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Master's Thesis in Geoinformatics for Urbanised Society (30 ECTS)

Analysing the role of key geographic factors in Israeli -Palestinian conflict

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Annotatsioon

Selle magistritöö eesmärk on hinnata põhjavee ja haritava maa rolli Iisraeli-Palestiina relvastatud konfliktis. Eesmärgi täitmiseks antakse temaatiline ülevaade ning tehakse ruumiline analüüs. Analüüs on jaotatud kolmeks. Esimene osa annab ülevaate konfliktist, kus lähtudes UCDP raamistikust klassifitseeritakse kõik konflikti sündmused ajavahemikus 1989-2000. Lisaks visualiseeritakse esimeses osas konflikti sündmuste ruumilist ja ajalist jaotust. Analüüsi teine osa näitab, kuidas on Iisraeli ja Palestiina territoriaalse võimu seisukohalt mitme aasta jooksul muutunud juurdepääs põhjaveele ja haritavale maale. Selle saamiseks tuletati potentsiaalsed põhjavee ja haritava maa tsoonid, kasutades analüütiliste hierarhiate ja kaalutud ülekatte meetodeid. Seejärel maskiti tulemused erinevate maakaartidega. Analüüsi kolmas osa näitas, kas konfliktisündmuste, Iisraeli ja Palestiina asumite ning potentsiaalsete põhjavee ja haritava maa tsoonide vahel on ruumiline seos. Tulemused näitasid, et asulad, eriti Läänekalda piirkonnas, olid potentsiaalsete põhjavee alade lähedal ja konflikti sündmused olid nende asutuste läheduses.

Võtmesõnad: Iisraeli-Palestiina konflikt, territoriaalsed vallutused, looduslikud varad ja relvastatud konflikt, analüütilise hierarhia protsess, kaalutud ülekatte analüüs

CERCS kood: S230- Sotsiaalne geograafia

Abstract

The aim of this master thesis is to assess the role of groundwater and arable land in the Israeli-Palestinian armed conflict through a review of literature and spatial analysis. The analysis is structured in three parts. The first part gives an overview of the conflict by classifying all the events of conflict between 1989-2000 based on the framework provided by the UCDP. It also visualises the spatial and temporal distribution of the events of conflict. The second part illustrates how the accessibility to groundwater and arable land in terms of territorial authority of the State of Israel and Palestine has changed over the period of several years. This was achieved by deriving potential groundwater and arable land zones using Analytical Hierarchy Process and Weighted Overlay method and masking the results with different territorial maps. The third part of the analysis shows whether there is a spatial relationship between the events of conflict, Israeli and Palestinian settlements and potential groundwater and arable land zones. The results showed that settlements especially in the West Bank area were situated near the potential groundwater areas and the events of conflict were in close proximity of the settlements.

Keywords: Israeli-Palestine conflict, territorial contest, natural resources and armed conflict, analytical hierarchical process, weighted overlay analysis

CERCS code: S230 – Social Geography

Contents

1. Introduction

The history of human society has been tainted with violent conflicts, wars, and bloodshed. The earliest conflicts have been traced back to prehistoric times, about 10,000 years ago in a place called *Nataruk*, situated in Eastern Africa, which resulted in two dozen deaths of men, women, and their young ones (Seemangal, 2016). Indulging in fierce competition over natural resources is one of humans' primitive traits as well as of most animals and often leads to aggression and violent conflicts (Briffa, 2010). Even today, territoriality remains one of the key factors inciting armed conflicts, as various countries continue to contest and claim common geographical landscapes; for example, the West Bank being contested by Israel and Palestine, and Kashmir by India, Pakistan, and China.

The role of geography and space or place specific elements in provoking territorial disputes has been proven to be crucial, may it be at the Artic in the north pole or the oil reserves in the middle east. These disputes often take the form of a geopolitical conflict where in the rivals exercise the political power to gain access to these locational benefits. The scale of these disputes might vary based on the intrinsic value of the geographic feature or a natural resource.

The Arab-Israeli conflict is one such conflict which is an infinitely complicated mesh almost impossible to unwind. In simpler terms, the conflict is basically a territorial one, in which both Arabs and Jews have been claiming their inherent right over the landscape of *'Palestina'* (as called by the Greek when they invaded it in 135 CE) which is the modern day Israel and Palestine (divided into West Bank and Gaza) or *Filastin* in Arabic (Gelvin, 2014). Arabs and Jews are both descendants of the ancient Canaanites, the people of Canaan who ruled over the same region as the modern-day Israel and Palestine which legitimates the respective claim of the region by both ethnic groups. The roots of the modern-day conflict were sowed by the British during the world wars with the politically notorious Balfour Declaration. The conflict has continued to worsen further during the Cold War due to the US and Russian intervention (Harms and Ferry, 2017).

One of the key reasons behind the conflict is Jerusalem which embodies sacredness and religious symbolism of the various religious groups - Jews, Christians, and the Muslims. However, the Jewish immigration during the world war into a not so fertile Palestinian landscape, catalysed another dimension of the conflict – a fight for the scarce natural resources necessary for survival and establishing a defensive territory. The availability of groundwater and arable land are a key to sustain human civilisation. A scarcity of these resources in the Palestinian landscape (including modern day Israel) has added fuel to the territorial conflict. The territorial divide or the Jewish occupation of Palestinian landscape began from 1917 and it is ongoing till present day. Willatts, 1946; Asadi, 1976; Efrat, 1988 and Elmusa, 1996, have indicated the possibility of certain geographic factors like the availability of groundwater and arable land informing the territorial contest and a systematic occupation of the landscape. However, a lucid quantitative geographic analysis of the factors driving the conflict is lacking (Efrat, 2006). With the advent of Geographic Information System, a new avenue into quantitative geographic research opened up. Platforms like ESRI's ArcGIS have strong capabilities to study human geography as well physical geographic processes based on empirical evidence.

Aim of the research:

To assess the role of groundwater and arable land in driving the Israeli-Palestinian conflict using relevant methods in geoinformatics.

2. Research Questions

- How are the events of armed conflict spatially and temporally distributed in Israel and Palestine?
- How has Israel and Palestine's accessibility to groundwater and arable land changed over time?
- Is there a relationship between the events of armed conflict and the accessibility to groundwater and arable land?

The thesis consists of three main sections, literature review, spatial analysis, and discussion & conclusion. The literature review outlines the key concepts in armed conflict and its spatial relationship with geography and natural resources, specifically in reference to the Israeli-Palestinian armed conflict thereby legitimating the research and laying the foundations for empirical analysis. The spatial analysis consists of three parts; firstly, the conflict analysis, analysing the change in the accessibility of groundwater and arable land to Israel and Palestinian territories, and last part consists of spatial overlay analysis. The analysis is followed by a discussion which provides the explanation of the results and conclusion along with recommendations for further research.

3. Literature Overview

3.1 Armed Conflict and Geography

3.1.1 Peace, Conflict and Armed Conflicts

The concepts of peace and conflict have been pluralistic in nature, being outlined by several authors and critics across different domains (Chelimo, 2007; Webel, 2007; Herbert, 2017). Historically, various philosophers and psychoanalysts have tried to outline the mental dimensions of what could be understood as peace while the physical and social dimensions have been a matter of discussion for the scholars concerned with the International Humanitarian Law (IHL) as well as various peace keeping organisations like the ICRC (Webel and Gultang, 2007). It is convenient to understand peace and conflict through a dialectical relationship; peace referring to happiness, justice, harmony, and condition of social stability and well-being while conflict representing a state of disagreement and incompatibility (Miller, 2005). Conflict does not necessarily have a negative connotation. It is an important condition for the growth and evolution of human society. A failure to resolve the conflict however could lead to uncalled-for situations like violence, war, or terrorism (Roppers, 2002).

When a conflict is between nation States or organized forces procuring armaments, it is referred to as an armed conflict. In 1863, during the conference of the ICRC held in Geneva, the first attempt towards framing a standard legislature – the IHL, regulating the conduct of various actors in an event of armed conflict was made. It was in the purview of the IHL that a lucid definition of armed conflict was framed. As a result, the IHL provided a definition of armed conflict based on a dichotomous classification i.e., International Armed conflicts (IAC) and Non-International Armed Conflicts (NIAC), the major difference being whether the conflict is taking place between two separate nation states or not (ICRC, 2007). Armed conflicts, however, cannot strictly be confined to any one of these two definitions; it could slide from one definition to another at any time during its course and dichotomous classification is therefore too simplified. The Uppsala Conflict Data Program (UCDP) and Peace Research Institute Oslo (PRIO) define armed conflicts as follows:

> A contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths. (Codebook, Version 4-2006, p.6)

Based on the parties involved in any conflict and the outcome of the conflict, the UCDP provides a more elaborate classification as shown in Table 1.

Table 1. Classification of armed conflicts (source: UCDP)

Description	**State-Based Armed Conflict**	**One Sided Violence**	**Non-State Conflict**
Who?	Governments, Rebel Groups	Governments, Organized groups, e.g. Rebel Groups	Organized groups, e.g. Rebel groups and communal groups

What?	Battle related deaths	Violence against civilians, e.g. massacre and genocide	Communal violence, violence between rebel groups

The definitions and the classification provided by the UCDP cover broad spectrum of several possible armed conflicts witnessed globally. Over the last 40 years, it has become the basis for more than 5000 scholarly works produced in peace and conflict research due to its systematic and verifiable data collection techniques (Melander, 2016). Therefore, this research has adopted the definitions developed by UCDP. Some key definitions which are utilized in this research are as follows:

> **Battle deaths:** Fatalities caused by the warring parties that can be directly related to combat, including civilian losses.
>
> **State Based Conflict**: A contested incompatibility over government and/or territory where at least one party is a state, and the use of armed forces results in at least 25 battle related deaths within a calendar year.
>
> **Non-State Conflict:** The use of armed forces between organized groups, none of which is a government of a state, resulting in at least 25 annual battle related deaths.
>
> **One sided violence:** The use of armed force by the government of a state or by a formally organized group against civilians, which results in at least 25 battle related deaths. Extra judicial killings in custody are excluded.
>
> **War:** A state-based conflict in resulting in at least 1000 battle deaths.
>
> (Palik et al. 2020, p. 5-6)

3.1.2 Spatial and geographic attributes of armed conflicts

In order to analyse or resolve conflict processes, it is necessary to understand the backdrop in which they exist which is ‘space’. Recent studies in peace and conflict studies have brought into light the mutually influencing relationship shared by peace and conflict processes, and space. For example, Hackl, 2016, and Höglund et al., 2016 have provided an account of how urban space and conflict processes exist on mutual frontiers. Spatial theories and approaches help reinforce the understanding of conflict processes, its dynamics, and underlying causes. However, the attributes and properties of space have not yet been thoroughly exploited for peace and conflict research (Bjorkdahl and Buckley-Zistel, 2016).

Peace and conflict are social attributes or a resultant of social conditions. Elaborate literature on how space is a social production has been provided by Henri Lefebvre in 1991, however not with an intention to analyse processes of peace and conflict. His work, nonetheless, provides an implicit account of how peace and conflict as social processes and space exist through a dialectical relationship. Another significant account is provided by Doreen Massey who argues that space is political due to the social relationships it encapsulates (Merriman et al., 2012).

Theories of 'Place' which is a more realistic notion of the abstract 'space', bring us closer to understand how peace and conflict are spatial processes. Places are constructed by the lived experiences of people. Peace and conflict are essentially and inherently a part and parcel of places materially, socially, and psychologically (Bjorkdahl and Buckley-Zistel, 2016).

A quantitative geographic approach for peace and conflict research provides the necessary instruments for its empirical analysis, especially with the advent of GIS. An empirical approach to understand and exploit socio-political processes addressing war and conflicts has been observed after the end of the world wars. Starr, 2013 and Starr et al., 2016, for example have showcased an empirical approach to elucidate processes of peace and conflict. Space in terms of territory highlights two major political attributes i.e., power and sovereignty and also brings out the most intrinsic and discriminatory idea of 'us' and 'them' constituted in almost all armed conflicts (Stephenne et al., 2009). The fundamental properties of space like contiguity, diffusion, neighbourhood, and border has been utilised to understand the events of armed conflicts and war suggesting that these events are not independent but rather intertwined with and are a resultant of sentiments embedded in a continuous social space (O'Louhglin, 1986). The following table illustrates how various spatial properties are utilised to address geographic and security issues using empirical methods and GIS.

Table 2: Quantitative geographic approach to address political and security issues (source: Stephenne et al., 2009)

Author	**Subject**	**Geography and Security concepts**	**Method used**
Wesley (1962)	Frequency of wars and geographical opportunity	Wars frequency/contiguity/proximity	Length of border/Population cells
Boulding (1962)	Conflict and defence	Distance following the log relation of Zipf (1946)	National strength, loss of strength gradient, cost function of influence
Starr and Most (1976)	Borders in International dimensions	Contiguity/type of border	Categorization of international borders dataset
Vasquez (1993)	The war puzzle	Territory/contiguity/neighbour/borders	Clustering of neighbours-distance between capitals/technology/number of wars
Wood and Milefsky (2002)	Territory and negotiations	Definition of border porosity based on geographic factors/changes in time	Geographic data set/GIS

3.1.3 Natural resources and Armed conflicts.

The most fundamental socio-political process which brings together geographic space, politics and conflicts is territoriality – the right of exercising power over a piece of land. Territoriality is a primitive and natural trait, but it becomes political in nature when applied to and exercised by formally organised groups like governments of states or various rebel organisations (Tunjic, 1999). Territorial right is exercised by drawing borders to demarcate the area of ownership. The availability of various natural resources often determines the extent of territory which could potentially turn into a political conflict when the same geographical space is contested by two of more nation states. Natural resources in fact were a key ambition behind imperialism, colonialism, and the consequent violence in the historical past in Africa and Asia (Billon, 2001; McQuade, 2019).

The key approaches to understand how natural resources lead to armed conflicts are explained here. The first approach suggests that a scarcity of natural resources often lead to violent conflicts. The distribution of natural resources over the geographical landscape of the planet is unequal. As a result, some of the regions face scarcity of certain natural resources. For example, the most fundamental natural resource necessary to sustain human life which is groundwater is dangerously scarce in the MENA region (Middle East and North Africa) to feed the inhabiting population. This kind of resource scarcity often catalyses or promotes armed conflicts as in case of Israel and Palestine (explained at length in the following chapters). The other approach focusses on how globally valued resources like oil and natural gas lead to geopolitical struggles and conflicts of a larger scale. The Middle East again is a hotspot of such a struggle, this time due to the availability of the most precious natural resource – oil. Global powers have had always fighting to establish and maintain a hegemony in the Middle East for the same reason (Billon, 2001; O'Lear, 2006). Table 3 illustrates natural resources and the resultant conflicts:

Table 3: Natural resources and related conflicts (source: Billon, 2001)

	Point	**Diffuse**
Proximate	*State control* Algeria (gas) Angola (oil) Chad (oil) Congo-Brazzaville (oil) Iran-Iraq (oil) Iran-Kuwait (oil) Liberia (iron ore, rubber) Nicaragua (coffee) Rwanda (coffee) Sierra Leone (rutile)	*Rebellion/Rioting* El Salvador (coffee) Guatemala (cropland) **Israel-Palestine (freshwater)** Mexico (cropland) Senegal-Mauritania (cropland)
Distant	*Secession* Angola/Cabinda (oil) Caucasus (oil) D.R. Congo (copper, cobalt, gold) Indonesia (oil, copper, gold)	*Warlordism* Afghanistan (opium) Angola (diamonds) Burma (opium, timber) Caucasus (drugs)

	Maroco/Western Sahara (phosphate) Nigeria/Biafra (oil) Papua New Guinea/Bougainville (copper) Senegal/Casamance (marijuana) Sudan (oil)	Cambodia (cocaine) D.R. Congo (diamonds, gold) Kurdistan (heroin) Lebanon (hash) Liberia (timber, diamonds, drugs) Peru (cocaine) Philippines (marijuana, timber) Sierra Leone (diamonds) Somalia (bananas, camels) Tajikistan (drugs)

3.2 Israeli-Palestine Conflict – a geographical perspective

The Arab-Israeli conflict (later became Israeli-Palestinian conflict) is one of the most complicated conflicts in history spanning for more than a hundred years. This chapter illustrates how intersection of geography and politics has played a significant role in the conflict. The Palestinian landscape being strategically located between Asia and Europe has always had wider geopolitical implications before, during and after the world wars (Willatts, 1946). However, these geopolitical complexities lie outside the scope of this thesis and have therefore not been addressed. This chapter discusses explains how the immigration of Jewish community in the early 1900 and its settlement planning influenced the conflict. Additionally, the role of groundwater and arable land in the territorial contest as well as the conflict have been explained.

3.2.1 Jewish immigration, settlement planning and its implications on the conflict

The Jewish immigration into Palestinian landscape (also known as *'Aliyah'*) sowed the seeds of the present day conflict between Israel and Palestine. When the immigration began in early 1900, the Palestinian landscape was undisputedly inhibited by the Palestinian Arabs with an exceptional Jewish minority also residing with harmony. Consequently, the *Aliyah* were followed by a territorial contest (but not a conflict then) as the local Arabs did not welcome a massive influx of Jewish immigrants (Orni and Efrat,1988; Efrat, 2006; Harms and Ferry, 2017). Until the establishment of the Israel as a state, it was challenging to produce an accurate census count since the national boundaries of the region kept changing. However, rough estimates from the British Mandate showed that the population count of Jews, Muslims, and Christians in between 1882 to 1946 changed from 15000, 400000 and 43000 to 600000, 130000 and 30000 respectively (Harms and Ferry, 2017). After the establishment of the state of Israel in 1948, several Jewish communities from Europe, Russia, and some Arab countries as well as Africa migrated to the newly established state thereby changing the demography significantly as can be seen from Figure 1 (Orni and Efrat, 1988; Black, 2018).

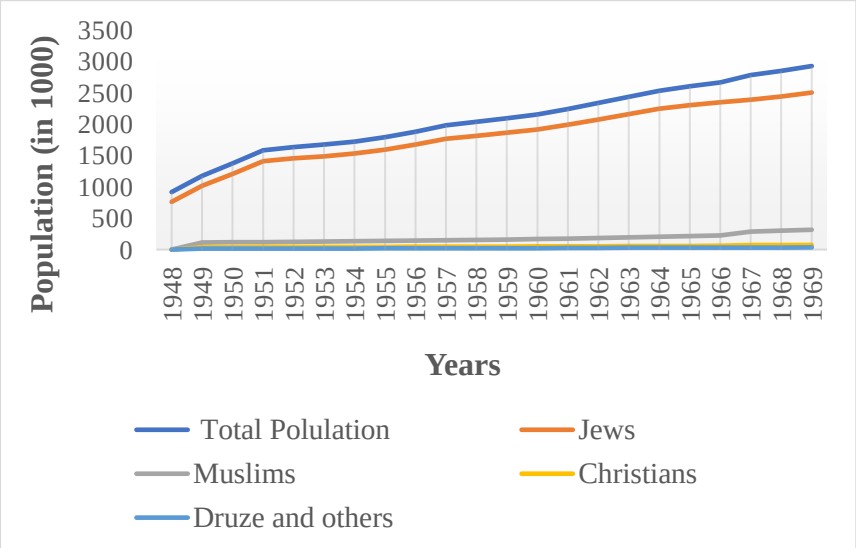


Figure 1: Population groups between 1948-1969 (source: Orni and Efrat,1988)

The Jewish settlement geography was driven with clear conception regarding the functionality (contributing to the communal economy through agriculture) and building a strong social and national identity. There were four different types of settlements which were differentiated based on a varying degree of private to public ownership, *Kibbutz* (owned by community), *Moshava shituffi, Moshav and Moshava* (owned privately) (Orni and Efrat,1988). All of these settlements were however designed to incorporate agricultural practices, often including mixed crops along with dairy and animal husbandry ultimately aiming at building a strong national economy (Gelvin, 2014). Settlement planning was therefore set to become a national symbol and a message that Jewish community in Palestine would not be absorbed as labour to the existing economic structure of the Arabs.

During the early 1900s, the Jewish settlements were concentrated in the coastal plains, Jaffa being the entry port of most immigrants. Judean hills as well as Galilee hills also had a few settlements. In the later years, a general trend showed a south and a eastward growth from the coastal plains. In the 1970s Tel Aviv, Haifa bay and Jerusalem became the urban centres of new settlements. The following shows the distribution of Jewish and non-Jewish population in 1969 in various districts and subdistricts.

Table 4: Jewish and Non-Jewish Population (in thousands) distribution across Israel and its districts in 1970 (source: Orni and Efrat,1988)

Districts Subdistricts	*Jews*	*Non-Jews*	*Total*	Districts Subdistricts	*Jews*	*Non-Jews*	*Total*
Jerusalem	**237.7**	**76.5**	**314.2**	**Central**	**482.**	**39.1**	**521.5**
Norther	**244.6**	**202.7**	**447.3**	Sharon	109.2	24.7	130.9
Safed	51.4	4.0	55.4	Petah Tiqwa	171.5	7.3	178.8
Kinneret	38.1	10.9	48.9	Ramla	74.7	6.7	81.4
Jezreel	87.7	75.5	162.7	Rehovot	130.0	0.5	130.5
Acre	67.5	12.8	180.2	**Tel Aviv**	**852.5**	**8.0**	**860.5**
Haifa	**386.3**	**68.8**	**455.1**	**Southern**	**292.6**	**27.5**	**320.1**
Haifa	312.0	24.8	336.8	Ashqelon	139.2	0.5	139.7
Hadera	74..3	44.3	118.3	Beersheba	153.4	27.5	180.4

Prior to the Six Day War in 1967, the Israeli settlement planning was primarily aimed at the distribution and establishment of a Jewish community across its territory. However, during the Six Day War, Israel acquired massive territories across all fronts – the West Bank from Jordan, Sinai peninsula in the south from Egypt and Golan from Syria. With the conquest, followed a change in the stance of its settlement policy. The new goal was to establish settlements in the newly occupied territories (Isaac, 2011). This also marked a transition point in the broader nature of the conflict; the conflict gradually becoming Israeli-Palestinian conflict from Arab-Israeli conflict as most Arab countries settled their borders with Israel in the later years following the six day war (Harms and Ferry, 2017). As a result, only West Bank remained the contested territory where Israeli settlements were being planned after the war.

The location of the Arab settlements in the West Bank was determined by the strong topography of the region characterised by a harsh and a hilly terrain. Most settlements were located on or near the hill tops and in the vicinity of fertile land and water resources since agriculture was the primary occupation of Arabs. The settlements were often located away from roads and transport network to avoid any confrontations with military troops (Orni and Efrat,1988; Efrat, 2006). Several plans were proposed to initiate new settlements in the West Bank under different governments. The Allon Plan was the first one which aimed at building Israeli Settlements in the Jordan Valley with fertile land and accessibility to water resources being the key rationale behind the planning. The *Gush Emunim* activities ('Bloc of Believers') in 1974 under the Likud government promoted settlements all over the West Bank except for the highly populated Arab villages, back by religious belief that the entire region rightfully belonged to the Jewish people (Efrat, 2006; Gelvin, 2014; Isaac, 2011). The Allon plan was never realised and the *Gush Emunim* on the other hand was gradually realising with an alternative geographic and economic rationale. The government believed that it would be possible to harvest winter crops in the valleys by technological investments into agricultural and water supply activities in the region which the local Arab farmers were not capable of achieving. Settlers from Gaza strip and the Sinai Peninsula were also shifted to the West Bank. This annexation of areas from West Bank , also referred to as the settler policy or settler colonialism has been promoting and building settlements in the West Bank since 1967 until present day (Efrat, 2006; Gelvin, 2014). With the imposition of settler colonialism, several Arab villages were destroyed in the West Bank area and the inhabitants were forced to leave their homeland and become refugees. This also marked the beginning of the Palestinian refugee crisis, which is still ongoing.

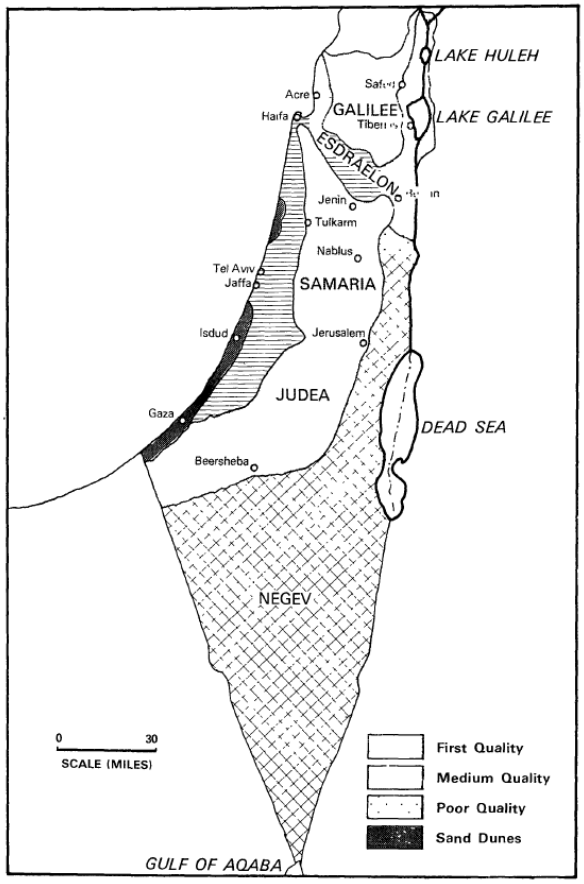
3.2.2 Arable Land

The soils found in Palestinian landscape could be typically classified as Mediterranean and Desert soil type. In the Negev, red, hammada, soil is found while loess in Beersheba is found. Coastal plains has red hamra soil as well as alluvial which are quite adaptable to farming. In the foothills and hills, rendzina soil is typical which are not quite rich. In the interior valleys, black, alluvial swamp soils are found which could be made arable by adding manure and fertilizers (Orni and Efrat,1988). Since the soils are susceptible to erosion, a number of soil conservation techniques are employed.

Water sources and physical terrain determine the soil fertility and agricultural productivity of the land. There were three main agricultural practices in this region during the British occupation, indigenous agriculture, modern intensive agriculture and citriculture. The following table shows how cultivated land was divided amongst the Arabs and Jews in the 1940s.

Table 5: Area and Value of Chief corps 1944-45 (in thousands) (source, Willatts, 1946)

Produce	**Arab**		**Jewish**		**Total**	
	Acres	£	*Acres*	£	*Acres*	£
Grains	1038	4403	54	497	1092	4900
Vegetables	60	5113	10	1746	70	6859
Fodder	6	157	30	951	36	1108
Fruits	89	3139	9	1380	98	4519
Olives	148	3320	2	53	150	3373
Melons	30	970	1.5	84	31.5	1054
Citrus	37	1600	38	2400	75	4000



The British divided the landscape into three different regions i.e., first quality, medium quality, and poor quality (Figure 2). The first quality land is situated in the coastal plains and the lowlands, medium quality on the central highlands and the poor quality on the steep valleys and southern part of Negev desert. The Israeli territory based on the Armistice lines of 1948 encompassed 95% of the good soil (Asadi, 1976) . It is interesting to observe that the immigration of the Jews in Palestine was concentrated in the north-western coastal plains of the region. The footprint laid by the initial Jewish immigrants also possibly became a rational of drafting the partition plan by the UN in 1947.

Figure 2 : Classification of Land productivity from the British Mandate (source: Asadi, 1976)

3.2.3 Groundwater

Groundwater is utilised for agriculture, domestic purposes as well as industrial purposes. The availability of groundwater in the Israel and Palestine is quite limited as compared to the usage which leads to a fierce contest on the available resources. The total amount oof water available through annual rainfall is around 10,000 cubic meters of which approx. 70 percent is lost in evaporation and evapotranspiration. Groundwater has been collected and stored through aqueducts (from the Roman times as well the 18th century), underground water pipes, dams, and wells (Orni and Efrat, 1988; Gvirtzman, 2012).

Water scarcity is not only limited to Israel and Palestine, but also to the surrounding countries and the whole of Middle-East in general. There are three fresh water sources in the Israel, Palestine as well as Jordan, the Lake of Galilee, the coastal aquifers, and the mountain aquifers. The Lake of Galilee is fed by the Jordan river system whose catchment area is spread across five different countries making the water usage from the lake a complicated geopolitical issue. The exploitation and unsustainable usage of freshwater from Lake of Galilee has led to environmental hazards as well (Orni and Efrat, 1988; Albert, 2011; Beyth, 2006) .

The Oslo agreements highlighted Palestinian's right to groundwater resources in Gaza and West Bank including the control over the aquifers. In order to address agreement, a Joint Water Commission (JWC) was set up. Multiple wells in West Bank were created and water to settlements was made available (Gvirtzman, 2012). Despite Israeli's aid to Palestinians water issues, its settler policy which was in place since 1970's only made the issue worse. On the other hand, there have been reports of Palestinian overconsumption and stealing from Israeli underground pipelines thereby breaching the JWC. With time, the groundwater continued to become the one of the key rationales behind the land annexation policies by Israel. Water experts as well as government officials in Israel have publicly pointed out water resource and Palestine's poor groundwater management one of the reasons of territorial expansions as well as occupation of West Bank region (Elmusa, 1996). Although the Israeli statehood, has shown sincere efforts towards water conservation, recycling, desalination, distribution thereby increasing the net availability of water, the water related conflict is not resolved (Beyth, 2006; Albert, 2011; Gvirtzman, 2012).

4. Study Area

The State of Israel and Palestine is the study area for the thesis. The state of Israel is located in between Middle East and Europe with the Mediterranean Sea on its west, with an area of 22145 sq. km. and approximately 6015 sq.km. on the top which includes the occupied Golan Heights and occupied areas in the West Bank (Figure 3). Tel Aviv and Jerusalem are the main urban centres with a population of 432892 and 801000 respectively. Palestine is territorially divided into two regions – West Bank on the east along the Jordan valley and Gaza on the southwestern coast. West Bank is spread over an area of 5640 sq. km. and is divided into three zones after the Oslo Accords (1993-1995) signed by the PA (Palestinian Authority) and the State of Israel. Area A (18%) is fully controlled by the PA, Area B (21%) is under a joint control and Area C (60 %) is under Israeli control (Figure 5). Gaza is under complete Palestinian control having an area of 365 sq.km. and it shares a boundary with Egypt. The State of Israel is divided into 15 districts; Golan, Safed, Kinneret, Nazareth and Akko in the north, Haifa, Hadera, Sharon, Petah-Tikva, Tel Aviv, Ramla, Rehovot and Ashkelon in the western coastal plains while Beersheba is the southern district which constitutes the Negev desert and is scarcely populated. West Bank is divided into 11 districts Tubas and Jericho facing the Jordan valley while Nablus, Nazareth, Tulkaram, Qalqilyah, Salfit, Ramallah, Bethlehem, and Hebron facing Israel and the separation wall. Jerusalem as a district is divided between both Israel and Palestine.

Figure 3: Israel-Palestine territories
(Data source: GADM, 2022)

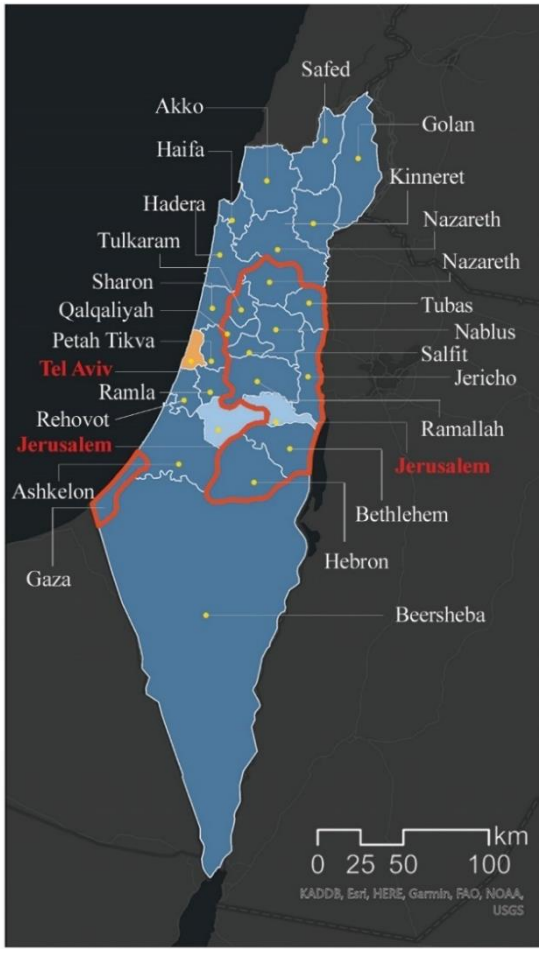


Figure 4: Districts in the Israel and Palestine
(Data source: World Atlas, 2021)

Various political and military organisations have been formed for the purpose of administration and security matters of Palestinian people as well as for representing the Palestinian movement against its occupation. PLO (Palestinian Liberation Organisation) acts as a representative body of the Palestinian people in UN and the international sphere. PA (Palestinian Authority) comprising mostly by the Fatah, handles the security and administrative affairs mainly in the West Bank while Gaza is governed by Hamas which is the military wing of Palestine. These organisations are not necessarily united in its conception of the conflict. Hamas, which is an extremist organisation, has been involved in armed conflict with the PA especially during 2006 in the Gaza strip after which it has gained de facto control over the region.

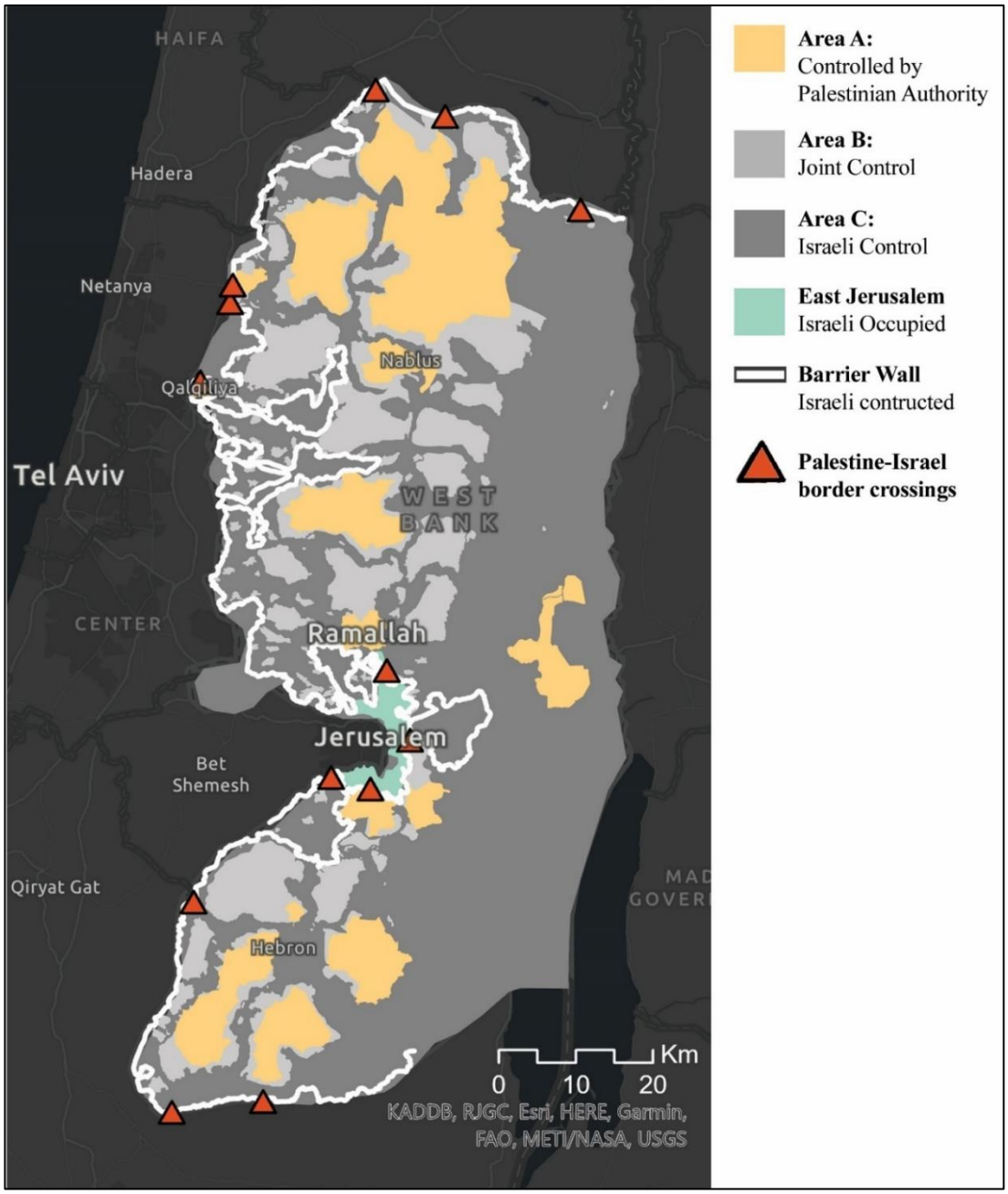


Figure 5: West Bank, Area A, B, and C (Data source: PA MOP, 2014; OCHA occupied Palestinian territory, 2019; OCHA occupied Palestinian territory, 2021)

5. Data and Methodology

This chapter explains the methods and data used for the spatial analysis. The analysis consists of three parts; firstly, the conflict analysis which classifies the armed conflict events as per the UCDP framework and also illustrates spatio-temporal distribution of armed conflict events in the study area. Second part analyses the change in the territorial authority and accessibility to groundwater and arable land to Israel and Palestinian territories from 1917 to present day, and the last part explains spatial relationship between establishment of Israeli settlements, location of groundwater and arable areas and armed conflict events. The analytical framework and the methodology used in this thesis has been explained using a schematic presentation in the figure below.

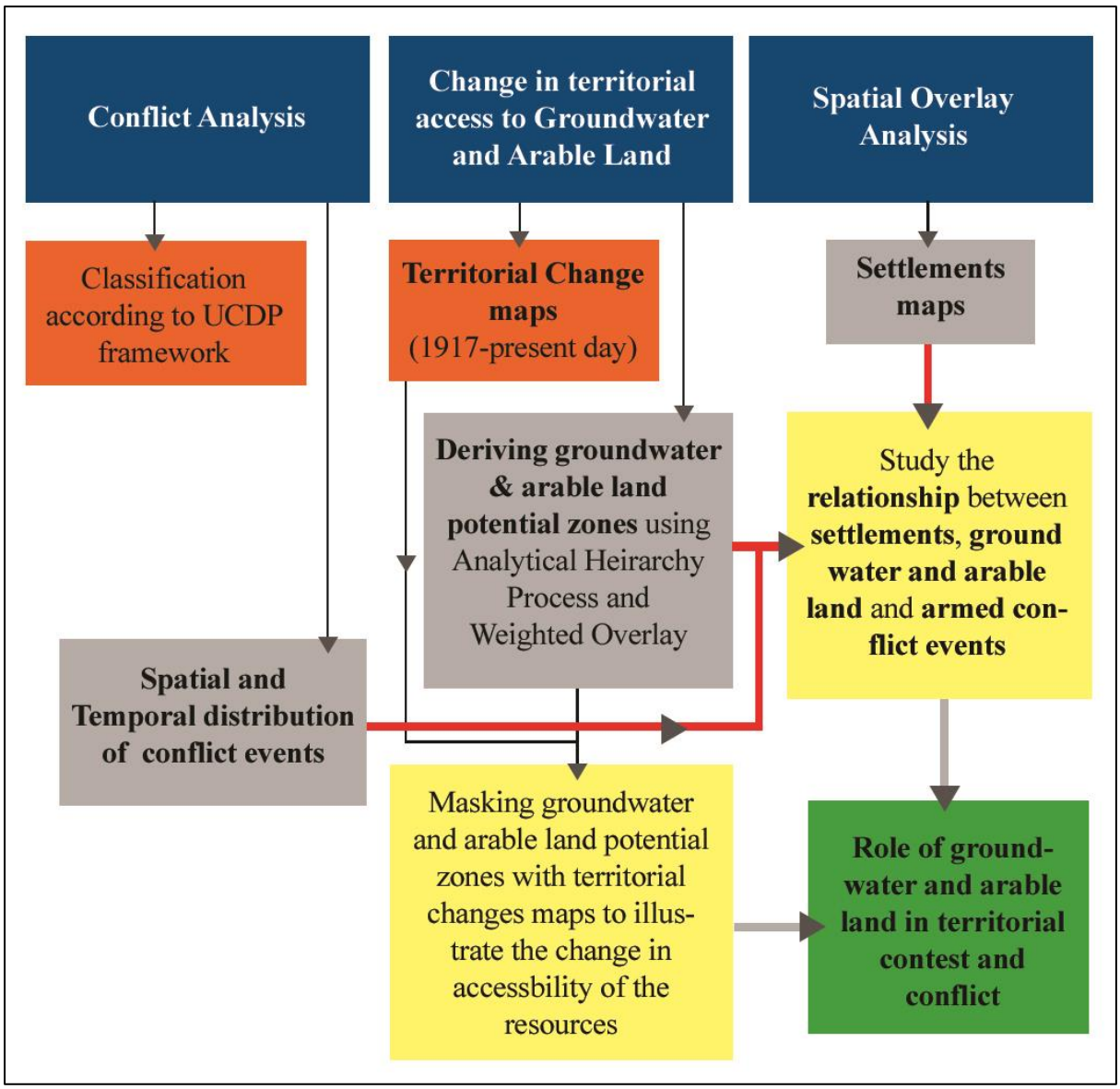


Figure 6: Analysis and methodological framework

5.1 Conflict Analysis (Conflict events classification and spatio-temporal distribution)

Method

The events of conflict have been classified according to the UCDP framework (Table 1) into State based armed conflict, non-state conflict and one-sided violence which is the standard event classification framework provided by the UCDP mentioned in section 3.1.1. For visualising the spatial distribution and concentration of armed conflict events, collect event tool was used. Individual events of conflict were colour coded based on 6 temporal classes (1989-2000, 2001-2005, 2006-2010, 2011-2015 and 2016-2020) to illustrate spatial as well as temporal distribution of conflict events in the study area. Scatter chart was prepared to show the temporal variation of the conflict events. This part of the analysis was structured to give an overview of how the conflict evolved over time, with different conflict actors and how it has spread and concentrated over the study area. The results from this part have been utilised for further analysis in section 5.3. Conflict events dataset before the year 1989 was not available and as a result, it was not possible to compare the events of conflicts before 1989 with the territorial changes, establishments of new settlements and potential zones of groundwater and arable land.

Data:

Table 6 : Data used for conflict analysis

Data	Type	Source	Resolution	Temporal range
UCDP Georeferenced Event Dataset (GED) Global version 21.1	Vector, Point	Uppsala Conflict Database Program	Fine grained to individual villages and individual days	1989-2020
GADM version 4.0	Vector, Polygon	GADM	Subdistricts	-

Table 7: GED sample

year	conflict_name	dyad_name	where_coordinates	latitude	longitude	country	best
1989	Israel: Palestine	Government of Israel - PFLP	Ramallah town	31.903	35.19555	Israel	1
1989	Israel: Palestine	Government of Israel - PFLP	West Bank	32	35.25	Israel	1
1989	Israel: Palestine	Government of Israel - PFLP-	Kfar Ruppin kibbutz	32.458	35.5561	Israel	3
1989	Israel: Palestine	Government of Israel - Fatah	Deir al-Balah refuge	31.426	34.34056	Israel	1
1989	Israel: Palestine	Government of Israel - Fatah	Nablus town	32.22	35.26362	Israel	4

5.2 Changing territorial access to groundwater and arable land

This part of the methods explains how Israel and Palestine's accessibility to groundwater and arable land has changed with time. By accessibility, here it means which of the two states have the territorial authority over the aforementioned natural resources. Firstly, territorial maps representing the national boundary of Palestine and Israel for the years 1917, 1942, 1947, 1948, 1967, 1995 and present day were created. These years were chosen as significant terrestrial occurred before these years. Further, groundwater and arable land potential zones were identified using Analytical Hierarchy Process (hereafter described as AHP) and weighted overlay analysis. The territorial maps were then masked on the groundwater potential and arable land potential zone maps to analyse how the territorial access to these resources have changed with time. Calculate geometry was used to identify the changes in Israel and Palestinian territories and simple arithmetic calculations were done to calculate the change in the access to different groundwater and arable land potential zones. The territorial access to these resources was represented in form charts .

Data (for analysing territorial changes):

Table 9: Data for analysing territorial change

Data	Type	Source
Territories for the year 1942	Vector Polygon, digitised from published sources	Gelvin, 2014
Territories for the year 1947, 1948 and 1967	Vector Polygon, digitised from published sources	Black, 2018
Territory for 1995	Vector, Polygon	GADM, 2022
Territories representing current situation Areas A, B and C	Vector, Polygon	PA MOP, 2014

Method (for delineating groundwater potential and arable land potential)

GIS has proven to be an efficient medium for mapping potential zones of groundwater availability (Krishnamurthy et al., 1996; Chowdhary et al., 2008). The potential of groundwater availability depends on multiple factors like precipitation, soil type, land use, lineament, slope, etc. and multi-criteria decision analysis like AHP is therefore suitable for analysing the potential groundwater zones. Arable land mapping, like groundwater potential mapping involves several criteria influencing or determining the suitability for arable lands and the same method was therefore used for identifying arable land zones. (Agrawal et al., 2013, Rahmati et al., 2014 Kamau et al., 2015; Otgonbayar et al., 2017; Arulbalaji et al., 2019, Natsagdor et al., 2020; Saranya & Saravanan, 2020; Roy et al., 2020; Al-Tani et al, 2021).

AHP is a method in multi-criteria decision analysis that generates relative weights of different parameters influencing a decision making process which was developed by Thomas Saaty in 1980 (Whittaker, 1987, Mu and Rosa, 2017). The weight of each parameter is calculated using a pairwise comparison matrix based on their relative importance in the decision making

process. A Normalised Principal Eigen Vector is derived from the comparison matrix in form of percentage. This percentage is a statistical representation of the significance of different factors in determining the final results (here, the potential zones). The pairwise comparison matrix also gives - Maximum Eigen value (λ max), Consistency index (CI) = (λ max - n)/(n − 1), Random index (RI) and Consistency ratio (CR) = CI/RI . The consistency ratio helps to evaluate the logical consistency of the generated weights using this method. If CR value is less than 10% , the level of precision is acceptable, if not, it needs to be revised (Mu and Rosa, 2017; Doke et al., 2021).

AHP is suitably integrated with weighted overlay analysis in GIS for deriving the final results. Weighted overlay analysis is a method of modelling suitability in GIS by using different spatial weight matrix based on the relative importance of different parameters in the study. All raster cells are assigned different spatial weights depending on its influence and then reclassified to a common scale (Doke et al., 2021, Hassan and Ahmad, 2020). Therefore, analytical hierarchy process along with weighted overlay has been used for identifying the groundwater potential and arable land potential zones in this thesis. Precipitation, drainage density, Landuse, slope, soil type, lithology, and lineament density have been considered to identify groundwater potential while precipitation, slope, soil type and temperature have been used to identify arable land potential. The manner in which they affect groundwater potential and arable land potential is described below.

Precipitation: The process by which atmospheric water vapour condenses into rain, snow, hail etc. and reaches back to the earth's surface. A higher amount of precipitation contributes to greater reserves of groundwater and better agricultural potential.

Drainage Density: USGS defines drainage density as the measurement of sum of the channel lengths per unit area. A higher drainage density contributes to a higher amount of groundwater potential.

Land use: It is the manner in which different land areas are utilised by humans for various socio-economic activities. Land uses with better infiltration or percolation like agriculture contribute to a higher groundwater potential while hard paved ground or constructed buildings contribute to a lower groundwater potential.

Slope: The higher the gradient of the land surface, the lower the rate of infiltration and percolation and vice versa. Increased slope makes the soil vulnerable to erosion and runoff leading to decrease in crop yield.

Soil: The main type of soils found in Israel and Palestine are calcisol (well drained and fertile), cambisol (poorly drained and moderately fertile), leptosol (medium drained and poor in fertility), regosol (well drained and medium fertile), vertisol (medium drained and fertile), solonchak (poorly drained and poor in fertility and luvisol, (well drained and highly fertile). Well drained soils contribute to a better groundwater potential and vice versa whereas soil fertility leads to better cropland suitability.

Lithology: It refers to the composition or types of rock strata. Different types of rocks have different capacity to hold groundwater. The major rocks constituting Israel and Palestine's

landscape are carbonate sedimentary rocks, unconsolidated sediments, basic volcanic and pyroclastic rocks. The first two being sedimentary rocks have a higher groundwater bearing capacity while the latter two have poor capacity except when characterised by prominent lineament features.

Lineament density: Lineament refers to the cracks and fractures in the lithological features. A higher lineament density leads to more water percolation and better groundwater potential.

Temperature: The landscape of the region has diverse climatic conditions and therefore a variety of crops are cultivated like wheat, barley, melons, citrus fruits, olives, etc. Considering the wide variety of crops cultivated, temperature is not the most critical factor for agriculture for this analysis. Moreover, technological advancements and green houses in the region makes it possible to modify the climatic conditions for crop cultivation. 25 deg C to 30 deg C is the optimum temperature considered here.

For AHP, these factors were utilised to generate relative significance of each factor in determining the potential zones using the pairwise comparison matrix. The pairwise comparison matrix was created based on the relative importance of each factor in determining the potential zones. The strength of significance is based on 9 classes: 1 - equal significance , 3 - medium significance, 5 – strong significance, 7 - very strong significance, 9 – maximum significance. 2,4,6, and 8 represent the interim significance between other values. The pairwise comparison matrices for groundwater and arable land potential are shown below. CI for groundwater potential was 0.054 which is less than 0.1 and for arable land potential, CI was 0.054 which is less than 0.06 and therefore both of them were logically consistent and acceptable (Mu and Rosa, 2017; Doke et al., 2021).

Table 10 : Pairwise comparison matrix for groundwater potential

Factors	Precipitation	Lithology	Drainage Density	Soil	Land cover	Slope	Lineament Density	Normalised Principal Eigen vector (%)
Precipitation	1	3	3	5	5	5	7	38.14
Lithology	1/3	1	3	3	5	5	5	24.54
Drainage Density	1/3	1/3	1	1	3	5	5	13.11
Soil	1/5	1/3	1	1	1	2	3	8.93
Landcover	1/5	1/5	1/3	1/2	1	1	1	6.61
Slope	1/5	1/5	1/3	1/2	1	1	1	5.00
Lineament density	1/5	1/5	1/3	1/3	1	1	1	3.67

Table 11 : Pairwise comparison matrix for arable potential

Factors	Precipitation	Temperature	Soil	Slope	Normalised Principal Eigen vector (%)
Precipitation	1	3	7	9	58.30
Soil	1/3	1	5	7	29.10
Slope	1/7	1/5	1	3	8.40
Temperature	1/9	1/7	1/3	1	4.20

The weighted overly analysis in ArcGIS Pro requires two inputs; firstly, the relative significance of different factors in determining the potential zones, which is represented by the Normalised Principal Eigen vector (%) in this study. The second input is how each factor affects the determination of potential zones. For example, precipitation is directly proportional to groundwater potential while slope is related inversely. This second input (based on a scale from 1-5) was derived from various thematic maps which were prepared to visualise different factors precipitation, slope, drainage density etc. for the study area. Using these two inputs, final results identifying groundwater and arable land potential zones were derived from weighted overlay analysis. The data and the method used to create the thematic maps is described below. All thematic maps were prepared using geoprocessing tools in ArcGIS Pro 2.8.0 unless specified. All data was projected in Israel TM grid co-ordinate system which is the standard coordinate system for the study area.

Table 12: Data for thematic maps

Attributes	**Data and source**	**Resolution**
Precipitation and Temperature	'prec 2.5m' and 'tavg 2.5m', Worldclim (2017)	2.5 min
Landuse	ESRI Landcover (2021)	10 m
Lithology	GLiM V 1.1 (2012)	0.5 deg
Soil	Harmonised World Soil Database (2008)	30 arc sec
Lineament Density	Landsat 8, Band 8 C2 L1,USGS (2021)	15 m
Slope, Drainage density	Digital Elevation Model, USGS (2015)	3 Arc-Sec/90m

Raster data – 'prec 2.5m' and 'tavg 2.5m' for 12 months for the year 2020 was used to generate mean precipitation and temperature maps. Raster calculator was used to calculate the mean precipitation and the study area was masked to generate the mean precipitation and temperature maps. 'ESRI Landcover data 2021' was masked using 'Extract by Mask' tool to generate the land-use map for the study area. Raster data - 'GLiM v1.1' was used to create the lithological map. The area of interest was masked using 'Extract by Mask' tool to generate the lithological map of the study area. To create the soil map, Harmonised World Soil Database (HWSD) was used with the help of HWSD viewer. The area of interest was extracted from HWSD viewer

and then digitised into vector polygons using georeferencing. The polygon layer representing different soil types were converted into raster data using 'Polygon to Raster' tool. To create lineament density map, two methods could be used; first in which the lineament features are digitised manually from various hill-shade maps created using different azimuth angles. An alternative method is automatic extraction of lineament features using PCI Geomatica software. The second method was used in this analysis primarily due to size of the study area. Digitising lineaments manually for the study area was unnecessarily laborious process and was therefore deemed to be less suitable. Relevant data tiles were filtered from 'Landsat 8 Band 8 C2 L1' from USGS EarthExplorer database. The data was further processed to correct surface reflectance in PCI Geomatica and then lineament features were extracted in vector format. Further, 'Line Density' tool was used to create the lineament density map. To create the slope map and drainage density map, digital elevation data from the Shuttle Radar Topography mission was used. Multiple data tiles were combined into a mosaic dataset and the study area was extracted. The data was then corrected to remove topographical distortions using 'Fill sink' tool. Stream network of the study area was created using the tools 'Flow Direction', 'Flow Accumulation' and 'Stream Order'. For extracting the stream network, 'Extract by Attributes' tool was used. The stream network was converted into line features using 'Stream to Feature' tool. Finally, 'Line Density' tool was used to create the drainage density map. Raster values of each thematic map were reclassified into 5 classes, 5 representing the maximum influence while 1 representing the minimum influence in order to be used as input data for the weighted overlay analysis. The reclassified spatial weights matrix representing different classes of each thematic map has been shown in Annexe 2.

5.3 Spatial Overlay Analysis

Method

This part of the methodology explains how the spatial relationship between establishment of new settlements, location of groundwater and arable land areas and conflict events was studied. Different maps are compared using spatial overlay technique and also separately. Firstly, a time series maps of establishments of Israeli and Palestinian settlements were presented to see if there was any spatial pattern. Further, groundwater and arable land potential maps were overlayed with settlement map to study the visual spatial relationship between the two. Lastly, the settlement maps were compared with conflict events map to study if there was any spatial relationship between settlements and conflict events. The settlement data was not available in digitised GIS format and as a result, analysis based on visual comparison and spatial overlay was used to study if there was a spatial relation amongst these phenomena.

Data

The settlement map were borrowed from Shoshan, 2012 while the other maps used were borrowed from the results produced in previous analysis of this thesis.

6. Study Results

6.1 Conflict Analysis (Conflict events classification and Spatio-temporal distribution)

The classification of conflict events as per the UCDP framework divides the conflict events in three main categories i.e., State-Based conflict, One-Sided violence, and Non-State conflict. The classification of conflict events in between 1989-2020 (Table 9) shows that there are multiple conflict actors, on the Palestinian side while the conflict from Israel's side has been state based. From the classification, it was seen that 84.88 % of the conflict is State-based armed conflict and 89.05% of the deaths resulted from the conflict are due to State-based conflict. Within the State-based conflict, the most significant actor from the Palestinian side is *Hamas* (a political and military organisation founded after the first Intifada in 1987) which is responsible for 49.38% of conflict events and 58.10 % conflict deaths. PIJ (Palestinian Islamic Jihad founded by students at Islamic University in Gaza) also constitutes a significant 13.56% of the conflict events and 12.46% of conflict deaths. AMB (al-Aqsa Martyrs Brigade, military group based in West Bank), PNA (Palestinian National Authority, *Fatah* controlled government organisation governing the West Bank area) and *Fatah* constitutes about 4% to 8% of conflict events. One-sided conflict (conflict involving civilians) constitutes 12.06 % of all conflict events out of which 8.52% events have been between the Government of Israel and civilians. Non-State conflict constitutes 3.05 % of all conflict events and have been fought between *Fatah* and *Hamas*, and *Hamas* and *June Ansar Allah* all of which are based in Palestine.

Table 13: Conflict Actors, events, and conflict deaths (1989-2020, UCDP)

Type of Conflict (1989-2020)	**Dyad name (Conflict actors)**	**Events**	***%***		**Deaths**	***%***	
State-based armed conflict	Government of Israel - PFLP	60	*1.73*	***84.88***	92	*1.09*	***89.05***
	Government of Israel - PFLP-GC	1	*0.03*		3	*0.04*	
	Government of Israel - Fatah	260	*7.49*		433	*5.12*	
	Government of Israel - Hamas	1715	*49.38*		4915	*58.10*	
	Government of Israel - PIJ	471	*13.56*		1054	*12.46*	
	Government of Israel - PNA	159	*4.58*		339	*4.01*	
	Government of Israel - AMB	156	*4.49*		277	*3.27*	
	Government of Israel - PRC	90	*2.59*		180	*2.13*	

	Government of Israel - Hezbollah	35	*1.01*		239	*2.83*	
	Government of Syria - Syrian insurgents	1	*0.03*		1	*0.01*	
One-Sided Conflict	Government of Israel - Civilians	296	*8.52*	***12.06***	244	*2.88*	***7.13***
	PIJ - Civilians	50	*1.44*		194	*2.29*	
	AMB - Civilians	72	*2.07*		164	*1.94*	
	Hezbollah - Civilians	1	*0.03*		1	*0.01*	
Non-State Conflict	Fatah - Hamas	105	*3.02*	***3.05***	295	*3.49*	***3.82***
	Hamas - Juned Ansar Allah	1	*0.03*		28	*0.33*	

The conflict events between 1989-2020 are seen to concentrated mainly in Gaza and West Bank and sporadic distribution of conflicts is also observed in the Israeli territory. In the West Bank area, the conflict events are prominently located on the western side of the territory i.e., in closer proximity to Jerusalem and Nablus while the eastern side of the territory i.e. the Jordan river valley witnessed very few events of conflicts. The temporal distribution of conflict events (Figure 7) shows three different intensities of the conflict. The conflict events between 1989-2000, tend to be less than 100 per year. These events are primarily spread over the West Bank region (Figure 9). The conflict intensity rises from 2001 and is between 400 to 100 conflict events per year until 2010. In 2014, the conflict is at its peak and is concentrated in the Gaza as seen from Figure 8. From 2015 to 2020, the conflict intensity seems to reduce and the number of conflict events in this duration tend to stay below 50. This part of the results therefore answers the first research question by explaining the spatial and temporal distribution of the conflict in Israel and Palestine.

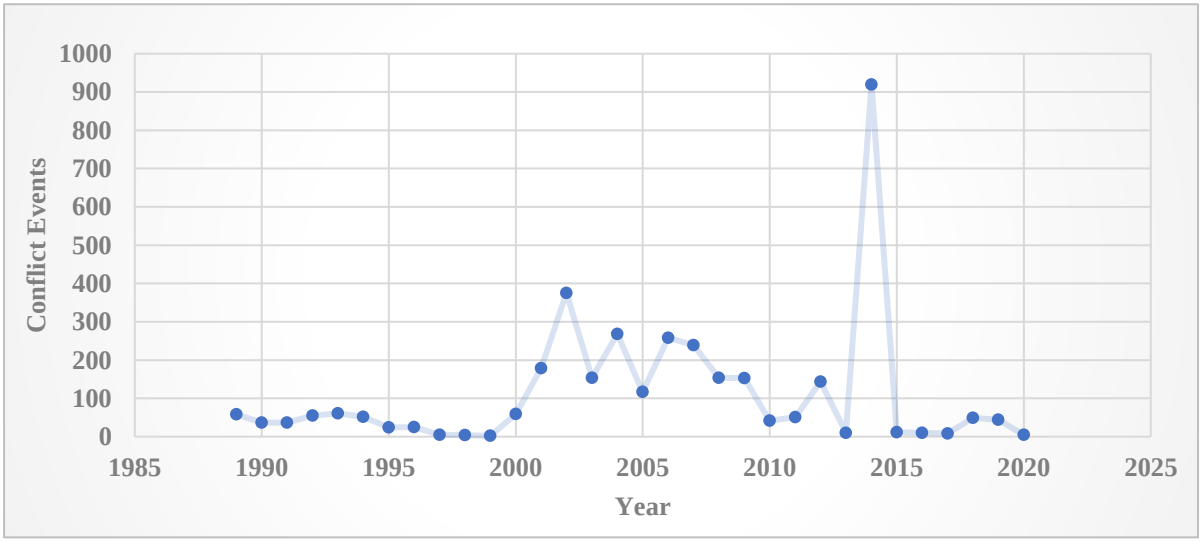


Figure 7 : Temporal distribution of conflict events in between 1989 to 2020

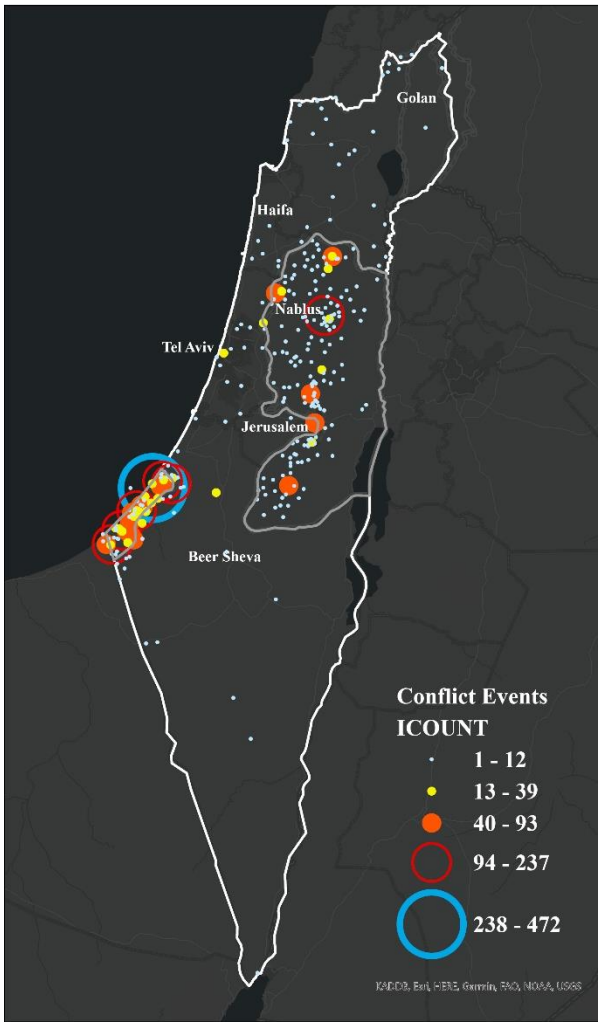


Figure 8: Conflict events intensity

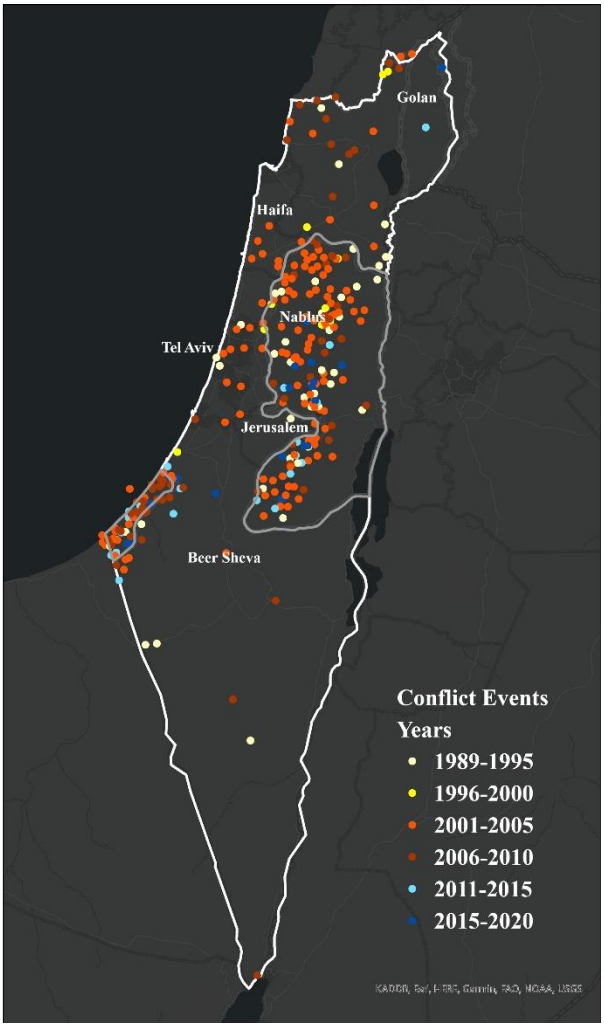


Figure 9: Conflict event spatio-temporal distribution

6.2 Change in territories and the accessibility to potential groundwater and arable land areas

The change in both the Israeli and Palestinian territories since the beginning of the conflict is significant as can be seen from Table 14. In 1917, Palestine constituted the whole region that includes present day Israel and Palestine except for the Golan heights. In 1942, Jewish owned land accounted for approximately 2275 sq. km. . In 1947, as a part of UNSCOP, Jewish state was allotted approximately 15287 sq.km. while Palestine was allotted 11863 sq.km which immediately led to a war. The outcome of the war resulted in Palestine loosing even more territory than what it was allotted. During the same year, Israel as a state was established and the territories of Israel and Palestine were 20900 sq.km. and 6220 sq,km. respectively. In 1967, after the end of the Six Day War, Israel conquered almost three times more territory on all

fronts (Sinai Peninsula from Egypt, Golan from Syria and the West Bank and Gaza strip from Palestine) which was however receded except for the Golan heights. In between 1993-1995, the Oslo Accords was signed to settle the territorial dispute in West Bank (Figure 10). Therefore in between 1917 and present day, Israeli territory has grown to be approximately 27025 sq.km. while Palestinian territory has shrunk to 1345 sq.km. and 1035 sq.km. is jointly controlled by both. With the change in the territories, the access to arable land as well as groundwater resource also changed, which is explained in the following passages.

Table 14: Territorial change in sq.km. (approximate values).

Attribute/Year	**1917**	**1942**	**1947**	**1948**	**1967**	**1995**	**Present Day**
Palestinian territory	27120	24845	11863	6220	--	6220 (5855,West Bank + 365, Gaza strip)	365, Gaza strip + 980, Area A + 1035, Joint Control
Jewish owned territory	< 5% of Palestine,	2275	15287	20900	89000	22145	27025 + 1035 (Joint Control)

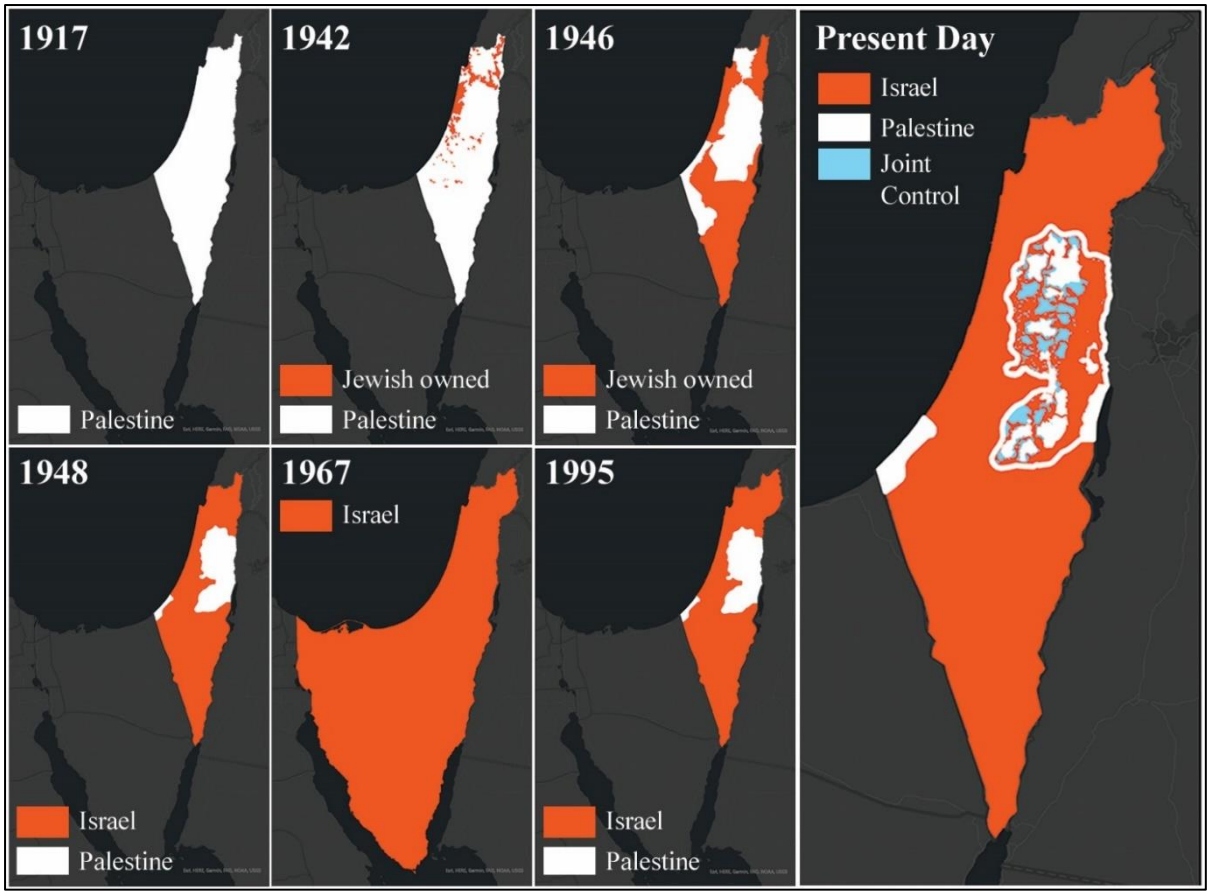


Figure 10: Showing the territorial changes from 1917-present day

Thematic maps for all factors affecting groundwater potential and arable land potential have been explained here. These maps also give an overview of various physical features of the study area. The elevation of the landscape ranges from 2374 meter to –128 meter. From the elevation map (Figure 11) and slope map (Figure 12), it is seen that there are three linear features stretching parallelly along the landscape i.e., the coastal planes on the west, the centrally hilly area, and the low lying Jordan valley in east. Drainage density map (Figure 13) shows possibility of stream formulation on both sides of the central hilly area. From the precipitation map, it can be seen that the amount of precipitation decreases from northern Golan to the southern Negev region (Figure 14). The temperature on the other hand varies with elevation, the elevated hilly areas being the coldest (Figure 15).

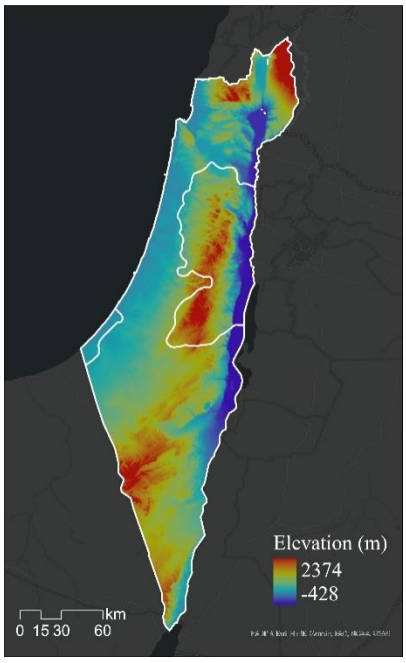


Figure 11 : Elevation

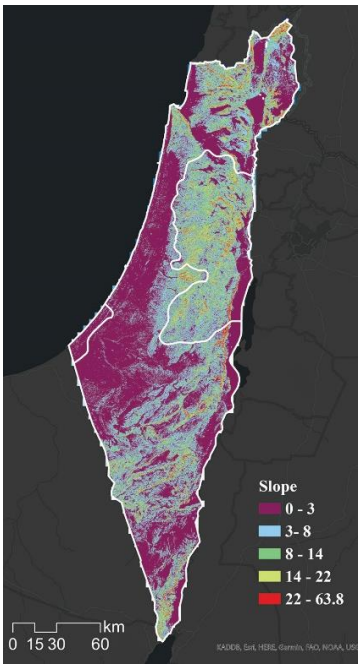


Figure 12 : Slope

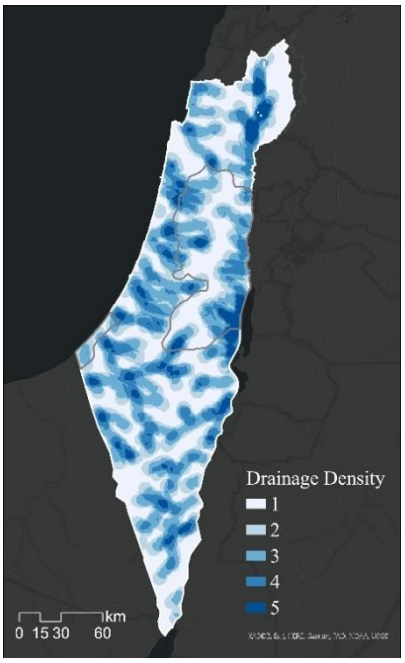
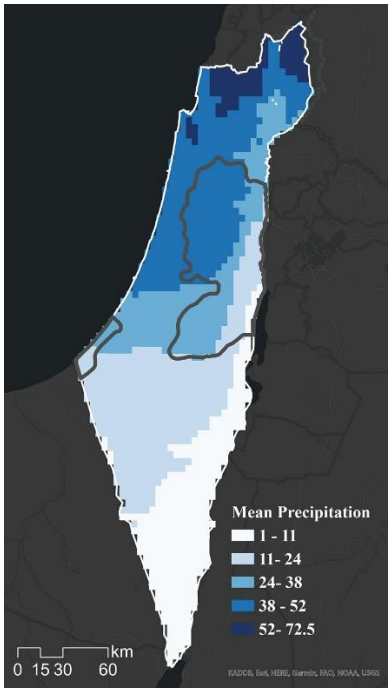
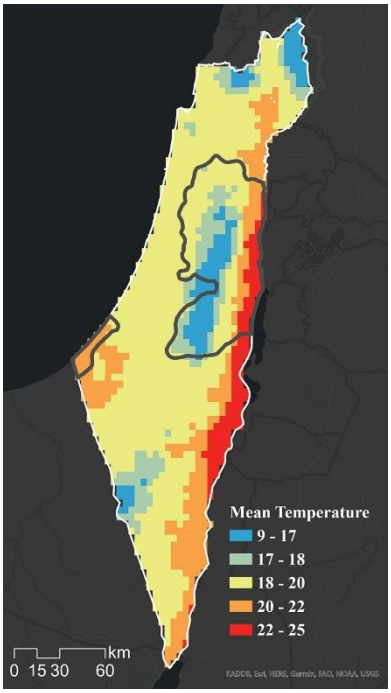


Figure 13 : Drainage density

The most prominent lineament features seem to be present in the north-eastern plains, central eastern plains and southwestern areas with some weaker lineaments also present on the central hilly area and towards the Jordan valley as can be seen from Figure 16. The lithological features (Figure 17) show that the central hilly area is composed of carbonate sedimentary rocks which have a high groundwater bearing capacity. Both the eastern and the western side of this area is composed of unconsolidated sediments which have a moderate to good water bearing capacity. The northern Golan is made up of pyroclastic rocks which have poor water bearing capacity unless characterised with lineaments. From the soil map (Figure 18), it is seen that the coastal plains are covered by regosol and luvisol and partly by calcisol and vertisol while the central hilly area is covered by luvisol, calcisol, and vertisol. The southern desert and Jordan valley is covered by leptosol and calcisol while the Golan area is covered by cambisol. The land-use map shows two prominent land uses i.e., croplands and built areas spread across the western coastal plain and central hill area while the southern Negev is a barren ground. From drainage density map (Figure 13) and the lineament map (Figure 16), it was also observed that the water bodies i.e., the Dead sea and the Galilee sea affected the results of these thematic maps.

However, this was not deemed to be a major flaw as these areas are not inhabited or witnessing conflicts and therefore did not interfere in further analysis.





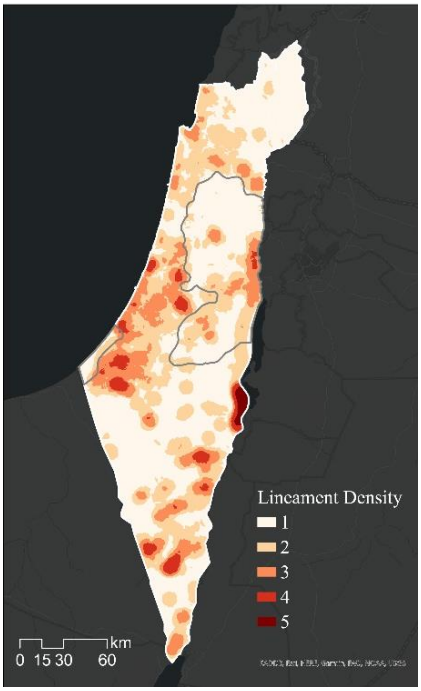
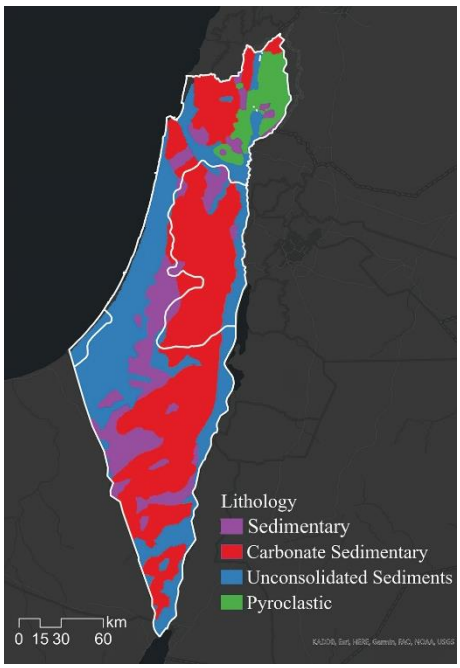
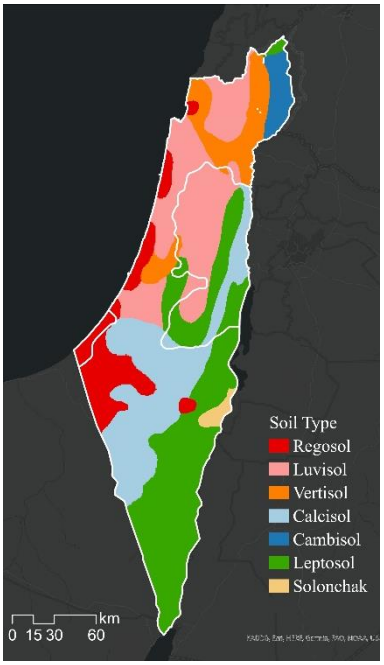


Figure 14: Precipitation (mm) Figure 15: Temperature (deg C) Figure 16: Lineament density





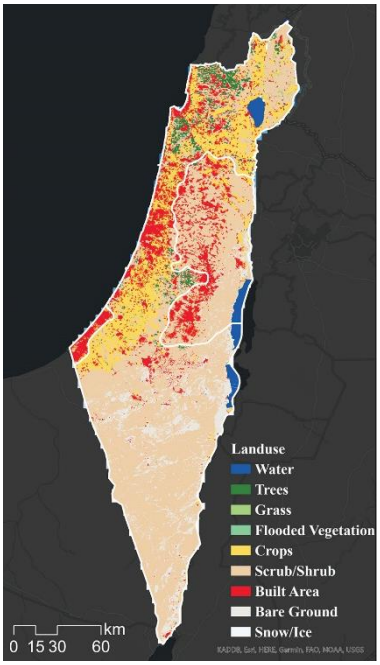


Figure 17: Lithology Figure 18: Types of Soil Figure 19. Landuse

Goundwater and arable land potential derived using AHP and Weighted Overlay based on the factors discussed above are explained here. The results for the AHP and weighted overlay analysis delineated four different zones of groundwater potential - highest, good, moderate and poor (Figure 20). The area with highest potential is 423.36 sq.km., good potential is 4604.4 sq.km., moderate potential is 8908.2 sq.km and 1305.56 sq.km. The results were then compared to an alternative reference – a map of groundwater wells in the West Bank region (Figure 21). When compared visually, the wells seem to be concentrated in regions near good potential spots of the results of this study.

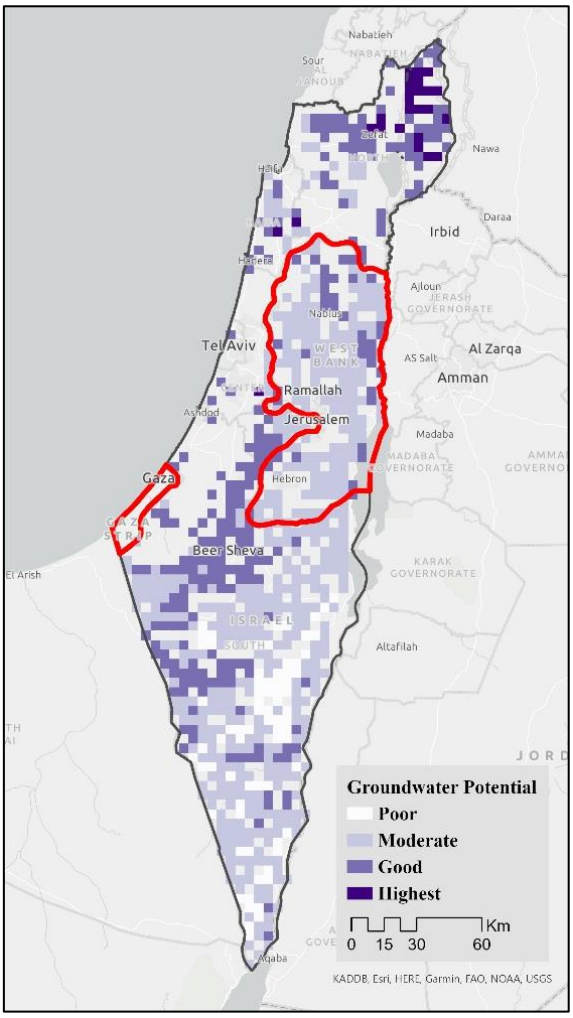


Figure 20: Groundwater potential zones

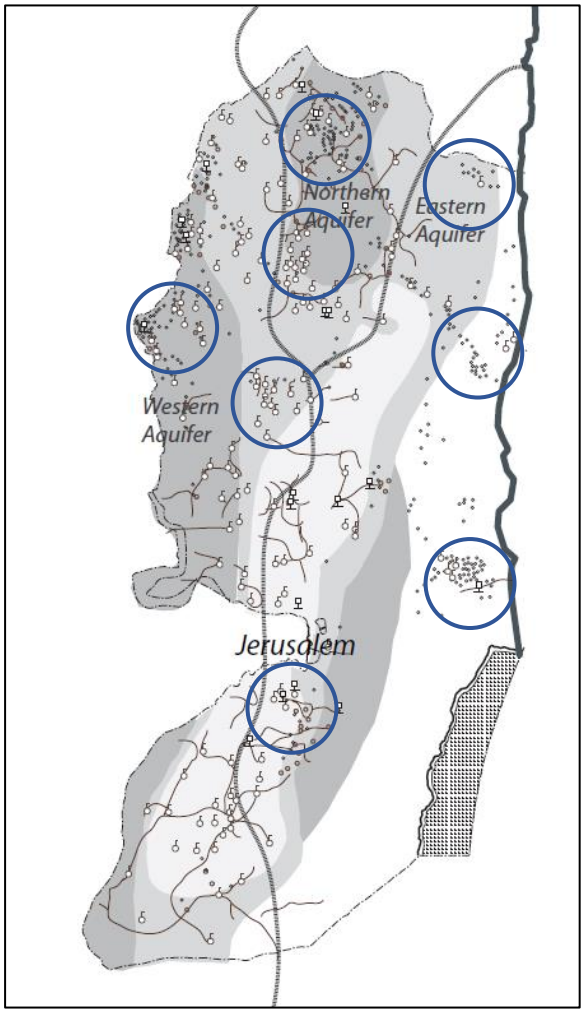


Figure 21: Well location in West Bank (source : Shoshan, 2012)

The results of arable land potential zones were also divided into four categories – highest, good, moderate, and poor (Figure 22). The area with highest potential is 2169.72 sq.km., good potential is 12224.52 sq.km., moderate potential is 10830.96 sq.km. and poor potential is 1464.12 sq.km. The results were then compared to the cropland map (Figure 23) of Government of Israel (which is meant for informational purpose and is not authoritative in nature). Based on a visual comparison, the results correlate with the cropland map as the highest and good potential area of the results corresponds to farms, winter crops and greenhouse plantations while the poor and moderate area corresponds to uncultivated areas.

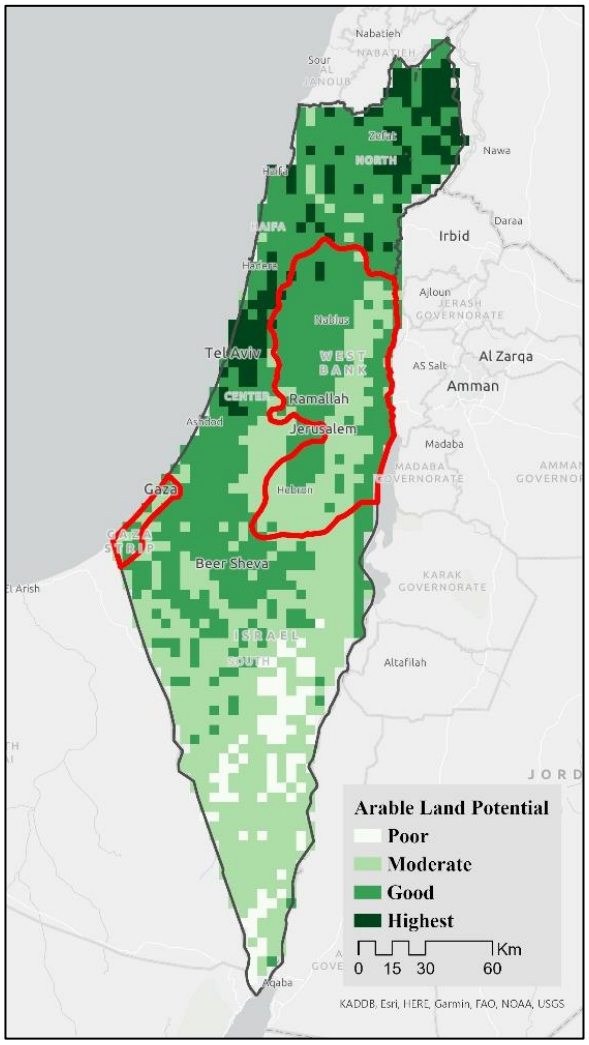


Figure 22: Arable land potential

Figure 23 : Cropland Map

(source: Government of Israel database)

The values of change in the territorial accessibility to groundwater and arable land shows a strong pattern. In between 1942 to 1995, Palestine has consistently lost accessibility to both groundwater and arable land potential zones while Israel has consistently gained the access as can be seen from figure 24, 25, 26 and 27. This part of the results, therefore answers the second research question by explaining how Israeli and Palestinian territorial accessibility to groundwater and arable land has changed over time.

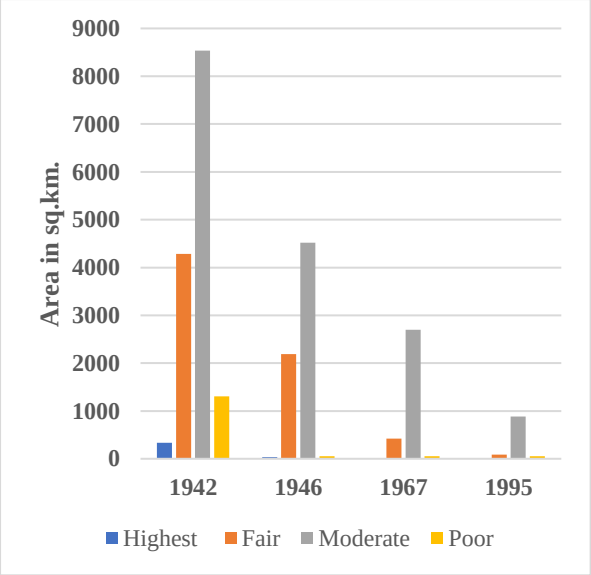


Figure 24: Palestine, groundwater access

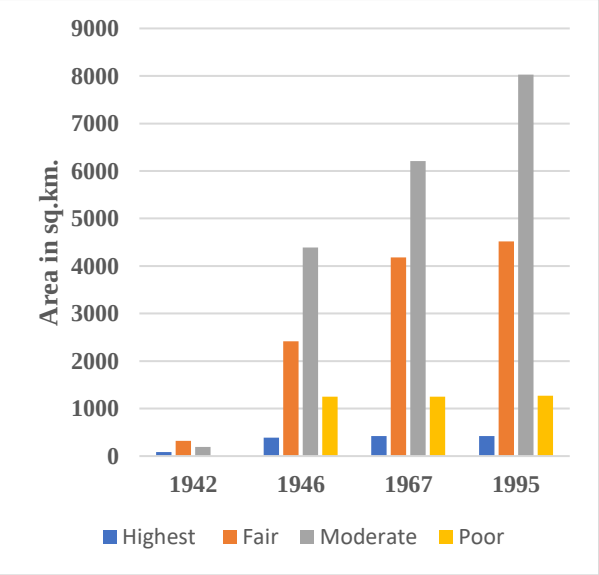


Figure 25: Israel, groundwater access

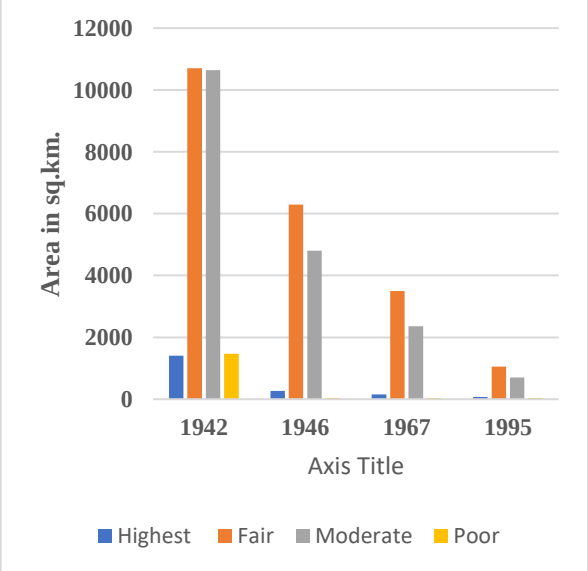


Figure 26: Palestine, arable land access

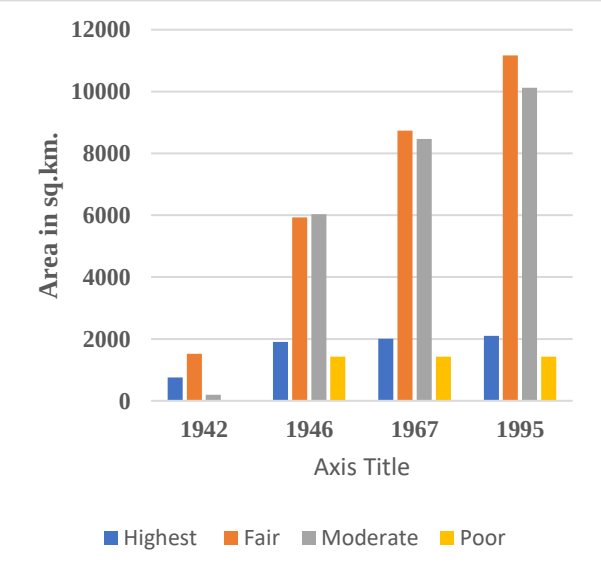


Figure 27: Israel, arable land access

6.3 Spatial Overlay Maps

The settlement maps of Arab and Jewish settlements from 1918-2010 were compared (Figure 28 and 29). The maps show how Palestinian settlements have been consistently pushed away from the coastal plains into the central hilly area in the West Bank, with the growing Israeli settlements in the landscape. The situation in 2010 shows how Israeli settlements have also spread in the West Bank region as well as the occupied Golan heights in the north.

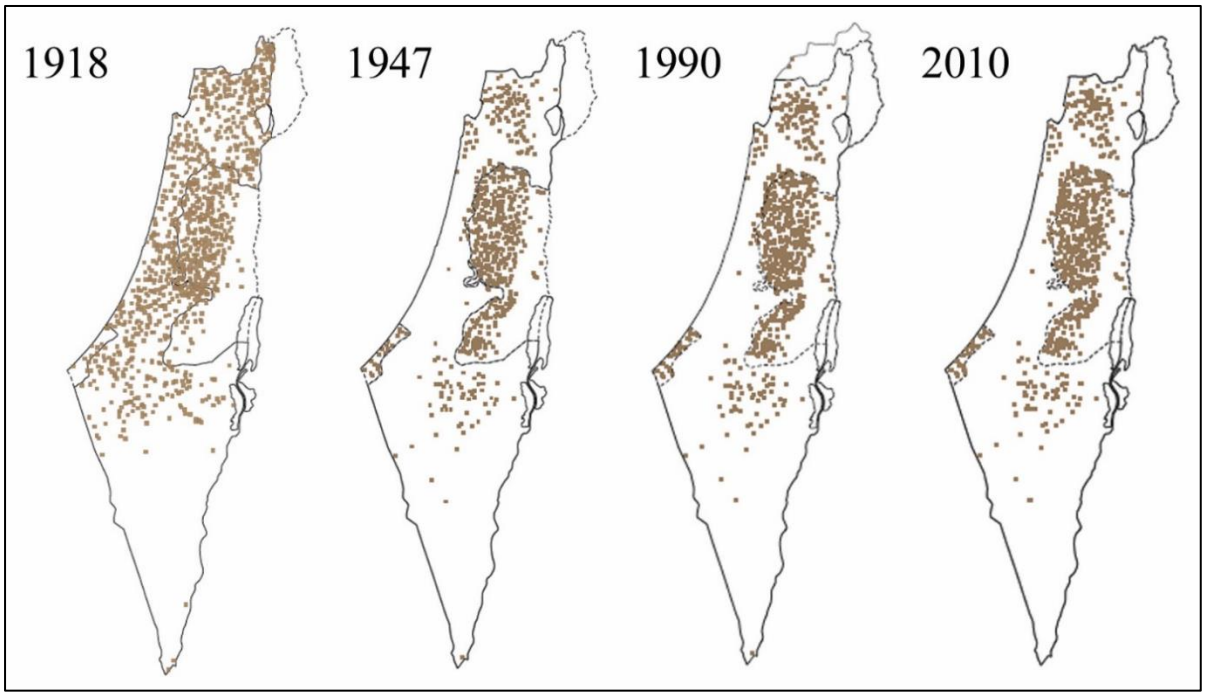


Figure 28: Timeseries maps of Palestinian settlements in between 1918-2010 (source: Shoshan, 2010)

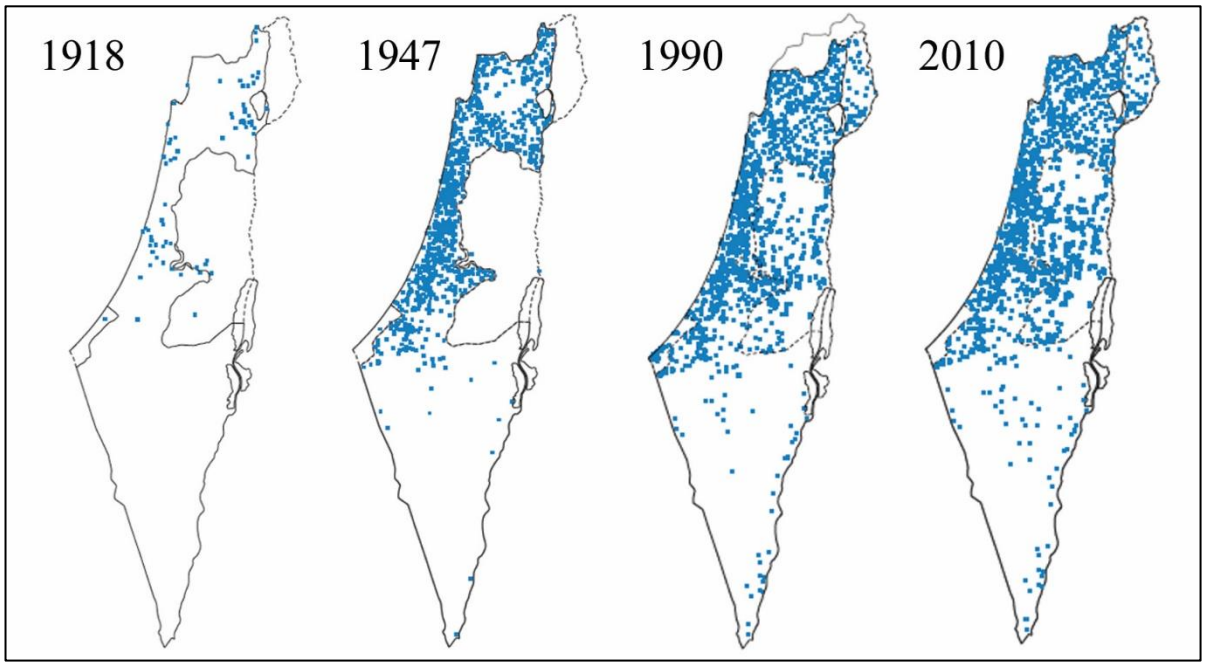


Figure 29: Timeseries maps of Jewish/Israeli settlements in between 1918-2010 (source: Shoshan, 2010)

The spatial overlay maps of groundwater and arable land potential zone maps and Israeli-Palestinian settlement maps (Figure 30 and 31) are explained here. The settlements do not seem to be concentrated around the better groundwater potential zones. However, on the other hand, the locations of the settlements are in closer proximity to better arable land potential zones while poor arable land zones are scarcely occupied.

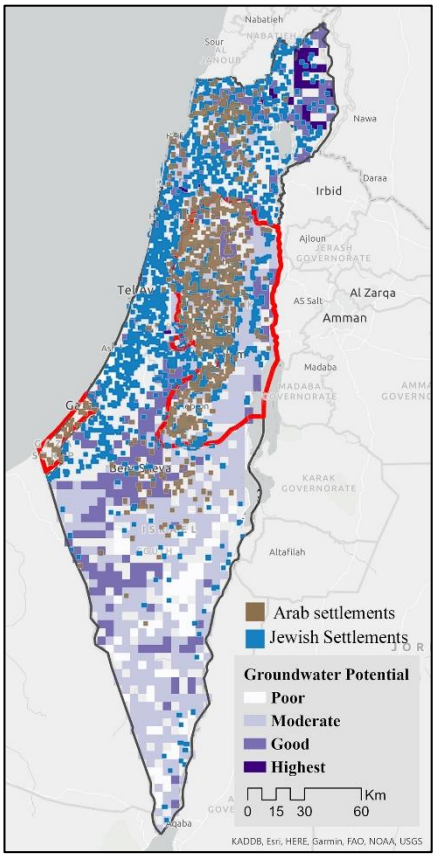


Figure 30: Groundwater zones and settlements

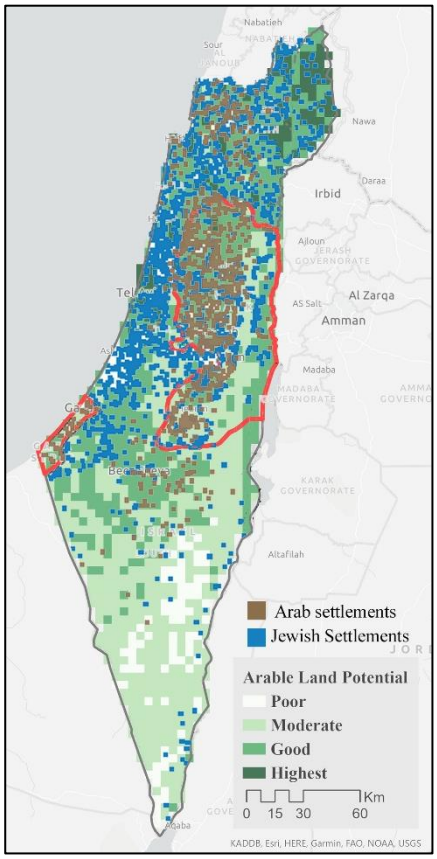


Figure 31: Arable land zones and settlements

Finally, the comparison of the settlement maps (Figure 32) with the map showing conflict events distribution (Figure 33) is explained here. The results show that the events of conflicts seem to be concentrated in areas that have both Israeli and Palestinian settlements in closer proximity which is mainly in the West Bank and also in the northern Akko and Safed districts.

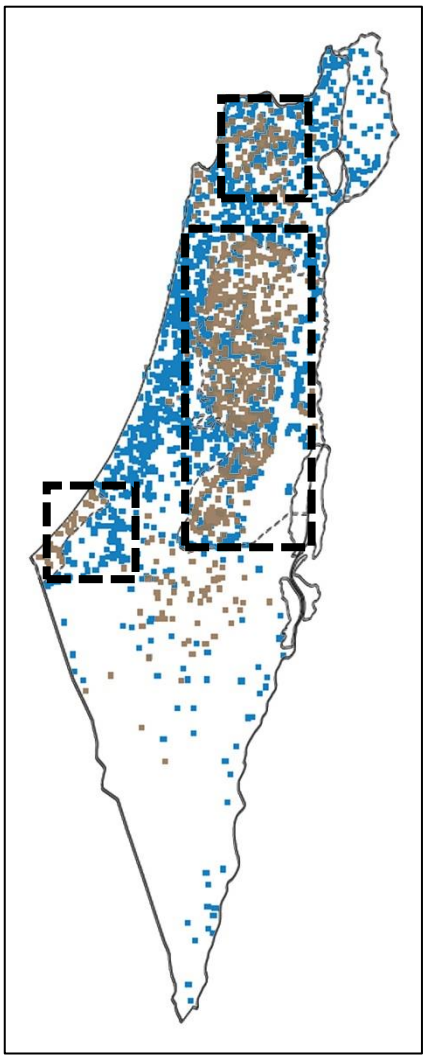


Figure 32: Settlements map

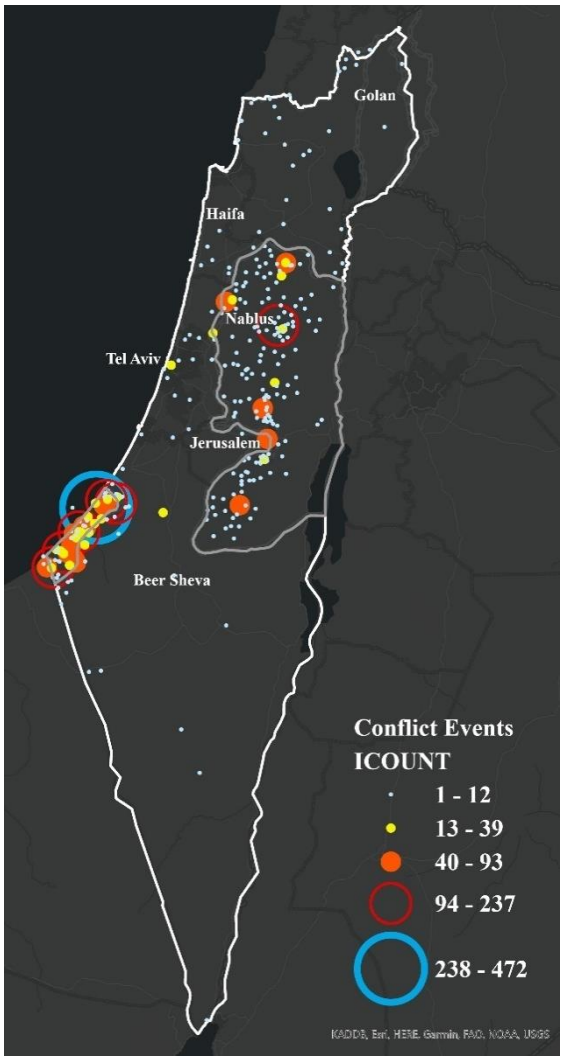


Figure 33: Conflict events distribution

7. Discussion and Conclusion

The results of this thesis illustrated the nature of the Israeli-Palestinian armed conflict and its spatio-temporal distribution in the landscape and also how the conflict has resulted into significant territorial changes, leading to a disproportionate access to key natural resources like groundwater and arable land. It also illustrated how the conflict was strategically powered by its settlement planning policies aiming mainly for the annexation of land areas in West Bank and Golan region, thereby creating a contest for groundwater and arable land, and leading to further events of conflict.

The classification of the conflict events according to the UCDP framework brings out a few critical inferences. Based on the classification, it is evident that the conflict has been consistently violent in nature, 84.88% being state-based conflict, resulting in 89.05% deaths, 12.06% being one-sided conflict, resulting in 7.13% of deaths and 3.05% being non-state conflict and resulting in 3.82% deaths. The conflict from the side of Palestinians is represented by various actors in varying proportions. It indicates how Palestinian people across different groups, from *Hamas* and *Fatah* being the largest political parties to PIJ being a student organisation are active in the conflict. Moreover, these groups have been engaged in conflict with different belief systems; for example, *Fatah* embodying nationalistic sentiments, *Hamas* being driven by radical *'Jihadist'* thinking and *Juned Ansar Allah* founded on religious beliefs. This has also resulted in various conflicts amongst these groups as seen from the classification (Table 13). The conflict events have been concentrated mainly in Gaza, being governed by Hamas and West Bank being governed by the PNA which indicates a spatial fragmentation in conflict from the Palestinian side, over and above a fragmented belief system. The varying intensity of conflicts (Figure 7) is indicative of possible attempts of conflict resolution (discussing which is beyond the scope of this thesis). Oslo Accords is one of the key agreements to be signed between PNA and the government of Israel aiming at resolving the conflict and territorial contest over the West Bank region.

Territorial contest that began with the Jewish *aliyah* in the early 1900 has resulted in continuous conflict events leading to significant territorial changes on both sides. The territorial changes before the establishment of Israel as a state, are mainly owed to the British Mandate and UNSCOP (Harms and Ferry, 2017). However, after the establishment of Israel, the territorial contest did not cease to exist. The results of second part of the analysis illustrate how the territorial change was also geographic in nature, in terms of accessibility to groundwater and arable land. The arable land with highest and good potential for agriculture in the region is located towards the western coastal plain where luvisol and calcisol soils are present. The land on the central hilly area is moderately suitable for crop cultivation while the southern Negev region having leptosol, is poorly suited for agriculture. Based on the territorial changes shown in the results, it is evident how the access to best suited arable land have changed in the favour of Israel from 1917 to present day which supports the claim by Asadi, 19766. A similar trend is as well observe in the accessibility to groundwater. The three main sources of groundwater in the study area are Galilee sea, mountain aquifers and coastal aquifers. With an increment in territory, Israel also gained access to groundwater resources mainly, the coastal aquifer and

Galilee sea. Lithological features play a key role in determining the availability of groundwater. The coastal planes, the central hilly area (West Bank) is composed of sedimentary rocks, mainly limestone which is amongst the best rocks for groundwater bearing capacity. The central hilly area is also characterised by steep slope which contributes to greater surface runoff and reduces the possibility of water percolation. However, a report published by USGS in 1964 presented a possibility of developing and using the mountain aquifer as groundwater storage reservoir (Schneider, 1964). The results for the groundwater potential zones as well, shows that the central hilly stretch is characterised by moderate to good groundwater potential zones thereby supporting the report. Therefore, it could be said that in between 1917 to present day, Israel has gained more access to both arable land and groundwater sources.

One of the anomalies in this part of results is Golan region being characterised by highest to good potential for both arable land and groundwater sources. From a geographic perspective, the probability of this scenario being accurate is quite low since the lithological features of this region are mainly pyroclastic rocks and cambisol soils which have poor groundwater bearing capacity and poor fertility, respectively. This occurrence could be explained by the fact that the precipitation received in this region is the maximum and the relative significance of precipitation derived based on AHP was 38.14% which seemed to have influenced the final results and led to this anomaly. This brings out one of the shortcomings of the methods used i.e., AHP and weighted overlay analysis. The accuracy and the logical consistency of the other parts of the results however weighs over this anomaly and the usage of AHP and weighted overlay for this study are therefore justified.

The last part of the results explained the relationship between establishment of settlements, availability of groundwater and arable land and emerging armed conflicts. The results showed a strong visual relationship between the location of settlements and arable land areas in between 1917-2010. Agriculture has been extremely important to cultural and socioeconomic activities of the region (Orni and Efrat, 1988; Gelvin, 2014). The establishments of the settlements in a closer proximity to arable land was therefore unavoidable and is also evident from the study results (Figure 30). The same visual relationship could not be established so strongly in the case of groundwater potential mainly due to the fact that groundwater in the region is also distributed via underground water infrastructure. The establishment of groundwater wells in the closer proximity of mountain aquifer (figure 19 and figure 20) however indicates the possibility of spatial relationship between Israeli and Arab settlements and groundwater sources. Therefore, it could be said that the establishment of new Israeli settlements along with the territorial gain, was driven by the location of arable land and groundwater. After the Oslo Accords (1993-1995), the territorial contest has only been limited to the West Bank area (which has both Jewish and Israeli settlements) since the Gaza strip is not being inhabited by Israeli settlers anymore after the disengagement plan in 2005. A visual comparison of the events of conflicts with the settlement map, indicates that the events of conflicts are being witnessed in the areas where both Israeli and Palestinian settlements reside in close proximity. Therefore, the results explain that there exists a spatial relationship between the location of arable and groundwater sources and the establishments of new Israeli settlements mainly in the West Bank area, ultimately leading to more conflict events in the region.

Based on the explanation of the results, all the research questions of the thesis have been addressed and the shortcomings of methods, data and results have been highlighted. It could be concluded that the location and availability of key natural resources i.e., groundwater and arable land have played visible role in territorial contest ultimately leading to more events of conflicts. The study was conducted on relatively larger spatial and temporal scale and therefore, it was not possible to show the same role of the geographic elements on a finer spatial and temporal scale in driving the conflict events. The use of AHP and Weighted Overlay analysis to study political and geographic rational behind the Israeli-Palestinian conflict was a novel approach taken in this thesis. The results of this thesis thereby takes a step forward in analysing the geographic drivers of Israeli-Palestinian conflict using GIS, the need of has been mentioned by in literature. The approach and methods used in this thesis provided a base to further incorporate other geographic elements like elevation, to study the same conflict or other geopolitical conflicts to understand the role of geographic features as conflict drivers.

The study recommends further research in the areas of spatial and transport planning to understand how road network has also been a key factor in fragmenting the Palestinian settlements in the West Bank using GIS tools like Network Analysis. Further research is also recommended in the area of groundwater in terms of desalination, water treatment, water quality and pumping which could help in addressing the water issue and possibly aiding in conflict resolution.

Summary

The aim of the thesis was to assess the role of groundwater and arable land in driving the Israeli-Palestinian conflict using relevant methods in geoinformatics. The study area for this research is the State of Israel and Palestine. The methodology for the study was structured to examine the potential relationship between Israeli settlements surrounding potential groundwater and arable land areas and the locations of events of conflict. The analysis was divided into three parts; firstly, the conflict analysis which included classification of conflict events according to the UCDP framework. Secondly, analysing the change in the accessibility of groundwater and arable land to Israel and Palestinian territories which was done using analytical hierarchy process and weighted overlay analysis, and last part consists of analysed the possible relation between all the phenomena. The results showed that a major part of the conflict is State-based armed conflict and its spread over West Bank and Gaza. The accessibility of groundwater and arable land had been changing significantly in the favour of Israeli from 1917 to present day which indicated a geographic rational in the territorial expansion and settlement planning. On a broader spatial and temporal scale, the conflict events were observed to be in the region where Israeli settlements were established.

Peamiste geograafiliste tegurite rolli analüüs Iisraeli-Palestiina konfliktis

Smit Rajshekhar Patel

Kokkuvõte

See magistritöö uurib põhjavee ja haritava maa potentsiaalselt rolli Iisraeli-Palestiina konflikti ajendamisel. Mitmed autorid kirjanduses on samuti täheldanud erinevate geograafiliste tegurite mõju konflikti kulgemisele, näiteks Willatts (1946), Asadi (1976), Efrat (1988) ja Elmusa (1996), kuid seni puudub selge kvanitatiivne geograafiline analüüs vastuolu ärgitavate faktorite kohta (Efrat, 2006).

Magistritöö eesmärk on hinnata põhjavee ja haritava maa rolli Iisraeli-Palestiina konflikti ärgitamises, kasutades selleks asjakohaseid geoinformaatika meetodeid. Järgnevatele uurimisküsimustele on töös vastatud kirjanduse ülevaate ja empiirilise analüüsi kaudu.

- Kuidas on relvastatud konflikti sündmused Iisraelis ja Palestiinas jaotunud ruumiliselt ja ajaliselt?
- Kuidas on Iisraeli ja Palestiina ligipääsetavus põhjaveele ja haritavale maale ajas muutunud?
- Kas relvastatud konflikti sündmuste ja põhjavee ning haritava maa ligipääsetavuse vahel on seos?

Uppsala Konflikti andmebaas (UCDP) ja rahu-uuringute instituut Oslos (PRIO) defineerivad relvastatud konflikte järgnevalt:

“Valitsusi ja/või territooriume puudutav võistlev kokkusobimatus, kus relvajõudude kasutamine kahe osapoole vahel, millest vähemalt üks on riigi valitsus, päädib vähemalt 25 lahinguga seotud surmaga.” (Codebook, Version 4 - 2006: 6)

Hiljutised rahu ja konflikti käsitlevad uuringud on toonud välja rahu ja konflikti protsesside ning ruumi vastastikku mõjutavad suhted. Näiteks Höglund *et al*. (2016) ja Hackl (2016) on näidanud, kuidas relvakonfliktid ja linnaruum eksisteerivad samades piirides. Erinevate loodusvarade kättesaadavus ning võistlus nende üle viib tihti relvastatud konfliktini, näiteks Iisraeli ja Palestiina puhul põhjavesi Läänekalda piirkonnas. Looduslike varade vähesus või ülemaailmselt hinnatud varade, nagu maagaas ja nafta, kättesaadavus on kaks peamist konfliktide põhjustajat (Billon, 2001, O’Lear, 2006).

Selle uurimistöö uurimispiirkonnaks on Iisrael ja Palestiina. Põhjavee kättesaadavus regioonis on piiratud, ainsateks allikateks on Kinnereti järv ja ranniku ning mäestike põhjaveekihid. Läänekaldal asuv mägede põhjaveekiht on hõivatud Iisraeli poolt, ohustades seeläbi Palestiina suveräänsust selle üle ja süvendades käimasolevat konflikti. Põllumajandus on alati olnud Palestiina kultuuris ja majanduses oluline (Orni, Efrat, 1980). Siiski moodustasid viljakad pinnased 95% territooriumist, mille Iisrael omandas 1948. aasta vaherahu alusel (Asadi, 1976). Pärast seda on Iisraeli asulad Jordani Läänekaldal alates 1970. aastatest kahandanud piirkonnas olemasolevat põhjavett ja haritavat maad, mis on sageli põhjustanud konflikte.

Uurimuse metoodika oli koostatud nii, et oleks võimalik uurida võimalikke seoseid põhjavee ja haritava maa alasid ümbritsevate Iisraeli asumite ja konflikti sündmuste asukohtade vahel. Metoodika esimene osa keskendub relvastatud konflikti sündmuste klassifikatsioonile, lähtudes UCDP raamistikust, ja nende sündmuste ruumilise ja ajalise jaotuse illustreerimisele. Teine osa keskendub põhjavee ja haritava maa territoriaalsele ligipääsetavusele ajas. Selleks piiritletakse uurimisalal põhjavee ja haritava maa potentsiaali, kasutades analüütilise hierarhia ja kaalutud ülekatte mudeleid. Lisaks tehti erinevate aastate territoriaalkaardid (1917, 1942, 1947, 1948, 1967, 1995 ja tänapäev), mille muutuste illustreerimiseks kasutati maskeerimist. Viimaks tehti ruumilise ülekattuvuse kaarte, et uurida võimalikke ruumilisi suhteid potentsiaalsete põhjavee ja haritava maa tsoonide, Iisraeli asunduste rajamise ja piirkonnas esinevate relvakonfliktide vahel.

UCDP raamistiku järgi relvastatud konflikti (1989-2020) klassifikatsioon näitas, et 84,88% konfliktidest olid riiklikud, 12,06% ühepoolsed ja 3,05% mitteriiklikud. Kuigi konflikt on olnud aktiivne kõigil kolmel tasemel, on peamine riikidevaheline konflikt Iisraeli ja Palestiina vahel. Ruumiliselt on konflikt koondunud kolme põhilisse piirkonda, st Gaza tsooni, Jeruusalemma ja mägesid ümbritseva põhjaveekihi piirkonda Läänekaldal. Ajaliselt oli konflikt oma haripunktis Gaza sõja ajal 2014. aastal. Põhjavee ja haritava maa ligipääsetavuse analüüs näitas et Iisraeli territoriaalset laienemist iseloomustab ligipääsetavuse suurenemine põhjaveele ja haritavale maale alates 1917. aastast (mis tähistas konflikti algust) kuni tänasepäevani. Läänekaldal olevate Iisraeli asulate arvu suurenemisega on Palestiina põhjavee ja haritava maa ressursid kiiresti vähenenud, soodustades seeläbi konflikti geograafilisel tasandil. Ruumilise ülekatte kaardid näitasid nähtavat seost Läänkalda piirkondade põhjavee ja haritava maa ligipääsetavuse, juudi asulate ja konflikti sündmuste asukohtade vahe. Asulate rajamine on aja jooksul üsna struktureerimata protsess, mistõttu on põhjus-tagajärg seose loomine täpsemal ruumilisel ja ajalisel skaalal keeruline. Koondatuna oli seos siiski nähtav ruumiliste ülekattekaartide ja põhjavee ning haritava maa piirkondade pideva Iisraeli poolt hõivamise kaudu.

Geograafia on olnud Iisraeli-Palestiina konfliktis keskne teema, kuna põhitegurid on võitlused põhjavee ja haritava maa pärast. Käesolevas magistritöös selgitatakse, kuidas relvakonflikti sündmused on seotud Läänekaldal asuvate juudiasunduste arvu kasvu ja Palestiina territooriumil peamistele loodusvaradele juurdepääsu vähenemisega. Seeläbi on lõputöö astunud sammu edasi Iisraeli-Palestiina konflikti käsitlemisel, kasutades kvantitatiivseid geograafilisi meetodeid ja GIS-i. Selles töös kasutatud analüütilise hierarhia protsessi ja kaalutud ülekatte tehnikate kasutamine poliitiliste konfliktide geograafiliste põhjenduste illustreerimiseks on uudne lähenemisviis, mida saaks veel edasi arendada, et integreerida ka muid geograafilisi tegureid nagu näiteks kõrgust. Töö põhjal saab soovitada täiendavade analüüside läbiviimist GIS-tehnikate (nt võrguanalüüsi) abil, et uurida, kas konfliktis on mänginud rolli ruumiline planeerimine ja avalik infrastruktuur, nagu teedevõrk ja transport.

Appendix

Annexe 1: An overview of the conflict – key events and warring parties

1881-1903 – Rising wave of nationalism in Europe along with antisemitic sentiments causes the first wave of Jewish migration to Palestine and the birth of Zionism.

Resentment amongst Arab Palestinians.

1917 – The Balfour Declaration announces the creation of a 'Jewish National Home' within Palestine.

1922 - Palestine (including present day Israel), Jordan, Iraq became a part of British Mandate while Syria and Lebanon became a part of French Mandate and the shaping of the present day Middle-East countries, rising Arab apprehension against the controversial Balfour declaration.

Jerusalem the holy place for all Christians, Jews and Muslims being contested.

1928 – First violent conflict in Jerusalem resulting in hundreds of deaths of Jews and Arabs

1930 – Rising atrocities against the Jews in Europe sparking new waves of Immigration to Palestine.

1937 – Peel's Commission proposes the partition of Palestinian landscape, allotting 20 % of land to the Jewish community.

1939-45 – World War 2 and The Jewish Holocaust leading to another wave of Jewish Migration into the 'Jewish National Home'.

Zionism receiving worldwide support of Jews thereby strengthening the movement

1947 – Britain withdraws from its colonies, US replacing its diplomatic stronghold in the Middle East.

UNSCOP proposing the partition of Palestine into separate Jewish (56% of territory) and Arab countries leading to Arab-Jewish civil war ; Arabs loose more territory

May 14, 1948, 4 pm – Ben Gurion declares the establishment of formal Jewish State in Palestine called *Medinath Yisrael* (State of Israel) now including 78 % territory.

International War and the birth of Arab-Israeli Conflict, sparks off Palestinian refugee migrations.

1956 – Suez Canal crisis as Britain, France and Israel invade Sinai Peninsula and take over Suez Canal. Israel called as a Western puppet, forced to withdraw from Sinai and Gaza and further deployment of UNEF in the region, followed by a decade of quietness.

Arab-Israeli conflict gets drawn into the Cold War. Israel garners US and French support and begins a nuclear armament program while Egypt, Syria and Iraq gets Russian support.

1964 – Rebellious sentiments amongst Palestinians grow, leading to the formation of PLO **(Palestinian Liberation Organisation)** and a militant group **al-Fatah.**

Increasing hostilities between Israeli-Arab countries especially on the Syrian border.

June 1967 – Six Day War. Israel comes out victorious with 3 times more territory.

Resolution 242 – Israeli recognition by the Arab neighbours, Palestine being completely ignored except for its refugee issue. Israel in return obligated to withdraw from the occupied territories (Sinai, Gaza, West Bank and Golan).

1968 – Violent conflict continues between Israel and PLO and Fatah as PLO continues to gain popularity now as the unilateral diplomatic front of the Palestine**. PFLP (Popular Front for the Liberation of Palestine)** and **PDFLP (Popular Democratic Front for the Liberation of Palestine)** founded.

1978 – Likud Government, a far right conservative party comes to power in Israel, reinforces occupied territories (West bank especially) as an intrinsic part of Israel, names it Judea and Samaria and initiates the settler policy adding woes to the conflict.

1982 – Israel's invasion of Lebanon aiming to abolish the PLO's headquarters in Lebanon. With the continued violent conflicts between Israel and PLO, the later gained increasing popularity in Gaza and West Bank both of which were about to become the centre stage of the conflict. Formation of **Hizballah** – militant group based in Lebanon.

1987-91 – The first Intifada, growing fear, resentment, and frustration among the Palestinians due to swift settler colonisation in West Bank and Gaza. Formation of **Hamas**, a militant group based on radical Islamist thinking – *jihad.*

1993-95 – Oslo Accord I and II, peace negotiations between Israel and PLO begins, Israel agrees to withdraw from Gaza and Jericho area in West Bank, establishments of Zones of control in the West Bank by Palestinians, Israeli and mutual control which was disapproved by Hamas.

1995-2000 – Negotiations between PA (PLO's political front) continue over the area distributions in the Zones in West Bank.

2000-03 – Second Intifada, a more violent clash resulting thousands of deaths over the course of the uprising creating the already existing rivalry more bitter. Many homes destroyed in the occupied West Bank territories by Israel and construction of the barrier wall in June 2002.

2004 – Withdrawal of Israel from Gaza, followed by Hamas's victory in the following elections.

2006 – Violence erupts between Gaza and Israel reaching war like intensity, with Hizballah adding to Israeli woes in the North. Violent conflict continues mainly on the Gaza front.

2014 – The Gaza war as a result of kidnappings of civilians from both sides and their deaths

2014-20 – The violence continues. 2017 marked a hundred years of conflict.

2021 – The latest violence erupts due to Israeli occupation of East Jerusalem

(Harms & Ferry, 2017, Black, 2017)

Annexe 2 Spatial Weights Matrix for weighted overlay Analysis

Factor	Classes	Weights (Groundwater)	Weights (Arable land)
Precipitation	1-11	1	1
	11-24	2	2
	24-38	3	3
	38-52	4	4
	52-72.5	5	5
Lithology	Sedimentary	5	-
	Carbonate Sedimentary	5	-
	Unconsolidated Sediments	4	-
	Pyroclastic	1	-
Landuse	Trees	3	-
	Grass	5	-
	Flooded vegetation	3	-
	Crops	5	-
	Scrubs	5	-
	Built area	1	-
	Barren ground	4	-
	Snow/Ice	1	-
Soil Type	Calcisol	4	4
	Cambisol	2	3
	Leptosol	3	1
	Regosol	5	3
	Vertisol	3	4
	Luvisol	4	5
	Solonchak	1	1
Temperature	9-17	-	3
	17-18	-	4
	18-20	-	4
	20-22	-	5
	22-25	-	5
Slope	0-1	5	5
	1-2	4	4
	2-3	3	3
	4-5	2	2
	5-63.8	1	1

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