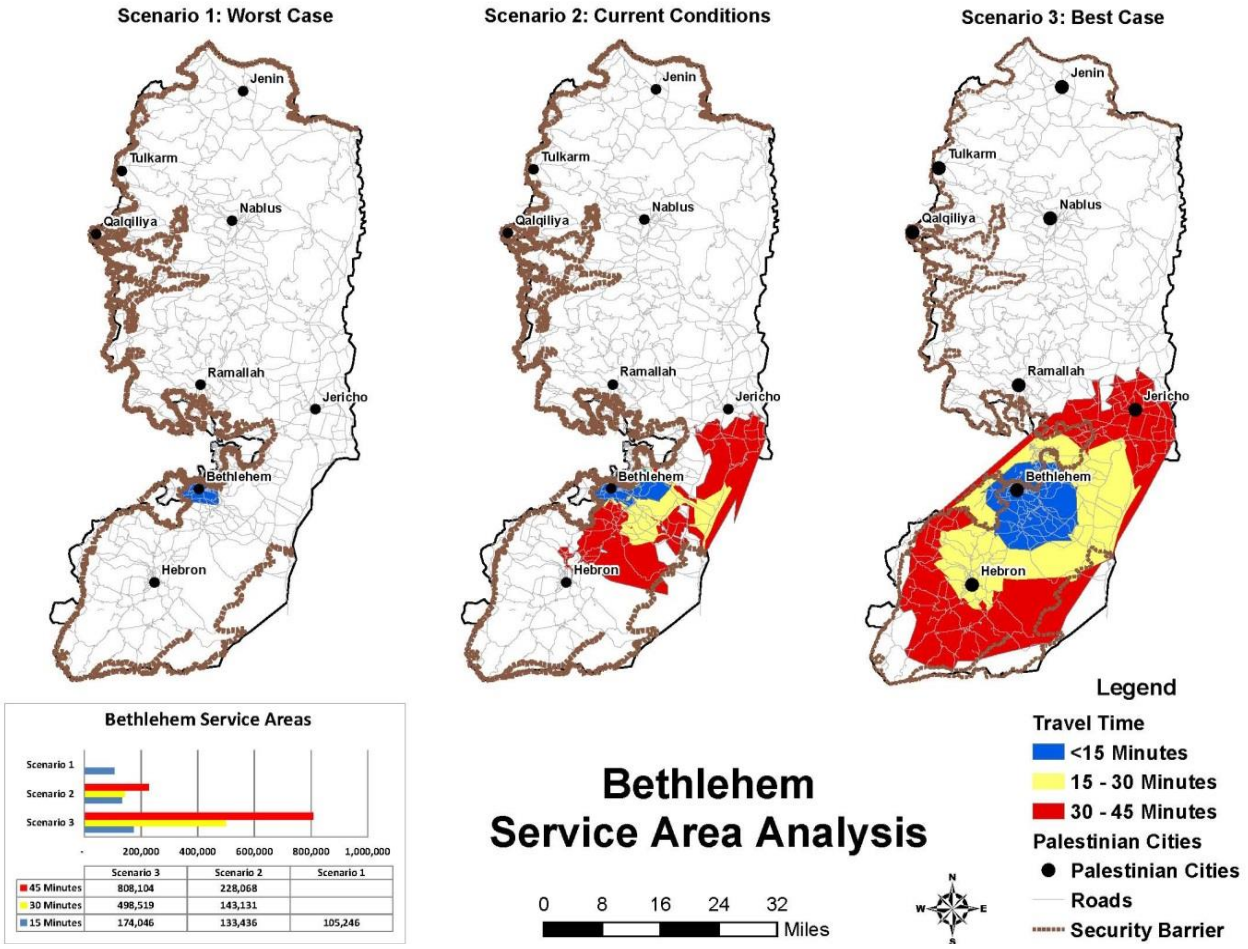


Figure 25: Bethlehem Service Area Analysis

The above map and accompanying table highlight the findings for the Bethlehem's Service Area Analysis set in the time frame of 15, 30 and 45 minutes for each scenario. In Scenario 1 (Worst Case) the onerous restrictions placed on mobility limit travel time to just 11.64 minutes away from Bethlehem's central business district, failing to even each the specified 15 minute timeframe. The resulting Service Area generated under the existing condition allows for a much greater degree of mobility in terms of absolute distance but permits only slightly more access in terms of reachable population centers. Even within the 45-minute threshold, the concentration of checkpoints, roadblocks and the security barrier bars access to the two closest cities of Jericho and Hebron in addition to the major urbanized areas surrounding Jerusalem. The relaxed specifications in Scenario 3 significantly improve the mobility conditions, allowing access to the outskirts of Jerusalem within 15 minutes, to Hebron within 30 minutes and to over 800,000 people within 45-minutes.

1.2 Hebron

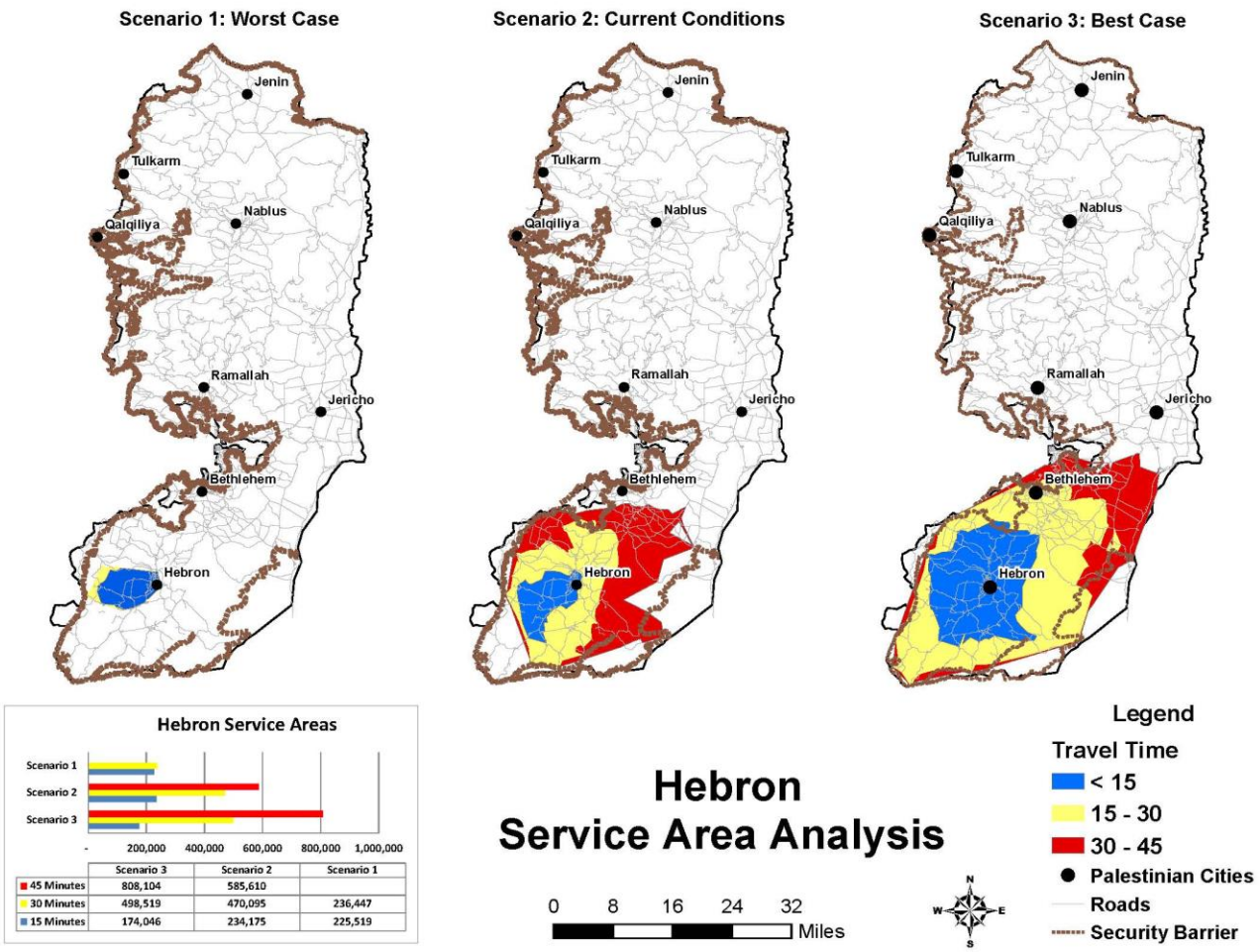


Figure 26: Hebron Service Area Analysis

Due to its orientation in the southern-most portion of the West Bank, Hebron's position fails to permit easy access to the majority of the major cities primarily located in the north. Although the Service Areas generated for Scenario 1 and Scenario 2 encompass significant population counts in comparison to other cities, the results for each scenario fall only within Hebron's immediate metropolitan area. As depicted in Scenario 2, under current conditions no connectivity is provided to any other major city within a

45-minute travel radius. The 45-minute threshold in Scenario 2 reaches the outskirts of Bethlehem, but fails to fully link with its economic center. However, under Scenario 3, Bethlehem is reachable within 30-minutes and the Jerusalem metropolitan areas can be accessed within 45-minutes.

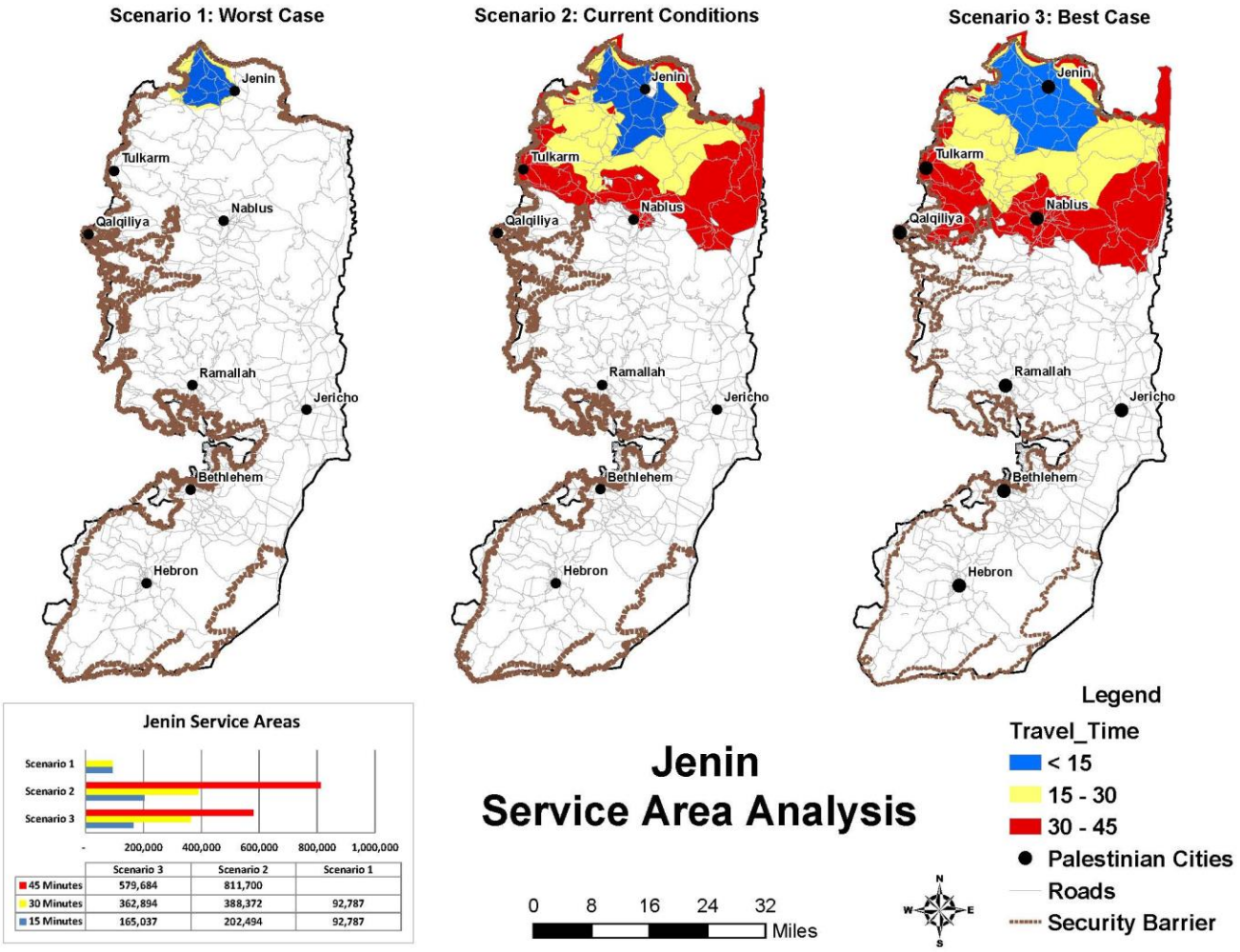


Figure 27: Jenin Service Area Analysis

Similarly to Hebron, Jenin is at a spatial disadvantage due to its position in the extreme northern portions of the West Bank, flanked to the immediate north and west by the Israeli border and the security barrier. The two major cities to the south, Tulkarm and Nablus, are reachable within 45-minute timeframe under Scenario 2, providing access to nearly 580,000 people, roughly ¼ of the West Bank's total population. The service areas produced for Scenario 2 and Scenario 3 are nearly the same size. In terms of distance,

there is little difference between the results for Scenario 2 and 3, yet the amount of population reachable within the maximum timeframe rises by more than 40% from 580,000 to over 810,000. The 45-minute threshold in Scenario 3 links Jenin with the entire metropolitan areas of Tulkarm and Nablus, while ending adjacent to the outskirts of Qalqiliya.

1.4 Jericho

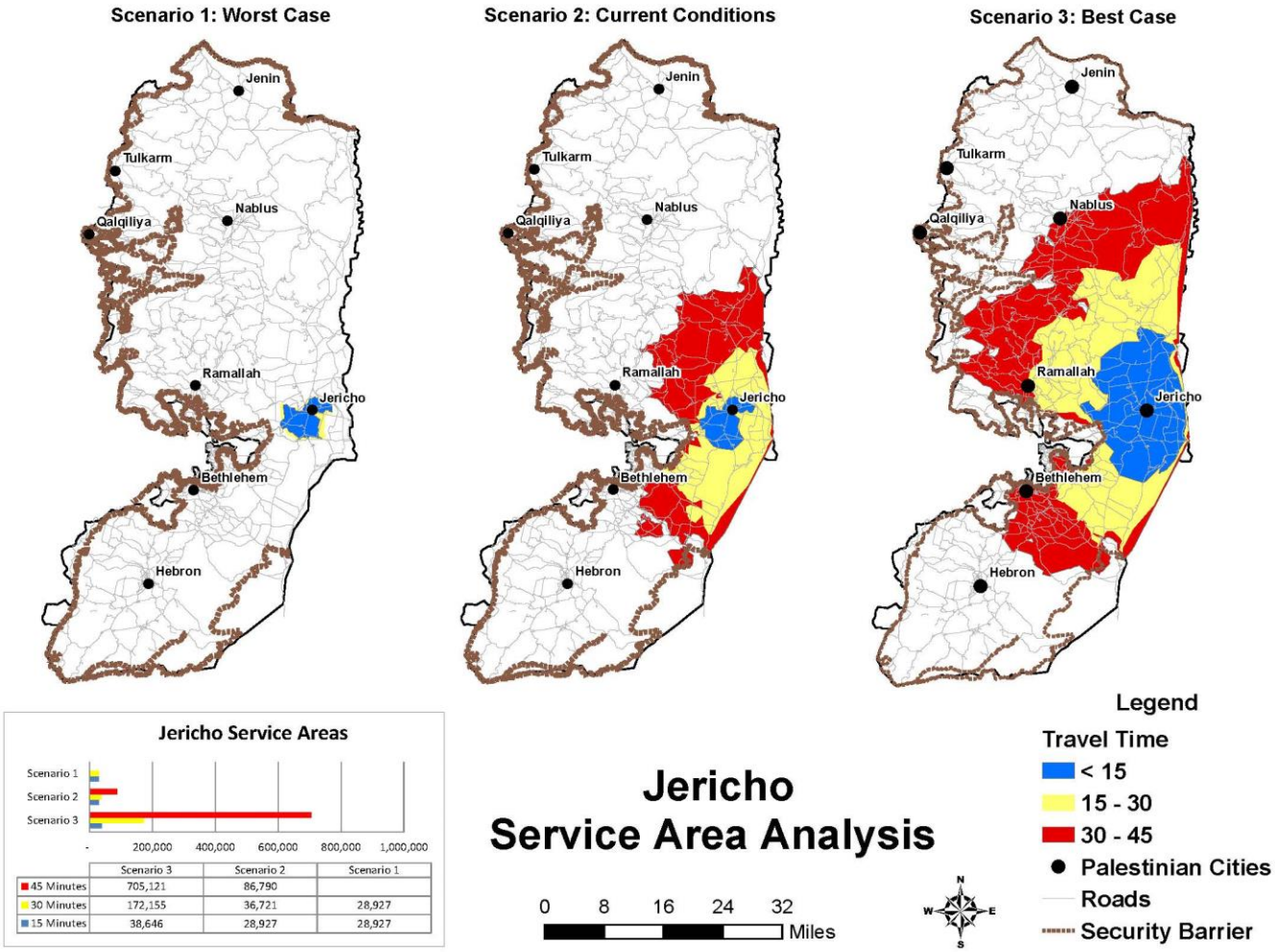


Figure 28: Jericho Service Area Analysis

Since it is situated in a central location neighboring the highly populated Jerusalem metropolitan area, it would be reasonable to assume that Jericho would provide among the greatest degrees of accessibility when compared to other major cities. However, the mobility conditions surrounding the city are extremely restrictive, compounded by the looming shadow of the security barrier extending its most lengthy

intrusion into the West Bank. Although its location is central in terms of north-south orientation, Jericho is located at the narrowest spot of the West Bank pinned between the Jewish settlements of the Jordan Valley and the heightened Israeli military presence surrounding Jerusalem. Jericho's close proximity to a high concentration of Israelis equates to increased security measures and mobility restrictions enforced by the occupying Israeli military. Under Scenario 1 and Scenario 2, Jericho's service areas include the lowest amount of total reachable populations, failing to access any other major city aside from the portions of the Jerusalem metropolitan area not sealed off by the security barrier. This is further highlighted by the fact that the within the 45-minute threshold of Scenario 2, only 3.68% of the West Bank's population is accessible. The population accessible in each service area remains relatively constant until dramatically rising in the 30-minute and 45-minute thresholds of the Scenario 3. When compared to the same timeframes in Scenario 2, the 30-minute and 45-minute thresholds in Scenario 3 increased population accessible by 368% and 712%, respectively. Without any of the existing checkpoints, roadblocks or roadgates, Bethlehem, Ramallah and Nablus can be accessed within 45 minutes from Jericho.

1.5 Nablus

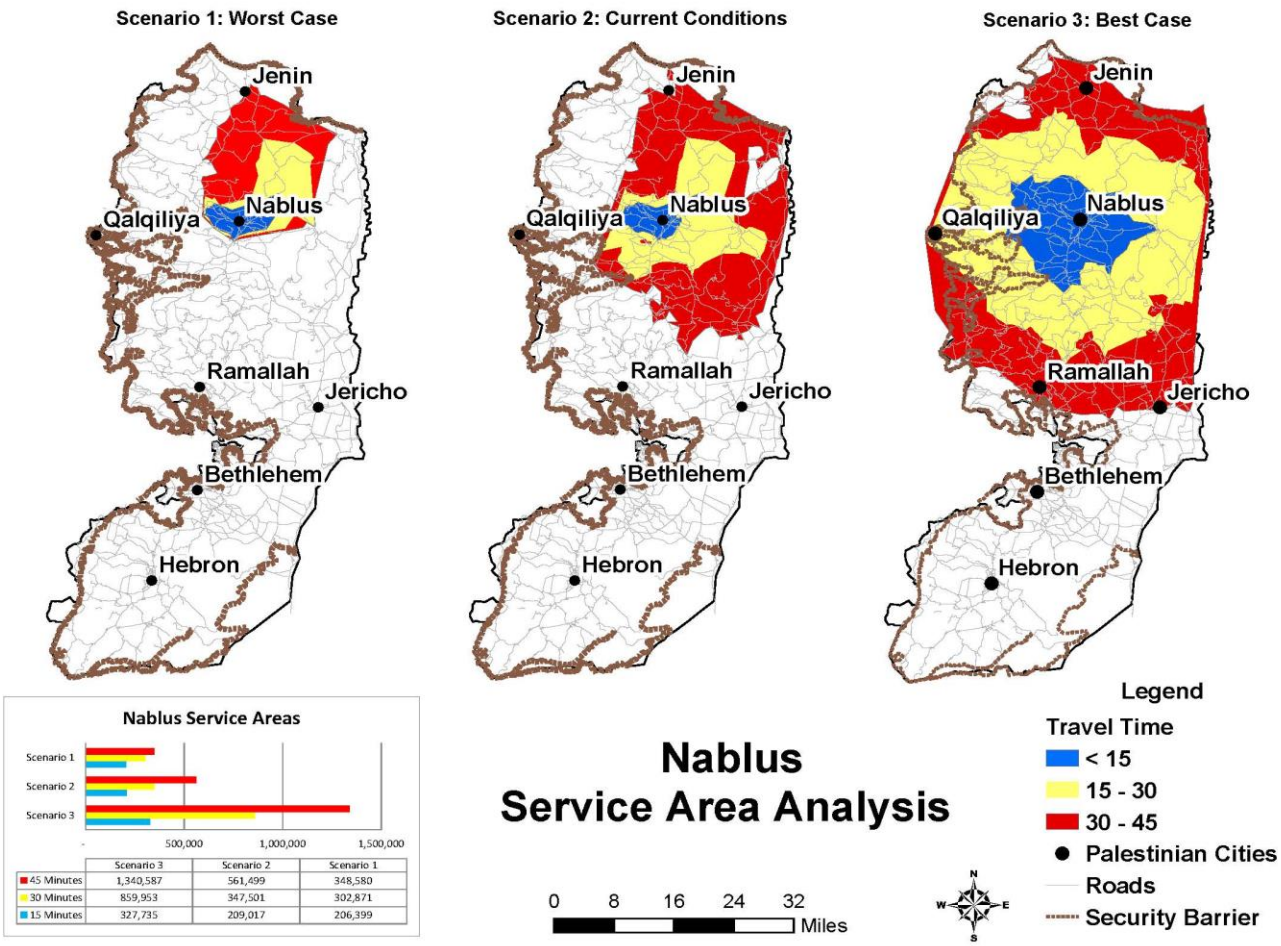


Figure 29: Nablus Service Area Analysis

Although positioned in the north-central portion of the West Bank, Nablus is surrounded by four major cities: Jenin to the north, Tulkarm and Qalqiliya to the west and Ramallah to the south. Despite this favorable situation, the checkpoints and roadblocks make travel to the west and south very limited. This is highlighted in the service areas generated for Scenario 1 and Scenario 2 as the population accessible remains relatively constant and unchanged, enabling access to only Jenin within 45 minutes. In terms of

distance, the service areas for Scenario 1 and Scenario 2 are quite large, permitting extensive travel to the north and east of Nablus. However, these areas are sparsely populated and rural. Without the restriction and impedances, access to Tulkarm and Qalqiliya is permitted within the 30-minute threshold and Ramallah and Jericho also are reachable within the 45-minute threshold. Under Scenario 3, Nablus' service areas provide access to the highest proportion of the West Bank population, with the 30-minute threshold reaching 36.5% of the population and the 45-minute threshold reaching 57%.

1.6 Qalqiliya

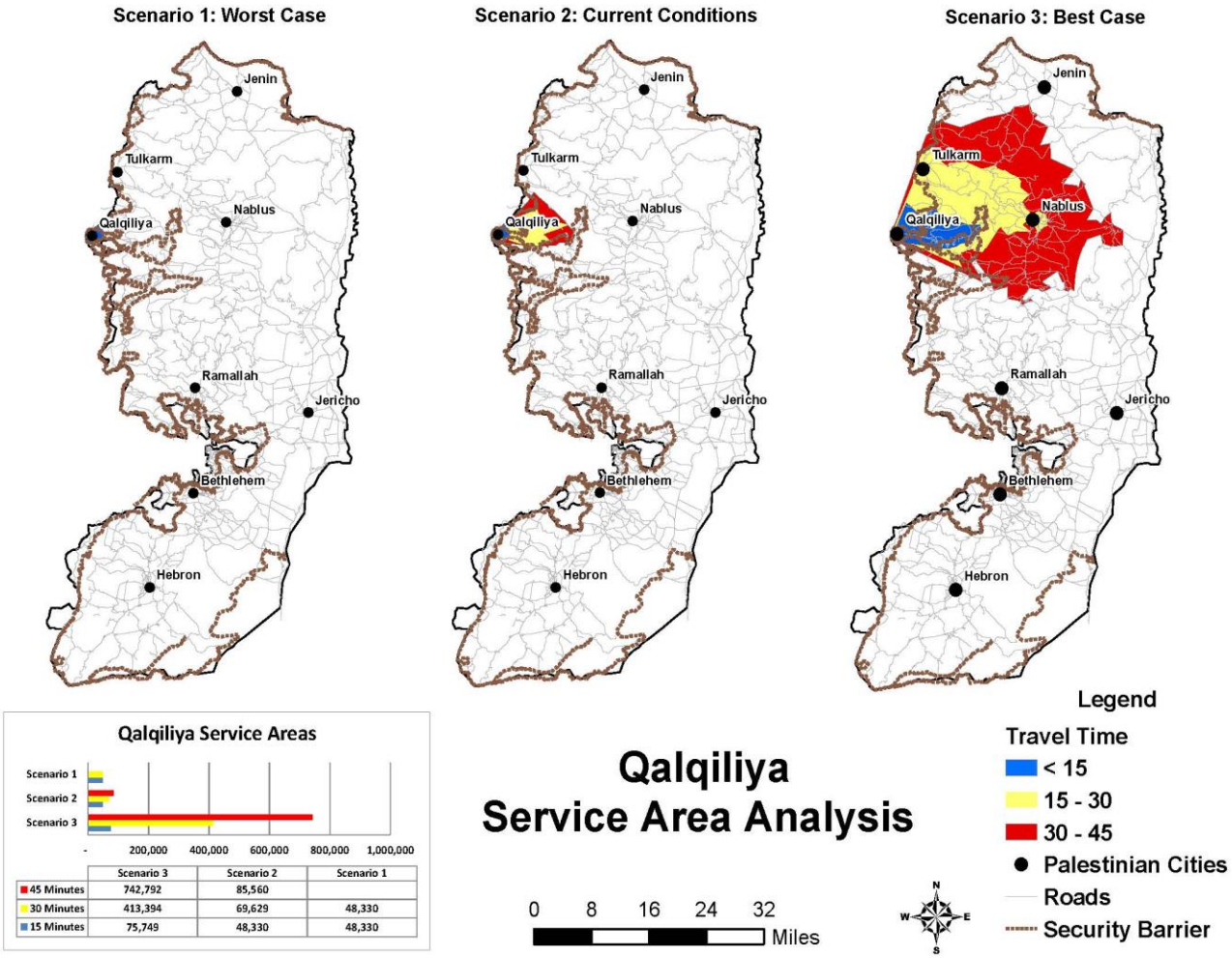


Figure 30: Qalqiliya Service Area Analysis

Unfortunately for the residents of Qalqiliya, the security barrier extends along all sides of the city, virtually enclosing it and disconnecting it from the rest of the West Bank. The only way in and out of Qalqiliya is though a single road that is interrupted by the security barrier at multiple points and lined with checkpoints. Needless to say, these conditions severely limit the extent of the service areas for Scenario 1 and Scenario 2.

Under current conditions, a 45-minute trip would barely get a Palestinian traveler away from the shadow of the security barrier, impeding access even to the closest major city of Tulkarm. Qalqiliya barely beats out Jericho as the least accessible Palestinian city under current conditions, reaching only 3.63% of the West Bank population within the maximum threshold. However, under Scenario 3 with the mobility only impeded by the security barrier, 480,000 people are accessible within the 30-minute threshold and over 740,000 (31.54% of the West Bank's population) are reachable within the 45-minute threshold.

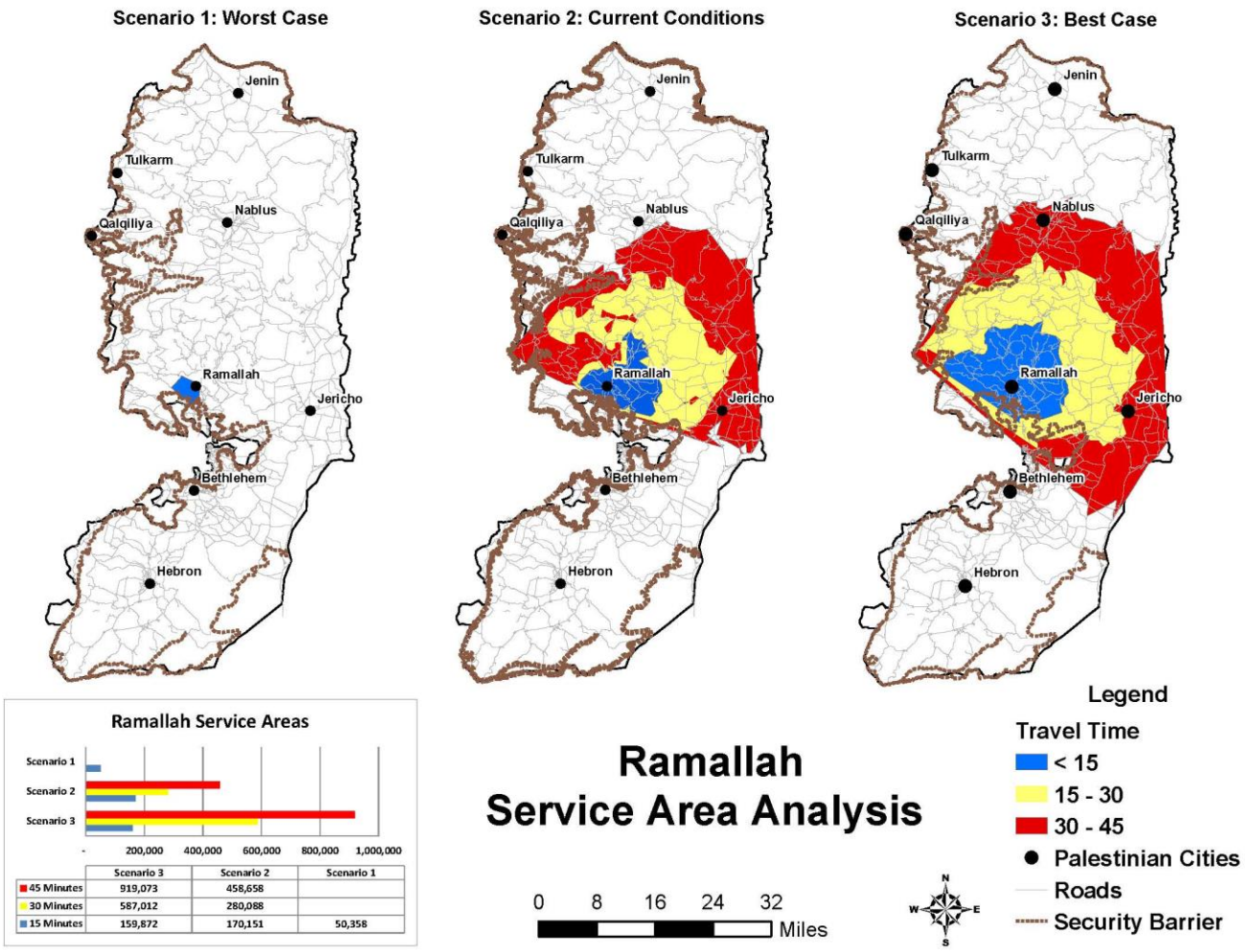


Figure 31: Ramallah Service Area Analysis

Although not as dire as the mobility situation surrounding Qalqiliya, travel to the south and southeast from Ramallah is severely hampered by the intrusive route of the security barrier. The conditions under Scenario 1 are so restrictive, a Palestinian can only travel a mere 8.63 minutes from Ramallah until encountering the first obstacle, severely limiting the size of the corresponding service areas. Despite being in close proximity to

Jericho, access to it is only attainable within the 45-minute threshold of Scenario 2. The service areas for Scenario 2 surrounding Ramallah are quite extensive, extending north and east significant distances, but this fails to contain any major metropolitan areas aside from Jericho. Without restrictions and impedances, the service areas for Scenario 3 are only slightly improved, including access to Nablus to the north in addition to Jericho at the maximum threshold. The alterations within the 30-minute threshold between Scenario 2 and Scenario 3 are only minor, with Scenario 2 reaching 11.89% of the West Banks population and Scenario 3 slightly increasing to access 16.60%. In addition, each fails to fully contain Jericho, only managing to penetrate its western metropolitan area. The 45-minute threshold for Scenario 3 generated a service area that provides access to Nablus, catching over 815,000 people, roughly 35% of the West Bank's population, within its boundaries.

1.8 Tulkarm

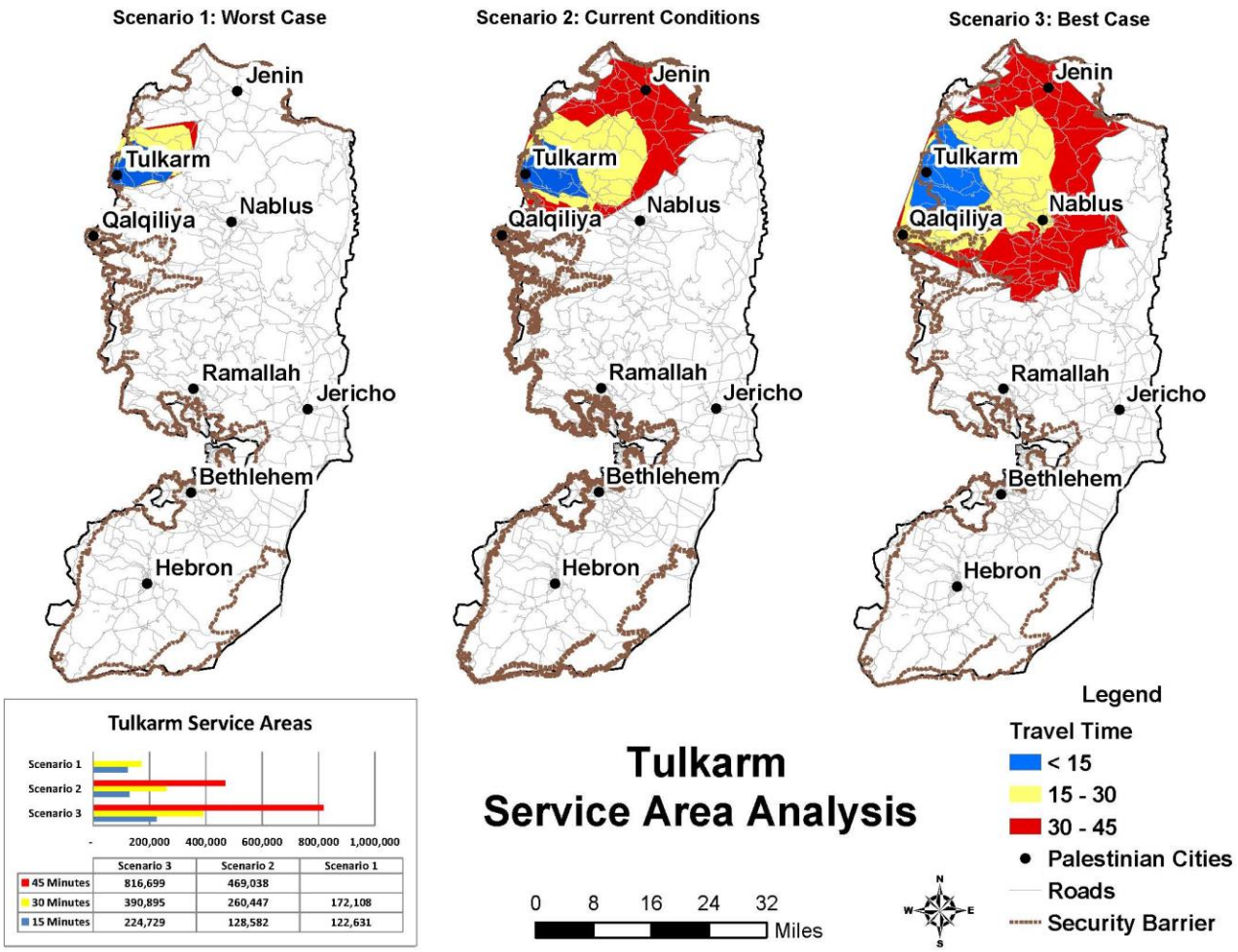


Figure 32: Tulkarm Service Area Analysis

Although located in the far north-western corner of the West Bank and pinned back against the security barrier, the service areas surrounding Tulkarm included a surprising number of people. Tulkarm benefits from its close proximity to Qalqiliya, Nablus and Jenin, with the 30-minute and 45-minute thresholds of Scenario 3 providing accessibility to all three metropolitan areas. The fragmented and invasive route of the security barrier limited the southward extent of the service areas for Scenario 1 and

Scenario 2, with each timeframe failing to reach Qalqiliya and Nablus. Despite this fact, the amount of people accessible for each scenario was at the same level as other major cities, with the 30-minute threshold of Scenario 2 reaching over 260,000 people and the 45-minute threshold reaching nearly 470,000. In comparison, Scenario 3 afforded a much higher degree of accessibility than the previous two scenarios, capturing nearly doubling the amount of population within each service area threshold.

2. Israeli Service Area Analysis

This section displays the maps generated from the Service Area Analysis of the eight isolated Israeli settlements. No service areas were calculated for Scenario 1 due to the assumption that travel would be inherently too dangerous for the small pockets of Jewish settlers if violence again plagued the West Bank. With many settlements situated along the periphery of larger Palestinian cities or in remote areas far removed from Israeli military instillations, the degree of mobility afforded to these settlers in a worst-case scenario would be extremely minimal at best. The service areas generated for Scenario 2 were determined using the Israeli network dataset and the service areas calculated for Scenario 3 were determined using the Palestinian network dataset utilized in the above section. By incorporating the Palestinian road network into Scenario 3, the mobility conditions associated with a best-case scenario could be most accurately simulated. The ability to utilize the much more expansive Palestinian road network without being impaired by heavy restrictions and impedances greatly enhances the accessibility of Jewish settlers throughout the West Bank. Just as no restrictions or impedances were activated in calculating the service areas for Scenario 3, mobility in Scenario 2 was only limited by a 15-minute delay for the minimal amount of checkpoints along Israeli bypass roads and at certain crossings along the security barrier. Jewish settlers were also permitted to access Israel in each scenario.

In contrast to the above section covering the Palestinian service areas, no explanation of the Israeli service areas is offered. This is due to the lack of any analysis technique used to contrast and compare the service areas except for size, which is easy

ascertained by visually comparing the side-by–side maps. For example, calculating the total amount of population within each service area is an effective mechanism to quantify accessibility for each Palestinian city. Due to the isolated nature of the Jewish settlements chosen for analysis, there is an absence of significant Israeli population, economic activity and desirable destinations reachable within a 45-minute trip. Of the 5 major Israeli cities used as destinations in the Closest Facility Analysis, only Jerusalem is contained within any of the service areas depicted below. Furthermore, the volume of each service area is relatively insignificant due to lack of desirable activity centers for Jewish settlers within the West Bank aside from Jerusalem.

The case of Hamra is indicative of the many service areas calculated for each settlement. These service areas are quite extensive for each scenario, however they each fail to significantly penetrate into Israel, essentially meaning that no desirable destination is accessible within a 45-minute trip. The service areas generated for Scenario 2 and Scenario 3 are very similar in size with no significant disparity existing.

2.1 Elon Moresh

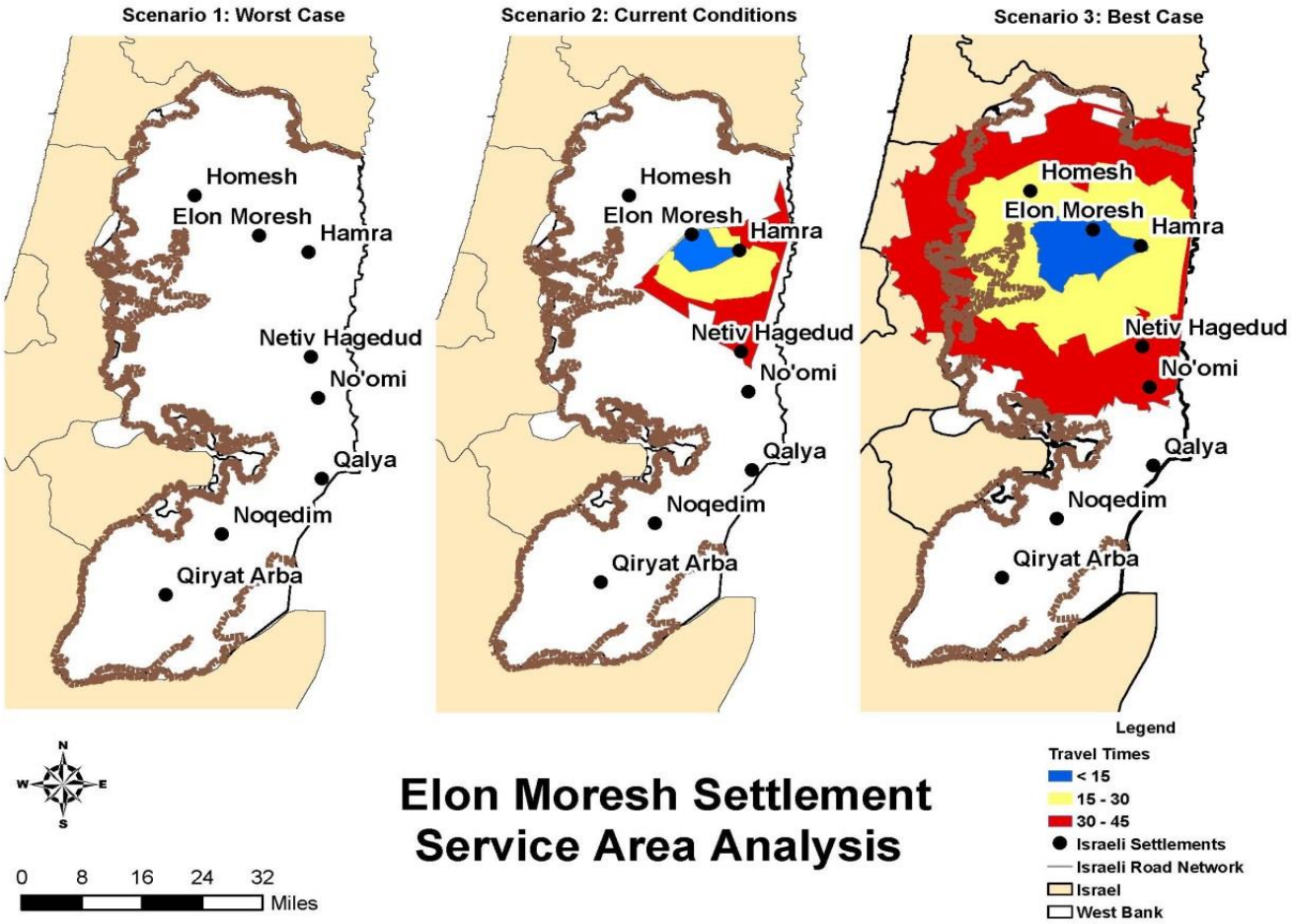


Figure 33: Elon Moresh Service Area Analysis

2.2 Hamra

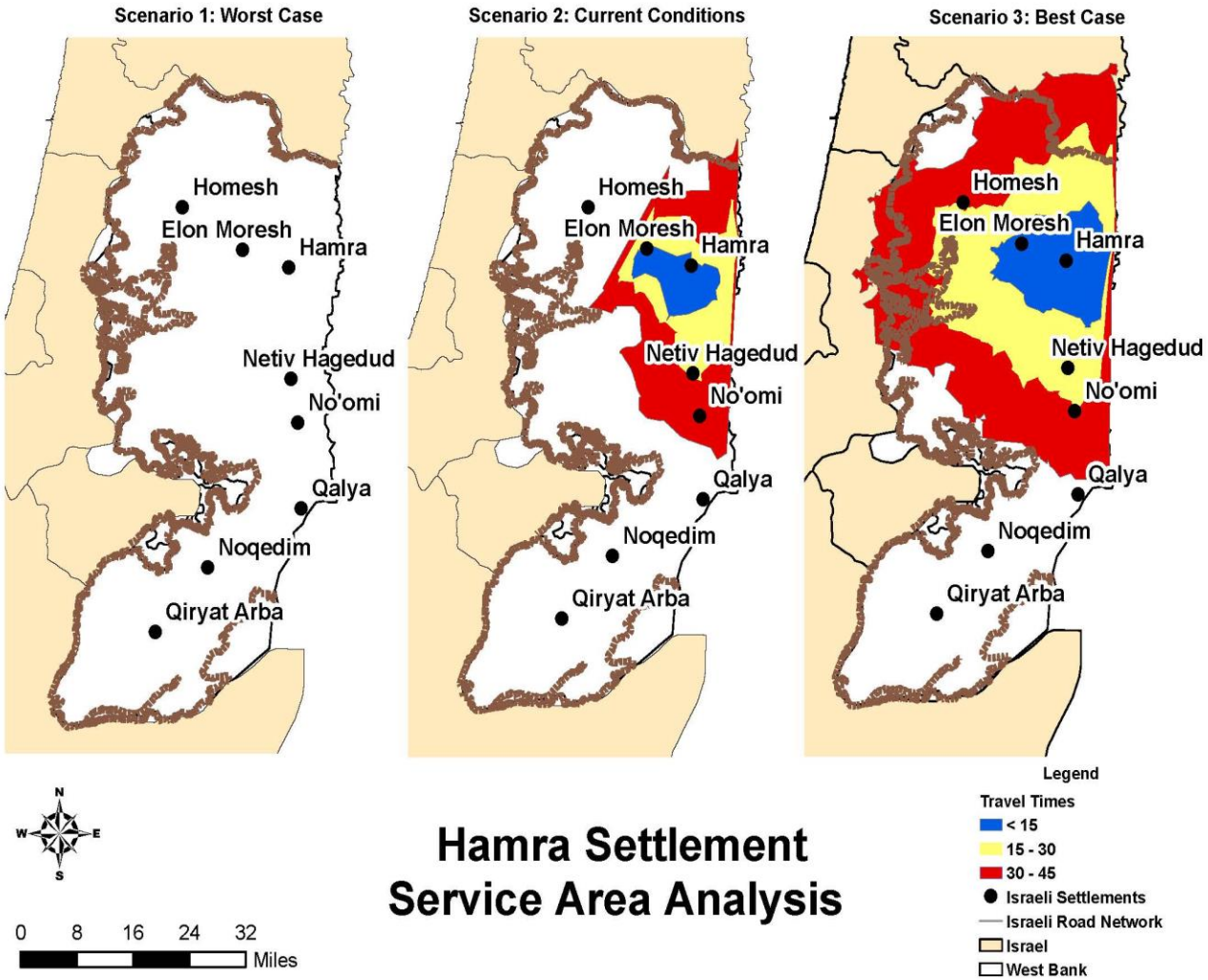


Figure 34: Hamra Service Area Analysis

2.3 Homesh

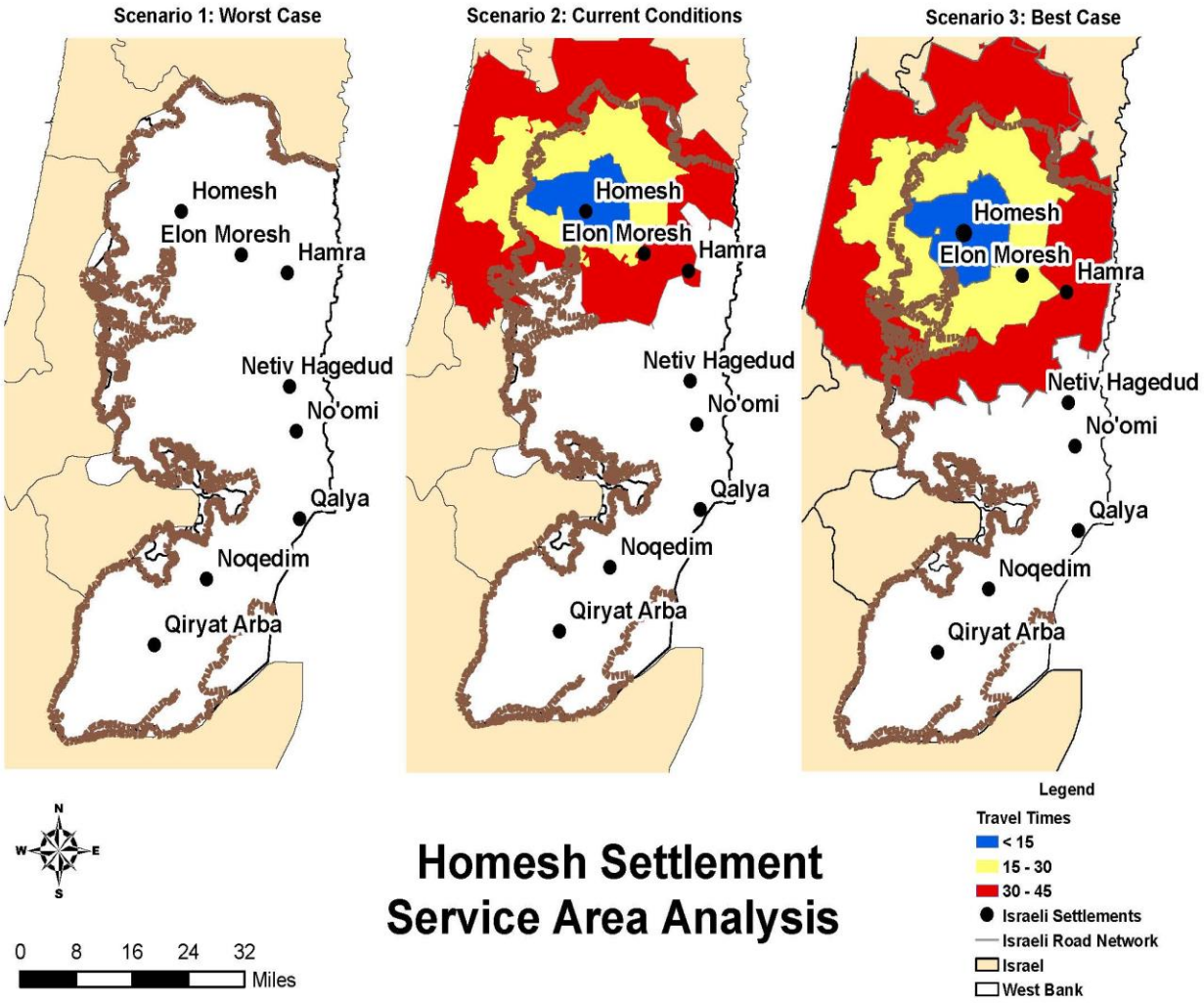


Figure 35: Homesh Service Area Analysis

2.4 *Netiv Hagedud*

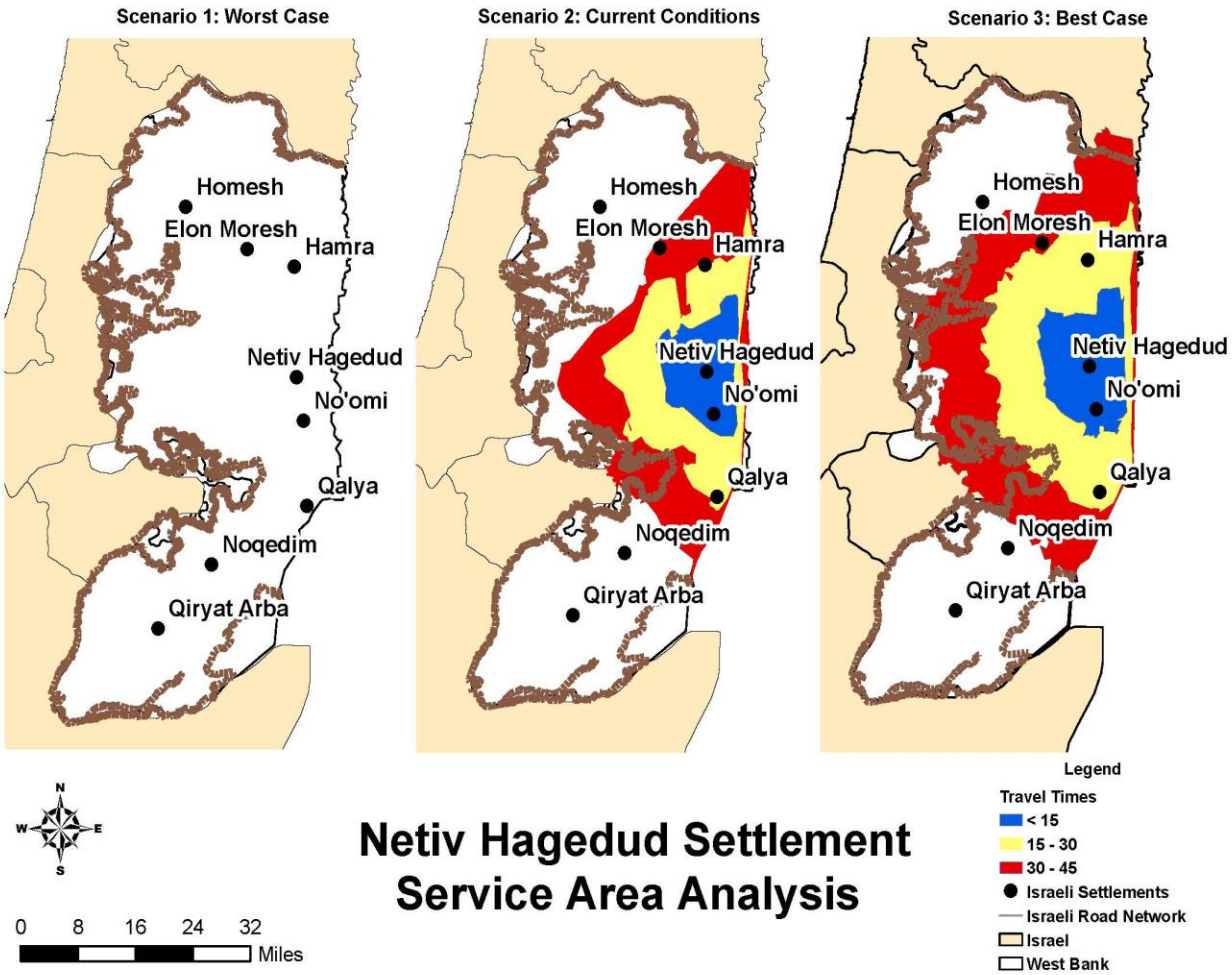


Figure 36: Netiv Hagedud Service Area Analysis

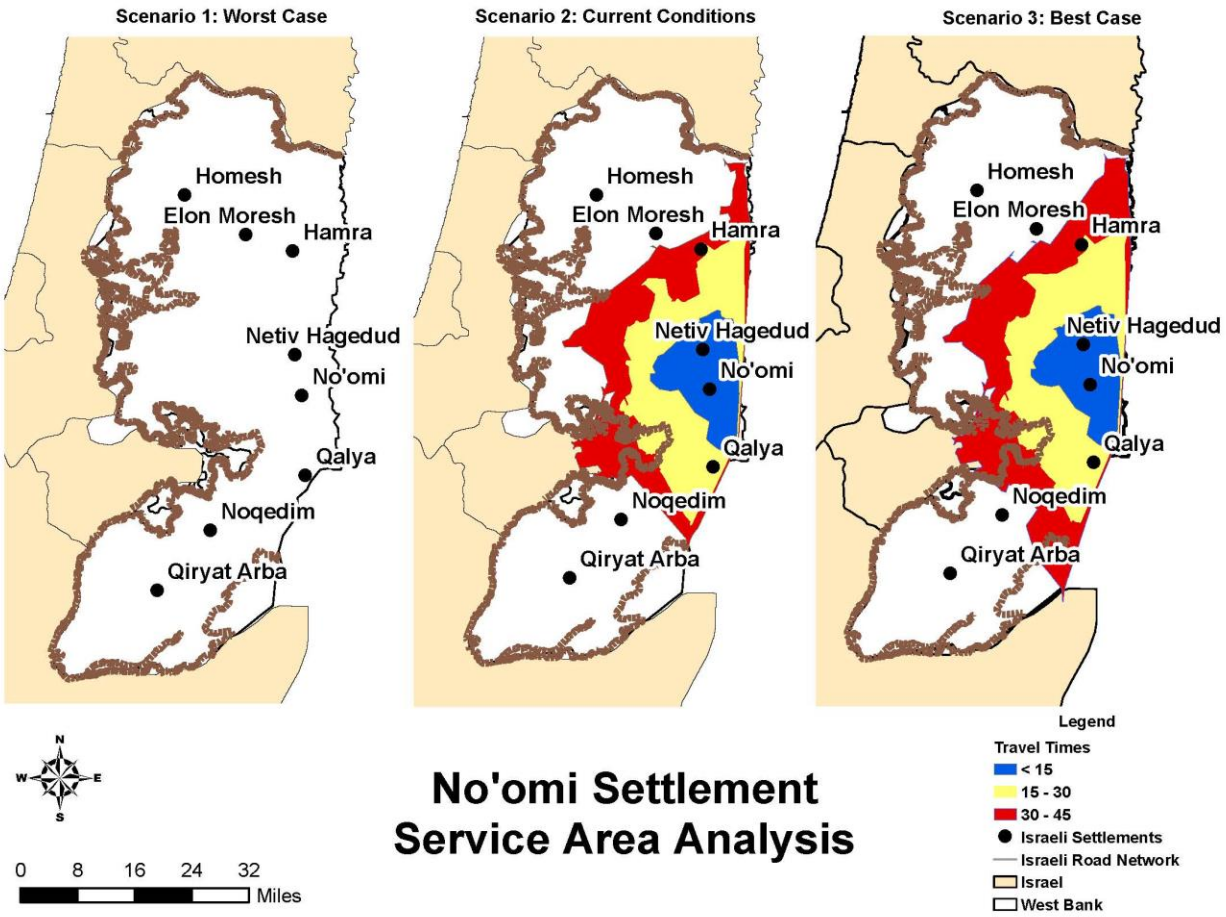


Figure 37: No'omi Service Area Analysis

2.6 Noqedim

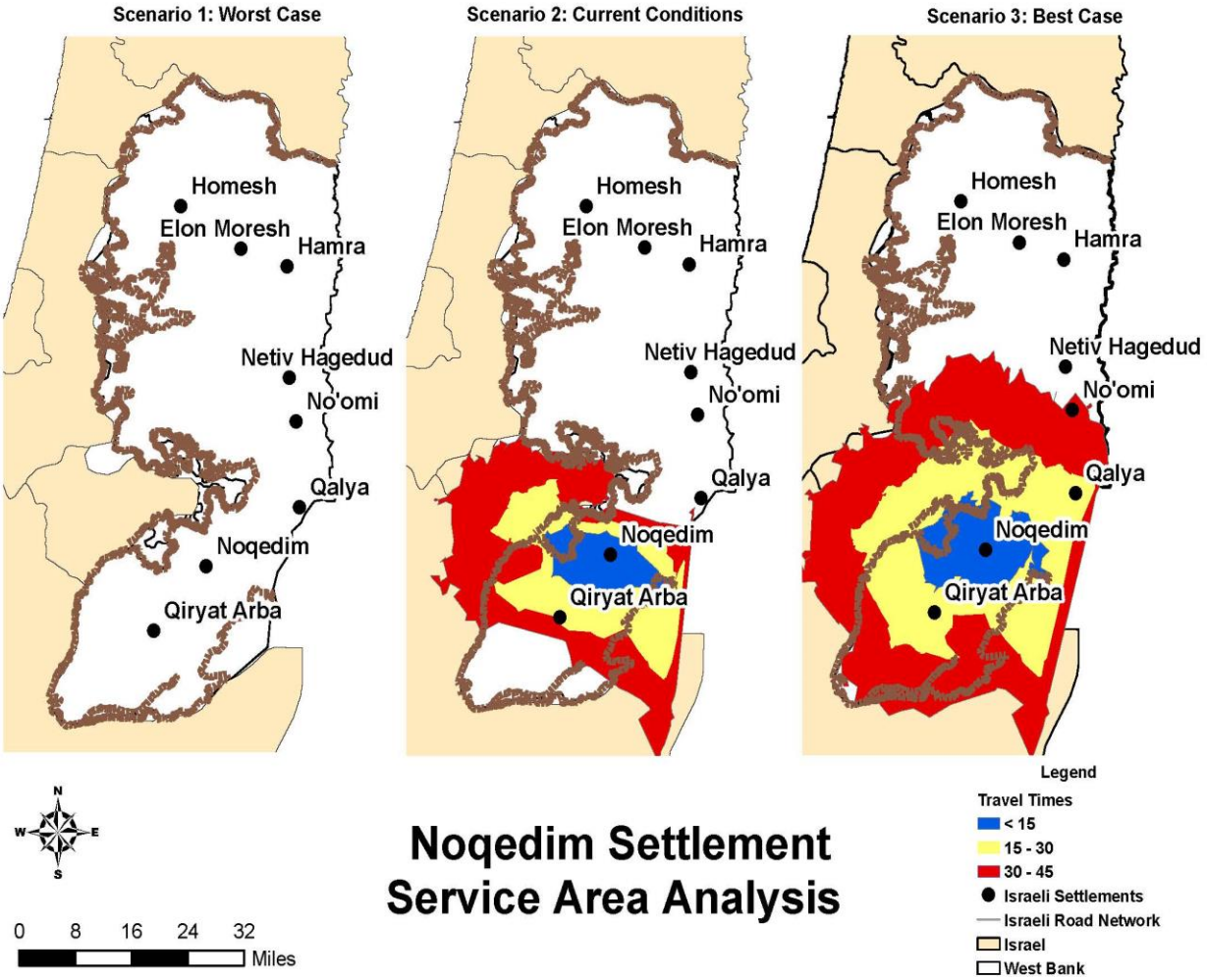


Figure 38: Noqedim Service Area Analysis

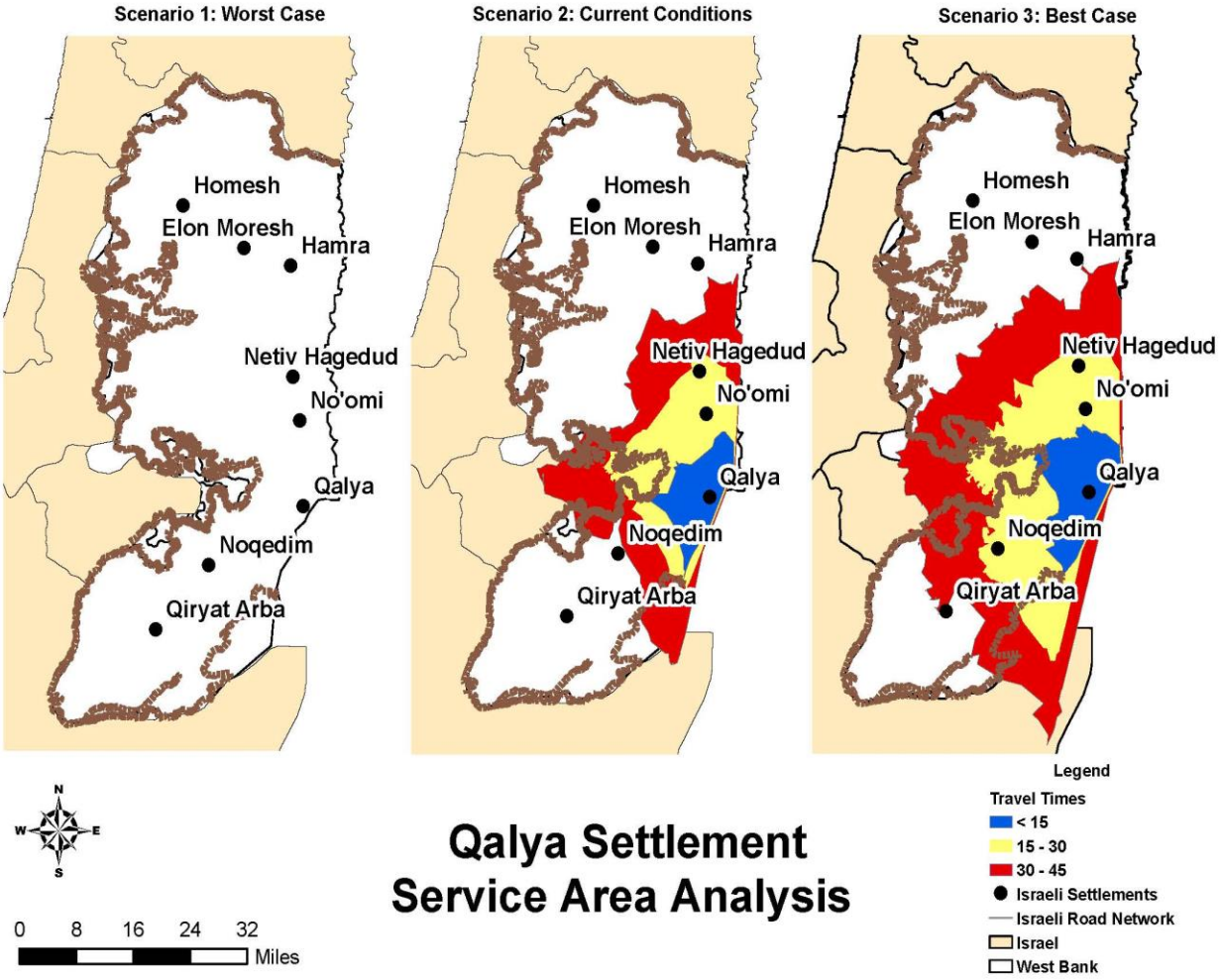


Figure 39: Qalya Service Area Analysis

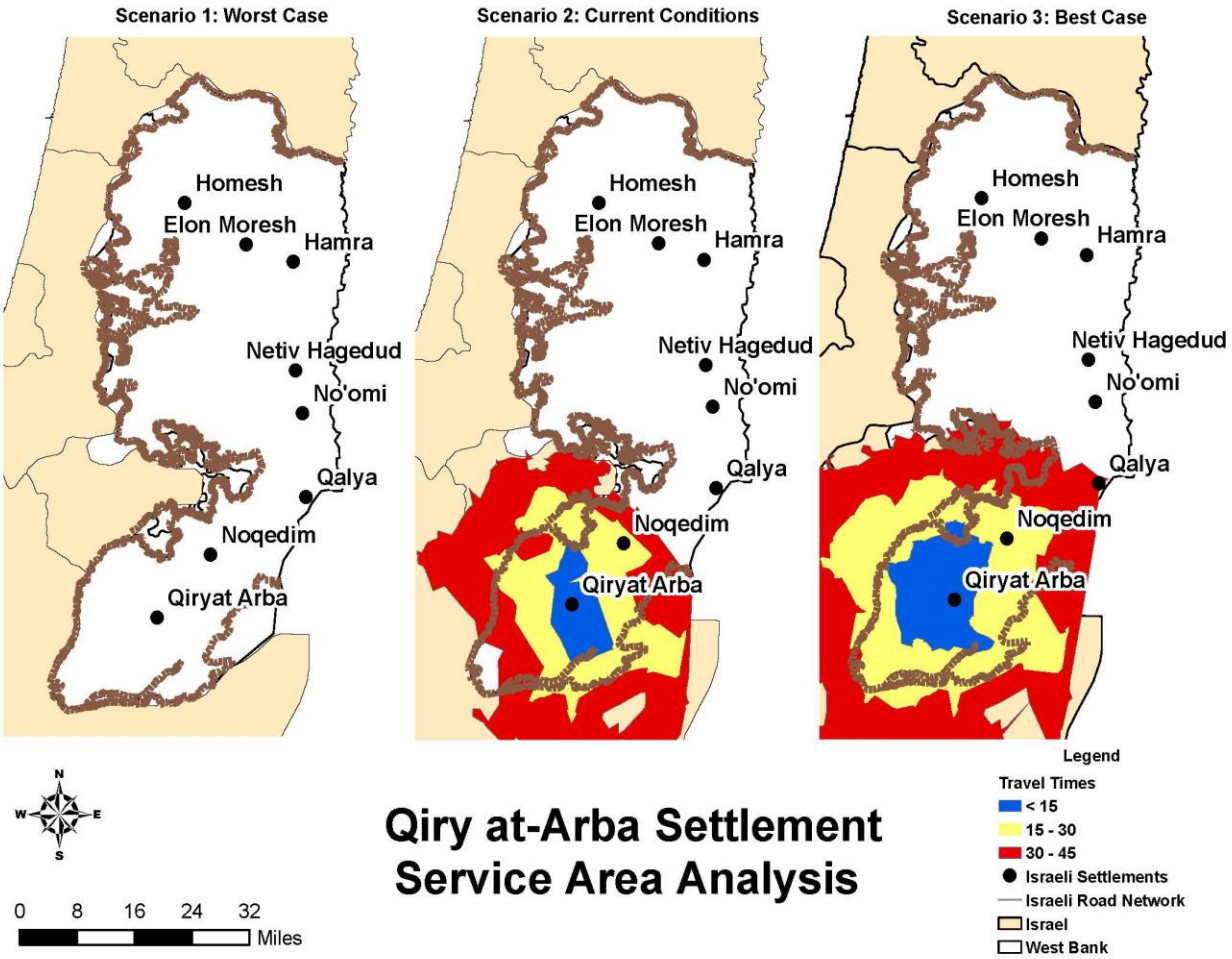


Figure 40: Qiry at_Arba Service Area Analysis

3. Palestinian Closest Facility Analysis

The Closest Facility Analysis determined the routes with the least amount of generalized time cost between each Palestinian city, generating a total of 64 or each Scenario 2 and Scenario 3. The conditions associated with Scenario 1 do not afford the opportunity to travel between the Palestinian cities, therefore no routes were generated for this scenario. The Palestinian network dataset was utilized in the analysis. For Scenario 2, roadblocks and roadgates were used as restrictions and the checkpoints added a 15-minute delay to the Travel Time. Aside from the security barrier, no restrictions or costs factored into the routes generated for Scenario 3.

3.1 Scenario 2

The table below summarizes the travel times of the least cost pathways generated through the Closest Facility Analysis that connects each Palestinian city under the existing restrictions and impedances.

Table 4: Results of the Palestinian Closest Facility Analysis for Scenario 2

City	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
Bethlehem	0.00	42.23	119.38	51.22	103.61	213.36	81.29	139.49
Hebron	42.23	0.00	148.62	80.45	132.85	242.59	110.52	168.73
Jenin	119.38	148.62	0.00	92.06	44.53	110.01	87.52	36.15
Jericho	51.22	80.45	92.06	0.00	76.29	186.04	53.97	112.17
Nablus	103.61	132.85	44.53	76.29	0.00	138.51	60.69	64.64
Qalqiliya	213.36	242.59	110.01	186.04	138.51	0.00	181.50	73.87
Ramallah	81.29	110.52	87.52	53.97	60.69	181.50	0.00	107.63
Tulkarm	139.49	168.73	36.15	112.17	73.87	73.87	107.63	0.00
Total	93.83	115.74	79.78	81.52	78.79	143.23	85.38	87.83

The map below highlights the least cost pathways generated from the Closest Facility Analysis connecting each of the eight Palestinian under the existing restrictions and impedances of Scenario 2, producing a total of 28 separate routes. Due to the substantial presence of restrictions and impedances, every route shares line segments signifying a common least cost pathway between each city, the individual routes are not distinguished from one another. As previously summarized in the Methodology section, all roadblocks and roagates are classified as impassible point restrictions and each checkpoint is passable but adds a 15-minute delay. The security barrier also acts as a constraint, limiting the potential pathways to the areas within the West Bank, leaving Israel completely inaccessible. Since travel through Jerusalem and its surrounding suburbs is made impossible due to the intrusive nature of the security battier, north-south

travel within the West Bank is forced to take circuitous routes detoured to the east of the security barrier passing through Jericho.

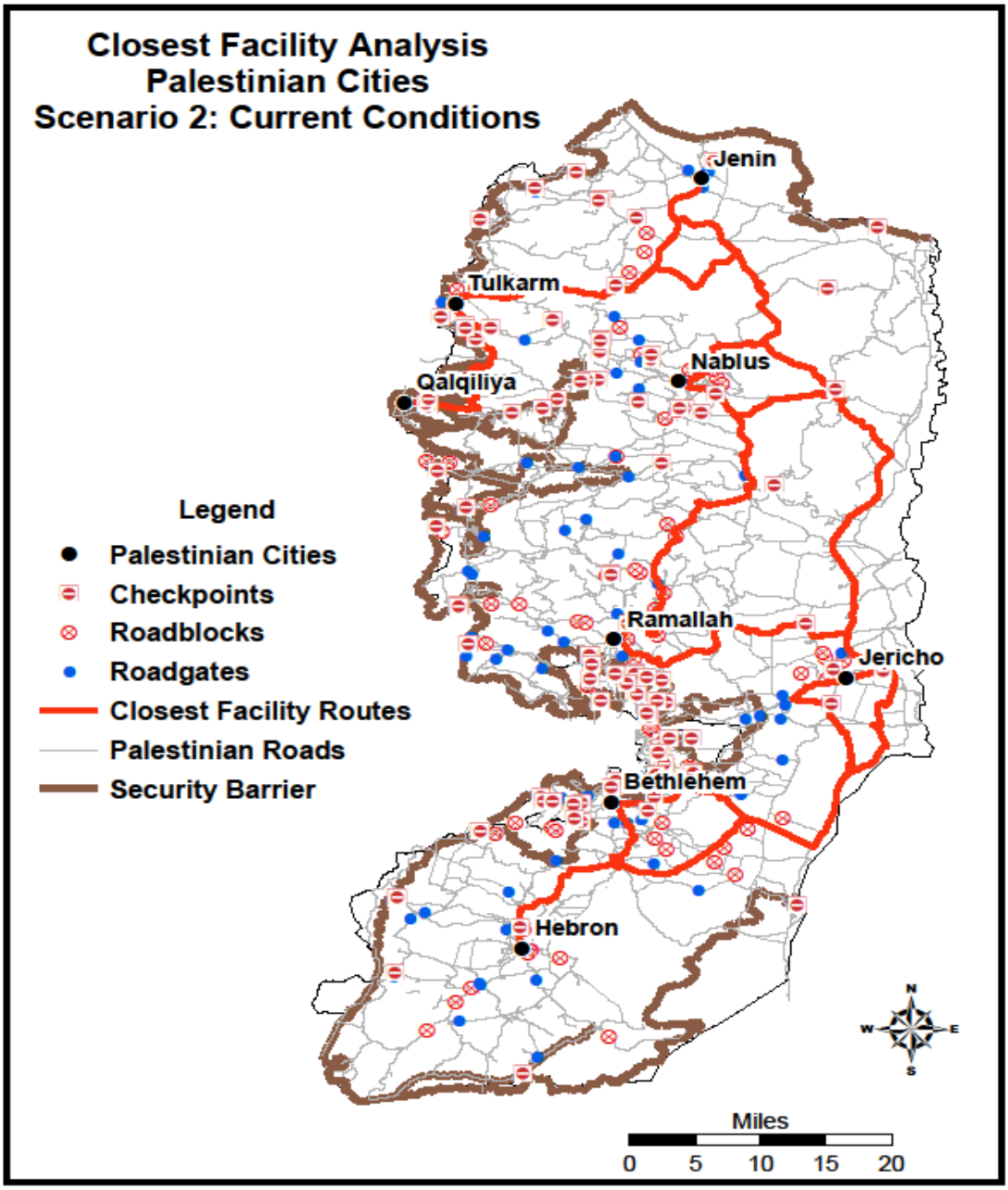


Figure 41: Palestinian Closest Facility routes for Scenario 2

3.2 Scenario 3

The table below summarizes the travel times of the least cost pathways generated through the Closest Facility Analysis that connects each pair of Palestinian cities with only the security barrier as restricting mobility.

Table 5: Results of the Palestinian Closest Facility Analysis for Scenario 3

City	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
Bethlehem	**0.00**	**25.57**	**105.70**	**36.75**	**80.57**	**107.72**	**59.11**	**106.94**
Hebron	**25.57**	**0.00**	**123.65**	**54.69**	**98.52**	**125.67**	**77.06**	**124.89**
Jenin	**105.70**	**123.65**	**0.00**	**68.96**	**36.68**	**49.42**	**73.80**	**34.45**
Jericho	**36.75**	**54.69**	**68.96**	**0.00**	**43.82**	**70.97**	**30.08**	**70.10**
Nablus	**80.57**	**98.52**	**36.68**	**43.82**	**0.00**	**27.15**	**37.12**	**26.37**
Qalqiliya	**107.72**	**125.67**	**49.42**	**70.97**	**27.15**	**0.00**	**64.27**	**25.20**
Ramallah	**59.11**	**77.06**	**73.80**	**30.08**	**37.12**	**64.27**	**0.00**	**63.49**
Tulkarm	**106.94**	**124.89**	**34.45**	**70.19**	**26.37**	**25.20**	**63.49**	**0.00**
Total	**522.36**	**630.05**	**492.66**	**375.22**	**350.22**	**470.42**	**404.93**	**451.53**

The map below highlights the least cost pathways generated from the Closest Facility Analysis connecting each of the eight Palestinian cities with the others without any of the existing restrictions or impedance aside from the security barrier. As in the map above for Scenario 2, each of the 28 routes share common line segments signifying common routes between cities, therefore the individual routes are not separately identified on the map. Since they were not factored into the analysis, the locations of checkpoints, roadblocks and roadgates are not highlighted.

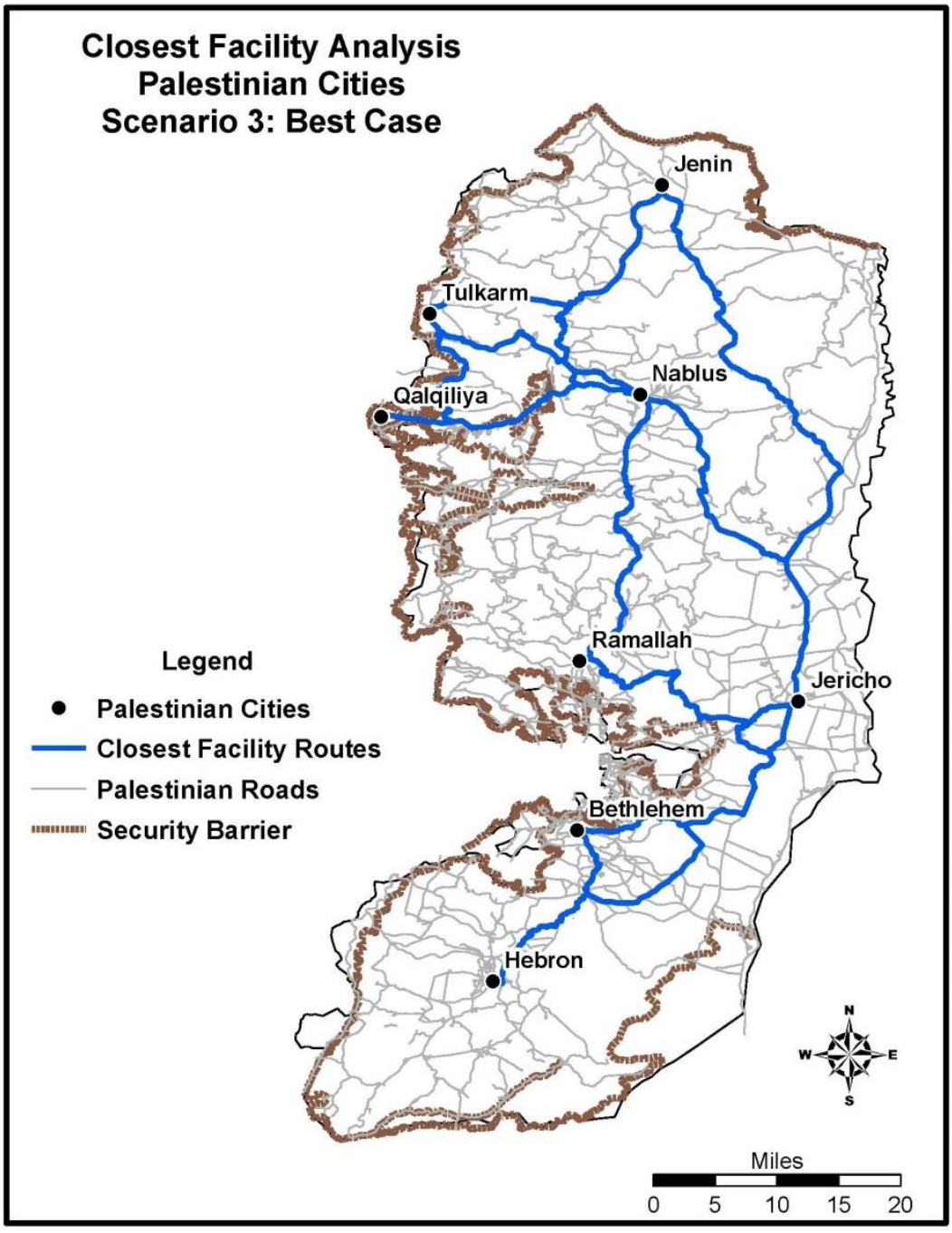


Figure 42: Palestinian Closest Facility routes for Scenario 3

4. Israeli Closest Facility Analysis

The Closest Facility Analysis determined the routes with the least amount of time cost between each Jewish settlement and the 5 major Israeli cities, generating a total of 40 routes for both Scenario 2 and Scenario 3. Due to the assumption that travel would be too dangerous for the isolated Jewish settlers if conflict were to resume, Scenario 1 was omitted from the analysis. The Israeli network dataset was utilized in determining the least cost routes for Scenario 2 as the Palestinian network dataset was used for Scenario 3. Just as no restrictions or impedances were activated in Scenario 3, mobility in Scenario 2 was only limited by a 15-minute delay for the checkpoints occurring on Israeli bypass roads and at certain crossing along the security barrier.

The chart below contains the results for the Closest Facility Analysis for both Scenario 2 and Scenario 3. The pathways are identified in the "Routes" column, with the name of the settlements appearing first connected with a hyphen to the destination city. Travel Times are measured in minutes. The differences and percent change between the time travels values for Scenario 3 and Scenario 2 are also shown on the chart with the averages of each column calculated in the last row.

Table 6: Israeli Closest Facility Analysis results for Scenario 2 and Scenario 3

Routes	Travel Time Scenario 3	Travel Time Scenario 2	Differ-ence	Percent Change
Elon Moresh - ASHDOD	84.92	102.59	17.67	-20.81%
Elon Moresh - BEER SHEVA	129.48	149.46	19.98	-15.43%
Elon Moresh - HAIFA	83.19	109.54	26.36	-31.68%
Elon Moresh - JERUSALEM	57.22	73.34	16.12	-28.17%
Elon Moresh - TEL AVIV - YAFO	55.28	72.96	17.67	-31.96%
Hamra - ASHDOD	91.37	105.20	13.84	-15.14%
Hamra - BEER SHEVA	131.97	142.90	10.93	-8.28%
Hamra - HAIFA	79.62	97.24	17.62	-22.12%
Hamra - JERUSALEM	56.92	61.04	4.12	-7.24%
Hamra - TEL AVIV - YAFO	61.73	75.57	13.84	-22.42%
Homesh - ASHDOD	84.77	81.60	-3.17	3.74%
Homesh - BEER SHEVA	133.28	128.47	-4.81	3.61%
Homesh - HAIFA	62.05	69.90	7.86	-12.66%
Homesh - JERUSALEM	82.77	90.26	7.49	-9.05%
Homesh - TEL AVIV - YAFO	54.82	51.96	-2.85	5.21%
Netiv Hagedud - ASHDOD	91.90	100.37	8.46	-9.21%
Netiv Hagedud - BEER SHEVA	111.57	116.50	4.93	-4.42%
Netiv Hagedud - HAIFA	99.03	105.59	6.56	-6.62%
Netiv Hagedud - JERUSALEM	38.29	45.33	7.04	-18.38%
Netiv Hagedud - TEL AVIV	71.15	85.34	14.19	-19.95%

No'omi - ASHDOD	85.32	93.28	7.96	-9.33%
No'omi - BEER SHEVA	102.79	107.51	4.72	-4.59%
No'omi - HAIFA	105.99	112.34	6.34	-5.99%
No'omi - JERUSALEM	29.51	38.37	8.86	-30.01%
No'omi - TEL AVIV - YAFO	76.92	89.81	12.88	-16.75%
Noqedim - ASHDOD	65.16	65.16	0.00	0.00%
Noqedim - BEER SHEVA	60.50	76.47	15.97	-26.40%
Noqedim - HAIFA	140.74	143.94	3.20	-2.27%
Noqedim - JERUSALEM	18.81	39.96	21.15	-112.42%
Noqedim - TEL AVIV - YAFO	70.68	70.68	0.00	0.00%
Qalya - ASHDOD	83.29	86.47	3.18	-3.82%
Qalya - BEER SHEVA	86.68	89.80	3.12	-3.60%
Qalya - HAIFA	127.69	131.41	3.71	-2.91%
Qalya - JERUSALEM	27.48	31.56	4.07	-14.83%
Qalya - TEL AVIV - YAFO	74.94	83.00	8.06	-10.76%
Qiryat Arba - ASHDOD	61.57	69.73	8.17	-13.26%
Qiryat Arba - BEER SHEVA	44.45	54.55	10.10	-22.73%
Qiryat Arba - HAIFA	146.43	148.52	2.09	-1.43%
Qiryat Arba - JERUSALEM	36.32	44.53	8.21	-22.62%
Qiryat Arba - TEL AVIV - YAFO	74.12	75.26	1.14	-1.53%
AVERAGE	**79.52**	**87.94**	**8.42**	**-14.41%**

4.1 Scenario 2

The map below highlights the routing of each least cost pathway under existing restrictions and impedances. With a total of 40 routes being generated for the Closest Facility Analysis, many share mutliple line segments, making it impossible to distinguish each indivdually on the map. This being so, each of the routes is simply depicted in red, with its origin and destination points distinguishable through the labeling of the settlements in black and the destination cities in labeled in red.

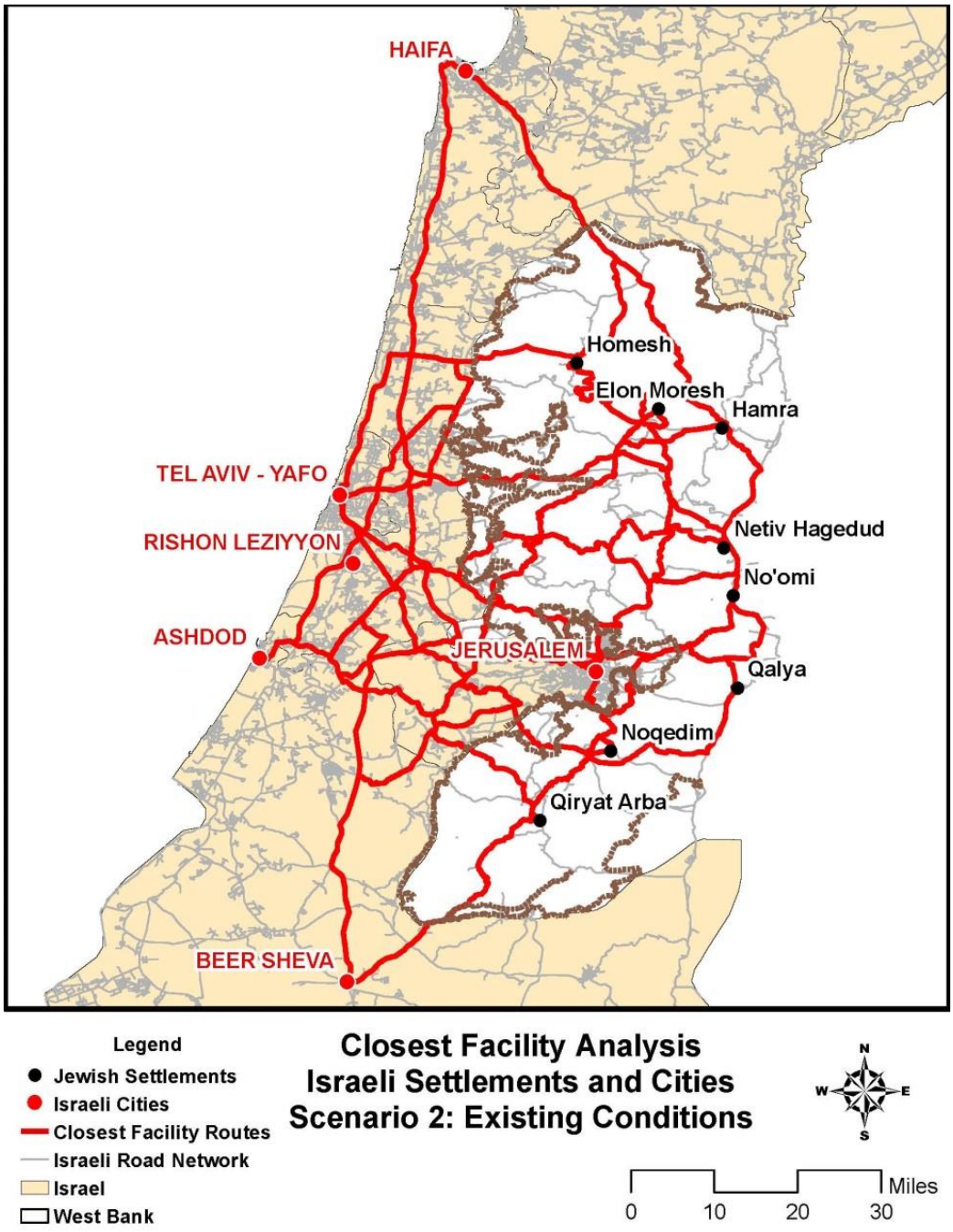


Figure 43: Israeli Closest Facility Analysis Scenario 2

4.2 Scenario 3

The map below displays the routing of each least cost pathway without any resrictions or impedances impacting mobility. As in previous maps, the number of routes and the overlap of line segments makes it difficult to highight the forty routes indvidually, therefore each pathway is summarized with a shared blue line. The origin and destination of the route can be seen through the labeling of the settlements and cities.

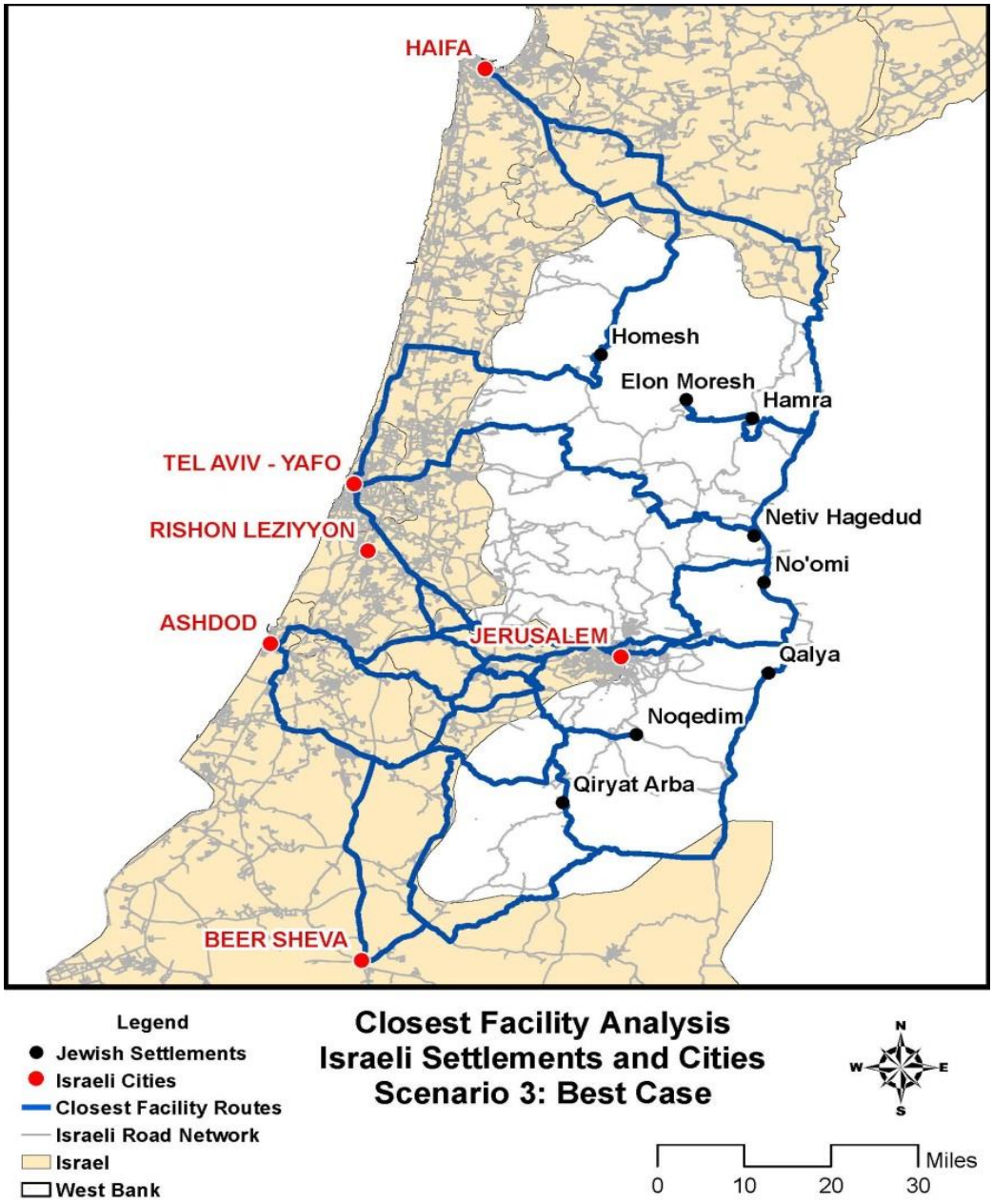


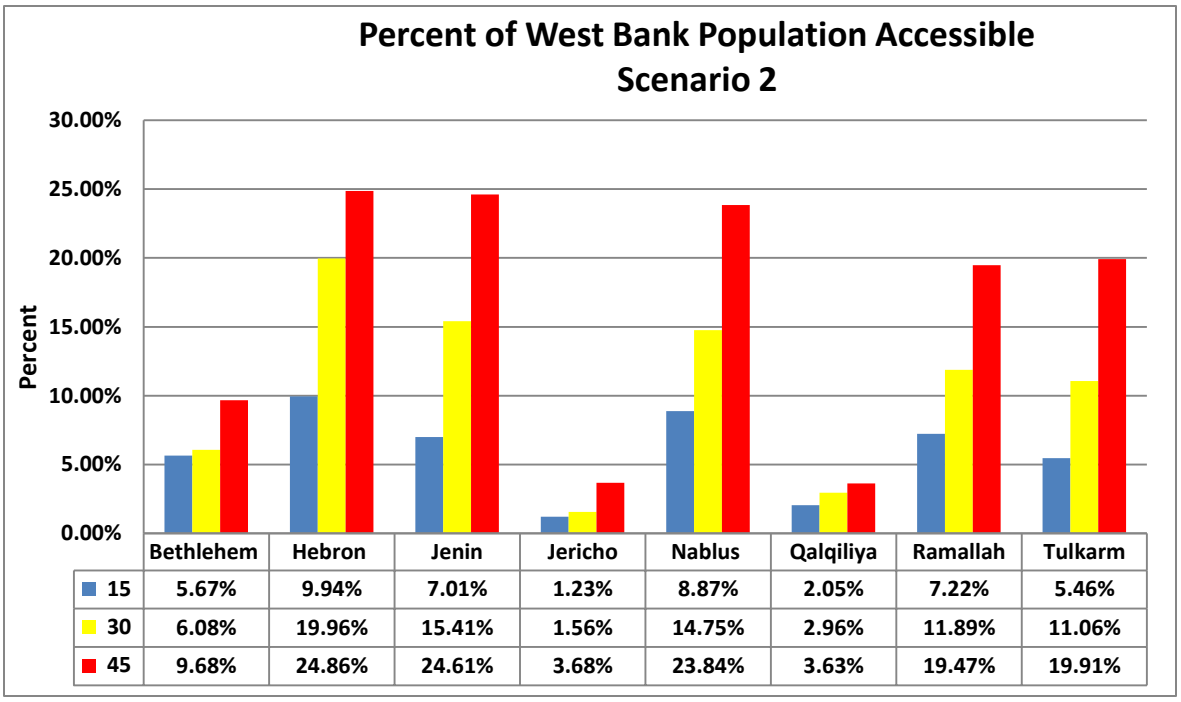
Figure 44: Israeli Closest Facility Analysis Scenario 3

V. Discussion

1. Palestinian Service Area Analysis

1.1 Palestinian Service Area Scenario 2

The graph below compares the percentage of Palestinian population within the West Bank accessible within each city's service area in Scenario 2. On average, 5.93% of the West Bank's population is contained within the service areas at the 15-minute threshold, 10.46% at the 30-minute threshold and 16.21% at the 45-minute threshold. This includes each city's own population. In each of the three timeframes, Hebron captures the highest proportion of the West Bank's population, followed closely by Jenin and Nablus. At the maximum 45-minute threshold, these three cities are accessible to nearly ¼ of the Palestinian population within the West Bank. Likewise, Ramallah and Tulkarm are accessible to nearly 20% of the population at the 45-minute timeframe, slightly above the 16.21% mean. Despite almost reaching the average percentage at the 15-minute threshold, Bethlehem falls far below the mean score for the 30-minute and 45-minute thresholds, only managing to capture a total of 9.68% of the population. Qalqiliya and Jericho contains the lowest percentage, with their service areas encompassing less than 4% of the population at their maximum thresholds.



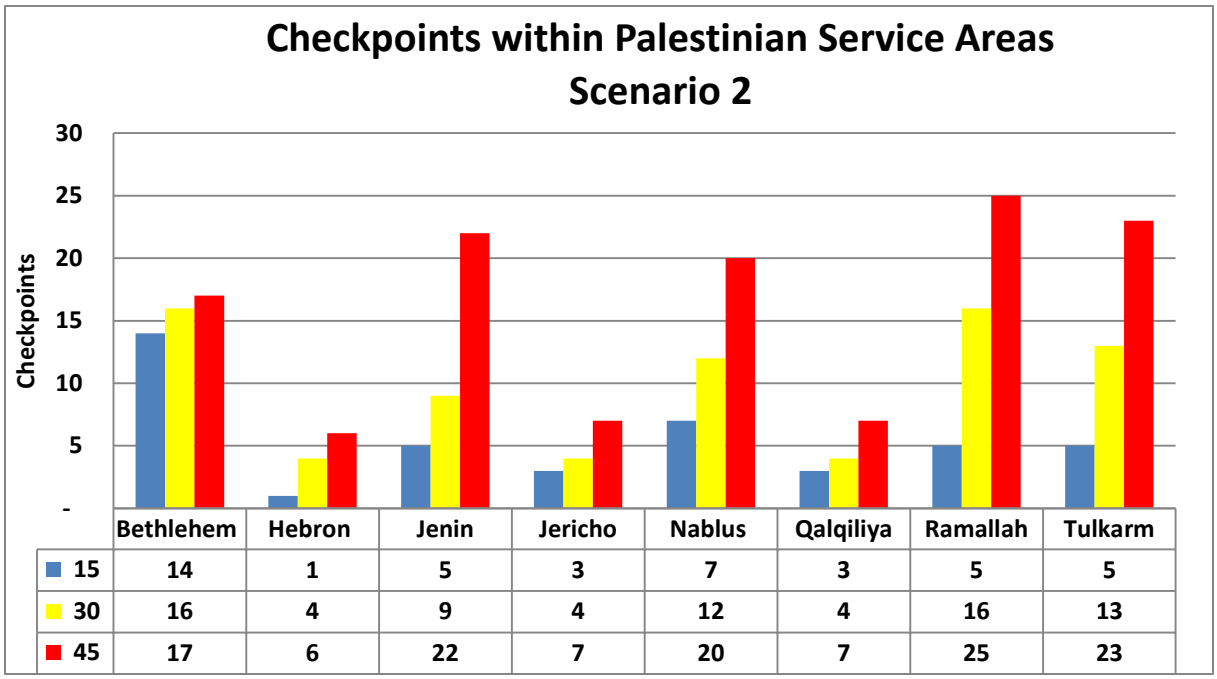
	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
15	5.67%	9.94%	7.01%	1.23%	8.87%	2.05%	7.22%	5.46%
30	6.08%	19.96%	15.41%	1.56%	14.75%	2.96%	11.89%	11.06%
45	9.68%	24.86%	24.61%	3.68%	23.84%	3.63%	19.47%	19.91%

Figure 45: Percent of West Bank Population Accessible, Scenario 2

As demonstrated in the graph above, there exists a large disparity between the degrees of accessibility for each city. Without the two least accessible cities, Jericho and Qalqiliya, the average population contained in each service areas increases from 16.21% to 20.45% at the maximum threshold. Upon closer examination, the route of the security barrier places Jericho and Qalqiliya at an inherent disadvantage, severely restricting their accessibility. As previously highlighted in the Results section, Qalqiliya is surrounded on all sides by the security barrier with a single road providing the only connectivity to the rest of the West Bank. Laden with checkpoints, this single route is clearly not an effective conduit to carry people and trade to and from Qalqiliya. Although not within the immediate proximity of the security barrier, accessibility to Jericho is also adversely impacted by the wall. The path of the security barrier reaches its maximum point of

intrusion as it wraps around Jerusalem, narrowing the width of Palestinian territory. The wall bars access to Jerusalem and impedes the most direct routes linking Jericho with Bethlehem and Ramallah, making them inaccessible within all timeframes.

Nablus, Jenin and Tulkarm possess the advantage of being within close proximity of each other, enabling their service areas to capture each other's populations without interference from the security barrier. Although isolated from the rest of the major cities in the southern portion of the West Bank, Hebron has the benefit of a proportionally high population within its boundaries. As the largest city in the West Bank, Hebron is home to nearly 250,000 Palestinians, contributing to its high degree of accessibility. In spite of possessing a population of only 27,000, Ramallah benefits from being within the Jerusalem metropolitan area, which is surrounded by numerous smaller localities along the security barrier. Similarly to Ramallah, Bethlehem has only about 25,000 inhabitants, but is situated to the immediate south of Jerusalem, separated only by the route of the security barrier. However, its service areas failed to capture populations from the Jerusalem metropolitan area to the same extent as Ramallah. The chart below, highlighting the number of checkpoints within each city's service areas, provides insight into why this occurred. With the security barrier making travel to the north and west impossible, the high number of checkpoints surrounding Bethlehem further impedes its service areas. At the 15-minute threshold, 14 checkpoints along the southern and eastern edge of Bethlehem stifle travel to and from the city. This is more than double the average of 6 checkpoints that occurred within all service areas at the 15-minute threshold.



	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
15	14	1	5	3	7	3	5	5
30	16	4	9	4	12	4	16	13
45	17	6	22	7	20	7	25	23

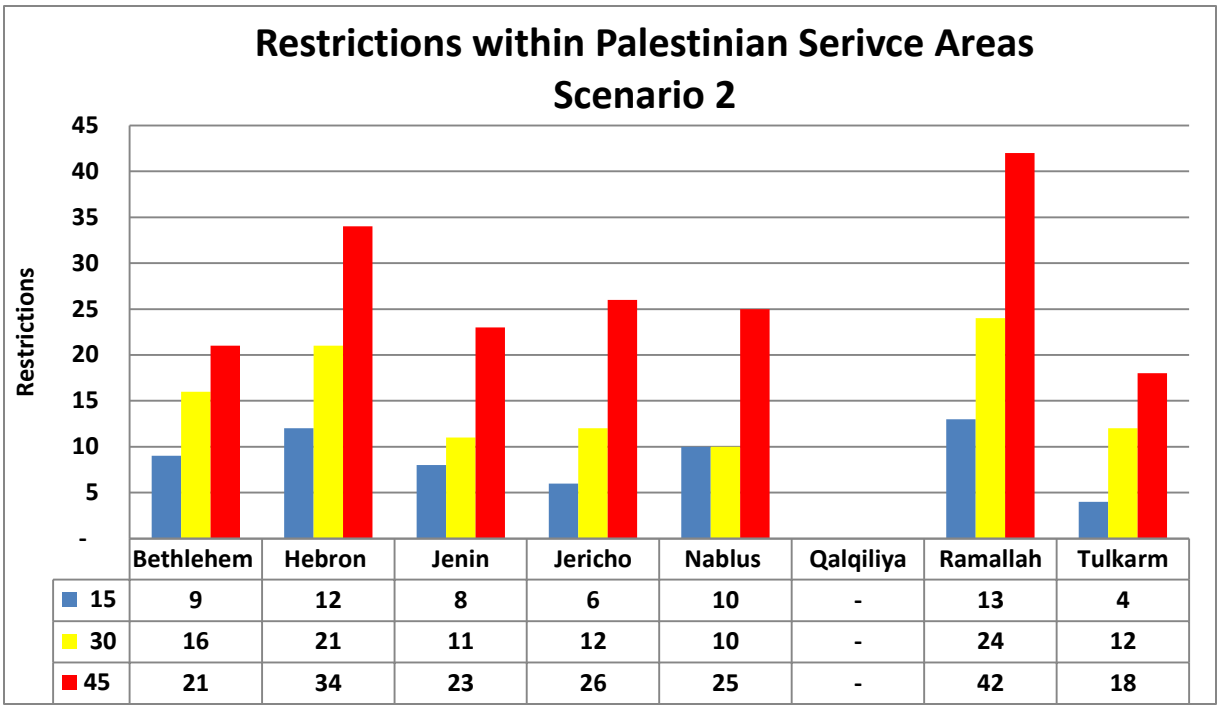
Figure 46: Checkpoints within Palestinian Service Areas, Scenario 2

In the case of Bethlehem, the prevalence of checkpoints surrounding the city can explain its position as the third least accessible city as its service areas failed to reach 10% of the West Bank's population in all three scenarios. Likewise, the lack of checkpoints surrounding Hebron enabled its service areas to reach a higher proportion of the population. The quantity of checkpoints occurring in each service area does not take into account their positioning and cannot solely be used to explain the mobility situation of each of the Palestinian cities. Qalqiliya possesses among the worst mobility conditions within the West Bank, yet it contains less than the average number of checkpoints in each threshold; the main obstacle is the security wall. In addition, the high numbers of checkpoints occurring in the 45-minute threshold for cities such as Jenin, Nablus, Ramallah and Tulkarm are due to the large size of their service areas and do not

accurately reflect their mobility conditions. Checkpoints that occur within the 15-minute threshold have the most impact in determining the size of the service areas generated for the 30-minute and 45-minute thresholds. These checkpoints lie closest to the cities, adding delay that is taken into account when calculating the extent of the 30-minute and 45-minute service areas. With 14 checkpoints inside Bethlehem's 15-minute service area, the city's 30-minute and 45-minute service areas were configured with the initial presence of a substantial delay.

As with the amount of checkpoints occurring in each service area, the number of restrictions (roadblocks and roadgates) must also be taken into context. The larger the service area, the more likely it will encompass a higher amount of restrictions. The graph below does not reflect the location of the restrictions as they occur around each city. Hebron has the second highest number of restrictions within its service areas, yet the majority are positioned to the south of the city where there are only minimal inhabitants. The restrictions surrounding Hebron are of little significance in determining its degree of accessibility. Conversely, the route of the security barrier and the strategic orientation of checkpoints work in conjunction to severely limit access to Qalqiliya, yet no restrictions are recorded within any of its service areas. On the other hand, the total amount of restrictions presents an accurate portrayal of the accessibility conditions associated with certain cities. With 42 restrictions occurring within its 45-minute threshold, Ramallah's maximum service area was prevented from extending into Nablus and garnering a higher proportion of the West Bank's population. Likewise, the hefty number of restrictions

placed around Bethlehem eliminates alternative routes, funneling traffic into roads that are regulated by the high number of checkpoints.



	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
15	9	12	8	6	10	-	13	4
30	16	21	11	12	10	-	24	12
45	21	34	23	26	25	-	42	18

Figure 47: Restrictions within Palestinian Service Areas, Scenario 2

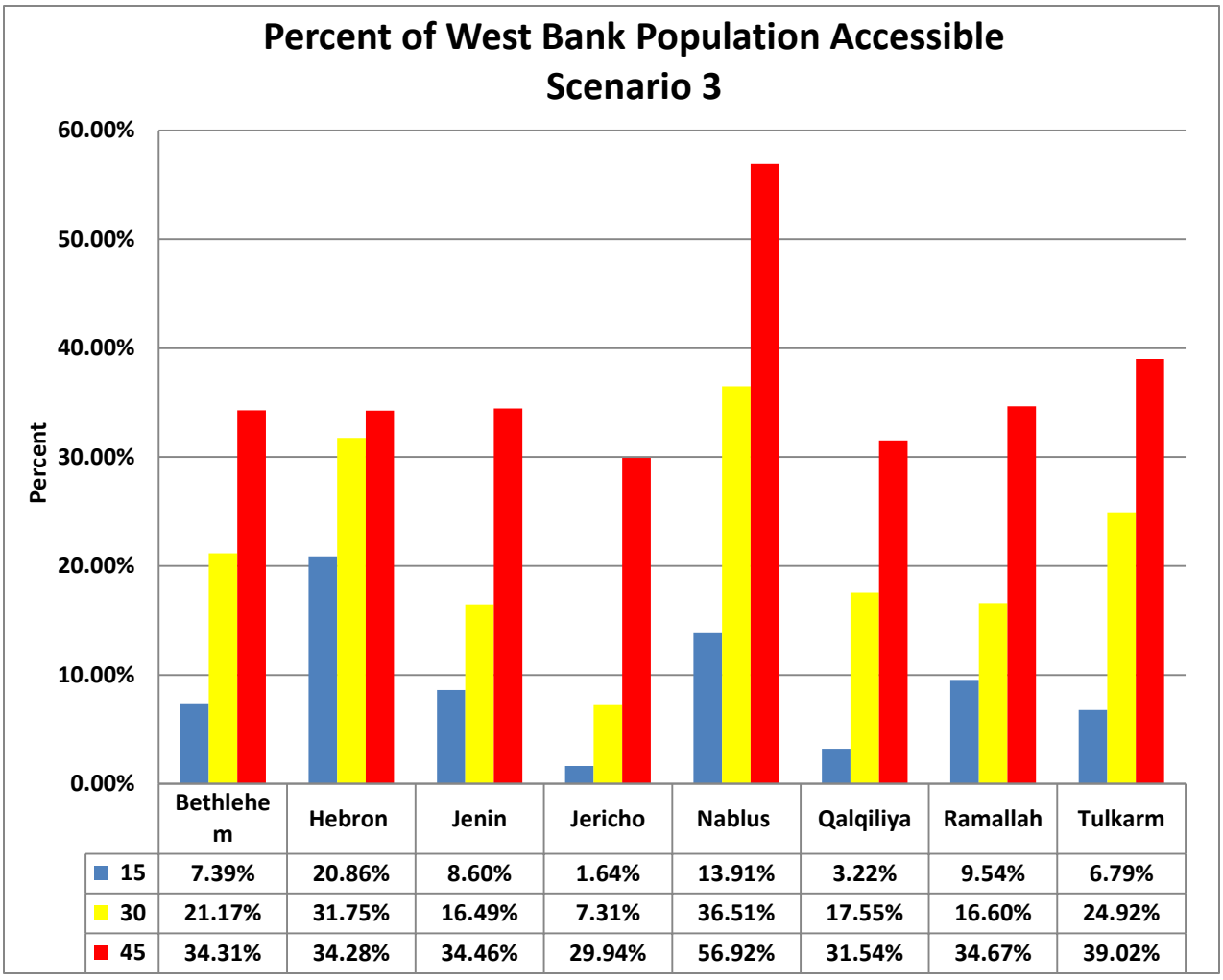
The amount of impedances and restrictions surrounding each city sheds light on determining which geographical region of the West Bank is the most restraining in its mobility conditions. Despite reaching nearly 20% of the West Bank population at its maximum threshold, Ramallah possesses a high concentration of roadblocks, roadgates and checkpoints within its service areas though this number decreases in the 30-minute and 45-minute thresholds. Jericho, Bethlehem and Ramallah are situated just across the security barrier from the Jerusalem metropolitan area and possess among the largest total amount of restrictions and impedances. Despite a dense concentration of people and

economic activity, the central portion of the West Bank within the vicinity of the Jerusalem metropolitan area is the least accessible. As previously discussed, in this area the security barrier is at its maximum point of intrusion, wrapping around Jerusalem and nearly cutting the West Bank in half. The prevalence of restrictions and impedances works in conjunction with the route of the security barrier to limit access between the Palestinian localities, essentially fragmenting these communities and isolating them from one another. As a major tourist destination and the largest city in Israel, ensuring the sanctity and security of Jerusalem is a vocal point of the Israeli government, which takes extra measures to ensure limited Palestinian accessibility to the city.

1.2 Palestinian Service Area Scenario 3

The graph below compares the percentage of the Palestinian population accessible within each city's service area in Scenario 3. With only the security barrier acting as a restriction, the service areas surrounding the 8 Palestinian cities were much larger, enabling them to reach a higher proportion of the West Bank's total population. On average, the service areas generated within the 15-minute threshold reach 8.99% of the population while the 30-minute timeframe contained 21.54% and the 45-minute timeframe 36.89%. Understandably, these percentages are significantly inflated when compared to the service areas generated in Scenario 2. When comparing the two settings, the percentages associated with Scenario 3 were more than double those of Scenario 2 in both the 30-minute and 45-minute thresholds. However, the difference between the two scenarios was only minor at the 15-minute threshold, with Scenario 3 only garnering a 3% improvement over Scenario 2. On an individual basis, the low percentage values

derived from the Jericho and Qaliliya service areas at the 15-minute threshold considerably drove the average down for both Scenario 2 and Scenario 3. In Scenario 2, Jericho was only accessible to 1.23% of the West Bank population and Qalqiliya was only slightly better at 2.05%. These values remain virtually stagnant despite the improved conditions of Scenario 3, with Jericho at 1.64% and Qalqiliya at 3.22%. Despite the absence of restrictions, the significance of the security barrier in restricting access cannot be understated even in Scenario 3. As explained in the previous section, Qalqiliya is surrounded by the barrier on all sides and the lack of checkpoints and roadblocks has virtually no impact on its accessibility in either Scenario 2 or Scenario 3. Wrapping around Jerusalem, the wall eliminates Jericho's quickest routes to Bethlehem and Ramallah, limiting its access to the densely populated Jerusalem metropolitan area.



	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
15	7.39%	20.86%	8.60%	1.64%	13.91%	3.22%	9.54%	6.79%
30	21.17%	31.75%	16.49%	7.31%	36.51%	17.55%	16.60%	24.92%
45	34.31%	34.28%	34.46%	29.94%	56.92%	31.54%	34.67%	39.02%

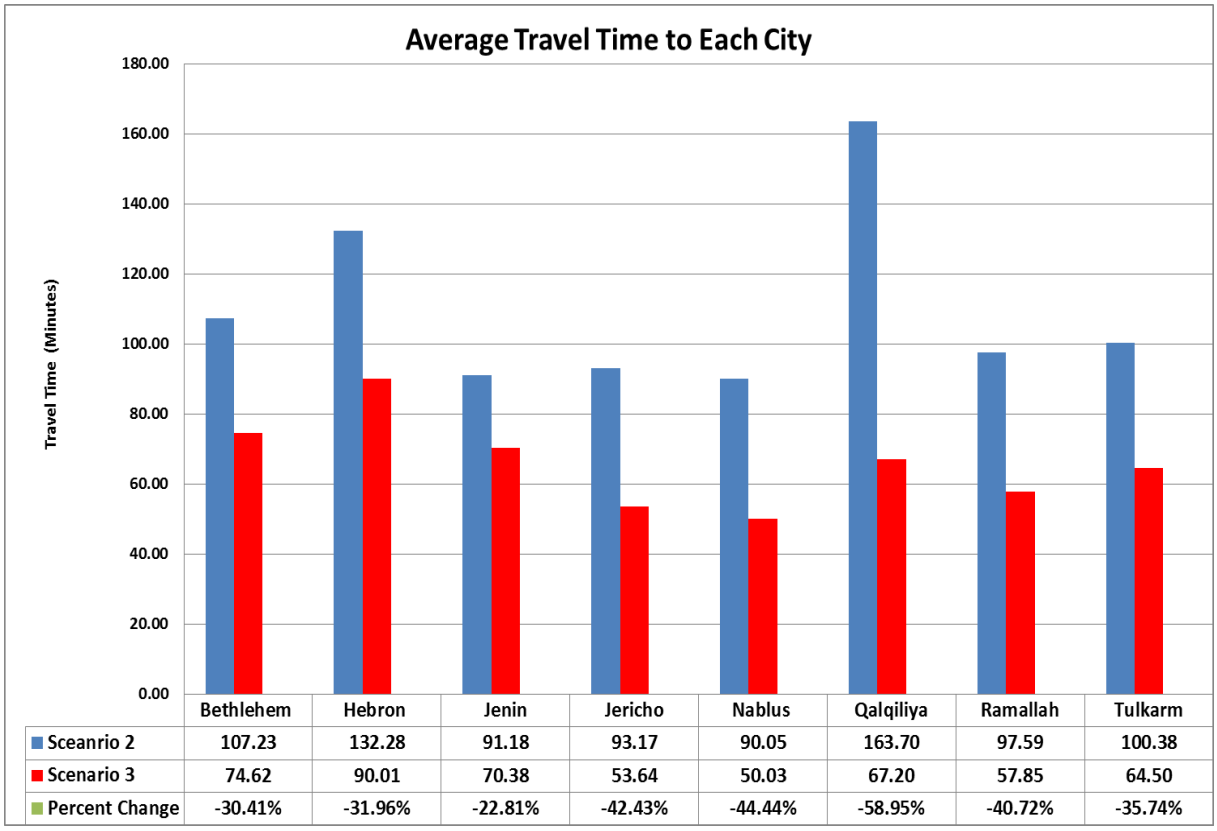
Figure 48: Percent of West Bank Population Accessible, Scenario 3

In spite of the security barrier's persistent influence on certain cities within the 15-minute thresholds, the absence of restrictions or impedances enabled each city to vastly improve its accessibility compared to the prior scenarios. With the improved conditions, Jericho's service areas reached a higher percentage of the West Bank population then Hebron which was the most accessible city in Scenario 2. Geographic location of the cities was the crucial determinant in rating accessibility for Scenario 3.

The clustering of 5 cities (Jenin, Nablus, Tulkarm and Qalqiliya) in the northern portion of the West Bank was responsible for their elevated values. Situated directly between Jenin, Nablus, Tulkarm and Qalqiliya, Nablus reached nearly 60% of the population. As the furthest city south, the Hebron's service areas were limited in the number of people they could contain. The cities heavily impacted by the high concentration of impedance and restrictions occurring with the Jerusalem metropolitan areas in Scenario 2, Bethlehem and Ramallah, were able to achieve greater access to this densely populated area in Scenario 3.

2. Palestinian Closest Facility Analysis

The graph and accompanying chart below depict the average travel time to each Palestinian city from all other cities based on the least-cost pathways generated in the Closest Facility Analysis. Time is measured by the minute as the red bars represent Scenario 2 and the blue bars Scenario 3. The Closest Facility Analysis created a total of 28 routes connecting each of the eight cities to one another. Therefore, each city served as the destination point of 7 routes not generated in its own analysis. The average travel times displayed in the graph below were derived from the travel times of these 7 routes. However, the routes which had the same city as the origin and destination (with a travel time of 0) were omitted from the average.



	Bethlehem	Hebron	Jenin	Jericho	Nablus	Qalqiliya	Ramallah	Tulkarm
Sceanrio 2	107.23	132.28	91.18	93.17	90.05	163.70	97.59	100.38
Scenario 3	74.62	90.01	70.38	53.64	50.03	67.20	57.85	64.50
Percent Change	-30.41%	-31.96%	-22.81%	-42.43%	-44.44%	-58.95%	-40.72%	-35.74%

Figure 49: Average Travel Time to each Palestinian city

The disparity between the travel time for the routes in Scenario 2 and the route in Scenario 3 is clearly exhibited. The average travel time under Scenario 2 is 109.45 minutes while the mean travel time under Scenario 3 is 66.03 minutes, meaning that the existing mobility restrictions and impedances increase travel time by over 65%. That is the equivalent of an hour long trip ballooning to encompass a 99 minute timeframe. Jenin is the only city where the difference in average travel times between Scenario 2 and Scenario 3 are relatively close with a 21 minute difference. Consistently, the least accessible Palestinian city through the previous section, Qalqiliya boasts the highest

discrepancy in average travel times, with the routes in Scenario 2 taking nearly 2.5 times longer than the Scenario 3 routes.

The chart below offers comparison between the travel times and routes generated by the Closest Facility Analysis for the city of Tulkarm using the least-cost pathway linking Tulkarm with the seven other Palestinian cities used in this study. The routes for Scenario 2 are highlighted in red and the routes for Scenario 3 shown in blue. The travel time to each city is displayed by the bars emanating from the destination points on top of the labeled names of the city. This demonstrates the contrast in travel times between the route generated for Scenario 2 and Scenario 3. The red bars positioned on the right of the city labels are the travel times for Scenario 2 as the blue bars are for the Scenario 3 values.

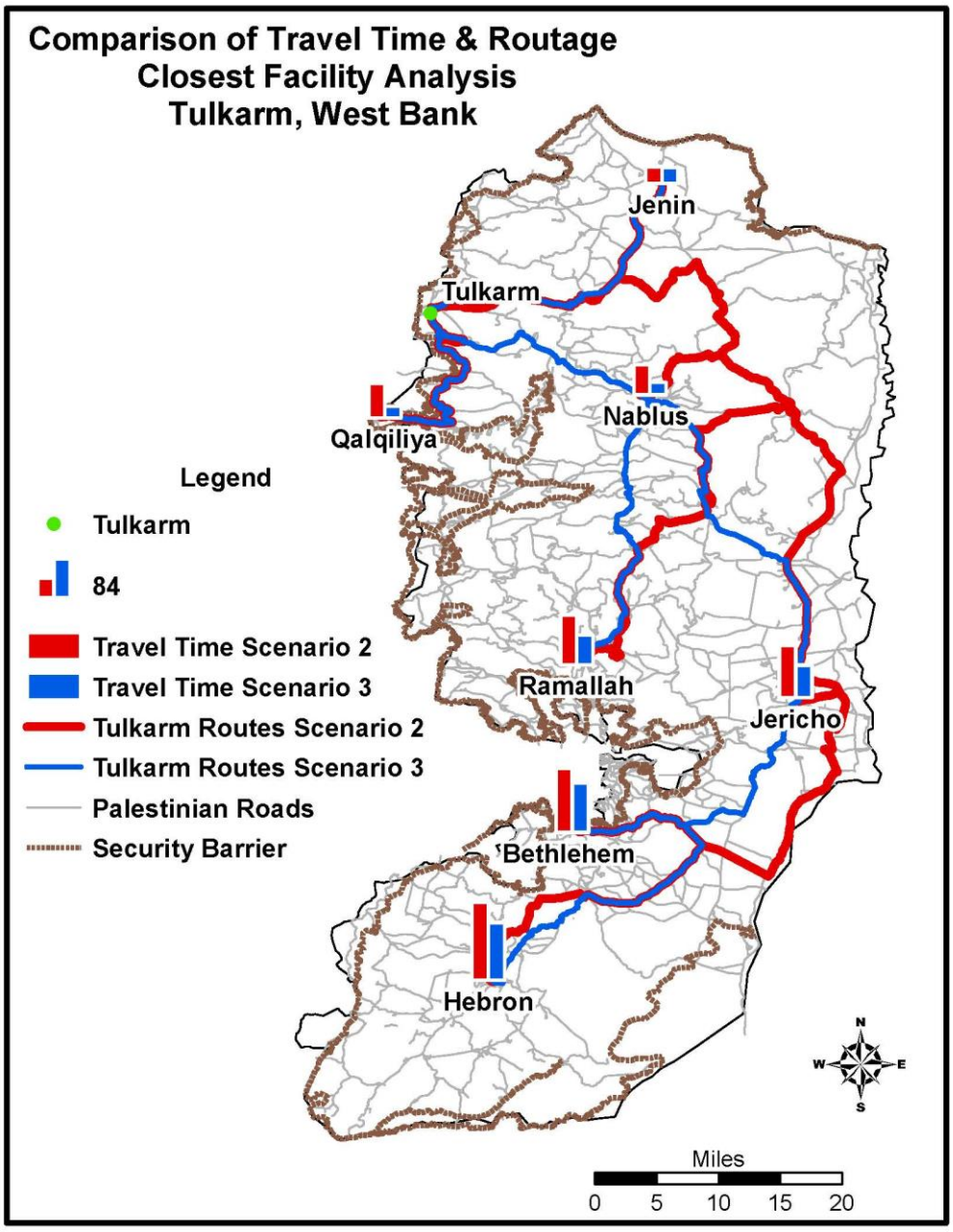


Figure 50: Comparison of travel times and routes, Palestinian Closest Facility Analysis

The primary purpose of the map above is to visually display how the locations of roadblocks, roadgates, checkpoints and the security barrier influence the course of movement between cities. Free from any interference, Palestinians are free to travel the

most direct routes when reaching desirable destinations, maximizing their efficiency by drastically cutting back on travel time. However, when the restrictions and impedances are in place, Palestinians are forced to endure long detours and unpredictable circumstances, traveling along regulated corridors that dramatically increase the total distance necessary to reach destinations. If accessing Nablus from Tulkarm, Scenario 3 allows unimpeded mobility along the most direct route while offering alternative courses of travel that increase connectivity, spreading traffic across a greater area and minimizing congestion along a single route. In contrast, Scenario 2 offers Palestinian travelers no choice in the route they take as the restrictions block access to alternatives, funneling everyone into a few major routes where movement is strictly regulated by checkpoints. Compared to the route in Scenario 3, the least-cost path generated for Scenario 2 adds considerable distance to the journey from Tulkarm to Nablus, causing the route to meander north towards Jenin, before turning west and finally cutting south to access Nablus from the northeast. In addition to the delays caused by each checkpoint, the indirectness of the routes further increases travel times by adding unnecessary distance. Furthermore, the minimal amount of connectivity between cities gives people no options in choosing the course in which they travel, compelling everyone to take the same route, contributing to high levels of congestion. Further hindering movement, long lines persist at every checkpoint as every traveler must stop and have their registration validated, adding further interruption to the trip.

3. Israeli Closest Facility Analysis

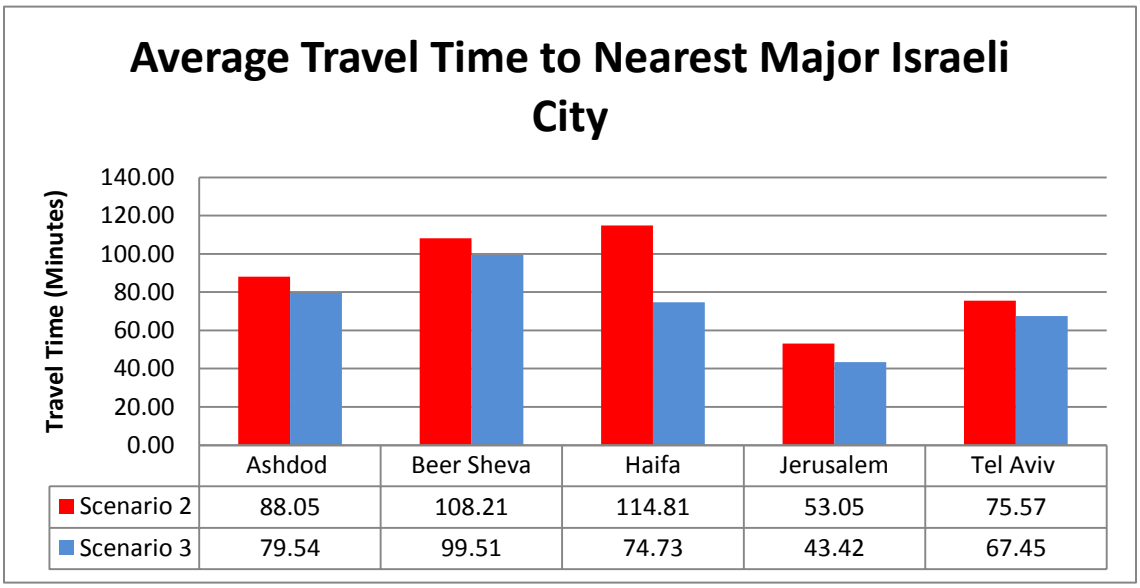
Unlike the Palestinian Closest Facility Analysis, which generates least-cost pathways between each of the eight cities, the Israeli Closest Facility Analysis connects the isolated Jewish Settlements to five major Israeli cities geographically dispersed throughout the nation. There exists a wide disparity between the service areas and least-cost pathways that evaluate Palestinian accessibility. The activation of restrictions and impedances offered a clear delineation in evaluating how each situation would affect mobility. Interpreting the Palestinian results through comparison, especially the differences in travel times between Scenario 2 and Scenario 3, was an ideal platform to analyze the relationship between accessibility and mobility constraints in place. However, the results gathered for the Jewish settlers are not as easily discernable. With no Scenario 1 analyzed here, the minimal number of checkpoints along the Israeli network was the only characteristic separating Scenario 2 and Scenario 3.

Although the differences in results were significantly less than those of the Palestinian Closest Facility Analysis, the least-cost pathways generated between the Jewish settlements and Israeli cities show that the Scenario 2 routes are on average just over 8 minutes longer than those for Scenario 3. Travel times diminished an average of 14.41% when the existing impedances and restrictions were absent from the Israeli network dataset. Cities centrally positioned within the spatial extent of Israel, such as Tel-Aviv and Jerusalem, were reachable within a shorter time from the majority of the settlements. Haifa, situated in the northern part of Israeli near the Lebanese border, and Beer-Sheva, the southernmost city analyzed, possessed longer travel times on average.

The travel times for both scenarios convey the remoteness of the 8 settlements as the average trip to Israeli activity centers was 79.52 minutes under the conditions of Scenario 3 and 87.94 minutes when the existing conditions of Scenario 2 are imposed. The results highlight the importance geographic position plays in influencing the prolonged travel times. The Israeli road network within the West Bank is highly efficient, considering its precarious situation in hostile land, offering Jewish settlers few delays aside from a limited number of checkpoints. The Israeli network allows Jewish settlers to bypass Palestinian restrictions and impedances, traveling along the most direct routes with speed limits reaching 50 miles per hour. However, these advantages cannot overcome the sheer isolation of the settlements.

Contrasting the travel times for each network under Scenario 3, the Palestinians' enjoy a higher degree of accessibility than the Jewish settlers, reaching major cities within an average trip of 66 minutes. Jewish settlers must travel an average of 79.5 minutes to access activity centers. Nevertheless, the harsh realities of the mobility restrictions imposed on the Palestinian population come to full fruition when the average travel times under existing conditions are compared. The maze of checkpoints and physical restrictions cause the average Palestinian travel time in Scenario 2 to dramatically rise, while Israeli network incurs a modest increase of only 8.42 minutes. Simply comparing the average travel times for Scenario 2 between the nationalities fails to highlight the impact of the mobility restrictions, as the average for the Palestinian network is 109.45 minutes and 87.94 minutes for the Israeli network. The true impact can be accurately measured by looking at the percent change from Scenario 3 to Scenario 2

each network experienced. The inclusion of the existing restrictions and impedances caused the average Palestinian travel time to increase nearly 66.03%, while the Israeli travel time only rose a slight 10.5%. Clearly, this differentiation demonstrates that the accessibility between major Palestinian activity centers is significantly more affected by the current mobility constraints than that of the Jewish settlers.

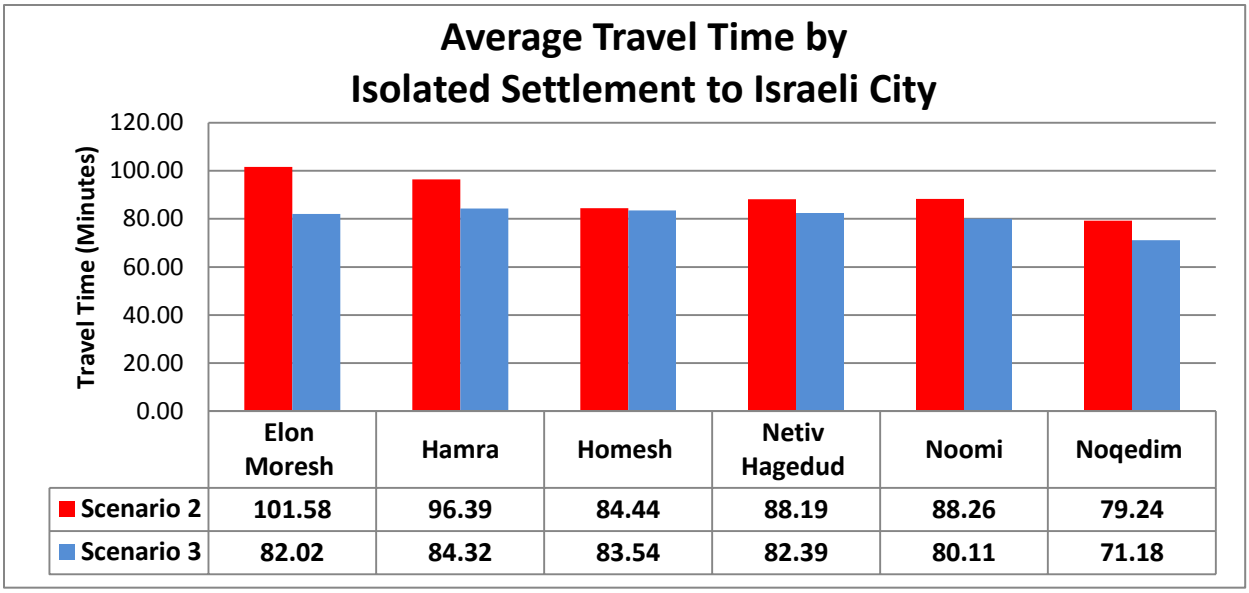


	Ashdod	Beer Sheva	Haifa	Jerusalem	Tel Aviv
Scenario 2	88.05	108.21	114.81	53.05	75.57
Scenario 3	79.54	99.51	74.73	43.42	67.45

Figure 51: Average travel time to nearest major Israeli city

As with the average travel times to major Israeli cities, the average travel time from each Jewish settlement is essentially determined by its geographic position within the West Bank and distance from the Israeli border. With the existing restraints imposed, it takes an average trip of 89 minutes to access any of the five major Israeli cities. Likewise, the average trip time is reduced to 80.6 minutes under the best case scenario. The consistency of these mean values essentially reinforces the logical assumption that

the most isolated settlements, situated deep inside the West Bank furthest from the Israeli border, are the least accessible due to their distance from major population centers. The existing mobility constraints have little impact on the degree of accessibility associated with each settlement. Boasting the only prominent difference in average travel time, the Elon Moresh settlement does highlight a notably deficiency of the Israeli road network. The Israeli network within the West Bank is limited in scope, offering the greatest connectivity to areas in close proximity to the security barrier and with high concentrations of settlements. Service is only extended to isolated settlements by providing connectivity with the closest major bypass road, making trips indirect and longer. In addition, isolated settlements such as Elon Moresh are more likely to face delays at checkpoints, as their orientation away from major bypass roads and in close proximity to Palestinian populations increases the likelihood of illegal access to prohibited roadways by Palestinians. Essentially, the Israeli military is compelled to establish checkpoints where minor arterials feed into the major bypass roads. The only way settlers from Elon Moresh can link into the system of bypass routes is to access them via minor Israeli roads which are more susceptible to incursion from Palestinian travelers. As a result, the Israeli military regulates access to its network by setting up checkpoints before these minor roadways intersection the bypass roads, inspecting all permits before allowing anyone entrance. Despite this feature, the indirect routing and checkpoints only increased the Elon Moresh settlers' average travel time by 19 minutes.



	Elon Moresh	Hamra	Homesh	Netiv Hagedud	Noomi	Noqedim
Scenario 2	101.58	96.39	84.44	88.19	88.26	79.24
Scenario 3	82.02	84.32	83.54	82.39	80.11	71.18

Figure 52: Average travel time by Jewish Settlement

The chart below specifies which Israeli city is most accessible to each of the Jewish settlements. Only separated from the West Bank by the security barrier, Jerusalem is reachable in the lowest travel time by 6 of the 8 settlements. As the most northern points of analysis, Haifa is the closest major metropolitan areas to the Homesh settlement. The only peculiar pairing is that of Elon Moresh and Tel-Aviv. Just south of Homesh, the travel time between Elon Moresh and Haifa is only slightly larger than the travel time between the settlement and Tel-Aviv. Comparison of travel times between the Scenario 2 and Scenario 3 reveals a large disparity between the values for Noqedim as existing impedances add nearly 21 minutes to the trip. Although only about 20 miles in length, it takes nearly 40 minutes to reach Jerusalem from Noqedim under Scenario 2 versus 18.81 minutes in Scenario 3, a 55% rise. In addition to Elon Moresh (as explained in the preceding paragraph), Noqedim stands as the only settlement to have its

accessibility considerably affected by the current mobility constraints, as its route in Scenario 2 is delayed and elongated by the occurrence of checkpoints.

Table 7: Comparison of travel times to closest Israeli city, Scenario 2 and Scenario 3

Settlement	Closest City	Travel Time Scenario 3	Travel Time Scenario 2
Elon Moresh	Tel-Aviv	55.28	72.96
Hamra	Jerusalem	56.92	61.04
Homesh	Haifa	62.05	69.90
Netiv Hagedud	Jerusalem	38.29	45.33
Noomi	Jerusalem	29.51	38.37
Noqedim	Jerusalem	18.81	39.96
Qalya	Jerusalem	27.48	31.56
Qiryat Arba	Jerusalem	36.32	44.53

The map below compares the closest facility routes generated for the No'omi settlement; its location is distinguished in green. The Scenario 2 least-cost pathways are highlighted in red while the Scenario 3 routes are depicted in blue. The total travel time to each city is displayed by the bars emanating from the destination points on top of the city labels. No'omi's accessibility conditions are indicative of the results produced from the Closest Facility Analysis for the other settlements. Travel times and routes connecting the isolated settlements with the major Israeli cities. The travel times for each scenario are nearly identical. The routing to each Israeli city persistently overlaps as travel times

for each scenario are nearly identical, with Beer-sheva and Haifa standing as the only disparity. Overall, the impact of the checkpoints is marginal, yet they decisively influence the route from No'omi to Beer-Sheva. In accessing Beer-sheva, the route generated for Scenario 3 is directly oriented towards its destination, proceeding from No'omi directly south along the Jordan Valley until it turns southwest, crossing the security barrier on two occasions before reaching its terminus. In contrast, the route generated under the existing impedances follows an indirect path, snaking west through Jerusalem into Israeli, where it meanders south towards Beer-sheva. Under current conditions, the route taken by Scenario 3 is interrupted by two checkpoints at the points where it passes through the security barrier, adding a 30 minute delay. Although their overall influence is slight, the Israeli mobility constraints do impede the accessibility of Jewish settlers in certain instances. In the case of No'omi, the occurrence of checkpoints simply increased its least-cost pathway to Beer-sheva in Scenario 2, increasing the travel time a mere 5 minutes above the Scenario 3 level.

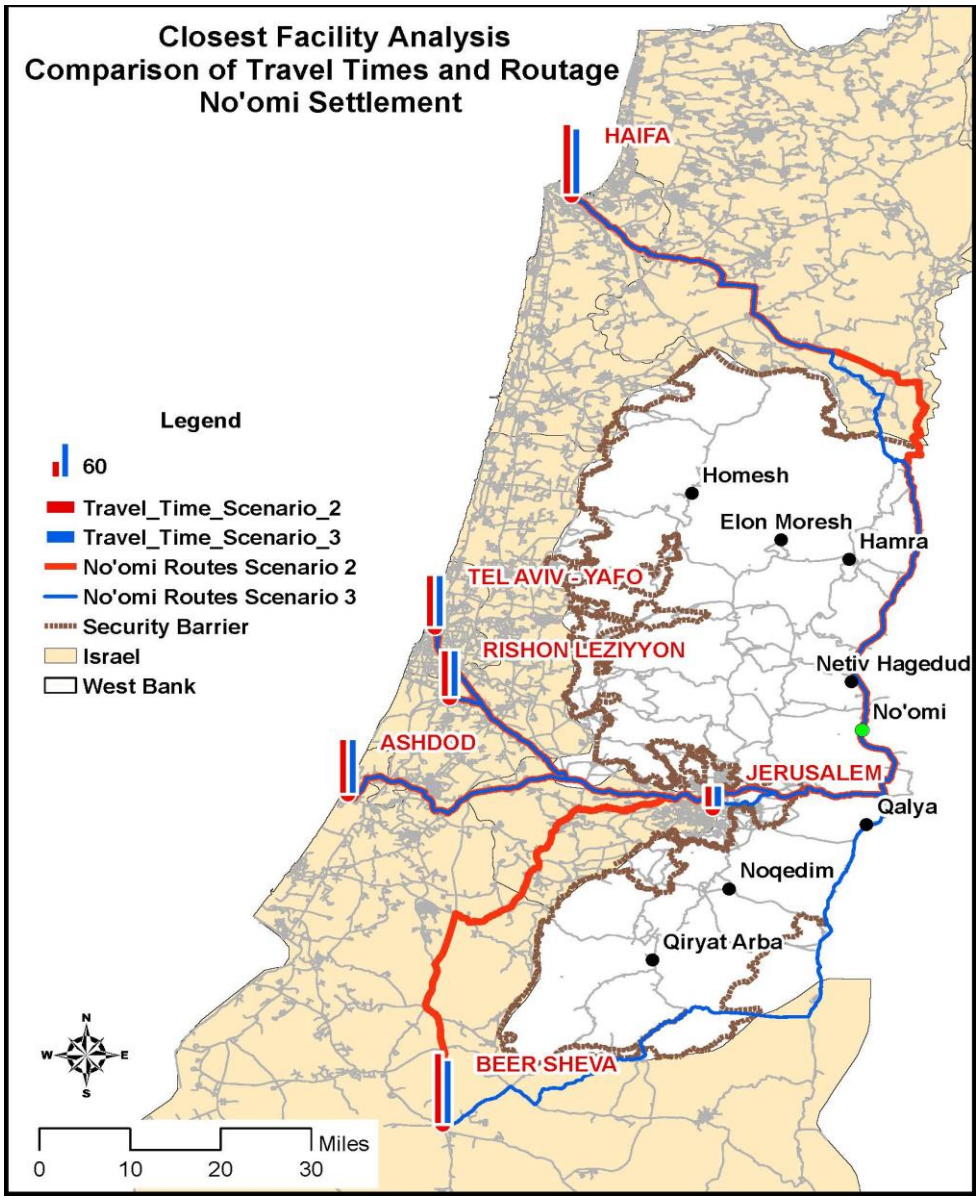


Figure 53: Closest Facility Analysis travel times and routes, No'omi settlement

VI. Conclusion

1. Summary of Study

This study assessed how the current policies resulting from the political response to the ongoing Israeli-Palestinian conflict impact the mobility and access of both the Palestinian and Israeli populations in the West Bank. The concept of accessibility was introduced as a mechanism from which to measure, evaluate and compare the effects of these mobility constraints implemented by the Israeli military. Although a widely studied and utilized term within transportation planning, there is no universally held definition of accessibility or a single preferred process to measure it. Due to the lack of data resources and availability of complex modeling software, the Network Analyst extension of ArcMap 10.1 was utilized as to simplify accessibility into a workable framework, enabling it to be interpreted and analyzed. Using spatial data collected from a variety of human rights organizations and international bodies, two separate network datasets were generated to simulate the transportation networks for the Palestinian and Israeli populations within the West Bank. The security barrier, roadblocks and roadgates were integrated into the Palestinian network as barriers inhibiting access, as crossing a checkpoint represented a delay of 15 minutes. For the Israeli network, the locations of checkpoints that occurred along the Israeli-only roadways within the West Bank represented the only impedance, adding a 15 minute delay. Prior to the creation of each network dataset, certain edits to the spatial data were performed in order to maximize the accuracy of results. In addition, speed limits, length in miles and travel time across each

line segment were computed for each line segment within the base road network for each of the Israeli and Palestinian networks.

Prior to performing the analysis, three scenarios were devised to relate the research objectives and questions to the analytical processes. Posed as the worst case scenario, Scenario 1 required all checkpoints, roadblocks, road-gates, and crossing points to be closed, making destinations inaccessible to Palestinians travelers and elevating security concerns for the isolated Jewish settlements. Scenario 2 reflected the existing state of mobility, where the security barrier, roadblocks and road-gates are closed and the appropriate delays at checkpoints are simulated. Replicating the most ideal situation, travel conditions in Scenario 3 simulated the absence of all restrictions and impedances along the Israeli network, with the security barrier representing the only restriction for Palestinian travel. In addition, 8 major Palestinian cities, 8 isolated Jewish settlements within the West Bank and 5 major Israeli cities were selected for analysis.

In evaluating Palestinian accessibility, Closest Facility Analysis and Service Area Analysis were performed, under the characteristics of the three scenarios, for each of the Palestinian cities. The Service Area Analysis generated a total 24 service areas (three for each of the eight cities) as the Closest Facility Analysis generated 28 least-cost pathways connecting each city. In evaluating the accessibility of the Jewish settlers, Service Areas Analysis and Closest Facility Analysis were performed for each settlement under the conditions of Scenario 2 and Scenario 3. A total of 16 service areas were generated (two for each of the eight settlements) along with 40 least-cost pathways connecting each settlement with each of the 5 major Israeli cities. Accessibility was assessed by

measuring the total population within each of the service areas and comparing the travel times of the least-cost pathways connecting the respective Palestinian or Israeli destinations.

The results from the Service Area Analysis for the Palestinian cities show that under the existing impedances and restrictions, Hebron offered the highest degree of accessibility as its service areas contained the largest population. Conversely, the service areas of Jericho and Qalqiliya possessed the lowest proportion of the West Bank's population at each timeframe, and are therefore the least accessible cities. Bethlehem possessed the greatest number of restrictions and impedances within its service area as its mobility was most affected by the Israeli military's constraints. The absence of the constraints enabled the service areas generated for Scenario 3 to encompass a higher proportion of the West Bank's population, greatly improving the accessibility afforded to each city. Although only improving 3% above the Scenario 2 levels at the 15 minute threshold, the percentage of total Palestinian population within the service areas generated for Scenario 3 increased 21.54% at the 30-minute threshold and 36.89% at the 45-minute threshold. The results from the Palestinian Closest Facility Analysis generated an average travel time of 109.45 minutes between each city compared to an average travel time of just 66.03 minutes in Scenario 3. The existing restrictions and impedances are responsible for increasing Palestinian travel time by nearly 65%.

The Service Area Analysis for the Jewish settlements drew very inconclusive results, with the service areas barely managing to encompass Jerusalem at the maximum threshold. For Scenario 2 and Scenario 3, many service areas were only limited to the

West Bank, unable to access activity centers inside Israel within a 45 minute trip. The results from the Closest Facility Analysis, generated least-cost routes between the 8 isolated settlements and major Israeli cities, showing the minimal constraints attributed to Scenario 2 only increased the average travel time by 8 minutes above Scenario 3 levels. This led to the conclusion that the advantages of the Israeli transportation network within the West Bank are unable to overcome the sheer geographic isolation of the Jewish settlements analyzed. Aside from the Elon Moresh and Noqedim settlements, the mobility conditions replicated in each scenario had little impact on the accessibility associated with each settlement. The degree of accessibility attributed to each settlement and city were mostly explained by geographic position and proximity, as the furthermost locations naturally possessed the longest travel times.

The differences in accessibility between the Palestinians and Israelis were gauged by measuring the percent change in average travel time of the least cost pathways from Scenario 3 to Scenario 2. The inclusion of the restrictions and impedances caused Palestinian average travel time to rise by more than 65% while the Israelis experienced only a modest 10.5% increase. Despite being only marginally impacted by the introduction of mobility restraints, the Jewish settlers must endure long trips to access major activity centers within Israel, averaging a travel time of 79.52 minutes in Scenario 2 and 87.94 minutes in Scenario 3. Comparatively, Palestinians trips averaged 109.45 minutes under the current constraints and diminished to 66.03 minutes with the removal of the constraints. The results of this study proved that the degree of accessibility afforded to the Palestinians will remarkably improve if the current impedances and

restrictions are either removed or made less severe. The geographic isolation of the Jewish settlements is a permanent and unwavering obstacle that will always diminish accessibility, which cannot be enhanced unless the Israeli road network within the West Bank is greatly expanded.

2. Strategies for Future Research

Primarily due to the limitations in data and availability of transportation modeling software, the results of this study were relatively limited in scope and may have not fully reflected the current mobility conditions within the West Bank. As exhibited through the Service Area Analysis of the Palestinian cities, the route of the security barrier has an extremely high impact in determining accessibility. Encircled by the barrier, the absence of checkpoints and roadblocks within Qalqiliya's service areas did not accurately reflect its truncated level of accessibility. Despite being consistently factored into every service area and least-cost pathway generated in the Palestinian analysis, this study failed to measure how much impact the security barrier played in determining accessibility. Future studies could simulate the wall's influence by recording its length in meters or feet around each city. Once the populations within each service area are calculated, this length can be multiplied by the population figure to measure the quantity of people who have their accessibility limited by route of the barrier. The greater the number of people affected would signify a service area most impacted by the route of the wall.

Furthermore, this study assumed all Palestinians travelers possessed the necessary permits and paperwork that enabled them to access certain stretches of Israeli

controlled roads. This caused certain service areas to be enlarged and the travel times along certain routes to diminish. A future study should strive to attain an already-built West Bank road network along with spatial data highlighting restrictions and impedances from the same source. Gathering spatial data from a variety of sources was a major factor in limiting the accuracy of this study's results. The points that distinguished checkpoints, roadblocks and roadgates did not exactly match up with either the Palestinian or Israeli road layers. Therefore, each of the individual points had to be edited and moved to the closest roadway in order to build the network dataset. This was both very time consuming and likely resulted in the misplacement of checkpoints, roadblocks and roadgates. Moreover, this study also relied on data that was from 2005 and 2006 that does not fully reflect the current condition of mobility within the West Bank. Since the mid-2000s, coinciding with the conclusion of the Second Intifada, the Israeli military has relaxed mobility constraints, eliminating a number of checkpoints, opening roadgates and issuing a higher number of permits. As a result, the accessibility measurements ascertained by this study are more obstructive and restraining them they actually are in the West Bank.

In focusing on the movement of people between major metropolitan centers, this study only touched on the complex issue of goods movement throughout the West Bank. The mobility restrictions implemented by the ISF complicates the ability of artisans, farmers, and merchants to move their products from one place to another. The mobility conditions associated with the movement of goods is entirely different then the attributes of individual travel throughout the West Bank. Designated checkpoints along the security barrier and surrounding major Palestinian cities regulate the movement of Palestinian

goods into and within the West Bank. The average wait time for each person at a checkpoint is estimated to be 15 minutes, yet the processing of goods is an arduous endeavor, requiring long wait times. Furthermore, the vast majority of checkpoints only processes people, meaning Palestinian tradesmen must take their merchandise along specific routes that are serviced by a checkpoints designated to processes goods. Just as the mobility constraints incurred by individual people has adversely impacted the Palestinian economy, the limitations on the movement of goods has further perpetuated the situation. Grinding trade to a halt increases the cost businesses owner must incur to make their product and get it to market where it can be sold. This increase in the price of doing businesses is passed along to the consumer in the form of higher prices and fewer available goods.

The utilization of a more sophisticated modeling technique, such as a gravity or utility measurement, would have yielded a higher degree of accuracy in assessing the accessibility of the Palestinian and Israeli populations within the West Bank. This study did not possess the technology and data resources necessary to run a gravity model or utility-based measurement, therefore it relied on the capabilities of the Network Analyst tool in ArcGIS 10.1 to produce distance-based and cumulative frequency measurements. As the analytical techniques utilized lacked relative complexity, the results may fail to precisely reflect the accessibility conditions that are currently exhibited in the West Bank. With the technological and data limitations taken into consideration, quantifying accessibility using Closest Facility Analysis and Service Area Analysis produced results that could be easily interpreted, analyzed and compared. Yet quantifying accessibility

using a gravity model configured in AutoCAD would greatly enhance the accuracy of the results and enable socioeconomic factors to influence the analysis. Future studies should strive to measure accessibility using modeling techniques that incorporate elements of the rational decision making process people undertake when determining which destinations to access instead of others.

The vagueness and lack of consensus regarding the synthesis of accessibility can be perceived as a positive aspect, leaving the door wide open for the introduction of new, innovative techniques that can improve upon the existing literature. With the continuous advance in technological capabilities and the absence of any preconceived restrictions presented in accessibility literature, the future possibilities are essentially limitless. Future studies should strive to be inventive, original and groundbreaking in employing new methods to measure accessibility, especially in relation to unique and complex situations such as the Palestinian-Israeli conflict. Just as the third world continues to develop economically and experience high population growth, the importance of mobility and transport to extend social equity to the most disadvantaged groups will dramatically increase. Improving accessibility will play a pivotal role in justifying the investment of public funds for transportation projects, extending educational, employment, and medical opportunities to millions of impoverished people. Developing more accurate mechanisms to measure accessibility can definitively show how mobility and transport contribute to economic development and public welfare. Transportation is a fundamental element of any society and accessibility is the primary method employed to gauge its efficiency and identify its shortcomings. Concentrating efforts to measure accessibility in the most

difficult of circumstances forces researchers to be innovative, developing new ways to measure and interpret accessibility that can be readily applied to less-challenging situations.

3. Recent Developments

Under the leadership of the United States Secretary of State John Kerry, the latest round of Israeli-Palestinian peace talks resumed On July 29, 2013, scheduling nine months of negotiations to reach an agreement to end the conflict in mid-2014 (Keinon and Abu Toameh 2014). With the first direct talks in over three years, the US sought to broker peace between the two nations, attempting to find a middle ground that created a Palestinian state while satisfying Israel's security concerns. Despite the initial optimism surrounding the talks, significant differences still divide the two nations, revolving around the continued Israeli military presence in Palestinian-claimed areas of the West Bank (particularly the Jordan Valley), the "right of return" of Palestinian refugees from the 1948 war to Israel proper, the situation surrounding which side controls Jerusalem, the ongoing construction of West Bank settlements, determining the borders of a Palestinian state and concerns over violence. All of these issues perpetuate the animosity between the two sides, leading to a stagnation in talks shortly after they had begun (BBC 2013). In an attempt to reinvigorate interest in the talks, John Kerry proposed a plan to invest neatly $4 billion into the ailing Palestinian economy, enticing the nations a officials to make concessions in reaching a peace deal. With the vast majority of the Israeli mobility restrictions still complicating movement of goods and people within the

West Bank, the Palestinian economy continues to suffer from prolonged stagnation due to the political response to the conflict. Businesses in Palestinian-controlled territories continue to struggle, as costs such as electricity, water and transport remain extremely high and the consumer base deteriorates due to nearly 25% unemployment (Knell 2014).

According to the President of Palestinian Authority Mahmoud Abbas, no peace can be reached with continued Israeli military presence within the West Bank. Despite Prime Minister Benjamin Netanyahu's reluctant recognition of the inevitability surrounding a future Palestinian state, elements of the conservative Israeli government refuse to accept this position, citing concern over Palestine's future government falling into the hands of Hamas and inciting further violence against Israeli citizens (BBC 2013). As a result, Jewish settlements continue to be built within Palestinian territories and Israeli officials insist on the continued presence of Israeli military personal along Palestine's borders and within the Jordan Valley. The likelihood of a future Palestinian state is further complicated by the route of the security barrier, as Israel believes it to be the rightful border between the two nations while Palestinian officials want all land seized by Israel following the Six Day War of 1967 returned to their sovereignty. However, the Palestinian delegation's insistence on the "right of return" for all Palestinian refugees displaced from previous wars has been the most divisive issue confronting the peace talks. Israel flat out refuses the proposition of allowing hundreds of thousands of Palestinian refugees to return to their former homes that lay in 1948 Israeli territory (BBC 2013).

The talks remained fruitless through December of 2013, when influential Palestinian politician Saeb Erekat urged John Kerry to personally intervene in attempt to salvage the negotiations (Kershner 2014). The prospect of reaching an agreement was further complicated when the conservative Likud Party, who comprise a major faction within the Israeli government, introduced a bill to annex the Jordan valley into Israel on December 26. Palestinian officials vehemently objected to the proposition, stating that the annexation of the Jordan Valley would undermine the functionality of any future Palestinian state by encapsulating the West Bank with Israeli controlled territory. However, due to the objection by Benjamin Netanyahu, the bill stalled in parliament, never coming to fruition. Another development was a proposition by Israeli Foreign Minister Avigdor Lieberman that Israel cede a portion of Arab-dominated northern Israeli to Palestine in exchange for the inclusion of settlements into Israel. Shortly after resuming again, the talks took another setback when the conservative controlled Israeli parliament approve the construction of 1,400 settler homes in the West Bank on the basis that the settlements were a vital component for ensuring Israeli security (Kershner 2014). Further approval of new settler homes was given in January of 2014, causing an outcry by Palestinian officials who felt that Israel has systematically attempting to undermine the peace talks. As the talks dragged on into February and March, territorial disputes continued to arise, with Palestinians refusing to relinquish any control over the West Bank to Israel, which wishes to annex 10% of the territory (BBC 2013). When Israel failed to release a set number of Palestinian prisoners as scheduled and previously agreed to, Mahmoud Abbas applied for membership in United Nations bodies. With the April

deadline to reach a peace agreement quickly approaching, Israel approved the construction of 700 hundred more settlement homes in the West Bank, compelling Palestinian officials to prove their commitment to the peace process by returning to the bargaining table. The April 14th killing of an off duty Israeli police officer by Palestinian militants in the West Bank caused a further delay in the negotiations (Lazaroff 2014)). A last ditch effort by American mediators salvaged the negotiations prior to their predetermined ending on the April 29th, and introduced the possibility of extending the talks past this deadline.

4. Looking to the Future

After ten months of negotiations, the most recent peace talks continue to falter, failing to bring either side to an agreement that would define the borders of a future Palestinian state and answer the ongoing question surrounding the proliferation of settlements into the West Bank. John Kerry has publicly expressed his dissatisfaction with failure of the peace negotiations to produce a mutual agreement, citing the stubborn stance exhibited by the Palestinians regarding the refugee's right of return and the unwillingness of the Israelis to halt settlement building (Kershner 2014). The future of the conflict remains as unclear as it's ever been as Secretary Kerry fears a third intifada if the talks continue to falter and fail to establish a framework for the creation of a Palestinian state. The Palestinian economy remains stagnated by the continued presence of mobility restraints enforced by the Israeli military and the ongoing fragmentation of Palestinian communities by the construction of new settlements. The negative impacts

the checkpoints, restrictions and security barrier have on accessibility for both Palestinians and Jewish settlers has been documented by this study. The current impedances and restrictions associated with the Palestinian transportation network increase inter-city travel time by 65%, while severely limiting the number of Palestinians who can access these activity centers within an appropriate time frame. The elimination of several checkpoints and roadblocks along with the opening of roadgates would serve to enhance intercity travel that is vital to connect economic activities and carry consumers to markets, but the absence of all mobility restrictions expressed in Scenario 3 will likely not become a reality in the near future,

The economic prospects must be improved in order to pave the road for peace talks and the eventual creation of a sovereign Palestine. Israeli security concerns are very legitimate and violence has decreased due to the implementation of the mobility restrictions and the construction of the security barrier (Lazaroff 2014). However, the Second Intifada has been over for nearly a decade, and the Palestinian leadership in the West Bank has adopted nonviolence, while the mobility constraints instituted during this period of violence are largely still in place. As a result, the Palestinian economy has been unable to recover and the daily lives of Palestinians continue to be interrupted and complicated by an occupying military force. The international community has already expressed its near unanimous agreement that a future Palestinian state will eventually become a reality. However, the economic and political viability of a Palestinian country is severely complicated by the presence of Israeli occupying forces, civil communities and border regulations. Continuing military presence in the West Bank has gone a long

way to ensuring Israeli security, but has come at significant cost to the Palestinian economy and its people. Based upon the findings of this study, the Israeli government must accept the realities associated with Palestinian sovereignty, refrain from the construction of new settlements and work with the international community to ensure mutual security for both nations. This can be only be achieved if the mobility constraints are alleviated and control over internal and external trade is transferred from the Israeli military to Palestine or the United Nations. While the Palestinian delegation is far from blameless in the breakdown of peace talks, they are correct in their assertion that the mobility restraints and building of new settlements fundamentally undermines the peace process and the prospect of a sovereign Palestine. Territorial concessions would likely have to be made by Palestine for Israel to consider a withdrawal of its forces from the West Bank, which will likely enrage certain elements within the Palestinian political system. Yet, the economic benefits gained from the absence or lessening of the mobility restrictions will be far outweigh the territorial loss of land already occupied by Israeli settlements.

The current position of Israeli is akin to the position of Egyptian under the leadership of President Anwar El Sadat following the conclusion of the 1973 Arab-Israeli war (Pace 1981). Despite not achieving a clear-cut military victory, Sadat had avenged his nation's embarrassing loss to the Israelis during the Six-Day War of 1967, recapturing lost territory and fighting the powerful Israeli military to a standstill. A stern Arab-nationalist, Sadat had elevated himself to become a national hero, a dynamic leader within the Middle East and a respected foe of Israel. However, Sadat did not use his

newfound power to instigate further violence, instead doing the unthinkable by reaching out to Israel for peace. Unlike other Arab leaders, he was willing to disregarding prior Arab-Israeli hostilities to accept the existence of Israel as a viable and sovereign state (Pace 1981). Sadat displayed his sincerity with an emotional speech delivered to the Israeli Parliament in 1977, telling the former foe that "If you want to live with us in this part of the world, in sincerity I tell you that we welcome you among us with all security and safety" (Pace 1981). Becoming the first Arab head of state to visit the Israel, Sadat met with Israeli Prime Minister Menachem Begin to begin peace negotiations facilitated by then US President Jimmy Carter in 1979. Despite several stalls in the talks, both sides were able to reach a peace agreement, signing the Camp David Accords on March 26, 1979, solidifying peace between Israel and Egypt (Pace 1981).

Despite an outcry by many Egyptians and allied Arab nations, Sadat had the courage and foresight to accept the reality of Israel's continued presence in the Middle East. Rather than continue pointless hostilities, El Sadat sought to create a lasting peace with his foe, establishing mutually beneficial diplomatic and economic ties to Israel and the United States in the process (Pace 1981). Sadly, Islamic extremists assassinated Sadat in 1981, primarily for his openness towards Israel and cordial relations with the western world. In spite of his untimely death, much can still be learned from his legacy, exemplified by his commitment to negotiations to resolve conflict. Israel currently finds itself in a position of power, yet they chose to use this power in a way that alienates the Palestinians, disregarding their positions and political aspirations. Just as El Sadat accepted the realities and implications associated with the enduring sovereignty of Israel,

the current Israeli government must accept the reality of a Palestinian state and be committed to the peace process. With a fertility rate much higher than Israel, the Palestinian people are not going away any time soon and the current political response to the conflict is essentially a road to nowhere. Israeli policies must evolve with the times, changing to reflect the current state of affairs rather than continuing to place Palestine under military occupation.

Through six decades of enduring conflict, employing a military response to regional disputes has ensured the continued survival of Israel but has done little to resolve the core issues that spur on the violence. Israel has proved its military superiority time and time again, but violence only breeds more violence, continuing the cycle of warfare that has undermined prior peace talks. Israel can use its economic and military power to show its commitment to peace without yielding any unfair advantage to Palestine, taking simple measures to improve its struggling economy and ease tensions. It took tremendous courage for Anwar El Sadat to swallow his pride, stand up to the Israeli parliament and display his commitment to peace. Israel can easily display its commitment to the peace process by reducing its military presence in the West Bank and halting the construction of settlements, enticing Palestine to ease their stance and negotiate for peace.

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