Regional Programme
Energy Security and Climate Change
Middle East and North Africa

KONRAD ADENAUER STIFTUNG

Climate Change Mitigation and Adaption in the Mediterranean: Synthesis Report and Future Perspectives

MANFRED A. LANGE

KAS-REMENA Publication Series - Synthesis
Climate Change Mitigation in the Eastern Mediterranean

Abstract

The Mediterranean and its rim countries are characterised by a wide spectrum of socio-economic, political and ethnic variety as well as an equally broad diversity of ecosystems and natural settings. The region is increasingly affected by ongoing and anticipated changes in climatic conditions and their various impacts. Local to regional (armed) conflicts and their repercussions on the life of affected populations in combination with substantial destructions of infrastructures, industrial facilities and human dwellings exacerbate the urgent need to find adequate and effective mitigation and adaptation strategies to reduce the adverse effects of climate change on already highly stressed communities.

Most of the Mediterranean countries are parties to the United Nations Framework Convention on Climate Change (UNFCCC) and major mitigation strategies introduced to and accepted by a number of Conferences of the Parties (COP; e.g., the Paris Agreement of 2015). However, concrete mitigation measures by individual countries represent quite different approaches. They comprise varying levels of stringency in reducing greenhouse gas emission and fall often short of the adopted COP-commitments.

The present paper aims to address and briefly describe mitigation and adaptation measures in six countries in the Eastern Mediterranean and the Middle East (EMME Region). This is mainly based on publically available government information and national communications to the UNFCCC. This information is compared to a series of articles depicting selected concrete mitigation (and adaptation) efforts in these countries that have been published by the Regional Programme on Energy Security and Climate Change Middle East and North Africa of the Konrad-Adenauer-Stiftung (KAS-REMENA).

While the measures for most of the considered countries are instrumental in advancing greenhouse gas emissions reductions on the national level, they largely fall short of a more comprehensive view on the challenges posed by climate change. Even though, the energy sector represents the dominant source of GHG emissions, the linkages between water-, energy- and food security in a given country in the context of the Energy-Water-Food Nexus are only partly addressed. In addition, the apparent lack of attention to social vulnerabilities are unlikely to result in effective mitigation and adaptation strategies.

Most of the studies considered here emphasise the need for more cooperation on the bi- and multilateral level, particularly in the context of- and in cooperation with the European Union's *Green Deal*. Thus, more efforts are needed to develop joint and cooperative strategies to decrease GHG emissions and to reduce adverse consequences of climate change. Holistically derived sustainable mitigation and adaptation measures that are applied on a regional level will ultimately pave the way for a sustainable and peaceful Eastern Mediterranean.

Background and Introduction

The Eastern Mediterranean and the Middle East (EMME) represents a region that is particularly affected by climate change. Currently recorded mean annual temperatures lie well above the global mean (Figure 1) and have made the region (and the entire Mediterranean Basin) one of the "global climate change hot spots" (*Giorgi, 2006*). The countries in the region (see Figure 1 in *Lange, 2023* and Figure 3 below) are characterised by stark contrasts in their environmental conditions, their economies and their socio-political settings.

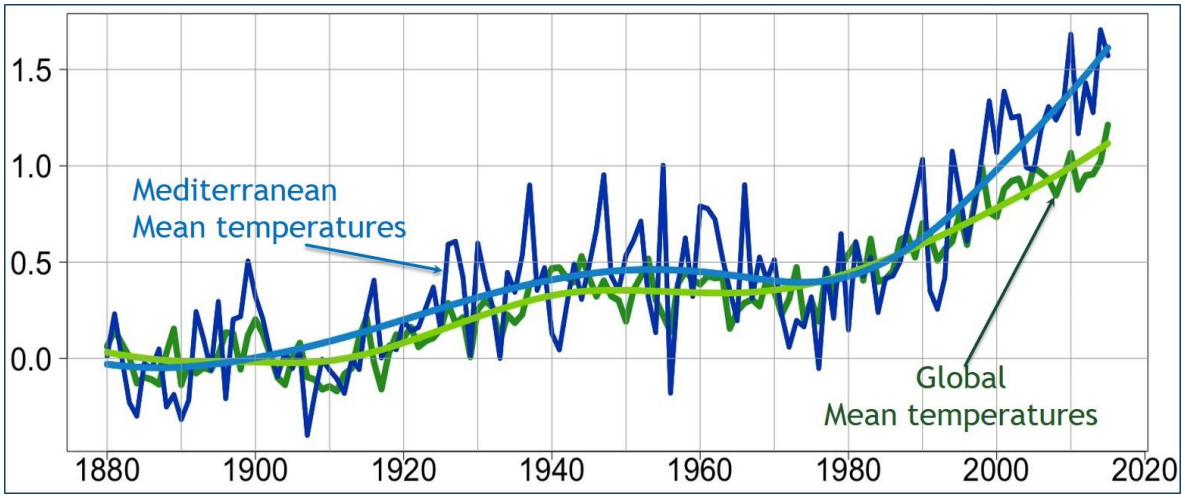

Figure 1: Anomalies of mean air temperatures (relative to 1880-1889) for the Mediterranean region (blue) and global values (green); Source: Cramer et al. (2018)

In addition, some of the countries continue to experience significant internal and externally imposed (armed) conflicts, which lead to major damage to buildings, infrastructure and entire dwellings as well as to significant hardships of the affected populations. These developments often result in internal and cross-border migration and growing social conflicts in the host countries between the local population and external migrants.

Future projections of climate change do not leave much hope for an improvement of the current situation in the EMME Region. Numerical climate models are driven by projected greenhouse gas (GHG) emissions (primarily, but not exclusively carbon dioxide, CO_2). These, emissions lead to corresponding atmospheric greenhouse gas concentrations, which have been labelled as Representative Concentration Pathway (RCP) in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and have been published by *van Vuuren et al. (2011).* The insert in Figure 2a represents the atmospheric CO_{2e}[1] concentrations for the 21st century. The main figure shows the projected mean global temperatures for moderate (RCP2.6) and maximum (RCP8.5) *Representative Concentration Pathways*.

Also shown as a red star in the insert of Figure 2a is the measured mean atmospheric CO_{2e} concentration for 2021 (*Umweltbundesamt, 2023*). The figure indicates that the recent concentration value lies well above the high greenhouse gas concentrations of RCP8.5. Thus, the maximum RCP8.5 seems to even underestimate concrete current atmospheric greenhouse gas concentrations. Consequently, the moderate and quite extreme temperature rises shown in figures 2b and 2c probably represent conservative estimates of projected climate changes in the EMME Region, which will amount to up to 5.5 to 6.0° temperature increases until the end of the century.

[1] CO_{2e} stands for equivalent CO_2 emissions; it is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP) by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming and to standardize the comparison of various greenhouse gases based on their potential to contribute to global warming over a specified time frame.

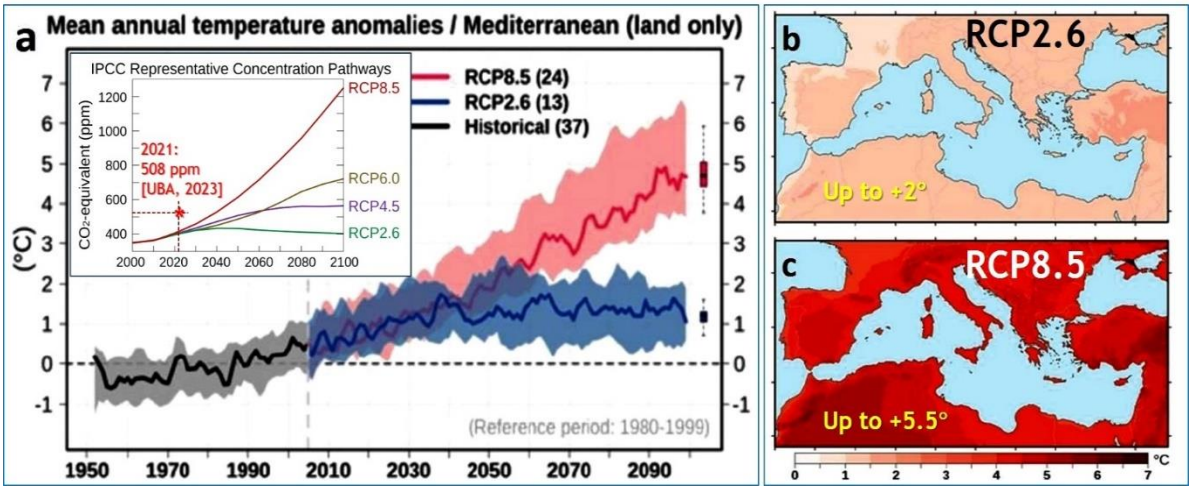

Figure 2: a: Projected changes in annual mean temperatures compared to the reference period (1980 to 1999) in the Mediterranean basin over land, based on moderate (RCP2.6) and high greenhouse gas concentrations (RCP8.5); insert: Representative Concentration Pathways and resultant atmospheric CO_{2e} concentrations for the 21st century; also shown is a measured mean atmospheric CO_{2e} concentration for 2021; b: Warming at the end of the 21st century (2080 to 2099) for RCP2.6; c: same for RCP8.5; sources: (MedECC, 2020; Umweltbundesamt, 2023; van Vuuren et al., 2011)

Given these circumstances, it is obvious that measures have to be taken to reduce the anticipated warming (i.e., mitigation) and simultaneously to device strategies to adapt to the unavoidable changes in climate conditions (adaptation) in the EMME region. While the first option primarily aims to reduce greenhouse gas emissions in the context of the *United Nations Framework Convention on Climate Change (UNFCCC; United Nations, 1992*) , the second aims at enhancing the resilience and adaptive capacity of affected communities and regions.

Against this backdrop, the Regional Programme on Energy Security and Climate Change Middle East and North Africa of the Konrad-Adenauer-Stiftung (KAS-REMENA) undertook the task to assemble a series of articles depicting the current mitigation (and adaptation) efforts in selected countries of the EMME region. Figure 3 provides a graphical depiction of the countries involved in this effort. The present paper aims to provide a summary and synthesis of these papers against the background of national mitigation and adaptation policies.

In the following, I will briefly describe the current GHG conditions and the proposed or planned efforts to reduce emissions in each of the countries covered by the series of articles (in alphabetical order; a short description of the conditions in the Palestinian Territories is also given). The descriptions of the emission reductions are based on national communications to the UNFCCC, on one hand, and the information and conclusions given in the articles of the series, on the other. As for the former, the information provided should not be seen as exhaustive and complete.

Figure 3: Countries involved in the publication series

Cyprus

The latest report on greenhouse gas emissions and their reduction of the Ministry of Agriculture, Rural Development and Environment of the Republic of Cyprus provides an overview over the national emission and removal-related trends in Cyprus *(Department of Environment, 2022b*). The total GHG emissions (excluding the emissions for land use, land-use change, and forestry) for 2020 amount to approximately 8,871.57 Gg CO_{2e}, up from 5,576.49 Gg CO_{2e} in 1990, an increase of 59.1% between 1990 and 2020.

In the report of the long-term low GHG emission development strategy for 2050 of the Republic of Cyprus *(Department of Environment, 2022a*) the authors state that Cyprus will follow the "collective European goal of a successful and sustainable transition to a climate-neutral economy by 2050". This is going to be achieved by following the government's strategic goal "to participate proportionately in the commitment towards a climate-neutral economy at EU level and to contribute to the European Green Deal promoted by the European Commission" (*European Commission*, 2019b).

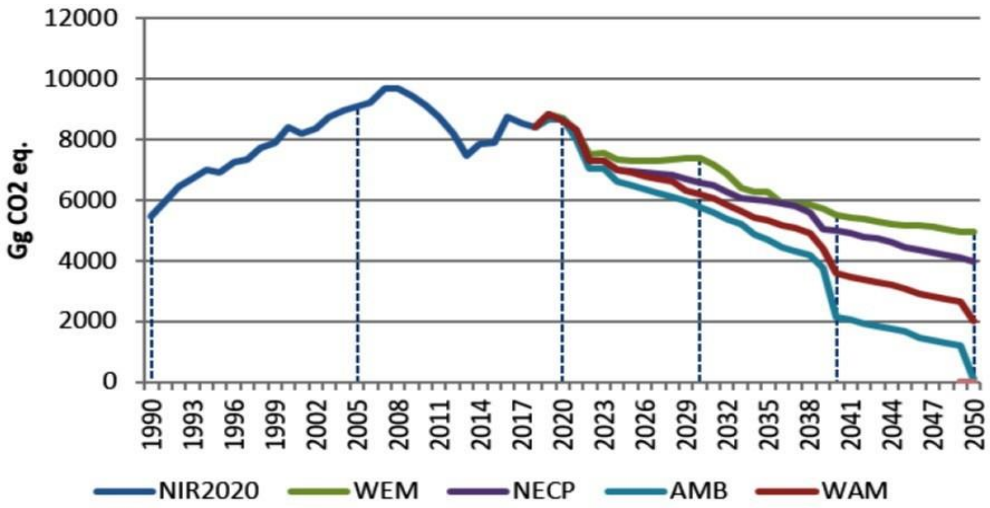

Figure 4: Projected emission reductions and enhancement of removals by 2050 with LULUCF in Cyprus (Land Use, Land Use Change and Forestry), where "NIR2020" are the GHG historical emissions according to the latest GHG inventory report available; WEM is the "With existing measures" scenario; NECP is the "Planned Policies and Measures" scenario as submitted through the NECP; WAM is the "Additional Measures" scenario; AMB is the "Ambitious" scenario towards carbon neutrality in 2050; source Department of Environment (2022a)

In order to advance cooperation on a regional level with the aim to formulate effective mitigation and adaptation strategies to climate change, the Cypriot Government initiated the "Eastern Mediterranean and Middle East Climate Change Initiative" in March 2019 (EMME-CCI) (https://emme-cci.org/). To that end, the *EMME Regional Action Plan*, a set of proposed projects and services has been formulated. The plan is based on the work of thirteen thematic task forces comprised of over 240 scientists under the coordination of *The Cyprus Institute*. It aims to ameliorate the impacts of regional climate change and to advance relevant mitigation actions, in line with the *Paris Agreement.*

In pursuing the reduction in greenhouse gas emissions, the Cypriot Government follows different scenarios ranging from the "Business-as-Usual" scenario (BaU) to the "Ambitious" scenario (AMB). Furthermore, three additional scenarios comprise the "existing measures" (WEM) scenario, the "planned policies and measures" scenario, i.e., the scenario submitted through the National Energy and Climate Plans (NECP) for 2030 and the "additional measures" scenario (WAM). Figure 4 presents the resulting greenhouse gas (GHG) emissions until 2050 (for more details, see *Department of Environment*, 2022a). However, the NECP scenario is the one currently applied in Cyprus, which will result in emission reductions

of 28% compared to 1990 and 56% compared to 2005 in 2050. The other measures contributing to the "Ambitious" scenario are still under consideration.

Given the relatively high demand of electricity both for space cooling and seawater desalination, particularly during the summer months, the annual demand per capita amounted to around 3,700 kWh in 2021, i.e., 14% below its 2010 level and 35% below the EU average. Renewable energies could play an important role to satisfy demand. However, the current share of renewables in electricity production stood only at 18.4% of total demand in 2021 (*enerdata, 2021*).

However, in the framework of the *long-term low GHG emission development strategy for 2050* of the Republic of Cyprus the estimated share of renewable energy in final energy consumption by 2050 ranges from 32% (BaU scenario) to 95% (AMB scenario). Given this quite ambitious goal, the share of renewable energy depends on the implementation rate of the policies and measures described in the NECP as well as the status of the implementation of electricity interconnection with neighbouring countries (*Department of Environment, 2022a*).

In his recent papers, the current author (*Lange, 2019; Lange, 2023*) describes innovative technologies that combine the generation of electricity and the production of freshwater through desalination that are driven by concentrating solar power (CSP). The experimental PROTEAS facility of the Cyprus Institute (*Papanicolas, 2010*) has been developed through bi- and multi-lateral cooperation and funded by numerous nationally and internationally funding agencies. The utilisation of "various forms of renewable energies in a hybrid renewable energy system in combination with energy storage devices (i.e., electrical and/or heat storage) offers new and innovative ways to enable the continuous provision of electricity" and freshwater (for more details, see *Lange, 2023*).

Egypt

Egypt, with approximately 113 million inhabitants in 2023, represents the most populous country in the EMME region. While Egypt's greenhouse gas emissions can be considered moderate on a global level, the country is highly vulnerable to the impacts of climate change, particularly related to water security and sea level rise (see below).

According to Egypt's *Third National Communication under the United Nations Framework Convention on Climate Change* (UNFCCC), the country's greenhouse gas emissions rose from 193.3 Mt CO_{2e} in 2000 to 247.97 Mt CO_{2e} in 2005. It was observed that CO_2 represents the lion share of the emissions with 66.3% and 67.6% of the total emissions in 2000 and 2005, respectively *(Egyptian Environmental Affairs Agency (EEAA), 2016*). According to the latest update, the First Biennial Update Report to the UNFCCC, Egypt's greenhouse gas emissions rose again to 325.6 Mt CO_{2e} in 2015, an increase of approximately 31% compared to the 2005-number (*Ministry of Environment, 2018*).

Egypt's GHG emissions by sector for 2005 and 2015 in Mt CO_{2e} are given in Figure 5. As can be seen, there are significant increases in emissions in all sectors, particularly in the energy sector, which accounts for 64.5% of total GHG emissions in 2015. The largest share of the total GHG emissions in the sector stems from fuel combustion activities, i.e., 95% and 97% of the energy sector's total GHG emissions in 2005 and 2015, respectively. 99% of the energy-related emissions in 2015 are comprised by CO_2 *(Ministry of Environment, 2018*). Natural gas and petroleum products account for 98% of the total primary energy consumption in FY 2014/2015 compared to 1.5% from hydropower, 0.4% from coal, and 0.1% from wind and solar power (*Ministry of Environment, 2018*).

Given these circumstances and having agreed to the *UNFCCC Paris Agreement of 2015 (United Nations, 2015*), the agreement entered into force in Egypt on November 4th, 2016, and was ratified by the Egyptian parliament in 2017. Earlier, it was noted that Egypt's high vulnerability to climatic variability and change calls for decisive measures aimed to adapt to the adverse impacts of climate change. To that end, Egypt

prepared its first *National Strategy for Climate Change Adaptation and Disaster Risk Reduction* in 2011 *(The Egyptian Cabinet, 2011*). In order to provide a comprehensive assessment on both mitigation and adaptation measures in Egypt until 2050, it was decided to formulate an *Egypt National Climate Change Strategy* (NCCS) aimed to express Egypt's commitment "…to deliver its fair share of climate action as part of global action to address climate change…" (*Egyptian Ministry of Environment, 2022*).

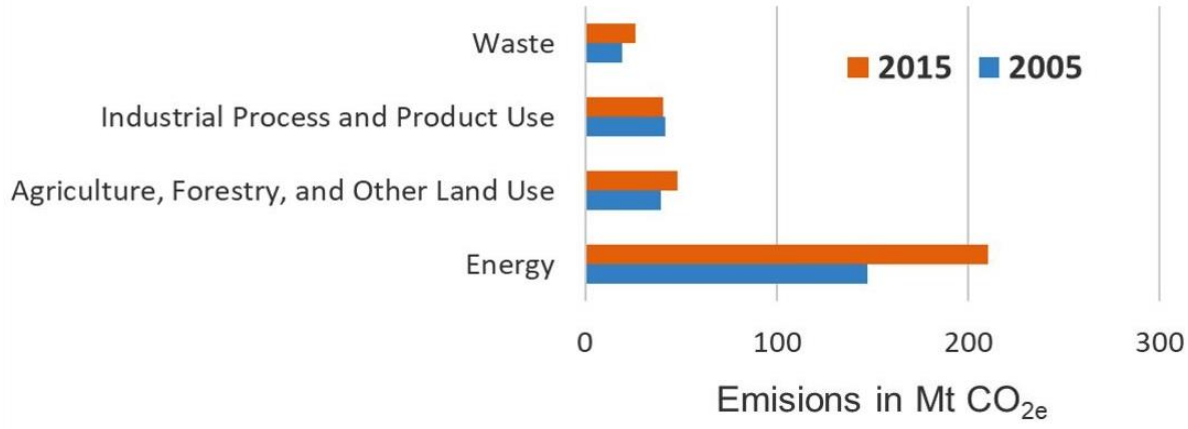

Figure 5: GHG emissions in Egypt by sector for 2005 and 2015 ; after Egyptian Environmental Affairs Agency (2016) and Ministry of Environment (2018)

The strategy outlines five main goals, with Goal 1 (*Achieving Sustainable Economic Growth and Low-Emission Development in Various Sectors*) and Goal 2 (*Enhancing Adaptive Capacity and Resilience to Climate Change and Alleviating the Associated Negative Impacts*) representing the two main goals. While they require most interventions in different sectors compared to other goals, they also result in the greatest impact on the reduction of greenhouse gas emissions and on adaptation to climate change impacts (more details can be found in *Egyptian Ministry of Environment, 2022*). In addition to presenting detailed descriptions of each of the five goals, which are comprised of 22 objectives, specific performance indicators for each goal are described. Moreover, the strategy outlines various crosscutting directions that underline the achievement of the abovementioned goals and objectives for Egypt, the proposed sources of financing as well as the costs of the envisioned mitigation and adaptation measures of the strategy in each sector *(Egyptian Ministry of Environment, 2022*). In the following, we will take a look at major impacts of climate change and more specific adaptation and mitigation measures as presented by *Jauad El Kharraz* (2023)

Jauad El Kharraz (2023) sets out by providing a brief description of natural hazards and impacts resulting from ongoing and anticipated changes of climate conditions, which have caused a significant number of human mortalities and sizeable economic losses over the last 20 years. The lack of available water for both human consumption and agricultural irrigation has continued to be a major challenge, affecting food and water security in the country. The prospects of decreasing precipitation in combination with increasing evaporation rates as a result of climate change may also adversely affect flow rates of the river Nile by up to 70%. Reduced water flows of the Nile, the most important source of water for the country, will enhance the challenges of water scarcity. Rising sea levels, resultant seawater intrusion into coastal aquifers and increased storm activities enhance the vulnerability of a large fraction of the population living in the Nile Delta and along the Mediterranean coast.

The energy sector still relies largely on fossil fuels, making it the major emitter of greenhouse gases in Egypt (see above). Lacking an adequate utilisation of the copiously available renewable energy sources, particularly solar energy, the contribution of new and renewable energy sources in the production of electrical energy amounted to no more than 4.4% as of 2019/2020 (*Egyptian Ministry of Environment, 2022*). While representing Africa's largest non-OPEC oil producer, climate change poses significant risks related

to inadequate supply capacity and may lead to system failures, rising outages, and brownouts (El Kharraz, 2023). In addition, climate change in combination with rising demand due to increased economic activities, on the one hand, and enhanced need for electricity for space cooling and energy-intensive seawater desalination on the other, will exacerbate risks to Egypt's energy security.

El Kharaz (2023) outlines a number of recommendations aimed to enhance Egypt's mitigation and adaptation capacities. This includes:

- an improved understanding of key vulnerabilities to the impacts of projected climate change and an increased public participation in specifying adequate mitigation and adaptation measures;
- a more comprehensive understanding of the risks of rising sea levels as a result of climate change and related enhanced vulnerabilities of coastal communities, based on improved environmental monitoring capabilities;
- the development of energy efficiency measures through a *Technology Needs Assessment* and by improving financing opportunities as well as providing legal support for public-private partnerships (PPPs); and
- the implementation of cross-sectoral climate-smart solutions for Egypt's agricultural and water management sectors at national and subnational levels in the framework of an assessment of the Water-Energy- and Food Nexus in the respective sectors of the economy.

Greece

In contrast to Egypt, Greece, similar to Cyprus, is a member of the European Union (EU). This implies that the government is obliged to follow EU rules and regulations with regard to greenhouse gas emission reductions.

According to the latest report of Greece to the UNFCCC (*Hellenic Republic, 2022*), greenhouse gas emissions (without *Land Use, Land-Use Change, and Forestry,* LULUCF) amounted to 74.84 Mt CO_{2e}, showing a decrease of 27.66% compared to 1990 levels. Carbon dioxide (CO_2) emissions with 74.31% of the total represented the largest fraction of the GHG emissions, followed by methane (CH4) with 12.94% and nitrous oxide (NO2) with 12.94%. The energy sector is by far the largest emitter, followed by the sectors international transport,

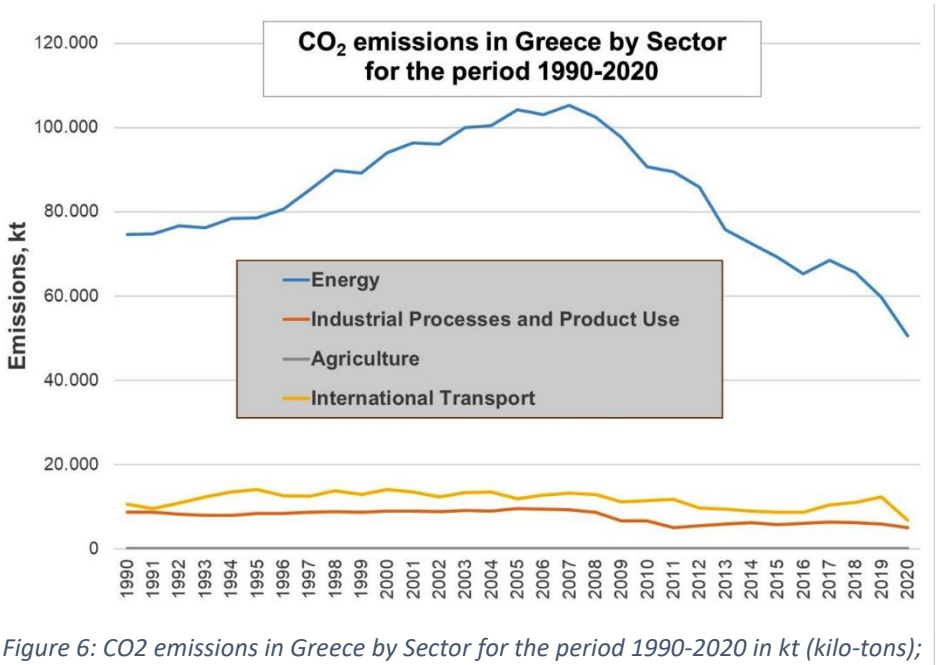

Figure 6: CO2 emissions in Greece by Sector for the period 1990-2020 in kt (kilo-tons); after Hellenic Republic (2022)

industrial processes and product use and agriculture (Figure 6) with average emissions for the years 1990 to 2020 of 83,768 kt, 11,589 kt, 7,632 kt and 37 kt, respectively *(Hellenic Republic, 2022*).

The sharp downturn of emissions after 2006 is caused by a drastic economic decline, which resulted in significant decreases in the *Gross Inland Consumption* and the *National Gross Domestic Product* (see Figure 1.1 in *Hellenic Republic, 2022*).

Greece not only aims to reduce emissions based on UNFCCC policies, but, as mentioned above, also adheres to EU emission reduction measures and policies (specifically the EU's Energy Union Goals by 2030) through national legislation implemented by *the Ministry of Environment and Energy* (MEEN). In 2019, the *National Energy and Climate Plan* (NECP) was issued by the Greek government as a "strategic plan for climate and energy issues, setting out a detailed roadmap regarding the attainment of specific energy and climate objectives by 2030" (*Hellenic Republic, 2019*). Based on the NECP, it was estimated that the total quantifiable reduction potential of GHG emissions, based on policies and measures (without LULUCF) will amount to 36.8Mt CO_{2e} for 2025 and to 39.8Mt CO_{2e} for 2030 (*Hellenic Republic, 2022*).

The implementation of the plan rests on three main goals/pillars (*Hellenic Republic, 2019*):

(i) reducing GHG emissions
(ii) increasing the share of renewable energy sources (RES) and
(iii) enhancing energy efficiency.

To obtain goal (i), the total GHG emissions will be reduced by at least 40% compared to 1990 in order to attain emission reduction objectives in individual sectors of the economy within and outside the emissions trading system, which are equivalent to the respective core EU objectives.

The share of renewable energy sources in the gross final energy consumption will have to reach at least 35% during the period 2021-2030 to reach goal (ii). To that end, it is planned to reach at least or exceed a share of renewable energy sources of 60%, 40% and 14% in gross final electricity consumption, in covering heating and cooling needs and in the transport sector, respectively.

To enhance energy efficiency (goal (iii)), it is planned for the final energy consumption not to exceed 191.9 TWh (16.5 Mtoe) in 2030, for the primary energy consumption not to exceed 244.2 TWh (21 Mtoe) in 2030 and to attain cumulative energy savings of 84.9 TWh (7.3 Mtoe) during the period 2021-2030.

Policy priorities and measures have been defined and selected in order to reach the ambitious targets set, consistently and effectively. In addition, procedures have been specified to assess the performance and evaluating the impacts of the policy measures and in order to obtain feedback concerning the policy priorities with a view to possibly revise and redefine the priorities, if needed *(for more details, see Hellenic Republic, 2019*).

The consultation and involvement of national, regional and EU bodies represents an integral element of the NECP. This includes the participation of the Hellenic Parliament, local and regional authorities, stakeholders, including social partners, and the involvement of civil society and the general public, as well as regional cooperation involving Cyprus, Egypt, Israel, Italy and Jordan (Hellenic Republic, 2019).

In his paper as part of this publication series, *Agis Digkas (2023)* points out that "climate change presents both challenges and opportunities for Greece in the Eastern Mediterranean region". He clearly points out that changes in climate conditions and their impacts have a direct bearing on the development model, various economic sectors and most of the ecosystems in Greece. These challenges will require appropriate adaptation strategies to both reduce adverse effects of these impacts and to ensure continued economic growth of the country.

More specifically, he explains that climate change represents threats to biodiversity and forest ecosystems, mainly resulting from an ever-increasing number of forest fires. Forests occupy over 65% of the land area of Greece and provide a variety of material goods, as well as contributing to the provision of quality water. Protecting these ecosystems, which are also vital for CO_2 sequestration, requires reforestation efforts as well as international cooperation to combat a growing number of the already mentioned wildfires of increasingly affected space. In 2021, the number of forest fires increased by 43% compared to the average of previous years in Greece. Moreover, the burned areas represent an even greater increase of about 500% compared to the same figure in 2020 (*Digkas, 2023*).

While still declining, the agricultural sector remains of particular importance to Greece and currently accounts for 3.9% of the national *Gross Domestic Product* (GDP) and constitutes 17% of the total Greek exports. However, agricultural productivity faces severe risks due to loss of arable land, increasing temperatures, shorter growing seasons and enhanced water scarcity as a result of falling precipitation rates. This requires effective adaptation measures and knowledge exchange with neighbouring countries and on an EU level in order to maintain food security and adequate export volumes of agricultural goods (more details, see *Digkas*, 2023).

Similarly to other countries in the Eastern Mediterranean, Greece faces increasing energy demands because of steadily increasing temperatures and longer heat waves particularly in towns and cities, which are affected by the "urban heat-island effect" (see, e.g., *Lange, 2019*). This requires significant amounts of electricity for space cooling, in order to maintain acceptable indoor conditions. While renewable energy sources such as hydropower plants and wind farms face various challenges as a result of climate change, solar/photovoltaic (PV) energy production offers significant benefits, despite the loss of PV output due to rising air temperatures. As outlined in the NECP (*Hellenic Republic, 2019*, see above). *Digkas* also emphasises the role of multilateral cooperation in developing interconnection and energy transmission infrastructure (*Digkas, 2023*).

The above mentioned implications of rising temperatures and extreme weather events will also adversely affect the tourism sector, which is vital to the Greek economy (*Digkas, 2023*). In addition, the adverse effects of climate change on cultural monuments and the loss of cultural heritage will have a significant bearing on Greece's attractiveness for tourists.

However, innovative technologies, collaboration on a national and international (EU-) level as well as developing and enhancing networks of bi- and multilateral cooperation can turn the above outlined challenges into opportunities for Greece. "Strengthening multilateral cooperation, knowledge sharing, and investing in resilient infrastructure" will reduce the adverse impacts of climate change through effective adaptation strategies and measures in the context of following the UN Sustainable Development Goals (*Digkas, 2023; UN General Assembly, 2015*).

Israel

Lying at the eastern rim of the Mediterranean, Israel, unlike most of its neighbours, represents a highly developed country with the highest GDP in the region. This notwithstanding, the authors of the paper considered here (Zohar and Abu Hamed, 2023) challenge the apparently ambitious mitigation strategy (see below).

Israel's total greenhouse gas (GHG) emissions in 2020 amounted to 77.42 million tons of CO_{2e} (77.42 Mt CO_{2e}), an increase of 3.5% relative to 2010 emissions but a decrease of 1.5% relative to 2015 emission levels (*State of Israel, 2023*).

With regard to the shares of GHG emissions of different sectors of Israel's economy (Figure 7), the energy industries dominate the distribution (48%), followed by the transport sector (22%) and the industrial sector (10%) (for more details, see *State of Israel, 2023* and Figure 7).

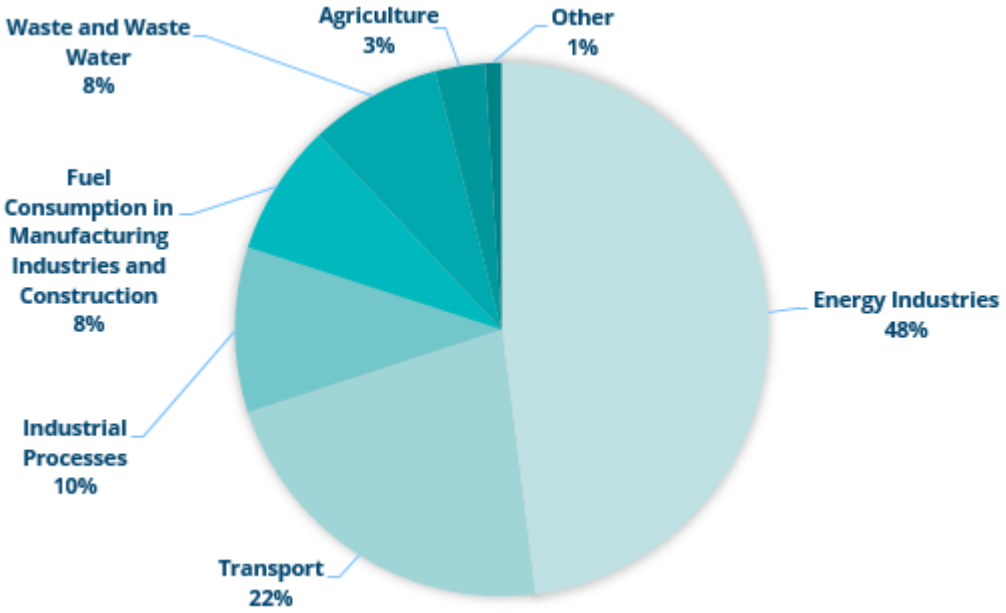

Figure 7: Israel's sectoral GHG emission shares in 2020; after (State of Israel, 2023)

In its updated *Nationally Determined Contribution under the Paris Agreement* (NDC), Israel declared emission reductions of 27% relative to 2015 levels by 2030 and 85% relative to 2015 levels by 2050. Moreover, during COP 27 in Glasgow, UK, Israel expanded these goals by committing to reach Zero Carbon Emissions by 2050 (*State of Israel, 2023*). As to the 2030 targets, a reduction of 47% regarding waste (excl. wastewater) and of 30% in the power generation and industry sectors relative to 2015 have been declared.

While these goals appear quite ambitious, *Zohar and Abu Hamed (2023)* in their paper argue that Israel's "climate change mitigation and adaptation plans are lagging, followed by unambitious emission reduction targets and the lack of sufficient supporting policies". This is reinforced by the fact that, even though the overall share of GHG emissions by Israel might be negligible on a global scale, the country is already experiencing significant impacts of climate change similar to other countries in the Eastern Mediterranean. Given the expected increase in demand, *Zohar and Abu Hamed (2023)* argue that the recent energy mix is inappropriate (Figure 8). In particular, the current use of renewable energy sources (8% of total demand) lacks far behind the significant potential. Israel aims to increase the use of renewables to 20% of the total sector production by 2025 and to 30% by 2030. The utilisation of coal is expected to decline to approximately 3% only by 2025 (*The Electricity Authority, 2021; Zohar and Hamed, 2023*).

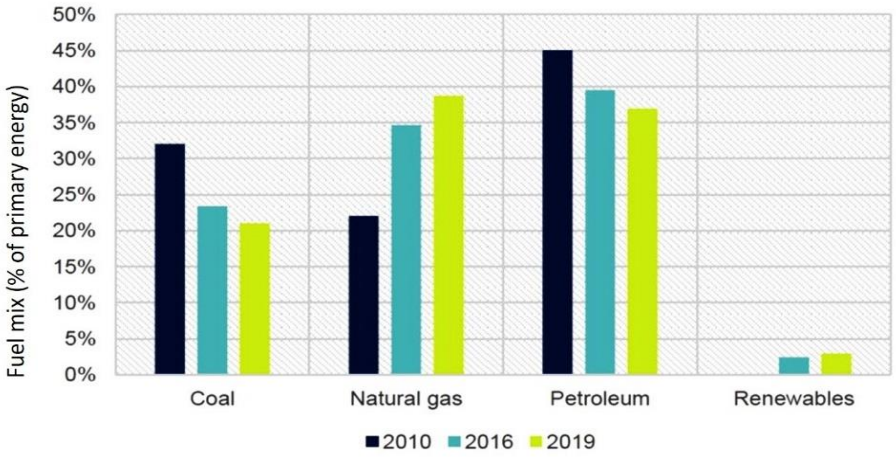

Figure 8: Israel's fuel mix (% of primary energy) between 2010 and 2019 (after State of Israel, 2023)

While Israel plans to decrease its CO_2 emissions per capita, the demographic development of the country, i.e., an expected increase in population is likely to offset this reduction. The above mentioned less ambitious emission reduction goals can be explained by several factors. This includes: the contributions of the natural gas sector to the government budget, which cannot be replaced easily by renewables, the shortage of land areas needed for a larger share of renewables (particular solar energy) and the inappropriately low investments in upgrading the transmission lines (for more details, see *Zohar and Hamed*, 2023). The latter seems to be the largest obstacle in expanding the utilisation of renewables in Israel. Moreover, expanding the transmission infrastructure is likely to require 5 to 15 years, which makes achieving the 30% goal by 2030 quite unlikely. Innovative approaches, e.g., the integration of renewable energy into the built environment may enable better prospects. Another promising technology is dual use of agricultural land through agro-photovoltaics. This not only affects the provision of renewable energy positively, but contributes also favourably to addressing the Water-Energy-Food Nexus in Israel (*Zohar and Hamed*, 2023).

Aside from a larger share of decentralised low-carbon systems, Zohar and Abu Hamed (2023) also argue for a stronger approach to regional cooperation with Israel's neighbouring countries. Israel can currently be considered as an "energy island", lacking any electricity connections with neighbouring countries. Even minor malfunctions can lead to blackouts and to severe adverse consequences for the food and water sector as well as for the health sector in Israel. Moreover, climate change and its impacts in the Eastern Mediterranean will have "spill over effects of climate change-driven crises in neighbouring countries", regardless of any efforts towards adaptation (*Zohar and Abu Hamed*, 2023).

An increasing fraction of Israel's water demand is being satisfied by desalination facilities. While the current annual desalination capacity stands at 585 mill. m^3, demand projections for 2050 result in a required annual capacity of 1,750 million m^3. Given the fact that the related electricity demand is currently largely satisfied by hydrocarbon fired power plants, the threefold increase in water demand by 2050 will imply either additional GHG emissions or a massive expansion of renewable energy production (*Zohar and Hamed*, 2023).

In light of these circumstances and taking into account significantly more favourable conditions for solar energy production in Jordan (more available space, lower production cost), as well as the complete dependence on water and energy supply from Israel in the Palestinian Territories, the regional environmental peacebuilding organisation *EcoPeace Middle East* (with support by the Konrad-Adenauer-Stiftung) developed a promising initiative. The "Blue-Green Deal" foresees the provision of solar energy by Jordan to Israel and Palestine to be used in seawater desalination and in exchange the delivery of freshwater to Jordan (more details, see *Bromberg et al.*, 2020; *Zohar and Abu Hamed*, 2023). This followed earlier initiatives by the *Arava Institute for Environmental Studies* in 2016, which resulted in constructive formal and informal environmental agreements between Israel, the Palestinian Territories and Jordan (*Zohar and Abu Hamed*, 2023).

An agreement to advance the "Blue-Green Deal" has been the signing of a cooperation agreement between Israel and Jordan ("Project Prosperity") in 2022 during COP27 in Sharm El-Sheikh, Egypt. Unfortunately, since the construction of a desalination plant in Gaza is still forthcoming, the Palestine Authorities are not part of the agreement.

However, previous and current political tensions and conflicts between Israel, the Palestinian Authorities and neighbouring countries have resulted in significant obstacles for Palestinian mitigation efforts. In particular, the unavailability of land for photovoltaic installation in the West Bank's "Area C" prevents advances in the initiation and realisation of renewable energy projects (i.e., mainly photovoltaics) in areas controlled by Israel (see below and *Kittaneh*, 2023; *Zohar and Abu Hamed*, 2023).

Initiating and advancing measures in Israel and its neighbouring countries in the Eastern Mediterranean in response to ongoing and future climate change face significant challenges based on the fact that regional mechanism to support cross-border cooperation in preparing and implementing regional

adaptation and mitigation plans are largely missing. Despite the importance of national adaptation and mitigation strategies, capacity building and information exchange, coordinated regional financing, establishing a regional cooperation council on climate change, and enhancing public-private partnerships should be, but have not yet been integral components of a developing regional cooperation in the Middle East (*Zohar and Hamed*, 2023).

Palestinian Territories

The Palestinian Territories have been facing significant challenges with regard to reaching or maintaining water-, energy- and food security independently of foreign assistance. This also limits the options with regard to GHG reduction and adaptation strategies. As described below, effective policies will depend on reaching "independence" as an independent state.

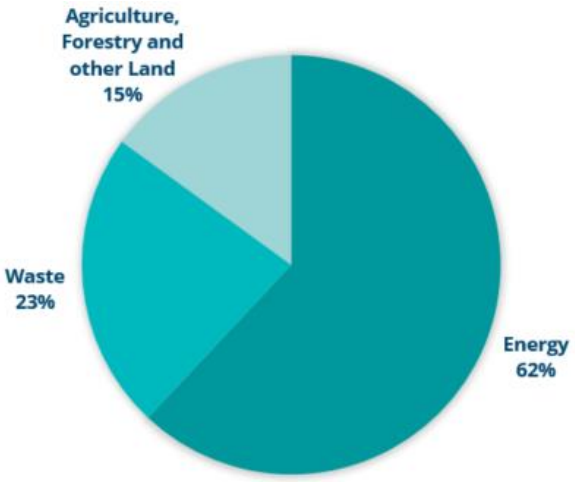

Figure 9: Sectoral distribution of GHG emissions (in %) in 2011 in the Palestinian Territories (State of Palestine, 2021)

Total GHG emissions in the Palestinian Territories amounted to 3.2 Mt CO_{2e} in 2011, which translates into 0.8 t CO_{2e} per capita (for the West Bank, including East Jerusalem, and the Gaza Strip), which lies significantly below the global average of 6.73 t CO_{2e}. The sectoral distribution (Figure 9) is dominated by GHG emissions from the energy sector (1.9 Mt CO_{2e}), followed by the waste (0.8 Mt CO_{2e}) and agriculture, forestry and other land use sector (0.5 Mt CO_{2e}) (*State of Palestine, 2021*).

The primary energy consumption in the Palestinian Territories in 2018 amounted 19.9 TWh. The energy is provided mainly by oil and gas (58%), energy, which goes mainly to the residential and transportation sectors, followed by electricity (29%) and only 13% of renewable energy sources (*meetMED, 2020*).

Given current developments, projections of "business as usual" (BAU) as well as possible reduction scenarios are quite uncertain. The latest report distinguishes between BAU and mitigation projections for a "status quo" and an "independence" scenario, respectively (for a definition of the scenarios, see *State of Palestine, 2021*).

In an earlier report, projections of future GHG emissions for a more detailed representation of sectors have been given in *State of Palestine (2016)*. Similar to the later report (see above), a "status quo" and an "independence" scenario have been considered for BAU projections between 2015 and 2040 (Figure 10). Mainly because of the expected significant increase in population (on the order of up to 500% until 2040) and in the GDP in the "independence" scenario, the largest increase in emissions is expected for the power generation sector. In the "status quo" scenario, the overall emissions, as well as those of the power generation sector emissions are significantly lower (*State of Palestine, 2016*).

While the annual total GHG emissions in 2040 in the earlier report amount to 9.13 Mt CO_{2e} and 18,06 Mt CO_{2e}, in the "status quo" and the "independence" scenario, respectively (*State of Palestine, 2016*), these numbers have been raised to 15.93 Mt CO_{2e} and 22.49 Mt CO_{2e} (*State of Palestine, 2021*). The main factors accounting for these increases are revised assumptions regarding transport and power generation and the inclusion of GHG emissions derived from imported electricity from Israel.

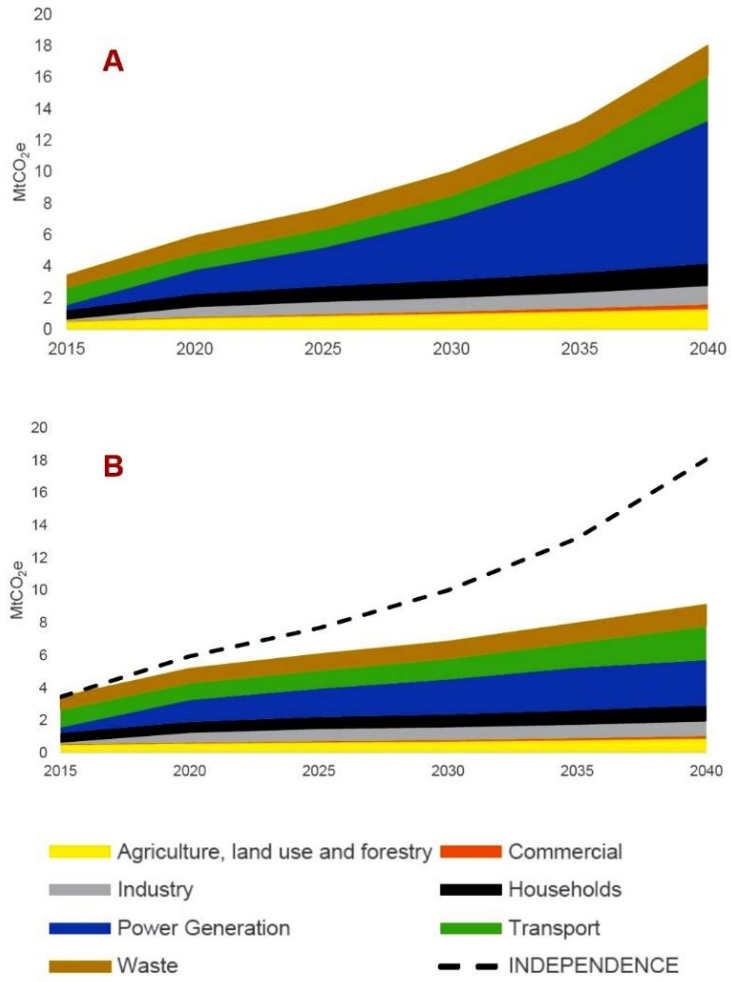

Figure 10: Emission Scenarios for the Palestinian Territories for different BAU Scenarios (A: "Independence" scenario; B: "Status quo" scenario) and different Sectors (after State of Palestine, 2016)

However, even though, the 2040 projections for GHG emissions lie well above the earlier values, the updated NDC implementation action plan considers the mitigation potential at 2.8 Mt CO_{2e} and 4,6 Mt CO_{2e} for the "status quo" and "independence" scenario, respectively. The resultant GHG emissions amount to approximately 13 Mt CO_{2e} and 22.5 Mt CO_{2e} for the "all mitigation status quo" and the "BAU Independence" scenarios, respectively (see Figure 1 in *State of Palestine*, 2021). This notwithstanding and given the current socio-economic situation as well as the high political instability, the ability to implement mitigation actions on the Palestinian side remains challenging. As long as the Palestinian Territories are almost entirely dependent on imported energy from Israel and thus lacks full control over its emissions profile, reduction scenarios remain hypothetical.

In his paper, *Omar Kittaneh (2023)* focusses on the energy sector of Palestine and the development options aimed to satisfy all of the future demand and to achieve enhanced energy security for the West Bank and Gaza. Recent institutional reforms of the electricity sector have paved the way towards accomplishing this objective. However, more efforts based on studies by the *Palestinian Energy and Natural Resources Authority* (PENRA) as well as substantial financial resources are needed to develop, optimise and carry out a "master plan that ensures meeting all demand requirements over a 20-year planning horizon" (*Kittaneh, 2023*).

Given the already mentioned current dependence on energy imports from Israel and the relatively sparse amount of electricity provided by the diesel-fired Gaza Power Plant, the need for alternative, independent power sources is obvious. Palestine is ideally situated to employ solar power generation with 3,000 sunshine hours per year and a high irradiance of 2,000 kWhm-2 (*Kittaneh, 2023*).

PENRA has developed plans to install PV devices on rooftops and on the ground with a capacity of over 500 MW by 2030 in Gaza. However, due to the sparse spaces available in Gaza, the options to expand on PV are much more constrained than for the West Bank. PENRA also argues for an expansion of conventional power plants fired by natural gas from *Gaza Marine*, an offshore Palestinian gas deposit discovered 20 years ago (*Kittaneh, 2023*).

Even though, the available land area in the West Bank would potentially enable solar power generation at a capacity of 3,000 MW, the available land area to be utilised lies almost entirely in the so-called Zone C, which is controlled by Israel and permits for construction are rarely granted there. Zones A and B, i.e., about 40% of the total land area of the West Bank are utilised mostly for Palestinian towns and industries.

This leaves available land area for PV-instalments for a capacity of no more than 103 MW. Thus, decentralised, independent micro- and mini-grids, combined with battery storage offer more realistic opportunities to realise viable and cost-effective renewable energy utilisation in Gaza (*Kittaneh, 2023*).

The recent attempts to develop plans by Israel and Jordan to "green" their economies, and given the risks posed by climate change to Palestine and its neighbours, may initiate regional cooperation aimed to achieve energy- and water security sustainably and environmentally friendly. The already mentioned "Blue-Green Deal" as proposed by EcoPeace Middle East and the Konrad-Adenauer-Stiftung *(more details in Bromberg et al., 2020*) can be considered a first step towards this goal. Another important step towards enhanced energy security for Palestine and Israel would be an agreement on the joint utilisation of land in Zone C of the West Bank for large PV-installations. Finally, an involvement of the European Union as part of the foreign policy aspects of the European Green Deal and the development of an appropriate legal regulatory framework encompassing all the relevant actors would significantly enhance regional cooperation towards achieving energy-, water- and food security in Palestine and its neighbouring countries *(Kittaneh, 2023*).

Türkiye

With a population of 85 million Türkiye represents one of the most populous countries in the EMME region. Unlike the Palestinian Territories, Türkiye has seen significant economic growth over the last few decades, which has been accompanied by rising GHG emissions. While this has caused concern by the government and has led to Türkiye striving to follow UNFCCC's recommendations, present mitigation objectives fall short of reaching the Convention's reduction targets (see below).

The total GHG emissions (excluding the LULUCF; *Land Use, Land Use Change and Forestry*) in Türkiye in 2020 amounted to 523.9 Mt CO_{2e}, an increase of 138.4% since 1990. The sectoral distribution clearly marks the energy industries as the sector with the highest emissions, followed by the transport sector, other sectors, including emissions from fuel consumption at residential, commercial, and institutional buildings and at agriculture and manufacturing industries and construction (Figure 11). It is seen that there has been an increase in emissions by the energy industries and transport sectors while emissions from manufacturing industries and construction decreased between 1990 and 2020 (*Republic of Türkiye, 2023*).

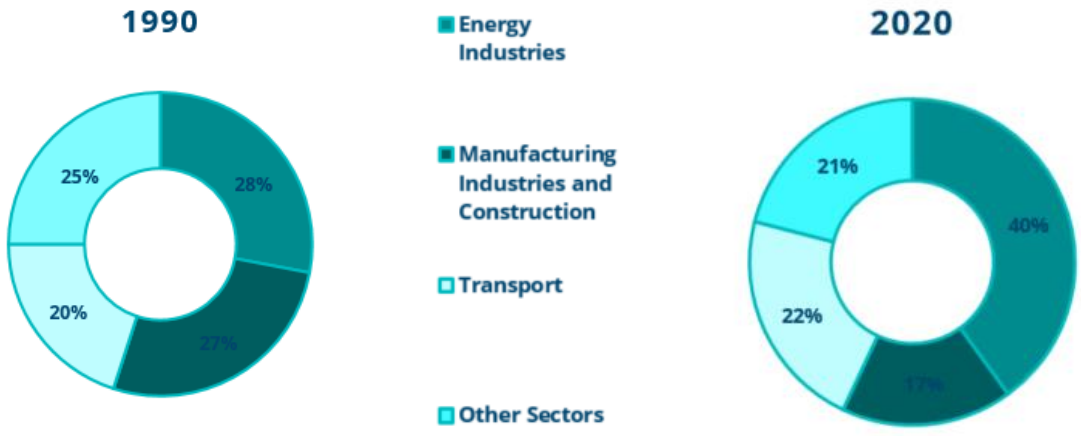

Figure 11: Türkiye's CO_{2e} emissions from fuel combustion by sectors, in 1990 and 2020 (after Republic of Türkiye, 2023)

The total installed power generation capacity in Türkiye amounted to 103.8 GW in 2022, which represents a fourfold increase since 1990 and is expected to grow to 189.7 GW by 2035 (*Republic of Türkiye, 2023*). A look at the shares of various sources of electricity generation in 2020 compared to 1990 reveals that coal

remains as the largest source while the shares of hydropower decreased and those of renewables and waste grew from zero to 17% of the total between 1990 and 2020 (Figure 12).

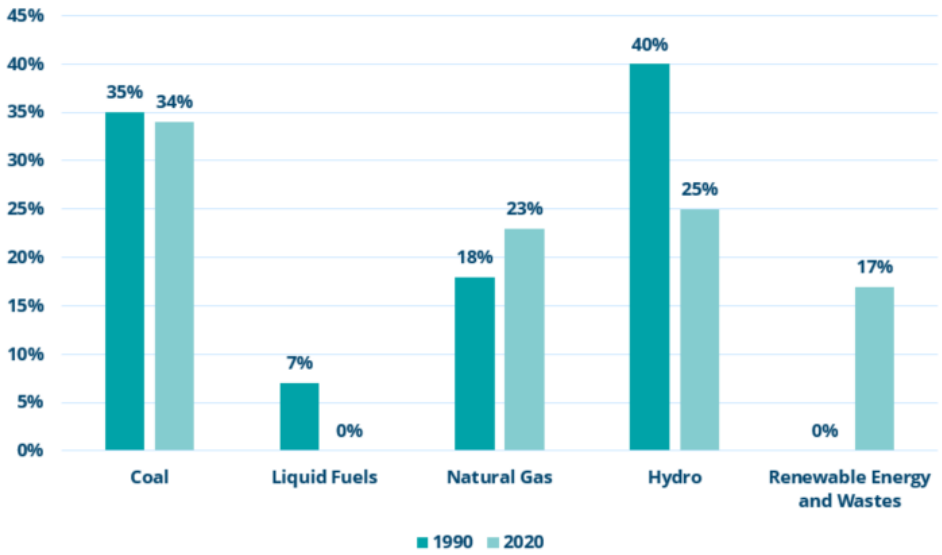

Figure 12: Electricity generation and shares by energy resources in 1990 and 2020 (after Republic of Türkiye, 2023)

Türkiye has seen a significant growth in urbanisation over the last 20 years. This is reflected in an increase in the number of new buildings since 2002 by 107.7% (*Republic of Türkiye, 2023*). It can also be seen in the vast emissions of CO_2 by the cement industry in 2020 (Figure 13).

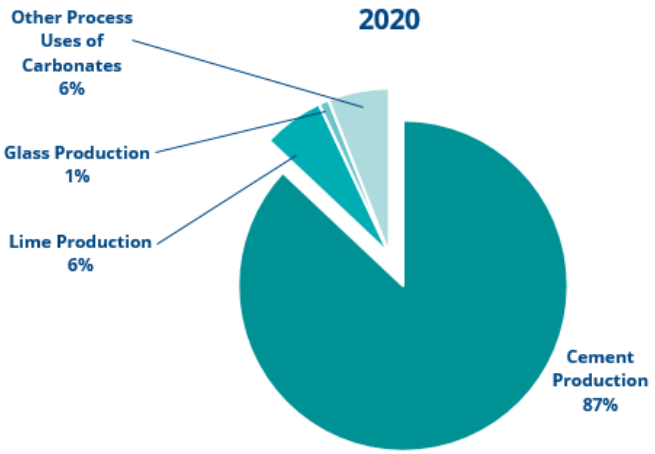

Figure 13: Share of CO_2 emissions from mineral production in Türkiye in 2020 (Republic of Türkiye, 2023)

Having joined the UNFCCC as a party on 24 May 2004, Türkiye ratified the *Kyoto Protocol* on 26 August 2009, and ratified the *Paris Agreement* on 7 October 2021. Ever since the first report on the *National Determined Contribution* (NDC) to the UNFCCC, Türkiye pledged to decrease its GHG emissions by 41% with its updated first NDC and aims for net-zero emissions by 2053 (*Republic of Türkiye, 2023*). These measures are described in detail in a number of government documents including the 11th Development Plan as of July 18, 2019, the *Climate Change Strategy* (2010-2023) and *National Climate Change Action Plan* (2011-2023) (more details can be found in *Republic of Türkiye, 2023*). In addition, in 2021, Türkiye issued a comprehensive "Green Deal Action Plan". The Plan aims for a carbon-neutral future and dwells on a green transformation of Türkiye's industries and adoption of measures for harmonising with the EU's Green Deal, especially in areas related to trade and industry" (*Republic of Türkiye, 2023*).

Given these initiatives by the Republic of Türkiye, *Güven Sak (2023)* examines the potential for accelerating the decarbonisation efforts in Türkiye and in the Eastern Mediterranean. In so doing, he scrutinises the

role of Türkiye and its relationship with the European Union in such efforts. As to the latter, Güven Sak argues that the *European Green Deal* (EGD) plays a particularly important role in the reduction of the continent's net GHG emissions to zero by 2053 and to "decouple" economic growth from carbon emissions (*European Commission*, 2019a).

However, by focusing on the countries of the Eastern Mediterranean, Güven Sak points out that there are significant obstacles and differences in advancing effective mitigation measures, e.g. with regard to phasing out coal as a major energy source. As can be seen (Figure 12), coal still plays a major, if not to say a dominant role in Türkiye's share of energy resources for electricity generation. While the need to phase out coal has been recognised by the government of Türkiye, progress towards determining an appropriate timetable remains forthcoming (*Sak, 2023*).

Similar disparities between Mediterranean countries are observed with regard to the *Notre Dame Global Adaptation Initiative Index* (ND-GAIN; *University of Notre Dam*, 2023). The index expresses comparisons between various countries' vulnerability to climate change as well as their policies to address its impacts. The higher the score, the better a country is prepared to deal with- and the lower its vulnerability to the impacts of climate change. Türkiye with a current index of 56.5 (up from 47.5 in 1995) stands at the 52nd rank of some 100 countries, ranks slightly below Cyprus, Greece, Israel, Italy and Malta, but significantly lower than France (*University of Notre Dam*, 2023).

In order to avoid losing a significant portion of export revenue due to non-compliance with the *European Carbon Border Adjustment Mechanism* (CBAM; *European Commission*, 2021), Türkiye developed and issued its "Green Deal Action Plan" (GDAP, see above) in 2021. Given that 45% of Türkiye's export volume reaches countries of the European Union, the GDAP aims to define "a roadmap for the preparation of more comprehensive action plans for achieving a carbon-neutral future" (*Sak, 2023*).

Türkiye's GHG emissions have recently grown to 523.9 Mt CO_{2e} (see above), which corresponds to around 12% of the EU-wide emissions. While the goal to reach net-zero emissions by 2053 is quite ambitious, the country failed to reach its intermediate emission reduction goals as announced during the COP27 at Sharm el Sheikh in November 2022. To reconcile this deficiency, Türkiye aims to pass a "Climate Law, which will specify Türkiye's Emissions Trading System (ETS) and carbon pricing mechanisms" as well as a carbon tax framework (*Sak, 2023*).

While the adoption of the *Customs Union* (CU) between the EU and Türkiye in 1996 has significantly contributed to Türkiye becoming an industrial country in the Eastern Mediterranean, the EGD requires a significant shift in the modernisation/decarbonisation of the country. *Sak (2023)* concludes that this may lead to a renewal of the existing CU arrangement and to advance efforts to significantly reduce environmental degradation and to lower GHG emissions in Türkiye.

However, reaching the goals of the EDG not only requires strong determination by political decision makers, it will also need to be supported by new European investments in sectors that are relevant for Türkiye's decarbonisation such as the energy sector. This implies that European countries assume a more integral part of the economy and provide incentives for the Turkish government to pursue its ambitious plans more forcefully. The already mentioned modernisation of the CU in light of the EGD may offer an adequate framework for enhanced future cooperation between the EU and Türkiye. Moreover, a common perspective not only on a bilateral but also on a regional basis is needed in order to advance decarbonisation pathways for the Mediterranean, in general, and the Eastern Mediterranean, in particular. This will not only benefit Türkiye, but may also give rise to a "greener Eastern Mediterranean" (*Sak, 2023*).

As to the latter, the *Eastern Mediterranean Gas Forum* (EMGF; https://emgf.org/), which was established in 2019, can provide a valuable stepping-stone towards regional cooperation. An even more ambitious, but also more effective tool for enhanced joint actions may be a – yet to be created – Mediterranean Climate Forum. Such a forum would be instrumental in facilitating constructive dialogue between the EU and

countries of the Eastern Mediterranean and may "lay the foundations of a blue growth strategy for the region as a whole" (*Sak, 2023*).

Summary and Conclusions

As summarised above, while the countries in the Eastern Mediterranean considered here (Cyprus, Egypt, Greece, Israel, Palestinian Territories and Türkiye) are all strongly affected by climate change and its impacts, mitigation and adaption strategies and measures differ widely between these countries. Table 1 provides an overview of current/recent GHG emissions and projected reductions or increases in emissions. The latter follow largely (with Egypt and Türkiye as exceptions) the NDSs reported to the UNFCCC.

As can be seen, while Cyprus, Greece and Israel aim for substantial reductions, GHG emissions in Egypt, the Palestinian Territories and Türkiye are likely to increase over the next decades. Given the highly unstable and challenging situation in the Palestinian Territories, the cited numbers can only be regarded as hypothetical.

This notwithstanding, all countries have developed mitigation strategies and actions addressing both GHG emissions and increases in energy efficiency in various sectors of the national economy. In all countries, the energy sector represents the dominant source of GHG emissions. Consequently, measures to reduce emissions and enhance efficiency address mostly this sector.

Given that the notorious scarcity of available water for agriculture and human consumption is a common characteristic for most countries in the Eastern Mediterranean, it is also known that anticipated changes in climate and their impacts will adversely affect future food production. The need for additional space cooling in urban environments during long-lasting heat waves in the foreseeable future (*Zittis et al., 2021*), will significantly increase the demand for electricity. Similarly, providing potable water to an increasingly drier region has resulted in efforts to build a growing number of desalination facilities in those countries of the Eastern Mediterranean that can afford the substantial investments. Seawater desalination is known to be extremely energy demanding, thus adding pressure on already stressed electricity demands (see, e.g., *Lange, 2013*).

However, despite the well-established interdependencies and feedbacks between water- and energy security (see, e.g., *Lange, 2019; Lange, 2023*), a thorough consideration of the Water-Energy Nexus in light of ongoing and future climate change, while mentioned in most of the country studies considered here , is largely absent from most government documents and related policies. Moreover, expanded considerations addressing food security in relation to energy and water availability through the concept of the Water-Energy-Food Nexus (for more details, see *Hoff, 2011*) is rarely mentioned in these documents. A common thread in the papers of the present publication series considered here is the clearly expressed need for more cooperation on the national, regional and international level. Bi- and multilateral cooperation such as the mentioned "Blue-Green Deal", a joint program between Israel, Jordan and the Palestinian Territories (*Bromberg et al., 2020*) is a good example for such efforts. Joining forces with the European Union through its "European Green Deal" program (*European Commission*, 2019a), seems to offer particularly promising opportunities to Türkiye and, to a lesser extent, the Palestinian Territories. The EU members Cyprus and Greece will follow the European goal of achieving a successful and sustainable transition to a climate-neutral economy by 2050 through cooperation with other EU members sharing similar characteristics and goals. The "Eastern Mediterranean and Middle East Climate Change Initiative" (EMME-CCI), proposed by the Republic of Cyprus, offers a possible mechanism to advance cooperation on a regional level (https://emme-cci.org/). However, despite some progress made through the signing of the *Sharm El-Sheikh Declaration* by the heads of state of some of the member countries of the EMME-CCI during the COP 27 in Sharm el Sheikh, Egypt in 2022, more advanced activities are still forthcoming.

Country	GHG Emissions[2]		Reductions or Increases in GHG Emission			Source and Remarks
	Year	Gg CO_{2e}	Gg CO_{2e}	% Reduction (-)/ Increases (+)	Target year	
Cyprus	2013	8 319	6 322	ca. -24	2030	Department of Environment, (2022a)
			4 000	ca. -52	2050	
Egypt	2000	193 238	512 000	ca. +265	2030	Climate Action Tracker (https://climateactiontracker.org/countries/egypt/); Egypt's reduction scenarios are considered "highly insufficient" ; the value shown represents the NDC target
Greece	2013	105 111	65 311	ca. -38	2030	Hellenic Republic (2022)
Israel	2010	75 416	47 512	-27	2030	State of Israel (2023)
			11 312	-85	2050	
Palestine	2011	3 200	15 930(SQ)	ca. +500	2040	State of Palestine (2021) Increases for "Status Quo Scenario" (SQ) and "Independence Scenario (IS) are highly uncertain
			22 490 (IS)	ca. +700		
Türkiye	2013	459102	ca. 770 000	ca. +168	2030	Climate Action Tracker (https://climateactiontracker.org/countries/turkey/); Türkiye's reduction scenarios are considered "critically insufficient"; the value shown represents the NDC target

Table 1: Current GHG Emissions and Reductions or increases in emissions according to national plans (NDCs)

The impacts of climate change on the vulnerability of regional and local communities and environments have mostly been considered by focusing on the physical aspects of vulnerability. However, it is known that sections of society already vulnerable to present climate variability could find this vulnerability exacerbated by the occurrence and scale of extreme climate events. It is therefore important to not only consider mitigation and GHG reductions with a view on minimising the physical impacts of climate change, but to also focus on social vulnerability in a given country *(for more details, see Adger, 1996; Kelly and Adger, 2000*).

Thus, the observed lack of clear GHG reduction targets in some of the countries considered here, in conjunction with, at least in part, challenging political and economic conditions and conflicts clouds the prospects for a rapid change in climate policies in the region. Moreover, the apparent lack of attention to social vulnerabilities and an only partly observable more holistic view on climate change impacts through, e.g., considerations of the Water-Energy-Food Nexus does not make the efforts to develop effective mitigation and adaptation strategies seem promising. Thus, more efforts are needed to develop joint and cooperative strategies to reduce GHG emissions through holistically derived sustainable measures aimed to reduce the adverse impacts of global change and to pave the way for a sustainable and peaceful Eastern Mediterranean.

[2] Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015, UNFCCC 2016 (except for Palestine: *State of Palestine*, 2021): Please note that the numbers given in the table are apparently not always compatible/identical with the numbers in the text, mainly because the reference years for the values in the table are different from those quoted in the body of the text.

About the Author

Prof. Dr. Manfred A. Lange currently serves as Professor at the Energy, Environment and Water Research Center (EEWRC) of the Cyprus Institute and as Director of the Future Earth MENA Regional Center (FEMREC). He is on the Steering Committee of the Mediterranean Experts on Climate and Environmental Change (MedECC). In prior positions, among others, he acted as Founding Director of the EEWRC, Acting Vice-President for Research at the Cyprus Institute, Director of the University of Münster's Center for Environmental Research as well as Professor in Geophysics at the WestfälischeWilhelms-Universität Münster, Germany. His main research interests include the assessment of climate change impacts with a focus on water- and energy security, renewable energy sources and energy- and water use efficiency in the built environment.

References

Adger, W. N., Approaches to Vulnerability to Climate Change, Centre for Social and Economic Research on the Global Environment, University of East Anglia, Norwich, and University College London, **CSERGE Working Paper, GEC 96-05**, 66 pp., 1996.

Bromberg, G., N. Majdalani and J. A. Taleb, A Green Blue Deal for the Middle East, EcoPeace Middle East, Tel Aviv, Ramallah, Amman, 26 pp., 2020. https://ecopeaceme.org/wp-content/uploads/2021/03/A-Green-Blue-Deal-for-the-Middle-East-EcoPeace.pdf.

Cramer, W., J. Guiot, M. Fader, J. Garrabou, J.-P. Gattuso, A. Iglesias, M. A. Lange, P. Lionello, M. C. Llasat, S. Paz, J. Peñuelas, M. Snoussi, A. Toreti, M. N. Tsimplis and E. Xoplaki, Climate change and interconnected risks to sustainable development in the Mediterranean, *Nature Climate Change*, **8** (11), 972-980, 2018, https://doi.org/10.1038/s41558-018-0299-2.

Department of Environment, Cyprus' Long-term low GHG emission development strategy - 2022 update, Ministry of Agriculture, Rural Development and Environment, Republic of Cyprus, 35 pp., 2022a.

Department of Environment, National Greenhouse Gas Inventory 2022, 2022 submission under the United Nations Convention on Climate Change and the Kyoto Protocol, Ministry of Agriculture, Rural Development and Environment, Republic of Cyprus, 393 pp., 2022b. https://unfccc.int/documents/461671.

Digkas, A., Greece in the Eastern Mediterranean: Challenges of Climate Change and Key Opportunities, Konrad-Adenauer-Stiftung e. V.; Regional Programme Energy Security and Climate Change Middle East and North Africa, **KAS-REMENA Publication Series: Climate Change Mitigation in the Eastern Mediterranean**, 11 pp., 2023. https://www.kas.de/documents/264147/264196/Greece+in+the+Eastern+Mediterranean+-+Challenges+of+Climate+Change+and+Key+Opportunities.pdf/1813f425-737c-f6ae-b80b-654202359ae6?version=1.0&t=1693243732025.

Egyptian Environmental Affairs Agency (EEAA), EGYPT THIRD NATIONAL COMMUNICATION Under the United Nations Framework Convention on Climate Change, 245 pp., 2016. https://unfccc.int/documents/77569.

Egyptian Ministry of Environment, Egypt National Climate Change Strategy (NCCS) 2050, 2022.

El Kharraz, J., Egypt as a Case Study, Konrad-Adenauer-Stiftung e. V.; Regional Programme Energy Security and Climate Change Middle East and North Africa, **KAS-REMENA Publication Series: Climate Change Mitigation in the Eastern Mediterranean**, submitted pp., 2023.

enerdata, Cyprus Energy Information, https://www.enerdata.net/estore/energy-market/cyprus/#:~:text=Cyprus%20Related%20Research&text=Electricity%20consumption%20per%20capita%20was,a%205.6%25%20drop%20in%202020., 2021, 06.12.2023.

European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions - The European Green Deal, pp. 24, Brussels, Belgium, 2019a.

European Commission, The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind, https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691, 2019b, 14.05.2023.

European Commission, Carbon Border Adjustment Mechanism: Questions and Answers, Brussels, Belgium, https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3661, 2021, 04.01.2024.

Hellenic Republic, National Energy and Climate Plan, Ministry of the Environment and Energy, Athens, Greece, 335 pp., 2019. https://energy.ec.europa.eu/system/files/2020-03/el_final_necp_main_en_0.pdf.

Hellenic Republic, 8th National Communication and 5th Biennial Report under the United Nations Framework Convention on Climate Change, Ministry of Environment and Energy/Division of

Climate Change and Air Quality, Athens, Greece, 521 pp., 2022. https://unfccc.int/sites/default/files/resource/NC8_BR5_Greece.pdf.

Hoff, H., Understanding the Nexus. Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus, Stockholm Environment Institute, Stockholm, Sweden, 52 pp., 2011. http://www.water-energy-food.org/documents/understanding_the_nexus.pdf.

Kelly, P. M. and W. N. Adger, Theory and Practice in Assessing Vulnerability to Climate Change andFacilitating Adaptation, *Climatic Change*, **47** (4), 325-352, 2000, 10.1023/A:1005627828199.

Kittaneh, O., Personal communication: The Palestinian Energy Sector: A Future Outlook, 2023.

Lange, M. A., Renewable Energy and Water Resources, in *Climate Vulnerability*, Editor-in-Chief: Roger, P. (ed.); Academic Press, Oxford, pp. 149-166, 2013.

Lange, M. A., Impacts of Climate Change on the Eastern Mediterranean and the Middle East and North Africa Region and the Water–Energy Nexus, *Atmosphere*, **10** (8), 455, 2019, https://doi.org/10.3390/atmos10080455.

Lange, M. A., The Climate Change Crisis in the Eastern Mediterranean and in Cyprus in the Context of the Water-Energy-Nexus, Konrad-Adenauer-Stiftung e. V.; Regional Programme Energy Security and Climate Change Middle East and North Africa, **KAS-REMENA Publication Series: Climate Change Mitigation in the Eastern Mediterranean**, 12 pp., 2023. http://www.kas.de/fr/web/remena/titre-unique/-/content/the-climate-change-crisis-in-the-eastern-mediterranean-and-cyprus-in-the-context-of-the-water-energy.

MedECC, Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report, Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, Cramer, W., J. Guiot, and K. Marini (eds.), 632 pp., 2020.

meetMED, Country Report on Energy Efficiency and Renewable Energy Investment Climate, Mitigation Enabling Energy Transition in the MEDiterranean region, 89 pp., 2020. https://meetmed.org/wp-content/uploads/2022/02/A31_PalestineClimate_FINAL.pdf.

Ministry of Environment, First Biennial Update Report to the United Nations Framework Convention on Climate Change, Egyptian Environmental Affairs Agency, Cairo, Egypt, 164 pp., 2018. https://unfccc.int/sites/default/files/resource/BUR%20Egypt%20EN.pdf.

Papanicolas, C. N., Research and Development Study for a Concentrated Solar Power - Desalinization of Sea Water (CSP-DSW) Project, The Cyprus Institute, Nicosia,Cyprus, 223 pp., 2010.

Republic of Türkiye, Eighth National Communication and Fifth Biennial Report of Türkiye under the UNFCCC, Ankara, Türkiye, 352 pp., 2023. https://unfccc.int/sites/default/files/resource/8NC-5BR%20T%C3%BCrkiye.pdf.

Sak, G., The Decarbonisation Agenda in Türkiye, the European Union and the Eastern Mediterranean, Konrad-Adenauer-Stiftung e. V.; Regional Programme Energy Security and Climate Change Middle East and North Africa, **KAS-REMENA Publication Series: Climate Change Mitigation in the Eastern Mediterranean**, 10 pp., 2023. https://www.kas.de/en/web/remena/single-title/-/content/the-decarbonisation-agenda-in-tuerkiye-the-european-union-and-the-eastern-mediterranean?fbclid=IwAR3pcGMLLz6vIiuYW16RVHLvjQfJGJM24IgpdiEB0-WgTJLEseigWHKLzL0.

State of Israel, Israel's Second Biennial Update Report, Ministry of Environmental Protection, Jerusalem, Israel, 86 pp., 2023. https://unfccc.int/sites/default/files/resource/2nd%20Biennial%20Update%20Report%202021%20final.pdf.

State of Palestine, Initial National Communication Report to the United Nations Framework Convention on Climate Change (UNFCCC), Environment Quality Authority, Ramallah, Palestine, 184 pp., 2016. https://unfccc.int/files/national_reports/non-annex_i_parties/application/pdf/initial_national_communication_report__state_of_palestine.pdf.

State of Palestine, The State of Palestine's First Nationally Determined Contributions (NDCs) - "Updated Submission", Palestinian Authority, Ramallah, Palestine, 55 pp., 2021.

https://unfccc.int/sites/default/files/NDC/2022-06/Updated%20NDC_%20State%20of%20Palestine_2021_FINAL.pdf.

The Egyptian Cabinet, Egypt's National Strategy for Adaptation to Climate Change And Disaster Risk Reduction, Information & Decision Support Center in cooperation with UNDP, Cairo, Egypt, 167 pp., 2011. http://www.climasouth.eu/docs/Adaptation011%20StrategyEgypt.pdf.

The Electricity Authority, Israeli Electricity Sector – Annual Report 2021, Jerusalem, Israel, 82 pp., 2021. https://www.gov.il/BlobFolder/generalpage/dochmeshek/he/Files_Netunei_hashmal_THE%20ELECTRICITY%20AUTHORITY%20_ANNUAL%20REPORT_2021.pdf.

Umweltbundesamt, Atmosphärische Treibhausgas-Konzentrationen, https://www.umweltbundesamt.de/daten/klima/atmosphaerische-treibhausgas-konzentrationen#kohlendioxid-, 2023, 10.11.2023.

UN General Assembly, Transforming our world : the 2030 Agenda for Sustainable Development, The United Nations, New York, USA, 35 pp., 2015. https://www.refworld.org/docid/57b6e3e44.html.

United Nations, United Nations Framework Convention on Climate Change, New York, U.S.A., 33 pp., 1992. https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf.

United Nations, The Paris Agreement, United Nations Framework Convention on Climate Change,, 27 pp., 2015. https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

University of Notre Dam, Notre Dame Environmental Change Initiative - Country Index, Notre Dame, IN 46556 USA, https://gain.nd.edu/our-work/country-index/, 2023, 04.01.2024.

van Vuuren, D. P., J. Edmonds, M. Kainuma, K. Riahi, A. Thomson, K. Hibbard, G. C. Hurtt, T. Kram, V. Krey, J.-F. Lamarque, T. Masui, M. Meinshausen, N. Nakicenovic, S. J. Smith and S. K. Rose, The representative concentration pathways: an overview, *Climatic Change*, **109** (1), 5, 2011, 10.1007/s10584-011-0148-z.

Zittis, G., P. Hadjinicolaou, M. Almazroui, E. Bucchignani, F. Driouech, K. El Rhaz, L. Kurnaz, G. Nikulin, A. Ntoumos, T. Ozturk, Y. Proestos, G. Stenchikov, R. Zaaboul and J. Lelieveld, Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa, *npj Climate and Atmospheric Science*, **4** (1), 20 pp., 2021, 10.1038/s41612-021-00178-7.

Zohar, T. and T. Abu Hamed, The Path Toward Low Carbon Energy Systems in Israel: Regional Cooperation for Mitigation of and Adaption to the Effects of Climate Change, Konrad-Adenauer-Stiftung e. V.; Regional Programme Energy Security and Climate Change Middle East and North Africa, **KAS-REMENA Publication Series: Climate Change Mitigation in the Eastern Mediterranean**, 8 pp., 2023. https://www.kas.de/en/web/remena/single-title/-/content/the-path-toward-low-carbon-energy-systems-in-israel.

Konrad-Adenauer-Stiftung e. V.

Konrad-Adenauer-Stiftung e.V.
Regional Programme Energy Security and Climate Change
Middle East and North Africa
info.remena@kas.de

Editor of the publication series:

Prof. Dr. Manfred A. Lange
Professor, Energy, Environment and Water Research Center (EEWRC)
Director, Future Earth MENA Regional Center (FEMRC)
m.a.lange@cyi.ac.cy