Climate Change Adaptation Strategy for the Occupied Palestinian Territory

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Final Report of Consultants* to the UNDP/PAPP initiative: *Climate Change Adaptation Strategy and Programme of Action for the Palestinian Authority

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Contents

Executive Summary iii

Acronyms and Abbreviations vi

1. Introduction 1

2. Current Vulnerability Assessment for the oPt 5
   2.1 Current climate conditions 5
   2.2 Current socio-economic conditions and stakeholder perceptions of sector exposure to climate change 8
   2.3 Sources of vulnerability
       2.3.1 Adaptive capacity and coping mechanisms 10
       2.3.2 Working definition of climate vulnerability 11
       2.3.3 Non-environmental sources of vulnerability 12
   2.4 Climate change impacts: alignment with national plans, UNDP goals and UNDP/PAPP priorities 14
   2.5 International legal context of Palestinian vulnerability to climate change impacts 15

3. Climate Change and Vulnerable Communities 19
   3.1 Identification of climate vulnerability-livelihood interaction 19
       3.1.1 West Bank 19
       3.1.2 The Gaza Strip 20
   3.2 Stakeholder selection of case studies 21
   3.3 West Bank: Massafer Yatta (Hebron Governorate) 22
       3.3.1 Climate and wider vulnerabilities in Massafer Yatta 22
       3.3.2 Water and food insecurity in Massafer Yatta 25
       3.3.3 Household and community coping mechanisms in Massafer Yatta 26
       3.3.4 At-Tuwani village: compounded vulnerability 27
   3.4 West Bank: Jordan River Valley 30
       3.4.1 Climate and wider vulnerabilities in the Jordan River Valley 30
       3.4.2 Water and food insecurity in the Jordan River Valley 36
       3.4.3 Household and community coping mechanisms in the Jordan River Valley 36
       3.4.4 Al Auja, Jericho District: compounded vulnerability 37
   3.5 West Bank: vulnerability pathways 38
   3.6 Gaza Strip 40
       3.6.1 Climate and wider vulnerabilities in the Gaza Strip 40
       3.6.2 Water and food insecurity in the Gaza Strip 42
       3.6.3 Household and community coping mechanisms in the Gaza Strip 45
   3.7 Gaza Strip: vulnerability pathways 46
Climate Change Adaptation Strategy for the Occupied Palestinian Territory

Executive Summary

1. The most significant environmental effects of climate change for the people of the oPt, over the course of this century, are projected to be a decrease in precipitation (with significant seasonal variation) and significant warming. Climate change forecasts for the eastern Mediterranean from high-resolution regional climate models give clear scientific backing to the Intergovernmental Panel on Climate Change (IPCC) projections for the region. In its Fourth Assessment Report, the IPCC predicts that, for the southern and eastern Mediterranean, warming over the 21st century will be larger than global annual mean warming – between 2.2-5.1°C according to a realistic emissions scenario (Scenario A1B). Annual precipitation rates are deemed likely to fall in the eastern Mediterranean – decreasing 10% by 2020 and 20% by 2050 – with an increased risk of summer drought.

2. There remain significant uncertainties about the precise impacts of climate change in the region. Indeed, it is not possible at the moment, with high scientific confidence, to differentiate climate hazards in the oPt on the basis of natural climate variability or long-term climate change. A precautionary approach is adopted in which improving adaptive capacity in the oPt – both for institutions and communities – delivers ‘no-regrets’ and ‘low-regrets’ benefits in terms of disaster risk reduction and human development even if long-term climate trends are less harmful than predicted. Furthermore, there is a need for climate modelling and research capacity-building in the oPt tailored to Palestinian adaptation priorities in the face of future climate risks.

3. This Climate Change Adaptation Strategy adopts the concept of climate vulnerability, defined as combined biophysical vulnerability and social vulnerability. Input from stakeholders in the West Bank and the Gaza Strip corroborated the initial premise of the Project Team that the water sector in the oPt justifies priority focus in terms of climate change impacts, and that agriculture is the Palestinian economic sector most sensitive to climate hazards, both current and future. This led to a strategic adaptation focus on reducing water insecurity and food insecurity. Within the oPt, the Project Team identified three regions (case studies) as having particularly high levels of climate vulnerability – Massafer Yatta (West Bank), the easternmost oPt areas of the Jordan River Valley (West Bank) and the Gaza Strip.

4. Already under significant pressure from rapid demographic growth, economic development and restrictions on development from Israel, freshwater resources in the oPt are predicted to become more physically scarce as climate change causes decreases in annual
participation. If the major asymmetries in water availability between the oPt and Israel remain, the political tensions that exist will be exacerbated. Water scarcity is not a robust predictor of violent conflict as ‘virtual water’ (water imported in the form of food) can ease local water or food shortages. But this can only serve as an effective means of climate change adaptation for the Palestinians if there is an increase in sustainable economic growth. The expected increased scarcity also means that the strategic planning of the agriculture sector by the Palestinian Authority (PA) needs to consider the potential impacts of climate change on food availability elsewhere in the world.

5. Historic forms of household and community coping by Palestinians in the face of climate and other hazards offer potential templates for adaptation to climate change in the oPt. However, the ongoing effects of the Israeli occupation undermine the conditions necessary to their operation, both economic – the free movement of goods and people – and political – national self-determination and democratic governance. Indeed, the continuing Israeli occupation fosters a wide range of maladaptive policies and practices (e.g. subsidised water-intensive livestock farming by settlers and the destruction of Palestinian olive groves) that need to be prevented to allow the development of Palestinian resilience to climate hazards.

6. Disaster risk reduction (DRR) – the development and implementation of policies and practices that minimise risks from disasters – is the first line of institutional defence against serious climate change impacts. Development of the DRR capacity within the PA is critical to effective climate change adaptation within the oPt. It is recommended, based on stakeholder feedback, that a revived Higher Council of Civil Defence would be an effective vehicle for mainstreaming climate risk reduction at a strategic level within the PA. This will require more systematic information on climate-related risks in order to provide an integrated understanding of the role of climate hazards in relation to other civil defence challenges facing Palestinians. It is recommended, therefore, that the Environmental Quality Authority serves as the lead agency within the PA for co-ordinating the collection, analysis and dissemination of information relating to the risks created by climate variability and long-term climate change.

7. There is enough agricultural information and meteorological evidence to justify priority risk management by the PA to address the impacts of drought and desertification in the oPt. The National Committee to Combat Desertification is the appropriate Palestinian strategic body to take lead responsibility for developing policies and measures relating to drought minimisation and management. This body needs to be actively supported by a technical committee comprising relevant PA ministries (especially the Palestinian Water Authority, the Ministry of Agriculture, and the Environmental Quality Authority). A drought early-warning system for the oPt is already under development, supported by UNDP
and Italian Development Cooperation. This will improve data collection on rainfall and soil moisture, providing a more scientific basis for minimising the risk of drought and desertification.

8. The PA is recommended to adopt this Climate Change Adaptation Strategy for the oPt as the most effective means by which the PA can enhance the capacity of the Palestinians to cope with current and future climate hazards. Initial efforts should be directed at addressing the six major climate-induced risks to food and water security identified in this report:

- Crop area changes due to decreases in optimal farming conditions;
- Decreased crop and livestock productivity;
- Increased risk of floods;
- Increased risk of drought and water scarcity;
- Increased irrigation requirements;
- Increased risks to public health from reduced drinking water quality (including saline intrusion in the Gaza Strip).

9. Of the adaptation options identified for the oPt, it is recommended that prioritisation is given to these no-regrets and low-regrets measures which are judged to have the highest levels of adaptive capacity and technical feasibility:

**No-regrets adaptation measures** (in no order of priority)
1. Development of flood contingency plans
2. Local increases in rainfall interception capacity
3. Establishment of clear water use priorities
4. Introduction of more efficient irrigation techniques
5. Review of drinking water quality management systems to incorporate climate risks
6. Increased (sustainable) production of freshwater
7. Increased use of brackish and treated wastewater
8. Equitable and reasonable utilisation of transboundary water resources between Israel and the Palestinians (implying a fairer reallocation of groundwater and freshwater)

**Low-regrets adaptation measures** (in no order of priority)
1. Prioritisation of irrigation for highest value crops
2. Increased scale of water harvesting
3. Protection of coastal sand dunes in the Gaza Strip
4. Diversification of rural livelihoods
5. Incorporation of climate adaptation in land use planning
6. Improved soil and crop management through increased use of precision agriculture
7. Selection of crops and ruminants for tolerance to heat and drought
### Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AHLC</td>
<td>Ad Hoc Liaison Committee</td>
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<tr>
<td>CAP</td>
<td>Consolidated Appeal Process</td>
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<td>CMWU</td>
<td>Coastal Municipalities Water Utility</td>
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<td>COHRE</td>
<td>Centre on Housing Rights and Evictions</td>
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<tr>
<td>DFID</td>
<td>(UK) Department for International Development</td>
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<tr>
<td>DWQ</td>
<td>drinking water quality</td>
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<td>ECHO</td>
<td>European Commission Humanitarian Aid Office</td>
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<td>DRR</td>
<td>Disaster Risk Reduction</td>
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<td>EQA</td>
<td>Environmental Quality Authority</td>
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<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>FTAP</td>
<td>Fast-Track Approval Process</td>
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<td>GCM</td>
<td>General Circulation Model</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<td>HCCD</td>
<td>Higher Council of Civil Defence</td>
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<td>HWASP</td>
<td>Hebron Water Access and Storage Project</td>
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<td>ICRC</td>
<td>International Committee of the Red Cross</td>
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<td>IDF</td>
<td>Israeli Defense Forces</td>
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<td>JICA</td>
<td>Japan International Cooperation Authority</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>MCM</td>
<td>million cubic metres</td>
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<td>MDG</td>
<td>Millennium Development Goal</td>
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<td>MoA</td>
<td>Ministry of Agriculture</td>
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<td>NAPA</td>
<td>National Adaptation Programme of Action</td>
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<td>NGO</td>
<td>Non Governmental Organisation</td>
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<tr>
<td>OCHA</td>
<td>(UN) Office for the Coordination of Humanitarian Affairs</td>
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<td>oPt</td>
<td>occupied Palestinian territory</td>
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<td>PA</td>
<td>Palestinian Authority</td>
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<td>PNPA</td>
<td>Palestinian National Policy Agenda</td>
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<td>PRDP</td>
<td>Palestinian Reform and Development Plan</td>
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<td>PWA</td>
<td>Palestinian Water Authority</td>
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<tr>
<td>RCM</td>
<td>Regional Climate Model</td>
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<tr>
<td>SIDA</td>
<td>Swedish International Development Cooperation Agency</td>
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<tr>
<td>UCODEP</td>
<td>Unity and Cooperation for the Development of People</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNDP/PAPP</td>
<td>United Nations Development Programme/Programme of Assistance to the Palestinian People</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>UNRWA</td>
<td>United Nations Relief and Works Agency for Palestine Refugees</td>
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<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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<td>WFP</td>
<td>World Food Programme</td>
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<td>WHO</td>
<td>World Health Organisation</td>
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Climate Change Adaptation Strategy for the Occupied Palestinian Territory

1. Introduction

Global warming is already altering the world’s climate. Its impacts are felt in all sectors of society, through changes in temperature and precipitation as well as through changes in the frequency and intensity of climatic extreme events. The impacts of climate change are likely negatively to affect progress toward development in the occupied Palestinian territory (oPt) in a number of key areas including agriculture and food security, water resources, coastal zones, public health, climate-related disaster risk management and natural resources management. Climate change will thus constrain the ability of the Palestinian Authority (PA) to reach poverty reduction and sustainable development objectives consistent with the United Nations (UN) Millennium Development Goals (MDGs).

The initial premise of the Climate Change Adaptation Project Team (hereafter the ‘Project Team’), based on a review of climate change scenarios for the eastern Mediterranean, was that the most important environmental effects of climate change for the oPt, over the course of this century, are likely to be a decrease in precipitation (with significant seasonal variation) and significant warming. This premise, which favours an adaptation focus on water insecurity – the lack of access of individuals to sufficient safe water for health and well-being – was confirmed, then developed, in consultations with stakeholders in Gaza and the West Bank during November 2008-January 2009. Water insecurity is above all about the absence of control and effective management of scarce water resources. This can apply locally, nationally and across borders: if water is not equitably allocated for agriculture and other food production, as in the case of transboundary water resources straddling Israel and the oPt, water insecurity can directly impact on food security. Therefore this report considers also food insecurity – defined for the oPt as households with income and consumption below $1.6 US per capita per day and households showing a decrease in total food and non-food expenditures (Food and Agriculture Organization 2007a: 58) – as a potentially major outcome of climate variability and/or change in the oPt.

This Climate Change Adaptation Strategy for the oPt is a key output of a work programme for the Palestinian Environmental Quality Authority (EQA) funded by the United Nations Development Programme/Programme of Assistance to the Palestinian People (UNDP/PAPP). Informed by the Adaptation Policy Frameworks for Climate Change recommended by UNDP (Lim et al. 2005), the Project Team adopted a vulnerability-based approach in developing the Strategy. In the oPt there are complex relationships between the climatic and

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non-climatic drivers of vulnerability. Climate-related events that are potentially harmful constitute hazards (Jones and Boer 2005: 99). Climate hazards are physical manifestations of climate variability or change: these can be events – such as droughts and heavy rainfall episodes – or longer-term changes in the mean value of climatic variables (Brooks 2003: 4). It is not possible at the moment to differentiate climate hazards in the oPt on the basis of climate variability or long-term climate change with any scientific rigour. However, it will be argued in this report that a precautionary approach is warranted in which improving adaptive capacity in the oPt – both for institutions and communities – will deliver ‘no regrets’ and ‘low regrets’ benefits (i.e. ‘do no harm’) in terms of disaster risk reduction and human development even if long-term climate trends are less harmful than predicted.

As noted in the UNDP Adaptation Policy Frameworks, analysing the capacity of stakeholders to identify and cope with adverse climate events is key to characterising current and possible future vulnerability (Conde and Lonsdale 2005: 49). Stakeholder input thus informed the work of the Project Team to identify the climate change situation in the oPt by means of a Vulnerability Assessment (Sections 2 and 3) and a Future Climate Risks Assessment (Section 4). While not comprehensive in coverage, we believe these assessments are sufficiently robust to be developed and refined over time.

The Vulnerability Assessment in this Climate Change Adaptation Strategy comprises a Current Vulnerability Assessment for the oPt (Section 2) and Climate Change and Vulnerable Communities (Section 3). Section 2 outlines current climate conditions and hazards in the oPt, then summarises socio-economic conditions and stakeholder perceptions of sector exposures to climate change. After acknowledging the major non-climatic sources of vulnerability, we highlight the challenge of climate change to national development and disaster reduction planning within the PA. It is also made clear that external states have significant climate change obligations to the Palestinians under international humanitarian and environmental law. Section 3 addresses community and household (livelihood) vulnerabilities from climate change. We focus on three oPt regions identified as having particularly high levels of climate vulnerability, understood as a combination of biophysical vulnerability and social vulnerability: the regions are Massafer Yatta (West Bank), the Jordan River Valley (West Bank) and the Gaza Strip. Building resilience to climate hazards can draw on local traditions of community adaptation, but these are impeded by the Israeli occupation.

Informed by recent scientific scenarios on climate change for the eastern Mediterranean, the Future Climate Risks Assessment (Section 4) considers a range of future climate outcomes in the oPt in terms of their impact for key sectors. A rigorous appraisal of future climate risks needs a close coupling of climate modelling and PA climate decision-making of the type proposed herein (which necessitates technical capacity-building). With reference to future socio-economic trends in the oPt (about which there are major uncertainties), we make some provisional forecasts about the extent to which vulnerable groups will be even more exposed by climate and non-climate stresses.
A draft of the Vulnerability Assessment (Sections 3 and 4) – entitled *Analysis of the Climate Change Situation in the oPt* – was circulated for feedback to stakeholders in April 2009. In May and August 2009 the Project Team also convened additional meetings with PA representatives in the West Bank and the Gaza Strip. Comments and suggestions received have fed into the **Proposed Adaptation Measures** contained in Section 5 of this *Adaptation Strategy*. Building on the assessment of vulnerability, the options for adaptation are focused on the Palestinian water sector and agricultural land use. This does not imply that there are not other actions that need to be undertaken to make Palestinian people less vulnerable to climate hazards. The *Adaptation Strategy for the oPt* is intended as a “living” document, which should be revised and extended over time.

The overriding goal of the *Adaptation Strategy* is to identify the most effective means by which the PA can enhance the capacity of the Palestinians to cope with current and future climate hazards. This is discussed in Section 6 as **Adaptive Capacity-building**, examining information needs for climate risk management and national-level institutional capacity-building. There are important technical and financial challenges to the development of Palestinian adaptive capacity, but the most significant constraints are external political barriers, as represented by the continuing Israeli occupation of the West Bank and the Gaza Strip. Indeed, the political feasibility of addressing these barriers depends on the uncertain prospect of final status negotiations between the Palestinians and Israelis.
2. Current Vulnerability Assessment for the oPt

2.1 Current climate conditions

Climate change will lead to an intensification of the global hydrological cycle and is likely to have major impacts on regional water resources, affecting both ground and surface water supply for domestic and industrial uses, irrigation, in-stream ecosystems and water-based recreation. Changes in the total amount of precipitation and in its frequency and intensity directly affect the magnitude and timing of runoff and the intensity of floods and droughts (IPCC 2007).

Climate change is projected to have significant impacts on conditions affecting global agriculture, including temperature and precipitation. Agriculture is still directly dependent on climate, since heat, sunlight and water are the main drivers of crop growth. While some aspects of climate change – such as longer growing seasons and warmer temperatures may bring benefits – there will also be a range of adverse impacts, including reduced water availability and more frequent extreme weather events. These impacts may put agricultural activities, certainly at the level of individual land managers and farm estates, at significant risk (AEA Energy & Environment 2007).

Where there has been limited high-resolution climate modelling for the eastern Mediterranean region, increased warming is forecast this century, combined with changes in rainfall amount and distribution (see Section 4.1). Some have argued that climate changes are already happening: analyses of precipitation and temperature data in the last century reveal rising summer temperatures and a delay in the rainfall season (Khatib et al. 2007), as well as increasing inland aridity (Kafle and Bruins 2009). Agricultural production in the oPt has already been affected by recent droughts, with predictions that climate hazards will become more pronounced over time. Thus, a great challenge for the PA in the coming decades will be the task of increasing food security (by domestic production and/or imports) in conditions of increased water stress. However, it is argued below (Section 2.3) that the influence of forecast climate changes on water availability in the oPt is still much less significant than existing water allocation patterns determined by Israel.

The climate of the oPt is traditionally described as ‘Mediterranean’, which is characterised by winter rain and summer drought. However, there is a great diversity in this climate, which is modified locally by latitude and altitude. This is especially apparent in the West Bank (Figure 2.1): climatic zones range from extremely arid to humid according to the De Martonne aridity index classification for arid areas (Land Research Centre 2007).
Annual rainfall in the West Bank is higher in the north (up to 700mm around Jenin) and lowest in the Dead Sea area of the south (80-100mm): alongside this latitudinal variation is an orographic one – the western slopes receive 500-600mm, while the eastern slopes receive 150-450mm (Ministry of Agriculture 2008: 2). Thus, the area suffering from greatest aridity (44%) is located at the south-eastern edge of the West Bank. This area, which is lightly populated, has been proposed as a strategic reserve of agricultural land for a future Palestinian state (Dudeen 2007).

Despite its small area (365km²) and generally flat terrain, there are also significant variations in the Gaza Strip’s temperate climate: the average seasonal rainfall is 522mm in the northern Beit Lahiya governorate and 225mm in the southern Rafah governorate (Palestinian Water Authority 2007). The Gaza Strip experiences hot, dry summers and mild winters. There is already some evidence that global warming is affecting the Gaza Strip: an analysis of daily temperature data from 1976 to 1995 has shown an increase in mean temperature of 0.4°C, which reflects above all an upward trend in
minimum temperature values (El-Kadi 2005). This finding is corroborated by Israeli research demonstrating that average temperatures in the eastern Mediterranean have increased steadily over the last 100 years (Krichak et. al 2007).

The present problems in the oPt that are related to water are many and varied. As in Israel and Jordan – also with limited water resources – the last eight years have seen reductions in the amount of rainfall received. Average rainfall for the West Bank during 2008-9 was 425mm – 22 percent below the historic average of 538mm; and at 316.3mm for the Gaza Strip was 12% below the historic average. The Palestinian Ministry of Agriculture recorded negative impacts of rainfall reductions on agricultural production in the West Bank, with problems to winter crops in the Gaza Strip from delayed rains; though agricultural conditions there were impacted more by Israeli military and security activities (Ministry of Agriculture 2009).

The oPt has low levels of per-capita water availability – three-quarters of the population are estimated to consume between 60-100 litres for domestic use per person per day (Zeitoun 2008: 14), compared to 330 litres/person/day in Israel. In the West Bank, average water availability for Palestinians is lowest at 50 litres/person/day compared to 369 litres/person/day for Israeli settlers (Palestinian Hydrology Group 2006; World Bank 2009). The WHO minimal standard for daily water consumption for direct human consumptive and hygiene needs is 100 litre/person/day (Chenoweth 2008: 247). Continuing population growth and predictions for regional climate change – with associated changes in precipitation levels and distribution – will intensify these problems. Indeed, it has been estimated that the oPt will experience a water deficit of $271 \times 10^6$ m$^3$ by 2020 (Mimi et al. 2003). Forecasted climate changes for the eastern Mediterranean mainly affect the start and duration of the different seasons, and the quantity of rainfall. This has two anticipated effects: firstly, periods of heavier rainfall will be concentrated in a shorter time, with consequent increased run-off and erosion and decreased absorption capacities of the soil. Less retained water will result in lower pasture production, forcing herders to purchase (more) fodder. Secondly, on the other hand, poorer rainfall would result in a lower quantity of water harvested and stored in cisterns, forcing herders to purchase (more) tankered water.

Increases in seasonal temperature variability, storminess and frequency of temperature extremes may endanger cold- and heat-sensitive crops. Greater rain intensities and resulting floods may damage crops. Drought damages are also expected to increase with the anticipated decrease in water availability, hotter temperatures and shorter winters. Under such conditions, more pests and pathogens will not only increase crop diseases but also their sensitivity to drought, and loss of biodiversity may reduce the natural control of agricultural pests. A delayed growing season would cause Palestinian agricultural sector to lose its advantage over countries in colder climates as an early exporter of flowers, fruits and vegetables (Ministry of Agriculture 2008).
2.2 Current socio-economic conditions and stakeholder perceptions of sector exposure to climate change

Current socio-economic and political conditions in the oPt are increasing the vulnerability of those groups and sectors most exposed to the negative effects of present climate variability and future climate change. The oPt is ranked 106 in the Human Development Index for 2007/8, in the middle-lower income of countries, although this ranking masks major regional and local disparities. According to UNDP/Programme of Assistance to the Palestinian People (UNDP/PAPP), the ongoing Israeli occupation (with its restrictions on labour, trade and financial/investment flows) and prolonged economic contraction are undermining human development goals. Following the end of the Second Intifada in February 2005, expectations were raised that the oPt would likely meet most MDGs by 2015 (Palestinian National MDG Steering Committee 2005), but recent trends show a sharp deterioration. 48% of Palestinians in the West Bank now live below the poverty line, which rises to 68% in southern Gaza and 72% in northern Gaza (UNDP/PAPP 2009a).

According to the PA, there are substantial pressures on the social service infrastructure – especially public school and hospitals – arising from the high birth rate, with a population growth rate of 3.4% per annum in the oPt.\(^2\) This is one of the highest in the Middle East and North Africa and 75% of the population is now under the age of thirty. The young population has borne the brunt of a recent deterioration in health and employment prospects – with young women facing higher hurdles for educational and economic advancement. (Palestinian National Authority 2008: 22). It is recognised that, for reasons more to do with the lack of political and economic sovereignty than demographic growth as such, the expanding population is becoming increasingly poor and vulnerable, leading to higher numbers dependent on social and humanitarian assistance.

The human development situation in the Gaza Strip is particularly bad. Even before Israel undertook *Operation Cast Lead* in the Gaza Strip (December 27 2008 to January 18 2009), Israeli economic sanctions and an external blockade\(^3\) had triggered a collapse in industrial activity and an historically high unemployment rate (49% just prior to Israeli military operation in December 2008). Aside from the high level of human casualties caused by *Operation Cast Lead*, post-conflict damage assessment indicated a serious threat to food and water security in the Gaza Strip – the razing of up to 18% of cultivated lands (including the destruction of greenhouses, livestock and poultry farms), serious damage or destruction to eleven registered groundwater wells and four water reservoirs, as well as damage to 19,920 metres of water pipes (UNDP/PAPP 2009b: PNA 2009).\(^4\)

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\(^2\) According to an official census in January 2008, the Palestinian population in the oPt is 3.77 million, with 2.35 million in the West Bank (including East Jerusalem) and 1.42 million in the Gaza Strip.
\(^3\) The economic sanctions and blockade against Gaza started with the January 2006 victory of Hamas in the Palestinian Legislative Elections: they were tightened even further in September 2007 following the declaration by Israel that the Gaza Strip was a ‘hostile entity’.
\(^4\) According to a survey conducted by the Palestinian Hydrology Group, in the worst affected areas of Al Attara and Ezbet Abed Rabbo half the water networks were damaged (PNA 2009: 29).
The first Millennium Development Goal (MDG 1 - the eradication of extreme poverty and hunger) is deemed by UNDP to be unlikely to be achieved by 2015 for the oPt as a whole. A survey of the latest available household and expenditure data for the West Bank and the Gaza Strip confirms that the oPt has faced a deepening of poverty, which relates to a continuing deterioration of living conditions (UNRWA 2009). A food security assessment undertaken by the Food and Agriculture Organization in March/April 2008 estimated that 25% of the West Bank population and 56% of the Gaza Strip population are food insecure (FAO 2008). Food insecurity is reflected in a rise of chronic malnutrition rates in children under five years of age – from 7.5% in 1996 to 10.4% in 2007: if such rates persist, it is likely that there will be long-term damage to standards of health in the oPt (UNDP/PAPP 2009a).

As noted elsewhere in this report (Sections 3 and 4.4.1), food insecurity in the oPt may increase due to the environmental effects of climate variability and change (e.g. rain-fed crops and grazing ranges hit by drought), but these impacts are always accentuated by the lack of effective Palestinian control over land and natural resources. This leads UNDP/PAPP to state that MDG 7 (ensuring environmental sustainability) is also unlikely to be met in the oPt by 2015. While the 2005 draft Palestinian Constitution recognises the right to a clean, safe environment and the PA has a dedicated environmental agency – the Environmental Quality Authority (EQA) – ecological sustainability cannot be delivered until the conflict with Israel is resolved and there is unimpeded regulatory capacity for the PA (UNDP/PAPP 2009a).

Consultations undertaken in December 2008 by the climate adaptation Project Team on behalf of, and in collaboration with, EQA and UNDP/PAPP surveyed perceptions by key stakeholders in the West Bank and the Gaza Strip – notably PA ministries and Palestinian NGOs – on those economic and policy sectors (potentially) exposed to climate change. This stakeholder input corroborated the initial premise of the Project Team that the water sector in the oPt justifies priority focus in terms of climate change impacts. The major exposures anticipated are summarised by sector as follows.

- **Water**
  - Increased water shortages from lower rainfall and higher evaporation
  - Increased stormwater flooding from greater rainfall variability
  - Insufficient rain to recharge aquifers.
  - Reduced surface and groundwater quality.
  - Lower supply of water from Israel.

- **Agriculture**
  - More frequent droughts and increased desertification.
  - Changes in economic viability of crops (e.g. shorter growing seasons)
  - Increased crop water requirements
  - Decline in grazing ranges and stocks.

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5 These consultations consisted of interviews and discussions with key stakeholders, a questionnaire survey of relevant experts, and two scoping meetings – one in Ramallah on December 15 2008 and a video conference scoping meeting with Gaza City participants on December 17. A Report on the Consultation and Scoping Meetings was delivered to EQA and UNDP/PAPP in January 2009.
- Higher food prices.
- **Energy**
  - Increased energy demands to cope with more temperature extremes
  - Rising fuel demands to cope with water shortages.
- **Public health**
  - Increase in public health ailments related to the lack of water such as diarrhoea, cholera and dehydration.
  - Increased heat stress from high temperature extreme events.
  - Spatial and temporal alteration of disease vectors, including malaria, Leishmaniasis, and tick-borne diseases.
- **Coastal management (the Gaza Strip)**
  - Saline intrusion into the Coastal Aquifer.
  - Land use impacts from sea-level rise and coastal erosion.
  - Soil degradation.
  - Loss of biodiversity

### 2.3 Sources of vulnerability

The stakeholder consultations undertaken by the Project Team in the oPt identified several forms of ‘vulnerability’ in the oPt. Apart from the expected impacts due to altered rainy seasons, temperature and humidity, physical infrastructures and livelihoods were also subject to the effects of the movement restrictions (especially in the Gaza Strip, but also between communities in the West Bank), the Wall, settlement expansion, and weak governmental authorities.

The array of non-environmental sources of vulnerability led us to employ the broad concept of *climate vulnerability*. It was clear also from these stakeholder consultations that the ‘real’ or ‘net’ impact of the combination of environmental and non-environmental risks was ‘dampened’ in a sense by the ways communities have responded to the risks – through such coping mechanisms as altering crop selection and cropping patterns, diversifying livelihoods and purchasing water from privately-run tanker trucks. The following sections provide a frame with which to understand and interpret the relationship between all such measured factors.

#### 2.3.1 Adaptive capacity and coping mechanisms

The terms ‘adaptation’ and ‘coping mechanisms’ are often used interchangeably in relation to environmental (and other) hazards. In examining the responses of communities to climatic phenomena, it is useful to think of each in terms of some sort of unit of measurement - coping range and adaptive capacity, as shown in Figure 2.1, for example. The two measures may be distinguished by their temporal aspects – with coping range relating to shorter-term responses, and adaptive capacity relating to longer-term responses.

Figure 2.1 shows how a minor decrease in water availability one season, for example, may induce a coping response such as water delivered by tanker from outside the watershed. A more substantial decrease in water availability
may lead to the more significant consequences of a failed harvest, while an extended drought period may push the community beyond its coping and adaptive limits – with consequences difficult to predict, but likely to be severe. The concept of environmental ‘thresholds’ has been developed to characterise the limit after which changes to the biophysical or social environment may be irreversible.

Figure 2.1: Coping range and adaptive capacity of communities related to water availability. Adapted from Vincent (2004).

Both coping range and adaptive capacity are key components of the central feature of this report – climate vulnerability.

2.3.2 Working definition of climate vulnerability

The 4th UNEP Global Environmental Outlook defines the concept of “vulnerability” as:

an intrinsic feature of people at risk. It is multidimensional, multidisciplinary, multisectoral and dynamic. It is defined here as a function of exposure, sensitivity to impacts and the ability or lack of ability to cope or adapt. The exposure can be to hazards such as drought, conflict or extreme price fluctuations, and also to underlying socio-economic, institutional and environmental conditions. The impacts not only depend on the exposure, but also on the sensitivity of the specific unit exposed (such as a watershed, island, household, village, city or country) and the ability to cope or adapt (UNEP 2007: Box 7.1).

The hazards, which can lead to vulnerability, are identified as both environmental and socio-political in nature. In this report, climate vulnerability is defined as combined biophysical vulnerability and social vulnerability (after Brooks 2003).

The IPCC’s definition of biophysical vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (2007). An evaluation of biophysical vulnerability is borrowed from Wisner et al. (2004), which sees it...
as one of the elements making up ‘risk’. Risk is equal to hazard (climate events or longer-term changes, in our case) multiplied by vulnerability (exposure to the climate, in our case). In other words, we may state that:

$$\text{Biophysical Vulnerability} = \frac{\text{Physical Risk}}{\text{Hazard}}.$$  

Social vulnerability is taken as the sensitivity of the human environment to the exposure of a hazard (Brooks 2003, Vincent 2004, see also Adger 2006). The working definition of social vulnerability recognises that measures communities take in response to biophysical vulnerability may greatly reduce the sensitivity of the community to the hazard. In other words, social vulnerability is the residual impact after adaptation measures and coping mechanisms have been considered, or:

$$\text{Social Vulnerability} = \text{Physical Risk} - \text{Adaptation}.$$

The ‘sensitivity’ aspect of social vulnerability may be further broken down into social, economic and political components. It is recognised that social features of a community – such as internal cohesion and group knowledge – may decrease the overall vulnerability of that community to environmental risks (e.g. by increasing adaptive capacity). Similarly, a community that enjoys a wealthy and diverse economic base would be considered less (socially) vulnerable than a community whose economy is weak and dependent on external factors. Communities may further experience the effects of political drivers of vulnerability, through ‘exposure’ resulting from sudden changes in the political context eliciting an armed or legal response. We will now elaborate further on non-environmental components of vulnerability.

### 2.3.3 Non-environmental sources of vulnerability

Social, economic and political aspects of climate vulnerability cover a broad range of issues. Political aspects relate primarily to the equitable distribution of resources and services – for example, whether water storage and distribution infrastructure or national climate change adaptation plans (both of which would reduce vulnerability) extend to the most marginalised communities. The issue of the inequitable distribution of such services is particularly salient in the oPt, where the advantages of well-established urban families over rural, Bedouin or refugee communities is well-documented (Trottier 1999, Roy 1995). Moreover, the residents of the Gaza Strip as a whole are currently more vulnerable than the residents of the West Bank, because of the harsh conditions on livelihoods and public health, created mainly by the Israeli siege of the Gaza Strip.

In consultation meetings undertaken by the Project Team, the chief non-environmental source of vulnerability throughout the oPt was generally agreed by stakeholders to be the Israeli occupation, in particular its access and

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6 For a collection of the different interpretations of environmental risk, see Brooks (2003: 7).

7 In his academic review of ‘vulnerability’, Adger notes that “other research presently argues that the key to understanding vulnerability lies in the interaction between social dynamics within a social-ecological system and that these dynamics are important for resilience” (Adger 2006: 273).
mobility restrictions. The extensive impact of the Israeli occupation on vulnerability is felt at both the national and community level.

The current form of the Israeli occupation of the West Bank and the Gaza Strip is a complex set of controls and restrictions affecting many aspects of daily life for all Palestinians.\(^8\) A salient and peculiar form of the Israeli occupation is that the management of human activity in the West Bank and the Gaza Strip is the responsibility of – and undertaken by – Palestinians themselves, through the PA (in practice Hamas for the Gaza Strip). Thus, the EQA shares the same responsibilities as any ministry of environment, but with its actual authority compromised by elements of the Israeli occupation, such as movement restrictions on staff. This means that proposed environmental initiatives (such as any intended projects to build resilience to the effects of climate change) face major hurdles. The same may be said for the Palestinian Ministry of Agriculture and Ministry of Planning. The Palestinian Water Authority, for its part, is even further hampered by the well-drilling restrictions imposed by the 1995 Oslo II Agreement, as well as the project-approval hurdles placed by the Joint Water Committee (Selby 2003). PA institutions are further weakened by deficits in technical capacity, rent-seeking behaviour and mismanagement of resources, such that they are unable to respond effectively to the climate vulnerability of the communities they are intended to serve.

The Israeli occupation also directly affects the climate vulnerability at the community-level. With over 400 checkpoints or roadblocks in the West Bank, many villagers are cut-off from alternative water supplies. This is the case in both Massafer Yatta and the Jordan Valley (Sections 3.3 and 3.4). In the Gaza Strip, any attempts to build infrastructure (such as the construction of reservoirs to increase resilience to dry spells, or coastal defences) are severely hampered by Israeli restrictions on the importation of basic building materials. Indeed, these continuing restrictions compromise the ‘building back better’ principle of *The Palestinian National Early Recovery and Reconstruction Plan for Gaza*, which aspires to infrastructure improvements in the wake of the extensive damage from the 2008/2009 Israeli military offensive (PNA 2009: 14-15).

So pervasive and influential on the climate vulnerability of Palestinian communities is the Israeli occupation that it – in and of itself – is considered here a ‘risk’, alongside the traditional risks of sea-level rise and altered rainfall patterns. Other non-environmental sources of climate vulnerability include livelihoods dependent on external factors (or limitations in the adaptive capacity of livelihood diversification), social divisions, weak social protection structures, inadequate domestic security, inadequate physical infrastructure and weaknesses in governance capacity.

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\(^8\) While Israel has stated that, with its unilateral withdrawal from the Gaza Strip in September 2005, its status as an occupying Power there has finished, it still maintains effective control of the Strip and thus remains bound by international humanitarian obligations regarding belligerent occupation (Dinstein 2009: 276-280).
Most Palestinian families derive their incomes from a variety of sources, including labour/direct livelihoods, but also small side-businesses (markets), remittances from family members (in the past, through work in Israel but more recently from work in the Gulf). Many more – especially in the Gaza Strip – also receive welfare. But the diverse incomes do not necessarily directly translate into resilience. The case of reliance on remittances from work in Israel shows how vulnerable the system was to the Israeli policy of less dependence on Palestinian workers (and the ‘boom’ which attracted many Palestinians to work in the Gulf has similarly dried up to a certain extent, with the financial crisis which began in 2008).

The political and economic sources of vulnerability are further compounded by divisions within Palestinian society. There are significant social and economic differences amongst Palestinians at a number of levels: between urban and rural citizens, between refugee and non-refugee communities in the same city, and between rural settlements and nomadic tribes.

### 2.4 Climate change impacts: alignment with national plans, UNDP goals and UNDP/PAPP priorities

In the oPt there are major governance challenges to climate change adaptation planning – the generally weak capacities of national agencies and local authorities to develop effective strategies on adaptation and disaster risk management; the lack of tools and systems to enable appropriate planning and implementation of climate change adaptation; and a general lack of information on technological adaptation and sustainable development options.

This UNDP/PAPP-funded climate change adaptation initiative for the oPt 2008-2009 reflects strategic UNDP goals for national capacity-building regarding climate change adaptation (UNDP Environment and Energy Group 2008):

- To enhance capacity of developing countries to design and implement policies to integrate adaptation into domestic plans, budgetary and fiscal policies, investments and practices
- To help countries identify, prioritise and implement short-term ‘no regrets’ adaptation responses (e.g. revised spatial and land-use plans, use of drought tolerant crops, enhanced emergency preparedness)
- To help countries mobilise additional sources of funding for implementing adaptation responses

In the oPt, this is consistent with UNDP/PAPP’s *Mid-Term Strategic Framework 2008-2011*, particularly its cross-cutting theme of environmental sustainability and its priority focus on democratic governance, including strengthening the capacity of the PA (UNDP/PAPP 2008).

The climate change adaptation initiative for the oPt involved developing a national *Climate Change Adaptation Strategy* and a *Palestinian Adaptation*
Programme of Action. This work is anticipated to deliver the following capacity-building outcomes for the PA:

- The identification of key climate change information and modelling needs for national development planning and environmental policy-making
- The identification of priority climate change adaptation policy options and measures
- Improvement in the capacity of PA decision-makers effectively to take account of climate change impacts
- Improvement in the capacity of PA staff to monitor and evaluate policies with regard to climate change

These objectives are consistent with the Palestinian Reform and Development Plan 2008-2010 (PRDP) (Palestinian National Authority 2008), which includes enhanced quality of life and good governance as national policy goals: EQA, as the relevant line ministry, has stated that an assessment of climate change impacts in the West Bank and the Gaza Strip is essential for national decision-making. Currently, climate change impact considerations are not integrated into the Palestinian National Policy Agenda (PNPA) – the framework setting the medium term priorities for the PA – and the PRDP. However, climate change risks are most likely to impinge on PRDP goals to increase agricultural output and provide more efficient and equitable water delivery to households. They are also likely to affect a number of other PRDP goals, including social security protection and health quality improvement. There is thus a clear need for climate change adaptation planning.

2.5 International legal context of Palestinian vulnerability to climate change impacts

It is necessary to clarify the extent to which Israel and other external state actors may have international legal responsibilities to prevent or reduce the negative impacts of climate change in the oPt, and also to assist Palestinians in adapting to climate change. These obligations arguably include preventing climate maladaptive practices and facilitating access to international adaptation funding. Such responsibility is a complex legal question, which cannot be covered in depth here, but two areas of international law are relevant to determining the specific environmental responsibilities to the Palestinian population.

1. International humanitarian law

There are compelling arguments that the occupied Palestinian territory is subject to the international law of belligerent occupation, including the Hague Convention [1907] and the Fourth Geneva Convention [1949] (Daibes-Murad 2005: 45-58; Dinstein 2009).9 These instruments – which

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9 The political representatives of the oPt have formally agreed to be bound by the Geneva Conventions. On 21 June 1989, the Swiss Federal Department of Foreign Affairs received a letter from the Permanent Observer of Palestine to the United Nations Office at Geneva informing the Swiss Federal Council "that the Executive Committee of the Palestine Liberation Organization, entrusted with the
impinge on Israel by their customary law status and on account of Israeli ratification in 1951 of the Fourth Geneva Convention – require Israel, as the occupying State, to take responsibility for meeting the needs of the civilian population, including the guardianship of natural resources (1907 Hague Convention Article 55) and prohibition of the extensive destruction and appropriation of property (Fourth Geneva Convention Article 147). In addition, Article 54(2) of Additional Protocol I [1977] explicitly prohibits the destruction, removal, and disablement of civilian objects indispensable to the survival of the civilian population, including agricultural areas, drinking water installations and irrigation works. While the Additional Protocol has not been signed or ratified by Israel, Article 54(2) codifies obligations already widely recognized in customary international law. Thus, there are sufficient legal grounds to suggest that the systematic disruption and destruction of Palestinian water and agricultural infrastructure – especially in Area C of the West Bank and Gaza (see Section 3 of this report) – are prima facie breaches of international humanitarian law. These actions, whether by agents of the State of Israel or citizens of that state (e.g. settlers), have significantly increased the water and food insecurity of the Palestinian population: the actions have also undermined the adaptive capacity of Palestinian households and communities in the face of (present and future) climate hazards.

In the West Bank and East Jerusalem, the Israeli-labelled ‘security fence’ has had major impacts on Palestinian water and food security (alongside other humanitarian impacts). Five years since the International Court of Justice declared in an Advisory Opinion that ‘the wall’ being constructed by Israel in the oPt was contrary to international law (International Court of Justice 2004), its persistence and extension have significantly affected agriculture and access to water sources. Impacts have included the confiscation of land, the uprooting of tens of thousands of olive trees, and the physical separation of communities from groundwater wells and natural springs (Food and Agriculture Organization 2007b; Office for the Coordination of Humanitarian Affairs 2009). While it has not been within the remit of the Project Team to survey the impacts of the Wall and its associated closure regime, its status and scope will impact directly on climate change adaptation measures in the West Bank. For example, the access restrictions on the use of Palestinian wells now on the Israeli side of the Wall are significantly reducing both current water provision (especially for agricultural use) and also the potential for future water extraction (especially from the Western Aquifer Basin).

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functions of the Government of the State of Palestine by decision of the Palestine National Council, decided, on 4 May 1989, to adhere to the Four Geneva Conventions of 12 August 1949 and the two Protocols additional thereto” (International Committee of the Red Cross 2009a).

10 The applicability of the Fourth Geneva Convention to the occupied Palestinian territory, including the designation of the State of Israel as the Occupying Power, was reaffirmed by the High Contracting Parties to the Fourth Geneva Convention in December 2001. They also reaffirmed the illegality of the Israeli settlements in the oPt (Government of Switzerland 2001). See also International Committee of the Red Cross (2009b).
The Advisory Opinion of the International Court includes the legal judgment that Israel should “return the land, orchards, olive groves and other immovable property seized from any natural or legal person for the purposes of construction of the wall in the Occupied Palestinian Territory. In the event that such restitution should prove to be materially impossible, Israel has an obligation to compensate the persons in question for the damage suffered” (International Court of Justice 2004: paragraph 153). According to the Court, all states are obliged under international humanitarian law not to recognise the illegal situation resulting from construction of the Wall.

2. International environmental law
According to Article 2 of the 1992 United Nations Framework Convention on Climate Change (UNFCCC), states have a duty of prevention with regard to dangerous climate change (Voigt 2008: 5), and they should act to achieve this in a way that allows ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable sustainable economic development. Through its global scope, this duty of prevention benefits in principle the oPt. ‘Palestine’ is of course not a Party to the UNFCCC, though it has legal status within the UN governance system. Insofar as the oPt receives climate change damage, there is also the application of the customary rule of international environmental law that states do not cause harm to the environment of other states or areas beyond national control. States could be construed as fulfilling this harm prevention obligation to the Palestinian population, in regards to climate change, by their climate mitigation efforts (reducing the problem at source) and/or by directly assisting adaptation efforts within the oPt (preventing or reducing specific impacts): Verheyen (2005: 35) labels the former indirect damage prevention and the latter direct damage prevention. There are conceptual uncertainties and practical difficulties over apportioning specific responsibilities of harm prevention to particular polluting states. However, the notion of ‘common but differentiated responsibility’, as employed in UNFCCC Article 3, directs attention instead to the special needs of those developing countries particularly vulnerable to the adverse effects of climate change (Verheyen 2005: 69-73). This justice aspiration could support the PA (or PLO), representing a territory with high climate vulnerability, in seeking access to climate change adaptation financing available under UNFCCC even though it is not a Party to the treaty.

11 Following the proclamation of the State of Palestine by the Palestinian National Council in November 1988, ‘Palestine’ was recognised as an entity by the United Nations General Assembly (UNGA Resolution 43/177 [1988]) and has since been afforded particular rights and privileges of participation – above those of an observer non-member state – in the work of the United Nations, including United Nations conferences (UNGA Resolution 52/250 [1998]).
3. Climate Change and Vulnerable Communities

3.1 Identification of climate vulnerability-livelihood interactions

The consultation sessions held by the Climate Adaptation Project Team with relevant stakeholders revealed a number of direct and indirect ways in which people’s livelihoods and climate vulnerability are related in the oPt. It was agreed in these sessions that the agricultural sector was the Palestinian economic sector most sensitive to climate hazards, both current and future. Agricultural water usage is 155 MCM/year – 66% of all water withdrawn by Palestinians in the oPt (Lautze and Kirshen 2009: 192). Agriculture is also an economically significant sector accounting for about 10% of the Palestinian GDP, 20% of exports and 15% of total employment (FAO 2009: 12). Vulnerability-livelihood interactions in the agricultural sector have thus been highlighted. This is not to imply that other sectors may not also be negatively affected by climate variability and change; rather, that there is an urgent need to address climatic adaptive capacity for those dependent on agricultural livelihoods.

3.1.1 Climate vulnerability-livelihood interactions in the West Bank

The main source of livelihoods of rural communities in the West Bank is agriculture. Agricultural activity is influenced by both the biophysical and socio-political components of climate vulnerability – specifically, risks associated with various aspects of the Israeli occupation and risks associated with decreased (and more variable) precipitation. As communicated in stakeholder discussions, the most direct impact of increased water scarcity on the vulnerable livelihoods of agricultural communities was taken to be reduced yields.

Both rain-fed and irrigated agriculture is common in the West Bank. Table 3.1 presents the total cultivated area in the West Bank as well as the crop (fruit trees, field crops and vegetables) distribution. The two types of irrigation systems, rain-fed and irrigated comprise, respectively, 94% and 6% of the agricultural area.

**Table 3.1:** Rain-fed and irrigated area of fruit trees, field crops and vegetables in the West Bank (PCBS, 2006) [hectares]

<table>
<thead>
<tr>
<th></th>
<th>Fruit trees</th>
<th>Field crops</th>
<th>Vegetables</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain-fed area</td>
<td>106,900</td>
<td>43,400</td>
<td>4,000</td>
<td>154,300</td>
</tr>
<tr>
<td>Irrigated area</td>
<td>2,100</td>
<td>1,500</td>
<td>8,600</td>
<td>12,200</td>
</tr>
<tr>
<td>Total</td>
<td>109,000</td>
<td>44,900</td>
<td>12,600</td>
<td>166,500</td>
</tr>
</tbody>
</table>

Under current water availability restrictions, and taking into consideration restricted access to lands, the irrigated area is unlikely to expand in the West Bank. The bulk of the cultivated land in the West Bank is located in the Jordan River Valley (Tubas and Jericho Governorates), and in the Governorates of Jenin and Tulkarm. Agriculture was one of the key sources of growth in the
economic recovery that has taken place since 2003. Changes in agricultural activities are more sensitive than other economic sectors in the oPt to climatic variability and change, though socio-economic and political factors mediate this environmental influence. In the West Bank the GDP from the agricultural sector is about 12% (PCBS, 2006).

The biophysical and social vulnerability of communities in the Jordan River Valley and Tubas dependent on irrigated agriculture is observed in the reductions of yields in recent year. In the Jordan River Valley (see Section 3.4) the livelihoods of the communities of Fesa’el and others are affected by Israel settlers taking over land (Peza’el settlement), and by the development of water supply through well-drilling, dependent on approval by the Joint Water Committee. On those fields where irrigated agriculture is possible, the decision to sow or not is usually governed by both a) the cost of water (which in this case is delivered and priced by Israel), and b) expected returns from the produce given the market restrictions (at Israeli checkpoints, most notably the ‘Hamra’ checkpoint preventing produce from reaching markets in Nablus).

The irrigation farming communities in the Jordan River Valley and Tubas join the rainfed farming communities of Massafer Yatta when it comes to biophysical vulnerability. Both reductions and changes in rainfall patterns have a direct impact on reduced yields, and therefore on livelihoods. Repeated drought cycles reduce the springflow for Tubas, limiting the extent of time the farmers there have for irrigating their crops – and for producing second or third yearly harvests. Dry years also result in freshwater cuts from the Israeli water supplier Mekorot to the residents of the Jordan River Valley (as was the case in 2008 also for domestic consumers in Israel), thereby limiting the number of harvests. The impact of reduced (or late) rains on the rainfed communities in Massfer Yatta is direct and disastrous (see Section 3.3 below). The failure of crops during the localised drought of 2005, for instance, was extensive to the point of obliging the international community to respond with emergency food distributions. Other interactions between agricultural livelihoods and climate risks include the increased salinity of groundwater and soils (and therefore reduced yields) due to reduced precipitation; the increased cost of tankered water (as a coping mechanism, during dry summer months) driven up by drought; and the degradation of grazing lands.

3.1.2 Climate vulnerability-livelihood interactions in the Gaza Strip
Farming communities in the Gaza Strip are affected by similar biophysical and social vulnerability. The closure of the Strip limits exports, thereby cutting off a source of income from produce (generally strawberries, oranges and cut flowers) destined for Israel, Egypt or Europe. The closure furthermore reduces imports of regulated fertilisers – which could significantly increase yields. Yields are also significantly reduced by decreases in water quality – primarily the increased salinity of the groundwater. Caused by over-pumping, infiltration of untreated or partially treated wastewater and sea-level rise, salinity levels in the groundwater can rise as high as 300-500 mg/l (Vengosh, et al. 2005). Further potential biophysical risks include reductions in precipitation (which can exacerbate groundwater salinity levels through reduced soil flushing and
groundwater recharge), and reductions in air moisture (which increase the soil water requirement of crops, or reduce fruit production).

The livelihoods of non-farming communities in the Gaza Strip are also affected by climate vulnerability. The closure has in effect changed the trend towards increased overall wealth (held as a model by the World Bank, until 1999) to one where, after the Israeli military offensive, poverty levels stand at around 65% (Palestinian National Authority 2009: 39). According to a Joint Rapid Food Security Assessment conducted in 2008, some 56% of citizens of the Gaza Strip are food insecure and 75% are receiving food assistance (WFP/FAO/UNRWA 2008). The increasingly poor drinking water quality also necessitates increased purchase of desalinated water from private-sector neighbourhood-level reverse osmosis units, or the purchase of under-the-sink water filtration units, both of which contribute to the ever-greater share of household income spent on basic services (Palestinian Water Authority 2008a, 2008b).

3.2 Stakeholder selection of case studies

This climate change adaptation initiative for the oPt is informed by the UNDP Adaptation Policy Frameworks for Climate Change (Lim et al. 2005), including their guidance on stakeholder consultation and vulnerability analysis. In consultation with EQA and UNDP/PAPP, stakeholders were identified by the Project Team as those affected by, or with an interest in, climate change adaptation. In order for adaptation decision-making to be inclusive in a human development sense, the Project Team set out to identify sectors and communities in the oPt most affected by the risk of climate change. Initial consultation meetings and a questionnaire survey (in November-December 2008) focused on eliciting perceptions on climate sensitivity of the oPt from key policy actors in the Gaza Strip and the West Bank.¹² From the feedback gathered, the water sector was confirmed as the priority sector for analysis, particularly as regards water availability for domestic consumption and Palestinian agricultural production.

As noted in the UNDP Adaptation Policy Frameworks, analysing the capacity of stakeholders to understand and cope with adverse climate events is key to characterising current and possible future vulnerability (Conde and Lonsdale 2005: 49). The Vulnerability Assessment adopted in this Climate Change Adaptation Strategy has been informed by stakeholder input, paying attention also to existing vulnerability definitions in use in development and disaster reduction planning, environmental management and MDG strategies in the oPt.

Guided by the UNDP model of vulnerability assessment (Downing and Patwardhan, 2005), geographical areas of highest climate vulnerability were selected by the Project Team on the basis of:

¹² For Gaza, the initial November-December 2008 meetings were by video-conference, followed up by a face-to-face consultation meetings in May 2009.
• Limited self-governing capacity
• High levels of water and food insecurity
• Movement and livelihood restrictions imposed by the Israeli occupation
• High levels of humanitarian assistance.

This method initially suggested that the most vulnerable groups would be found in Area ‘C’ of the West Bank (Massafer Yatta, Jordan River Valley) and Umm al Nasser, Mawasi and other coastal areas in the Gaza Strip. These candidate areas were then presented at two stakeholder scoping meetings in the West Bank and the Gaza Strip during December 2008, which discussed the planned climate change analysis and vulnerability assessment to be undertaken by the Project team, and also brainstormed climate adaptation priorities. Stakeholder input corroborated the initial premise of the Project Team that the water sector justified priority focus in terms of climate change impacts, and that the case studies for vulnerable communities should be identified on the basis of high levels of water and food insecurity. The consultation exercise refined the local vulnerability focus for the West Bank, with Massafer Yatta (south Hebron hills) and the easternmost oPt areas of the Jordan River Valley. However, stakeholder representatives from the Gaza Strip persuaded the Project Team – even before the Israeli military operation of 27 Dec 2008 to 16 Jan 2009 – that the Strip must be dealt with as a whole in terms of high climate vulnerability rather than the two communities initially suggested.

3.3 West Bank: Massafer Yatta (Hebron Governorate)

3.3.1 Climate and wider vulnerabilities in Massafer Yatta
Massafer Yatta is a semi-arid area (3,500 hectares) comprising 19 farming hamlets in the south-east of the Hebron Governorate (Map 3.1). In January 2009, the United Nations Office for Coordination of Humanitarian Affairs (OCHA) estimated that the area contained 12,000 Palestinian inhabitants. While the nearby town of Yatta (population 60,000) is zoned as Area A under the Oslo Interim Accords of 1995, Massafer Yatta is classified as Area C and therefore under complete Israeli control. Traditional farming methods have been rain-fed field crops, olives and the rearing of sheep and goats. Israeli restrictions on pumping in the region have prevented farmers in the area from developing irrigated agriculture. West of Yatta are various, scattered Bedouin communities who live in tents and shacks and raise livestock (Centre on Housing Rights and Evictions 2008b: 32).

Recent changes in the rainfall regime (reduced and later rains) have had severe impacts in the region, with localised droughts in 2005/6, 2007/8 and 2008/9 triggering emergency food distribution from international humanitarian organisations. In the past 6 years, according to the Manager of the Joint

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13 The West Bank scoping meeting took place at Birzeit University on December 15. The Gaza scoping meeting was held by video-conference on December 17 (as the consultants were prevented from travelling to Gaza City).
Services Council for Massafer Yatta, average rainfall has dropped from 400mm a year to 180mm. The Agriculture Department for Hebron Governorate acknowledges that there has been a dramatic drop in rainfall since 2002/3, which is impacting negatively on farmers due to reduced and more variable water availability.

Map scale: 7.8mm = 1km

**Map 3.1:** Massafer Yatta region of Hebron Governorate (UN Office for Coordination of Humanitarian Affairs West Bank Closure-Hebron, April 2008)

[The black-yellow cross between At-Tuwani (see Section 3.3.4) and the Israeli settlement of Ma’on indicates a Road Gate preventing access to At-Tuwani (and Yatta) from hamlets further south in Area C (dotted area on the map above the 1949 Armistice Green Line). The West Bank Separation Barrier on the southern edge of the region is marked as constructed (thick line red line) and planned (black/white) as at April 2008: Beit Yatir is an Orthodox Jewish moshav established in 1979 on occupied Palestinian land].

The reduced rainfall is claimed by the Agriculture Department to be the main cause of a significant drop in crop production in Yatta District (Yatta city and Massafer Yatta) in the last ten years. While there has been almost a doubling of cultivated land from 33,570 dunums in 2000 to 61,225 dunums – with increased cultivation of all major crops except chickpeas (Table 3.2a), agricultural productivity has declined significantly during the same period – down 25% for wheat, almost half for barley and almost 60% for lentils, with smaller reductions for the other main crops (Table 3.2b). The problem is greatest on the 60,000 dunums used for pasture, where the combination of recurrent droughts and overgrazing has caused a dramatic reduction in the quality of the grazing land, with the loss of indigenous field crops, extensive

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14 Interview with Saber Alhurini, At-Tuwani Village, 16 December 2008. Since 2003/4 the Hebron Meteorological Station has recorded an average rainfall of 446.8mm compared to a 535.78mm average for the preceding ten years.

15 Interview with Head and Deputy Head of Hebron Agriculture Department, Hebron, 11 May 2009.
soil erosion and a decline in domesticated *Harrathi* honey bees. Here, again, there is a direct link to the Israeli mobility restrictions, as the increased pressure on the grazing lands (e.g. the number of sheep has increased from approximately 30,000 in 1998 to 90,000 in 2008) was triggered by farmers no longer being able to enter Israel for seasonal work.

**Table 3.2a**: Agricultural land use (dunum) in Yatta District (Hebron Agriculture Department, 2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat</th>
<th>Barley</th>
<th>Lentils</th>
<th>Vicia</th>
<th>Chickpeas</th>
<th>Biqa</th>
<th>Olives</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3700</td>
<td>14900</td>
<td>2500</td>
<td>2000</td>
<td>210</td>
<td>260</td>
<td>10000</td>
</tr>
<tr>
<td>2008</td>
<td>6300</td>
<td>32000</td>
<td>3000</td>
<td>2100</td>
<td>25</td>
<td>2800</td>
<td>15000</td>
</tr>
</tbody>
</table>

Units are dunums [1 dunum = 0.1 hectare]

**Table 3.2b**: Agricultural productivity (kg/dunum) in Yatta District (Hebron Agriculture Department, 2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Wheat</th>
<th>Barley</th>
<th>Lentils</th>
<th>Vicia</th>
<th>Chickpeas</th>
<th>Biqa</th>
<th>Olives</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>80</td>
<td>105</td>
<td>51</td>
<td>75</td>
<td>75</td>
<td>400</td>
<td>60</td>
</tr>
<tr>
<td>2008</td>
<td>60</td>
<td>50</td>
<td>30</td>
<td>50</td>
<td>50</td>
<td>300</td>
<td>50</td>
</tr>
</tbody>
</table>

Units are kg yield per dunum [1 dunum = 0.1 hectare]

The biophysical vulnerability of Massafer Yatta is compounded by high social vulnerability. There is no water or electricity network most of the Palestinian villages, only two schools and a health clinic only staffed a day a week. The lack of access to health care in the area has been shown to impact particularly on women and children. Its Oslo-II defined ‘Area C’ status places severe constraints on residence and movement for Palestinians: this has led to widespread forced evictions, household demolitions and mobility restrictions (Centre on Housing Rights and Evictions 2008b: 32-34). There are eight Israeli settlements and settler outposts that have cut the residents of Massafer Yatta off from direct routes to Yatta – the traditional market destination for their agricultural goods as well as other important services. While settlement construction began in the early 1980s, movement restrictions in the area intensified following the start of the Second *Intifada* in September 2000: now seemingly permanent, a network of roadblocks, checkpoints, earthwalls and trenches erodes the means by which Palestinians can maintain their livelihoods (Food and Agriculture Organization 2007b: 29). The Israeli Separation Barrier running through the southern periphery of Massafer Yatta has accentuated access restrictions: in January 2009 Israeli authorities declared the area between the Barrier and the Green Line a closed military area.

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17 One of the hamlets that has already suffered loss of access to grazing land and springs as a result of the Separation Barrier is the village of Imnezil, near to the settlement of BeitYatir.
OCHA has highlighted serious instances of violence by Israeli settlers against Palestinian civilians and property in the south of the Hebron Governorate. This violence – which has included destruction of, and denial of access to, Palestinian agricultural and grazing land – has increased significantly in the past couple of years. During the first ten months of 2008, 9% of all settler aggression in the West Bank took place in the south Hebron area, from Adh Dharririya in the west to Massafer Yatta in the east (Office for Coordination of Humanitarian Affairs 2008: 4). The violence used by Israeli settlers against Palestinians in Massafer Yatta has resulted in village water supplies being contaminated, the poisoning of livestock, and attacks on shepherds and schoolchildren (Section 3.3.4). A 2005 survey of Palestinian families in Massafer Yatta revealed that 75 families (837 people) from 11 hamlets had been internally displaced from the area as a result of settler violence (Office for Coordination of Humanitarian Affairs 2008: 6). This internal displacement has increased the number of families in poverty, who are now dependent on humanitarian aid.

3.3.2 Water and food insecurity in Massafer Yatta

Lack of access to secure, affordable water in Massafer Yatta has also become a pressing humanitarian concern. Palestinian villagers mainly receive water from rainwater harvesting, or buy water to fill household cisterns from water tanker trucks. While most of the 13 wells in the area are Palestinian, their productivity has significantly decreased in the wake of Israeli restrictions on Palestinian well maintenance and rehabilitation. In July 2008, as a result of the summer drought, 90% of the communities in Massafer Yatta had no water left in their cisterns (Centre on Housing Rights and Evictions 2008b: 32). In contrast, Israeli authorities ensure that Israeli settlements in the area are connected to the well-maintained Israeli national water network, which delivers water at a subsidised rate. Settlers in the area thus consume up to ten times more water than their Palestinian neighbours, at up to one tenth of the cost (Environmental Resource Management 2007). Regional data on the Hebron district from the Palestinian Water Authority indicates a water deficit for Palestinian inhabitants of 12.8 million cubic metres annually.

Given that the existing water supply and storage infrastructure for Palestinians struggles to meet basic needs, the reduced precipitation anticipated as a result of climate change clearly has less significance than these political determinants of water insecurity. Since 2001 humanitarian and development organisations have responded to Palestinian water insecurity in the region by making investments in water infrastructure and funding water delivery for domestic and animal consumption. The investments have been insufficient, however. Following a particularly dry 2004/2005 winter, which resulted in very low yields, food insecurity remained so high that international agencies had to organise humanitarian food distributions for the first time in recent history.

Faced with continued restrictions on ‘Area C’, donor interventions have been hampered and still have been unable to implement adequate infrastructure to improve food or water security. For example, in 2008 the Italian NGO UCOD EP facilitated the delivery of 22,500 cubic metres of water to villages in Massafer Yatta, while ICRC provided an emergency water distribution to 1000
herders and their 50,000 sheep. The various priority water projects underway in the area include a US $9.5 million investment by the International Committee of the Red Cross (ICRC) on three water reservoirs and an improved water distribution network for Massafer Yatta (Palestinian Water Authority 2008).

According to the UN Food and Agriculture Organization (2007a), in 2006 28% of the Palestinian households in the Hebron Governorate were food insecure.\(^\text{18}\) Given the relative wealth of many residents of Hebron, this figure likely understates food insecurity in Massafer Yatta, which, in the context of economic isolation from Yatta and reduced access for villagers to the Israeli labour market across the Green Line, has meant an increased dependence for subsistence on livestock rearing. In February-March 2007 a survey of south Hebron villages under the UK Department for International Development (DFID)-funded Hebron Water Access and Storage Project (HWASP) revealed extensive food insecurity linked to the confiscation of, or displacement from, traditional open grazing areas by settlers and the Israeli Civil Administration. The priority need reported by villagers was for affordable animal fodder with which to maintain their livelihoods (Environmental Resource Management 2007). In January 2009 UCODEP estimated that fodder prices were accounting for 75% of the input costs for herders in Massafer Yatta (UCODEP 2009).

The water and food insecurity facing Palestinian villagers in Massafer Yatta reflect in part the unfavourable weather conditions experienced in recent years. Falling precipitation has reduced the volume of rainwater harvested by villagers, forcing villagers to buy tankered water from Yatta or Hebron: in 2008 these purchases were taking up to 30% of monthly income, straining household budgets and depleting savings (Centre on Housing Rights and Evictions 2008b: 33). Furthermore, both sharp winter frosts and summer droughts have caused a shift to less intensive herding and led to the failure of rain-fed agriculture. Climate change predictions (see Section 4.1) suggest that these conditions will become more frequent, meaning that responsible agencies will still need to factor climate vulnerability into development planning for Massafer Yatta. However, current water and food insecurity is more a function of Israeli political and economic restrictions on Palestinian livelihood options than of environmental constraints.

### 3.3.3 Household and community coping mechanisms in Massafer Yatta

At least from the time of Ottoman rule, sedentary farmers and Bedouins in the southern Hebron region have effectively adapted to periods of drought by shifting between livestock breeding and small-scale framing, as well as seeking employment in the city (e.g. the glass industry in Hebron). This adaptation to climatic hazards and other pressures on livelihoods is evident in the khirba villages in the region where inhabitants only stay intermittently and land is not cultivated until environmental and socio-economic conditions are favourable (Krämer 2008: 136). That the Hebron Governorate still includes

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\(^{18}\) See p.6 of this report for the FAO definition of food insecurity.
both the largest area in the oPt for barley cultivation and highest concentration of farm animals suggests a good coordination between agricultural subsectors in response to varied conditions of food production (Food and Agriculture Organization 2007b: 18).

These traditional forms of household and community coping in the face of adversity offer cultural templates for adaptation to climate change, but the ongoing effects of the Israeli occupation undermine the economic conditions necessary to their operation – the free movement of goods and people – and also block the development of Palestinian institutional capacity. To be sure, Palestinian households have had to cope with problems not directly linked to Israeli government policy – e.g. a financial crisis in the PA, fluctuations in food and fuel prices – but the absence of effective control of their natural resources is at the root cause of Palestinian water and food insecurity in Massafer Yatta as well as the rest of the West Bank (Food and Agriculture Organization 2007a). Outside the jurisdiction of the PA and subject to an oppressive closure regime, the villages of Massafer Yatta experience this disempowerment most acutely. Such erosion of their adaptive capacity accentuates their climate vulnerability.

In practice, chronic water and food crises in Massafer Yatta have so far been averted by direct aid from international organisations and NGOs. Emergency relief can protect lives, but without investment in sustainable livelihoods and meaningful moves to political self-determination, it can also perpetuate social vulnerabilities. Where development organisations have participated in longer-term capacity-building – e.g. the 2001-2005 investment of DFID in water and sanitation facilities in Massafer Yatta – structures have been systematically demolished by the Israeli Defence Forces (IDF) and/or blocked off from use by settlers. The steadfast way in which these structures have been repaired or replaced by villagers, often in the face of new demolition orders, is itself a coping mechanism and an assertion of political agency (Environmental Resource Management 2007; Centre on Housing Rights and Evictions 2008b: 23).

### 3.3.4 At-Tuwani Village: compounded vulnerability

At-Tuwani is one of the villages located in Massafer Yatta: it has 280 inhabitants and a traditional village area of 110 dunums, of which only 30 dunums is recognised by the Israeli authorities. Most of the villagers work on the land as they no longer have access to Israeli labour markets, with some minor additional income from women’s craftwork. Located to the immediate east of At-Tuwani is the Israeli settlement of Ma’on (established in 1981) and the settlement outpost of Hill 833. According to the Centre on Housing Rights and Evictions (2008b: 34), these settlements have expropriated over 1,500 dunums of land from At-Tuwani village. Settlers have also prevented the use by local Palestinians of two traditional roads connecting At-Tuwani to two villages in the east – Tuba and Maghaer al Abeed – while the Israeli Civil Administration also regularly blocks direct road access from At-Tuwani to

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19 Information from interview with Saber Alhurini, Head of At-Tuwani Village Council, 16 December 2008.
Yatta. As At-Tuwani is a gateway for local villages to markets in Yatta, these movement restrictions undermine the local agricultural economy.

Access issues impact on all aspects of the life of the village. There is a primary school on At-Tuwani serving both the village children and catering also for up to 25 children from Tuba and Maghaer al Abeed. The most direct route to the school for children outside At-Tuwani is one of the public roads targeted by settlers. Since the construction of the school in 1998 (now subject to a demolition order after the expiry of a 10-year stay of execution from the Israeli Civil Administration), children attending it from neighbouring villages have frequently been subject to verbal and physical assault from settlers. The Israeli authorities have failed to stop these attacks or prosecute any settlers responsible: the IDF has been instructed to provide escorts to the children, but international peace monitors report these escorts to be unreliable. At-Tuwani also hosts a mosque open to surrounding villagers, which like the school, is also under a demolition order. Outside the village, olive-pickers and shepherds from At-Tuwani, Tuba and Maghayir al Abeed have been harassed and even shot at by settlers from Hill 833. In May 2009 villagers reported that in the previous month, Israeli settlers had destroyed the yield from 100 dunums of planted barley and beans.

In At-Tuwani there is one functioning community cistern serving approximately 120 people: it is fed by a natural spring, but the output of the spring has declined in the last 5-6 years – from a winter peak of 30m$^3$/day to 4m$^3$/day. This loss is attributed by the villagers to reduced rainfall – including a recognition that the shift may relate to climate change – and the extraction of groundwater by nearby settlers’ wells: the lack of information on the latter precludes a more precise determination of water supply changes. Other household rainwater catchment cisterns in the village are dry, with villagers reliant on rainwater harvesting, the purchase of water from outside sources, and occasional deliveries of water arranged by humanitarian organisations. These external supplies are sometimes disrupted by settlers placing obstacles on the access road (Centre on Housing Rights and Evictions 2008b: 34). In 2008 the European Commission Humanitarian Aid Office (ECHO) paid for a concrete water storage facility at At-Tuwani (Figure 5) as part of a $311,000 programme on investment in water distribution for vulnerable communities in the southern West Bank. The facility was built without permission from the Israeli Civil Administration and therefore currently faces a demolition order. It is not unusual for some humanitarian organisations to ignore Israeli prohibitions on the construction of Palestinian infrastructure in Area C, claiming that the basic livelihood needs of vulnerable Palestinians have priority.

As with other villagers in Massafer Yatta, the residents of At-Tuwani have developed coping strategies in the face of multiple environmental and social problems.

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21 Interviews with villagers, 11 May 2009.
22 Information from interview with Saber Alhurini, Head of At-Tuwani Village Council, 16 December 2008.
stresses. These strategies include reduction in the size of flocks, seeking seasonal work elsewhere (insofar as travel beyond the village is possible), and tendering collectively for development and humanitarian construction projects in the locality (which some donors, such as DFID, have encouraged). Adaptation in the face of compound vulnerability has given the villagers the potential for resilience to the greater environmental pressures in the region predicted with climate change (which may already be happening), but their capability to adapt to climate change is significantly eroded by the nature and scope of the Israeli occupation. Whether or not it is intended, the rise of unchecked settler violence against villagers in Massafer Yatta – which is not confined to At-Tuwani – is causing the depopulation of Arab villages in the area.

Figure 3.1: A community rainwater cistern/water storage tank built for the village of At-Tuwani in 2008
The cistern was funded by the Spanish Government and managed by the European Commission Humanitarian Aid Office (ECHO). The Israeli settlement of Ma’on can be seen at the top of the hill. Cistern construction was stopped before completion by the IDF: the unfinished structure is under an Israeli demolition order for violating building restrictions in Area C.
3.4 West Bank: Jordan River Valley

3.4.1 Climate and wider vulnerabilities in the Jordan River Valley

Map 3.2 shows the area of the Jordan River Valley identified by the Project team as having high climate vulnerability (the ‘Study Area’). It is located in the easternmost oPt parts of the West Bank of the Jordan River Valley, which includes the watershed areas of Wadi Qilt, Wadi Auja and Wadi Far'a. The Study Area is administratively located in three governorates: Jericho and Al-Aghwar Governorate, Tubas Governorate, and a part of Nablus Governorate. It covers 29 local government units, consisting of two municipalities and 27 village councils.

Map 3.2. Location map for the Study Area
Since 2005, the Jordan Valley has been off limits to all Palestinians who cannot prove that they reside there, and for those that can, a strict regime of closures and checkpoints makes freedom of movement extremely difficult. The northern Jordan Valley is rich in agricultural land. A large number of small communities reside in this area, many of them Bedouin or fellaheen (farmers) dependent on herding livestock and agriculture for their livelihoods.

The Study Area currently has a population of about 100,000. The climate categorised as arid to semi-arid zone, with annual average rainfall ranging from 80-200 mm/year along the flat area, 166mm/year for Jericho City to 200-350 mm/year in the mountainous area. Mean monthly temperatures in Jericho and Wadi Far’a range between a minimum of 13.1°C in December to a maximum of 32.4°C in August. Evaporation rates are high due to the high temperatures, intensive sunshine and low humidity, particularly during the period of May through September. Annual average evaporation in Jericho reaches around 2,100 mm (JICA 2008). A high incidence of poverty is observed in the agricultural sector of the Study Area. The regional poverty rate and the poverty rate of the agricultural sector are 29.7% and 50.4%, respectively.

The number of farm households, inclusive of agriculture and livestock, is about 2,200. It is estimated that about 32,000 persons in the Study Area are engaged in agriculture. The agricultural land in the Study Area is categorized into two land units – Rainfed Land and Irrigated Land. The irrigated land covers about 61,000 dunum (6,100 ha), which is over 90% of the total agricultural land use in the Study Area: this is about half the irrigated land in the West Bank (Table 3.1). The total production of field crops and forages in the Study Area is 25,539 tons, which is 12.5% of the total production in the West Bank. Production of major vegetables includes: eggplant, tomato, cucumber, squash and maize. Fruit trees in the Study Area are planted over 22,000 dunum, which is equivalent to 20% of the area for fruit tree planting in the West Bank. Bananas (9,800 tons or 3,305 dunum) and palm dates (1,274 tons or 1,988 dunum) are planted only in Jericho because of its suitable climate conditions. Most of the agricultural products produced in the Study Area are cash crops. The main destinations of the products are other areas in the West Bank and Israel. Livestock and dairy production in the Study Area includes the production of milk (goats, sheep and cattle), meat (broiler, goats, sheep and cows), eggs and honey. Most of the Bedouins who live in the Study Area engage in livestock production and herding.

Since September 2000 farmers in this region have faced several obstacles as a result of the Israeli occupation and military measures in response to the Second Intifada. Access by Palestinians to their land and markets has been restricted. Checkpoints, blockades, the ‘back-to-back’ goods-transfer system and destroyed or blocked roads have created logistical chaos and extreme increases in transportation costs. It has become economically infeasible both to move inputs in a timely manner to the producers and to move outputs to food processors or to internal or external markets. The cost of the
transportation increase has been especially severe in the eastern side of the West Bank.

In the Study Area, there are a number of wadis, which are broadly demarcated into eleven major wadi basins (Wadi Hahal Milah, Wadi Abu Sidra, Wadi Far’a, Wadi Ahmer, Wadi Auja, Wadi Nueima, Wadi Quilt, Wadi Marar and Wadi Mukallak). Floodwater is currently not utilised, since there is no intake facility installed in the wadis.

There are roughly 88 of a total of 184 agricultural wells in the Jordan River Valley currently functioning. Most of the wells were drilled from 1950 to just prior to the Israeli occupation in 1966, and many have been abandoned for lack of maintenance or reduced capacity. There is a large drop of groundwater level in the case study area, mainly as a result of Israeli deep well extraction for settlements. The previously-mentioned obstacles created by the Joint Water Committee have stifled Palestinian development of the area, even if the Valley is located above the Eastern Aquifer Basin, which is the one basin Israelis allow Palestinian drilling. There are also a high number of unlicensed Palestinian wells in the valley behind Nablus leading to the Jordan River Valley (Palestinian Water Authority 2008c).

A group of 24 springs located in the Study Area is listed in Table 3.3 together with the average discharge data for each spring. Table 3.4 presents the characteristics of sub-regions in the Study Area.

**Table 3.3:** Springs in the Study Area, showing 2007/2008 discharges

<table>
<thead>
<tr>
<th>Name of the spring</th>
<th>Average discharge (MCM/yr)</th>
<th>Name of the spring</th>
<th>Average Discharge (MCM/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamad &amp; Baidah</td>
<td>0.88</td>
<td>Fasayil</td>
<td>0.66</td>
</tr>
<tr>
<td>Qdairah</td>
<td>1.19</td>
<td>Al Dyuk</td>
<td>4.86</td>
</tr>
<tr>
<td>Jeser</td>
<td>0.14</td>
<td>Al Nwai’mah</td>
<td>2.6</td>
</tr>
<tr>
<td>Tabban</td>
<td>1.29</td>
<td>Al shusah</td>
<td>0.61</td>
</tr>
<tr>
<td>Al Subyan</td>
<td>0.19</td>
<td>Al Sultan</td>
<td>5.54</td>
</tr>
<tr>
<td>Balata</td>
<td>0.18</td>
<td>Shibli</td>
<td>0.85</td>
</tr>
<tr>
<td>Dafna</td>
<td>0.13</td>
<td>Abu Saleh</td>
<td>0.19</td>
</tr>
<tr>
<td>Al’Auja</td>
<td>9.55</td>
<td>Meskah</td>
<td>1.29</td>
</tr>
<tr>
<td>Al Qilt &amp; Al Fawwar</td>
<td>6.55</td>
<td>Al Far’ah</td>
<td>5.31</td>
</tr>
<tr>
<td>Sub-region</td>
<td>Population</td>
<td>Water resource (MCM/yr)</td>
<td>Water Resources</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
<td>-------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Al Fawwar</td>
<td>4.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fa’ra</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al Ru’yan</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jericho/Al'Auja</td>
<td>35,589</td>
<td>27.14</td>
<td>• Spring Water is abundant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Spring has a seasonal fluctuation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Wells water is brackish.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Precipitation is very low.</td>
</tr>
<tr>
<td>Lower Al Far'a</td>
<td>7,982</td>
<td>5.87</td>
<td>• Wells water is brackish.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• There are wells, which are not operated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Precipitation is very low.</td>
</tr>
<tr>
<td>West Tubas</td>
<td>50,659</td>
<td>11.28</td>
<td>• Spring water is abundant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• There are few wells.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Wells water is brackish.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Precipitation is relatively high.</td>
</tr>
<tr>
<td>North Tubas</td>
<td>3,143</td>
<td>4.48</td>
<td>• Pumping potential from wells is relatively high.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• There are wells which are not operated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Water is supplied from Mekorot.</td>
</tr>
</tbody>
</table>

Source: JICA (2008)
Palestinian water use in the area is presently sourced from spring water and groundwater. Although water is mainly utilised for irrigation and livestock in the Study Area, these water resources are currently being utilised inefficiently.

Most of the localities in the Study Area have *high water insecurity*: they suffer from an extreme shortage of safe and reliable water supply for domestic and agricultural uses during the summer. The present problems that are related to water availability in the study area are varied and are due mainly to:

1. Changes in the total amount of precipitation and in its frequency and intensity directly affecting the magnitude and timing of runoff and the intensity of floods and droughts. In the last three years the Study Area and the whole oPt have experienced poor winter rains, close to an extended drought. The 2008-2009 winter saw a drastic drop in rainfall throughout the oPt. The average rainfall for the West Bank was 22 below the historic average annual of 425mm (see Figure 3.2).

![Figure 3.2: Main canal for Al-Auja Spring at the height of the rainy season (January 2009)](image)

2. As was the case in Massafer Yatta, the root causes of the water insecurity in the Jordan River Valley include natural phenomena as well as the acts and omissions of Israel. A report by the Centre on Housing Rights and Evictions (COHRE 2008b) details alleged violations of human rights law insofar as they relate to water, including: i) Reducing accessibility to water sources through denial of travel to the Jordan River, or to traditional water-collection points like local springs; ii) Reducing the ability to develop water and sanitation services, through the denial of permission to construct water and sanitation infrastructure like deep wells (particularly in Area C, through the previously-mentioned Joint Water Committee); iii) Reducing the quantity of water
for personal and domestic needs, through indiscriminate or deliberate destruction of water infrastructure such as pipes, cisterns and wells. These actions have made communities vulnerable to outbreaks of water-borne disease, reducing overall public health levels. Figure 3.5 describes such ‘vulnerability paths’.

3. Most of the reduction in the springs’ discharge can also be attributed to damage of the conveyance system and inadequate maintenance of the water distribution infrastructure (seepage, leakage in the main conveyance canals or natural conveyance systems and insufficient capacities of those conveyance facilities).

4. Today the discharge of most of the springs – on which communities depend for both domestic and livestock needs – has been dramatically reduced: Israeli deep wells drilled in the area, supplying water to settlements, may be the greatest contributing factor to this decline, although lack of access to local water extraction rates from these wells makes it difficult to determine their precise effects.

5. The lack of development of surface water infrastructure. Since water demand is expected to increase in the future, efficient utilisation of the existing water resources, as well as development of new water resources is essential in the Study Area. Such investment would also facilitate a more predictable water supply: at the moment, the springs are an unstable water supply because of the seasonal fluctuations.

6. Damaged agricultural wells (Figure 3.3). In recent years, the PWA and the Ministry of Agriculture, with the help of international donors, have rehabilitated wells where Israeli restrictions allow this. Figure 3.4 shows a well (100m depth) on the outskirts of Jericho city rehabilitated by FAO in 2008 funded by the European Commission Humanitarian Aid Office (ECHO).

Figure 3.3: abandoned well

Figure 3.4: rehabilitated well
3.4.2 Water and food insecurity in the Jordan River Valley

Agriculture remains an important source of livelihood for the Palestinian people, especially for women. A large share of the agricultural land area is used to produce crops under rainfed conditions. But the characteristics of the land, the variability in annual rainfall, and the limited supply of freshwater results in extreme year-to-year changes in the production of food and agricultural products. The limited supply and high cost of water restrict the expansion of irrigated areas and these water costs can only be covered by relatively high value crops which are able to reach markets. Cereals, legumes and oilseeds are not high value crops. Production of these crops represents a relatively small share of the consumption requirement and so the only short-term solution to instability is to ensure adequate imported stocks to cover shortfalls.

Recent droughts, combined with a diminished area of grazing lands, poor access to water, mobility restrictions to grazing land and lack of diversified livelihoods have collectively put at risk the very sustainability of the herding livelihood in West Bank communities. Moreover, a steep increase of fodder, cereals and water prices in 2007 has pushed herders into a deeper cycle of indebtedness, resulting in a reduction in families’ ability to buy food hence justifying the need to deliver immediate food aid to the affected communities and develop mid-term activities geared at ameliorating the households’ food security and their economic self-sufficiency (Food and Agriculture Organization 2007a, JICA 2008).

The overall climate for progress towards achieving increased access to food for all was abruptly disrupted in September 2000 with the onset of the Second Intifada. The prospect and unpredictability of closures has since created an environment of uncertainty and risk within the Palestinian economy that has seriously reduced investment. This was compounded by the extraordinarily high transaction costs and restrictions on access to alternative markets for import or export as stipulated under the Paris Protocol. Domestic output and exports declined and labour flows to Israel were sharply curtailed, all of which directly contributed to rising unemployment, poverty and increased levels of food insecurity.

3.4.3 Household and community coping mechanisms in the Jordan River Valley

With rising unemployment, falling incomes and an increased number of dependent household members, per capita household incomes in the Study Area have fallen and many households have been forced to find alternative means to provide food for their families. Households in the region have responded to these severe livelihood constraints by adopting a variety of short-term coping mechanisms that have so far helped them get by, though there is a risk is that their ability to recover in the future is being undermined.

Home-gardens are used as a source of food by half of the West Bank respondent households (Food and Agriculture Organization 2007a). However, the cost of inputs and lack of access to water are constraints. Some of the new unemployed are rearing poultry in an effort to earn an income but their
efforts often fail because of the high cost of feed and lack of access to markets due to curfew and movement restrictions.

One of the main crops in the Study Area (especially in the Jordan Valley around Jericho) is the banana, whose crop water requirement is very high. Bananas traditionally occupied 30-50% of the total irrigated area around Jericho. The current water use for bananas in the area is estimated to be around 3000 m$^3$/dunum. In the last years, many farmers have stopped planting bananas and citrus fruits due to the shortage of water for agriculture. In a visit to the Jericho Governorate in January 2009, the Project Team were informed by the Ministry of Agriculture that from 1998 to 2008, the area of citrus production in the governorate had dropped from 5000 dunum to 600 dunum, while the area of banana cultivation had fallen even more dramatically from 7000 dunum to 300 dunum.  

3.4.4 **Al Auja, Jericho District: compounded vulnerability**  
Located north of Jericho, Al Auja spring is one of the most important in the Eastern Aquifer Basin with an average discharge rate of between 8 and 10 MCM of good quality water per year. The water from the spring is primarily used for agriculture, with a small quantity utilised for domestic purposes. However, in recent years, the spring discharge rate has halved (5 MCM), moving from a continuous flow to a seasonal one (November/December – May). According to the Ministry of Agriculture and Friends of the Earth Middle East, the Al Auja spring has been badly affected by the drilling of two Israeli wells upstream which tap the same aquifer (the upper aquifer system in the Eastern Aquifer Basin) resulting in reduced discharge, lower capacity, and reducing the quantity of water available in the spring. The lengthy (more than 35km long) Al Auja distribution canal suffers from serious leakage through cracks. There is a great need to rehabilitate the eye of the spring, and also approximately 9 km of the main distribution canal. However, as Al Auja spring is located in a closed military zone in Area C, requests to the JWC and the Civil Administration to rehabilitate the spring and first section of the canal have repeatedly been denied.

The town of Al Auja (population less than 5,000) is located in Area B, but is dependent on the water from Al Auja spring for domestic and agricultural use. Al Auja is an agricultural community, mainly reliant on water-intensive banana production. There are around 12 agricultural wells in Al-Auja but the water quality in these wells is poor and highly saline. Due to a lack of water in 2008, the banana crop of many farmers was ruined. Attempts by the Ministry of Agriculture and NGOs to convince the farmers of this area to change to less water-intensive crops have been met with resistance. Bananas can only be grown in Al Ajua and Jericho, and are relatively profitable. A kilogram of bananas fetches around NIS 5 whereas the profit from growing tomatoes barely covers the cost of water. Also, bananas are sold on the local market.

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23 Information from interview with Ibrahim Qtishat, Director, Jericho Agriculture Department, Ministry of Agriculture, 22 January 2009.
24 Personal communication from Ministry of Agriculture officials (Jericho District) and Friends of the Earth Middle East Al Auja Project Coordinator (Iyad Aburdeineh), 22 January 2009.
Due to closures and restrictions on the movement of people and goods both within the West Bank and across borders, the export of produce has become increasingly difficult for farmers in the West Bank. The lack of access, both to water and to markets, has rendered this agricultural community destitute.

As the discharge from Al Auja spring is insufficient and unreliable, the residents must resort to the purchase of water from the Israeli water-provider Mekerot. Mekerot cut the water supply to Al Auja in the summer of 2008, highlighting the compounded vulnerability of residents – dependent on an unreliable free and an unreliable expensive source of water. PWA requests for an additional water filling point for the area have been denied at the JWC. The community thus further suffers from an inadequate quantity of clean drinking water, and health problems are common.

The farmers in the Study Area normally use drip irrigation pipes or sprinklers for irrigation. The farmers in each sub-region area have water rights on an hourly basis. According to the traditional schedule, the farmers open and close their own gates at the branch canals by themselves. The farmers have their own ponds to store their water entitlement, which is based on the seasons. This means that the water right is not defined based on volume, but on customary usage. In addition, the water used by each farmer in each irrigated area is unknown due to the absence of any measuring system. This lack of information is a challenge to climate adaptation planning.

3.5 West Bank: vulnerability pathways

The physical scarcity of natural resources in West Bank is compounded by human-induced or conflict-induced scarcity. The diverse effects are felt in compounding ways, all of which lead either to more precarious livelihoods or tensions between communities (or between Palestinian ministries, or at the inter-state level). Figure 3.5 suggests visually a number of these ‘vulnerability paths’ identified following consultations with stakeholders. The figure demonstrates, for instance, that the vulnerability experienced from the Israeli occupation results in tensions between the communities and the water-service provider (PWA or Ministry of Agriculture), or between the communities themselves (in case of unlicensed Palestinian connections or wells drying up – around Wadi Fara’ for example). The restrictions on well-drilling (according to the terms of the 1995 Oslo II Agreement), and the movement restrictions preventing farmers from regular access to their land or to markets, have a direct effect on yields, and thus on livelihoods.

Figure 3.5 also shows that the risk of reduced precipitation is a potential cause of a decrease in the resilience of livelihoods. Anticipated reductions in precipitation lead to reductions in freshwater (springs), in groundwater, and in soil moisture. The result again is reduced yields that either directly affect the livelihood of the farmers in question, or affect it even more substantially through an indirect method: loss of land ownership if it remains fallow for three years (under an old Ottoman land law invoked by the Israeli Government). Thus the political and physical aspects of climate vulnerability are intermixed.
Figure 3.5: Climate Vulnerability Pathways in the West Bank
3.6 Gaza Strip

3.6.1 Climate and wider vulnerabilities in the Gaza Strip

According to the stakeholders consulted, the Israeli siege of the Gaza Strip is the main source of vulnerability of all its communities. The effects of climate change are expected to make the current crisis situation worse through reduction of built-up resilience in a variety of ways.

Communities identified by stakeholders as socially and/or physically vulnerable (though the Gaza Strip as a whole is considered vulnerable):

- people living on banks of Wadi Gaza
- people living beside the growing sewage lakes, e.g. Umm Nasser
- residents of Jabalya and Khan Younis, due to recent stormwater overflows
- residents of the coastal Mawasi area
- residents of inland low lands, including neighbourhoods of Gaza City.

There was consensus that the Gaza Strip as a whole is exposed to many different environmental hazards (high biophysical vulnerability), and that the capacity of people to adapt is low (high social vulnerability). Therefore, it may be considered that the Gaza Strip as a whole has high climate vulnerability. The different exposures lead to different coping mechanisms and adaptive capacity, some of which will now be described.

As shown figuratively in Figure 3.6, the Israeli siege of the Gaza Strip has significantly reduced imports and exports, particularly from 2006 onwards. There is much less passage of people, of crops and building materials. The Gaza Strip’s overall ‘carrying capacity’ – already stretched from the influx of refugees in 1948 and 1967 – is thus only minimally assisted by the development of coping mechanisms and collective adaptive capacity. Food imports reduce reliance on limited freshwater supply to produce food locally. When imports are cut, pressure increases on the already decreasing per capita availability of water. The local market also quickly gets saturated by local produce, thereby limiting the economic benefits of greater self-reliance.

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25 Initial data collection in the Gaza Strip was conducted prior to the Israeli assault that began 28 December 2008. Analysis has been conducted following the assault, including a field visit and meeting with stakeholders on 6-7 May and 19 August 2009.
Figure 3.6: Schematic illustration of the effects on the Gaza Strip of the reduced trade of goods. The tightening closure of the Gaza Strip means less ability for people to cope and adapt. Climate vulnerability increases as per capita freshwater availability drops. [MCM/y = million cubic metres per year]

The real physical scarcity of natural resources in the Gaza Strip is thus compounded by scarcity induced by conflict. The effects are felt, as they are in the West Bank, in terms of collapsed livelihoods and contaminated groundwater, though with perhaps less impact on increasing tensions between different stakeholders, and much worse direct effects on public
health (Figure 3.10). Farmers squeeze a living from their ever-reducing yields, gastro-intestinal disease and malnutrition rates increase, and the community fabric is worn through in ways that are beyond the scope of this study to investigate.

3.6.2 Water and food insecurity
Palestinians living in the Gaza Strip suffer the effects of both water quantity and water quality issues. The Strip sits entirely within the Coastal Aquifer Basin, which runs from the tip of Egypt through Gaza up towards Haifa. Israeli over-pumping of the Coastal Aquifer in the 1960s and 1970s led to greater seawater intrusion. Such contamination of the aquifer was countered by reducing pumping from this aquifer and replacing it through increased pumping from other sources inside Israel (such as from the Lake of Tiberias or from the Western Aquifer Basin). Palestinians living in the Gaza Strip are prevented from accessing alternative water sources, such as the transfer of water from the West Bank or the purchase of significant quantities of water from Israel.

Extensive over-pumping of the Gazan portion of the Coastal Aquifer Basin has been occurring for decades. The ‘sustainable limit’ of the Coastal Aquifer has been estimated at 350 MCM/y, of which the Gazan portion is roughly 55 MCM/y (Yacoubi 2008). Total pumping within the Gaza Strip in 2006 was estimated at roughly 150 MCM/y (distributed roughly 50 – 50 for agricultural and domestic consumption). Not accounting for return flows, this means that the Gazan portion of the aquifer is being over-drawn nearly three times its sustainable limit. With additional water stress predicted from rapid population growth and climate change, the need for a major (150 MCM/year) desalination facility for Gaza Strip is becoming ever more apparent (e.g. Phillips et al. 2009: 182), and this was expressed by Gazan stakeholders in consultations for this report with the Project Team.

The lack of alternative water sources contributes to existing water quality problems. Due primarily to its permeable and sandy cover, the aquifer within the Gaza Strip has a significant ‘intrinsic vulnerability’ to pollution (Almasri 2008). Over-pumping (particularly with the rush of new wells following the withdrawal of Israeli troops and lack of Palestinian regulation in 1995) induces increased seawater intrusion. Reduced recharge means less dilution of agricultural fertilisers and pesticides, although the potential for contamination can be partially offset by longer flow paths to the water table. Untreated or partially treated wastewater (including the ‘sewage lakes’ of the Northern Treatment Plant in Beit Lahiya and the rapidly growing raw sewage outflows around Khan Younis and Rafah) seep into the groundwater, further increasing nitrate and chloride levels (Figure 3.7). These levels are now 2 and 3 times the WHO recommended standard (Centre on Housing Rights and Evictions 2008a). A further source of contamination occurs naturally – the Eocene salts migrating under the border from Israel (Vengosh et al. 2005).
There is a serious deficiency in wastewater treatment for Khan Younis. A temporary wastewater treatment plant has been funded by the ICRC, and the Japanese Government is funding a permanent treatment plant and main pressure line. At present, though, most sewage is dumped untreated into storm water drains and the lagoon.

The water situation in the Gaza Strip was once termed a ‘looming disaster’. The disaster is no longer looming – it is clear and present. The effects of the over-pumping and unregulated water extraction are felt in a variety of ways. In terms of public health, the drinking water quality has led to gastro-intestinal diseases gum disease and anaemia and diarrhoea (Al-Farra 2005, Centre on Housing Rights and Evictions 2008a). The effects on livelihoods – particularly those sustained by agriculture – are no less harsh.

Increased salinity levels in the groundwater directly reduce the yields of crops which can sustain them at all – e.g. onions and pulses. Other crops – such as oranges, strawberries, cherry tomatoes, and cut flowers – have little tolerance to high salinity levels (Centre on Housing Rights and Evictions 2008a). Livelihoods dependent on agricultural production and export have proven vulnerable not only to water quality, however. The siege of the Gaza Strip has meant that the fishermen and farmers who would sell their products to Israel (or to the Gulf or Europe, via Israeli middlemen) have seen the lines they supply dry up. The common local scene of peppers rotting instead of being sold is testament to the vulnerability of such livelihoods to politically-driven barriers and markets. After any such failure, the farmers no longer take the risk (and cost) associated with the inputs required to produce for the market (Figure 3.8).
Following the unilateral Israeli disengagement from the Gaza Strip in 2005, Palestinian investment in the former settlers’ greenhouses produced a successful crop – 8,400 metric tons of cherry tomatoes, peppers, cucumbers and strawberries – in 2006, but less than a fifth was exported because of Israeli restrictions at the Karni border crossing (despite an Israeli-PA 2005 Agreement on Movement and Access). The increased severity of border restrictions under the siege has resulted in a collapse in Gazan agricultural production for export.

The same politically-driven trade barriers and markets are responsible for the overall level of food insecurity in the Gaza Strip. Reliant upon Israel (and to a lesser extent, Egypt) for all goods not produced in the Gaza Strip, the population as a whole is entirely vulnerable to Israeli decisions about the amount of food allowed in. The closure regime also affects the Gaza Strip fishing zone, which has shrunk from 20 nautical miles (negotiated with Israel under the 1994 Gaza-Jericho Agreement) to more restricted limits unilaterally imposed by Israel – 6 nautical miles from October 2006 and 3 nautical miles since December 2008. There is continuing evidence of coercive actions by the Israeli Navy against Palestinian fishing vessels: since the end of Operation Cast Lead OCHA has reported on several instances in which Israeli Navy vessels have fired on and boarded Palestinian fishing boats. The Israeli restriction of the Gazan fishing zone has significantly reduced the local supply of fish.

In response to the extensive and enduring mechanisms of the closure, 75% of the population in the Gaza Strip has become reliant on food handouts from development and humanitarian agencies (WFP/FAO/UNRWA, 2008). The food insecurity of the Strip is thus directly related to the Israeli closure regime.
3.6.3 **Household and community coping mechanisms**

Community coping mechanisms responding to food insecurity are related with ways to bypass the siege. Thus increased ‘smuggling’ through the tunnels dug under the border with Egypt, or – in the case of February 2008 – breaking down the wall separating the people from the markets in Egypt (Figure 3.9).

The adaptive capacity of Palestinians in the Gaza Strip under the Israeli siege is almost entirely defined by such emergency coping mechanisms. In other words, the ability to develop longer-term adaptive mechanisms to cope with climate vulnerability is severely degraded by the siege.

**Figure 3.9**: The iron wall separating the Gaza Strip from Egypt, torn down February 2008.

Coping mechanisms developed to deal with the very poor water quality are diverse. The PWA and the Coastal Municipalities Water Utility (CMWU) face a dilemma about how to confront the untreated wastewater – let it continue to seep into the freshwater aquifer and pose a grave public health risk, or pump it several kilometres into the sea during an interim period in which a treatment
plant would be built. The latter option has been closed down by the siege, and the contamination of the freshwater aquifer continues.

Many of the families that can afford to have installed under-the-sink water treatment units (reverse osmosis) in attempts to ensure clean drinking water for domestic use. However, according to the PWA, much of the water produced by such filters remains biologically contaminated for lack of proper maintenance. Neighbourhood water vendors have developed to sell treated water (again, through small scale reverse osmosis plants) to people at a more affordable cost. The quality of this water is not regulated, and has not been tested. Contamination is very likely either at the source (because of poor maintenance) or during transportation (contaminants entering the jerry-cans and buckets used to transport the water). The PWA, Coastal Management Water Utility and municipalities have adapted their water-supply system. In Khan Younis, for example, the CMWU notifies the residents when it supplies safe water (from a less polluted source) and when it supplies unsafe water – which may still safely be used for washing. The water authorities have also developed the habit of mixing sources of safe and unsafe water – to increase the amount of water available for drinking, at a marginally safer quality level.

Adaptation to the water crisis in the agricultural sector is becoming evident through eventual change of crops to less water intensive and more salt-resistant ones, such as dates. Such agricultural practice is in fact a return to the traditional crops of the Gaza Strip, whereas water-intensive citrus production originated as a policy of the Israeli occupation. The stakeholders consulted also identified the development of solar food-drying techniques, as a result of greater self-reliance and limited availability of cooking gas.

### 3.7 Gaza Strip: vulnerability pathways

Figure 3.10 shows graphically those environmental hazards relating to climate vulnerability identified by the stakeholders. The bulk of the vulnerability paths arise from, or are compounded by, the Israeli siege and closure of Gaza Strip. Also visible from Figure 3.10 are the multiple paths that lead to reductions in the quality of the groundwater, reducing both public health levels and the resilience of livelihoods. The Israeli military offensive of December 2008-January 2009 intensified the humanitarian crisis in the Gaza Strip, with high civilian deaths and injuries, as well as extensive destruction of public infrastructure.

The climate vulnerability of residents of the Gaza Strip is further compounded by the expected environmental impacts of climate change. A higher variability in precipitation translates into reduced yields for rainfed agriculture, and could also mean a greater frequency of flash floods (Figure 4.4). Reduced amounts of precipitation will mean greater strain on groundwater resources. Increased temperatures may also lead to greater groundwater pumping because of increased desertification, particularly in the south. Finally, any sea level rise will contaminate the coastal soil and increase the saline intrusion already experienced throughout the Gaza Strip.
Figure 3.10: Climate Vulnerability Pathways in the Gaza Strip
4. Future Climate-Risks Assessment

4.1 Climate projections for the oPt region

For the eastern Mediterranean, climate predictions have to contend with a lack of scientific observations on regional atmospheric conditions and limited long-term environmental data. There are also unresolved issues regarding the calibration of Atmosphere-Ocean General Circulation Models (GCMs) and Regional Climate Models (RCMs) in order to simulate conditions consistent with environmental processes of particular importance to the Mediterranean region, such as the incorporation of dust into the atmosphere and multiple sources of pollution (Wigley 1992; Mellouki and Ravishankara 2007). However, regional climate change simulations undertaken by different models have delivered a surprisingly consistent account of climate change over the Mediterranean (Giorgio and Lionello 2007; Plan Bleu 2008). These forecasts give general scientific backing to the Intergovernmental Panel on Climate Change (IPCC) projections for the region: in its *Fourth Assessment Report* the IPCC predicts that, for the southern and eastern Mediterranean, warming over the 21st century will be larger than global annual mean warming – between 2.2 and 5.1°C according to an optimistic emissions scenario (A1B),26 in which rapid economic growth and technological change have reduced reliance on fossil-intensive energy sources. Annual precipitation is deemed very likely to fall in the eastern Mediterranean – decreasing 10% by 2020 and 20% by 2050 – with an increased risk of summer drought (Christensen et al. 2007).

However, the climate projections derived from high-resolution climate models applied to the eastern Mediterranean region also differ in some key respects from the lower resolution IPCC forecasts. The reported findings of three such models have been consulted to identify climate projections pertinent to the oPt:

1. The Japanese Meteorological Agency Atmosphere General Circulation Model (JMA-AGCM) with 20km grid squares. This climate model was run for the eastern Mediterranean according to three time-slices – present climate (1982-1993) and then two future runs (2080-2099) with moderate and high climate sensitivity. The future climate change scenarios were based on IPCC emissions scenario A1B (Kitoh et. al 2008).

2. The GLOWA-Jordan River RCM, which uses an American non-hydrostatic meteorological model with nested steps at resolutions of 54km², 18km² and 8km² (MM5). This has downscaled climate data from two global circulation models – ECHAM4 and HadCM3 – running two 30-year time slices (1960-1990 and 2070-2099) for IPCC emissions scenarios A2 and B2. It has also run the A1B scenario for

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26 The various greenhouse gas emissions scenarios developed within the UNFCCC framework are set out in Intergovernmental Panel on Climate Change (2000) *Special Report on Emissions Scenarios*, Geneva: IPCC. It should be noted that recent data reveals the growth rate of global greenhouse emissions to be *above* that predicted across the IPCC emissions scenarios (Anderson and Bows 2008).
1958-1996 (control run) and 2007-2045 (forecasts). The meteorological fields generated have also been coupled with a hydrological model WaSiM to provide the first estimates of hydrological responses of the Upper Jordan River to forecasted climate change (Plan Bleu 2008: 1-41, GLOWA-Jordan River Project 2008; Khatib 2009).

3. The Sea Atmosphere Mediterranean Model (SAMM), which combines the French AGCM ARPEGE-Climate Model of 50 km$^2$ resolution with a regional Ocean General Circulation Model (OGCM) with 10km grid squares. Climate simulations for the Mediterranean were run from 1960-2100 using observed values up to 2000 and, beyond that year, projected values according to IPCC emissions scenario A2 (Somot et al. 2008).

However, caution is needed applying the projections from these models to the oPt because of the use of simplifying parameterisations, the different emission scenario runs and, given the small size of the territory (6020 km$^2$), the generally coarse spatial resolution of the models. Even those with the highest resolution (grid sizes down to 8km for MM5 and 20km for JMA-AGCM) miss local orographic and environmental variations within the West Bank and Gaza. Above all, none of these models takes into account socio-economic impacts particular to the oPt, which suggests the need for a regional downscaling model tailored to address Palestinian adaptation priorities in the face of future climate risks (see Section 4.2). More generally, a multi-model comparative approach is necessary to reduce uncertainty regarding the future impacts of climate change in the eastern Mediterranean.

4.1.1 Temperature
A pronounced warming for the eastern Mediterranean is projected throughout this century by each of the climate models above, which would be highest in the summer season. The GLOWA MM5 model and French SAMM model (Figure 4.1) both predict temperatures rises up to 3.5$^\circ$C by the end of the century with warming stronger in the summer than the winter, while the JMA-AGCM model forecasts annual mean surface temperature rises for the region of between 2.6$^\circ$C (moderate climate sensitivity) and 4.8$^\circ$C (high climate sensitivity) for the region. Recent runs of the ECHAM4 and HadCM3 GCMs under the B2 emissions scenario confirm substantial temperature rises of up to 4$^\circ$C for the eastern Mediterranean region (Hertig and Jacobbeit 2007). Increases in inter-annual variability of temperatures, along, with mean warming, are also forecast to lead to a greater number of high temperature events (Giorgi and Lionello 2007).
4.1.2 Precipitation

There is significant uncertainty regarding forecasted precipitation patterns for the eastern Mediterranean and the Middle East, in part because of insufficient observational data for the oPt. For example, in the mid-1990s Israeli researchers (Ben-Gai et al. 1996) reported increased annual rainfall for southern Israel of up to 30% in the preceding 30 years, with increases also on the western slopes of the West Bank mountains. In contrast, to the north of Tel Aviv, rainfall amounts had decreased (Stienberger and Gazit-Yaari 1996; SUSMAQ 2003: 5-7). Figure 4.2 illustrates this mixed geographical pattern.
Current predictions from the high-resolution climate models are for significant falls in annual rainfall over the eastern Mediterranean region by 2100, including decreasing winter precipitation by 2100 of up to 35% compared to late twentieth century timelines. As shown in Figure 4.3, the GLOWA MM5 run between 1958-1996 and 2007-2045 forecasts a mid-century decrease in precipitation by 100 to 200mm in the northern oPt (above 31ºN), and a shift in the rainfall season into March and April (Khatib 2009). Precipitation falls are attributed to increased anticyclonic circulation and stability. Combined with an increase in temperatures, this drying is forecast to causing higher losses from evaporation. The two climate models incorporating hydrological discharge calculations have divergent results for the Jordan River – the WaSim hydrological model coupled with the GLOWA MM5 forecasts discharge reductions of up to 40% by 2070-2099, while JMA-AGCM projects a dramatic 82-98% collapse in the Jordan River flow (at an unspecified location) by 2100.
Figure 4.3: Forecasted changes in precipitation, under IPCC emissions scenario A1B, for 2007-2045 compared to annual average precipitation during 1958-1996 (Source: GLOWA-Jordan River Project 2008)
Recent data on average annual rainfall for the West Bank and the Gaza Strip does indicate a decline since 2002/3: at 354.1mm the 2007/8 annual rainfall for the West Bank was at 66% of the 25-year historical average; while at 261.9mm the 2007/2008 average rainfall for the Gaza Strip was the lowest since 1999 and 73% of the 25-year historical average (Ministry of Agriculture 2008). The period is too short, of course to confidently attribute this recent fall-off in rainfall as part of longer-term decline induced by climate change as opposed to ‘natural’ climate variability. It is clear that the expected changes in precipitation (and humidity) will affect groundwater sources. No studies have been carried out on this to date, however, and the impacts of changes in climate on groundwater resources are difficult to estimate with any certainty.

4.1.3 Extreme weather events

There is an indication from the regional climate models that a tendency towards more extreme weather events can be expected for the eastern Mediterranean as a result of climate change. This includes a higher number of yearly days of high temperature (daily maximum temperatures above 30ºC), though there is more uncertainty here than with general temperature and precipitation trends. The Applied Research Institute-Jerusalem (2006) has identified nine extreme weather events in the oPt from 1997-2004, including acute heat waves (July-August 1998, July 2000, May 2004), a major sand storm induced by the lowest recorded atmospheric pressure in May 2003, and heavy spring storms in the West Bank (March 1997) and Jerusalem (January 1999). Israeli forecasts of regional climate change also feature a prediction of more extreme and volatile weather conditions throughout this century (Office of the Chief Scientist 2008).

For the oPt, high precipitating events (HPEs) leading to flash floods are of particular significance in contexts in which the regional water management infrastructure lacks resilience. Such was the case in the Gaza Strip at the end of October 2008, where stormwater and wastewater drainage systems were overwhelmed by an unusually intense HPE-induced flash flood (Figure 4.4). Beaulant et al. (2008) have run the SAMM climate model to reproduce precipitation systems typical of Mediterranean regions, including HPEs, but this has not yet been applied to the specific hydrological contexts of the oPt. Ongoing research with the GLOWA MM5 model is focusing on an analysis of extreme events (Khatib 2009).
4.1.4 Evapotranspiration
The combination of temperature increases and reduced precipitation caused by global warming is expected to increase evapotranspiration rates in the eastern Mediterranean, resulting in growing aridity. With limited long-term data sets for the oPt, none of the regional climate models is capable of generating plausible predictions on evapotranspiration for the West Bank and the Gaza Strip. Below (Section 4.4.1) is summarised one of the few scientific efforts to model the agricultural effects of climate-induced evapo-transpiration rates for two governorates in the West Bank. In addition, the Applied Research Institute-Jerusalem (2006) has examined changing evaporation rates in the Gaza Strip by comparing averaged data sets for 1925-1934 and 1997-2005. This analysis recorded reduced average monthly evaporation rates, which is explained in part by a long-term rise in soil salinity as a result of growing groundwater extraction. Such apparent contradictions highlight the continuing uncertainty attached to predicting climate change impacts in local environmental contexts within the oPt, as well as the need to enhance significantly the data collection and climate modelling capacity of the PA.

4.1.5 Sea level rise
Without considering climate change, the Ministry of Environmental Affairs 2000 Plan for Coastal Protection and Environment cites sources predicting annual surges of 64cm, with century surges rising up to 110cm (Ministry of Environmental Affairs 2000). According to the greenhouse gas emissions scenario, sea levels are forecast by the IPCC to rise at least 18 to 38cm (emissions scenario B1) and as much as 26 to 59cm (emissions scenario...
A1F1) by 2100. Recent research on polar ice flow processes has indicated that these estimates in the IPCC Fourth Assessment Report (2007) may be too conservative. Indeed, in its draft Climate Change Adaptation Programme (2008), the Israeli Ministry of Environmental Protection anticipates a 10mm/year rise in sea level in the Mediterranean, though this dramatic forecast is on the basis of expert consultation rather than robust climatological analysis (Office of the Chief Scientist 2008). More accurate predictions for the Mediterranean Sea are possible only through longer time-series data from satellite altimetry and a more comprehensive in-situ tide-gauge network. Improved data collection and analysis would improve scientific understanding on why, since 1993, the sea levels in the Eastern Mediterranean have risen more than the Western Mediterranean (Plan Bleu 2008: 1-22). In any case, the estimates of existing climate models that the mean sea level for the Mediterranean Sea will rise by 35cm by 2100 still pose a serious threat to the Gaza Strip, through the ‘saline intrusion – livelihoods’ vulnerability path identified in Figure 3.10.

4.2 Future climate change risks

The assessment of future climate risks for the oPt is limited by significant uncertainty regarding the nature and scope of regional and local impacts. This is a consequence of incomplete data and limited climate modelling within the PNA. In such a situation, eliciting information from stakeholders on how they perceive climate risks can provide valuable guidance for adaptation planning (Jones and Mearns 2005): that approach has guided this report (e.g. Section 2.2), alongside a review of scientific forecasts of climate change and a climate vulnerability analysis focusing on water and food insecurity. There have also been several academic assessments of future climate risks by Palestinian researchers. In our overview below (Section 4.4) of key climate impacts on priority policy sectors, we highlight a valuable recent study looking at a range of potential climate impacts on demand for irrigation water in the agricultural sector (Section 4.4.1).

Nevertheless, the comprehensive assessment of future climate risks requires in-depth domestic research capabilities. There is an identified need for the PNA to acquire increased capacity for monitoring and modelling rainfall variability and long-term climate change in the oPt. Without such systematic analysis (which relies on expensive access to supercomputer capacity), there will remain significant uncertainties regarding future climate change impacts in the oPt, and the policy prioritisation of adaptation measures will rely more on expert judgement than the systematic quantitative reach of downscaled climate modelling.

27 In consultation with the EQA and the Project Team, the UK Hadley Centre for Climate Research developed a proposal for providing the PNA and Palestinian research community with high resolution climate change information for the purposes of assessing future climate risks and assisting climate adaptation decision-making. This proposal is yet to find donor funding (Hadley Centre for Climate Research 2008).
4.3 Extrapolations of existing socio-economic trends to 2020 and 2050

Uncertainty about the future of course also characterises the general welfare of the Palestinian population. As we have seen (Section 2.2), the current 48% to 68% poverty levels have over-stretched the social service infrastructure. The Palestinian economy is stifled by movement and access restrictions, apparently ensuring that the generally very young and rapidly growing Palestinian population will fare no better than their parents. Arguably, the ‘carrying capacity’ of the Gaza Strip has already been reached (Section 3.1).

At 3.4% per annum growth rate, the 2020 Palestinian population is expected to be 5.7 million (3.5M in West Bank, 2.2M in the Gaza Strip). The 2040 population could grow to over 10 million ((6.8M in West Bank, 4.1M in the Gaza Strip) even without the return of any refugees. In the absence of an economy and territory unable to sustain such numbers, it is certain at least that the coping mechanisms and adaptive capacity of the people as a whole will have reached their limits. Certainly, and at the very least, the MDG targets set for 2015 would not have been met, and poverty rates will rise as public health levels drop. The situation could be expected to be less dramatic were the Palestinian economy to flourish. Doubts remain, however, as to the possibility of this occurring – and whether it is not already too late to pull communities out of the current crisis.

Were the Israeli partial blockade (on the West Bank) and total blockade (on the Gaza Strip) lifted completely, the Palestinian economy could be expected to flourish as it did in the late 1990s (exceeding even World Bank expectations ((World Bank 2003a, World Bank 2003b)). However, the current political situation obliges all analysts to be realistic about the opportunities for significant improvement in the near or even medium-term future. The ‘worst case’ scenario in the oPt is usually also considered the ‘most likely’ scenario. Further, there is the question whether some ‘thresholds’ have already been breached to the point of irreversibility or not (see Section 4.5).

4.4 Impacts on policy sectors

4.4.1 Agriculture
Palestinian farmers both in the West Bank and the Gaza Strip will face challenges to mitigate decreased water availability predicted to be a result of climate change. Agricultural livelihoods, particularly within rural rainfed farming communities, are always directly affected by rainfall and drought incidence. As we have seen, however, their climate vulnerability is also attributable to: Israeli restrictions on movement and access to land, resources, and markets; a weak institutional framework; and an increase in farming production costs (including water supply) along with decreasing profits. The construction of the separation barrier, the expanding presence of settlements and settlers roads, and the imposition of restrictions on movement and access
have jeopardised the watering and seasonal migration of herds, reduced grazing land and in many cases prevented access to closer filling points. This has forced herders to purchase water from more distant (but accessible) filling points, incurring higher transportation costs.

There have been a few attempts to model the effects of climate change on the agricultural sector in the oPt using the CROPWAT model. According to CROPWAT simulations undertaken by CMWU in the Gaza Strip, an annual average increase in temperature of 1°C will increase crop water requirements in the Gaza Strip by 6-11%.\textsuperscript{28} For the West Bank, Abu-Jamous (2009) has undertaken a recent assessment, which employed the CROPWAT model to explore climate change impacts on the demand for irrigation water, focusing on agricultural data from the Jericho and Al-Aghwar Governorates. In view of the uncertainties associated with future projections of climate change, a number of climate scenarios were constructed for testing (Waggoner, 1990; Ben-Gai et al., 1998; Abu-Taleb 2000). As set out in Figure 4.4, these climate change scenarios applied relative precipitation (P) changes of P-20%, P-10%, P, P+10% and P+20%, and temperature (T)+1°C, T+2°C, and T+3°C to the monthly average series temperature and precipitation values respectively. For each climatic scenario, reference evapotranspiration ($\text{ET}_o$), Crop Water Requirement (CWR) and Irrigation Water Requirement (IWR) for Jericho and Al-Aghwar Governorate were calculated.

\begin{table}
\centering
\begin{tabular}{|l|l|l|l|}
\hline
Phenomena & Projection of Probable Global Annual Average Change & Regional Average Distribution of Change & Confidence of Projection for Global (G) and Regional (R) Averages \\
\hline
Temperature & +2 to 5°C & -3 to +10°C & G- High \\
& & & R- Medium \\
Sea Level & +10 to 100 cm & & G- High \\
& & & R- Medium \\
Precipitation & +7 to 15% & -20 to +20% & G-High \\
& & & R- Low \\
Evapotranspiration & +5 to 10% & -10 to +10T & G-High \\
& & & R- Low \\
Runoff & Increase & -50 to +50% & G-Medium \\
& & & R-Low \\
\hline
\end{tabular}
\caption{Climate change predictions (after Waggoner 1990)}
\end{table}

\textbf{Figure 4.4:} Climate change predictions (after Waggoner 1990)

\textbf{Figure 4.5} below presents $\text{ET}_o$, CWR and IWR findings for some of the crops planted in the Jericho and Al-Aghwar Governorates based on figures for monthly average temperature.

\textsuperscript{28} Information given to Project Team by CMWU representatives at the Gaza Strip Climate Change Scoping Meeting, 17 December 2008.
**Figure 4.5**: Evapotranspiration ($ET_o$), Crop Water Requirement (CWR) and Irrigation Water Requirement (IWR) for some of the crops planted at Jericho and Al-Aghwar Governorate crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (1000m²)</th>
<th>$ET_o$ (mm/period)</th>
<th>CWR (mm/period)</th>
<th>IWR (mm/period)</th>
<th>Total irrig. req. X 10^6 (MCM/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruit Trees</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bananas</td>
<td>2100</td>
<td>1376.75</td>
<td>1200.85</td>
<td>1124.98</td>
<td>2.4</td>
</tr>
<tr>
<td>Dates</td>
<td>1882</td>
<td>1727.48</td>
<td>1614.39</td>
<td>1482.51</td>
<td>2.8</td>
</tr>
<tr>
<td>Pomegranates</td>
<td>70</td>
<td>1727.48</td>
<td>1073.35</td>
<td>941.47</td>
<td>0.1</td>
</tr>
<tr>
<td>Grapes</td>
<td>348</td>
<td>1727.48</td>
<td>879.92</td>
<td>751.12</td>
<td>0.3</td>
</tr>
<tr>
<td>Citrus</td>
<td>1132</td>
<td>1727.48</td>
<td>1171.67</td>
<td>1039.79</td>
<td>1.2</td>
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<tr>
<td>Olives</td>
<td>85</td>
<td>1727.48</td>
<td>1149.74</td>
<td>1017.86</td>
<td>0.1</td>
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<td><strong>Vegetables</strong></td>
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<td></td>
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<tr>
<td>Squash</td>
<td>9180</td>
<td>428.62</td>
<td>387.29</td>
<td>335.73</td>
<td>3.1</td>
</tr>
<tr>
<td>Corn</td>
<td>6868</td>
<td>266.37</td>
<td>191.73</td>
<td>135.05</td>
<td>0.9</td>
</tr>
<tr>
<td>Eggplant</td>
<td>4817</td>
<td>460.16</td>
<td>382.77</td>
<td>310.35</td>
<td>1.5</td>
</tr>
<tr>
<td>Tomato</td>
<td>3468</td>
<td>460.16</td>
<td>382.77</td>
<td>310.35</td>
<td>1.1</td>
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<tr>
<td>Green beans</td>
<td>1760</td>
<td>251.46</td>
<td>189.14</td>
<td>142.68</td>
<td>0.3</td>
</tr>
<tr>
<td>Fababean</td>
<td>835</td>
<td>369.76</td>
<td>272.21</td>
<td>163.36</td>
<td>0.1</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>994</td>
<td>266.37</td>
<td>224.24</td>
<td>167.56</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Jew's Mallows</strong></td>
<td>782</td>
<td>1727.48</td>
<td>1437.72</td>
<td>1305.84</td>
<td>1.0</td>
</tr>
<tr>
<td>Cabbage</td>
<td>795</td>
<td>266.37</td>
<td>224.24</td>
<td>167.56</td>
<td>0.1</td>
</tr>
<tr>
<td>Snake Cucumber</td>
<td>586</td>
<td>274.05</td>
<td>244.17</td>
<td>182.31</td>
<td>0.1</td>
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<tr>
<td>Pepper</td>
<td>569</td>
<td>319.3</td>
<td>253.96</td>
<td>165.5</td>
<td>0.1</td>
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<td>chilli pepper</td>
<td>499</td>
<td>319.3</td>
<td>253.96</td>
<td>165.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Okra</td>
<td>570</td>
<td>753.15</td>
<td>733.04</td>
<td>685.09</td>
<td>0.4</td>
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<td>Pumpkin</td>
<td>455</td>
<td>388.6</td>
<td>289.98</td>
<td>263.34</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Field Crops</strong></td>
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<td></td>
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<tr>
<td>Wheat</td>
<td>3980</td>
<td>957.25</td>
<td>804.13</td>
<td>687.23</td>
<td>2.7</td>
</tr>
<tr>
<td>Barley</td>
<td>1180</td>
<td>248.09</td>
<td>177.31</td>
<td>68.47</td>
<td>0.1</td>
</tr>
<tr>
<td>Vetch</td>
<td>89</td>
<td>1727.48</td>
<td>1297.59</td>
<td>1186.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Alfalaf</td>
<td>820</td>
<td>1727.48</td>
<td>1297.59</td>
<td>1186.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Onion (Dry)</td>
<td>256</td>
<td>640.34</td>
<td>586.47</td>
<td>454.58</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>44120</td>
<td></td>
<td></td>
<td></td>
<td>19.95</td>
</tr>
</tbody>
</table>

Source: Abu-Jamous (2009)

Figure 4.6 calculates irrigation water demand figures by applying the relative temperature changes of $T+1^°C$, $T+2^°C$, and $T+3^°C$ to the monthly average series temperature and relative precipitation changes of P-20%, P-10%, P, P+10% and P+20%.
The scenarios show that increasing temperatures accentuate the impacts on IWR of decreasing precipitation; with the T+3, P-20% scenario being the worst in terms of additional water requirements needed – an additional 2.95 MCM are required annually to overcome the water lost in evapotranspiration compared to the ‘best’ scenario (temperature steady, P + 20%). It should be noted that crop yields are shown to be more highly affected by changes in temperature than changes in precipitation. This type of water modelling is essential to determine the risks to the Palestinian agricultural sector caused by current and future climate hazards.

4.4.2 Energy

The Palestinian Energy Authority has not yet engaged in any climate change adaptation planning, so there are no policy statements on the potential energy impacts of climate change impacts (e.g. demands from increased water pumping needs). However, in consultations for this report, PEA staff stated that the energy consequences of climate change impacts are most likely insignificant in relation to bulk power supply priorities in the oPt. There is continuing growth in energy demand across all sectors, but the PA relies heavily on energy imports from Israel and is prevented from securing energy sources from other countries. The modernisation of power transmission and distribution networks is currently underway, facilitated by donor commitments and a 2007 Energy Sector Review conducted by the World Bank (World Bank 2007). In the Gaza Strip this programme of work has been set back by the extensive destruction of electricity infrastructure as a result of the recent Israeli military offensive (Palestinian National Authority 2009: 30-31).

In discussions with the Project Team, the PEA highlighted its strong interest in climate change mitigation and clean energy, notably the anticipated role for increased renewable sources and greater energy efficiency in an independent Palestinian energy system. Projects under consideration include a proposed 100MW Concentrated Solar Power plant for Jericho and a proposed solar-powered desalination plant in the Gaza strip. In addition, the scaling up of production of domestic solar water heaters in the oPt (already used by two-thirds of Palestinian households) would deliver economic and environmental benefits.
There is clearly an untapped potential in the oPt for energy measures that simultaneously deliver climate mitigation and adaptation benefits, particularly in situations of increased water scarcity as a result of climate change. Though the feasibility of solar power for desalination has yet to be established, its utility for household electrification has been demonstrated throughout the Mediterranean. Similarly, small-scale use of wind energy could well be feasible for water pumping from shallow wells in the Gaza Strip and particular hilly areas in the West Bank (Ibrik 2009). Furthermore, the decentralised use of solar PV technology for the pumping of irrigation water has already been successfully demonstrated on a pilot basis in Jordan and has significant potential in remote areas of the West Bank, where citrus farmers typically depend on micro-irrigation methods using spring water. It is important to stress that such developments should be justifiable in relation to climate-related water scarcity but not as adaptations to Israeli restrictions on groundwater extraction and prohibition of access to the Jordan River. These political restrictions on Palestinian water availability fall under the legal scope of the Fourth Geneva Convention (and its Protocol) and are properly the subject of final status negotiations on water.

4.4.3 Public health
Palestinians living in the affected areas are set to face increased public health issues related to the lack of water such as diarrhoea, cholera and dehydration. One main problem is a growing problem of mosquitoes – one of the issues raised by the stakeholder consultation meetings. In its initial appraisal of the domestic consequences of climate change, the Israeli Ministry of Environmental Protection also predicts an increase in mosquito populations and their distribution (Office of the Chief Scientist 2008: 91-93). The treatment of such a problem is expensive as the farmer/shepherd will be required to spray insecticides once every couple of weeks with an average of 1 litre per dunum.

The risk of parasitic disease may increase with climate change because increased annual and seasonal variability, elevated mean temperature, and extreme weather events may allow the spread of existing vectors and establishment of new invasive ones. Cold-sensitive vectors of human diseases, such as Leishmaniasis, tick-borne diseases etc., which proliferate in summer, are expected to increase in oPt with the longer and hotter summers resulting from the projected delay of winter rains. There is a clear need for research to model the potential vectors of diseases that may arise from climate change in the oPt.

4.4.4 Coastal management
In 2000, the Ministry of Environmental Affairs – forerunner of the EQA – made a persuasive case for the immediate implementation of a Coastal Area Protection and Management Plan (Ministry of Environmental Affairs 2000). Their report describes damages expected and observed to off-shore currents, sea bed fluctuations, seawater quality (from solid waste dumping and wastewater runoff) as a result of human activities: it also considers the impacts of sea level rise attributed to climate change. The combined impacts of human activities are forecast to be felt first and foremost by the fishing
industry, which is already witnessing shifts from rocky to muddy or sandy habitats. Coastal erosion is also expected to increase as the sand in coastal areas is mined in quarries for use in construction. The UNDP Disaster Risk Reduction report further emphasises the importance of the coast for the livelihoods and quality of life of residents in the Gaza Strip (Al-Dabbeek 2008).

The Ministry of Environmental Affairs Coastal Protection Plan makes specific recommendations that will help conserve the coastal areas – such as ‘set back lines’ (beyond which no construction is allowed), improvements in fisheries legislation and techniques and habitat conservation efforts. The very poor regulatory and legal context in the Gaza Strip, however, ensures that even the most basic of such recommendations will likely not be implemented. Expected changes in currents that will follow climate change-induced sea-level rises will impact the coastal area in ways that are difficult to predict, but may safely be expected to exacerbate the situation.

4.4.5 **Biodiversity conservation**

The variety of physical environments within the oPt gives rise to rich land and marine biodiversity. While there is no systematic database of biodiversity in the Gaza Strip and the West Bank, the oPt shares threats to biodiversity with other territories in the Mediterranean biome – these include rising human population density, urbanisation, agricultural land use and invasive species (Underwood et al. 2009). However, the unique structures and practices of the occupation have negatively affected biodiversity through extensive settlement building, the construction of the Wall and the growth of a parallel road infrastructure for the use of settlers and the military. The effects of climate change on natural ecosystems in the oPt are difficult to predict, being highly dependent on the nature of local ecological habitats, as well as the rate and scope of climate-induced environmental changes. For example, there are indications that regional warming may stimulate growth of some fisheries of economic value to the Palestinians (*Sardinella aurita*), while at the same time causing local population extinctions and the proliferation of harmful species (UNEP-MAP-RAC/SPA 2008: 38-40). The spread of warm-water species in the eastern Mediterranean will likely have multiple direct and indirect effects, including new introduction of exotic species through the Suez Canal (Bianchi 2007).

Consideration of the impacts of potential climate change on biodiversity is outside the remit of this report, which is focused on human well-being in the face of existing and future threats to food and water security. In the realm of human development, it is nevertheless important for further development of this Strategy to focus on the linkages between *livelihoods* and biodiversity conservation. This is particularly relevant for the Palestinian agricultural sector; for example, the impacts of temperature changes on flowering and fruiting of olive trees, and the role of indigenous species and genetic diversity in the selection of crops and ruminants tolerant to high temperatures and drought (one of the low-regrets adaptation options presented below: see Section 5.3). Increasing afforestation with native species can improve water retention and quality, while also providing protected natural and semi-natural areas of value for recreation and (eco)tourism. Beyond the realm of
livelihoods, protected natural areas have a high cultural value for Palestinian self-identity.

4.5 Thresholds of harm for vulnerable groups

As demonstrated in Figure 3.6, the ‘carrying capacity’ of the Gaza Strip is reduced as the mitigating effects of food and goods trade is hampered by the Israeli siege. The concept of a territory’s ‘carrying capacity’ is thus linked with the previously discussed coping mechanisms and adaptive capacity. Food imports, for example, may be viewed as a mechanism by which the residents of the Gaza strip cope with the lack of good quality water to grow their own food. A build-up of reliance on food imports from Egypt or Israel may eventually develop into a certain capacity of the Strip to adapt in the long-term to its over-population (or lack of natural resources).

Quantification of that ‘capacity’ is beyond the scope of this study, but interesting nonetheless to consider. Jones and Mearns (2004) offer useful guidance on assessing future risks, based on thresholds beyond which coping mechanisms and adaptive capacity can no longer deal with. The concept was dealt with in Figure 2.1, which shows how during extended drought periods, the amount of water availability may fall first beyond the coping range and then outside of the adaptive capacity of the community in question.

It is of critical importance that the relevance of such ‘thresholds’ of harm are considered for vulnerable groups. Reliant on rainfed farming in a land dominated by the Israeli military and settlers, the residents of Massafer Yatta are coping only in the sense that they are surviving. In terms of water availability, their coping mechanisms were exceeded during the 2005 drought, which necessitated the food distribution as a response from the international donor community. With repeated dry spells possibly brought on through climate change, the communities’ longer-term adaptive capacity may routinely be exceeded – and the people would have endured a threshold that would have seen their lifestyles unsustainable. The environmental harm threshold exceeded, most or all of the residents may move to the urban areas and find menial work.

Many of the residents of the Gaza Strip cope with the poor quality water through household or neighbourhood-level desalination units. Farmers there cope with the poor quality water through switching of crops. If, in a worst-case scenario, an increase in crop water requirements combines with a further decrease in water quality, such coping mechanisms may prove insufficient to sustain the farmers’ livelihoods. At some point that is difficult to determine without further analysis, the vulnerability paths (Section 3.10) that erode the resilience of livelihoods may push the people into different livelihoods altogether. With that threshold breached, a new set of vulnerabilities may now have to be faced. Once more, it should be noted that the social dimensions of this climate vulnerability are much more determining than are the biophysical dimensions.
Further study into the relations between climate vulnerability and livelihoods is required, and would necessarily be supplemented by higher-resolution climate analysis oriented to priority policy sectors and protecting the most vulnerable communities. In any event, the thresholds that are breached, and/or are likely to be breached, necessitate climate adaptation policy at the national level.
5. Proposed Adaptation Options

5.1 National proactive adaptation

National adaptation to climate change encompasses a range of responses to the impacts of this change, focusing on climate events that pose a significant risk to a country. In the case of the oPt, the Future Climate Risks Assessment above (Section 4) suggested that, over the next 40-50 years, regional climate change trends are likely to include a fall in annual average precipitation, an increased incidence of drought, and an increase in the frequency of extreme events. The assessment of future climate risks for the oPt is of course limited by various uncertainties regarding the nature and scope of regional and local impacts, but adaptation is justified because the costs of inaction may well be substantial. Climate change impacts are likely negatively to affect human and economic development in the oPt in a number of key areas – agriculture and food security, water resources, coastal zones, public health, and disaster risk reduction. Above all, these impacts will fall on a population already with high social vulnerability and dependent to a large degree on external humanitarian and development assistance.

Adaptation to climate change can involve governmental, civil society and private sector actors. The focus of this national Climate Change Adaptation Strategy is on state institutions and actors, such as those responsible for setting the general plans and policies by which significant climate change impacts can be addressed by all societal actors. Of course, due to the occupation by Israel of the West Bank and the Gaza Strip, the PA is currently denied sovereign jurisdiction to exercise exclusive political authority regarding the management of climate risk. This situation, which obliges Israel and other external actors to assist the Palestinians in reducing their climate vulnerability (see Section 2.5), has been taken into consideration in the prioritisation of adaptation policies and measures below. All recommended adaptation options are compatible with the minimal legal obligations of international humanitarian law regarding the protection of the Palestinian population from harm.

The focus of the following proposed adaptation measures is also on proactive (planned) as opposed to reactive actions. Proactive responses involve anticipation and planning in climate change risk management, while reactive responses are taken after climate change impacts have been realised (Adger et al. 2005: 7-8). Examples of the former at the governmental level include national polices for strengthening food and water security, while reactive state responses include post-event infrastructure reconstruction and water rationing. It is important to note that, while any national strategy for climate adaptation should stress proactive actions (as set out in Section 5.2 below) to reduce the severity of climate change impacts, the uncertainties in forecasting climate hazards mean that reactive responses will always also be necessary. These can usually only be considered in the context of particular events. However, the areas of highest risk can be anticipated and responsible national bodies (e.g. the Higher Council of Civil Defence and the National
Committee to Combat Desertification: see Section 5.3 below) can consider and prepare guidance on reactive response options.

5.2 Identification of adaptation measures

Informed by the Vulnerability Analysis (Sections 2 and 3) and Climate Risks Assessment (Section 4) above, a number of options are now presented for adaptation measures in the oPt. To recall, the overriding goal of the Climate Change Adaptation Strategy for the oPt is to identify and implement the most effective means by which the PA can build the capacity of the Palestinians to cope with current and future climate hazards. The water and agriculture sectors are argued to justify initial identification of adaptation options on account of their high sensitivity to climate change and their critical importance to public health and livelihoods in the oPt. The participatory process by which this strategy has been developed (stakeholder consultations and feedback) is compatible with the National Adaptation Programmes of Action (NAPAs) developed by several Least Developed Countries under the UNFCCC. Indeed, a Palestinian Adaptation Programme of Action is released alongside this report, setting out in more detail the stakeholder participation that shaped the Climate Change Adaptation Strategy for the oPt.

Table 5.1 below presents a set of adaptation measures for the oPt in relation to key climate-induced risks to food and water security. Six major risks are identified, which are linked to the vulnerability pathways mapped out in Section 3 of this report for the West Bank (Figure 3.5) and Gaza (Figure 3.10):

1. Crop area changes due to decreases in optimal farming conditions;
2. Decreased crop and livestock productivity;
3. Increased risk of floods;
4. Increased risk of drought and water scarcity;
5. Saline intrusion in Gaza from forecasted sea level rise;
6. Increased risks to public health from reduced drinking water quality.

The measures represent integrated adaptation options for the agriculture and water sectors in the oPt. They are consistent with the emphasis in the Palestinian Reform Development Plan on the strategic importance attached by the PA to the Palestinian agricultural sector (for economic development, food security and poverty reduction). This means that structural economic change away from agriculture is not a politically feasible climate adaptation strategy in the short-term. Each proposed adaptation measure is classified by:

- Category – whether the adaptation measure is technical (T), managerial (M), or infrastructural (I);
- Scale – whether the measure would be implemented at a regional/local rural level (R), national sector level (N) or in urban areas (U);
- Adaptive capacity – the relative value of the measure in enhancing coping capacity to climate hazards: low (L), moderate (M) or high (H);
- Technical feasibility – on the basis of national technological knowledge and expertise, this is scored low (L), moderate (M) or high (H);
- Potential economic cost – prior to any precise costing, an indicative value of low (L), moderate (M) or high (H) is given for each measure.
Table 5.1: Consequences for food and water security of the identified climate risks, adaptation options, option category, scale of implementation, adaptive capacity, technical feasibility and potential cost

<table>
<thead>
<tr>
<th>Consequences for food and water and security</th>
<th>Agricultural and water-sector adaptation</th>
<th>Category</th>
<th>Scale</th>
<th>Adaptive capacity</th>
<th>Technical feasibility</th>
<th>Potential cost</th>
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<td>1. Crop area changes due to decreases in optimal farming conditions</td>
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<tr>
<td>Changes in monthly precipitation distribution</td>
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<td>N</td>
<td>H</td>
<td>M</td>
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<td>R</td>
<td>M</td>
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<td>H</td>
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<td>R</td>
<td>H</td>
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<td>M</td>
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<td>Switching to drought-resistant</td>
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<td>R</td>
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<td>R</td>
<td>H</td>
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<td>2. Decreased crop and livestock productivity</td>
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<tr>
<td>Increase of extreme events frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased magnitude of extreme events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased expenditure in emergency</td>
<td>Contingency plan development</td>
<td>M</td>
<td>N</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>and remediation actions</td>
<td>Enhanced flood plain management</td>
<td>M</td>
<td>N</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Flash flood frequency and intensity increase</td>
<td>Increased local-level rainfall</td>
<td>M</td>
<td>R/U</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>interception (e.g. green lands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction of grazing pressures</td>
<td>M</td>
<td>R</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>to protect against soil erosion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooding</td>
<td>Increased drainage &amp; storm runoff capacity</td>
<td>I</td>
<td>R/U</td>
<td>H</td>
<td>H</td>
<td>L/M</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------------------------</td>
<td>---</td>
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<td>---</td>
<td>---</td>
<td>-----</td>
</tr>
</tbody>
</table>

### 4. Increased risk of drought and water scarcity

**Main climatic causes of risk:**
- Decreased annual and/or seasonal precipitation
- Decreased groundwater recharge rates
- Increase in the frequency of extreme conditions (droughts and heat waves)

**Conflicts among water users due to drought and water scarcity**
- Set clear water use priorities
- Increased regional-level rainfall interception (e.g., afforestation)
- Increased freshwater production
- Awareness-raising on water conservation techniques
- Improved field drainage and soil absorption capacity
- Use of drought tolerant crops and ruminants
- Local use of treated wastewater for agriculture
- Development of new water sources including desalination

<table>
<thead>
<tr>
<th>Water supply reduced</th>
<th>Increased regional-level rainfall interception (e.g., afforestation)</th>
<th>M</th>
<th>N</th>
<th>H</th>
<th>H</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased freshwater production</td>
<td>N</td>
<td>R/U</td>
<td>H</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Awareness-raising on water conservation techniques</td>
<td>I</td>
<td>R/U</td>
<td>M</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Improved field drainage and soil absorption capacity</td>
<td>T</td>
<td>R/U</td>
<td>L</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Use of drought tolerant crops and ruminants</td>
<td>M</td>
<td>R</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Local use of treated wastewater for agriculture</td>
<td>T</td>
<td>R</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Development of new water sources including desalination</td>
<td>I</td>
<td>N</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

### 5. Increased irrigation requirements

**Main climatic causes of risk:**
- Decreased and more variable precipitation
- Decreased groundwater recharge rates
- Increase of drought and heat stress conditions frequency

**Water availability decrease**
- Investment in efficient irrigation equipment (e.g., trickle irrigation)
- Use of treated wastewater
- Increased water harvesting (e.g., Critchley et al. 1991)
- Desalination of brackish water
- Development of new wells

<table>
<thead>
<tr>
<th>Investment in efficient irrigation equipment (e.g., trickle irrigation)</th>
<th>T</th>
<th>R</th>
<th>H</th>
<th>H</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of treated wastewater</td>
<td>T</td>
<td>R</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Increased water harvesting (e.g., Critchley et al. 1991)</td>
<td>T</td>
<td>R</td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Desalination of brackish water</td>
<td>M</td>
<td>R</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Development of new wells</td>
<td>I</td>
<td>N</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

### 6. Increased risks to public health from reduced drinking water quality (DWQ)

**Main climatic causes of risk:**
- Decreased and more variable precipitation
- Decreased groundwater recharge rates
- Saline intrusion from sea-level rise (Gaza Strip)

**Drinking water quality decrease**
- Incorporation of climate risks in national DWQ management
- Increased water quality monitoring
- Identification of minimum household water requirements
- Equitable groundwater utilisation
- Prohibit use of untreated wastewater in agriculture

<table>
<thead>
<tr>
<th>Incorporation of climate risks in national DWQ management</th>
<th>M</th>
<th>N</th>
<th>H</th>
<th>H</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased water quality monitoring</td>
<td>T</td>
<td>N</td>
<td>H</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Identification of minimum household water requirements</td>
<td>T</td>
<td>N</td>
<td>H</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Equitable groundwater utilisation</td>
<td>M</td>
<td>R/U</td>
<td>H</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Prohibit use of untreated wastewater in agriculture</td>
<td>I</td>
<td>R</td>
<td>M</td>
<td>H</td>
<td>M</td>
</tr>
</tbody>
</table>

**Groundwater contamination**
- Increased wastewater treatment
- Protection of coastal sand dunes
- Coastal protection structures

| Increased wastewater treatment                               | I | R | M | H | H |
| Protection of coastal sand dunes                            | M | R | H | H | M |
| Coastal protection structures                                | I | R | H | H | H |

---

2. Scale of implementation = R: Regional/local rural level, N: National policy sector, U: Urban areas
3. Adaptive capacity level, technical feasibility and potential cost = M: Moderate, H: High, L: Low

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68
5.3 Prioritisation of adaptation measures

Due to the uncertainties concerning the potentially high costs of adapting to climate change impacts, developing countries building an Adaptation Policy Framework are usually encouraged to prioritise adaptation options according to so-called ‘no-regrets’ and ‘low-regrets’ activities (Niang-Diop and Bosch 2005: 196), where:

- **No-regrets options** are those that are justified under current climate conditions and are further justified when probable climate change is considered. An example is the reduction of water pollution for health-related reasons.

- **Low-regrets options** are those that require small additional outlays to address the effects of climate change. An example is the improvement of drainage and storm runoff capacity in urban areas.

In the context of the oPt, where recent climate trends are already resembling the drought-prone conditions forecast by climate change, more adaptation options are covered by these two categories than would otherwise have been the case. In other words, the burden of proof for justifying climate adaptation measures has been reduced. This is reinforced by the fact that those most vulnerable to climate change are also typically those groups already targeted for poverty reduction, food security measures and other MDG activities by the PNA and external donors. Protection of the most vulnerable is an overlapping strategic objective between this Climate Change Adaptation Strategy and the UN human development agenda for the oPt.

The adaptation options identified above are now categorised in terms of no-regrets (Table 5.2) and low-regrets (Table 5.3) measures, with prioritisation of the measures according to levels of adaptive capacity and technical feasibility. It is logical to give preference to measures with higher adaptive capacity and technical feasibility: again, the crucial distinction between the two sets of measures is that no-regrets make sense even if no climate change occurs, while the low-regrets measures are directed more at the negative effects of climate change. The prioritised climate adaptation measures listed – those with high adaptive capacity – may be considered as practically feasible for implementation within the next 3 years under the PRDP process.

These are indicative rankings, informed by stakeholder consultations and evidence-based judgements. Current data limitations on climate impacts in the oPt (Sections 4.2 and 6.1) mean that a systematic quantitative valuation and ranking of priority adaptation options is not possible. Should the PA choose to adopt this Climate Change Adaptation Strategy, they would be the starting-point, after open and inclusive policy-making, for precise budgetary calculations and technical assessments. It should be noted that this type of matrix could also be used to identify potential adaptation measures for other policy sectors, as determined by national planning bodies, ministries and other specialised agencies (Section 6.2). This would be expected as the climate change adaptation strategy extends out from water and agriculture to other policy sectors.
### Table 5.2: No-regrets adaptation options (in no order of priority)

<table>
<thead>
<tr>
<th>Adaptation measure</th>
<th>Adaptive Capacity</th>
<th>Technical Feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Development of flood contingency plans</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>2. Local increases in rainfall interception</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>3. Establishment of clear water use priorities</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>4. Introduction of more efficient irrigation</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>5. Review of drinking water quality management system to incorporate climate risks</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>6. Increased (sustainable) use of freshwater</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>7. Increased use of brackish water and treated wastewater</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>8. Equitable and reasonable utilisation of transboundary water sources between Israel and the Palestinians</td>
<td>High</td>
<td>High (but politically challenging)</td>
</tr>
<tr>
<td>9. Awareness-raising on water conservation</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>10. Change in cropping and livestock patterns for productivity gains</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

### Table 5.3: Low-regrets adaptation options (in no order of priority)

<table>
<thead>
<tr>
<th>Adaptation measure</th>
<th>Adaptive Capacity</th>
<th>Technical Feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prioritised use of irrigation for highest value crops</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>2. Increased scale of water harvesting</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>3. Protection of coastal sand dunes</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>4. Rural livelihood diversification</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>5. Adaptive land use planning</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>6. Precision agriculture: improved soil and crop management</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>7. Alteration of crop and ruminant selections for more tolerance to heat and drought</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>8. Prohibition of use of untreated wastewater in agriculture</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>9. Strengthened capacity of agricultural extension services</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>11. Enhanced flood plain management</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>12. Reduced grazing pressures on rangelands</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Consideration of no-regrets and low-regrets options does not mean that high cost adaptation measures should be ignored. Those also judged to have both high adaptive capacity and technical feasibility include:

- Increased water use efficiency from infrastructure investment;
- Development of ‘new water’ sources, including substantial desalination capacity for the Gaza Strip;
• New coastal protection measures for the Gaza Strip (e.g. wave breaks and offshore structures).

These are the types of sector-wide options that may still be considered by the PA donors, especially for donor-funded investment programmes in water infrastructure that are needed anyway for human and economic development reasons. For example, as recently recognised by the World Bank, irrigated agriculture – which currently employs 117,000 people and contributes 12% to the GDP of the oPt – could be a key sector for the revival of the Palestinian economy (World Bank 2009: xii). Moreover, major investment in seawater and brackish water desalination for domestic use and industrial use could release pressure on renewable water sources for agriculture.29

5.4 Climate change adaptation in strategic national planning

The involvement of stakeholders in all stages of the UNDP/PAPP adaptation planning for the oPt is designed to nurture an effective and legitimate adaptation planning policy. Climate change risks are most likely to impinge on PRDP goals to increase agricultural output and provide more efficient and equitable water delivery to households. As representative of, and responsible to, the Palestinian people, PA mainstreaming of climate change adaptation will strengthen the climate change resilience of vulnerable communities.

Disaster risk reduction (DRR) – the development and implementation of policies and practices that minimise risks from disasters – is the first line of institutional defence against serious climate change impacts (Mitchell and van Aalst 2008). Therefore, the DRR capacity within the PA is critical to effective climate change adaptation within the oPt. Under the Palestinian Civil Defence Law (1998), the Minister of Internal Affairs chairs a disaster response committee – the Higher Council of Civil Defence (HCCD) – which formally involves 13 different institutions from across the PA, but this is not currently functioning. A recent UNDP/PAPP-funded review of the DRR infrastructure on the oPt (Al-Dabbeek 2008) revealed a number of weaknesses, including:

• Limited legal frameworks for disaster risk reduction, which are response-led rather than preventative
• Underdevelopment of policies for disaster preparedness, mitigation, and emergency response.
• Weak institutional capacity in disaster management and rescue operations.
• Lack of capacity and training in disaster risk management and policy implementation at government level (national and local).
• Lack of coordination between central and the local level authorities in disaster management activities

29 The use of solar thermal power for seawater desalination is under consideration by the Palestinian Energy Authority; this would have combined climate change mitigation and adaptation benefits (see Section 4.4.2).
It should be noted that these considerable capacity gaps in DRR will remain insofar as there remains no effective Palestinian control of what remains territory under occupation. The absence of functioning sovereignty – evident in the lack of control of borders, the absence of a monopoly of control of military force, and the inability to exercise exclusive judicial authority (even in Area A) – undermines the ability of governmental institutions to meet civil defence and disaster risk reduction responsibilities. This institutional gap has created a substantial role for non-governmental organisations (NGOs) in providing disaster assistance and relief (e.g. Palestinian Medical Relief Committee, Palestinian Red Crescent). A National Agency for Disaster Risk Reduction was established in 2004 to coordinate NGO efforts, but this has not removed the need for building DRR capacity within the PA.

In the consultations on climate change adaptation conducted by the Project Team, governmental stakeholders agreed that the Civil Defence Law should be strengthened, that HCCD should be reinvigorated, and that climate change risks need to be integrated into an effective institutional structure for DDR in the oPt. This will require more systematic information on environment-related risks in order to provide an integrated understanding of the role of climate hazards. However, there exists Palestinian expertise on water vulnerability mapping for the Gaza Strip (e.g. Almasri 2008) and the West Bank (e.g. Mimi and Assi 2009) that can be utilised and extended to incorporate climate information in systematic hazard and risk assessment.

**Table 5.4: Main types of hazards in the oPt (adapted from Al-Dabbeek 2008: 22)**

<table>
<thead>
<tr>
<th>Hazard Type</th>
<th>Probability of Occurrence</th>
<th>Probability of Damage</th>
<th>Priority(^{30})</th>
<th>Total damage in last 10 years</th>
<th>Last severe events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquakes</td>
<td>High</td>
<td>High</td>
<td>first</td>
<td>Limited</td>
<td>1927</td>
</tr>
<tr>
<td>Droughts</td>
<td>Medium</td>
<td>High in the long run</td>
<td>second</td>
<td>Tens of millions</td>
<td></td>
</tr>
<tr>
<td>Epidemic outbreaks of disease</td>
<td>Low</td>
<td>Low</td>
<td>third</td>
<td>Millions</td>
<td>1981</td>
</tr>
</tbody>
</table>

\(^{30}\)The priority ordering, where ‘first’ indicates greatest policy priority and ‘third’ lowest policy priority, relates to an appraisal of the probability of occurrence, probability of damage, the number of expected human losses and injuries, and the value of expected damages to national resources (al-Dabbeek 2008: 22).
Table 5.4 (above) sets out the results of a preliminary hazard assessment for oPt conducted by Al-Dabbeek (2008: 22). It can be seen that disaster risks directly related to climate change are significant: the probability of damage from **droughts and desertification** is estimated to be high in the long run, though still deemed to be less of a policy priority than the Israeli occupation, population displacement, and earthquake preparedness. According to Al-Dabbeek (2008: 20), the recent experience with drought has renewed concerns about the inadequacy of contingency planning efforts and the lack of proper risk assessment, response plans and coordination between the different governmental levels. These concerns were also relayed to the Climate Change Adaptation Project Team in consultations with the Ministry of Agriculture. A drought early warning system is now under development: this will improve data collection on rainfall and soil moisture, providing a more scientific basis for minimising the risk of drought.

Indeed, there is already enough agricultural information and meteorological evidence to justify priority risk management by the Prime Minister’s Office and the PA to address the impacts of drought and desertification in the oPt. The **National Committee to Combat Desertification** is the appropriate Palestinian strategic body to take lead responsibility for developing policies and measures relating to drought minimisation and management.\(^{31}\) This could include the authority to impose emergency measures during hydrological and/or agricultural droughts. While similar national committees have not always been effective at the inter-ministerial level (e.g. the National Water Council), they tend to have efficient technical committees comprising relevant experts. Such a technical committee would comprise relevant PA ministries (especially the Palestinian Water Authority, the Ministry of Agriculture, and the Environmental Quality Authority). In addressing drought management it could draw on similar practice in other countries with proven experience in minimising drought risks (e.g. Tunisia, Morocco). Informed by stakeholder engagement, this expert group could identify planning and management options for the National Committee.

\(^{31}\) The proposed National Committee to Combat Desertification is awaiting approval by presidential decree, though the suggestion here is that, due to its relevant expertise, it is also charged to look at drought.
Lastly, it is recommended that climate change adaptation planning be formally embedded within the PA, with the Environmental Quality Authority confirmed as the line agency, (in consultation with other ministries according to sectoral impacts forecasted as a result of climate change). At the moment climate change risks are not integrated into national development planning. Integrating climate change adaptation (and logically also climate change mitigation) responsibility into the current PRDP and its successor will necessitate capacity-building for the main ministries involved: suggested key areas for institutional strengthening are set out in Section 6.2 below.

5.5 Inclusion in development assistance frameworks

Several international donors have started to express an interest in financing climate change activities in the oPt. Indeed, under a Small Grants Programme managed since 1999 by UNDP/PAPP under the Global Environmental Facility (GEF), there have been approximately 30 demonstration projects addressing climate change mitigation and adaptation: these include the use of solar power for pumping irrigation water, domestic water heating and the drying of agricultural crops. However, few of these GEF pilot projects have led to a wider uptake of adaptive technologies or practices.

More widely, the need to address climate risks hardly features in the substantial commitments to the oPt made at international donors’ conferences in December 2007 Paris (US $7.7 billion) and March 2009 in Sharm el-Sheikh (US $.4.48 billion). This is unsurprising given the current focus of major donors’ support (e.g. European Union, USAID) on maintaining the institutional viability of the PA and dispensing humanitarian assistance to vulnerable sections of the Palestinian population. Arguably, donors remain preoccupied with emergency interventions rather than longer-term development programmes, as recognised in recent reports by the Food and Agriculture Organization (2009) and World Bank (2009).

Integrating climate vulnerability concerns into the existing aid development assistance frameworks for the oPt will not be easy, especially given recurrent concerns about the lack of aid effectiveness (e.g. Le More 2008). It is recommended that the central coordinative body for donor support to the Palestinians, the Ad Hoc Liaison Committee (AHLC), include climate adaptation financing in its remit. Where possible, such financing should reinforce existing human development goals and PNA priorities. To help realise this goal, the AHLC could assist the PNA in its efforts to seek direct access to the various funds for climate adaptation activities available under the UNFCCC (Haites 2008) and other sources, notably the World Bank Climate Investment Funds (see also Section 6.2.4). Moves in this direction have already been undertaken with the recent revival of the Environmental Sector Working Group, co-chaired by the Swedish Government and EQA.

32 It is notable that climate change adaptation barely registered in these reports, which addressed other fundamental issues concerning water and food security in the oPt.
6. Adaptive Capacity-building

The Vulnerability Assessment in this report (Sections 2 and 3) reviewed the extent of climate vulnerability throughout the oPt, focusing geographically on regions of high vulnerability to present and future climate hazards. The complexity of the challenge in addressing major climate stresses is evident from the ‘vulnerability pathways’ illustrated in Figures 3.5 and 3.10. Also revealed by the Vulnerability Assessment was the relatively low adaptive capacity of Palestinian governmental institutions in the face of climate risks. Adaptive capacity, to recall, is the long-term ability of a system to cope with existing and future climate hazards (see Section 2.3.1). In this section, the focus is on some of the means by which the most relevant PA institutions – EQA, Ministry of Agriculture and the PWA – could improve their capacity to reduce climate vulnerability in the West Bank and the Gaza Strip. These institutions should have lead political responsibility for adaptation, helping to create the conditions to build the adaptive capacity of communities and individuals.

There are major structural challenges facing the PA agencies relating to effective climate adaptation policy-making, which have been traced by observers to political differences, resource deficiencies and managerial weaknesses. In terms of PA capacity-building, coordinated environmental information collection and use is an immediate priority (Section 6.1). Again, though, such constraints are accentuated by the external challenges posed by the Israeli occupation. Adaptive capacity at the national level in the oPt is directly compromised by movement restrictions as well as insecure, insufficient water and land resources. Some of the best agricultural land is taken by Israeli settlements in the Jordan River Valley, while 20% of arable land in the Gaza Strip is off-limits to farmers because it falls within the Israeli security zone adjoining the border. Similarly, Israeli restrictions prevent both bulk imports of clean water in the Gaza Strip and the full development of irrigation in the West bank. Plans to develop capacity to reduce climate vulnerability must be grounded in the current political reality of PA institutions with limited jurisdiction and weak authority over the oPt.

6.1 Information needs for climate risk management

Effective climate risk management in the oPt requires the coordinated collection, analysis and dissemination of relevant information. There are many potential sources of information (both environmental and non-environmental), but data can be structured according to the three key risk management challenges:

1. Identifying climate impacts in the oPt by means of environmental monitoring networks and the development of forecasting capacity;
2. Monitoring the climate vulnerability of sectors and communities at risk;
3. Collating and disseminating relevant information on successful (and unsuccessful) climate adaptive practices.
Creating this information requires a focused approach where data is collected, stored, processed and analysed and then disseminated according to priority issues and needs, as determined by dialogue among stakeholders. This is challenging as multiple actors and policy sectors are likely to be relevant. It is thus advisable that one agency should be responsible for conducting or supervising the production of climate risk information, focussing on what data is needed, and how it can be produced, collated and disseminated. It is important that the adequacy of existing data sources is assessed (e.g. the coverage and data scope of meteorological stations in the West Bank and the Gaza Strip), and the continuity of climate data gathering is maintained. The challenge is to manage climate data in the oPt in such a way that it can be reliably generated and then readily converted for a variety of information uses by governmental and non-governmental actors.

Within the oPt, climate-relevant information (e.g. drought assessments, meteorological data, water supply and quality information) is collected by the Ministry of Agriculture, the Palestinian Central Bureau of Statistics, the Palestinian Meteorological Department and the Palestinian Water Authority. The available data is scattered, and is collected by different institutions without adequate coordination. The data is not always effectively processed, screened and evaluated, though there are emerging examples of good practice, such as the drought early warning system developed by the Ministry of Agriculture. As yet, though, there is no central hub or ‘clearinghouse’ within this dispersed climate information infrastructure. It is recommended, therefore, that the Environmental Quality Authority serves as the lead agency within the PA for co-ordinating the collection, analysis and dissemination of core information relating to climate variability and long-term change.

Environmental information management training would be a pre-requisite for those charged with managing climate information within the PA. A common reference point for this information could be a national climate assessment for which this Climate Adaptation Strategy for the occupied Palestinian territory is one potential starting-point – notably its Vulnerability Assessment and Climate Risks Assessment. A unified national assessment, supported by technical capacity-building on electronic information management tools and services, would be the most efficient means of identifying a clear hub of up-to-date climate information. Of course, there will be regional and sectoral information needs from a diverse set of user (decision-makers, the public, private sector actors), which will often require additional data generation and collation. The public agency in charge of the management of climate information might benefit from a stakeholder advisory board, in order to help determine climate information collection and management priorities over time.

6.2 National-level institutional capacity-building

Two national planning bodies have been highlighted for their strategic importance for mainstreaming climate change adaptation in the West Bank and the Gaza Strip (Section 5.4):
• The integration of climate risk management with national disaster risk reduction under the responsibility of a revived *Higher Council of Civil Defence*;

• The strategic development of policies and measures relating to drought minimisation and management under a *National Committee to Combat Desertification*.

It is also recommended that the *Environmental Quality Authority* (on behalf of the PA) should take responsibility for national climate change adaptation planning. National governmental institutions should serve to create the conditions by which communities and individuals can improve their capacity to cope with climate stresses and hazards. Bearing in mind more pressing social, political and environmental priorities, the PA is advised to consider adopting this *Climate Change Adaptation Strategy*. This would imply:

1. Formalising climate change adaptation planning within the PA, with *EQA confirmed as the line agency responsible for climate change adaptation planning*, (in consultation with the Ministry of Agriculture, the PWA, and other ministries according to the forecasted sectoral impacts of climate change). This collaboration is important given the possibility of increased inter-ministerial tensions as a result of climate change – an issue raised by stakeholders when identifying vulnerability pathways for the West Bank (Figure 3.5). The technical committee on climate change already established within EQA (Section 6.2.1 below) should continue in order to support this adaptation planning role, as mandated by the PA.

2. Integrating this climate change adaptation (and logically also climate change mitigation) responsibility with the successor to the *Palestinian Reform and Development Plan 2008-2010* (PRDP). Climate change risks already impinge on PRDP goals to increase agricultural output and provide more efficient and equitable water delivery to households; and these risks also affect other PRDP goals, including social security protection and health quality improvement. The need for integration is therefore obvious.

3. As recommended above (Section 6.1), EQA should serve as the lead agency within the PA for co-ordinating the collection, analysis and dissemination of core information relating to climate variability and long-term change. This includes scenario planning for adaptation policy through a high-resolution climate model (Section 6.2.1 below).

4. Dedicated funding from the Ministry of Planning targeting sectors and communities in the oPt with the highest climate vulnerability. Development assistance frameworks (Section 5.5) are the logical source for such funding, but in accordance with Palestinian priorities for climate adaptation rather than donor preferences.

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33 The focus here on climate change adaptation is consistent with the actions expected of “particularly vulnerable” countries under the UNFCCC (ratified by Israel); however, there is already interest in the climate change mitigation in the PA (particularly in the Palestinian Energy Authority) and, as developing countries are asked to assume more responsibility for mitigation activities, it would make sense for the PA to identify priority mitigation actions, including ones that also have adaptation value (See Section 4.4.2). The identification of mitigation options is outside the remit for this study.
For the four governmental bodies likely to be most involved in climate change adaptation planning, there are also separate capacity issues. Highlighted now are those issues that arose in stakeholder consultations, as the Climate Change Adaptation Strategy for the occupied Palestinian territory was developed, about institutional capacity-building to reduce vulnerability and increase resilience to climate change.

6.2.1 Environmental Quality Authority

EQA is the lead agency on climate change for the PA – a role that reflects the fact that EQA is the main Palestinian governmental body responsible for environmental protection. Its mission statement, which reflects Article 2 of the Palestinian Environmental Law No. 7/99, calls for EQA to “safeguard and protect the environment, control and limit the degradation of natural resources, prevent further pollution, enhance environmental awareness and ensure environmentally sustainable development.”

EQA is the successor to the Ministry of Environmental Affairs, created by the PA in 2000. Its institutional restructuring as EQA, which was supported by a number of external donors (including the IUCN, Italian Cooperation and UNDP), has created a professional, decentralised environmental agency that is committed to inter-ministerial working and participatory decision-making. However, there are currently problems arising from constraints placed by Hamas on EQA staff in the Gaza Strip, including the Chairman of EQA. It is essential that EQA is allowed to operate effectively as a national environmental agency for the oPt for the benefit of all Palestinians.

This Climate Change Adaptation Strategy for the occupied Palestinian territory is the key outcome of a UNDP/PAPP-funded initiative to assist EQA to formulate a national strategy for dealing with climate change, under the Natural Resources Conservation policy area of the Palestinian National Policy Agenda. While not explicitly mentioned in the PRDP 2008-10, the Ministry of Planning approved the climate adaptation project for EQA at the end of 2007. As mentioned earlier in this report (Section 2.4), the project was designed to deliver the following capacity-building outcomes for the PA:

- The identification of key climate change information and modelling needs for national development planning and environmental policy-making;
- The identification of priority climate change adaptation policy options and measures;
- Improvement in the capacity of PA decision-makers effectively to take account of climate change impacts;
- Improvement in the capacity of PA staff to monitor and evaluate policies with regard to climate change.

EQA has been the lead agency for the climate change adaptation initiative supported by UNDP/PAPP, and consolidation of the capacity gains generated by it rests, firstly, on the formal designation of EQA as the line agency responsible for climate change adaptation planning within the PA, in close
cooperation with the PWA and Ministry of Agriculture. Within EQA, the management of the climate change adaptation project has been the responsibility of a national technical committee featuring Director Generals from Environmental Resources, Environmental Protection, Projects and International Relations, Policies and Planning, and Administration and Financial Affairs. It is recommended that this technical committee continues to oversee the adoption and implementation of both a national climate change adaptation strategy for the oPt. The committee could also consider follow-up work; for example, the development of climate change mitigation policies and measures with the Palestinian Energy Authority and other agencies.

The comprehensive assessment of future climate risks requires domestic research and expertise. There is an identified need for the PA to acquire increased capacity for monitoring and modelling rainfall variability and long-term climate change in the oPt (Section 4.2). Without such systematic analysis, there will remain significant uncertainties regarding future climate change impacts in the oPt, and the scientific basis for the prioritisation of adaptation policies and measures. Training of EQA and other PA staff with climate planning responsibilities should cover essential technical aspects of climate risk management, taking advantage of advanced training programmes offered by external donors; e.g. EQA staff members are currently taking courses on Climate Change Adaptation and Mitigation offered by the Swedish International Development Cooperation Agency (SIDA).

Of course, this Climate Change Adaptation Strategy for the Occupied Palestinian Territory has highlighted the climate vulnerability of the agricultural sector. Under Article 17 of the Palestinian Environmental Law No. 7/99, the Ministry of Environmental Affairs (now EQA) is required to cooperate with the Ministry of Agriculture and other specialized agencies in developing procedures for dry-land farming. In accordance with this responsibility, which covers some of the agricultural areas most sensitive to protracted drought, it is recommended that EQA participates, with the Ministry of Agriculture, in the development of drought minimisation and management guidelines in support of the National Committee to Combat Desertification; this would require a broader mandate than the current National Committee, considering the relationships between desertification and drought.

Under Article 75 of the Environmental Law 7/99, EQA is charged with cooperating with other countries to exchange scientific and technical information, coordinate joint environmental research programmes, and undertake joint environmental cooperation regarding relevant Palestinian environmental commitments. On this basis, EQA has an active international relations role for the PA, including observer status in the UN Convention to Combat Desertification. It is important that this external work is extended to the international climate change regime. EQA is already leading PA efforts to ensure formal Palestinian participation in the United Nations Framework Convention on Climate Change (UNFCCC), which is consistent with

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34 For example, on 9 October 2009 EQA received an invitation from the UNFCCC Secretariat to attend, as an Observer, COP15 in Copenhagen in December 2009.
international environmental law (see Section 2.4) and UN General Assembly Resolution 52/250: Participation of Palestine in the work of the United Nations. The status and scope of this involvement would be determined in negotiations with the UNFCCC Secretariat and contracting Parties, but would need to include the question of Palestinian access to UNFCCC climate adaptation funding mechanisms.

In summary, capacity-building for climate change adaptation planning within EQA would need to include at least the following components:

- The formal designation of EQA as the line agency responsible for climate change adaptation planning within the PA, in cooperation with the Ministry of Agriculture and the PWA (and in consultation with other ministries and specialised agencies according to agreed planning priorities);
- The continuation of the EQA technical committee on climate change to oversee the implementation of a national climate change adaptation strategy and to consider other climate change policy areas for development;
- The appointment of EQA as the lead agency within the PA for coordinating the collection, analysis and dissemination of key information relating to climate variability and long-term change (Section 6.1). This includes scenario planning and high-resolution regional climate modelling tailored to Palestinian climate risk management needs;
- The training of selected EQA and other PA staff in climate change adaptation (and mitigation) planning and management, including technical training on the use of climate models. Such training should take advantage where possible of advanced professional development programmes offered by external donors, but also be able to rely on a core training budget provided by the PA;
- In cooperation with the Ministry of Agriculture and other agencies, the participation of EQA in the development of drought minimisation and management guidelines for the National Committee to Combat Desertification;
- EQA, on behalf of the PA (or PLO), to lead efforts to ensure formal Palestinian participation in UNFCCC. The status and scope of this involvement would be determined in negotiations with the UNFCCC Secretariat and contracting Parties, but should include Palestinian access to UNFCCC climate adaptation funding mechanisms.

6.2.2 Ministry of Agriculture
From the vulnerability pathways identified earlier in the Climate Change Adaptation Strategy (Figures 3.5 and 3.9), it can be seen that climate change is forecast to impact negatively on livelihoods, primarily through reduced crop yields from lower, more variable precipitation and higher temperatures (and also saline intrusion in the Gaza Strip). Agricultural livelihoods in rain-fed farming communities are particularly vulnerable, though this vulnerability is also caused by Israeli restrictions on movement and access to land, resources, and markets, and an increase in farming production costs (including for water) along with decreasing profits. The constraints posed by
the Israeli occupation are generally beyond the reach of government interventions. However, there are also internal structural weaknesses in the Palestinian agricultural sector: the Food and Agriculture Organization (FAO 2009: 14-15) has pinpointed the following:

- Most Palestinian products for domestic markets are not competitive in terms of quality compared to similar products coming from Israel;
- Marketing strategies are still traditional, which favour small-volume sales through intermediaries with limited returns;
- There has been limited investment in new agricultural equipment, new technologies and crop diversification;
- The lack of availability of irrigation water is compounded by weak enforcement of existing laws, the over-extraction of aquifers and the deterioration of water infrastructure.

An immediate adaptive capacity-building priority for the Ministry of Agriculture is to model the effects of climate change on the agricultural sector in the oPt, as part of the information management for climate risk mentioned above, where EQA is recommended to be the lead climate information coordinator (Section 6.1). This Climate Change Adaptation Strategy has already drawn attention to the type of research necessary, using the example of the analysis by Abu-Jamous (2009) of climate change impacts on the demand for irrigation water. From this assessment (as noted in Section 4.4.1), it was observed that crop yields were affected more by changes in temperature than changes in precipitation. This suggests that the careful monitoring of humidity and crop evapotranspiration rates should be part of any monitoring network designed to enhance the adaptive capacity of the agricultural sector. This type of modelling – extended also to rain-fed agriculture – is essential to determine the climate risks to the Palestinian agricultural sector.

Climate change considerations need to be integrated into the agricultural development goals of the PRDP 2008-10, which include a 15% increase in agricultural output, a 10% growth in agricultural employment and an increase of 25% in agricultural exports. For the PA the agricultural sector has a pivotal role in economic recovery, poverty alleviation and reducing food insecurity in the oPt. At the same time, it is recognised that the Ministry of Agriculture needs strengthening in order to drive these development goals. It makes sense, therefore, to incorporate climate risk management in proposed capacity-building of the Ministry’s General Directorate for Planning and Policy, which is already responsible for the technical management of drought. This would affect departments responsible for policy and planning, project preparation, technical and international cooperation, monitoring and evaluation, and GIS mapping (FAO 2009: 34).

In the stakeholder consultations informing this Climate Change Adaptation Strategy, the Ministry of Agriculture stated that an inter-ministerial planning framework and technical committee is needed to address the risks in the oPt of recurrent droughts and desertification, including linkages to climate variability and change. It is recommended that the Ministry of Agriculture lead the development of drought minimisation and management guidelines for the
agricultural sector in support of a functioning National Committee to Combat Desertification (the Ministry already has a thematic group looking at drought). These should provide a scientific basis for identifying different types of drought (including linkages to desertification), which can draw on the new drought early warning system developed by external donors for the ministry.

Strengthening of the extension services function of the Ministry of Agriculture has been identified as a capacity-building priority by FAO (2009: 15). It is recommended that future technical assistance for building up extension services should take into account climate risk management considerations. Technical and financial assistance to farmers compatible with reduced climate vulnerability include: the improved management of soil moisture in rain-fed areas, the introduction of more water harvesting techniques (e.g. Abdallah 2006), the rehabilitation of grazing areas, switching to drought-resistant crops, and the development of community-based irrigation schemes (e.g. Hedger and Cacouris 2008: 51-52). As suggested by the Ministry in consultations, the private sector could also be mobilised effectively here; for example, by developing an effective insurance system for the agricultural sector.

In summary, capacity-building within the Ministry of Agriculture to increase the resilience of farmers would include at least the following components:

- Routine monitoring of crop evapotranspiration rates, alongside rainfall and soil moisture;
- The incorporation of a climate risk management capacity in the proposed strengthening of the General Directorate for Planning and Policy;
- The development of drought minimisation and management guidelines in support of the National Committee to Combat Desertification;
- Improved agricultural outreach and extension services;
- Strategic climate planning capacity (including modelling, in cooperation with EQA).

6.2.3 Palestinian Water Authority

The PWA has commissioned a number of reports related to its capacity-building, three of which overlapped with the UNDP/PAPP Climate Change Adaptation Initiative: these are:

- Water Governance Programme: Building the Capacity of Institutional Reform of the Water Sector (PWA 2008b);
- An Audit of Operations and Projects in the Water Sector in Palestine: The Strategic Refocusing of Water Sector Infrastructure (Audit Environmental 2008);

The latter two reports focused on the political obstacles to effective national-level water management in the oPt. Causes identified by the World Bank for poor water management by the PWA – that are relevant to water-related climate vulnerability and adaptation planning – include: (a) implementation
constraints [movement restrictions by Israel] that impede investment and maintenance of water infrastructure; and (b) the weak institutional capacity of the PWA for planning, implementation and management, including the loss of regulatory capacity in the Gaza Strip (World Bank 2009: 67).

The capacity of the PWA to reform itself was highlighted in the UNDP-financed Water Governance Programme (PWA 2008b). This report noted the benefits that would derive from enhanced capacity at all levels – from licensing and consumer affairs through to middle-level management in the Planning and Quality Assurance departments, through to the level of the PWA Director Generals themselves. The effects of a weak legal and regulatory context were also emphasised: this context inevitably impedes the ability of the PWA to implement climate change adaptation plans and other climate risk management measures.

The Norwegian-financed Audit of Operations and Projects in the Water Sector in Palestine proposes the introduction of a Fast-Track Approval Process (FTAP) to bypass the effects of the Israeli movement and trade restrictions, particularly in Gaza. The FTAP is designed to facilitate the construction of water projects of a humanitarian nature, and if adopted by both sides, would serve to directly address the climate vulnerability of the communities in Gaza, and the West Bank communities of Area C. Climate risk information should be available during FTAP decision-making. The Audit also recommends the creation of a Strategy, Policy and Project Implementation Unit to refocus the institutional priorities of the PWA. Such a prioritisation is an opportune moment to consider policy related to climate vulnerability and adaptation in the oPt.

The capacity required by the PWA to address climate vulnerability ultimately depends on its role within any National Climate Adaptation Plan adopted by the PA. Basic capacity that would be required in any and all cases would focus on the central point of the ‘vulnerability pathways’ identified in this report for the West Bank (Figure 3.5) and the Gaza Strip (Figure 3.10) – groundwater quality. The PWA is thus advised to reinforce its water quality monitoring programmes, and supplement these with predictive capacity on future groundwater use and availability. Particular attention should be paid to seawater intrusion in the Coastal Aquifer (Gaza Strip) and saline levels in the Jordan Rover Valley. The monitoring programme should also cover surface water sources, notably the wadis and – following Permanent Status negotiations – the Jordan River.

In summary, capacity-building within the PWA to address climate variability and change would include at least the following components:

- Monitoring of groundwater quality and quantity;
- Monitoring of surface water (springs, wadis and the Jordan River);
- Incorporation of climate risk information in any new Fast-Track Approval Process for new water infrastructure projects;
• Strategic climate change adaptation planning (including high-resolution hydrological modelling, in cooperation with EQA) in support of water policy-making.

6.2.4 Ministry of Planning

The Ministry of Planning has a central role in coordinating socio-economic development in the oPt, including overseeing the strategic planning process, linking planning to budgeting, and ensuring that international assistance to the Palestinians is effectively managed. As donors show an increasing interest in financing climate change adaptation (and mitigation) activities, it is essential that the Ministry is able to coordinate aid so that there is no duplication of activities between donors: this is a point that the Ministry highlighted with the Project Team in stakeholder discussions for the Climate Change Adaptation Initiative. The Ministry has been supportive of the high level of stakeholder engagement in the development of the Climate Change Adaptation Strategy for the oPt and the Palestinian Adaptation Programme of Action.

It was recommended above (Section 6.2) that the Ministry of Planning funds adaptation measures for sectors and communities in the oPt with the highest levels of climate vulnerability. Development assistance frameworks (Section 5.5) are the logical source for such funding, but in accordance with Palestinian priorities for climate adaptation and human development, and also taking into account wider social trends (e.g. population growth forecasts in Gaza and the West Bank). Institutionally, the Directorate General of Aid Management and Coordination (DG-AMC) in the Ministry of Planning has been strengthened in recent years (as a result partly of significant financial and technical assistance from Belgian Technical Cooperation), and there are currently four Strategy Groups and associated Sector Working Groups promoting aid harmonisation with national planning objectives. However, climate change adaptation issues falls outside this structure, so there is need here to integrate climate risks.

Capacity-building within the Ministry of Planning to address climate risks would therefore include at least the following components:

• Including climate change adaptation (and climate change mitigation) priorities in the next Palestinian Reform and Development Plan;
• Supporting PNA recommendations for the Ad Hoc Liaison Committee to include climate adaptation financing in its remit (Section 5.5. above);
• Including climate risk management information, where relevant, in the selection and approval of development programmes and projects by Sector Working Groups;
• Investigating the options for participating in regional climate change adaptation programmes compatible with the social and economic development needs of Palestinians.
6.3 Monitoring and evaluation

Adoption, in part or whole, of this *Climate Change Adaptation Strategy* by the PA would require a monitoring and evaluation plan for implementing the relevant elements. This strategy’s recommended adaptation actions – the prioritisation of adaptation measures (Section 5) and adaptive capacity-building of state institutions (Section 6) – are complementary and should be pursued simultaneously for the effective development of climate change adaptation in the oPt. Monitoring is required to oversee these twin adaptation tracks, and provide routine information on the progress of their various components according to targets agreed by stakeholders. Evaluation is the process of systematically and determining the effectiveness, efficiency, and fairness of climate change adaptation activities.

In common with best practice for adaptation planning, it is recommended that a central monitoring and evaluation unit be established within, or under the jurisdiction of, a strategic government agency (Perez and Yohe 2005: 209). The location for such a unit in the oPt would be the responsibility for the PA; however, it would make administrative sense for the Ministry of Planning to have this jurisdiction. If it is agreed with the recommendation above (Section 6.2) that EQA becomes the line agency responsible for overseeing the implementation of a national climate change adaptation strategy in the oPt, the **EQA-led technical committee on climate change could serve this monitoring and evaluation unit role** (with delegated authority from the Ministry of Planning). This role fits also with another recommendation above that EQA should serve as the lead PA agency for co-ordinating the collection, analysis and dissemination of key information relating to climate variability and long-term change (Section 6.1). Of course, this would necessitate the allocation of appropriate financial and human resources, including relevant staff training.

UNDP/PAPP goals for enhancing the capacity of the PA to adapt to climate change include the integration of adaptation activities into domestic planning, budgetary and fiscal policies, and other policy interventions (Section 2.4). It is therefore important that climate change adaptation priorities are included in the 2010-2012 PDRP, which would help prevent their marginalisation from strategic planning priorities and PA-approved flows of donor assistance. As climate adaptation moves, over time, into mainstream national planning, the monitoring and evaluation of adaptation measures would be expected to become part of routine management processes in the relevant ministries. However, there is likely to remain the need for a dedicated monitoring and evaluation unit on climate change adaptation, if only because the high degree of uncertainty regarding climate change risks and socio-economic trends in the oPt. Also, in Palestinian Permanent Status negotiations with the Israelis, knowledge of climate change risks will be necessary for protecting Palestinian interests in key files relating to water and food security.

The development of a monitoring and evaluation framework for implementing this *Climate Change Adaptation Strategy for the occupied Palestinian territory* would recognise that its overall objective is:
• To implement the most effective means by which the PA can enhance the capacity of the Palestinians to cope with current and future climate hazards.

It has been argued in this report, based on stakeholder consultations, that the water sector in the oPt justifies priority focus in terms of climate change impacts, and that agriculture is the Palestinian economic sector most sensitive to climate hazards. This leads to the identification of two strategic outcomes for climate change adaptation in the oPt:

1. **Water security** – sustained access of individuals to sufficient safe water for health and well-being in the face of significant climate risks (e.g. water scarcity and reduced quality). One relevant benchmark that could be considered for adoption is the WHO minimal standard of daily water consumption for direct human consumptive and hygiene needs – 100 litres/person/day (Section 2.1);

2. **Food security** – sustained household income and consumption above a minimal level, with no decreases in total food and non-food expenditures, in the face of significant climate risks. This follows the benchmark for food security in the oPt set by the Food and Agriculture Organization (2007a: 58), although its chosen minimal level of daily income & expenditure in the oPt ($1.6 US) is questioned by some stakeholders.

These outcomes guided the no-regrets and low-regrets adaptation measures formulated above (Section 5.3). To recall, these measures relate to key climate-induced risks to food and water security identified for the oPt (Section 5.2):

- Crop area changes due to decreases in optimal farming conditions;
- Decreased crop and livestock productivity;
- Increased risk of floods;
- Increased risk of drought and water scarcity;
- Increased irrigation requirements;
- Increased risks to public health from reduced drinking water quality (including saline intrusion in the Gaza Strip).

The evaluation of adaptation measures to address these risks will need to be continually revised with increasing availability of precise information on these risks from high resolution climate modelling and regional environmental monitoring. While not comprehensive, illustrative planning matrices (Tables 6.1 and 6.2) are now presented for the priority climate adaptation measures.\(^{35}\) Depending on which adaptation options (if any) are adopted by the PA, it is recommended in practice that the proposed EQA technical committee on climate change (Section 6.2.1) compiles the detailed monitoring and

\(^{35}\) In line with UNDP/PAPP interest in no-regrets and low-regrets options, the high cost adaptation options set out in Section 5.3 will not be presented in an indicative planning matrix. However, this can readily be done should major financing be available for any of these options.
evaluation matrices. Such matrices can be applied to different scales and levels to capture both geographical and social (e.g. gender) inequalities in climate vulnerability. This matrix development should include consultation with stakeholders. The formulation of measurable indicators is critical to verifying the effectiveness, fairness and efficiency of adaptation measures.

**Table 6.1:** Monitoring and Evaluation of No-Regrets Priority Adaptation Measures

<table>
<thead>
<tr>
<th>Adaptation measure</th>
<th>Indicator examples</th>
<th>Baseline data sources</th>
<th>Indicative targets</th>
<th>Lead PA responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of flood contingency plans</td>
<td>No. of active flood plans; Access to flood shelters; Flood Hazard Index.</td>
<td>Rates of flood occurrence; Forecasting of flood events; Population density.</td>
<td>Increased no. of flood plans; Greater access to flood shelters; Training for civil defence staff.</td>
<td>Ministry of Interior (Civil Defence), Ministry of Local Government &amp; PWA</td>
</tr>
<tr>
<td>Local increases in rainfall interception capacity</td>
<td>Proportion of rainfall intercepted (in representative environments).</td>
<td>Rainfall intensity &amp; distribution; Vegetation storage; Evaporation; Runoff rates.</td>
<td>Options for increasing local rainfall interception for vegetation (e.g. green lands).</td>
<td>EQA &amp; Ministry of Agriculture (MoA)</td>
</tr>
<tr>
<td>Setting of clear water use priorities</td>
<td>Social support for National Water Plan; Stakeholder support for National Water Council.</td>
<td>Stakeholder views on water use priorities in the oPt; Survey of water-related disputes and conflicts.</td>
<td>Redrafted National Water Plan based on consensus; Functioning National Water Council.</td>
<td>PWA</td>
</tr>
<tr>
<td>More efficient irrigation</td>
<td>Use of irrigation by farmers (by area, season, farm type, irrigation system and volume).</td>
<td>Survey data on irrigation usage; Evaporation rates for different crop selections and mixes.</td>
<td>Increased coverage of more efficient irrigation methods (by area &amp; relative water volume).</td>
<td>MoA</td>
</tr>
<tr>
<td>Review of drinking water quality management system</td>
<td>No. of climate resilient drinking water quality plans; No. of relevant training courses undertaken.</td>
<td>Water quality data; Climate risk coverage in drinking water quality policy and plans.</td>
<td>Increased water quality monitoring; Integration of climate risks in water quality planning.</td>
<td>Ministry of Health, PWA</td>
</tr>
<tr>
<td>Increased (sustainable) production of freshwater</td>
<td>Sustainable aquifer recharge rates; Use of, and access to, freshwater.</td>
<td>Aquifer recharge rates; Joint Water Committee approvals of Palestinian well proposals.</td>
<td>Increased water extraction from sustainable sources; JWC approvals water supply proposals.</td>
<td>PWA</td>
</tr>
</tbody>
</table>
### Table 6.2: Monitoring and Evaluation of Low-Regrets Priority Adaptation Measures

<table>
<thead>
<tr>
<th>Adaptation measure</th>
<th>Indicator examples</th>
<th>Baseline data sources</th>
<th>Indicative targets</th>
<th>Lead PA responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased irrigation for highest value crops</td>
<td>Irrigation network coverage for highest value crops.</td>
<td>Irrigation scheduling and coverage; Irrigation water use rates.</td>
<td>Increased network coverage for proven irrigation methods.</td>
<td>MoA</td>
</tr>
<tr>
<td>Increased use of water harvesting</td>
<td>Use rates and coverage of floodwater harvesting; Use rates and coverage of rainwater harvesting.</td>
<td>Research studies on water harvesting; Water storage rates for different water harvesting techniques.</td>
<td>Growth in use of harvested floodwater; Growth in use of harvested rainwater.</td>
<td>PWA, MoA &amp; Ministry of Local Govt.</td>
</tr>
<tr>
<td>Protection of coastal sand dunes</td>
<td>Excavation of sand from coastal dunes (licensed and unlicensed); Biodiversity mapping of coastal dunes.</td>
<td>GIS information on extent of coastal dunes; Monitoring data from Coastal &amp; Marine Environmental Action Plan.</td>
<td>Sustainable and licensed sand extraction rates; Effective enforcement of protected setback zones.</td>
<td>EQA, CMWU, Ministry of Planning</td>
</tr>
<tr>
<td>Rural livelihood diversification</td>
<td>Household income rates; Rural livelihood sources; Access and movement restrictions on communities.</td>
<td>Sources and rates of rural household incomes; Investment in rural livelihood diversification activities.</td>
<td>Increased rural incomes; Increased mix of rural jobs; Improved access and movement in rural areas.</td>
<td>MoA</td>
</tr>
<tr>
<td>Adaptive land use planning</td>
<td>Proportion of operational land use plans incorporating climate risk information.</td>
<td>GIS information on land use assessment and management; Climate risk assessment.</td>
<td>Adoption of climate risk assessment in strategic land use planning.</td>
<td>Ministry of Planning, MoA, EQA &amp; Ministry of Local Govt.</td>
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<tr>
<td>Precision agriculture: improved soil and crop management</td>
<td>On-farm use of viable precision agriculture</td>
<td>Soil moisture content; Crop yields and quality data for precision agriculture.</td>
<td>Increased uptake of tested and proven precision agriculture.</td>
<td>MoA</td>
</tr>
<tr>
<td>Heat- and drought-resistant crop and ruminant selections</td>
<td>No. of advisory sessions given to farmers on climate-resilient crop and ruminants; Uptake of heat- and drought-resistant crops and ruminants.</td>
<td>Information on yield and quality on climate-resistant crops and ruminants; Training capacity of agricultural extension services.</td>
<td>Increased uptake of climate-resilient crops and ruminants; Advisory sessions on climate-resilient crops and ruminants.</td>
<td>MoA</td>
</tr>
</tbody>
</table>
7. Conclusion

Recent climate change predictions from high-resolution regional models have delivered similar forecasts of climate change for the eastern Mediterranean. The most significant environmental effects of climate change for the oPt, over the course of this century, are likely to be a decrease in precipitation (with significant seasonal variation) and significant warming. These simulations give scientific backing to the Intergovernmental Panel on Climate Change (IPCC) projections for the region. In its Fourth Assessment Report, the IPCC predicts that, for the southern and eastern Mediterranean, warming over the 21st century will be larger than global annual mean warming – between 2.2-5.1ºC according to an optimistic emissions scenario (A1B). Annual precipitation is deemed likely to fall – decreasing 10% by 2020 and 20% by 2050 – with an increased risk of summer drought.

There remain significant uncertainties about the precise impacts of climate change in the region. Indeed, it is not possible at the moment, with high scientific confidence, to differentiate climate hazards in the oPt on the basis of ‘natural’ climate variability or long-term climate change. Indeed, there is a need for climate modelling and research capacity-building in the oPt tailored to Palestinian adaptation priorities in the face of future climate risks. A precautionary approach is warranted in which improving adaptive capacity in the oPt – both for institutions and communities – delivers ‘no regrets’ and ‘low regrets’ benefits in terms of disaster risk reduction and human development even if long-term climate trends are less harmful than predicted.

This report adopts the concept of climate vulnerability, defined as combined biophysical vulnerability and social vulnerability. Input from stakeholders in the West Bank and the Gaza Strip corroborated the initial premise of the Project Team that the water sector in the oPt justifies priority focus in terms of climate change impacts, and that agriculture is the Palestinian economic sector most sensitive to climate hazards, both current and future. This led to an adaptation focus at the regional and local level on water insecurity and food insecurity. Within the oPt, the Project Team identified three regions as having the highest levels of climate vulnerability – Massafer Yatta (Hebron Governorate, West Bank), the easternmost oPt areas of the Jordan River Valley (West Bank) and the Gaza Strip. The identification of these regions does not mean that there are not other areas in the oPt with high levels of climate vulnerability.

Freshwater resources in the oPt, already under significant pressure from rapid demographic growth and economic development, are predicted to become more scarce as climate change causes decreases in precipitation taking into account current distributional arrangements between Israel and the oPt. If the major asymmetries in water availability between the oPt and Israel remain, existing political tensions will be exacerbated – a scenario sketched out in the interim report of the Israeli Interministerial Steering Committee on Climate Change (Office of the Chief Scientist 2008) and also in a recent report by the International Institute for Sustainable Development (Brown and Crawford 2009). However, water scarcity is not a robust predictor of violent conflict as ‘virtual water’ (water imported in the form of food) can ease local water or food
shortages (El-Fadel and Maroun 2008; Zeitoun 2008). However, the effects of the asymmetrical distribution of resources and significant physical scarcity on the Palestinian side already fuels Palestinian-Israeli tensions, and these are likely to increase. Furthermore, virtual water can only serve as an effective means of climate change adaptation for the Palestinians if there is effective poverty reduction and sustainable economic growth. It also means that the potential impacts of climate change on food availability elsewhere in the world need to be considered with regards to strategic planning of the Palestinian agricultural sector.

Historic forms of household and community coping by Palestinians in the face of climate and other hazards offer cultural templates for adaptation to climate change in the oPt. However, the ongoing effects of the Israeli occupation undermine the conditions necessary to their operation, both economic – the free movement of goods and people – and also political – national self-determination and democratic governance. The occupation fosters a wide range of maladaptive policies and practices (e.g. subsidised water-intensive livestock farming by settlers and the destruction of Palestinian olive groves) that severely restrict the development of resilience to climate hazards. There are also maladaptive Palestinian practices that need to be addressed (e.g. unlicensed ‘scavenger’ wells), though these are far less significant than the far-reaching effects of the occupation.

The Palestinian Authority (PA) is recommended to adopt this Climate Change Adaptation Strategy for the oPt as the most effective means by which the PA can enhance the capacity of the Palestinians to cope with current and future climate hazards. Initial efforts should be directed at addressing the six major climate-induced risks to food and water security identified in this report:

- Crop area changes due to decreases in optimal farming conditions
- Decreased crop and livestock productivity;
- Increased risk of floods
- Increased risk of drought and water scarcity;
- Increased irrigation requirements
- Increased risks to public health from reduced drinking water quality (including saline intrusion in Gaza).

Of the adaptation options identified for the oPt, it is recommended that prioritisation is given to those no-regrets which are judged to have the highest levels of adaptive capacity and technical feasibility:

1. Development of flood contingency plans
2. Local increases in rainfall interception capacity
3. Establishment of clear water use priorities
4. Introduction of more efficient irrigation techniques
5. Review of drinking water quality management systems to incorporate climate risks
6. Increased brackish water and treated wastewater use
7. Equitable and reasonable use of transboundary water resources between Israel and the Palestinians

Subject to the availability of funding support, it is also recommended that consideration is given by the PA to adopting also these low-regrets measures which have the highest levels of adaptive capacity and technical feasibility:

1. Increased in irrigation for highest value crops
2. Increased use of water harvesting
3. Protection of coastal sand dunes in the Gaza Strip
4. Rural livelihood diversification
5. Incorporation of climate adaptation in land use planning
6. Greater use of precision agriculture for improved soil and crop management
7. Selection of crops and ruminants for more tolerance to heat and drought

Consideration of no-regrets and low-regrets options does not mean that high cost adaptation measures should be ignored. Those also judged to have both high adaptive capacity and technical feasibility are:

- Increased water use efficiency from infrastructure investment;
- Development of ‘new water’ sources, including substantial desalination capacity for the Gaza Strip;
- New coastal protection measures for the Gaza Strip(e.g. wave breaks and offshore structures).

These are the types of sector-wide options that may still be considered by the PA donors, especially for donor-funded investment programmes in water infrastructure that are needed anyway for human and economic development reasons. For example, major donor investment in seawater and brackish water desalination for domestic use and industrial use could release pressure on renewable water sources for agriculture.

The PA, through its line agency for climate change – EQA – is committed to the development of an inclusive national strategy for climate change adaptation. As supported by UNDP/PAPP on behalf of the PA, this Climate Change Adaptation Strategy for the occupied Palestinian Territory has been informed by extensive consultation with governmental and nongovernmental stakeholders. Indeed, the active participation of decision-makers and communities in defining their own infrastructure of protection against climate change and other risks is consistent with, and supports, PA goals for the political and economic self-determination of the Palestinian people. It is hoped at the same time that the transboundary management challenge of climate change will encourage, where possible, technical and political cooperation between the PA and regional neighbours.
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