23 Social, Environmental and Security Impacts of Climate Change on the Eastern Mediterranean

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23.1 Introduction[1]

This chapter discusses climate change impacts for the Eastern Mediterranean, with a particular emphasis on the *Occupied Palestinian Territories* (OPT) that comprise the West Bank, including East Jerusalem, and the Gaza Strip. According to the *Intergovernmental Panel on Climate Change* (IPCC 2007a: 13), the average global temperature is projected to rise until 2100 by a range of 1.1–6.4°C, and the sea level has been projected to rise between 18 and 58 cm.[2] Data on the projected climate change at the regional scale are lacking (IPCC 1990, 1996a, 1998, 2001a, 2007a, 2007b, 2007c, 2007d).

Climate change will have many negative impacts for the Eastern Mediterranean region and the OPT that include increases in temperature and sea-level rise (SLR), of hydro-meteorological hazards (heatwaves, droughts, storms, floods, spread of diseases, etc.), changes in precipitation and evaporation rates, water scarcity, and desertification. These complement other environmental challenges, such as increased salinity of soils and of surface-water and groundwater, depletion of stratospheric ozone, and loss of biodiversity. All these physical impacts may result in declining crop yields and failure (leading to food insecurity), and to societal effects, such as 'environmentally-induced migration'.

The projected SLR poses a threat to the Eastern Mediterranean cities with a high population density and concentration of economic activity along the coast. A typical example is the Gaza Strip, which is particularly vulnerable to these effects, as it lacks the resources to prepare for potential hazards. The climate change impacts will and should lead people to take new measures, actions, and strategies that aim to engage them in combating climate change, by changing their mindset and utilizing the situation to catalyse actions for long-term improvements.

This chapter discusses potential climate change impacts for the OPT by specifying environmental, technical, economic, social, political, geopolitical, and security consequences, besides adaptation policies, on the local and regional context, for a SLR between 23 cm and 200 cm (0.23–2 m) until the year 2100. These seven issues are:

1. Possible ecological effects of the *Israeli Segregation Wall* (ISW) on the local climate;
2. Impacts of sea-level rise (SLR) on the Gaza Strip;
3. Climate change impacts on water scarcity and transboundary aquifer systems;
4. Climate-change coping strategies for the *Jordan River Basin* (JRB), and water conflict;
5. *Red Sea-Dead Sea Conveyance* (RSDSC) project and its possible impacts on regional climate;
6. Deforestation, desertification, and land degradation as causes of and effects on climate change;
7. Mitigating climate change impacts with renewable energy.

Global climate change is to a large extent due to human activity, resulting from the burning of fossil fuels and land-use changes, such as deforestation that reduces the amount of CO_2 being absorbed (Brauch/Spring/Grin/Mesjasz/Kameri-Mbote/Behera/Chourou/Krummenacher 2009). On possible political and societal effects of global climate change, three main scenarios were developed by US experts. The *German*

1 The Author wishes to extend his sincere thanks to his colleagues at the *Geographic Information Systems* (GIS) and Remote Sensing Unit of the *Applied Research Institute – Jerusalem* (ARIJ), Palestine, for their help in providing the maps for this chapter.

2 Rahmstorf (2007) assumed even much higher increases in the SLR – up to 140 cm (1.4 m). The IPCC Chairman R.K. Pachauri (2008) referred to potential SLR, for assumed stabilization levels of greenhouse gases (GHG) in the atmosphere between 445 and 710 ppm, of between 40 cm and 240 cm (0.4–2.4 m) (table 23.5 below).

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Advisory Council on Climate Change (WBGU 2008, 2008a, 2008b) distinguished four conflict constellations due to climate-change induced effects.

23.1.1 Three Policy Scenarios for US National Security

The three scenarios developed by a team of American experts (Campbell/Gulledge/McNeill/Podesta/Ogden/Fuerth/Woolsey/Lennon/Smith/Weitz/Mix 2007: 55–92; chap 42 by Scheffran) are:

1. The *Expected Scenario* projects the effects of an average global temperature increase of 1.3°C and an SLR of 23 cm by the year 2040. Global implications for this scenario would include: internal and cross-boundary tensions for US national security by environmentally-induced migration; conflicts sparked by resource scarcity; and increases in diseases and health-related problems in general, which will have economic consequences. The physical effects of climate change will have societal, political, economic, and security impacts.
2. The *Severe Scenario* foresees profound and potentially destabilizing global effects when the average temperature will increase by 2.6°C and the sea level will rise by 52 cm by the year 2040, what will trigger massive societal events, leading to a dramatic rise in migration and changes in agricultural patterns and water availability. Armed conflicts among nations due to natural resources scarcity could also take place in various parts of the world.
3. The *Catastrophic Scenario* assumes an increase in the average global temperature of 5.6°C and an SLR of 200 cm (2 m). It foresees strong and surprising interactions between the two great security threats of global climate change and international terrorism posing almost inconceivable challenges as human societies would struggle to adapt to it.

23.1.2 Four Conflict Constellations for International Security

From an international security perspective, the WBGU in its report on *Climate Change as a Security Risk* has mapped the most highly affected regions by identifying four major issues, for which climate change is expected to cause critical developments (WBGU 2008a: 79–130; they are summarized in chap. 41 by Bauer; Brauch 2002, 2007, 2009a, 2009c):

1. *Climate-Induced Degradation of Freshwater Resources*: About 1.1 billion people are currently without access to safe drinking water. The situation could worsen for hundreds of millions of people as climate change alters the variability of precipitation and the quantity of available water. Demand for water is increasing due to population growth and mounting aspirations. This triggers distributional conflicts and poses major challenges to water management in many countries. The countries which will suffer the greatest water stress are generally those which lack the political and institutional framework necessary for the adaptation of water and crisis management systems. This could overstretch existing conflict resolution mechanisms, ultimately leading to destabilization and violence, specifically in the Middle East.
2. *Climate-Induced Decline in Food Production*: More than 850 million people worldwide are currently undernourished. This situation is likely to worsen in future as a result of climate change, as food insecurity in the lower latitudes, especially in many developing countries, will increase with a temperature rise of just 2°C. With global warming of 2–4°C, a drop in agricultural productivity is anticipated worldwide. This trend will be substantially reinforced by desertification, soil salination and/or water scarcity. In North Africa and the Middle East this may trigger regional food crises and further undermine the economic performance of weak and unstable states, thereby exacerbating destabilization, the collapse of social systems, and violent conflicts.
3. *Climate-Induced Increase in Storms and Flood Disasters*: Climate change is likely to result in more intensive storms and heavy precipitation that will affect many cities and industrial regions in coastal zones. Conflicts are likely to occur more frequently in future, because: a) certain regions, especially at risk from storm and flood disasters (e.g. Central America, which have weak economic and political capacities), will make adaptation and crisis management more difficult; b) frequent storm and flood disasters along the densely populated east coasts of India and China could cause major damage and trigger or intensify migration processes.
4. *Environmentally-Induced Migration*:[3] Migration may increase conflicts in transit and target regions. In developing countries, in particular, the increases in drought, soil degradation, and water scarcity, in combination with high population growth, unstable institutions, poverty and high lev-

els of dependency on agriculture, imply a significant risk of environmental migration. Transboundary environmental migration will mainly occur as south-south migration, but Europe and North America must expect increased migratory pressure from regions which are most at risk from climate change. The question as to which states will have to bear the costs of environmentally-induced migration in the future also contains conflict potential.

Of these four conflict constellations, the first two are highly relevant to, and pertinent for, the national security of a future Palestinian state and for the human security of the Palestinian people.

23.1.3 Impacts of Climate Change on Human Security

From a human security perspective (Barnett/Adger; Brauch 2005, 2008), the *Human Security Network* (HSN), during the Greek Chairmanship in 2007–2008, addressed the climate change impact on vulnerable groups (Brauch 2009a, 2009c; Fuentes Julio/Brauch 2009). The *Friends of Human Security* (FHS) and the *United Nations Office for the Coordination of Humanitarian Affairs* (OCHA) also discussed issues of climate change and human security at a symposium on 31 July 2007.[4] Prior to the first debate on climate change at the UN Security Council, a group of scientists submitted a policy memorandum[5] that addresses challenges for the people, which are also highly relevant for the Palestinian people in the OPT, with a high degree of social vulnerability. Poor and underdeveloped nations, e.g. in the Middle East, may have fewer resources and less endurance to deal with climate change and its impacts and consequences.

3 The WBGU (2008, 2008a, 2008b) study identifies the four 'conflict constellations', which "are defined as typical causal linkages at the interface of the environment and society, whose dynamic can lead to social destabilization and, in the end, to violence." The WBGU study summarizes the climate change impacts for regional 'hotspots', including *the Middle East and North Africa* (MENA). For an expert study on Southern Europe and North Africa, see Brauch 2007b; chap. 26 by Brauch.

4 See: Workshop on: "Climate Change from the Perspective of Human Security" (UNTFHS 2007). See the presentation by Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator, John Holmes, on: "Human security and disaster reduction" (Holmes 2007).

5 See: Wisner/Fordham/Kelman/Johnston/Simon/Lavell/Brauch/Spring/Wilches-Chaux/Moench/Weiner 2007.

23.2 Middle East

The Middle East is one of the most water-stressed regions. Climate change is expected to make water resources even scarcer in the *Middle East and North Africa* (MENA), particularly in Jordan and the OPT[6] that will experience an even greater regional water stress.[7]

During the 20th century, observations have shown that global climate change has already caused less rainfalls, higher temperatures and higher evaporation rates, SLR, extreme weather events, and biodiversity loss. As a result of climate change, many species are

6 To better understand the water scarcity and conflict and some other important issues related to the water situation in the MENA region, this literature survey may be helpful: Davis/Maks/Richardson 1980; Shuval 1980; Khouri 1981; Stauffer 1982; Stork 1983; Cooley 1984; Matson/Naff 1984; Dillman 1989; El-Hindi 1990; Issar 1990; Lee/Bulloch 1990; Nijim 1990; Salameh 1990; Wishart 1990; Casa 1991; Hurwitz 1991; Pearce 1991; Al-Weshah 1992; Baskin 1992; Salem 1992; Sexton 1992; Bulloch/Darwish 1993; Postel 1993; Vesilind 1993; Biswas 1994; Isaac/Shuval 1994; Kliot 1994; Moore 1994; Neff 1994; Allen/Mallat 1995; Elmusa 1995; Haddadin 1995; Hof 1995; Libiszewski 1995; Lowi 1995; Schulz 1995; The Economist 1995; Wolf 1995; Isaac/Selby 1996; Rouyer 1996; Shuval 1996; Wolf 1996; Hof 1997; Pastor 1997; Kubursi/Isaac 1998; Allan 1999; Soffer/Copaken 1999; Alatout 2000; Amery/Wolf 2000; Brooks/Mehmet 2000; B'tselem 2000; Isaac 2000; Rook 2000; Allan 2001; Castelein/Otte 2001; Hass 2001; Allan 2002; Daibes 2003; Issar 2003; Mair/Kamat/Liu 2003; Rouyer 2003; Seitz 2003; Selby 2003; Brauch 2004; Haddad 2004; Handcock 2004; Hayek 2004; Issar 2004; Issar/Zohar 2004; Klawitter/Qazzaz 2004; Schwarz 2004; Soffer 2004; World Bank 2004; Frederiksen 2005; Khatib/Assaf/Claeys/ Daoud 2005; Messerschmid 2005; Selby 2005; Abu Zeid 2006; Bashir 2006; Bohannon 2006; Brauch 2006; Feitelson 2006; Fisher/Huber-Lee 2006; Gray/Hilal 2006; IRIN 2006; Tal 2006; Tropp/Jaegerskog 2006; Aliewi/Assaf 2007; Allan 2007; Baker/Freeman/Steinber 2007; Brauch 2007a, 2007e; Frederiksen 2007; Isaac/Salem 2007; Pearce 2007a, 2007b; Phillips/Attili/McCaffrey/Murray 2007; RSS 2007a; Salem 2007; Salem/Isaac 2007; Shuval/Dweik 2007; UNESCO 2007; Bergstein 2008; Bigman 2008; Biswas/Rached/Tortajada 2008; Dinar 2008; Fischhendler 2008; Hoetzl/Moeller/Rosenthal 2008; Lendman 2008; Makdisi 2008; World Bank 2008c; Zeitoun 2008; Zeitoun/Allan 2008; Zereini/Hoetzl 2008; Abdel Hamid 2009; Pedersen 2009; Picow 2009).

expected to disappear. A recent IPCC (2008) report warns that temperatures in the Middle East have increased 2–3°C in the last century, which is faster than the global average of about 1°C (Pedersen 2008). As a result, the Middle East region is expected to have fewer but more intense rain events, increased droughts, and decreasing resources of fresh water. More than 80 per cent of climate models have shown that rainfall in the MENA region will decrease by up to 40 mm per year (ENN 2008). With rainfall decreasing, the growing seasons for farmers will be shorter.

The Middle East is already experiencing a severe water crisis that is partly due to a mismanagement of freshwater resources. Within the next few decades, climate change will have severe regional impacts, not only for the natural environment, but also for the political and socio-economic context, adding to the political instability and tensions in the region. The dispute over water has been and will remain part of the Israeli-Palestinian, and of the Israeli-Arab conflict.

If water becomes too scarce under the climate change scenarios and conflict constellations discussed above, given the political circumstances affecting the region, then the Palestinians in the OPT will become the first victims who will further suffer from climate change. Water prices will rise dramatically. The Palestinians in the OPT presently purchase water for 5 NIS (*New Israeli Shekel*) or about 1.5 US$/$m^3$ (Salem/Isaac 2007) from *Mekorot*, a semi-private Israeli water company whose major shareholders are the Jewish Agency and the Jewish National Fund. Further, the decrease of agricultural lands will result in higher food prices, particularly for fruits, vegetables, and cereals, and, thus, their food security will be badly affected.

The projected SLR could affect the nearby aquifers due to the sea water intrusion. The *Gaza Coastal Aquifer System* (GCAS), which provides water to approximately 1.5 million Palestinians, is a typical example for such a disaster. Higher temperatures, annual decreases in precipitation, and higher rates of evaporation have already reduced the available fresh water (surface-water and groundwater) in the OPT. Israel, for example, which consumes more than 85 per cent of the water that should be allocated to the Palestinians in the OPT, must urgently take decisive measures to reduce the large-scale planting of water-consuming crops, and reduce the huge amounts of water that irrigate large areas, in order to conserve the use of water.

23.3 Historical Palestine – Occupied Palestinian Territories

Historical (or Mandate) *Palestine* (HP, including the OPT and Israel), with its small territory of about 27,000 km^2, is characterized by drylands and a natural habitat, where significant topographic and climatic variations prevail, what is a unique phenomenon in the MENA region (figure 23.1). Being located in West Asia, at the edge of the 'Fertile Crescent', and east of the Mediterranean Basin, HP has been a centre where human civilizations originated and spread throughout human history (Issar/Zohar 2009). Its long history of indigenous and invading cultures, and human movements for trade and politics have made HP a migration route for the exchange and dispersion of crops, seeds, flowers, and animal species. Many species have, thus, entered the region throughout history, making HP highly biodiverse by hosting over 4,000 plants, 120 mammals, 500 birds, 100 reptile and amphibian species, about 1,000 fishes, and an unknown number (5,000 to 10,000) of insects (Zohary/Feinbrun-Dothan 1984). Several species experience threats of degradation and extinction, and many are classified as 'endangered species'.

Based on its geographic attributes and geomorphologic and topographical characteristics, HP is recognized as rich and diverse, composed of five climatic zones: the coastal zone, the semi-coastal zone, the central highlands zone, the eastern slopes zone, and the Jordan Valley zone (Salem 2008a) that have a common flora and fauna. HP was primarily an agricultural country, and the West Bank in particular, has been a major food producer. Agriculture makes up a large part of the Palestinian economy and land use, representing 30 per cent of the Palestinian *Gross National Product* (GNP), with more than 50 per cent of the population benefiting directly from food production. Only 31 per cent of the land in the OPT is cultivated, 32 per cent is classified as grazing land, and the rest is classified as urban and barren land. Of the cultivated area, 28 per cent is considered rain-fed, and 3 per cent is irrigated mainly for vegetables.

The West Bank is located on the central highlands of HP, just above the Jordan Valley, while the Gaza

7 The MENA region is one of the most water scarce regions of the world, where 5 per cent of the world's population has access to only 1 per cent of the planet's freshwater resources (World Bank 2004, 2007a, 2008c). By 2025, most countries in MENA will face an absolute water scarcity (Abu Zeid 2006).

Figure 23.1: Historical Palestine within the Current Regional Context. **Source**: ARIJ (2009).

Strip runs along the South-eastern Mediterranean. The OPT, located between 31° 13' and 32° 33' latitude, and between 34° 13' and 35° 34' longitude, comprises a total area of 6,023 km^2, whereby the West Bank covers 5,661 km^2 and the Gaza Strip covers only 362 km^2.

The US *Population Reference Bureau* (PRB 2004) estimated the population of the OPT at 3.8 million (with an *annual population increase* (API) of 3.5 per cent); of Israel at 6.8 million (API: 1.6 per cent); of Jordan at 5.6 million (API: 2.4 per cent); of Lebanon

Table 23.1: Projected Population Growth for the Narrow Middle East countries for the Period 2005-2050. **Source:** UN (2001, 2005, 2009).

	Population in 2005 (UN 2009)	Projected Population in 2050 (UN 2009)	Projected Population Difference 2005-2050
Egypt	77 154 000	129 533 000	52 379 000
Syria	19 121 000	36 911 000	17 790 000
Jordan	5 566 000	10 241 000	3 957 000
Israel	6 692 000	10 649 000	3 957 000
OPT (Palestine)	3 762 000	10 265 000	6 503 000
Lebanon	4 082 000	5 033 000	951 000

at 4.5 million (API: 1.7 per cent); of Syria at 18 million (API: 2.4 per cent); and of Egypt at about 74 million (API: 2.0 per cent).

Table 23.1 shows the highest *projected population difference* (PPD, in percentage) for the OPT (Palestine) followed by Jordan, where PPD reaches to 269 per cent and 139 per cent, respectively. The lowest PPD is for Lebanon followed by Israel, where it reaches to 43 per cent and 67 per cent, respectively. Egypt and Syria will have lower PPD (68 per cent and 125 per cent, respectively) than the OPT (Palestine) and Jordan, and higher PPD than Lebanon and Israel. A PPD in the range of 43–269 per cent over 45 years will put extra pressure on the region's water resources and on the environment, taking climate change impacts into account.

According to the *Palestinian Central Bureau of Statistics* (PCBS 2008, 2008a), the OPT's population was about 4 million in the year 2007, about 2.5 million in the West Bank and 1.5 million in the Gaza Strip. The present estimated natural population growth rate for the Palestinians in the OPT is 3.5 per cent (3.1 per cent in the West Bank; 3.7 per cent in the Gaza Strip), being one of the highest growth rates in the Middle East (Salem 2009a). The average population density in the West Bank is 432 persons/km^2 in the total area, and 6,842 persons/km^2 in urban areas (PCBS 2006), while in the Gaza Strip, the average population density is 3,981 capita/km^2 in the total area, and 7,485 capita/km^2 in urban areas (PCBS 2006), making it one of the most densely populated areas in the world.

The climate in HP is typically Mediterranean, with a long, hot and dry summer; a short, cool and rainy winter, and a dry autumn. The temperature and the evaporation rate increase in the south and east. The average annual rainfall ranges from less than 50 mm to 800 mm, almost 70 per cent occurs between November and February, and the rest between March and May. The climate change impacts on rainfall, evaporation, desertification and storm intensity have been observed in the OPT which has suffered from severe shortages of natural resources, particularly water.

23.4 Climate Change Impacts on the OPT

This section reviews major physical and socio-economic impacts of climate change on the OPT for water resources (23.4.1), agriculture (23.4.2), due to Sea-Level Rise (23.4.3), for biodiversity (23.4.4), and human health (23.4.5).

23.4.1 Water Resources

Interest in water resources in the Mediterranean has risen due to population growth and increase in density in urban areas (Brauch 2007). The water demand in the OPT is dominated by three major user groups: agricultural irrigation, domestic use, and industry. Even without climate change the water scarcity in the Middle East is a huge problem, politically, demographically and economically. A rapid growth in agricultural and industrial output is needed to sustain the growing population, which requires a good water management.

23.4.2 Agriculture

In the OPT fruit production is a primary source of income for agricultural areas, which is extremely vulnerable to temperature extremes which the OPT experienced since the 1980's (table 23.2).

The following impacts of climate change are projected for agriculture in the OPT:

- Increases of temperature and extreme-events frequency will reduce crop yields (some crops are

Table 23.2: Extreme Weather Events in the OPT (1997-2004). **Source:** Salem (2007).

Date	Event
18-19 March 1997	A heavy storm hit the central and southern parts of the West Bank, which was the second heaviest storm in March during the past 60 years.
July-August 1998	The hottest summer in 35 years where the temperature rose up to 46.8°C in Jericho.
September-November 1998	The driest and warmest autumn during the past 58 years.
24 January 1999	A hail storm hit Jerusalem with hail stones as big as marbles (1.3 cm in diameter).
28 November 1999	Unusually cold and dry weather. The temperature in Jerusalem dropped to 6°C below zero.
July 2000	The hottest month of July in the last 50 years, with a mean temperature of 4°C higher than average. The highest recorded temperature (41°C) in Jerusalem since 1888.
February 2003	The wettest month since December 1991, and the wettest February ever recorded.
29-30 May 2003	Lowest pressure (995 mb) ever recorded in May, accompanied by an incredible sand storm that covered the entire OPT and the region with thick red sand and dust.
9-10 May 2004	Very intense heat affected the OPT, especially during the night of 9 May, when 32°C was recorded in Jerusalem. In the following nights, the temperature in Jerusalem was 20°C lower than the temperature at noon.

more tolerant than others), and will negatively affect marginal land and its farmers.

- Mean-temperatures modification will induce changes of the agricultural distribution of crops.
- Water scarcity will force farmers to abandon marginal land and will increase desertication.
- Socio-economic impacts, associated with the loss of agricultural and other related jobs, will result in increasing unemployment and in the loss of income, as well as in political disorder.

23.4.3 Sea-Level Rise

The Gaza Strip covers 40 km of the South-eastern coast of the Mediterranean Sea and is only 11 km wide. The *sea-level rise* (SLR) due to global warming will enhance erosion of the Gaza Strip beaches, and will also cause sea water intrusion into the *Gaza Coastal Aquifer System* (GCAS). Some low-lying coastal structures will be affected or damaged, causing a huge loss in valuable lands and buildings and forcing inhabitants to migrate.

23.4.4 Biodiversity

During the 20th century global warming has already resulted in extensive biodiversity losses. The Mediterranean Basin is one of 25 'global biodiversity hotspots' (Myers/Mittermeier/Mittermeier/Fonseca/Kent 2000). The biodiversity in HP has been high, being at a crossroad of African, Asian, and Mediterranean bio-geographic regions. The speed and magnitude of climate change may elicit different responses at different levels of ecological organizations, namely the people, the species, and the communities, and at all levels of the ecosystems.

23.4.5 Human Health

Climate change is expected to have critical impacts on human health in the Mediterranean and in the OPT, due to the lack of advanced medical care. It will have both direct and indirect impacts on the Palestinian society (Salem 2008b). People who suffer from pollen and dust allergies will suffer more from changes in climate, as the allergy season will start earlier, last longer, and become more intense. In the past, the allergy season started in May but now it starts in March. An increase in respiratory diseases is expected among children, the elderly, and those with chronic diseases. In addition, the very young, the very old, and the very weak are likely to be affected by heatwaves and, thus, mortality rates may increase in these groups.[8]

Many prevalent human diseases are linked to climate fluctuations, including cardiovascular mortality and respiratory illnesses (due to heatwaves), infectious diseases, and malnutrition from crop failures. The *World Health Organization* (WHO) estimated that the warming and precipitation trends, due to anthropogenic climate change during the period of 1972–2002, had claimed annually over 150,000 premature lives (WHO 2002). The global warming trend has already increased mortality rates (Patz/Campbell-Lendrum/Holloway/Foley 2005).

Indirect impacts of climate change may appear from diseases being transmitted by insects. Many diseases may spread in the OPT, particularly in the Gaza Strip, where impacts are expected to be severe. A cause of greatest concern is the possible spread of malaria (Kovats/Menne/McMichail/Corvaln/Bertollini 2000). Approximately half of the world's population is at risk of malaria, with over 270 million cases per year and more than one million deaths (WHO 1998, 2009).

23.5 Climate Change Impacts due to Man-Made Activities

For a healthy and productive environment, the impact of climate change and its causes must be taken into account (Pararas-Carayannis 2003). These factors have contributed to anthropogenic climate change: a) burning of fossil fuels; b) rise in urbanization, industrialization and consumption; c) production of huge amounts of waste; d) increased air, water, and soil pollution; e) lack of appropriate land and water management; f) deforestation; and g) many wars.

23.5.1 Effects of the Israeli Segregation Wall on Climate Change

The construction of the *Israeli Segregation Wall* (ISW) was started in 2002. Until December 2008 its total length had reached 768 km on the northern, western, and southern borders of the West Bank and it encircled East Jerusalem. The ISW (table 23.3; figure 23.2) consists of a 4–5 m high double-layered electric metal fence, reinforced with barbed wire, trenches, surveillance cameras, sensors, footprint-detection tracks, security patrols, and military roads. Other parts of the ISW, dividing Palestinian population centres, consist of 8–12 m high concrete segments that form an immense solid concrete barrier with military watchtowers lined up to 250 metres apart. The ISW has devastated an area of 40–100 m along its route. Besides its huge cost, the ISW has major environmental, social, economical, and political impacts on the Palestinians in the West Bank (ARIJ 2007, 2008).

Table 23.3: Changes in the Route of the Israeli Segregation Wall (ISW) between June 2004 and December 2008. **Source:** ARIJ (2008).

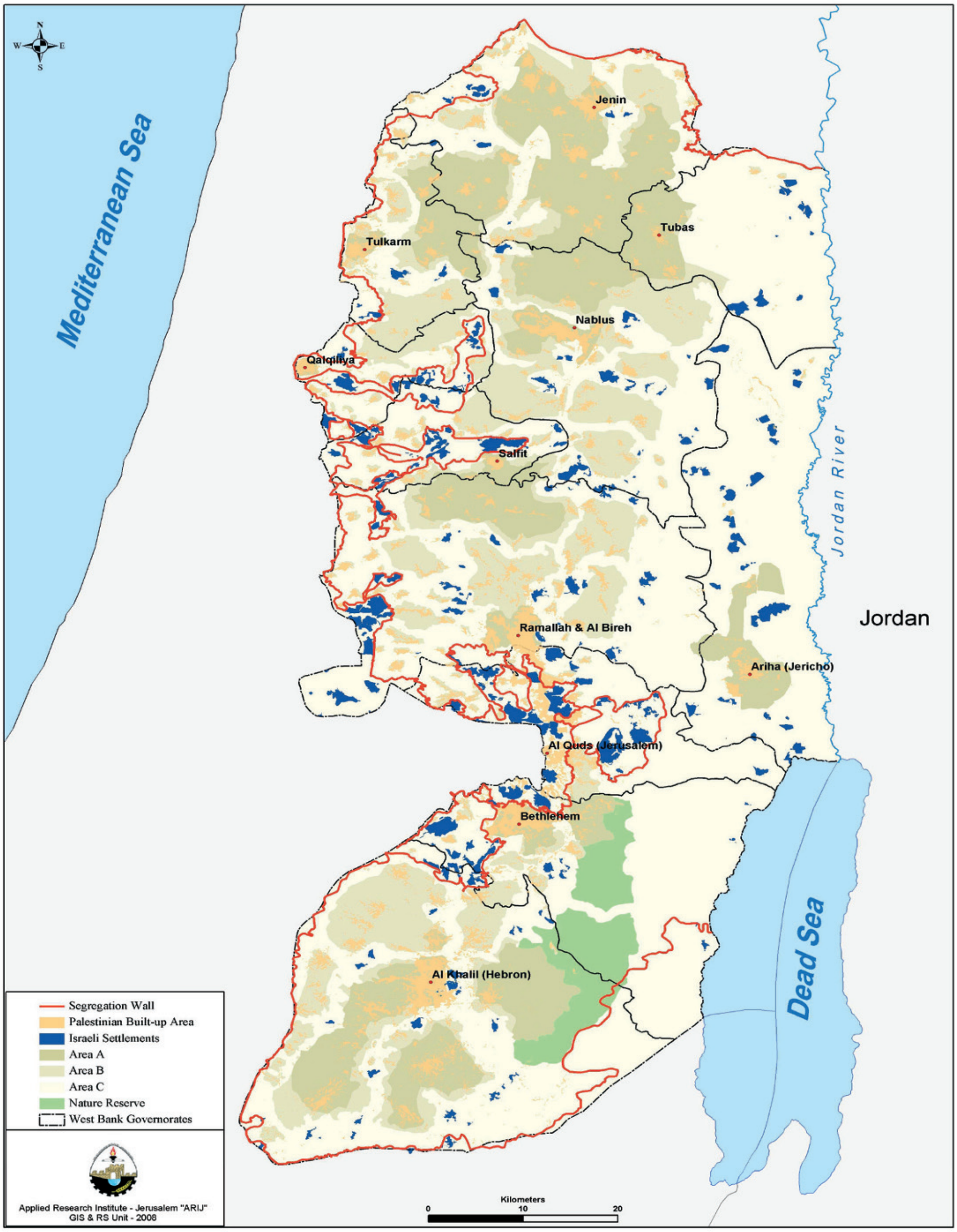
Date of Change	Wall Length (km)	Area Isolated (km²)	Of the West Bank's Area (per cent)
June 2004	645	633	11.2
February 2005	683	565	10
April 2006	703	555	9.8
April 2007	770	713	12.6
December 2008	768	734	13

In June 2002, the Israeli Government launched its policy of unilateral segregation of Israel and the OPT by establishing a segregation zone along the western terrains of the West Bank which covers large areas that are rich in natural resources (groundwater, springs, agricultural lands), grabbing fertile agricultural land, isolating Palestinian communities in enclaves, undermining the territorial contiguity between Palestinian villages and cities, controlling the natural resources, and encapsulating most of the Israeli settlements built illegally on Palestinian lands since 1967.

A decision of the *International Court of Justice* (ICJ) of 9 July 2004 saw the ISW as an attempt to connect illegal Jewish settlements in the West Bank to Israel by annexing Palestinian land. The ISW will have significant impacts on future negotiations on borders. By building the ISW (and of 200 Jewish settlements) on confiscated Palestinian territory, Israel violated the Hague Convention of 1907 and the Fourth Geneva Convention of 1949 (IHL 1907, 1949). The ISW violates the right to self determination and basic human rights, especially the right of free movement and access to holy places, work, health, education, and to an adequate standard of living. 'Self-defence' cannot be used to justify violating international legal principles and the rights of a people living under military occupation (McMahon 2005). The ICJ concluded

8 On May 18, 2007, Greece assumed the tenth Chairmanship of the *Human Security Network* (HSN) founded in 1999, which includes countries from Europe, North and South Americas, Africa and the Middle East. The HSN supports the United Nations' principles and aims at raising the awareness of the international community in the direction of effective support and protection of vulnerable population groups against modern threats to human security, which undermine development prospects in many parts of the world. Within the framework of its Chairmanship, Greece's priority is to point out the relationship between climate change and human security at international level. The aim is to raise the international community's awareness of the impact of climate change and global warming on human security, with regard to vulnerable groups, particularly children, women and persons fleeing their homes, due to climate change impacts (GMFA 2007).

Figure 23.2: The Israeli Segregation Wall (ISW) and Segregation Zones in the West Bank. **Source:** ARIJ (2008).



that the ISW was contrary to international law and, therefore, Israel must cease the wall's construction.

Since 2002 the route of the ISW has been changed several times (table 23.3) to benefit Israeli settlements in the West Bank, thus expanding the segregated zones. In September 2004, the Israeli army issued military orders that created a buffer zone of 150–200 m on the Palestinian side where new construction by Palestinian citizens is prohibited. As a result, an additional area of 252 km^2 (or 4.4 per cent) of the West Bank has become inaccessible to Palestinians.

Until December 2008 the ISW was 768 km long, of which only 80 km (10.4 per cent) follows the 1949 'Armistice Line' or 'Green Line' (figure 23.1, 23.2). The

ISW has isolated 734 km^2 (13 per cent) of the West Bank's area (table 23.3). By its completion, the ISW will enclose 107 Israeli settlements (with 425,000 Jewish settlers), and it will totally enclose East Jerusalem. The settlers that will be enclosed represent more than 80 per cent of all settlers in the West Bank (ARIJ 2008). Israel has made a few cosmetic changes of the ISW's route that do not ameliorate its devastating effects on the Palestinians and their lands and properties. The goal of these small changes has been to include more settlements between the ISW and the 1949 Armistice Line.

The Israeli army has consolidated its control over the West Bank in the Eastern segregation zone (1,555 km^2, or 27.5 per cent of the West Bank), through 28 military checkpoints. Until December 2008, Israel has illegally established 670 checkpoints in the West Bank (ARIJ 2008). After the 1967 War, Israel classified some 925 km^2 as a 'closed military area', and it illegally classified an additional 632 km^2 of the Eastern segregation zone as 'state land', which includes the settlements and the military bases, and parts of the closed military areas. The Israeli segregation plan appropriates more than 40 per cent of the West Bank (ARIJ 2007, 2008).

Until winter 2008, about half (377 km) of the ISW's total length (768 km) was completed; 12.4 per cent (or 95 km) of it was under construction (ARIJ 2008), and plans to complete an additional 38.5 per cent (or 296 km) were confirmed. The boundaries of 29 Palestinian villages (or 216.7 km^2) are trapped in enclaves behind the ISW, and another 138 Palestinian villages (or 555 km^2) are significantly affected and lost behind the path of the ISW. Furthermore, 45 Palestinian communities with more than 43,000 people will be isolated in the Eastern segregation zone.

The Western segregation zone includes 107 Israeli settlements in the West Bank that cover an area of 106.7 km^2 (or 15 per cent of the zone). In addition, 56 settlement outposts are located in this zone. Settlements in the Eastern segregation zone cover an area of 38 km^2 (or 2.4 per cent of the zone). In the Eastern segregation zone 12,550 Israeli settlers live in 39 settlements, besides 30 settlement outposts. Until December 2008, the total number of settlement outposts has reached 220, in addition to the 200 settlements spreading all over the occupied West Bank (ARIJ 2008).

The ISW has considerable impacts on the region's water supplies around it. "The climate of Palestine is semi-arid, and water sources are precious. In villages around Qalqilya and Tulkarm, more than 30 wells will be lost in the first phase of the wall [ISW]. These wells, located in the western groundwater basin, were drilled prior to the 1967 Israeli occupation of the West Bank. As a result, Palestinians will lose nearly 18 percent of their share of the basin's water" (Reese 2003). The Israeli journalist Meron Benvenisti claimed, "terrible environmental damage is being inflicted on large areas in the heart of the country. Seventeen million cubic meters of soil, with tens of thousands of olive trees, thousands of dunoms of orchards and groves, tens of thousands of dunoms of natural growth, hot houses, archaeological sites and [water] wells – as well as the fabric of life of hundreds of thousands of people [Palestinians] – are being crushed by giant bulldozers. Yet the environmental organizations have nothing to say about the damage caused by the fence [ISW]. On the contrary, they exploit the tragedies of others to promote their own interests. The destruction of the Palestinian environment presents the opportunity to demand 'environmental compensation' within Israel. Moreover, the environmentalists are fighting for safe passage for small wildlife, while ignoring the fact that freedom of movement is being denied to hundreds of thousands of people – including small children – in an arbitrary manner. What selective sensitivity!" (Benvenisti 2004).

Due to the ISW, the Palestinians in the West Bank have already lost huge amounts of their water in the *Western* (WAS), *North-Eastern* (N-EAS) and *Eastern Aquifer Systems* (EAS). Further, parts of their agricultural land and many water wells and springs were lost (Salem/Isaac 2007):

- Up to 192 km^2 of agricultural lands are isolated in the Western, in addition to 844 km^2 in the Eastern segregation zone, which both constitute 18.3 per cent of the West Bank's total area (5,661 km^2).
- Up to 247 km^2 of forest land and areas with shrubs are isolated in the Western and 708 km^2 in the Eastern segregation zone, which constitute 16.9 per cent of the West Bank's total area.
- The Eastern segregation zone has isolated 204 groundwater wells and 43 springs, and the Western segregation zone has isolated 29 groundwater wells and 29 springs.

The negative ecological footprint of the ISW is enormous, as huge areas of fertile Palestinian lands in the West Bank are lost, being isolated behind the ISW and thus beyond the reach of Palestinian communities. With the construction of the ISW a large number of trees have been uprooted, what has severe impacts on the hydrology of the watersheds in the affected areas.

As a result of the ISW, considerable changes in water quantity and quality have occurred in the stream channel morphology, in the groundwater levels, and in the region's water supplies. The surface water flow has been altered, and severe increases in the rates of erosion and sedimentation have already occurred. Given this complex geopolitical situation, politics has, directly and indirectly, contributed to local changes of the climate (Salem 2008c). The OPT is not only suffering from Israeli policies and practices but also from the SLR due to the impacts of global climate change.

23.5.2 Sea-Level Rise Impacts on the Gaza Strip

The Gaza Strip (figure 23.3), with a total area of 362 km^2 and a population of about 1.5 million, is one of the most densely populated areas worldwide. The Israeli buffer zones along Gaza's northern and eastern borders are based on a clause of the Oslo Agreement (1994), under which Israel maintains a 0.5 km wide zone along the 58 km long northern and eastern borders of the Gaza Strip. This buffer zone occupies 29 km^2 (8 per cent) of Gaza's territory and is controlled by the Israeli army with a Palestinian security monitoring. In September 2000, the Israeli army unilaterally expanded this zone from 800 up to 1,300 metres.

This buffer zone is off limits for Palestinians who are not allowed to build, cultivate, or to be in or close to that area. When the Israeli army completed its disengagement from the Gaza Strip in late 2005 the buffer zone then covered 61 km^2 (or 17 per cent of the territory of the Gaza Strip). On 28 June 2007, the Israeli army expanded the buffer zone along the Gaza Strip's northern and eastern borders to become 1.5 km wide. Accordingly, this newly defined buffer zone occupies an area of 87 km^2 (or 24 per cent of the Gaza Strip; Salem 2007). No recent information is yet available about the new size of the buffer zone after Israel's most recent war in the Gaza Strip from 27 December 2008 to 18 January 2009.

The Gaza Strip is a foreshore plain gradually sloping westwards to the Mediterranean Sea. It has four ridges with different elevations, ranging from 20 to 90 m above sea level. With its extremely large population and low altitude, the Gaza Strip is highly vulnerable to climate change impacts.

The population of the Gaza Strip experiences severe water quality and quantity problems. These include: a) intrusion of sea water, and of saline water from deeper saline strata into the *Gaza Coastal Aquifer System* (GCAS); b) high levels of water pollution (high concentrations of chloride, nitrate and other chemicals); c) biological and chemical contamination, due to untreated sewage and the heavy use of pesticides and fertilizers in agriculture which penetrate into the GCAS; d) return flows from intensive irrigation; and e) over-extraction of water from the GCAS. This is in addition to the rapid population growth, the high level of poverty, the spread of diseases, and the scarcity of water resources. All these problems are beyond the capacity of the Gaza Strip's inhabitants. These problems have caused not only environmental hazards but also profound risks to peace, stability, and sustainable development (Kelly/Homer-Dixon 1998; Brauch 2003; Salem/Isaac 2007). These problems have already resulted in 'environmental migration', in addition to the 'political and economical migrations' the Gaza Strip has experienced for a long time.

Qahman and Zhou (2001) predicted that by the year 2015, the sea water intrusion will be 2,300 m (2.3 km) in the upper part of the GCAS and 2,800 m (2.8 km) in the GCAS's lower part. The poor quality of water supply in the Gaza Strip is such a major concern for its people that it is seriously affecting their quality of life and, thus, exposes them to severe health risks (Alfarra/Lubad 2004; Bohannon 2006; IRIN 2006; Salem/Isaac 2007; Abu Heen/Tubail/Abu El-Naeem 2008).

These problems have already contributed to a serious deterioration of the local environment. The projected climate change impacts for the Gaza Strip during the next 30 to 100 years will be significant. Considerable attention should be paid to problems of SLR, sea water intrusion, and water contamination and their impacts on environmental migration, poverty, hunger and health problems, as well as on instability in this small and very densely populated area.

Scenarios of the *United Nations Environment Programme* (UNEP) indicated that a 50 cm rise in sea level could displace millions of Egyptians living close to the Mediterranean shoreline by the year 2050.[9] As the Gaza Strip is a natural extension of the Egyptian coastal shores on the Mediterranean, it will be affected by the SLR in a similar way. To give a rough estimate of the SLR for the Gaza Strip, the empirical equation given by El Raey (2007) is used (table 23.4).

Table 23.4 shows that for the last century, the sea level rose about 20 cm, and it will rise another 23 cm

9 See FoEME (2007); El Raey, Nasr, Frihy, Desouki and Dewidar (1995); El Raey, Fouda and Nasr (1997); El Raey, Dewidar and El Hattab (1999); Agrawala, Moehner, El Raey, Conway, van Aalst, Hagenstad and Smith (2004); El Raey (2007); chap. 45 by El Raey.

Figure 23.3: The Gaza Strip Surrounded by Three Israeli Buffer Zones. **Source:** ARIJ (2008).

until the end of this century. Over the 185 years from 1915 to 2100, the sea level in the Gaza Strip rose or may rise by at least 43 cm, or about 0.23 cm/yr. These values correspond with the findings of UNEP for the global SLR by 2 cm in the 18th, by 6 cm in the 19th, and 19 cm in the 20th century (UNEP 2009; IRIN 2009a).

According to recent publications the SLR may accelerate. When the ice melted at the end of the last ice age 10,000 years ago, the sea level rose by between 70 and 130 cm per century (UNEP 2009). Recent studies argued that if the atmospheric CO_2 concentrations were not kept below 350 part per million (ppm), the results could be disastrous (Hansen/Sato/Kharecha/Beerling/Masson-Delmotte/Pagani/Raymo/Royer/Zachos 2008). The current level of CO_2 concentration in the atmosphere is 385 ppm. If it exceeds 450 ppm, it could lead to a catastrophic SLR. The EU has set a target to stabilize the atmospheric GHG concentration at 550 ppm by the year 2035 (TGG 2008). Hansen argued that the EU target of 550 ppm should be reduced to 350 ppm if "humanity wishes to pre-

Table 23.4: Calculated Sea-Level Rise (SLR) for the Gaza Strip's Region during the Period of 1915-2100 (based on the El Raey's (2007) empirical equation for the Port Said Area in Egypt: *Y = 0.2314X - 442.7, where Y is SLR in cm and X is year.*).

1915 (cm)	1925 (cm)	1950 (cm)	1975 (cm)	2000 (cm)	2010 (cm)	2025 (cm)	2050 (cm)	2075 (cm)	2100 (cm)
0.4	2.8	8.5	14.3	20.1	22.4	25.9	31.7	37.5	43.2

Table 23.5: Characteristics of the Stabilization Scenarios. **Source**: Pachauri (2008).

Stabilization level (ppm CO_2-eq)	Global mean temp. increase (°C)	Year CO_2 needs to peak	Global sea level rise above pre-industrial from thermal expansion (m)
445 – 490	2.0 – 2.4	2000 – 2015	0.4 – 1.4
490 – 535	2.4 – 2.8	2000 – 2020	0.5 – 1.7
535 – 590	2.8 – 3.2	2010 – 2030	0.6 – 1.9
590 – 710	3.2 – 4.0	2020 – 2060	0.6 – 2.4

serve a planet similar to that on which civilization developed" (Pilkington 2008). Table 23.5 shows the SLR for the next 50 years due to increases in global mean temperature.

Studies on the SLR in the Gaza Strip are urgently needed, especially after Israel's 21 day invasion in 2008/2009, which also caused huge damages to the environment (Bergstein 2009; Falk 2009; IRIN 2009b, 2009c; Kloosterman 2009; Mitchell 2009; Salem 2009b, 2009c).

23.5.3 Water Scarcity and Transboundary Aquifer Systems

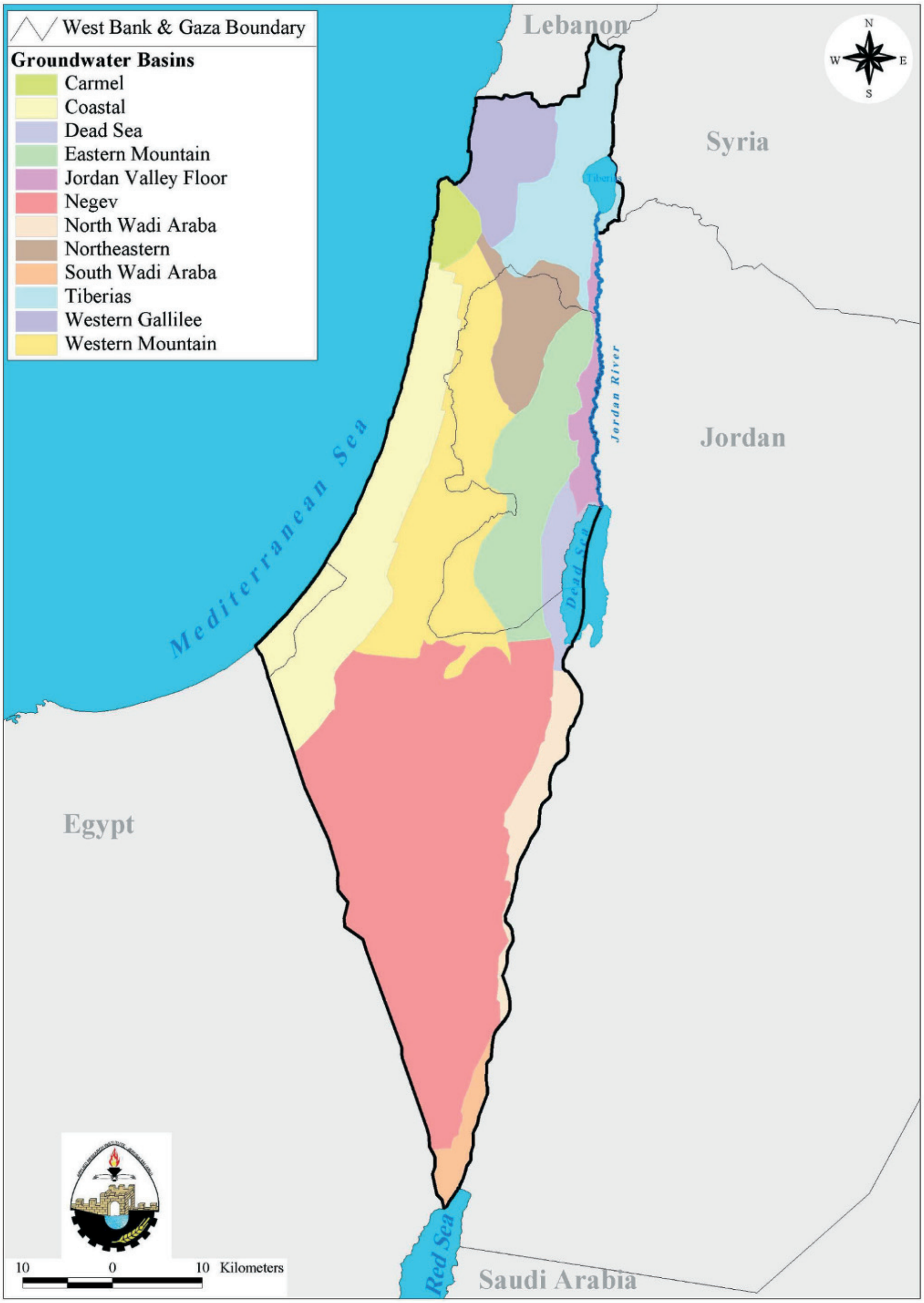
During the 5th World Water Forum in Istanbul in March 2009, Koïchiro Matsuura, Director of UNESCO, said, "that unless we change our behaviour towards fresh water we will face a major water crisis. Water is the principal medium through which climate change will affect economic, social, and environmental conditions" (IRIN 2009d).

Historical Palestine (HP) includes 11 groundwater aquifer systems (figure 23.4) of which three are in the West Bank: the *Western* (WAS), *North-Eastern* (N-EAS), and the *Eastern Aquifer Systems* (EAS) which all comprise the *Mountain Aquifer Basin* (MAB), as well as the *Gaza Coastal Aquifer System* (GCAS) under the Gaza Strip (figure 23.4, 23.5). These four aquifer systems are extensively used by Israel and the 200 Jewish settlements in the OPT (Salem/Isaac 2007). The Palestinians have severely suffered from huge water shortages (for domestic, agricultural and industrial needs). The Palestinians are only allowed to use 15 per cent of their own water. As Israel controls the water in these aquifer systems, the impacts of climate change will double in the OPT, given the severe water shortages and Israeli denials of Palestinian water rights.

Independent research by Palestinians is urgently needed to acquire detailed knowledge on the aquifer systems in the OPT, their recharge and discharge areas, the status of wells penetrating them, and their delineation, as well as on the flow of pollutants within these aquifer systems.

The *Western Aquifer System* (WAS) is the largest system, with a safe yield of 365 million cubic metres/year (MCM/yr), of which 40 MCM is brackish water. Eighty per cent of its recharge area is in the West Bank, whereas 80 per cent of its storage area is in Israel. The water flows towards the coastal plain in the west (figure 23.5), making it a shared basin for Israelis and Palestinians. Water in this WAS is mainly of good quality and is largely used for municipal supply. Israelis have exploited this system through 300 deep wells in the west of the Green Line, as well as through the deep wells drilled by *Mekorot* in the West Bank (Salem/Isaac 2007). Palestinians consume only about 7.5 per cent of this water. They extract their water from 138 wells, including 120

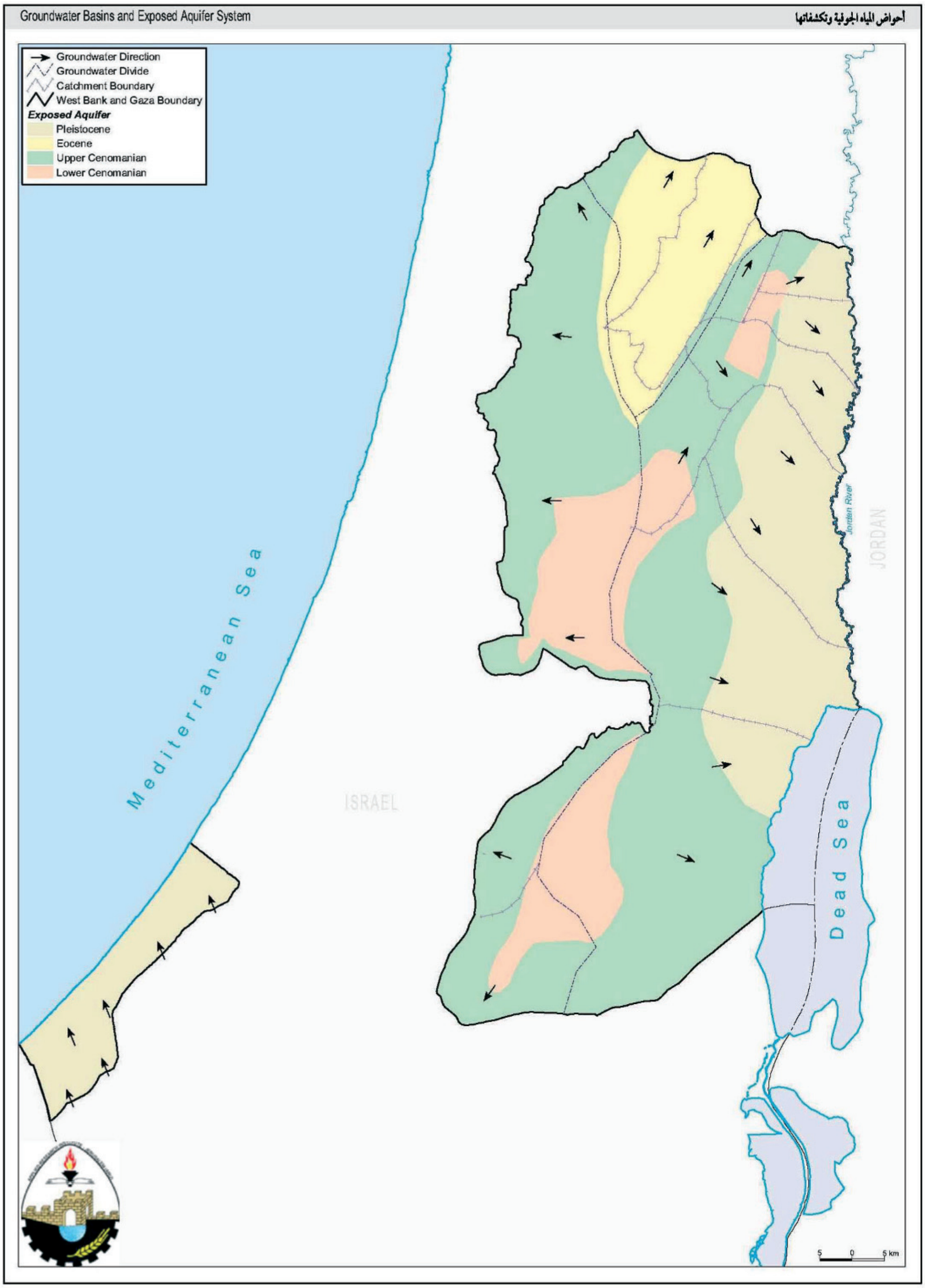
Figure 23.4: The Aquifer Systems in Historical Palestine (including Israel and the OPT). **Source:** Salem and Isaac (2007).



wells for irrigation use and 18 wells for domestic use in Qalqilya, Tulkarm, and western Nablus (figure 23.2). There are 35 springs with an average flow of approximately 0.1 l/s (360 l/hr). Many of these wells are beyond the reach of Palestinian communities as they are isolated behind the ISW.

The *North-Eastern Aquifer System* (N-EAS) has an annual safe yield of 145 MCM, of which 70 MCM is brackish water. Palestinians in the Jenin district and eastern Nablus (figure 23.2) consume only about 18 per cent for both irrigation and domestic purposes. There are 86 Palestinian wells, including 78 for irrigation and 8 for domestic use. The general groundwater

Figure 23.5: The Aquifer Systems in the Occupied West Bank and Gaza Strip. **Source:** Salem and Isaac (2007).



flow in this aquifer system is towards the natural springs in the north and north-east (figure 23.5).

The *Eastern Aquifer System* (EAS) has an annual safe yield of 175 MCM, of which 70 MCM is brackish water. This EAS lies entirely in the West Bank and was exclusively used by Palestinian villagers and farmers until 1967 (Salem/Isaac 2007). Then Israel expanded its control and tapped it to supply Jewish settlements in the West Bank. Seventy-nine springs, with an average discharge of more than 0.1 l/s (360 l/hr), provide 90 per cent of the total annual spring discharge in the West Bank. There are 122 Palestinian wells drilled in this system, including 109 for irrigation and 13 for domestic use. The groundwater flows towards the Jordan Valley and the Dead Sea (figure 23.5).

The *Gaza Coastal Aquifer System* (GCAS) is the sole water source for Palestinians in the Gaza Strip (figure 23.5), providing it with 96 per cent of its needs. This aquifer system is a continuation of the shallow sandy/sandstone Coastal Aquifer used by Israel (figure 23.4). Over 4,000 wells penetrate the GCAS with depths ranging from 25 to 30 metres. The annual safe yield of this system is 55 MCM. It has been overused with more than 120 MCM annually. As a result, the groundwater table fell below sea level, and saline water has intruded the aquifer system in many areas.

23.5.4 Water Scarcity, Climate Change Coping Strategies for the Jordan River Basin (JRB), and Water Conflict

The study of the impacts of climate change for water scarcity, biodiversity, agriculture, ecosystems, irrigation, desertification, etc. requires multidisciplinary scientific knowledge based on *in situ* and remote sensing measurements, monitoring and experiments, socio-economic data, and modelling from conventional and non-conventional methods of water management and of their ecological and socio-economic implications.

While Historical Palestine and Jordan have one of the lowest per capita water supplies worldwide, the water demand has rapidly increased due to population growth and economic development. These conditions have further deteriorated due to the political conflict. Climate projections for the Eastern Mediterranean refer to increased aridity, which has started during the past few decades with lower precipitation and higher evaporation rates. Temperature increases and prolonged droughts have severely reduced the surface-water and groundwater supplies.

The *Upper Catchment of the Jordan River* (UCJR) is a valley (80 km long and 15–30 km wide), covering approximately 1,600 km^2. The flow into the UCJR is continuous throughout the year, with an average yield of about 500 MCM annually, all of which is taken by Israel, contributing about 25 per cent of Israel's total water budget (Salem/Isaac 2007). Since 1967, the OPT has not benefited from the JRB's waters. Most groundwater resources in the region are transboundary, requiring strategies for sustainable water management based on regional collaboration.

Research on climate change impacts for the JRB and other regional transboundary water resources requires comprehensive analyses on: a) the range of environmental stresses and their effects; b) the resilience of regional ecosystems; c) the adaptive capacity of regional socio-economic systems to changes in the hydrological cycle and water resources; d) the interactions of agriculture and irrigation with water resources and regional atmospheric processes; and e) the extreme events (droughts, heatwaves, floods, etc.). The studies of the *Global Change of the Water Cycle* (GLOWA) on the JRB (Part I, II), focusing on the Upper and Lower Catchments of the Jordan River, indicated that an increase in average temperature of 0.75°C and a decrease in rainfall will take place in the JRB during the period from 2007 to 2045 (GLOWA 2007).

The water resources available to Palestinians in the OPT are, per capita, among the lowest in the world (Salem/Isaac 2007). The Israeli per capita consumption for domestic and agricultural uses is 254 *cubic metres per year* (m^3/yr), while the Palestinian per capita consumption for both domestic and agricultural uses is only 81 m^3/yr, or less than one third of the Israeli per capita consumption. The Israelis take about 60 per cent of their water needs from the JRB, more than 25 per cent from the *Mountain Aquifer Basin* (MAB), and the rest from desalination and water treatment plants, water harvesting, and fossil water in the Negev Aquifer System (figure 23.4). A study referred to high rates of radioactive elements (radium isotopes) in the fossil groundwater aquifers in the Middle East. The study on the Disi Aquifer System in southern Jordan concluded that the findings raise concerns about the safety of this and similar non-renewable groundwater aquifer systems, exacerbating the already severe water crisis in the Middle East (Vengosh/Herschfeld/Vinson/Dwyer/Raanan/Rimawi/Al-Zoubi/Akkawi/Marie/Haquin/Zaarur/Ganor 2009).

Most of the Israeli water consumption (75 per cent) goes to irrigated agriculture (Isaac/Selby 1996; Salem/Isaac 2007), though this sector contributes less than five per cent to the Israeli GDP, and only two per cent of the Israeli labour (including support service) is employed in this sector (IMA 2004). Almost half of Israel's cultivated land is irrigated, and about 70 per cent of the land cultivated by Israeli settlers in the West Bank is irrigated. By contrast, only 6 per cent of the Palestinian land is irrigated and the rest is rain-fed, although agriculture is more important to the Palestinians and more central to their economy than to the Israelis, as it contributed about 11 per cent to the Palestinian GDP in the year 2004 (Attaya 2005) and more than 26 per cent to employment in the OPT (HighBeam 2007).

Since June 1967, Israel imposed several military orders to control the Palestinian water resources, including the Order No. 92 of 15 August 1967 (JMCC 1995), stating that the water is to be considered a strategic resource and all new wells must be approved by the Israeli military where both Israelis and Palestinians are purportedly given equal consideration. While Israel and its settlers consume more than 85 per cent of the Palestinian water resources, Israel has granted only a few wells to the Palestinians (Isaac/Salem 2007). Many other military orders followed, extending a complete Israeli military control over Palestinian water resources, including the three West Bank aquifer systems of the MAB, the JRB and its tributaries, Lake Tiberias, and the Syrian Golan Heights. The Palestinian water and fishing rights in Lake Tiberias are unquestionable, based on the fact that the Palestinians are riparians with the privilege of equitable utilization.

While the Palestinians are not allowed to drill new wells or rehabilitate old ones, Israel drilled deep wells in the four aquifer systems (WAS, N-EAS, EAS, and GCAS; figure 23.4) under the OPT. This means that the old shallow Palestinian wells dry up, leaving the Palestinian population without water, especially in hot summers and during drought. The Palestinians have no choice but to buy their water from *Mekorot* that extracts it from the four aquifer systems under the West Bank.

Israel takes about 60 per cent of the surface water (685 MCM/yr) of the Jordan River, while Jordan receives 23 per cent (263 MCM/yr), Syria 11 per cent (126 MCM/yr), and Lebanon only 0.3 per cent (3.4 (MCM/yr), and the rest (5.7 per cent or 65 MCM/yr) flows into the Dead Sea.

Currently the Palestinians in the OPT receive nothing from the JRB. Until their water rights in the JRB were taken away by the Israelis, the Palestinians had used this water for centuries and they extracted 30 MCM/yr for domestic and agricultural purposes. Israel claims prior usage of the MAB (Shuval 2007), but denies the Palestinians' prior use of the Jordan River's waters. Palestinians have used the MAB's waters for centuries. They used the natural springs that are recharged from the WAS, and they had a few deep wells penetrating that system, long before Israel was established in 1948. With the construction of the ISW, Israel has surrounded important Palestinian water resources, including many springs and wells owned by Palestinians.

It is estimated that 70 per cent of the recharge area of the Western Aquifer System has been or will be isolated between the ISW and the Green Line (figure 23.2). In the northern part of the West Bank, the ISW acts as a concrete dam, trapping water and preventing it from flowing west and thus causing flooding in nearby areas. Furthermore, while the 200 Israeli settlements in the West Bank always receive water, the Palestinians in the West Bank may get water once or twice a month. About 25 per cent of the West Bank's Palestinian population are still not connected to the water network. Bringing water to these people is still a decision of Israel, according to the 1993 Oslo Agreement that divided the West Bank into 'Area A', 'Area B', and 'Area C', each of which has certain jurisdictions (Salem 2009a).

Article 6 of the *UN Convention on the Law of the Non-Navigational Uses of International Watercourses* (1997) on 'Factors Relevant to Equitable and Reasonable Utilization' states the following factors should be considered in water conflicts (UN 2005b; Salem/ Isaac 2007):

> 1) the geography of the basin, including the drainage areas; 2) the hydrology of the basin, including the contribution of water by each basin (if more than one); 3) the climate affecting the basin; 4) the past utilization of the basin's water; 5) the economic and social needs of each of the basin's riparians; 6) the population dependent on the basin's water, with regard to each of the basin's riparians; 7) the comparative costs of alternative means that satisfy the economic and social needs of the basin's riparians; 8) the availability of other water resources; 9) the avoidance of unnecessary waste in the utilization of the basin's water; 10) the practicability of compensation to one or more of the basin's riparians, as a means of adjusting conflicts among users; and 11) the degree to which the needs of a riparian of the basin may be satisfied, without causing substantial injury to any of the basin's riparians.

Israel bases its claims on the fourth point (Shuval 2007), while ignoring the other 10 points that do not give Israel a favourable treatment regarding the water resources in Historical Palestine. Israel has ignored (Shuval 2007) the vast history of the prior Palestinian use and current needs, as well as the Palestinian shares of the water resources in the region. In this case, Israel has violated the Hague Resolutions of 1907 (IHL 1907) and the Fourth Geneva Convention of 1949 (IHL 1949), and many other international treaties, by controlling and exploiting the water resources far beyond what is allocated to Israel. Israel has ignored the water agreements signed with the Palestinian leadership in 1993 and 1995, according to the Oslo Peace Agreements, whereby Israel should acknowledge the Palestinians' immediate needs of 28.6 MCM/yr and future needs of 70–80 MCM/yr (Palestine Facts 2009).

Israel argues that huge extraction of water from the Jordan River is supported by international law (Shuval 2007), basing its claims on a draft proposal called the *Johnston Plan* (JP) which they negotiated with their Arab neighbours in 1956 (Elmusa 1997). Israel considered the JP as a de facto law and invoked it on occasions. The JP called for the *West Ghor Canal* (WGC) to supply the West Bank with 250 MCM/yr to meet the needs of the Palestinians. While the WGC was never built and the JP was never enacted due to the political conflict, the Palestinian water rights in the JRB still remain. Before Israel was established in 1948, the Jewish Agency ignored the *Ionides Plan* (IP) of 1939 which outlined a realistic assessment of water resources in the region (Elmusa 1997; Isaac/Salem 2007).

But Israel has never been interested in solving the water conflict with the Palestinians with respect to their water rights based on international law. Instead, Israel has been concerned about giving the Palestinians the minimum of what they need. Accordingly, Israel has always addressed the concerns of the Palestinian people in the OPT in terms of *water needs but not water rights* (Rouyer 2003).

While denying the Palestinians their water rights, Israel suggested water quantities for Palestinians from non-conventional sources, such as desalinization, water treatment, and water imports from Turkey. To find a common ground for a lasting peace, the allocation of waters among Palestinians and Israelis in *Historical Palestine* (HP) should be equally shared, and Israel needs to do its part to demonstrate that it has genuine peace aspirations with its neighbours.

A proposal has been made, based on international law, to solve the water conflict between Israel and Palestine fairly and peacefully, where the population size is considered (Salem/Isaac 2007; Isaac/Salem 2007). Under this proposal, the annual renewable amount of water in HP, which is about 2086 MCM/yr, should be equally shared, whereby the Palestinians in the OPT would get 698 MCM/yr instead of the 238 MCM/yr presently allocated to them. The Israelis would get 1,388 MCM/yr instead of the 1,959 MCM/yr they currently use. Accordingly, the per capita share would be 241 m^3/yr for both Palestinians and Israelis, instead of the 81 m^3/yr and 254 m^3/yr, which are presently consumed per person, respectively, in the OPT and Israel (including the illegal Jewish settlements in the OPT). A joint management structure would have to be agreed upon by both sides for the monitoring and compliance with these quotas, to assure protection of the water resources and a periodic reallocation, based on climatic and demographic changes.

This proposal reflects equity, which is essential for sustaining peace, stability, security and development. It offers the best way for resolving the water rights issue. It introduces an integrated water management scheme that will expedite resolving water conflicts not only between the Israelis and the Palestinians, but also among the Israelis, Jordanians, Syrians and Lebanese. The proposal encourages regional and international water cooperation. Such an initiative for a fair solution of the water conflict between Israelis and Palestinians and in the Middle East needs cooperation with other international bodies, such as the *Quartet* (UN, EU, USA, and Russia).

During the Euro-Mediterranean Ministerial Conference on Water in 2008 at the Dead Sea, in Jordan, the ministers decided to identify the different stages and the most suitable framework needed to strengthen the coordination of existing networks of information and expertise on water in an independent and neutral way (EuroMed 2008a). The ministers avoided any reference to the water conflicts in the Middle East.

23.5.5 Red Sea-Dead Sea Conveyance Project and Climate Change

The Dead Sea is the lowest body of water on the Earth's surface (421 m below sea level). Its water has the highest salinity and density of sea water. Its shores are the natural borders of Historical Palestine (OPT and Israel) on the west, and of Jordan on the east (figures 23.1, 23.5).

The goal of the proposed *Conveyance between the Red Sea and the Dead Sea* (figure 23.6) is to restore the considerable decline of the Dead Sea water level that dropped since the 1970's by more than 25 m. This negative water balance is due to the diversion of water from the catchment area of the Dead Sea by Israel, Jordan, and Syria (Bromberg 2008). This results in a loss of huge amounts of water that should be discharged in the Dead Sea. It is also due to the water mismanagement policies and strategies of upstream countries, and due to Israeli and Jordanian pumping of the Dead Sea water into evaporation ponds to produce salt. Thus, the Dead Sea Basin, a unique natural heritage (habitat for wildlife), a global cultural, archaeological and religious site, a natural clinic for many illnesses, and a tourist resort, is threatened with disappearing (Salem 2009d).

During the *World Summit on Sustainable Development* (WSSD) in Johannesburg in 2002, Israel and Jordan announced their interest to save the Dead Sea by constructing the *Red Sea-Dead Sea Conveyance* (RSDSC) that would pipe water from the Red Sea to the Dead Sea. The proposed RSDSC would be located in the Wadi Araba (Arava) between the Gulf of Aqaba and the Dead Sea (figure 23.6). The RSDSC would be between 180 and 200 km long, and it would transfer two billion cubic metres of salt water per year (BCM/yr), of which about 850 million cubic metres (MCM/yr) would be desalinated, and the huge amounts of salt from the desalination process would be left behind and dumped into the Dead Sea (Salem 2009d).

The difference in the water level between the Red Sea and the Dead Sea of about 590 m would be used for power generation. This includes the natural difference of water levels between both seas (about 420 m) and the height (about 170 m) to which the Red Sea water must be pumped. The power would be used for running the desalination plant(s) as part of the project. Although the RSDSC project (figure 23.6) may have some positive impacts, it would form a real hazard due to its environmental impacts and its possible contributions to climate change.

The RSDSC project would be one of the biggest projects in the region to restore the Dead Sea, to generate power, to provide fresh water to neighbouring nations, to establish development projects, to build new cities and rehabilitation centres, to create jobs, and to activate the peace process in the region. However, critics on both sides of the Dead Sea argue that this project fails to address the root cause of the depletion of the Dead Sea, which may have serious negative side effects.

The RSDSC would cross the Araba (Arava) Valley, a highly active seismic area, where many earthquakes and a steady micro-seismic activity along the fault in the Jordan Rift Valley have been documented (El-Atrash/Salem/Isaac 2008; Salem 2009d). Geologists, seismologists and earthquake engineers predicted that (given the 1–10 mm annual slip rate) the Dead Sea fault could trigger fatal earthquakes of 7.0 in magnitude every 200 years (Klinger/Avouac/Dorbath/Abu Karaki/Tisnerat 2000; El-Atrash/Salem/Isaac 2008; Salem 2009d), where the hydropower facilities and the desalination plant(s) would be highly vulnerable. Some argue that the large amount of explosives needed for the construction of the RSDSC and the large quantities of sea water that will be transported through the RSDSC could lead to strong seismic activities, as the Earth crust in the project's area is thinner than elsewhere. Furthermore, hundreds of sinkholes have already emerged along the shores of the Dead Sea and, hence, large areas are subsiding (Closson 2005; Salem 2009d).

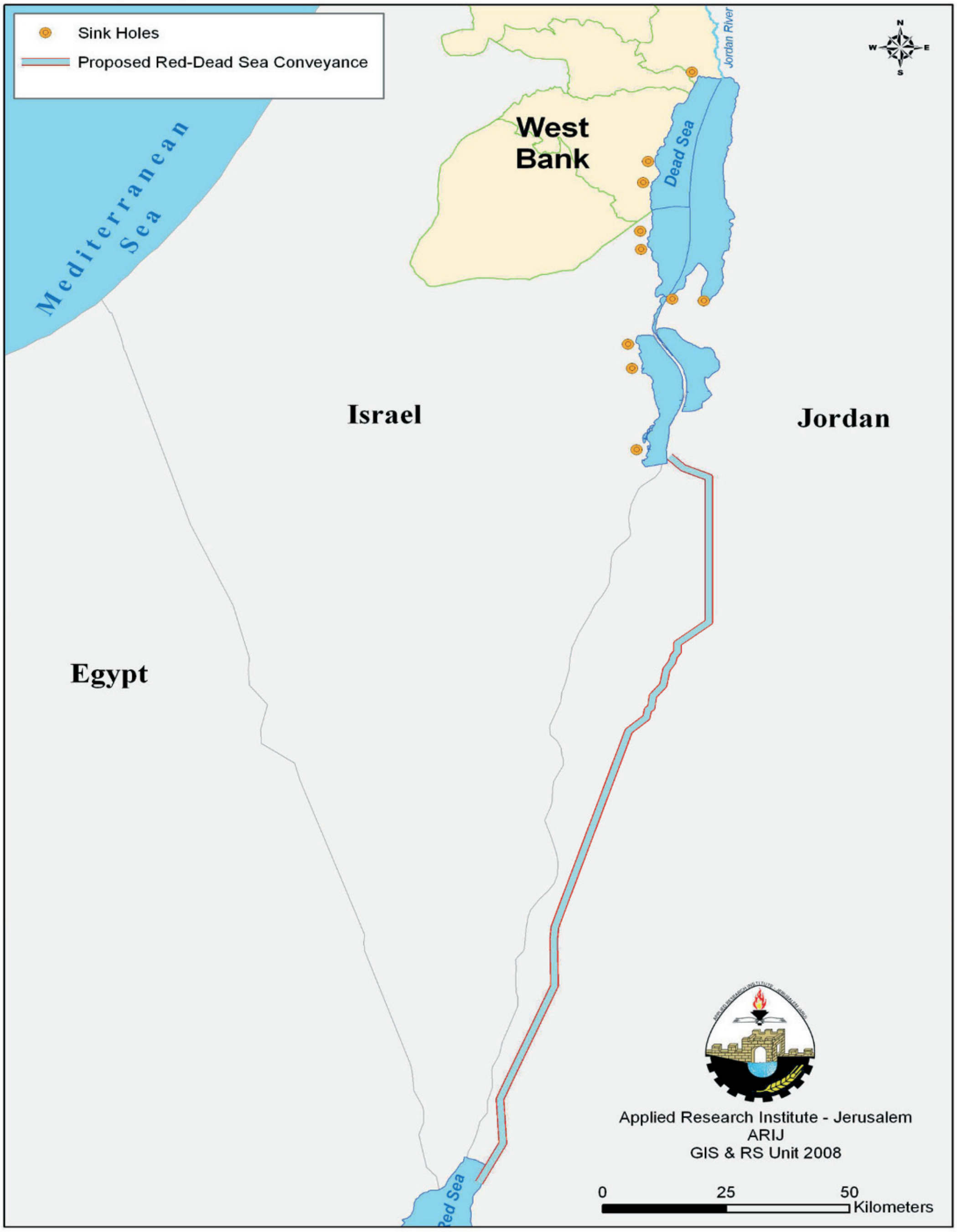
Besides these potential seismic hazards, the huge intakes of saline water from the Red Sea may have unwanted and unpredicted implications for the marine ecosystem of the Red Sea that has some of the most beautiful coral reefs in the world. The RSDSC project will place the fragile coral reefs of the Jordanian city of Aqaba and the Israeli city of Eilat at risk (Bromberg 2008). The Dead Sea itself is already a severely disturbed ecosystem due to anthropogenic interventions in its water balance, and, thus, this mega project would have negative impacts on the fragile ecosystem of the Dead Sea.

Mixing the waters of the Red Sea and the Dead Sea would have considerable negative environmental impacts that would affect the chemical and biological characteristics of both seas, and would affect tourism and the salt industries. Experiments by a team of scientists from the Geological Survey of Israel have shown that mixing the water from both seas could lead to blooms of algae, to precipitation of gypsum, and to turning the water red (Gavrieli/Bein/Oren 2005; Shafy 2007; Salem 2009d). Environmentalists argued that the waters of the Red and Dead Seas may not mix well and may damage the fragile ecosystem of the Dead Sea, and could kill the delicate micro-organisms of the Dead Sea and harm its appeal to tourists.

The inflow of sea water and the brine from desalination into the Dead Sea will have major impacts on the Dead Sea's limnology, geochemistry and biology. During the filling stage, relatively diluted surface water may emerge and the rate of evaporation may increase. Dilution of the surface water may result in microbial blooming of unknown duration. Once the target level would be reached, the inflow would be outbalanced by evaporation, and salinity of the surface water would increase, due to the accumulation of salt.

Gidon Bromberg of *Friends of the Earth – Middle East* (FoEME) warned that mixing water from the Red Sea with the unique chemical soup of the Dead Sea could create a natural disaster:

Figure 23.6: The Proposed Red Sea-Dead Sea Conveyance (RSDSC). **Source:** El-Atrash, Salem and Isaac (2008).



The Dead Sea's [natural] mix of bromide, potash, magnesium and salt is like no other body of water on the planet. By bringing in [the Dead Sea], the marine [Red Sea] water, this composition will be changed. There is concern about algae growth and we could see the sea change from deep blue to red and brown and the different waters could separate (TimesOnLine, 13 September 2006).

The proposed RSDSC would cross the *Eastern Aquifer System* (EAS), what may increase the probability of a groundwater contamination due to leakage or sudden overflows of the non-treated sea water with high saltwater concentrations to be transported through the RSDSC.

Some environmentalists claim that the RSDSC is driven by the Israeli and Jordanian construction companies' interest in such a mega project. "The RSDSC is not the only solution to the water problem, neither is it going to undo the mismanagement of the Jordan's water resources", Dureid Mahasneh, the Secretary General of the Jordan Valley Authority, explained. He added, "Re-exporting water in the form of watermelons and tomatoes is part of the Jordan's mismanagement that also has to stop" (El-Shamayleh 2007). Gidon Bromberg (2008) suggested alternatives for the RSDSC Project:

> Our vision is based on water sharing, water conservation technologies, sustainable agriculture and sustainable tourism. The Peres [Israeli President Shimon Peres]-Tshuva [Israeli billionaire Yitzhak Tshuva]-World Bank (WB) vision may lead to ecological disaster.

According to the *World Wildlife Foundation* (WWF), extracting salt from sea water to make it drinkable is the wrong way to handle global water shortages that could also exacerbate climate change (WWF 2007), as desalination uses large amounts of energy, emits greenhouse gases, and destroys marine life in some coastal areas. Pumping two *billion cubic metres* (BCM) of saline water out of the Red Sea could alter water temperatures in the Red Sea Gulf. The rate of building these desalination plants seems to be growing exponentially. If that continues, greenhouse gas emissions would accelerate and increase climate change dramatically (WWF 2007).

It is argued that the construction of huge desalination plants on both sides of the proposed RSDSC would produce huge amounts of CO_2 and other GHG emissions that would contribute to a temperature increase in the region above the present high temperatures that usually reach up to 50°C during the summer months. The higher evaporation rates could result in greater humidity. All these changes, possibly resulting from desalination plants and the huge RSDSC project, may contribute to a change in the regional climate that would further deteriorate the present conditions in the region with water scarcity, water, air and soil pollution, and damage to the ecosystems.

23.5.6 Deforestation, Desertification, and Land Degradation: Causes and Effects on Climate Change

Land-use change is related to climate change both as a cause for and as a possible effect of climate change (Dale 1997). Trees are a carbon sink. Thus, cutting millions of trees (as Israel does in the OPT) reduces the potential for absorbing CO_2. Desertification and land degradation may contribute to changes in the local climate and may become irreversible due to climate change.

23.5.6.1 Deforestation

Deforestation causes up to 30 per cent of global GHG emissions (Johnson 2008). Due to the deforestation and the land-use changes in the Amazon, Brazil has become a major GHG emitter (Manneh 2008). Accordingly, some groups have suggested that stopping deforestation should be included in the post 2012-Kyoto Climate Change Agreement (GCA 2007; Hmaidan 2008).

According to the *Arab Group for the Protection of Nature* (APN), Israel has cut about 1.4 million trees in the OPT between 2001 and 2005 (APN 2005), of which 1.1 million disappeared between 2001 and 2003, including 263,000 olive trees, 356,000 citrus trees, 113,000 forest trees, 69,000 stone fruit trees, 51,000 grape vines, 18,000 banana trees, 23,000 palm trees, and 251,471 other trees (Abdelrahman 2005). For example, to build the Jewish settlement of Jabal Abu Ghnaim (or Har Homa), Israel has cut more than 60,000 pine trees between 1997 and 2007 (figure 23.7).

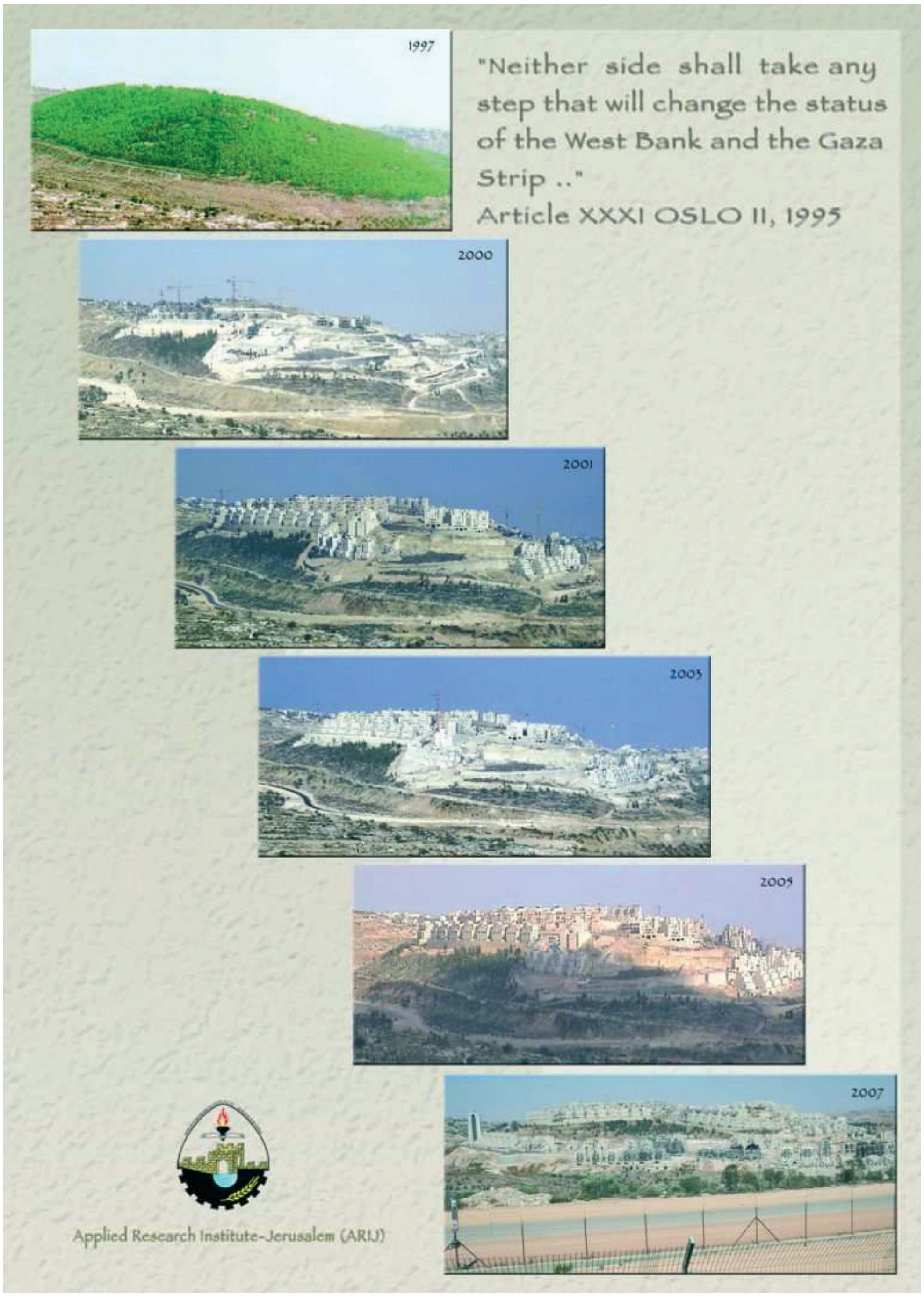
23.5.6.2 Desertification

Land degradation and desertification have also contributed to changes in the climate of the OPT, whose biodiversity has seriously declined since 1967 (Salem 2008a), on which no accurate figures are available. According to a study by CAMRE, ACSAD and UNEP (2004), the desertification in Palestine is mainly due to the practices and activities of the Israeli occupation authorities. Other factors include the overexploitation of the water resources, confiscation of the agricultural land, and the increase of the level of salinity. These factors have led to the decrease of agricultural production, drying up of water resources, disappearance of wildlife, deterioration of rangelands, and encroachment of sand dunes (UNEP 2004). The Palestinian lands suffer from the consequences of desertification that resulted in a decrease in the fertility of arable lands.

23.5.6.3 Land (Soil) Degradation

Soils are degraded due to many factors, including erosion, acidication and salinization. In the OPT, the major causes are soil erosion from water and wind, and *in situ* soil deterioration, due to chemical and physical soil degradation. Incorrect agricultural management

Figure 23.7: The Israeli Settlement of Jabal Abu Ghneim (Har Homa) in the West Bank, as developed in a 10-year period (1997-2007): **Source:** ARIJ (2007, 2008).



due to water scarcity, uncontrolled domestic and industrial dumping sites, and the heavy use of fertilizers and pesticides are important reasons behind the *in situ* soil deterioration in the West Bank (Salem 2008a). The Israeli occupation has increased the pressure on the land that Palestinians retain access to, encouraging overgrazing and intensive farming practices, besides creating a difficult environment for planning and implementing sustainable land-management schemes.

Anthropogenic soil degradation in the OPT includes political and socio-economic factors and existing land-use practices, whereas the natural causes include changes in precipitation intensity and temperatures. These natural factors are a response to air and water transport of soil particles. However, the anthropogenic factors are more tangible due to Israeli activities in the OPT that have contributed to the destruction of the Palestinian environment (Twite 2003; Salem 2009c). "There is no Palestinian environmental problem without bearing on Israelis, and no Israeli problem without consequences for Palestinians" (Twite 1998).

The misuse of arable lands by Palestinians has led to the destruction of the natural land's cover that stabilizes the soil cover. The prevailing rain-fed agriculture in the dry and semi-dry regions in the OPT has contributed to the destabilization of the soil cover, which causes deterioration of the soil particles. This has led to a decline in the fertility rates of arable lands, where the affected particles lost much of their ability to absorb the rainfall, leaving them susceptible to percolate to the underneath soil layers. The cultivation of lands in dry periods has made the surface soil more susceptible to air erosion. The loss of balance between the major elements of the surrounding environment (plants, animals, soils, water, etc.), due to the unsustainable use of natural resources by humans, has caused decreases in the quality of soils.

23.5.7 Reducing Climate Change Impacts with Renewable Energy

Most of the electrical energy consumed by Palestinians in the OPT is imported from Israel through the *Jerusalem District Electricity Company* (JDEC). There is one electric power plant in the Gaza Strip, which has been repeatedly damaged through Israeli air strikes and land incursions. This power plant generates about 40 per cent of the Gaza Strip's electricity, and the rest is imported from Israel and Egypt. While the percentage of households in the OPT which are connected to the *Public Electricity Network* (PEN) reached 99.4 per cent in January 2005 (PCBS 2006), there are still many localities with 10,000's of Palestinians without electricity as some localities are far from the PEN and connecting them would be costly; and as it is difficult for some localities to get electricity because they are close to Israeli settlements or military bases.

Compared with other Middle Eastern countries, the cost of electricity in the OPT is high and higher than in Israel (Salem 2007). The cost for industrial and commercial purposes is higher than for domestic use. The electricity cost for domestic use is about 14 US cent/kwh, while it is about 18 US cent/kwh for industrial and commercial uses according to the JDEC's tariff of 2007.

The average electricity consumption per household was 227 kwh in July 2006, 264 kwh in July 2005, but 380 kwh in July 1999 (PCBS 2007). It reached 332 kwh in the middle of the West Bank and did not exceed 196 kwh in the north. The average was about 240 kwh in urban localities, 190 kwh in rural areas, and 230 kwh in refugee camps. The overall average per capita electricity consumption in the OPT in July 2006 was 35.8 kwh (PCBS 2007).

The OPT is behind many other countries in using *Renewable Energy Sources* (RES), such as solar, wind, and biogas. Research projects are needed to pursue these objectives (Salem 2008d):

- to assess the opportunities for cost-effective *Renewable Energy Technologies* (RET) to be primarily used in rural areas and remote villages in the OPT which have no electricity;
- to assess their effectiveness through better knowledge of social and end-user behaviour;
- to assess the society's acceptability for clean and efficient RET;
- to measure the impact of electrification on socio-economic development in rural areas; and
- to enable parts of the society to widen their knowledge and expertise on RET, which will help Palestinians to build capacities and improve their way of life.

By embracing the RES the Palestinian society may move towards a cleaner environment. This could be done in collaboration with local, regional and international academic, industrial and other institutions. This is particularly important due to the high prices of fossil fuels many Palestinians cannot afford due to the unstable political and economic situation in the OPT.

Research projects on RES in the OPT will contribute to partnerships with different stakeholders, particularly the EU within the *Union for the Mediterranean* (UM). On 3–4 November 2008, ministers from *European and MENA* countries agreed in Marseille on launching a *Mediterranean Solar Plan* (MSP) and a *Euro-Mediterranean Climate Change Framework* (EMCCF), in support of regional efforts to combat climate change (EuroMed 2008b). Such an initiative could become a cornerstone for a clean environment and for programmes that will encourage using RES in the OPT. This will enhance the multiple relationships (economical, political, social, environmental, etc.)

between the OPT and the EU and other international organizations (Salem 2008d).

As the MENA region has increasingly been affected by the impacts of climate change, Palestinian policy-makers should be highly concerned about its impacts on the environment in Palestine. As this region has been negatively affected by rapid variations in temperatures, rates of low precipitation and high evaporation, hot summers, cold winters, and by desertification and deforestation, using RES should become an excellent option to gradually eliminate the dependence of the Palestinian people on fossil fuels (Salem 2008d).

Developing RET, particularly solar and wind technologies, would enable Palestinians to produce their own electricity. This is particularly important, as this system would require low maintenance and could be used for long periods of time, and would create jobs. It would enable Palestinians to gradually reduce their dependence on imports of fuels and electricity from Israel. As some Palestinian localities still have no access to the *Regional Electricity Grid* (REG), this has forced some Palestinians to leave their homes and move to other places that have electricity. Thus, international donors should support the Palestinians in using RET to help them overcome the hardships they have been facing for a long time.

23.6 Conclusions

Israel, the OPT, and Jordan have been and will be affected by climate change impacts. According to UNEP (2003): "The Middle East is a meeting point of many escalating environmental threats. This is particularly the case in the Occupied Palestinian Territories. Long-term environmental degradation has occurred over recent decades. In an already densely populated area, there are additional problems of scarcity of water resources and land, rapid population growth, a long-lasting refugee situation, climate change, desertification, and land degradation."

As climate-induced resource scarcity could escalate existing conflicts, violence and political turmoil, the Euro-Mediterranean Partnership suggested integrating the climate change dimension into water resource management (EuroMed 2008c). Unless adequate and urgent actions are taken to reduce vulnerability to climate change, the region will be exposed to large economic and social risks, which will put further pressures on groundwater that has been used beyond the aquifers' recharge potential (EuroMed 2008a, 2008b, 2008c).

Besides the political instability, the impacts of climate change will intensify in the Eastern Mediterranean, with more pressure on the OPT, what is due to the following reasons:

- Water scarcity contributes to deteriorating health and socio-economic conditions besides high rates of poverty and unemployment.
- As precipitation has been projected to decline further, more conflicts may occur in the Middle East besides the existing tensions and past wars.
- Geopolitics has so far prevented joint initiatives in addressing regional climate change impacts. The Israeli Segregation Wall (ISW) and settlements in the OPT have increased the pressure on the limited natural resources that may have impact on local changes in climate. These activities have resulted in deforestation, land degradation, desertification, a decline or loss of biodiversity and of water resources.
- The possible construction of mega projects, such as the Red Sea-Dead Sea Conveyance will cause huge ecological and environmental damage that may have impact on climate change.
- Given its high population density and growth, the Gaza Strip is extremely vulnerable to climate change impacts, due to sea-level rise, sea-water intrusion and water shortages, besides many other socio-political and socio-economic problems. Under present political conditions adaptation to combat climate change in the Gaza Strip is not feasible, and, therefore, mitigation measures are urgently needed.

In the Eastern Mediterranean region, political circumstances have been the main cause that efforts to address the causes and impacts of climate change are widely lacking (Brauch 2009b). As long as a peaceful resolution of the Middle East conflict is missing, the Eastern Mediterranean region will severely suffer from climate change impacts. Technical initiatives were suggested to develop and use renewable energy technologies in the region, especially solar energy.

On 22 May 2008, Prince Hassan Bin Talal of Jordan, in a speech to the *United Nations General Assembly*, addressed the linkages among global instability, climate change, and human security (Bin Talal 2008):

> Rising temperatures and extreme climate patterns are also having an enormous impact on human security. Many people, especially the poor in some of the world's

most crowded and marginally productive areas are affected by: a lack of water for drinking and irrigation; a decline in agricultural production; increased resource scarcity; loss of supportive wildlife; widespread diseases from mosquitoes and other pests; declining health; economic losses caused by hurricanes, tornadoes and cyclones; volatility in economic output and trade; and increasing poverty.

The harmful impact of these climate extremes on human livelihoods and living conditions, combined with heightened competition for scarce resources, has triggered disputes over territory, food and water supplies, social and cultural traditions, and tribal and religious differences. Fundamental and unresolved issues of territoriality, identity and movement of peoples lead to sectarian and ethnic violence, armed conflict, mass migration and the spread of infectious diseases. ... The health, well-being and rights of those who are forced to leave their homes and communities through external disruptions must be given particular attention. We usually think of migrants and refugees fleeing political conflict, but increasingly there are also victims of the menacing effects of global warming. We are currently witnessing many instances of this kind of temperature-driven civil strife and social displacement in parts of Central Asia, the Middle East, Africa and Latin America.