

EGYPT FOURTH NATIONAL COMMUNICATION REPORT

Under the United Nations Framework
Convention on Climate Change

This report is submitted to
The United Nations Framework Convention on Climate
Change (UNFCCC)

Mar 2025

Published by:
Ministry of Environment
Cairo New Capital - Governmental District
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Foreword

I am very pleased to submit the Fourth National Communication Report of the Arab Republic of Egypt (ARE), which contains our efforts and achievements in mitigating climate change and adapting to its negative impacts.

Climate change is the most serious threat facing humankind and a global challenge that we must work collectively to overcome. According to the World Meteorological Organisation (WMO), 2024 was the hottest year on record, with global temperatures 1.55°C above pre-industrial revolution levels—the first time the 1.5°C Paris Agreement threshold was surpassed in a full year. The past decade (2015–2024) has also been the warmest, with each year ranking in the top ten hottest years. To cope with the looming crisis of climate change, the international community adopted the Paris Agreement in December 2015, which entered into force in November 2016. Under this agreement, all signatory countries agreed to work to reduce greenhouse gas (GHG) emissions. The Parliament of the ARE has ratified the Paris Agreement, submitting its instrument of ratification with the United Nations Secretariat in November 2016.

Egypt has made significant headway toward the integration of policies and measures to mitigate and adapt to the severe consequences of climate change. For the first time, climate change has become a central priority in policy design among different stakeholders in the public and private sectors and civil societies. This was reflected in the 27th Conference of Parties (COP), which Egypt hosted in Sharm El-Sheikh in November 2022. It is no longer the responsibility of a single institution to expedite the climate policy agenda; rather, it is currently viewed as a collaborative effort requiring coherent policy design and integration. Sector-specific strategies are increasingly aligning with climate change.

All parties under the United Nations Framework Convention on Climate Change (UNFCCC) are required to submit National Communications that contain GHG reduction policies and future plans for the UNFCCC to review their national GHG reduction efforts. The purpose of National Communications is for all Parties to share their efforts and achievements in responding to climate change so that they may better work hand-in-hand to solve the issue.

The Fourth National Communication Report highlights Egypt's commitment to strike the right balance between achieving inclusive and sustainable growth, embracing a sustainable development approach, and ensuring resilience in the face of global crises such as COVID and climate change. It also underscores Egypt's full realisation of the economic and social implications of climate change. By launching an ambitious economic reform programme in recent years and adopting the Sustainable Development Strategy (SDS): Egypt Vision 2030, the country has emphasised the importance of accelerating the transition to a green and circular economy.

The ARE has established legal and institutional mechanisms to combat climate change, including the Framework Act on Environmental Protection, Development, and Climate Change. Its comprehensive policy framework encompasses Egypt's Vision 2030, the Long-Term Low Emission Development Strategy 2050 (LT-LEDS), the National Climate Change Strategy 2050 (NCCS), the National Strategy for Disaster Risk Reduction 2030, the National Strategy for Adaptation to Climate Change, and various sectoral strategies. In its updated Nationally Determined Contribution (NDC) on June 25, 2023, the ARE set 2030 sectoral targets to reduce greenhouse gas emissions from business-as-usual (BAU) levels, aligning with the Paris Agreement's commitments since 2015.

The ARE will continue to take proactive measures to cope with climate change. To embrace the move toward climate-friendly, low-carbon energy sources, ARE will increase the share of renewables in its energy mix to 42% by 2035. Furthermore, the government will introduce diverse investment incentives to help achieve GHG reduction without disruption.

The strengthening of global solidarity in implementing climate action measures remains imperative. I hope this Fourth National Communication of the ARE serves as an opportunity to respond to climate change and strengthen cooperation with the international community.

Dr. Yassmin Fouad
Minister of Environment,
Egypt

4NC Development and Collaboration

This Fourth National Communication of Egypt has been developed in compliance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC). It follows the UNFCCC reporting guidelines outlined in Decision 17/CP.8 and its Annex, ensuring transparency, accuracy, completeness, comparability, and consistency.

It has been produced as part of the Fourth National Communication Project (NC4Egypt), implemented under the supervision of the Egyptian Environmental Affairs Agency (EEAA), with support from the United Nations Development Programme (UNDP) and funding from the Global Environment Facility (GEF).

The formulation of this National Communication was a collaborative effort, drawing on the expertise and input of key governmental entities, specialists, and stakeholders across various sectors, as detailed in the list below.

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Acronyms & Abbreviations

A2	IPCC Special Report on Emissions Scenarios (SRES) pathway describing a world with high population growth, low international cooperation, and high emissions levels
AASTM	Arab Academy for Science, Technology and Maritime Transport
ACSAD	Arab Centre for the Study of Arid and Drylands
AD	Activity Data
ADAPTM	Climate Change Management Through Adaptation and Mitigation
AEMET	State Meteorological Agency of Spain
AFD	Agence Française de Développement
AFOLU	Agriculture, Forestry and Other Land Use
AGN	African Group of Negotiators on Climate Change
ArabCOF	Arab Climate Outlook Forum
ARC	Agricultural Research Center
ARCA	Alexandria Research Center for Adaptation to Climate Change
ARE	Arab Republic of Egypt
ASI	Avoid–Shift–Improve
ASRT	Academy of Scientific Research and Technology
AU	African Union
AUC	American University in Cairo
B1	IPCC SRES scenario emphasizing global sustainability, clean technology, and low emissions
1B	Is a scenario based on Egypt’s Energy Strategy 2035
BAU	Business as Usual
BOD	Biological Oxygen Demand
BMZ	Germany’s Federal Ministry for Economic Cooperation and Development
BP	British Petroleum
BRT	Bus Rapid Transit
BSC	Barcelona Supercomputing Center
BUR	Biennial Update Report
BUR1	First Biennial Update Report
C3SDI	Centre of Excellence for Research and Applied Studies on Climate Change and Sustainable Development
CAHOSCC	Committee of African Heads of State and Government on Climate Change
CAPMAS	Central Agency for Public Mobilization and Statistics
CB3 Project	Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions Project
CBD	Convention on Biological Diversity
CCCD	Climate Change Central Department
CCRMP	Climate Change Risk Management Programme
CCS	Carbon Capture and Sequestration
CCT	Cairo Climate Talks
CCUS	Carbon capture, utilization, and storage
CCVI	Climate Improved Coastal Vulnerability Index
CDC	Communicable Disease Control Center
CDM	Clean Development Mechanism
CDM-DNA	Clean Development Mechanism - Designated National Authority
CDW	Construction and Demolition Waste
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CEDAW	Convention on the Elimination of all Forms of Discrimination Against Women
CERF	Egypt-China Cooperation Program
CESD	Center of Education for Sustainable Development
CICCRE	Center of Information for Climate Change and Renewable Energy
V	Centre for Innovation, Governance and Green Economy
CIAS	Coastal Acquisition System Wave Recorder
CLAC	Central Laboratory of Agricultural Climate
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CORDEX	Coordinated Regional Climate Downscaling Experiment
CoRI	Coastal Research Institute
COSMO	Consortium for Small-scale Modeling
COVID-19	Coronavirus Disease 2019
CPA	Component Project Activity
CSLF	Carbon Sequestration Leadership Forum
CSP	Concentrated Solar Power

CSR	Corporate Social Responsibility
CTF	Clean Technology Fund
CUF	Capacity utilization factors
CVI	Coastal Vulnerability Index
DAAD	German Academic Exchange Service
DOWM	Department of Organizing Waste Management
DRC	Democratic Republic of the Congo
DRC	Desert Research Center
EAFMS	Egyptian Authority for Maritime Safety
EAS	Economic Affairs Sector
EBRD	European Bank for Reconstruction and Development
ECCADP	Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions in Egypt Project
ECHEM	Egyptian Petrochemicals Holding Company
ECMWF	European Centre for Medium-Range Weather Forecasts
ECRI	Environment and Climate Change Research Institute
EDC	Ethylene Dichloride
EDHS	Egyptian Demographic and Health Survey
EE	Energy Efficiency
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egyptian Electricity Holding Company
EETC	Egyptian Electricity Transmission Company
EF	Emissions Factor
EGAS	Egyptian Natural Gas Holding Company
EGP	Egyptian Pound
EGPC	Egyptian General Petroleum Corporation
EHA	Egyptian Hotels Association
EHMC	Environmental Hazards and Mitigation Center, Cairo University
EIB	European Investment Bank
EIMP	Environmental Information and Monitoring Program
EMA	Egyptian Meteorological Authority
EMDS	Electric Motor Driven Systems
ENCPC	National Cleaner Production Centre
EnMS	Energy Management System
ENODC	Egyptian National Oceanographic Data Center
ENR	Egyptian National Railway
EOS	Egyptian Organization for Standardization and Quality
EPR	Extended Producer Responsibility
ERA	Electric Utility and Consumer Protection Regulatory Agency
ETF	Enhanced Transparency Framework
EU	European Union
EUMETSAT	European Organization for Exploitation of Meteorological Satellites
EV	Electric Vehicles
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
FEI	Federation of the Egyptian Industry
FEPS	Faculty of Economics and Political Science at Cairo University
FES	Friedrich Ebert Foundation
FFS	Farmer Field School
FNC	Fourth National Communication
FOD	First Order Decay Method
FY	Fiscal Year
G7	Group of Seven
G77	Group of 77; a coalition of developing countries at the United Nations
GAN	Global Adaptation Network
GCF	Green Climate Fund
GCM	General Circulation Model
GCM	Global Climate Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GERD	Grand Ethiopian Renaissance Dam
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GIMED	Green Impact MED Project: Positive Investments for Positive Impacts
GIS	Geographic Information System
GIZ	German Agency for International Cooperation

GNP	Gross National Product
GoE	Government of Egypt
GOIEC	General Organization for Import & Export Control
GPG	Good Practice Guidance
GPRS	Green Pyramid Rating System
GTU	Green Tourism Unit
GWP	Global Warming Potential
GWP-Med	Global Water Partnership – Mediterranean
GWR	Ground Water Resources
H1	First Half
HAD	High Aswan Dam
HCWW	National Holding Company of Water and Wastewater
HDI	Human Development Index
HEPCA	Hurghada Environmental Protection and Conservation Association
HIVOS	Humanist Institute for Development Cooperation
IAEA	International Atomic Energy Agency
ICE	Internal Combustion Engine
ICID	International Commission on Irrigation and Drainage
ICZM	Integrated Coastal Zone Management
IDA	Industrial Development Authority
IDSC	Information and Decision Support Center
IE3	International Efficiency class 3
IEA	International Energy Agency
IEE	Industrial Energy Efficiency Project
IER	Incineration with Energy Recovery
IFAD	International Fund for Agricultural Development
IGCC	Integrated Gasification Combined Cycle
IGSR	Institute for Graduate Studies and Research, Alexandria University
IMF	International Monetary Fund
IOC	Intergovernmental Oceanographic Commission
IODE	Oceanographic Data and Information Exchange Programme
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRENA	International Renewable Energy Agency
IsDB	Islamic Development Bank
ISES	Integrated Sustainable Energy Strategy
ISO	International Organization for Standardization
IT	Information Technology
IUCN	International Union for Conservation of Nature
IUSD	Integrated Urbanism & Sustainable Design
IWMI	International Water Management Institute
JBIC	Japan Bank for International Cooperation
JCEE	Egyptian German Joint Committee on Renewable Energy, Energy Efficiency and Environmental Protection
KWF	German Credit Institute for Reconstruction
LAKI	Lima Adaptation Knowledge Initiative
LAS	League of Arab States
LC	Least Concern
LCOY	Local Conference of Youth
LECB	Low Emission Capacity Building Programme
LED	Light Emitting Diode lighting
LEDS	Low-Emission Development Strategies
LNG	Liquefied Natural Gas
LPG	Liquefied petroleum gas
LRT	Light Rail Transit
MALR	Ministry of Agriculture and Land Reclamation
Mbbl	Million barrels
MBT	Mechanical-Biological Treatment
MEAs	Multilateral Environmental Agreements
MENA	Middle East and North Africa
MDF	Medium-density wood panels
Mo	Met Office
MoCA	Ministry of Civil Aviation
MODIS	Moderate Resolution Imaging Spectroradiometer
MoE	Ministry of Environment
MoERE	Ministry of Electricity and Renewable Energy

MoHP	Ministry of Health and Population
MoHUUC	Ministry of Housing, utilities and urban Communities
MoLD	Ministry of Local Development
MoPMR	Ministry of Petroleum and Mineral Resources
MoT	Ministry of Transportation
MoTA	Ministry of Tourism and Antiquities
MTI	Ministry of Trade and Industry
MoU	Memorandum of Understanding
MRV	Measurement, Reporting, and Verification
MSMEDA	Micro, Small and Medium Enterprise Development Agency
MSW	Municipal Solid Waste
MSW	Master of Social Work
MWRI	Ministry of Water Resources and Irrigation
NAMAs	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAT	National Authority Tunnel
NARSSS	National Authority of Remote Sensing and Space Sciences
NBFS	Non-Banking Financial Sector
NCs	National Communications
NC4 Project	National Communication Fourth Report Project
NCCC	National Council for Climate Change
NCCM	National Council for Childhood and Motherhood
NCW	National Council for Women
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
NEAP	National Environmental Action Plan
NEEAP	National Energy Efficiency Action Plan
NG	Natural Gas
NGOs	Non-Governmental Organizations
NH	Non-Hydrostatic model
NHWTC	Nasiriya Hazardous Waste Treatment Centre
NIOF	National Institute of Oceanography and Fisheries
NIS	Non-indigenous species
NRC	National Research Center
NREA	National Renewable Energy Authority
NPV	Net Present Value
NSWMP	National Solid Waste Management Programme
NWRC	National Water Research Center
NZT	Net Zero Teesside
ODS	Ozone Depleting Substances
O&M	Operation and Maintenance
OSPOS	Opera Wave Suspended Recorder
pH	Potential of Hydrogen
PLA	Ports and Lighthouses Administration
PoAs	Programme of Activities
PPP	Private-Public Partnership
PV	Photovoltaic
Q1	First Quarter
Q2	Second Quarter
Q4	Fourth Quarter
QA/QC	Quality Assurance / Quality Control
R&D	Research & Development
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
RD&D	Research, Development and Deployment
RDF	Refuse Derived Fuel
RE	Renewable Energy
RICCAR	Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region
RIndustry	Affordable Resources for Egypt's Industrial Growth Project
ROWA	Regional Office of West Asia
SADS	Sustainable Agricultural Development Strategy
SAR	Second Assessment Report
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCBD	Secretariat of the Convention on Biological Diversity

SDGs	Sustainable Development Goals
SDS	Sustainable Development Strategy, Egypt Vision 2030
SECO	State Secretariat for Economic Affairs of Switzerland
SEI	Specific Energy Intensity
SHIP	Solar Heating in Industrial Processes Project
SLR	Sea Level Rise
SMEs	Small and Medium-sized Enterprises
SNC	Second National Communication
SPI	Standardized Precipitation Index
SRI	Survey Research Institute
STDF	Science and Technology Development Fund
STT	Sea Surface Temperature
STP	Sustainable Transport Programme
SWD	Solid Waste Disposal
SWDS	Solid waste disposal sites
SWERI	Soil, Water and Environment Research Institute
SWH	Solar Water Heating
SWM	Solid Waste Management
TACCC	Transparency Accuracy Completeness Comparability Consistency
TCI	Temperature Condition Index
TDA	Tourism Development Authority
TFEC	Total Final Energy Consumption
TNC	Third National Communication
ToT	Training of Trainers
TSR	Thermal Substitution Rates
UAE	United Arab Emirates
UK	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-ESCWA	United Nations Economic and Social Commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
US	United States
USD	United States Dollar
USDA	United States Department of Agriculture
V&A	Vulnerability and Adaptation
VCI	Vegetation Condition Index
VHI	Vegetation Health Index
VNR	Voluntary National Report
VSD	Variable Speed Drives
WB	World Bank
WFP	World Food Programme
WHO	World Health Organisation
WISE	Workforce Improvement and Skills Enhancement Project
WMRA	Waste Management Regulatory Authority
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting model
WWTP	Wastewater treatment plants
YLE	Youth Love Egypt Foundation

Units of Measurement	
BCM	Billion Cubic Meters
°C	Degrees Celsius
CH₄	Methane
CO	Carbon Monoxide
CO₂	Carbon Dioxide
CO₂e	Carbon Dioxide Equivalent
°F	Degrees Fahrenheit
Gg	Giga Gram (1.000.000.000 gram)
Gg CO₂e	Gigagrams of Carbon Dioxide Equivalent
g/kWh	Grams per kilowatt-hour
GW	Giga Watt (10 ⁹ watt)
GWH	Gigawatt-hour
HWN	Heat Waves Number
HWF	Heat Waves Frequency
HWD	Heat Waves Duration
ktoe	kilotonnes of oil equivalent
Km	Kilometer
km²	Square kilometer
M	Meters
M	Million
m³/day	Cubic meters per day
m³/hr	Cubic meters per hour
Mbbl	Million barrels
MM	Mm
MtCO₂e	Million tonnes of carbon dioxide equivalent
M/S	Meters per second
Mt	Million tonnes
MTOE	Million Tone Oil Equivalent
MW	Mega Watt (10 ⁶ watt)
N₂O	Nitrous Oxide
R10mm	Number of days with rainfall ≥ 10 mm
Rx3day	Maximum precipitation accumulated over any three consecutive days within a given period
tCO₂e	Tonnes of Carbon Dioxide Equivalent

Executive Summary

Egypt's Fourth National Communication (FNC) to the United Nations Framework Convention on Climate Change (UNFCCC) provides a comprehensive assessment of the country's climate action in response to increasing environmental challenges. As a nation highly vulnerable to water scarcity, rising sea levels, and extreme weather, Egypt has adopted a multifaceted approach that integrates policy-driven strategies and cross-sectoral and institutional coordination to address climate change while aligning with Egypt Vision 2030 and global climate commitments.

The report details national circumstances, greenhouse gas emissions trends, mitigation efforts, adaptation strategies, and capacity-building initiatives, emphasising mitigation programmes and targeted policies across key sectors such as energy, industry, agriculture, and infrastructure. It also highlights key policy measures, financial mechanisms, and governance structures that support Egypt's transition toward low-carbon and climate-resilient development. While progress has been significant, institutional, financial, and technological gaps remain critical barriers to achieving sustainability. Addressing these challenges through enhanced international cooperation, investment, and capacity building will be essential to strengthening resilience and ensuring a sustainable, low-carbon future.

NATIONAL CIRCUMSTANCES

Egypt, located at the northeast corner of Africa, spans 1,001,450 km², with a 3,500 km coastline along the Mediterranean and Red Sea. The country's terrain is predominantly desert, with the Nile Valley and Delta supporting 95% of the population on just 4% of the total land area. Egypt has a hot, arid climate, characterised by scorching summers, mild winters, and minimal rainfall (20–200 mm annually). Seasonal Khamaseen winds bring dust storms and temperature surges in early summer. With a population of about 102 million in 2020 (CAPMAS), Egypt has high urban concentration, particularly in Greater Cairo (18.7 million) and Alexandria (4.8 million), while 57% of the population resides in rural areas. The country also hosts around 9 million refugees due to regional instability. Internal migration is mainly directed toward urban centres for economic opportunities.

Egypt follows a semi-presidential system with 27 governorates and a bicameral parliament. Economic reforms have driven fiscal stabilisation, but challenges persist, including high public debt, weak private-sector job creation, and underperforming non-oil exports and foreign direct investment (FDI) inflows. Egypt's 2016/17 currency flotation initially led to GDP contraction and inflationary pressures, but gradual stabilisation followed. By 2018/19, growth had reached 5.6%, before the COVID-19 pandemic caused a sharp decline to 3.6% in 2019/20, with a 1.7% contraction in Q4.

Key sectors—including tourism, manufacturing, the Suez Canal, and energy—suffered due to global restrictions and reduced demand. Despite a modest recovery in late 2020 (0.7% and 2% growth in Q1 and Q2), economic pressures remained. To mitigate the impact, the government launched an EGP 100 billion stimulus package, providing financial relief to informal workers, tax and loan deferrals, and subsidised credit for affected sectors, reinforcing economic stability amidst ongoing challenges.

Water resources remain under severe pressure, with the Nile River providing 55.5 billion cubic metres (BCM) annually as Egypt's primary source. The Grand Ethiopian Renaissance Dam (GERD) poses further risks, increasing reliance on desalination, groundwater extraction, and wastewater reuse. Agriculture is the largest consumer of water, followed by municipal and industrial use.

The energy sector, on the other hand, is undergoing a transition, with ongoing efforts to diversify the energy mix, while natural gas (NG) and petroleum continue to account for the majority of consumption as of 2014/15 (98%). Renewable energy (RE) capacity is expanding, particularly in solar and wind power, contributing to the country's growing clean energy portfolio. Electricity generation capacity has increased to 59,530 MW, ensuring 99.8% electrification nationwide. Industrial energy demand remains

significant, especially in cement and fertiliser production, while subsidy reforms since 2016 have driven efficiency improvements and reduced overall consumption.

The industrial sector has expanded, with establishments increasing from 53,000 (2016) to 61,000 (2021) (+15%). Industrial production grew by 20% (2016–2021), especially in automotive and electronics manufacturing, while FDI in industry rose from \$2.2 billion (2016) to \$3.8 billion (2020). Agriculture remains a key sector, employing 21.1% of the workforce and contributing 11.4% to GDP. The cultivated land area expanded to 38,360 km² in 2018, driven by land reclamation projects. Modern irrigation and improved water management are being implemented to enhance resilience against climate variability.

Despite ongoing efforts, the waste management sector continues to encounter capacity constraints, with municipal solid waste generation reaching 21.7 million tonnes in 2016 and growing annually by 3.4%. Strengthening infrastructure, closing regulatory gaps, and mobilising adequate funding are critical steps to mitigate associated methane (CH₄) and CO₂ emissions.

Egypt has strengthened climate governance, ratifying the UNFCCC (1994) and the Paris Agreement (2017). Institutional developments include the Climate Change Unit (1996), its upgrade to the Central Climate Change Department (2009), and the establishment of the National Climate Change Council (2015), chaired by the Prime Minister. Climate policies are embedded in Egypt Vision 2030 and national development frameworks.

NATIONAL GREENHOUSE GAS INVENTORY

Egypt's greenhouse gas (GHG) inventory for 2016 and 2017 was prepared in accordance with the 2006 IPCC Guidelines using IPCC software. Total emissions amounted to **349,052 Gg CO₂e** in 2016 and **359,745 Gg CO₂e** in 2017.

The energy sector remained the largest source of emissions, contributing **65%** in 2016 and **62%** in 2017. Within this sector, energy industries accounted for **45%** in 2016 and **46%** in 2017, followed by transport at **18%** and **17%**, respectively. The IPPU sector contributed **11%** of national emissions in 2016 and **12%** in 2017, dominated by the minerals industry, with cement production representing **61%** in 2016 and **59%** in 2017. Iron and steel accounted for **9%** in 2016 and **11%** in 2017, while other subsectors made smaller contributions.

The AFOLU sector contributed **16%** in 2016 and **18%** in 2017, mainly from agricultural soil (**64%** in 2016 and **70%** in 2017), followed by livestock (**29%** and **23%**). Waste sector emissions were stable at about **8%** of the total, with solid waste disposal the largest contributor (**50%** in 2016 and **48%** in 2017), followed by wastewater treatment and discharge (**47%** and **49%**). Incineration, open burning, and biological treatment contributed about **3%** combined in both years. Methane remained the dominant gas in the waste sector (**over 92%**), while nitrous oxide dominated AFOLU emissions (**68%** in 2016; **72%** in 2017).

To ensure time series consistency, recalculations were carried out for 1990, 2000, 2005, and 2015, especially in the energy and IPPU sectors, using updated data and improved methodologies. Uncertainty analysis indicates around **9.4%** for inventory level estimates and about **22.9%** for the trend, which points to the need for improved activity data and country-specific emission factors.

During the preparation process, several challenges were encountered. These included the absence of systematic data collection procedures and standardized questionnaires, incomplete reporting from some entities, inconsistencies across data sources, lack of verification mechanisms, and data gaps in some categories. To address these challenges, it is recommended that CAPMAS remain the principal entity responsible for collecting activity data, working on a calendar-year basis for both public and private sectors to avoid double counting. Data should be provided in consistent units compatible with IPCC software requirements. The development of country-specific emission factors is strongly encouraged to better reflect national circumstances. Finally, a clear and systematic coordination mechanism should be

established, led by the Climate Change Central Department (CCCD) within the Egyptian Environmental Affairs Agency (EEAA) as the focal point and CAPMAS in its role as knowledge manager, in cooperation with relevant ministries and data-providing entities.

MITIGATION POLICIES AND MEASURES

Egypt's mitigation policies and measures have been specifically developed and selected to align with the country's national development priorities and climate goals. Their design is grounded in key national planning documents, most notably the Sustainable Development Strategy (SDS) 2030 and the Integrated Sustainable Energy Strategy (ISES) 2035 and informed by a comprehensive review of sector-specific strategies adopted by relevant ministries. This alignment ensures coherence across sectors and integration of climate action within broader economic planning.

For the period 2018–2030, a total of 27 mitigation measures or programmes have been identified, covering seven key sectors: energy (including petroleum and electricity), industry, transport, agriculture, waste, tourism, and buildings. These measures constitute the core of Egypt's mitigation efforts. Modelling was used to assess the impact of these identified climate mitigation measures across the seven sectors and to compare their outcomes against the Business-As-Usual (BAU) scenario.

If these measures are not taken, Egypt's emissions are expected to go over 600 million tonnes of CO₂ equivalent (MtCO_{2e}) by 2030, mainly coming from electricity (33%), industry (23%), and transport (19.7%). With these measures in place, a 24% reduction is expected. With implementation, these mitigation measures are expected to achieve a 24% reduction, avoiding approximately 150 MtCO_{2e} by 2030.

A substantial portion of Egypt's projected emission reductions is expected to come from the electricity sector, primarily through the Renewable Energy Maximisation Scenario outlined in the Integrated Sustainable Energy Strategy (ISES) 2035. Complementing these efforts are several cross-sectoral initiatives, including the energy and fuel subsidy reform programme launched in 2014, fuel consumption rationalisation, the implementation of energy efficiency (EE) systems, and emission reduction initiatives. Notably, the establishment of solar power stations to supply energy to various units in the oil and gas sector further supports decarbonisation goals.

The subsidy reform programme alone is projected to reduce emissions by 40 MtCO_{2e} annually by 2030, contributing to a cumulative reduction of 264 MtCO_{2e} by that year. Within the electricity sector, the following mitigation actions have been prioritised:

- Enhancing end-use EE.
- Expanding the share of RE.
- Deploying advanced low-emission technologies (e.g., CCS, next-generation nuclear).
- Promoting biosequestration through terrestrial ecosystems.

Across other sectors, mitigation actions include:

- **Industry:** EE, energy management systems, renewable integration, alternative fuels, and waste heat recovery.
- **Transport:** adoption of the Avoid–Shift–Improve (ASI) strategy to reduce demand, shift to cleaner modes, and improve fuel and vehicle efficiency.
- **Agriculture:** reducing methane from rice and fertilizer use, improving waste management, promoting bioenergy, and adopting climate-smart and low-emission practices.
- **Waste:** improved landfilling, incineration with energy recovery, gasification, anaerobic digestion, composting, and co-firing in cement kilns.

Egypt's approach also acknowledges the importance of addressing both demand-side and supply-side mitigation opportunities. The sectoral policies and measures highlighted above represent the demand side, focusing on reducing emissions through changes in consumption and production. On the supply

side, Egypt emphasises structural reforms such as investment in human capital, public sector modernisation, correcting labour market distortions, and industrial diversification to support an inclusive and sustainable transition.

VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

Egypt faces significant climate vulnerabilities driven by rising temperatures, sea level rise (SLR), increased frequency of extreme weather events (heatwaves, flash floods, droughts), and changing precipitation patterns. The national assessment highlights critical exposure across multiple sectors—most notably energy, water resources, agriculture, coastal zones, biodiversity, public health, tourism, and infrastructure.

Between 2001 and 2011, sea surface temperatures in the Mediterranean near the Nile Delta rose by 1–2°C, increasing the vulnerability of freshwater and brackish fisheries (FAO, 2018). SLR, averaging 3.5 mm/year (1993–2006), has heightened flood risks in the low-lying Nile Delta. Meanwhile, flash flood frequency has increased since 2010, exacerbated by urbanisation and reduced land permeability, leading to greater runoff during intense rainfall events.

The water sector is among the most climate-sensitive, with mounting stress from limited natural resources, growing demand, and transboundary challenges. Egypt is heavily dependent on the Nile River, which provides 55.5 BCM annually. However, upstream developments, particularly the GERD, pose a danger of human-induced droughts, reduced flow, and energy shortages. The largest water consumer in Egypt, agriculture, also suffers severe impacts. Climate-induced variability and upstream interventions could exacerbate the socio-economic consequences of prolonged water stress, as illustrated by historical drought records (e.g., 1978–1987).

In the agriculture sector, climate change has reduced crop yields by up to 28%, increased water demand by 8%, and disrupted planting cycles due to heatwaves, droughts, and erratic rainfall. Income losses, food security risks, and land degradation are rising concerns. Adaptation responses include breeding climate-resilient crop varieties, shifting planting calendars, enhancing irrigation efficiency, and expanding agricultural extension services for farmer training and early warning.

SLR and saltwater intrusion pose a significant threat to livelihoods, infrastructure, and freshwater aquifers in coastal zones, particularly the Nile Delta. Alexandria alone, home to 40% of Egypt's industrial capacity, could incur annual losses exceeding US\$500 million by 2050 due to coastal flooding. Tourism in the Red Sea region also faces risks, particularly from coral bleaching and biodiversity loss impacting dive tourism and fisheries.

Public health risks are escalating, including the spread of water- and food-borne diseases, heat-related illnesses, and air pollution. Adaptation in the health sector includes vaccination programmes, early detection and response systems, and public awareness campaigns.

The energy sector is vulnerable through reduced hydropower generation and increased cooling demand during heatwaves. Infrastructure and urban settlements are also under pressure from extreme weather events, with notable examples such as the 2021 "Dragon Storm". Egypt has initiated a broad range of adaptation projects, including:

- Building Resilient Food Security Systems in Southern Egypt (Adaptation Fund).
- Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions (GCF-funded ECCADP).
- Large-scale investments in non-conventional water resources, such as the Mahsama, Bahr El-Baqar, and New Delta water treatment plants.
- The expansion of wastewater reuse and desalination capacity is targeted to reach 1.5 million m/day by 2030.

Economically, climate change is expected to cost Egypt between 2% and 6% of GDP by 2060, with annual losses reaching up to 350 billion EGP under high-impact scenarios. Tourism losses alone could exceed US\$350,000 daily in Red Sea destinations by 2050. These figures underscore the cost-effectiveness of early adaptation investments. While Egypt has committed substantial national resources to adaptation, the scale of current and projected impacts indicates that there is an immediate need for enhanced international financing, technical support, and further sector-specific vulnerability assessments to design robust, science-based adaptation responses.

CAPACITY BUILDING, EDUCATION, INFORMATION, TRAINING, NETWORKING, PUBLIC AWARENESS AND GENDER

Egypt is advancing climate action through a growing range of capacity building, education, and awareness-raising initiatives, reflecting the country's recognition of the need for integrated, society-wide responses to climate change. While government-led programmes and international cooperation have supported climate mitigation and adaptation efforts, most initiatives include capacity building as a partial component. There remains a pressing need, however, for dedicated technical capacity building focused on data analysis, forecasting, measurement, and greenhouse gas inventory (GHGI) management, as well as upskilling local experts in carbon capture, clean technologies, and net-zero strategies.

The education sector is increasingly embedding climate and sustainability themes across undergraduate and postgraduate programmes. The Ministry of Environment (MoE) plays a key role in integrating environmental topics into school curricula, delivering public seminars, and utilising social media and campaigns to raise climate awareness. Youth and civil society organisations are also being mobilised to lead community-based initiatives that promote environmental consciousness.

Gender is receiving growing attention, particularly through the ministry's collaboration with the National Council for Women (NCW). Dedicated initiatives have been implemented to increase the awareness of the impacts and adaptations of climate change among women, particularly in rural areas. However, further capacity building is needed in gender-responsive planning, including gender analysis, disaggregated data collection, and mainstreaming gender considerations into climate policy development.

Overall, while Egypt has taken meaningful steps toward enhancing capacity and awareness, scaling up targeted, inclusive, and technically focused programmes remains essential to ensure effective and equitable climate action across all sectors of society.

FINANCIAL SUPPORT, TECHNOLOGY TRANSFER, CAPACITY GAPS AND CONSTRAINTS

This chapter outlines Egypt's progress and challenges in mobilising climate finance, enabling technology transfer, and building institutional and human capacity to support its national and international climate commitments. Egypt's Vision 2030, the National Climate Change Strategy 2050, and its obligations under the UNFCCC, Kyoto Protocol, and Paris Agreement guide these efforts.

Egypt has taken important steps to establish an enabling environment for climate action. These include legal and institutional reforms, the creation of the National Council for Climate Change (NCCC), and improved coordination mechanisms. Recent legislation, such as Law No. 202 for integrated waste management, and the restructuring of key agencies signal commitment to mainstream environmental sustainability. However, significant gaps persist in enforcement, inter-agency coordination, and the capacity of subnational institutions.

Despite limited public resources, Egypt is increasingly directing investment toward climate-related projects. Notable examples include the issuance of green bonds, increased public green investment allocations, and access to international climate finance mechanisms like the Green Climate Fund (GCF). Still, financing remains insufficient relative to the scale of adaptation and mitigation needs, especially given Egypt's high vulnerability to climate risks. The chapter also emphasises the need for:

- Strengthened technology transfer, particularly in energy, agriculture, water, and transport.
- Improved measurement, reporting, and verification (MRV) systems.
- Stronger knowledge management and institutional memory, especially at the local level.
- Gender-responsive planning, recognising women's disproportionate vulnerability to climate impacts, especially in agriculture.
- Legal and policy reforms that address new environmental challenges and incorporate climate considerations into economic decisions.

Looking ahead, Egypt must build on its progress by scaling up green investments, accelerating regulatory reform, enhancing technical and institutional capacities, and securing stronger international partnerships to close the climate finance and technology gaps.

RESEARCH AND SYSTEMATIC OBSERVATIONS

In recognition of its growing vulnerability to climate change, Egypt has steadily strengthened institutional, scientific, and technical capacities to support climate-related research, data collection, and systematic observation. Since the early 1990s, national bodies such as the National Committee for Integrated Coastal Zone Management (ICZM) and the Information and Decision Support Centre have guided planning, research, and adaptation. The MoE and the Egyptian Environmental Affairs Agency's (EEAA) lead national climate resilience efforts in coordination with key ministries in water, agriculture, energy, industry, and defence.

A network of specialized institutions supports climate policy and adaptation through modelling, impact assessments, and innovation in key sectors such as agriculture, water, and biodiversity. National and internationally funded research addresses Egypt's core vulnerabilities, including climate modelling, coastal risk mapping, and agricultural impacts. Studies project up to a 10% decline in crop yields by 2050 due to heat and salinity, and over one-third of Egypt's Mediterranean coastline is considered highly vulnerable to SLR. Additional research priorities include biodiversity loss, marine degradation, and air pollution, which costs Greater Cairo approximately 1.4% of GDP annually.

Systematic observation is led by the Egyptian Meteorological Authority (EMA) and the Agricultural Research Centre, supported by expanded radar and early warning systems. The Ministry of Water Resources and Irrigation (MWRI) oversees hydrological monitoring; however, there are persistent data gaps, especially regarding rainfall and groundwater. Various institutions undertake marine and environmental monitoring, with the EIMP ensuring data quality. The Ministry of Health and Population tracks health trends and environmental risks, with growing attention to the links between climate variability and disease patterns, reinforcing the role of early warning systems.

Overall, while Egypt has made commendable progress in institutionalising climate research and observation, challenges remain. These include gaps in regional data sharing, limited infrastructure in the Nile Basin, and the need for stronger integration of scientific findings into policy and planning. Sustained investment in data systems, modelling, and interdisciplinary collaboration remains vital to enhancing climate resilience across Egypt's most vulnerable sectors.

1. National Circumstances

1.1 Introduction

This Fourth National Communication (FNC) serves as an update to Egypt's Third National Communication (TNC), submitted in 2016. Since then, Egypt has undergone continuous transformation, driven by economic reform, institutional modernisation, and rising environmental challenges. The country has advanced a broad agenda to enhance resilience, improve public services, and integrate sustainability into national development planning.

Climate change is no longer treated as a sectoral concern but is now embedded across key areas such as water, energy, health, and urban development. This evolving approach reflects Egypt's commitment to adaptive governance and sustainable growth, aligned with its obligations under the UNFCCC. The following sections outline the national circumstances shaping Egypt's climate response and its path toward a low-emission, climate-resilient future.

1.2 Geographic Location

The Arab Republic of Egypt is situated between latitudes 22° and 32° north, extending approximately 1,024 kilometres from north to south and 1,240 kilometres from east to west. Egypt, strategically positioned at the northeastern corner of Africa, also serves as a bridge to Asia through the Sinai Peninsula. The country spans a total area of 1,001,450 square kilometres, of which 995,450 square kilometres constitute landmass. Egypt's coastline stretches over 3,500 kilometres along the Mediterranean Sea to the north and the Red Sea to the east. The northern region of Egypt concentrates most of its population and economic activity along the Nile Valley and Delta. Egypt shares its borders with Palestine to the northeast, Sudan to the south, and Libya to the west. Its topography is diverse, ranging from 133 metres below sea level to 2,629 metres above sea level in the mountainous terrain of the Sinai Peninsula.

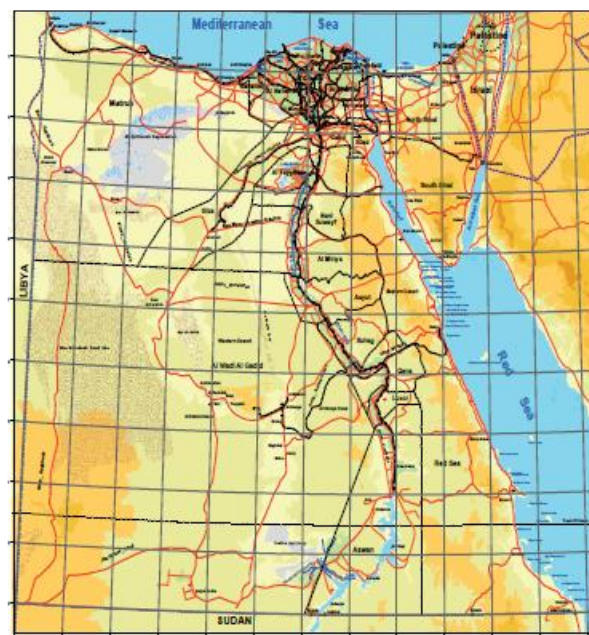


Figure 1-1: Map of Egypt

1.3 Climatic Conditions

Egypt's climate is desertic, hot and dry (The World Bank). There are two main seasons: a moderate winter from November to late March and a hot summer from mid-April to October. The seasonal differences result from daily temperature changes and wind variations. Summers are scorching and dry in Egypt. The hot and dry Khamaseen winds blow early in the summer from the southern deserts. The wind brings scorching dust and sand particles that keep daily high temperatures in the range of 40°C (104°F). The average low temperature is approximately 16.7°C (62.1°F) in the winter, and average high temperatures are in the range of 22.8°C (73°F) to 31.7°C (89.1°F) in the summer on the north coast.

Winters are mild and usually sunny except in the mountains of the Sinai Peninsula at high altitudes. During winter, the Sinai Mountains and several northern coastal cities experience frost and snowfall. The annual precipitation rate in Egypt is between 0 mm and 200 mm along the Mediterranean coast. Alexandria and Rafah experience more concentrated rains. It is rare that other Egyptian territories receive precipitation due to the desertic and arid climate (vide infra). Figure 1-2 shows the annual mean distribution over Egyptian regions.

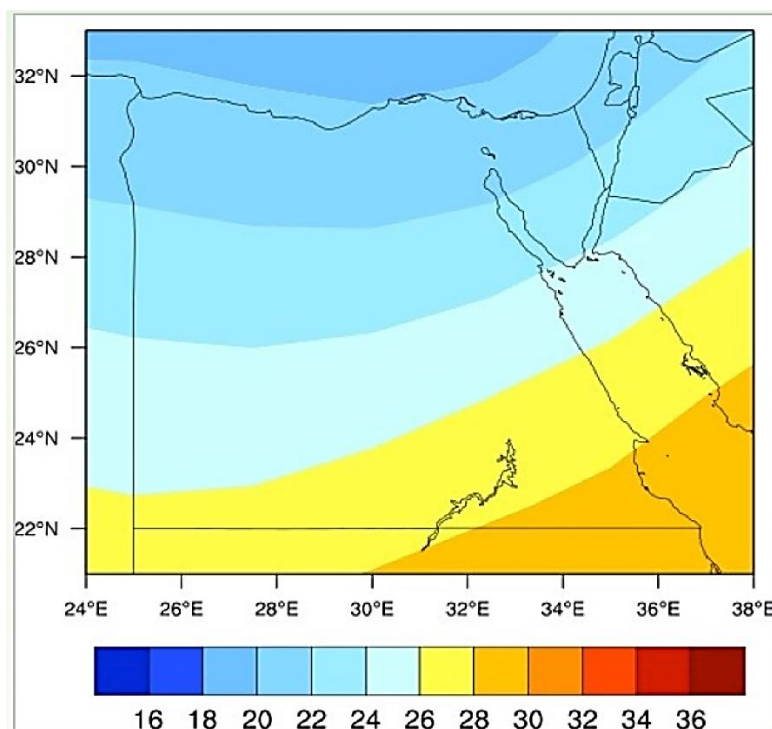


Figure 1-2: Mean air temperature over Egypt regions (NREA)

Most localities in Egypt receive less than 80 mm of precipitation annually. The Mediterranean coast is the region with the highest rainfall, with Alexandria registering up to 200 mm of precipitation annually. Despite relatively high humidity levels, sea breezes in Alexandria help moderate moisture, maintaining comfortable conditions. Precipitation decreases significantly moving southward; Cairo receives just over 10 mm annually, yet experiences summer humidity levels as high as 77%, with much lower humidity prevailing for the rest of the year.

Further south of Cairo, rainfall is minimal, with some areas experiencing years without precipitation, followed by sudden downpours that can trigger flash floods. The Sinai Peninsula is distinguished by many wells and oases that sustain small settlements, many of which have historically served as waypoints along ancient trade routes. It receives a relatively higher amount

of rainfall, with the northern regions receiving approximately 120 mm annually. Water drainage from Egypt's central plateau toward the Mediterranean Sea enables limited agriculture in the northern coastal zones, particularly around Al-Arish. As illustrated in Figure 1-3, the annual mean relative humidity is highest in the northern coastal regions, while Figure 1-4 shows that annual mean precipitation is likewise concentrated in these northern areas. In contrast, Upper Egypt remains arid, receiving very little rainfall throughout the year.

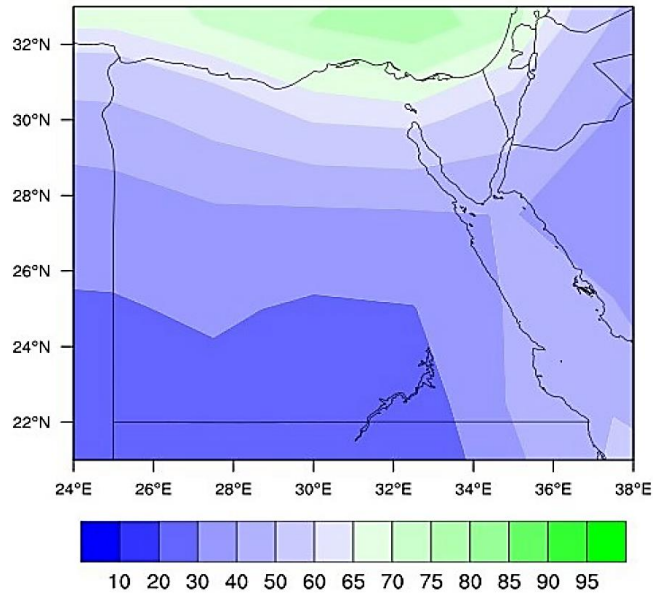


Figure 1-3: Annual mean relative humidity (%) (NREA)

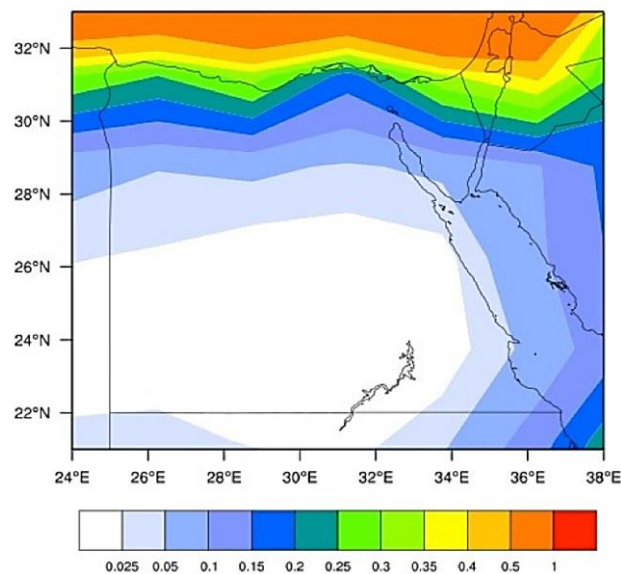


Figure 1-4: Annual mean precipitation (mm) (NREA)

One of the defining features of Egypt's climate is the occurrence of hot spring winds known locally as the Khamaseen. These winds typically occur in April, though they may also appear in March or May. Originating from intense low-pressure systems over the Isthmus of Suez, the Khamaseen sweep westward across North Africa's northern coast, gathering speed and momentum due to the absence of natural geographic barriers. As they travel across the desert, these winds reach high

velocities, sometimes up to 140 kilometres per hour, and carry large volumes of sand and dust. The resulting sandstorms can cause temperatures to rise abruptly, with recorded increases of up to 20°C within two hours. Khamaseen winds often blow intermittently over several days, with wide-ranging impacts that include respiratory illness in humans and animals, damage to crops, and occasional destruction of buildings and infrastructure.

In December 2005, the Egyptian Wind Atlas was issued in cooperation with the Danish RISO Laboratories and the Egyptian Meteorological Authority (EMA) to indicate appropriate and promising areas to benefit from wind energy in generating electricity. The Atlas redeemed the availability of promising areas endowed with high wind speeds in the Gulf of Suez and on both sides of the Nile, as well as areas in Sinai which are suitable for establishing large projects to generate electricity from wind energy. Figure 1-5 presents the annual mean surface wind in metres/sec. over Egypt. This figure illustrates the wind resource map of Egypt. The wind resource map provides an overview of the climatological wind conditions over Egypt. The coastal zones on the Red Sea are very windy, especially close along the Ras Gharib strip (Zafarana and Gabal Al-Zeit). The coastal zones facing the Mediterranean are less windy but still have rich wind resources. Furthermore, wide areas south of the Nile Valley show high wind speeds. The average speed in the Gulf of Suez is about 10.5 m/s at a height of 50 m. Moreover, the average speed in the eastern and western parts of the Nile is about 7.5 m/s at an altitude of 80 m.

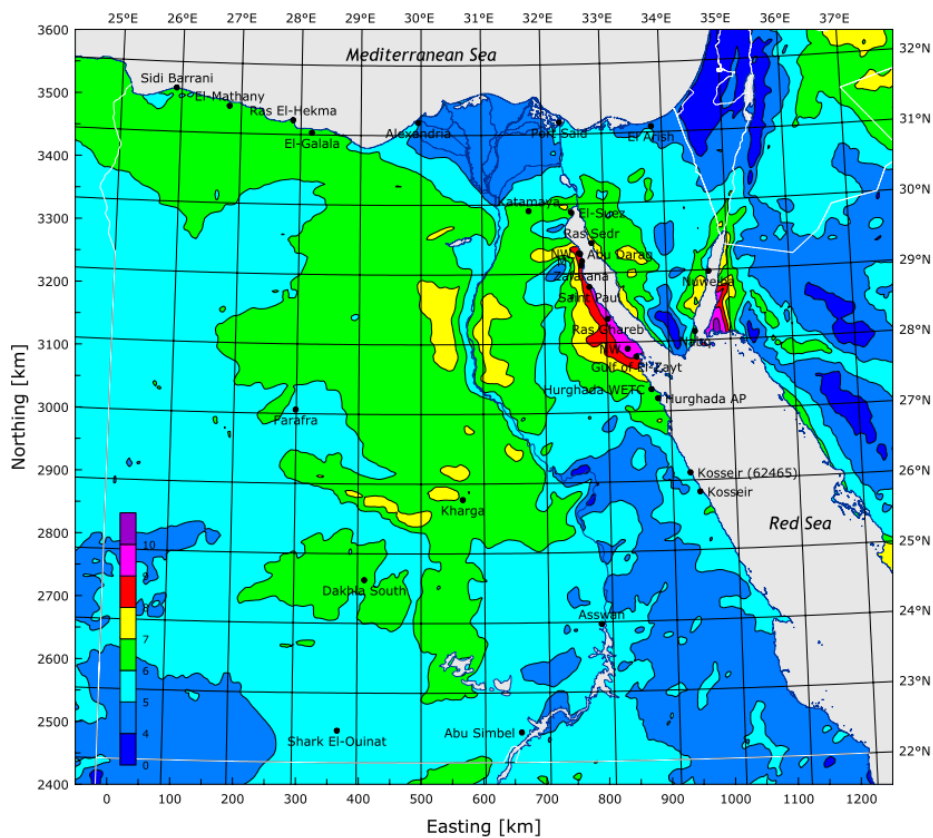


Figure 1-5: Wind resource map of Egypt: mean wind speed at 50 m a.g.l. determined by mesoscale modelling (Mortensen, Said Said, & Badger, 2009)

1.4 Population

Egypt is a developing country whose population is growing quickly. The Egyptians face multiple developmental challenges and aspirations for economic growth in 2021. Table 1-1 lists the main socio-economic indications of Egypt.

Table 1-1: Summary of the main socio-economic indicators of Egypt in 2020 (CAPMAS, 2020)

Indicator	Value
Population (million)	102.06
Urban population as percentage of total population	42.9%
Population below poverty line (percentage, 2019/2020)	٢٩,٧%
Unemployment rate (percentage)	7.4%
Life expectancy at death (years)	66.9
Male	72.3
Female	
Literacy rate (percentage)	75.4%
GDP (2020/2021) Billion EGP	6195
Billion USD (1 USD = 15.8 EGP, Central Bank of Egypt in 2020/2021)	394.2
GDP per capita (USD)	3,019.21

Egypt's population reached about 102 million in 2020 (CAPMAS, 2020). Historical census data shows that the population doubled three times over the past century: first between 1897 and 1947 (from 9.7 million to 19 million), then between 1947 and 1976, and again between 1976 and 2006, when it grew from 36.6 million to 72.82 million within the Republic. By the 2017 census, the population had risen further to 94.8 million. Egypt is one of the world's most densely populated nations, according to the World Development Indicators.

1.4.1 Population Density

As of 2017, the most densely populated region in Egypt was Lower Egypt, comprising the governorates of Damietta, Dakahlia, Sharkia, Qaliobia, Kafr El-Sheikh, Gharbia, Menoufia, Beheira, and Ismailia, which collectively accounted for 43.2% of the total population. This was followed by Upper Egypt, including the governorates of Giza, Beni Suef, Fayoum, Minya, Assiut, Sohag, Qena, Aswan, and Luxor, where 38% of the population resided. 17.1% of the population resided in the urban governorates of Cairo, Alexandria, Port Said, Suez, 6th of October, and Helwan. In contrast, the frontier governorates of Red Sea, Matrouh, New Valley (El-Wadi El-Gedid), North Sinai, and South Sinai accounted for the smallest proportion of the total population, at a mere 1.7%.

Approximately 95% of Egypt's population resides in the Nile Valley and Delta, which together account for just 4% of the country's total land area. This concentrated settlement results in an average population density of 1,136 persons per square kilometre, placing considerable pressure on the Nile River ecosystem. As of 2015, more than 20% of the national population lived in the Greater Cairo area, with an estimated 18.7 million inhabitants. Alexandria is the second most populous city, home to 4.8 million people (CAPMAS, 2016).

Although internal migration is prevalent among young males, approximately 57% of Egyptians reside in rural areas. Many of them relocate to megacities in search of better living conditions and

employment opportunities. This trend persists despite government initiatives aimed at encouraging youth to settle in newly reclaimed desert regions.

1.4.2 Urbanization Rate

According to the Central Agency for Public Mobilisation and Statistics (CAPMAS) Statistical Yearbook (2020), 42.9% of Egypt's population lived in urban areas in 2019. This urban–rural distribution has shifted slightly since 1990, when 43.4% of the population was urban and 56.6% was rural, indicating a marginal decrease in urban share over the past three decades. Nevertheless, there has been a substantial increase in urbanisation in comparison to 1907, when only 17.2% of the population resided in urban areas and 82.8% in rural ones. This long-term trend is attributed to the expansion of existing cities, the construction of new urban centres, and the growth of industrial zones. In terms of household characteristics, the urban overcrowding rate stands at 1.41 persons per room, with an average family size of 3.89. In contrast, rural areas have a lower overcrowding rate of 1.21 but a higher average household size of 4.16 persons.

1.4.3 Public Health

Egypt's healthcare system is divided among the Ministry of Health and Population, which provides 30% of services; the Ministry of Higher Education and Scientific Research, which delivers another 30% through university hospitals; and the Health Insurance Organisation, which accounts for 10% of services, in addition to private hospitals. The central government is responsible for providing primary and emergency healthcare services to Egyptian citizens, as well as for setting healthcare policies and strategies and overseeing public healthcare financing. There are government plans to reform the healthcare system and implement universal health insurance coverage for all Egyptians by 2030.

The key entities overseeing Egypt's healthcare system are the Ministry of Health and Population, the Ministry of Higher Education and Scientific Research, and the Health Insurance Organisation. The Ministry of Health and Population is the primary provider of integrated public healthcare, offering both preventive and curative services. It also regulates and supervises health services to ensure quality, equity, and citizen safety. It also works to improve health insurance services, increase access to health care for everyone, and create public health policies that tackle important national health issues like chronic diseases, malnutrition, reproductive health, smoking, accidents, injuries, and new health threats.

1.5 Governance

Egypt is a democratic, civil, and modern state composed of 27 governorates. It operates under a constitutional semi-presidential system. The legislative branch consists of two chambers: the House of Representatives and the Senate. The principal legislative body is the House of Representatives, which may consist of up to 596 members. Of these, 448 are elected through single-member plurality voting and 120 through proportional representation across four nationwide districts.

The House of Representatives serves a five-year term. According to the Constitution, 50% of its members may pass a motion of censure to compel the government to resign. As a result, the prime minister and the cabinet are typically drawn from the majority party or coalition. In the Senate, 176 members are elected directly, while the President of the Republic appoints 88 members for six-year terms. Half of the Senate is renewed every three years, and its legislative authority is limited. In

cases of disagreement, the House of Representatives has the final say on most legislation. The judicial branch includes:

- The Court of Cassation, composed of a president and panels of five judges organised in specialised circuits.
- The Supreme Administrative Court, the highest body of the State Council, also operates through panels of five judges organised into judicial circuits.

1.6 Eco-system and Biodiversity

1.6.1 Ecosystem

The land area of Egypt is composed of desert (92%) and agricultural land (8%). The country comprises 22 main habitat groups, such as Gebel Elba; Mountains and Wadies of the Eastern Desert; Red Sea Littoral Habitats; Red Sea Islands; Red Sea Marine Habitats; Mountains and Wadies of South Sinai; Central and North Sinai; Mediterranean Wetlands; Nile Valley and Delta; Gebel Owainat and Al-Gelf Al-Kebir; Western Desert Depressions and Oases; Sand and Dunes of the Western Desert; and Western Desert Mediterranean Coast and Mediterranean. The main features of these dry land areas are rocky surfaces, eroded pavement, gravel desert, sand dunes, slopes, and cliffs, yet the composition of plants in these areas differs from one from the other.

1.6.2 Biodiversity

Three hundred and twenty-four species of fauna and a lot of species of flora which exist in desert habitats are considered of ecological importance, especially in Sinai. Along with deserts, wetlands also constitute an important ecosystem, with 80 plants, 100 animals and 82 fish, notably along the Nile spreading over 1,530 km of the national territory. Overall, Egyptian biodiversity comprises 143 types of globally important species, 800 species of non-flowering plants, 2,302 flowering plants, 111 species of mammals, 480 species of birds, 109 species of reptiles, 9 species of amphibians, and more than 1,000 species of fish.

There exist many invertebrates: 10,000 to 15,000 species of insects, more than 200 types of coral species, 800 species of molluscs and over 1,000 crustaceans (Secretariat of the Convention on Biological Diversity (SCBD). , n.d.). Eighteen indigenous coral species are the world's best because of not having been subjected to coral bleaching. Two types of mangroves (*Avicenna marina* and *Rhizophora mucronata*) provide shelter for numerous species (40 species of insects, 72 species of butterflies, 65 molluscs, 17 polychaetes, and 22 species of fish). Yet the abundance in species is likely to decline in the coming years. Overall, 51 species of mammals are already endangered, along with 26 bird species and 26 reptile species. In coastal ecosystems, which represent one of the most threatened natural habitats, endangered mammals amount to at least 17 species, sharks to 20, birds to 300, fish to 150, algae to 80, coral species to 20, molluscs to 80, and crustaceans to 60, with many seaweed species also currently at great risk. The mangrove ecosystem is also vulnerable despite its area having increased from 525 hectares in 2002 to 800 hectares by the end of 2007 because of the establishment of a protection programme. In terms of mountain ecosystems, many of the 600 plant types, found primarily on Mount Sinai (Jabel Saraba) and Mount Katrina, are now endangered.

Further, the Sinai tiger has not been seen for 20 years. The genetic components of some fauna and flora species support the development of medicinal, agricultural, and industrial products as well as the basic daily needs of local communities. In addition, biodiversity supports the development of many new industries (e.g., ecotourism) which provide high economic return. The World Bank (WB) Group has reported a slight decrease in the number of marine protected areas in Egypt's territorial waters, from 4.952% in 2016 to 4.951%. Marine protected areas are intertidal or subtidal zones that are legally or effectively designated for environmental protection, and include their waters, ecosystems, and cultural or historical features.

1.6.3 Water Resources

Egypt's annual water demand is 114 billion BCM, with an imported virtual water volume of approximately 34 BCM per year to bridge the gap between demand and available resources. The Nile River remains Egypt's primary freshwater source, supplying 97.7% of the country's total freshwater needs. Additionally, 98% of Egypt's freshwater resources originate beyond its borders, with the Nile alone accounting for 93% of the country's total water supply.

This heavy reliance on transboundary water presents a critical challenge for water policymakers and decision-makers. As shown in Table 1-2 (MWRI, 2022), the Nile River provides an annual share of 55.5 BCM under the 1959 Nile Waters Agreement. However, this allocation is increasingly uncertain due to the construction and operation of the Grand Ethiopian Renaissance Dam (GERD).

Egypt's freshwater resources, which include subterranean aquifers, the reuse of agricultural drainage and treated wastewater, rain and floods, and seawater desalination, contribute an estimated 21.69 BCM annually, supplementing the Nile's supply. These resources have increased in recent years, as detailed in Table 1-2.

Table 1-2: Water availability and sources in Egypt (MWRI, 2022)

Water Input	Supply (BCM/year)	Demand by Sector	Demand (BCM/year)
Share from the Nile (Aswan Dam)	55.50	Drinking	11.48
Underground Water	2.50	Industry	5.52
Reuse of Agricultural Drainage Water	15.36	Agriculture	61.87
Rain and Floods	1.30	Evaporation Losses	2.50
Seawater Desalination	0.38		
Shallow Underground (Delta)	6.33		
Total	81.37		81.37

Nile River. The Nile River provides approximately 93% of Egypt's annual renewable water resources, with an allocated share of 55.5 billion cubic meters per year (BCM/yr.) under the 1959 Nile Water Agreement. The Nile's water originates from three distinct sources: the Equatorial Lakes Plateau, the Bahr Al-Ghazal sub-basin, and the Ethiopian Highlands. Since these sub-basins are climatically independent, the impacts of climate change must be assessed separately for each region.

Egypt is heavily reliant on Nile water and currently utilises nearly all its available resources. However, national water demand significantly exceeds this availability, placing the water system

under considerable stress. As a result, even relatively small reductions in water availability could have immediate and far-reaching consequences.

Agriculture is the largest water-consuming sector in Egypt, making it the most vulnerable to reductions in flow, particularly at Aswan. On the other hand, securing the water supply for drinking and industrial purposes is crucial for maintaining national stability, regardless of the circumstances. Given the essential social and economic value of these sectors, their water needs are prioritised over agricultural use.

In addition to reduced agricultural output, the Grand Ethiopian Renaissance Dam (GERD) is expected to impact hydropower generation at the High Aswan Dam (HAD). Furthermore, reduced releases could at times hinder navigation along the Aswan–Luxor stretch due to lower water levels. The potential impact on fisheries, however, is expected to be minimal.

On February 24–25, 2013, Cairo hosted a conference on the “Climate Change Impact on the Nile Basin: Exchange of Experiences within the Basin,” where multiple country reports were presented. Egypt’s Country Report featured results from a statistically downscaled model based on the UK Met Office (MO) Regional Circulation Model. The findings indicated that projected changes in rainfall, temperature, and potential evapotranspiration were less significant than previously estimated. The study outlined the following ranges of change in flow:

- Blue Nile (Diem): (-19%) to (+29%)
- White Nile (Malakal): (-8%) to (+10%)
- Main Nile (Dongola): (-13%) to (+36%)

The report further highlights uncertainty in the direction of change for rainfall and river flow. The Regional Circulation Model, while helpful in narrowing the range of uncertainty, cautions that it does not account for all influencing factors. Additionally, Research Report (2), published by the International Water Management Institute and Utah State University, titled “Climate Change Impacts on Hydrology and Water Resources of the Upper Blue Nile River Basin, Ethiopia,” presented the following findings:

- Climate in most Upper Blue Nile River Basin is likely to become wetter and warmer in the 2050s.
- Low flows may become higher, and severe mid- to long-term droughts are likely to become less frequent throughout the entire basin.

Although subject to uncertainty due to the limitations of current climate models, projections indicate that the region may retain its potential for hydropower generation, extended flow duration, and increased water storage capacity by the 2050s, without significantly impacting outflows to downstream riparian countries. The potential effects of climate change on the hydrology and water resources of the Nile Basin, based on downscaled simulations from 11 General Circulation Models (GCMs) and two global emission scenarios (A2¹ & B1²), reveal the following findings:

¹ IPCC Special Report on Emissions Scenarios (SRES) pathway describing a world with high population growth, low international cooperation, and high emissions levels.

² IPCC SRES scenario emphasizing global sustainability, clean technology, and low emissions.

- The Nile Basin will experience increase in precipitation early in the century (Period I, 2010-2039), followed by decreases later in the century (Period II, 2040-2069 and Period III, 2070-2099) except for the eastern-most Ethiopian highlands which is expected to experience increases in summer precipitation by 2080-2100.
- Summarized as spatial average over the entire Nile Basin, multi model – average Nile Basin precipitation changes as percentage of the period (1950-1999) are 115 (117), 98 (104) and 93 (96) while temperature changes are 1.5 (1.3), 3.2(2.8), 4.4 (3.6). The given figures are for A2 scenarios and B1 figures between brackets.

Groundwater. Egypt has huge natural mineral water resources. Table 1-3 demonstrate the main aquifers in Egypt and their potential water supply. However, most of them have not yet been significantly exploited. The main obstacles in utilizing deep groundwater resource are the great depth (up to 1,500 meters in some areas) and deteriorating water quality at increasing depth (MWRI, 2022).

Table 1-3: Main aquifers in Egypt. (NWRI, n.d.)

Aquifers	Main Features
Nile aquifer	87% of the total groundwater in Egypt, 100-300 m ³ /hr
Nubian sandstone aquifer	Covers 2 million km ² , the total volume stored is about 150,000 BCM
Fissured aquifer	Covers 50% of the surface area of Egypt, with productivity from 5 m ³ /hr to more than 300 m ³ /hr
Moghra aquifer	Found near the surface from Wadi Natroun to Wadi Farigh
Coastal aquifer	On the northern and western coasts. Recharged by rainfall
Hardrock aquifer	Located in the Eastern Desert and southern Sinai. Recharged by small quantities of infiltrating rainwater

Non-conventional water resources. Non-conventional water resources include agricultural drainage water, desalinated brackish groundwater and/or seawater, and treated municipal wastewater. These resources represent 27.1% of the total available water resources, and are generally used for agriculture, landscaping, and industry through specialized processes. Desalination is practiced on a small scale at present, mainly along the Red Sea coast (MWRI, 2022).

1.7 Economy

Egypt's recent macroeconomic and structural reforms stabilised the economy and have allowed the country to enter the global COVID-19 crisis with improving fiscal and external accounts. However, the adverse repercussions of the pandemic have since undermined this recent progress, shedding light on longstanding challenges. These include sluggish private sector activity and job creation, especially in the formal sector; underperforming non-oil exports and FDI; an elevated government

debt-to-GDP ratio (despite its significant reduction in recent years); below-potential revenue mobilisation; and an unfavourable budget structure, with limited allocations to key sectors, such as health and education.

International reserves remain relatively ample, at USD 40.1 billion at the end of January 2021, although still below their pre-crisis peak of USD 45.5 billion. External accounts were still bolstered by remittances, rebounding foreign portfolio inflows, and external financing, notably from the International Monetary Fund (IMF), Eurobond issuances, and an innovative green bond. Growth is forecast to decline from 3.6% in FY2019/20 to 2.3% in FY2020/21, considering the ongoing effect of the pandemic and especially the renewed surge in the COVID-19 cases since end-2020. The slowing of economic activity is expected to have adverse social implications.

1.7.1 Economic Programme

Real growth declined from 5.6% in FY2018/19 to 3.6% during FY2019/20, as the COVID-19 crisis caused a year-on-year contraction of 1.7% during April to June (Q4-FY2019/20). Growth inched upward in July to September and October to December (Q1 and Q2 FY2020/21) with the lifting of a night-time curfew and easing of social distancing measures, albeit remaining low at 0.7% and 2%, respectively. Key sectors, such as tourism, manufacturing, the Suez Canal and oil and gas extractives, continue to be severely impacted by restrictions on international travel, the slump in demand, and disruptions to supply chains and trade, both domestically and abroad. International reserves remain relatively ample, at US\$40.1 billion at the end of January 2021, although still below their pre-crisis peak of US\$45.5 billion. External accounts were still bolstered by remittances, rebounding foreign portfolio inflows, and external financing, notably from the IMF, Eurobond issuances, and an innovative green bond.

Growth is forecast to decline from 3.6% in FY2019/20 to 2.3% in FY2020/21, considering the ongoing effect of the pandemic, and especially the renewed surge in the COVID-19 cases since end-2020. The slowing of economic activity is expected to have adverse social implications. At the outset of the COVID-19 crisis, the government devised an emergency response package worth LE100 billion (1.7% of FY2019/20 GDP). Key measures include an exceptional monetary grant to irregular workers and the expansion of existing cash transfer programs. Forbearance measures were introduced in the form of delayed tax filing and loan repayments, in addition to subsidized credit for targeted sectors. The Central Bank of Egypt slashed policy rates by 400 basis-points to ease liquidity and enable individuals to access credit at favourable terms. This monetary expansion came against the backdrop of subdued inflation, registered at 5.7% in FY2019/20, which further declined to 4.5 % during the H1-FY2020/21.

Under the scenario that the COVID-19 vaccine is steadily rolled out through 2021 and early 2022, Egypt is expected to slowly start regaining its pre-pandemic growth momentum by FY2021/22/23. A downside scenario for growth over the forecast horizon would happen if the vaccination process became more protracted or variants of the disease caused further disruption, with lockdowns repeatedly imposed. The multi-dimensional health and economic crisis caused by the pandemic underscores the importance of advancing the human capital agenda, fast-tracking digital transformation, and strengthening social protection. A second wave of pending reforms, designed to unleash private sector activity and address Egypt's long-standing structural challenges, is crucial to create better employment opportunities and improve livelihoods.

1.7.2 Gross Domestic Product (GDP)

As of 2020, Egypt's total GDP reached \$363.07 billion, marking a 65% increase from 2010, when it stood at \$218.98 billion (World Bank, n.d.). Between 2000 and 2010, GDP growth was nearly twice the previous decade's rate, rising by 119%. Despite fluctuations, annual GDP growth in Egypt has generally declined over the past three decades, with a notable increase in 2000. Growth rates were recorded at 5.7% in 1990, 6.4% in 2000, 5.1% in 2010, and 3.6% in 2020 (World Bank, n.d.).

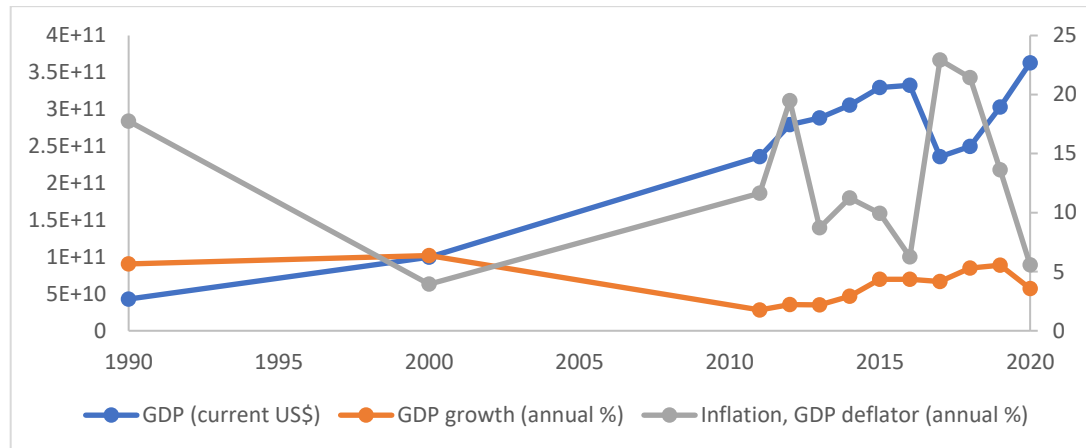


Figure 1-6: Economic profile development between 1990 and 2020

Figure 1-6 illustrates Egypt's economic profile development from 1990 to 2020. Between 1990 and 2000, GDP exhibited gradual growth, followed by a sharper increase from 2000 to 2010. Growth continued steadily until 2015 before experiencing a sharp decline between 2016 and 2017, likely due to the liberalisation of the national currency exchange rate in November 2016 as part of economic reform efforts. This period also saw a significant surge in inflation. However, GDP rebounded after 2017, accompanied by a decline in inflation.

1.7.3 Unemployment

Unemployment declined to 7.2% by Q2-FY2020/21 (after spiking at 9.6% six months earlier), as the initial drop in total employment at the outset of the COVID-19 crisis was reversed, and both labour force participation and employment rates rebounded from their large initial dip, though they remained below potential at 43.5% and 40.4% of the working-age population (The World Bank Group). According to CAMPAS 2021, the unemployment rate has declined between 2016 and 2019. While only 7.9% of people over 15 are unemployed.

1.8 Key Economic Sectors

The main key sectors producing GHG emissions and climate change represent a potential threat to them are energy, transportation, industry, agriculture, and waste.

1.8.1 Energy Sector

Since 2007, Egypt has faced a growing gap between energy production and rising demand, which escalated into a crisis in 2012/13 and 2013/14, placing additional strain on the national economy. In response, the government undertook intensive efforts to revise energy strategies and policies to address the crisis and promote sustainable development.

To ensure the energy sector meets national development needs, authorities developed the Integrated and Sustainable Energy Strategy 2035, which was approved by the Supreme Energy Council in October 2016. This strategy aims to enhance the technical and financial sustainability of the energy sector while aligning with the National Strategy for Sustainable Development (Egypt Vision 2030) and the country’s submitted First Updated NDC, which aims to achieve a 42% share of renewable energy by 2035. It also prioritises energy price liberalisation and sector restructuring to align with global climate commitments, particularly the Paris Agreement.

In line with these objectives, the sector has made significant efforts to secure and diversify primary energy sources, gradually restructure and phase out government subsidies according to a timeline that considers social dimensions and improve both energy production and consumption efficiency. These efforts also include increasing reliance on RE sources, particularly solar and wind power, and expanding the use of low-carbon energy options, such as NG as a substitute for butane in households and compressed natural gas (CNG) for vehicles. These initiatives have contributed to reducing overall energy consumption, particularly electricity, and have led to a notable reduction in greenhouse gas emissions.

According to the Ministry of Petroleum and Mineral Resources (MoPMR), Egypt has signed 86 new agreements with major international oil companies, securing a total capital commitment of \$15 billion over the past six years. Egypt successfully rescheduled all outstanding debts in the petroleum sector in 2019–2020, thereby strengthening its relationships with key global industry players. Additionally, Egypt achieved NG self-sufficiency in September 2018, allowing for the resumption of gas exports.

Despite these advancements, Bloomberg New Energy Finance forecasts that electricity generation capacity will struggle to keep pace with rising demand, which is projected to be among the highest in Africa by the mid-2020s. To address this challenge, Egypt aims to expand its energy capacity by accelerating RE deployment (IRENA, 2018).

As of FY 2014/2015, NG and petroleum products accounted for 98% of Egypt’s total primary energy consumption, compared to 1.5% from hydropower, 0.4% from coal, and just 0.1% from wind and solar power (IEA, 2018). The residential sector is the largest electricity consumer (44%), followed by industry (26%) (MoERE, 2016). Within the industrial sector, energy-intensive industries such as cement and fertiliser production are among the highest consumers of NG.

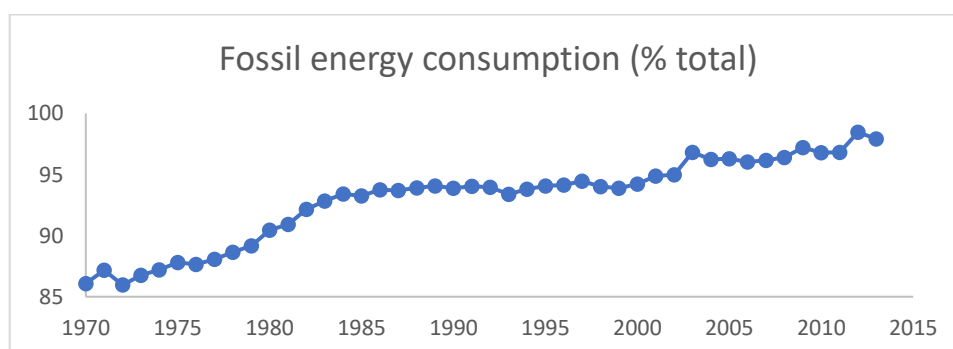


Figure 1-7: Fossil energy consumption development between 1970 and 2014 as a percentage of total consumed energy (WB)

To enhance electricity generation security, Egypt increased its power plant capacity to 58,353 MW, with total electricity production reaching 199,984.3 GWh. Production efficiency improved to 45.9%, while fuel consumption declined to 191.1 g/kWh in FY 2018/2019, compared to 214.1 g/kWh in FY 2014/15, with an annual decrease rate of 2.2%. By the end of FY 2018/19, electricity production grew at a rate of 1.6%. However, in FY 2019/20, while installed capacity increased to 59,530 MW, total electricity production declined to 197,357 GWh, reflecting a negative growth rate of 1.2%. Despite this decline, production efficiency rose further to 47.4%, and fuel consumption decreased to 185.2 g/kWh.

In the context of energy market liberalisation and Egypt's strategic vision to become a regional hub for energy exchange and trade, a series of measures have been undertaken, most notably the modernisation of the gas market to stimulate private sector participation. A key milestone in this effort was the establishment of the East Mediterranean Gas Forum, aimed at maximising the benefits of Egypt's existing infrastructure and facilities. These efforts have been supported by legislative developments, including Presidential Decree No. 196/2017 enacting the Gas Law and Prime Ministerial Decree No. 230/2018, which issued the law's executive regulations.

1.8.1.1 Energy Security

Egypt is nearing universal access to electricity, with an electrification rate exceeding 99.8% (World Bank, 2017). Most of the population, including those in rural areas, now receive adequate electricity services. However, the country experienced a severe energy crisis in 2014, highlighting the urgency of implementing a diversified electricity strategy to ensure a sustainable and reliable power supply.

In 2014, the electricity sector faced widespread blackouts and service disruptions, driven by fuel shortages, infrastructure constraints, distorted fuel export pricing, and rapid population growth—factors that collectively widened the gap between supply and demand. The electricity deficit peaked in August 2014, when demand reached 28 GW. Although installed capacity was available, many power plants were unable to meet peak demand due to fuel shortages, resulting in frequent outages (IRENA, 2018).

Hydropower, generated from the Aswan High Dam, the Aswan Old Dam, and the Isna and Nag Hammadi barrages, contributes approximately 3% of Egypt's total energy production. In 2012, hydropower generation totalled around 13.2 billion kilowatt-hours (US Energy Information Administration, 2018).

1.8.1.2 Energy Balance

Egypt aims to double its installed electricity capacity by 2030, up from approximately 50 GW in 2018, by integrating RE, coal, and nuclear power into its energy mix. To address the ongoing energy imbalance, the government has implemented several measures, including increased reliance on NG imports, diversification through renewables, the adoption of EE improvements, and enhanced operation and maintenance programs.

Figure 1-8, based on data from the International Energy Agency (IEA), illustrates the changing composition of Egypt's energy supply by source between 1990 and 2018. The figure shows a steady increase in the use of NG, while reliance on crude oil has declined. Due to insufficient domestic production of crude oil and refined petroleum products, petroleum imports have grown

significantly, reaching 90.44 million barrels at a value of USD 11 billion in 2012/13 and USD 13.2 billion in 2014. Additionally, the decline in NG production since 2014 led Egypt to begin importing liquefied natural gas (LNG) (BP, 2017b).

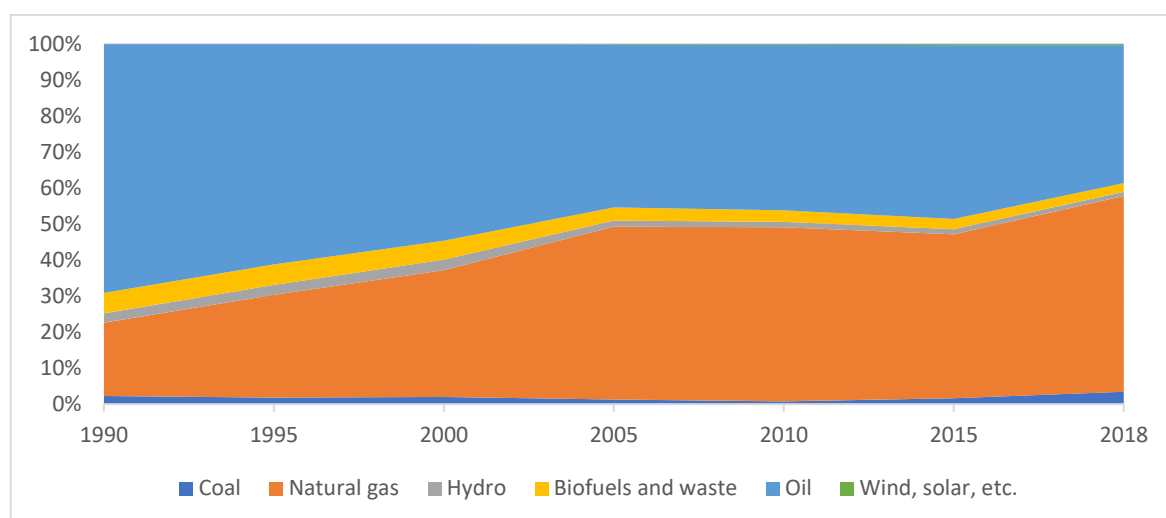


Figure 1-8: Energy supply source balance in Egypt between 1990 and 2018 ((Internation Energy Agency (IEA))

Renewable energy accounts for 8.7% of Egypt’s Total Final Energy Consumption (TFEC), with contributions from hydropower, solar, and wind (IRENA, 2018). The expansion of renewables plays a crucial role in addressing Egypt’s challenges in maintaining stable power generation amid fluctuating NG production and in reducing rising CO₂ emissions. At the same time, the contribution of biofuels and waste has shown a steady decline (IRENA, 2018). Notably, coal consumption increased between 2015 and 2018, reversing the significant reductions achieved between 2005 and 2010. While wind and solar energy have historically represented the smallest share of Egypt’s energy supply from 1990 to 2018, they have shown gradual progress in recent years.

1.8.1.3 Renewable Energy

Egypt’s national electricity grid has seen significant upgrades in its transmission and distribution infrastructure, resulting in a noticeable reduction in system losses. At the same time, the country’s shift toward renewable energy (RE) has gained momentum. In FY 2018/19, on-grid RE capacity reached 5,082 MW, contributing 8.84% of total electricity generation. This capacity grew to 5,848 MW by FY 2019/20, with 12% of installed capacity and electricity output coming from renewable sources. Total installed renewable energy capacity was 6,110 MW as of September 2020, with 2,832 MW derived from hydropower, which accounts for 20% of Egypt’s peak demand. These developments helped avoid the use of approximately 5.2 million tonnes of fossil fuels annually and prevented an estimated 16 million tonnes of carbon emissions. (NREA, 2022)

Figure 1-9, based on WB data, illustrates the share of renewable combustibles in Egypt’s total energy consumption from 1971 to 2014. Despite the steady decline in this share, factors beyond the government’s reduced interest in biofuel production may influence the trend. Potential contributing factors include the ongoing economic infeasibility of renewable energy technologies, particularly for low- and middle-income communities, and accelerated population growth, which has led to an increase in overall energy demand.

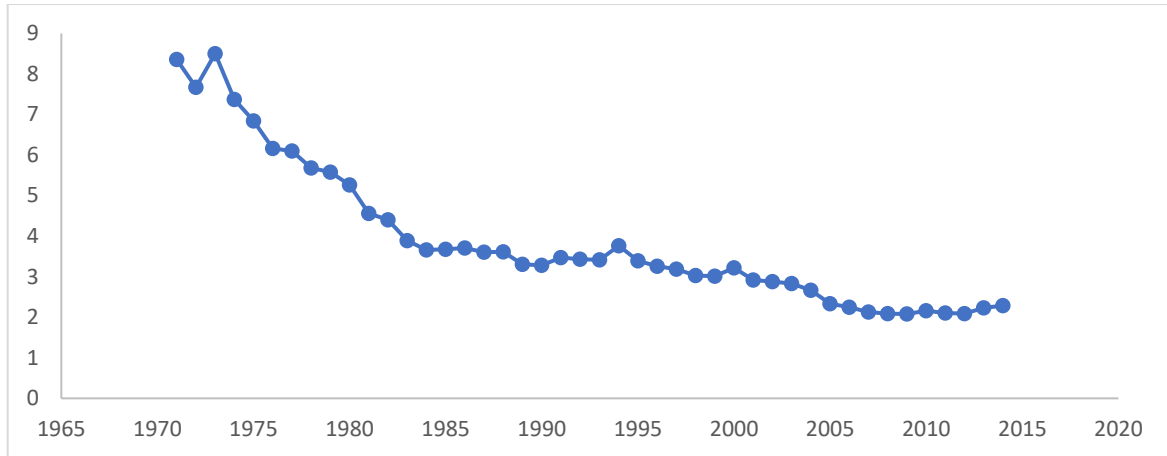


Figure 1-9 Combustible renewables and waste (% of total energy) between 1970 and 2014 (WB, 2020)

1.8.2 Transportation

Table 1-4 presents key transport sector indicators in Egypt, as reported by the Ministry of Transportation (MoT). In 2020, the total volume of imported cargo reached 97 million tonnes, while 59 million tonnes were transported domestically or exported. A total of 100,333 passengers arrived at Egyptian ports, whereas 1,028 passengers departed in the same year. Additionally, Egyptian ports handled 1.7 million imported containers and 1.8 million exported containers.

Table 1-4: Port Traffic in Egypt in 2020 (MoT, 2021)

Total Volume of Imported Cargo to Egyptian Ports	97 million Tonnes
Total Volume of exported Cargo from Egyptian Ports	59 million Tonnes
The total volume of cargo from the specialized ports	8 million Tonnes
Total Volume of Cargo to Egyptian Ports	164 million Tonnes
Total number of imported Containers to Egyptian Ports	1.7 million containers
Total number of exported Containers from Egyptian Ports	1.8 million containers
Total numbers of transit Containers in Egyptian Ports	4.1 million containers
Total number of Containers to Egyptian Ports	7.6 million containers
Total number of Passenger arrivals to Egyptian Ports	100,333 arrivals
Total number of Departing passengers from Egyptian Ports	71,028 passengers

1.8.2.1 Railways

Figure 1-10 illustrates the development of Egypt's rail transport network between 1995 and 2015, as reported by The WB Group. This includes expansions and upgrades to conventional railway lines, metro systems, and tram networks across the country.

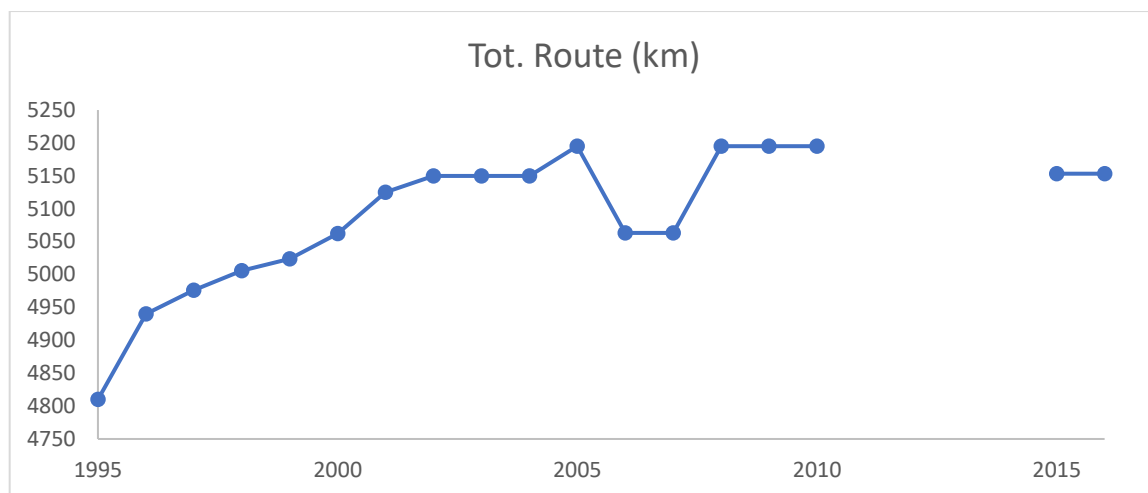


Figure 1-10 Number of total rail route (km) (WB)

1.8.2.2 Civil Aviation

Between 1970 and 1985, the air traveller statistics in Egypt kept growing, though the numbers were generally exceedingly small (2-3 million travellers) compared to the following years. For the next 30 years, between 1986 and 2006, the air traveller numbers fluctuated every year, up and down, with minimum and maximums of 2.3 and 6.7 million a year, respectively. For the following period (2009-upwards), the statistical fluctuation endures but with more significant numbers compared to both previous periods, reaching 14 million travellers in 2019.

1.8.3 Industry

Egypt's industry sector has made significant progress in recent years, with various indicators reflecting the country's growing industrialisation and economic diversification. While challenges remain, particularly regarding energy availability and costs, the government has taken steps to address these issues. Efforts to develop the sector and attract foreign investment have contributed to a more favourable business environment for industrial activity.

Since 2016, the industry sector has been on a steady growth trajectory, driven by government policies aimed at improving the business climate and increasing foreign investment. Various indicators highlight this expansion, reinforcing Egypt's commitment to industrial and economic development. A key measure of this growth is the increase in industrial facilities across the country. According to CAPMAS, the number of industrial establishments rose from 53,000 in 2016 to 61,000 in 2021, marking a 15% growth rate. The manufacturing sector, which continues to be the dominant contributor to industrial activity in Egypt, has largely fuelled this expansion.

Another key indicator of the industry sector's growth has been the increase in industrial production. According to data from the Ministry of Trade and Industry (MTI), industrial production in Egypt increased by 20% between 2016 and 2021, with the manufacturing sector accounting for the bulk of this growth. The government's efforts to promote the manufacturing sector, particularly in high-value-added industries such as automotive and electronics, have helped to drive this growth.

One of the greatest challenges facing the industry sector in Egypt has been the availability and cost of energy. The country has been grappling with an energy crisis recently, with frequent power outages and fuel shortages affecting industrial production. However, the government has been

working to address these challenges by investing in RE sources such as wind and solar power, as well as upgrading the country's energy infrastructure.

Foreign investment has also played a key role in the growth of the industry sector in Egypt. According to the Ministry of Investment and International Cooperation, FDI in the country's industry sector increased from \$2.2 billion in 2016 to \$3.8 billion in 2020, representing a growth rate of 73%. This growth was driven by several factors, including the government's efforts to improve the business environment, the country's strategic location as a gateway to Africa and the Middle East, and the availability of a skilled and relatively low-cost workforce.

Egypt's most important industries have been evolving steadily since 2016, with the government's efforts to promote them and attract foreign investment playing a key role in their growth. While there are still challenges to be addressed, such as the availability of energy and the need to improve the business environment, these industries continue to show strong potential for future growth and development.

Automotive Industry: Egypt's automotive industry has witnessed significant growth over the past years, attracting major global manufacturers such as General Motors, Hyundai, and Nissan, all of which have established production facilities in the country. According to the MTI, the sector's production value reached EGP 19 billion in 2016. This upward trajectory has been supported by government initiatives aimed at boosting local manufacturing, as well as the advantages of a skilled workforce and competitive labour costs.

Textile Industry: The textile industry is one of Egypt's most historic and well-established sectors, playing a significant role in the national economy for decades. According to data from CAPMAS, the industry's production value was EGP 18 billion in 2016. Its continued growth has been supported by the sector's adaptability to evolving consumer demands and reinforced by government initiatives and incentives aimed at revitalising local textile manufacturing.

Construction Industry: The construction industry is another key sector of the Egyptian economy, and it has been growing steadily since 2016. According to data from CAPMAS, the construction industry's production value increased from EGP 83 billion in 2016 to EGP 379 billion in 2021, representing a growth rate of 32%. This growth has been driven by the government's investment in infrastructure projects such as roads, bridges, and new cities, as well as the demand for housing and commercial real estate.

Food and Beverage Industry: The food and beverage industry is one of Egypt's largest and most diversified sectors, spanning agricultural production, food processing, and distribution. According to data from CAPMAS, the industry's production value stood at EGP 126 billion in 2016. The country's large and growing population, along with government initiatives aimed at strengthening agricultural output and enhancing food security, fuel its continued expansion.

Information Technology Industry: The information technology (IT) industry has been one of the fastest-growing industries in Egypt in recent years, with the government investing heavily in the sector to promote innovation and entrepreneurship. According to data from the Ministry of Communications and Information Technology, the IT industry's production value increased from EGP 56 billion in 2016 to EGP 99 billion in 2020, representing a growth rate of 77%. This growth has been driven by the country's young and tech-savvy population, as well as the availability of a skilled workforce and relatively low labour costs.

1.8.4 Agriculture and Land Reclamation

The agriculture, forestry, and hunting sector is a significant component of Egypt's economy. In 2019, it employed 21.1% of the total workforce and contributed 11.4% to the GDP at current prices

by product at factor cost, based on economic activity data for 2018/2019. The agriculture sector recorded a growth rate of 3.3% during the same period (CAPMAS, 2020).

Egypt's agricultural land area has faced fluctuations and challenges between 1960 and 2018. In 1964, agricultural land expanded following a ruling by the Supreme Constitutional Court, which declared Law No. 104/1964 on agricultural reform unconstitutional. This decision returned confiscated lands to private owners. For the next decade, Egypt's agricultural land remained stable at approximately 29,000 km² until 1975, when it began to decline, reaching 24,470 km² by 1979. However, starting in 1991, the country witnessed a significant increase in agricultural land, which has continued to expand. By 2018, Egypt's total agricultural land was estimated at 38,360 km².

1.8.4.1 Agricultural Crops

According to the CAPMAS yearly book of 2020, the total cultivated area in Egypt included total palm trees, sugarcane, cotton, trefoil, and wooden trees. The winter vegetable production included loaded potatoes, tomatoes, and other vegetables. The other winter crops included gram, fenugreek, lupine, medical and perfumed plants, green forage, tavola and others. The summer vegetables included watermelon as well. The winter others included yellow and green corn, clover, hegaz, onions (green, single, loader), sunflower, luffa, samar, barada, broom corn, medical and aromatic plants, wooden trees, and green feed.

1.8.4.2 Cultivated Lands

Egyptian agricultural land can be classified into "Oldland", comprising the lands of the Nile Valley and the Nile Delta which have been irrigated and intensively cultivated since ancient times and which represent about 65% of the cultivated area, and "Newland", entailing lands that have been reclaimed relatively recently or are in the process of being reclaimed now, representing about 35% of the cultivated area. The cultivated land base of Egypt is about 38360 sq. km (CAPMAS 2020). Additionally, national investment in the agriculture and irrigation sectors grew by 11% – from \$1.6 billion in 2014 to \$1.8 billion in 2015. Improvement in water availability and efficiency could be achieved by water management through more effective on-farm practices, changes in cropping patterns towards less water-consuming crops, and the introduction of improved irrigation systems, as well as the reuse of drainage water and treated sewage water (MALR, 2009).

1.8.4.3 Reclamation Programme

The Egyptian Ministry of Agriculture and Land Reclamation (MALR) announced an effort to reclaim approximately 1.5 million acres (607,028 ha) of marginal or desert lands for agricultural use. Egypt has undertaken similar strategies in the past with limited success. Limited water resources and significant urban encroachment are increasingly straining the country's agricultural lands (USDA, 2016). While the Government of Egypt's objectives in land reclamation are laudable and certainly necessary in the long term, Post has identified several significant challenges that could ultimately hinder the project's success.

The first of these is the costs. Estimated costs for completion of the project reach as high as EGP 37 billion (USD 4.7 billion), which is significant given the country's precarious economic situation. The second challenge is water. Drilling and maintaining 5,000 irrigation wells in harsh desert conditions will require significant technical expertise as well as a long-term resource commitment. Additionally, the use of underground water raises questions about the sustainability of the water source. The third challenge is management of the reclaimed land. It is not entirely clear yet how land will be distributed, and which parties will be responsible for maintenance of the infrastructure. If land reclamation is successful, its future usefulness will depend on clear rules and responsibilities among all parties involved (USDA, 2016).

1.8.5 Waste

Egypt generates an estimated 26 million tonnes of municipal solid waste annually, reflecting increasing pressure on the country's waste management system amid rising population and evolving consumption patterns. While approximately 24 million tonnes of this waste are collected, the rest remain uncollected each year, particularly in informal and underserved areas, posing environmental and public health risks.

According to the MoE, the waste in Egypt in 2017/2018 equalled 75744 tonnes and was composed of organic materials (43.5%), paper/cardboard (13.9%), plastics (10.29%), transferable materials Refuse Derived Fuel (RDF) (13.46%), and others (18.34%). In 2016, around 21.7 million tonnes of municipal solid waste were generated. Driven by population growth and changing patterns of consumption, waste generation is expected to increase at a rate of 3.4% per year. Waste management services and infrastructure are unable to keep pace with these growth rates. Only around 60 per cent of the waste produced is collected currently, and less than 20 per cent of this is properly disposed of or recycled. While some cities maintain clean public spaces, the situation in other parts of the country is problematic (GIZ, 2019).

1.8.5.1 Waste Management

Despite efforts to improve collection, Egypt's waste management infrastructure continues to face significant capacity constraints. In 2016, the total volume of municipal solid waste was estimated at 21.7 million tonnes, with projections indicating an annual growth rate of 3.4%, driven by demographic and economic factors. By 2017/2018, the composition of Egypt's waste stream was dominated by organic materials (43.5%), followed by paper and cardboard (13.9%), plastics (10.29%), refuse-derived fuel (13.46%), and other materials (18.34%), according to the MoE.

The primary methods of waste treatment and disposal in Egypt are landfilling and limited resource recovery. Approximately 8.5 million tonnes of the waste collected are subjected to treatment procedures. Nevertheless, a substantial amount—approximately 15.5 million tonnes—continues to be disposed of in landfills, with depths varying from 5 to 15 meters, contingent upon the specific conditions of the site. It is evident that there is a significant disparity between the generation of waste and its effective management, as only approximately 20% of the total waste is treated or recycled appropriately (GIZ, 2019).

A large portion of waste in Egypt is improperly discarded in open areas, waterways, and streets, causing serious environmental pollution, health risks, and economic losses—particularly in tourism. Despite international support, waste management institutions face structural weaknesses, including inadequate legal frameworks, unclear responsibilities, lack of strategic planning, and chronic underfunding. There is an urgent need for sustainable investment and improved service delivery (GIZ, 2019).

In response, Egypt has begun investing in waste-to-resource initiatives that aim to reduce environmental burdens and promote circular economy practices. Of the waste treated, 50% (approximately 4.3 million tonnes annually) is converted into organic compost, while 20% (around 1.7 million tonnes) is processed into RDF for industrial energy use. These efforts indicate a positive

shift towards more sustainable waste management; however, additional investment, institutional strengthening, and public awareness are necessary to enhance performance throughout the entire value chain—from generation to final disposal.

A key challenge in managing municipal solid waste (MSW) is the lack of adequate collection equipment, which the MoE attributes to poor maintenance and insufficient resources for upgrading and expanding waste collection and treatment infrastructure. Addressing this issue requires capacity building to enhance technical expertise in equipment operation and maintenance, alongside the development of technical guidelines. However, securing adequate funding remains essential for the effective management of municipal solid waste.

To improve waste management efficiency, it is crucial to integrate the informal waste sector into formal public and private waste management systems. Establishing economic instruments, such as public-private partnerships (PPPs), and investing in human resource development will play a fundamental role in implementing and enforcing existing policies. Additionally, enhancing coordination among governmental entities responsible for MSW regulation and operations is necessary to streamline efforts. Public awareness campaigns promoting at-source waste separation will further support waste management initiatives at both the governmental and corporate levels. The waste sector is also a significant contributor to greenhouse gas emissions, particularly from solid waste disposal sites (SWDS), wastewater handling, and waste incineration.

The treatment of urban wastewater and the resulting wastewater sludge is accomplished using aerobic and anaerobic processes. The domestic wastewater handling in Egypt falls under the responsibility of entities undertaking design, implementation, operation and maintenance for water & wastewater utilities affiliated to the Ministry of Housing, Utilities and Urban Communities, represented by the Holding Company of Water and Wastewater, the National Authority for Potable Water and Wastewater, the Executive Organisation for Potable Water & Wastewater, and the Authority of Urban Communities. The number of wastewater treatment plants (WWTP) has increased over the years.

1.8.5.2 Legislation, Policies, and Institutional Structure

In 2020, the Egyptian government issued Decree 202, replacing the Waste Management Department with the Department of Organising Waste Management (DOWM) under the MoE. DOWM is responsible for organising, monitoring, and developing an integrated and holistic waste management system. It also aims to attract and encourage investment in the sector to support sustainable development and foster international cooperation in waste management.

To achieve its objectives, DOWM collaborates with local city councils and new urban community authorities to coordinate waste separation, transportation, storage, and safe disposal. All employees in the sector must receive adequate training from licensed entities engaged in integrated waste management. Additionally, DOWM is responsible for issuing waste management licences to all stakeholders, including local authorities. In partnership with the Ministry of Electricity and RE, DOWM also plays a key role in determining tariffs for waste-to-energy production.

1.9 Climate Change Institutional Framework

Egypt's climate change governance is anchored in a structured institutional framework that enables the coordination of policy development, implementation, and monitoring across sectors. Key institutions and mechanisms have been established to support national efforts in addressing climate change, ensuring alignment with both development priorities and international commitments.

1.9.1 Institutional Arrangements

Egypt's climate institutional arrangements have progressively evolved to support national and international commitments to climate action. Key institutions have been established and strengthened to coordinate policy, governance, and implementation efforts across sectors.

Egypt's environmental and climate governance framework has undergone significant development since the early 1990s, laying the institutional foundations for effective climate action. The Ministry of Environment (MoE), established in 1997 and led by the country's first full-time Minister of Environment under Presidential Decree No. 275/1997, is the primary authority responsible for environmental policy formulation, implementation, and oversight. The Ministry operates through the EEAA, which serves as its executive arm at the central level. Originally established in 1982 and restructured under Law No. 4/1994 for Environmental Protection, the EEAA was mandated to lead on environmental coordination, develop legislation and standards, enforce compliance, and implement environmental projects and studies. In 1994, the Environmental Protection Fund was also established to stimulate investment in environmental initiatives.

Egypt ratified the UNFCCC in 1994 as a non-Annex I Party, reinforcing its commitment to addressing climate change. Even before that, in 1992, Egypt had created a Climate Change Unit within the EEAA, which was designated as the national focal point for the UNFCCC and the Kyoto Protocol, with responsibility for coordinating national and international climate-related activities. This unit was formally established in 1996 and later upgraded to the Climate Change Central Department (CCCD) in 2009, enhancing the institutional capacity for climate governance.

In parallel, several coordination mechanisms were introduced to support policy integration. The National Committee on Climate Change, formed in 1997 and restructured in 2007 under Decree No. 272, was mandated to oversee national climate policy. The National Committee for the Clean Development Mechanism was established in 2005 and reformed in 2010 to manage and approve Clean Development Mechanism (CDM) projects in Egypt. To further institutionalise climate governance, the National Council for Climate Change (NCCC) was created in 2015 under Prime Ministerial Decree No. 1912/2015. Initially chaired by the Minister of Environment, the Council was restructured in 2019 through Decree No. 1129/2019, with the Prime Minister assuming chairmanship—an indication of heightened political prioritisation of climate action. The Council's membership was expanded to include key ministries, civil society representatives, private sector actors, and national experts, thereby enhancing cross-sectoral coordination and whole-of-government engagement.

Today, the NCCC serves as Egypt's central body for climate policy formulation, strategic planning, and monitoring implementation, while the CCCD acts as its technical secretariat, facilitating coordination and ensuring follow-through. Egypt submitted its first NDC to the UNFCCC in June 2017, reinforcing its international commitments.

Egypt's climate governance framework aligns with broader sustainable development goals (SDGs), particularly through the SDS: Egypt Vision 2030. Launched in line with the United Nations 2030 Agenda, SDS 2030 integrates economic, social, and environmental dimensions into national planning, providing a coherent framework for aligning development and climate objectives.

1.9.2 Monitoring, Reporting, and Verification (MRV)

1.9.2.1 *Current Status*

Egypt has made notable progress in developing a national Monitoring, Reporting, and Verification (MRV) system as a foundation for climate transparency and accountability. A draft MRV structure, endorsed by the NCCC chaired by the Prime Minister, was developed in consultation with key government entities but has yet to be fully institutionalised. The system is structured around four pillars: (1) GHG inventories, (2) mitigation actions, (3) support received, and (4) adaptation measures. The EEAA, through its CCCD, serves as the coordinating body, while CAPMAS is expected to support data management through a dedicated GHG unit. Line ministries are also encouraged to establish focal points to facilitate sectoral data collection and reporting. Within this broader MRV system, the Mitigation MRV Framework has specific objectives:

- To track the progress of low-emission policies and associated mitigation actions in achieving national targets and policy goals.
- To serve as a guiding tool for policymakers in the development and refinement of future mitigation actions.
- To ensure transparency and credibility in reporting mitigation outcomes.

The scope of mitigation MRV expands upon the current domestic framework, conforming to international standards and adapting to Egypt's institutional context. Its successful implementation hinges on several key elements, including:

- Regular measurement and monitoring of GHG emissions using consistent, complete, and sector-adapted methodologies.
- Methodological alignment with international best practices for tracking emissions and assessing mitigation indicators.
- Independent quality assurance and verification to ensure the accuracy and completeness of data.
- Adequate financial and human resources, along with effective inter-institutional coordination and communication mechanisms.

The MRV system also includes a structured reporting process, which should cover:

- GHG emission reduction progress by sector and indicator.
- Emission estimates across all relevant sectors.
- Compliance with biennial update report (BUR) requirements and future obligations under the Paris Agreement.
- Identification of financial and capacity-building needs related to mitigation policies.

1.9.2.2 *Enabling Conditions and Barriers*

As a non-Annex I country under the UNFCCC, Egypt's climate change actions are voluntary and conditional upon the availability of international financial, technical, and capacity-building support. These resources are essential for enabling Egypt to implement its mitigation and adaptation commitments while pursuing national sustainable development and poverty reduction goals:

1. Data Availability, Access, and Quality

Limited and inconsistent sectoral data hinder accurate GHG inventory estimates and effective tracking of mitigation actions. Gaps exist in reporting support received, climate finance classification, and sectoral needs. These challenges stem from weak institutional coordination, inconsistent data formats, and limited data accessibility. Addressing them requires standardised reporting templates, improved data systems, advanced methodologies (higher IPCC tiers), and national emission factor development.

2. Limited Resources for the Coordinating Entity

The CCCD under the EEAA requires stronger institutional support and resources to fulfil its coordination role. Effective collaboration among ministries, statistical agencies, and sectoral actors is vital for building robust data frameworks. A long-term solution includes establishing an IT-based National Inventory Management System to automate data flows, enhance QA/QC, and maintain a national emission factor database.

3. Institutional Barriers in MRV Implementation

Weak institutional structures limited sectoral integration, and a lack of research-based policy inputs constrain MRV implementation. These issues, highlighted in Egypt's TNC, continue to obstruct the scaling of successful mitigation measures and reduce transparency. A centralised inventory of good practices and lessons learnt is needed to support future MRV enhancements and informed decision-making.

4. Capacity Constraints for Climate Finance Access

Mobilising climate finance remains a key challenge due to limited national capacity to develop high-quality, donor-aligned project proposals. Achieving NDC and related targets requires skilled personnel, technical expertise, and strong institutional systems. Bridging this gap will necessitate substantial investment in capacity building and international support.

2 National Greenhouse Gas Inventory

2.1 Introduction

This chapter presents Egypt's greenhouse gas (GHG) inventory for the years 2016 and 2017. It describes the data collection approach and process, the analysis of collected data, and the calculations carried out using the Intergovernmental Panel on Climate Change (IPCC) software. It also includes the results of the uncertainty analysis and the applied Quality Assurance (QA)/Quality Control (QC) procedures. In addition, the report identifies the gaps and challenges faced in data collection for GHG estimation, including institutional arrangements, and sets out an improvement plan to strengthen the preparation of future inventories.

To support data collection, tailored questionnaires were developed and distributed to relevant national authorities. For the energy sector, the primary sources of activity data were the Ministry of Petroleum and Mineral Resources (MoPMR) and the International Energy Agency (IEA). The Industrial Processes and Product Use sector drew on several sources of information, as detailed in the report. For the Agriculture, Forestry and Other Land Use (AFOLU) sector, activity data for 2016 and 2017 were primarily obtained from official national sources, including the Central Agency for Public Mobilisation and Statistics (CAPMAS), the Economic Affairs Sector (EAS) through its Annual Bulletin of Agricultural Economics, and the Food and Agriculture Organisation (FAO). For the waste sector, three main types of data sources were used to generate the final inputs for the 2006 IPCC software: (1) tailored data collection forms submitted to CAPMAS and various ministries and national agencies responsible for waste sector categories, (2) published national, ministerial, and sectoral reports, and (3) Egypt's First Biennial Update Report (BUR1) GHG inventory and its associated documentation.

The 2016/2017 greenhouse gas inventory (GHGI) was prepared using the updated 2006 IPCC Software, Version 2.691, in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The methodology applied for the GHGI within Egypt's Fourth National Communication (NC4) includes the following:

- Agreement on time series with the project team and the inventory team and team leader.
- Data collection; parameter and assumption development.
- Cross-checks from multiple sources, as available.
- Review, update and modify previous data used in estimates included in Egypt's BUR1.
- Data quality checks (QA/QC).
- Data entry into 2006 IPCC GHGI Software.
- GHG calculations and results extraction from 2006 IPCC GHGI Software.
- Time series consistency checks.
- Review by GHGI team and team leader.
- Reporting and content development for NC4 GHGI Chapter.
- Preparation of training material for national stakeholders.

In addition to the greenhouse gas emissions reported for the inventory years 2016 and 2017 in Egypt's NC4, the report also presents a trend analysis covering the period 1990–2017. This analysis draws on earlier submissions, including the Initial, Second, and Third National Communications, as well as Egypt's BUR 1. Together, these reports provide inventory data for the years 1990, 2000, 2005, and 2006–2015, respectively.

2.2 Breakdown of GHG Emissions by Sector

2.2.1 Energy Sector

2.2.1.1 Overview

According to IEA data, Egypt's total energy supply was about 96 MTOE in 2018 and 93 MTOE in 2017. The average annual growth rate of total final energy supply was 3.7% between 2010 and 2018 and 7.6% between 2015 and 2017. Figure 2-1 illustrates the evolution of primary energy supply by fuel type. Natural gas has consistently held the largest share in Egypt's primary energy supply over the years. Since 2014, however, coal has been introduced in the cement industry due to shortages of natural gas at that time. More recently, natural gas has again become available to all categories of consumers.

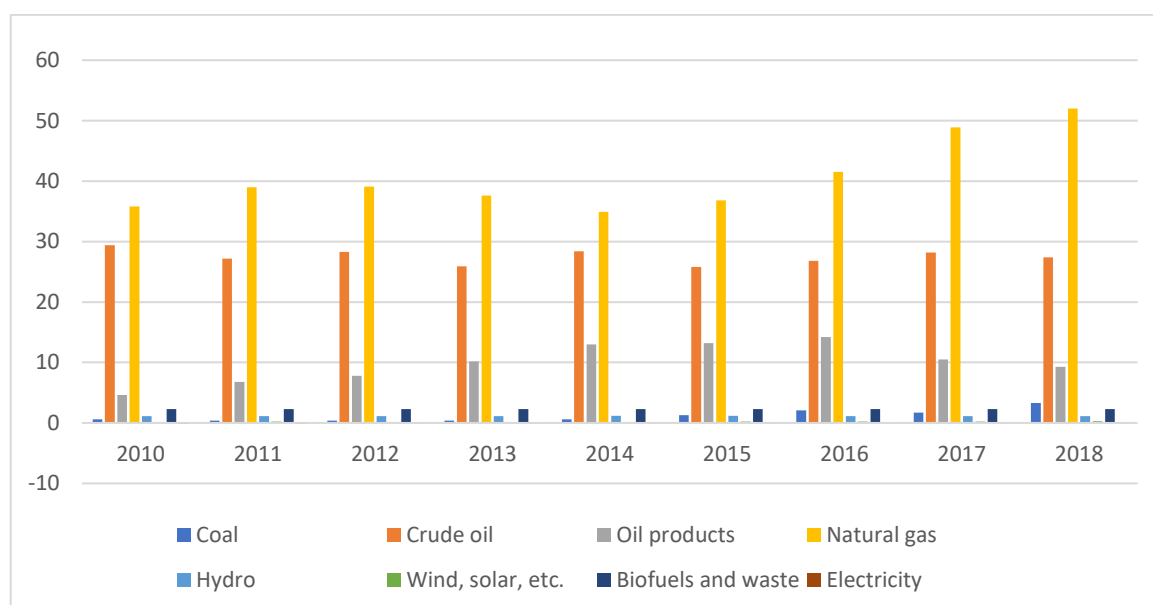


Figure 2-1: Evolution of Egypt primary energy supply (MTOE)

From the demand side, Egypt's final energy consumption in 2018 reached about 61 MTOE, with an average annual growth rate of 2% between 2010 and 2018. In 2017, final energy consumption was about 60 MTOE, with an average growth rate of 2.9% over the period 2015 to 2017. Figure 2-2 presents the evolution of final energy consumption between 2010 and 2018.

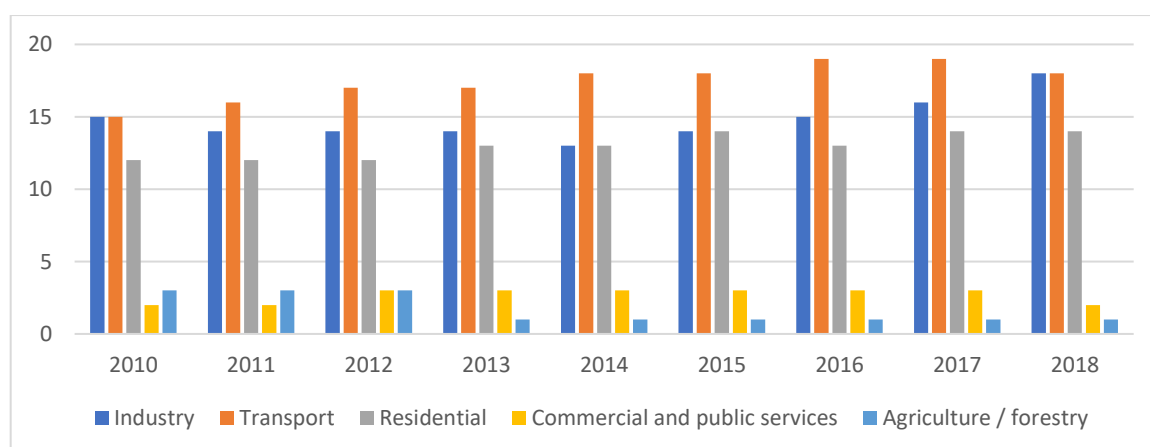


Figure 2-2: Evolution of final energy consumption (MTOE)

Egypt energy sector total GHG emissions in 2016 and 2017 were 225,850 and 228,867 Gg, respectively³, with annual growth rate of 1.3%.⁴ These emissions are generated primarily from fossil fuel combustion activities, along with fugitive emissions from oil and natural gas operations. Table 2-1 presents the Energy sector emissions for 2015, 2016, and 2017. The average annual growth rate of GHG emissions from the energy sector over the period 2015 to 2016 is 3%.

Table 2-1: GHG emissions of energy sector

GHG gas	2015 ⁵		2016		2017	
	Gg CO2eq	% of total	Gg CO2eq	% of total	Gg CO2eq	% of total
CO ₂	215,780	98.45%	222,410	98.48%	225,498	98.53%
CH ₄	2,392	1.09%	2,366	1.05%	2,336	1.02%
N ₂ O	1,000	0.46%	1,074	0.48%	1034	0.45%
CO _{2e}	219,172	100%	225,850	100%	228,867	100%

2.2.1.2 Methodology and Assumptions

The approach used to estimate the greenhouse gas inventory and to collect data for the energy sector consisted of the following:

- 2016 IPCC inventory guidelines were used, and IPCC Inventory Software Ver 2.691 was used for estimating emissions.
- Reliable activity data for the energy sector was used from national (mainly MoPMR) and international sources, specifically the IEA, UN data, and British Petroleum (BP) websites.
- Both default emission factors in the 2006 IPCC good practice guidance (tier 1) and country-specific emission factors (tier 2) were used.
- Emissions from international⁶ & domestic aviation were calculated. However, only domestic aviation was included in the Egypt GHG inventory while emissions from international aviation were reported as memo item.
- Aggregated fuel data for the transport and industrial sector have been utilized due to unavailability of detailed data. GHG emissions for the transport sector included civil aviation (domestic), road transportation and railways; and
- Emissions resulting from the use of coal as a fuel in the cement industry since 2014 was included.

³ Activity data from 1990 to 2015 was improved and updated.

⁴ Activity data from 1990 to 2015 was improved and updated.

⁵ The BUR 1 AD has been updated and modified from 1990 to 2015 and the GHG emissions were also recalculated using 2019 IPCC software.

⁶ Emissions from international flights are calculated but not included in the total GHG emissions.

2.2.1.3 Activity Data

Activity data for the years 1990 to 2015 was reviewed, updated, and revised, with the International Energy Agency (IEA) website serving as the primary source. For the years 2016 and 2017, most activity data was obtained directly from the Ministry of Petroleum and Mineral Resources (MoPMR), the Ministry of Electricity and Renewable Energy (MoERE), and the Tebbin Institute for Metallurgical Studies. Missing data for these years was supplemented using the IEA, UN Data, and BP websites, which significantly improved accuracy compared to the estimates reported in Egypt's Biennial Update Report BUR 1. The following subsections present a detailed description of this data.

2.2.1.4 Emission Factors

Egypt has developed country-specific emission factors and net heating values for certain fuels. Table 2-2 presents both the default and the country-specific emission factors and net heating values for these fuels, along with their sources.

Table 2-2: Default and National Heating value of Fuels and Emission Factors

Fuel type	NHV (TJ/Gg)	EF (t CO ₂ /TJ)
Gas/Diesel Oil*	43.20	73.390
Residual Fuel Oil*	41.23	75.860
Special LFO**	45.65	IPCC default values
Kerosene**	46.27	
Jet Gasoline**	46.28	
Gasoline**	46.99	
Liquefied Petroleum Gases**	49.14	
Natural Gas*	48.9	55.697
Bituminous coal*	26.99	96.170
Petroleum coke*	34.11	94.270
Other fuels	IPCC Default value	

*Development of National Country Specific Emission Factors for Energy Sector, Egypt, Integral 2018

** Ministry of Petroleum & Mineral Resources (MoPMR), Egypt

2.2.1.5 Trend Analysis

The IPCC software generated greenhouse gas trends for the period 1990 to 2017. Figure 2-3 and Figure 2-4 present the evolution of GHG emissions from the energy sector and its main activities, expressed in Gg CO₂e. Fuel combustion activities accounted for almost 97% of energy sector emissions in 2016 and 2017, with an average annual growth rate of 1.5% between 2015 and 2017. Table 2-3 presents the average annual growth rates of GHG emissions.

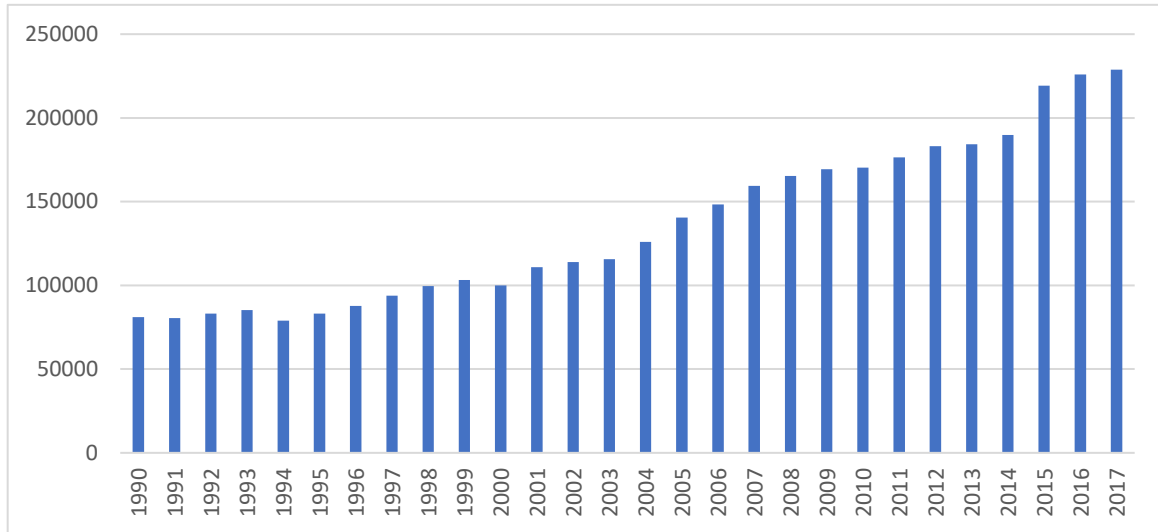


Figure 2-3: Evolution of GHG emissions of the energy sector (Gg CO_{2e})

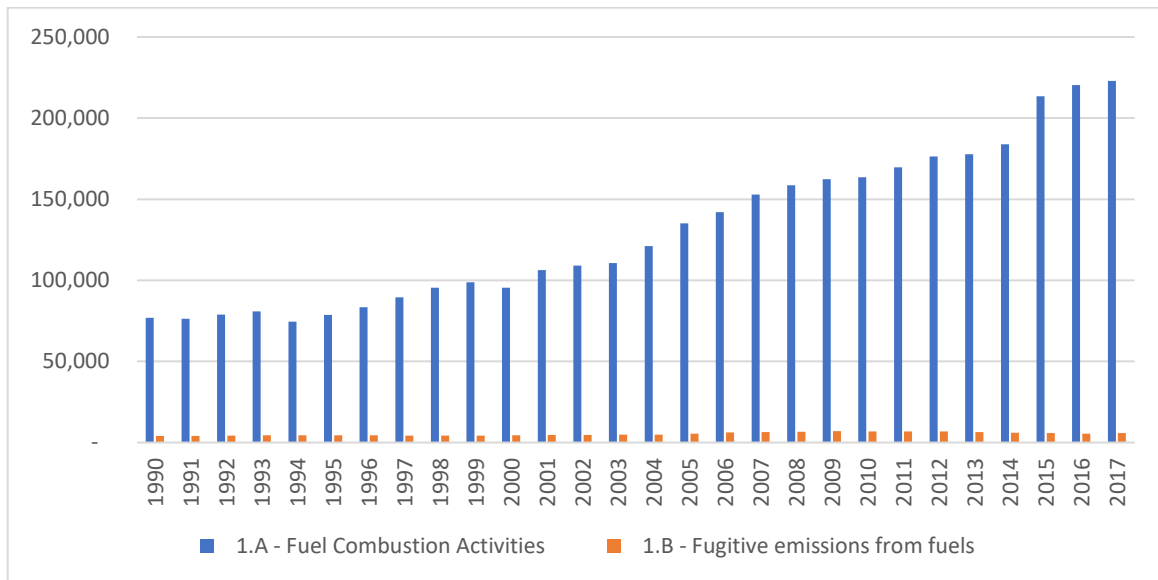


Figure 2-4: Evolution of GHG emissions of the energy sector main activities (Gg CO_{2e})

Table 2-3: GHG emission average annual growth rates

Sector/sub sector	1990-2005	2005 -2015	2015-2016	2016-2017 ⁷
Energy	4.9%	5.6%	3%	1.4%
Fuel combustion	5.0%	5.8%	3.2%	1.2%
Fugitive emissions from fuels	2.3%	0.6%	-5.2% ⁸	8.5%

Figure 2-5 presents the evolution of GHG emissions from energy industry activities, namely electricity generation, petroleum refineries, and the manufacturing of solid fuels. Electricity generation accounted for about 97% of energy industry emissions in both 2016 and 2017 and increased at an average rate of 1.2% between 2015 and 2017. Over the same period, emissions from

⁷ Oil production in 2017 reduced by 5% and gas production increased by 21% compared to 2016. While gas production in 2016 reduced by 7.1% compared to 2015

⁸ This is due the reduction in oil and gas production

petroleum refineries declined by an average of -0.6%⁹ annually, while emissions from solid fuel manufacturing grew by 1.2%.

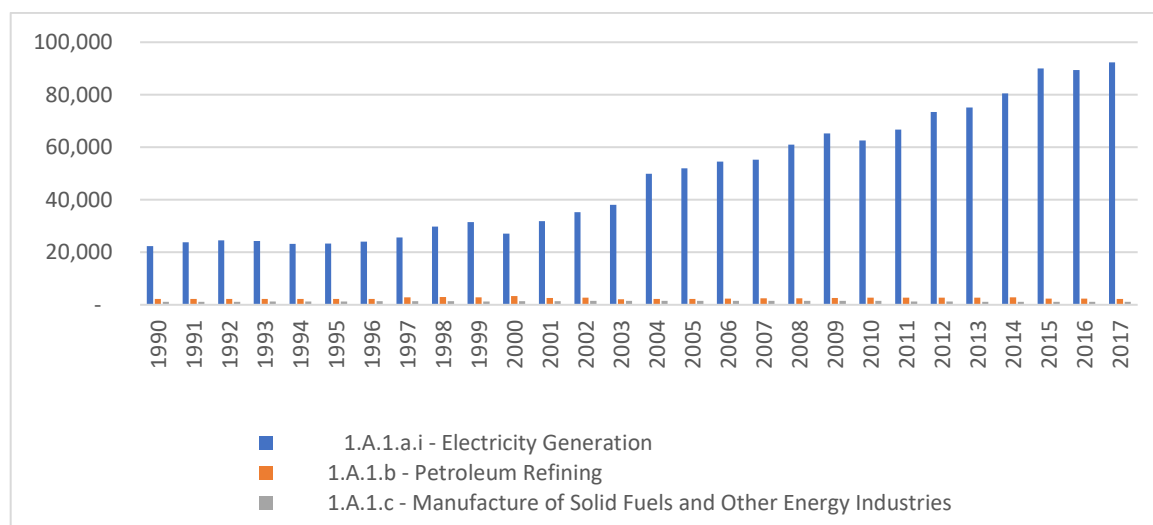


Figure 2-5: Evolution of GHG emissions of the energy industries activities (Gg CO_{2e})

Domestic aviation GHG emissions declined from 56 Gg in 2015 to 47 Gg in 2016 and 46 Gg in 2017. Figure 2-6 shows the evolution of transport sector emissions from 1990 to 2017, covering domestic aviation, road transport, and railways. The road transport GHG emissions were 24% and 23% of the fuel combustion activities in 2016 and 2017, respectively.

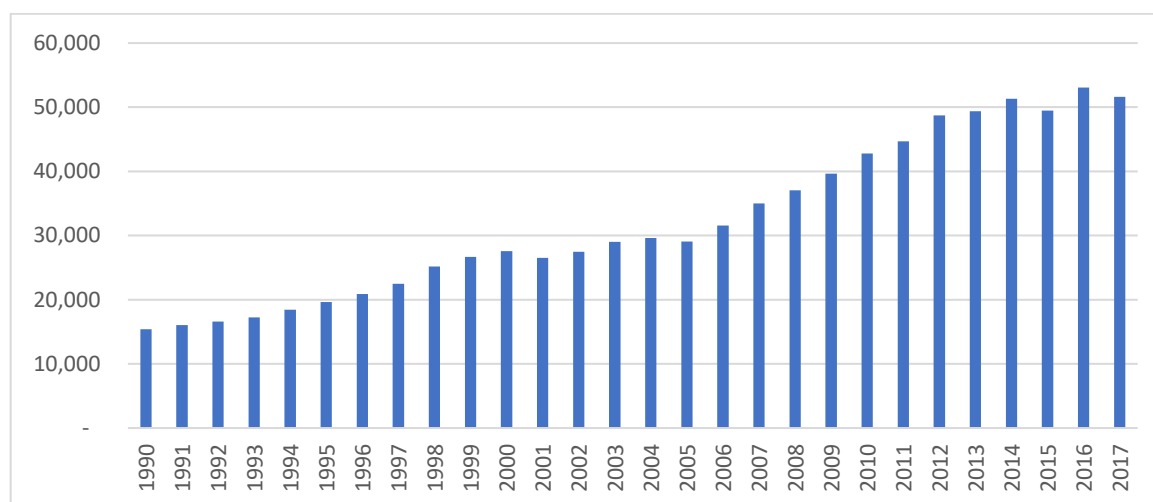


Figure 2-6: Evolution of GHG emissions of the transport sector (Gg CO_{2e})

From 1990 to 2015, commercial sector fuel consumption was grouped under “other and unknown sectors”, which included diesel fuel, natural gas, and other fuels. From 2015 onwards, diesel fuel consumption for the commercial sector was reported separately and is available for 2015, 2016, and 2017. In 2016 and 2017, the residential sector accounted for about 54% of emissions from the “other sectors” category, while the commercial sector contributed about 38%. The average annual growth rate of residential sector GHG emissions between 2015 and 2017 was 2.3%. These figures underline

⁹ The negative GR% due to the reduction in fuel consumption.

the importance of disaggregating sectoral data, as it provides a clearer basis for analysing trends and improves the accuracy of future inventories.

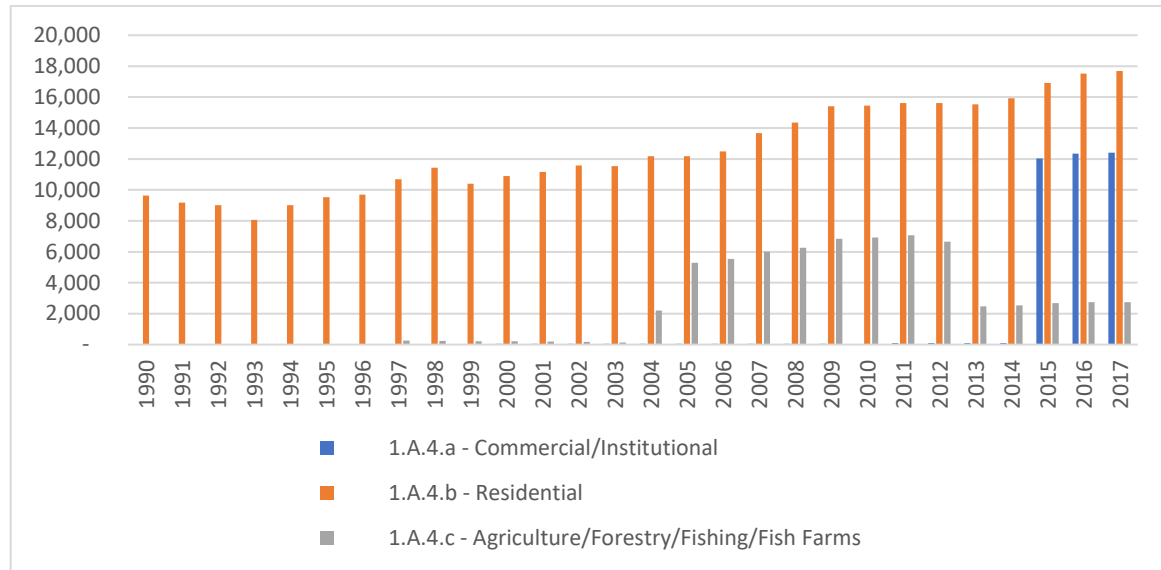


Figure 2-7: Evolution of GHG emissions of the commercial, residential and agriculture sectors (Gg)

Figure 2-8 presents the annual GHG emissions from oil and gas venting and flaring. These emissions accounted for 2.4% of energy sector emissions in 2016 and 2.6% in 2017. The pattern of venting and flaring emissions follows the same trend as oil and gas production.

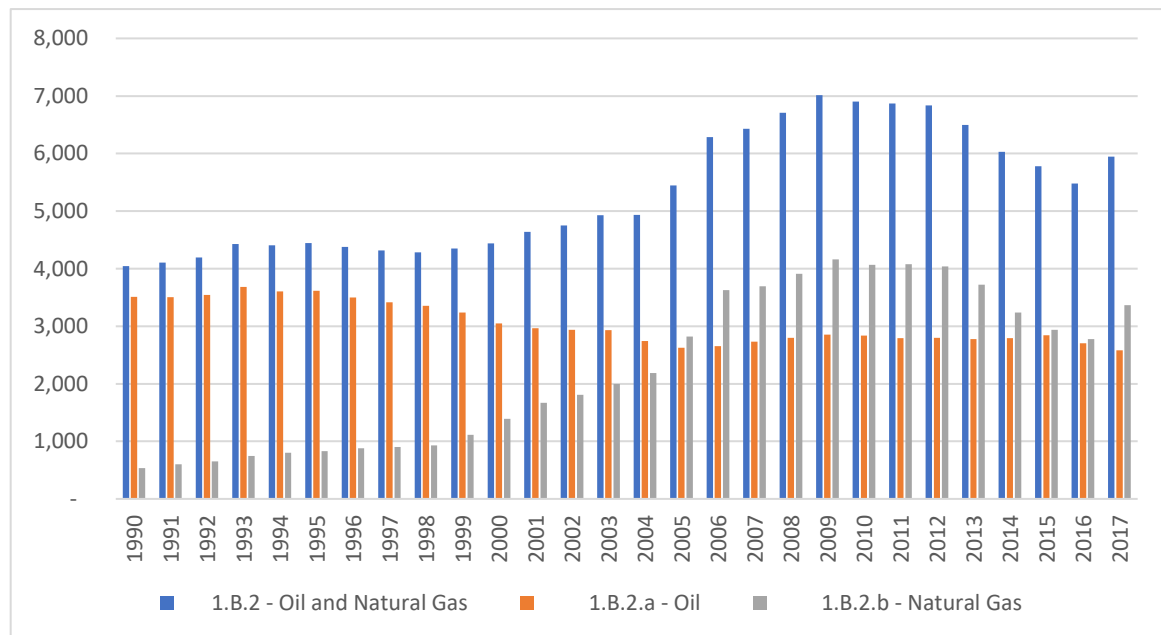


Figure 2-8: Evolution of GHG emissions of oil & gas sectors (venting and flaring) (Gg)

2.2.1.6 Emission per Gas and Category

In 2015, 2016 and 2017 CO₂ emissions account for 98.5% of total GHG emissions of the energy sector as shown in Table 2-4 to

Table 2-6. The tables show the individual emissions by each category and sub-categories.

Table 2-4: CO₂, CH₄ & N₂O Emissions for the year 2015

Categories	CO ₂	CH ₄	N ₂ O	CO ₂ e
1 - Energy	215,780	113.89	3.23	219,171.86
1.A - Fuel Combustion Activities	210,797	76.57	3.19	213,394.77
1.A.1 - Energy Industries	92,330	51.31	0.37	93,520.50
1.A.1.a - Main Activity Electricity and Heat Production	89,923	2.27	0.35	90,077.73
1.A.1.a.i - Electricity Generation	89,923	2.27	0.35	90,077.73
1.A.1.b - Petroleum Refining	2,307	0.09	0.02	2,315.08
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	100	48.95	0.00	1,127.69
1.A.1.c.i - Manufacture of Solid Fuels	100	48.95	0.00	1,127.69
1.A.2 - Manufacturing Industries and Construction	38,664	1.14	0.26	38,768.32
1.A.3 - Transport	48,459	12.79	2.38	49,466.72
1.A.3.a - Civil Aviation	55	0.00	0.00	55.57
1.A.3.a.ii - Domestic Aviation	55	0.00	0.00	55.57
1.A.3.b - Road Transportation	48,404	12.79	2.38	49,411.15
1.A.4 - Other Sectors	31,344	11.33	0.19	31,639.23
1.A.4.a - Commercial/Institutional	11,886	5.61	0.12	12,040.08
1.A.4.b - Residential	16,789	5.36	0.05	16,916.46
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	2,668	0.36	0.02	2,682.69
1.A.4.c.i - Stationary	2,668	0.36	0.02	2,682.69
1.B - Fugitive emissions from fuels	4,983	37.31	0.03	5,777.10
1.B.2 - Oil and Natural Gas	4,983	37.31	0.03	5,777.10
1.B.2.a - Oil	2,049	37.28	0.03	2,841.46
1.B.2.a.i - Venting	5	36.03	0.00	761.44
1.B.2.a.ii - Flaring	2,044	1.24	0.03	2,080.02
1.B.2.b - Natural Gas	2,935	0.04	0.00	2,935.64
1.B.2.b.i - Venting	2,875	0.00	0.00	2,874.89
1.B.2.b.ii - Flaring	60	0.04	0.00	60.74

Table 2-5: CO₂, CH₄ & N₂O Emissions for the year 2016

Categories	CO ₂	CH ₄	N ₂ O	CO ₂ e
1 - Energy	222,409.83	112.67	3.47	225,850.24
1.A - Fuel Combustion Activities	217,686.09	77.14	3.43	220,370.76
1.A.1 - Energy Industries	91,685.29	51.63	0.35	92,878.75
1.A.1.a - Main Activity Electricity and Heat Production	89,260.75	2.21	0.33	89,410.49
1.A.1.a.i - Electricity Generation	89,260.75	2.21	0.33	89,410.49
1.A.1.b - Petroleum Refining	2,311.14	0.09	0.02	2,318.95
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	113.41	49.33	0.00	1,149.31
1.A.1.c.i - Manufacture of Solid Fuels	113.41	49.33	0.00	1,149.31
1.A.2 - Manufacturing Industries and Construction	41,677.18	1.17	0.31	41,798.31
1.A.3 - Transport	52,020.07	12.85	2.58	53,089.75
1.A.3.a - Civil Aviation	46.33	0.00	0.00	46.74
1.A.3.a.ii - Domestic Aviation	46.33	0.00	0.00	46.74
1.A.3.b - Road Transportation	51,973.75	12.85	2.58	53,043.01
1.A.4 - Other Sectors	32,303.54	11.49	0.19	32,603.94
1.A.4.a - Commercial/Institutional	12,180.86	5.68	0.12	12,337.19
1.A.4.b - Residential	17,388.04	5.44	0.05	17,517.35
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	2,734.64	0.37	0.02	2,749.40
1.A.4.c.i - Stationary	2,734.64	0.37	0.02	2,749.40
1.B - Fugitive emissions from fuels	4,723.74	35.52	0.03	5,479.48
1.B.2 - Oil and Natural Gas	4,723.74	35.52	0.03	5,479.48
1.B.2.a - Oil	1,950.38	35.49	0.03	2,705.06
1.B.2.a.i - Venting	4.51	34.30	0.00	724.89
1.B.2.a.ii - Flaring	1,945.87	1.18	0.03	1,980.18
1.B.2.b - Natural Gas	2,773.36	0.04	0.00	2,774.42
1.B.2.b.i - Venting	2,717.01	0.00	0.00	2,717.01
1.B.2.b.ii - Flaring	56.35	0.04	0.00	57.41

Table 2-6: CO₂, CH₄ & N₂O Emissions for the year 2017

Categories	CO ₂	CH ₄	N ₂ O	CO ₂ e
1 - Energy	225,497.54	111.24	3.33	228,867.49
1.A - Fuel Combustion Activities	220,271.88	77.32	3.30	222,919.90
1.A.1 - Energy Industries	94,527.63	51.92	0.32	95,715.72
1.A.1.a - Main Activity Electricity and Heat Production	92,139.56	2.12	0.30	92,276.08
1.A.1.a.i - Electricity Generation	92,139.56	2.12	0.30	92,276.08
1.A.1.b - Petroleum Refining	2,279.82	0.09	0.02	2,287.53
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	108.25	49.70	0.00	1,152.11
1.A.1.c.i - Manufacture of Solid Fuels	108.25	49.70	0.00	1,152.11
1.A.2 - Manufacturing Industries and Construction	42,659.32	1.18	0.28	42,772.05
1.A.3 - Transport	50,552.18	12.65	2.51	51,596.81
1.A.3.a - Civil Aviation	45.35	0.00	0.00	45.76
1.A.3.a.ii - Domestic Aviation	45.35	0.00	0.00	45.76
1.A.3.b - Road Transportation	50,506.82	12.65	2.51	51,551.05
1.A.4 - Other Sectors	32,532.76	11.58	0.19	32,835.32
1.A.4.a - Commercial/Institutional	12,250.61	5.72	0.12	12,407.98
1.A.4.b - Residential	17,551.81	5.49	0.05	17,682.26
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	2,730.34	0.37	0.02	2,745.07
1.A.4.c.i - Stationary	2,730.34	0.37	0.02	2,745.07
1.B - Fugitive emissions from fuels	5,225.66	33.93	0.03	5,947.59
1.B.2 - Oil and Natural Gas	5,225.66	33.93	0.03	5,947.59
1.B.2.a - Oil	1,862.44	33.89	0.03	2,583.09
1.B.2.a.i - Venting	4.31	32.76	0.00	692.20
1.B.2.a.ii - Flaring	1,858.13	1.13	0.03	1,890.89
1.B.2.b - Natural Gas	3,363.22	0.04	0.00	3,364.50
1.B.2.b.i - Venting	3,294.88	0.00	0.00	3,294.88
1.B.2.b.ii - Flaring	68.34	0.04	0.00	69.62

2.3 Industrial Processes and Product Use (IPPU) Sector

2.3.1 Overview

The Industrial Processes and Product Use (IPPU) category covers greenhouse gas emissions arising from industrial processes, the use of greenhouse gases in products, and the non-energy use of fossil fuel carbon. According to the IPCC, the IPPU category is divided into eight subcategories:

- Mineral Industry
- Chemical Industry
- Metal Industry
- Non-Energy Products from Fuels and Solvent Use
- Electronics Industry
- Product Uses as Substitutes for Ozone Depleting Substances
- Other Product Manufacture and Use
- Other

2.3.2 Methodology and Assumptions

The greenhouse gas inventory for the IPPU sector was prepared in accordance with the *Guidelines for the Preparation of National Communications from Parties not Included in Annex I to the Convention*, as contained in the Annex to Decision 17/CP.8 of the Conference of the Parties. Figure 2-9 provides an overview of the tasks undertaken to develop the GHGI for the IPPU sector.

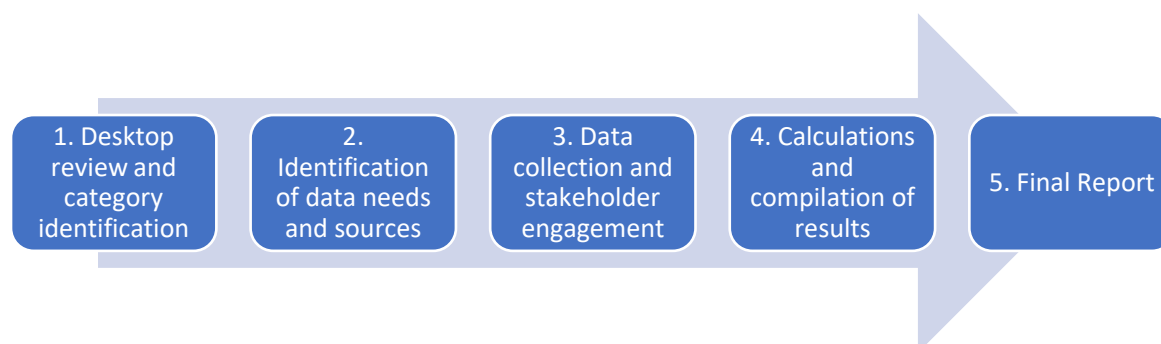


Figure 2-9: Methodology adopted for estimating GHG inventory for IPPU sector.

- **Desktop review and category identification:** Review of the 2006 IPCC Guidelines for all sub-categories in the IPPU sector and the GHG Inventory from Egypt's previous years. It also included desktop industry research to determine all the subcategories applicable to Egypt.
- **Identification of data needs and sources:** This section outlines the types of data required for the estimation process and their corresponding sources.
- **Data collection and stakeholder engagement:** Questionnaires and data collection sheets were prepared and disseminated to the relevant entities. The Ministry of Environment (MoE) sent data-sharing requests to all the identified entities prior to disseminating the questionnaires or arranging meetings.
- **Calculations and compilation of results: assumptions**
 - The default Global Warming Potential (GWP) values from the IPCC Second Assessment Report (SAR) were used for calculating the CO₂ equivalent values.

- Default emission factors and IPCC Excellent Practice Guidance (GPG) for the GHGI estimations were used. Country- or sector-specific emission factors were used in calculations in limited cases, when available.
- Calculations were made using version 2.691 of the IPCC GHGI software.

2.3.3 Activity Data

The type of requested data varied according to each industry's emission sources and the calculation formulae provided by the IPCC Guidelines. The requested data included:

- Annual production data.
- Annual design capacity.
- Annual consumption data.
- Annual Import/export data for emission estimation from products use.
- Type of process/technology/raw materials used in production/use.

Various data sources were identified including:

- Central Agency for Public Mobilization and Statistics (CAPMAS) as the main source of official aggregated industrial data in Egypt.
- The Industrial Development Authority (IDA) within the ministry of Trade and Industry (MoTI).
- Federation of Egyptian Industries (FEI).
- Egyptian Petrochemicals Holding company (ECHEM).
- Ozone Unit within the Egyptian Environmental Affairs Agency (EEAA).
- Coal Unit within the Egyptian Environmental Affairs Agency (EEAA).
- Egyptian National Cleaner Production Centre (ENCPC) within the ministry of Trade and Industry (MoTI).
- Online publicly available data sources (i.e., international statistics, annual reports from ECHEM and CAPMAS, etc).

2.3.4 Emission Factors

For the estimation of the 2016 and 2017 GHG inventories, default IPCC emission factors were applied unless otherwise specified.

2.3.5 Trend Analysis

Figure 2-10 presents the trend analysis of the IPPU sector between 1990 and 2017, reflecting the recalculations conducted for several subcategories. The results show that emissions from the sector have been increasing consistently over the entire period.

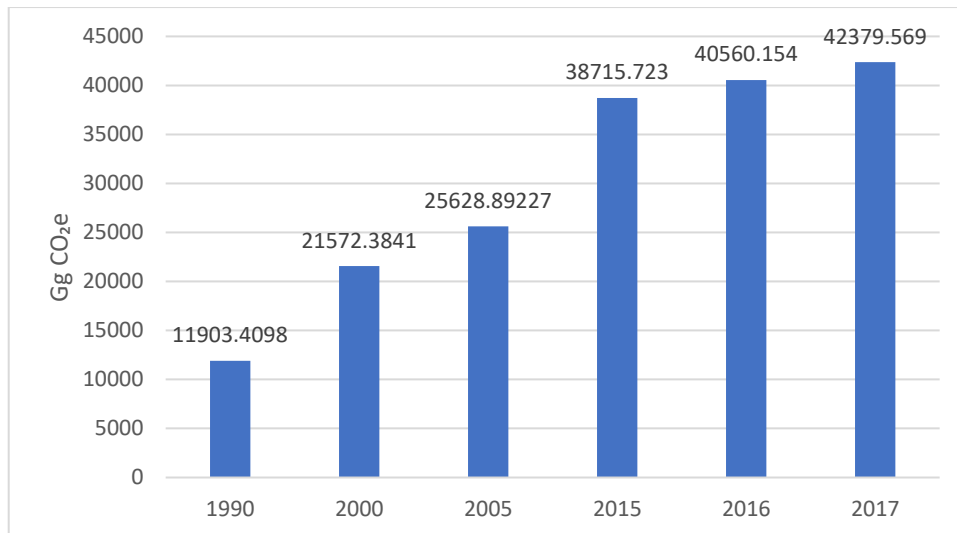


Figure 2-10: IPPU sector GHG emissions 1990-2017

For the 2015–2017 inventory years, the mineral industries contributed the largest share of GHG emissions within the IPPU sector. Most of these emissions were from cement production, which accounted for 60–63% of the sector’s total emissions, making it the single largest emitter. The metals industry ranked second, followed by the chemicals industry. Figure 2-11, Figure 2-12, and Figure 2-13 illustrate the sectoral contributions for 2015, 2016, and 2017, respectively. This confirms the dominant role of cement production in Egypt’s industrial emissions profile.

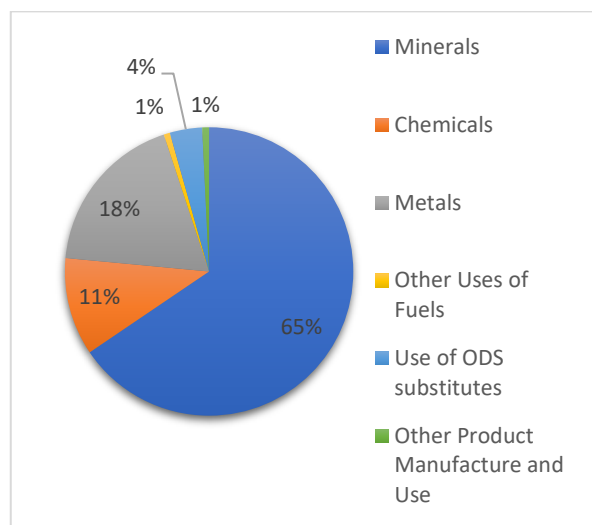


Figure 2-11: Sectoral contribution for GHGI 2015

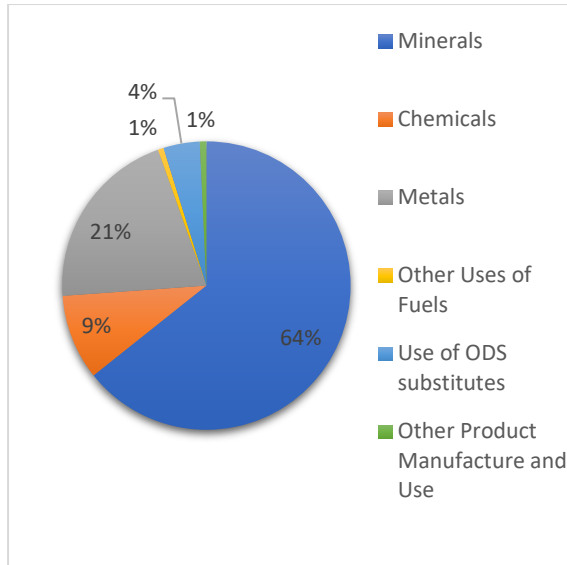


Figure 2-12: Sectoral contribution for GHGI 2016

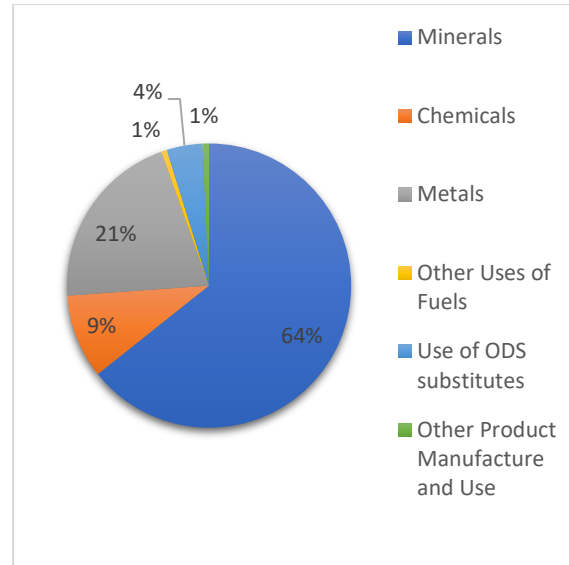


Figure 2-13: Sectoral contribution for GHGI 2017

2.3.6 Emissions per Gas and Category

Between 2015 and 2017, carbon dioxide represented the predominant share of emissions from the IPPU sector, accounting for 84% in 2015, 81% in 2016, and 82% in 2017. The contribution of each gas to the sector's emissions for these inventory years is shown in Figure 2-14, Figure 2-15, and Figure 2-16, respectively.

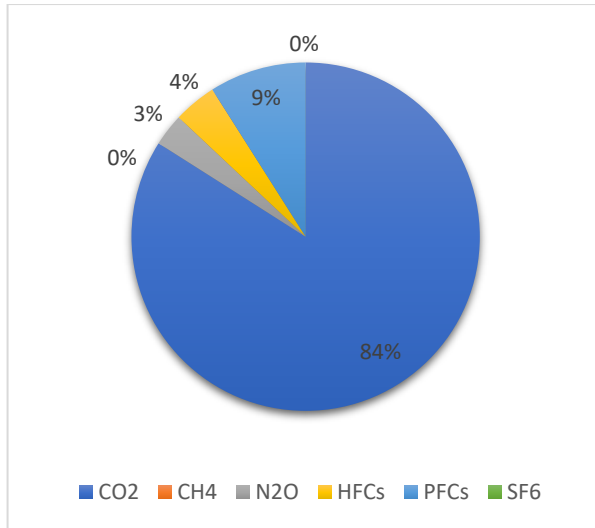


Figure 2-14: Contribution of each GHG in 2015 inventory

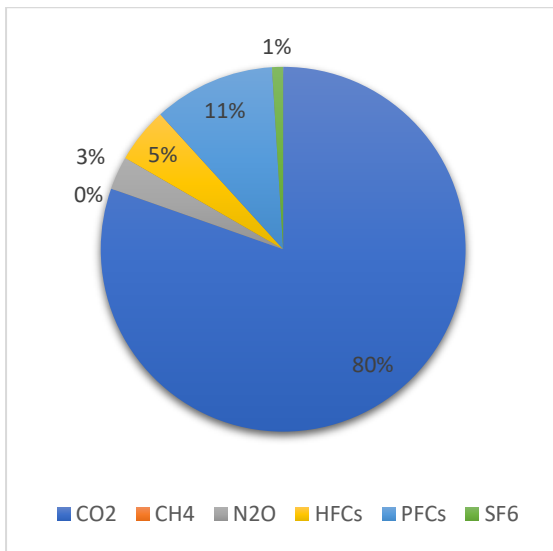


Figure 2-15: Contribution of each GHG in 2016 inventory

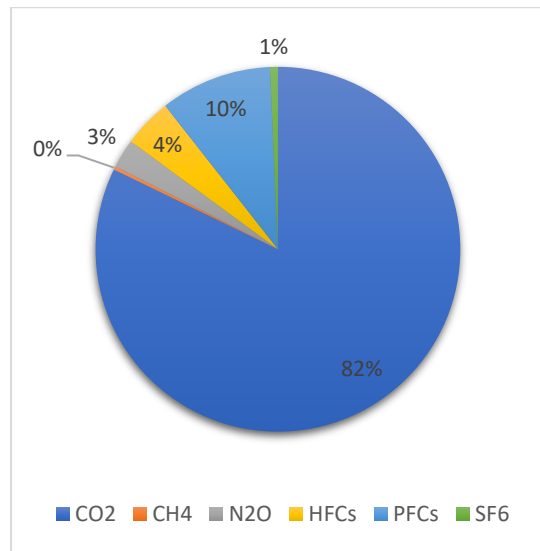


Figure 2-16: Contribution of each GHG in 2017 inventory

2.4 Agriculture, Forestry, and Other Land Use (AFOLU) Sector

2.4.1 Overview

Egypt has a total land area of approximately 1 million km², most of which is desert, with only about 5.5% inhabited. Settlements are concentrated in and around the Nile Delta and along the Nile Valley, which narrows considerably in Upper Egypt. The total cultivated land area in 2017 was about 3.84 million hectares (9.13 million feddan), compared to 9.10 million feddan in 2015, representing an increase of 0.03% of the total land area. This cultivated area consists largely of old lands and newly reclaimed areas. The climate is arid, with very limited rainfall confined to a narrow strip along the northern coast. The Nile River remains the principal and almost exclusive source of surface water, with agriculture depending heavily on it and consuming between 80% and 85% of the annual water supply.

Agricultural processes and activities are the main sources of methane (CH₄) and nitrous oxide (N₂O). Field burning of agricultural residues contributes emissions of CH₄, N₂O, carbon monoxide (CO), and nitrogen oxides (NO_x). Enteric fermentation in livestock generates CH₄, while manure management emits both N₂O and CH₄. Rice cultivation releases CH₄ because of the anaerobic decomposition of organic matter. The application of synthetic fertilisers contributes both direct and indirect N₂O emissions from nitrogen added to soils. Land-use change, in turn, is primarily a source of carbon dioxide (CO₂).

2.4.2 Methodology and Assumptions

The GHGI for the AFOLU sector in 2016 and 2017 was prepared in accordance with the 2006 IPCC Guidelines. Tier 1 IPCC methods were applied to estimate emissions, using default emission factors due to the limited availability of activity data and the absence of country-specific emission factors. The main data sources for calculating AFOLU sector emissions were the CAPMAS, the EAS, and the FAO.

Emissions are reported in gigagrams (thousand tonnes) of carbon dioxide equivalent (Gg CO₂e). The default GWP values from the IPCC SAR, based on a 100-year time horizon, were used to calculate the CO₂ equivalent values.

2.4.3 Activity Data

The data sources for the AFOLU sector vary by category, with livestock and land data provided mainly by CAPMAS and the FAO. Within these categories, annual crops cover all cultivated crops in Egypt, while perennial crops include fruits, wood trees, and palm. Data on cropland converted to settlements and on other land converted to cropland (land reclamation) are available only from CAPMAS. For biomass burning in croplands, activity data is available in tonnes but not per hectare. In this case, expert judgement was applied by assuming 3% of the total annual and perennial crop area, based on CAPMAS data.

Data on fertilisers, particularly urea, presents additional challenges. The Economic Affairs Sector (EAS) reports consumption only for public sector production and does not account for output from the private sector or the free zone. At the same time, FAO data are considered unreliable, as they suggest an implausible increase in urea consumption from 3.5 million tonnes in 2016 to 14.5 million tonnes in 2017. To address these inconsistencies, data from the World Bank on fertiliser use per hectare was used to calculate total nitrogen fertiliser consumption in 2016 and 2017, while CAPMAS figures were used separately to estimate urea consumption. CAPMAS data indicate that urea accounted for approximately 75% of total nitrogen fertiliser use in Egypt.

2.4.4 Emission Factors

Tier 1 default values from IPCC 2006 guidelines for the emission factors were used for the AFOLU sector.

2.4.5 Trend Analysis

In the previous National Communications submitted to the UNFCCC since 1990 (First, Second, and Third National Communications), greenhouse gas emissions from the AFOLU sector were estimated using the default methodology of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC, 1996) and the *Recommended Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. This default methodology attributes all GHG emissions from agricultural soils to a range of agricultural activities that add nitrogen to soils, thereby increasing the amount of nitrogen available for nitrification and denitrification, and ultimately the level of N₂O emissions. Within this framework, three sources of N₂O emissions are distinguished: (a) direct emissions of N₂O from agricultural soils, (b) direct soil emissions of N₂O from animal production, and (c) indirect emissions of N₂O associated with agricultural activities.

Direct N₂O emissions from agricultural soils encompass all nitrogen inputs to the soils that result from various cropping practices. These practices comprise the application of synthetic fertilisers, the use of animal waste, the cultivation of nitrogen-fixing crops, the mineralisation of crop residues, and the mineralisation of soil nitrogen resulting from the cultivation of histosols. In the BUR1 and the NC4, however, the approach differs slightly due to the application of the 2006 IPCC Guidelines. These guidelines introduced the term '*managed soils*' to represent GHG emissions from agricultural soils. This category includes all national anthropogenic emissions of N₂O, both direct and indirect, from managed soils, as well as CO₂ emissions resulting from the application of liming materials and urea-containing fertilisers. For consistency, the term "*agricultural soils*" is retained in the trend analysis.

It should also be noted that GHG emissions related to land-use change were calculated only for the years 2016 and 2017. As a result, these emissions were not included in the trend analysis.

Table 2-7 presents GHG emissions from the AFOLU sector over the period 1990–2017, expressed in Gg CO₂e. The results show a consistent upward trend in total emissions from 1990 to 2017, except for 2005. In that year, the recalculated emissions reported in the First Biennial Update Report (BUR) were 31.3% higher than those reported for 2005 in the Third National Communication (TNC). Furthermore, BUR1 data indicate that GHG emissions in 2005 were 6.6% higher than in 2015, reflecting a shift in fertiliser consumption policies introduced by the Ministry of Agriculture and Land Reclamation.

Emissions from agricultural soils varied significantly from year to year throughout the period 1990–2017. This variability is closely linked to changes in the use of fertilisers, both natural and synthetic, in the agricultural sector.

Table 2-7: GHG emissions from AFOLU sector over the period 1990 -2017 (Gg CO₂e)

	INC 1990	SNC 2000	TNC 2005	BUR1 2005	BUR1 2015	NC4	
	CO ₂ equivalent (Gg)						
	2016	2017					
Total AFOLU	17,913	31,720	39,446	51,787	48,390	55,208	63,928
Enteric Fermentation	6,7901	8,080	9,063	10,099	10,693	10,334	9,655
Manure Management	488	9,200	3,974	4,532	5,793	6,314	5,956
Rice cultivation	3,989	2,480	4,637	4,425	3,576	3,980	3,847

	INC 1990	SNC 2000	TNC 2005	BUR1 2005	BUR1 2015	NC4	
	CO ₂ equivalent (Gg)						
Agricultural Soils	6,541	10,220	20,022	30,200	26,461	34,528	44,381
Emissions from biomass burning	205	1,730	1,751	650	784	57	57

Emissions from enteric fermentation remained largely unchanged between 1990 and 2017. However, a slight decrease was observed in 2016 and 2017 compared to 2015, reflecting a reduction in the number of animals. Similarly, emissions from manure management showed no significant variation over the same period.

In contrast, emissions from rice cultivation were influenced by the extent of the cultivated rice area. Following 2005, Egypt adopted a policy to reduce the area planted with rice as part of efforts to conserve water resources, which directly affected associated GHG emissions.

Emissions from biomass burning fluctuated significantly between 1990 and 2017, mainly due to limitations in the availability of consistent data. For 2016 and 2017, estimates were based on expert judgement, applying an assumption that 3% of total cropland was subject to burning, as reported by CAPMAS data for land categories.

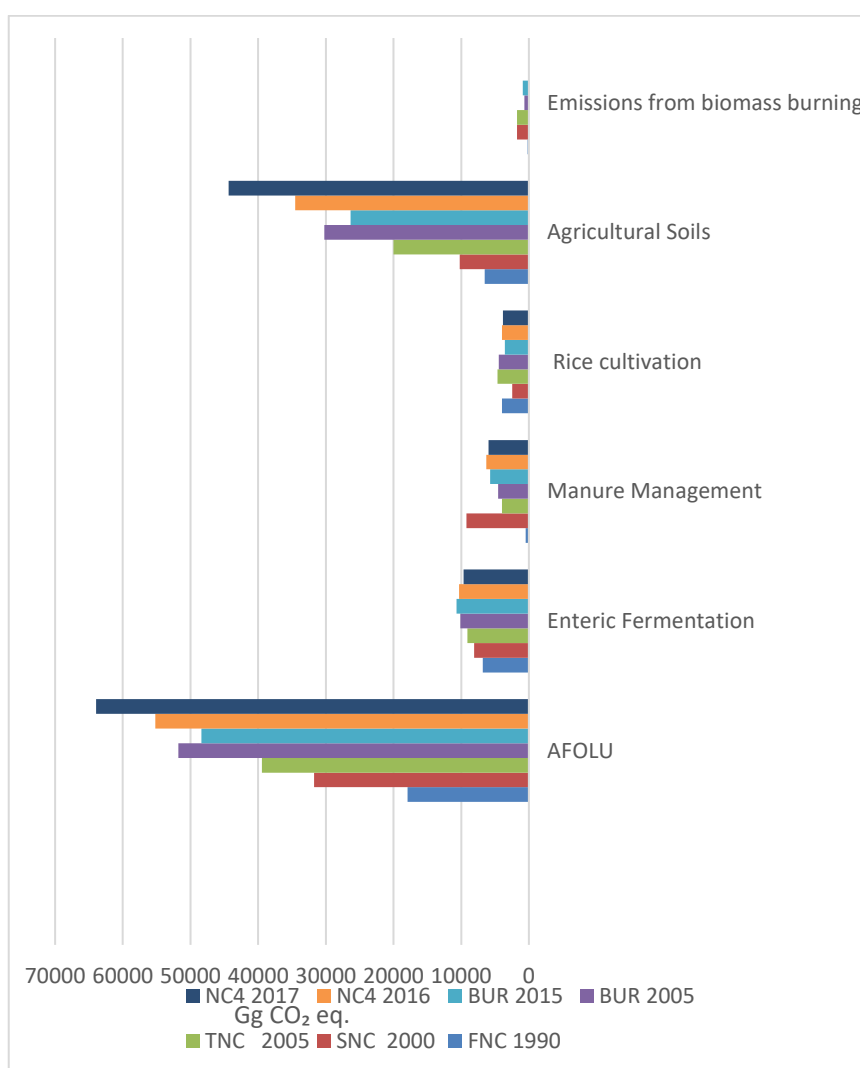


Figure 2-17: GHG emissions from AFOLU sector over the period 1990 – 2017 (Gg CO₂eq)

Figure 2-17 depicts GHG emissions from the AFOLU sector over the period 1990–2017, expressed in Gg CO₂e. In 2016 and 2017, emissions from enteric fermentation accounted for 18.7% and 15.1% of the sector total, respectively. Emissions from manure management contributed 11.4% in 2016 and 9.3% in 2017, reflecting the decline in livestock numbers in 2017.

By contrast, emissions from agricultural soils increased from 62.5% in 2016 to 69.4% in 2017. This rise was linked to a 38.8% increase in the use of synthetic fertilisers, which was driven by a reduced supply of manure available for soil fertilisation.

2.4.6 Emission per Gas and Category

The AFOLU sector emissions consisted of 68% nitrous oxide (N₂O), 28% methane (CH₄), and 4% carbon dioxide (CO₂) in 2016, and 73% N₂O, 23% CH₄, and 4% CO₂ in 2017, as shown in Figure 2-18. The increase in N₂O emissions in 2017 compared to 2016 is attributed mainly to agricultural soils, particularly the greater use of synthetic fertilisers.

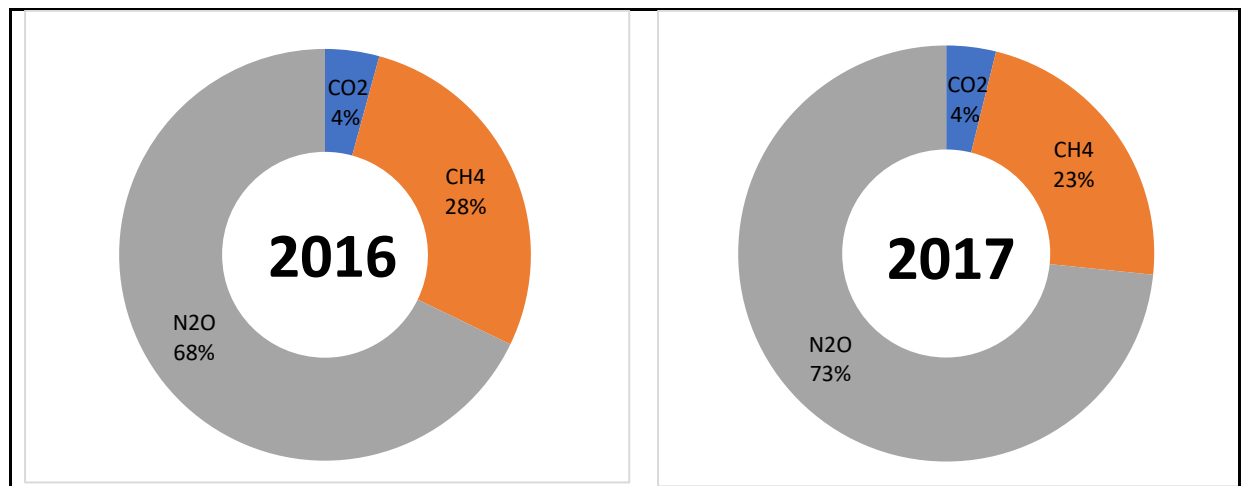


Figure 2-18: Emissions per gas for the AFOLU sector, 2016 & 2017

Emissions per category of the AFOLU GHG emissions are illustrated in Figure 2-19, Figure 2-20.

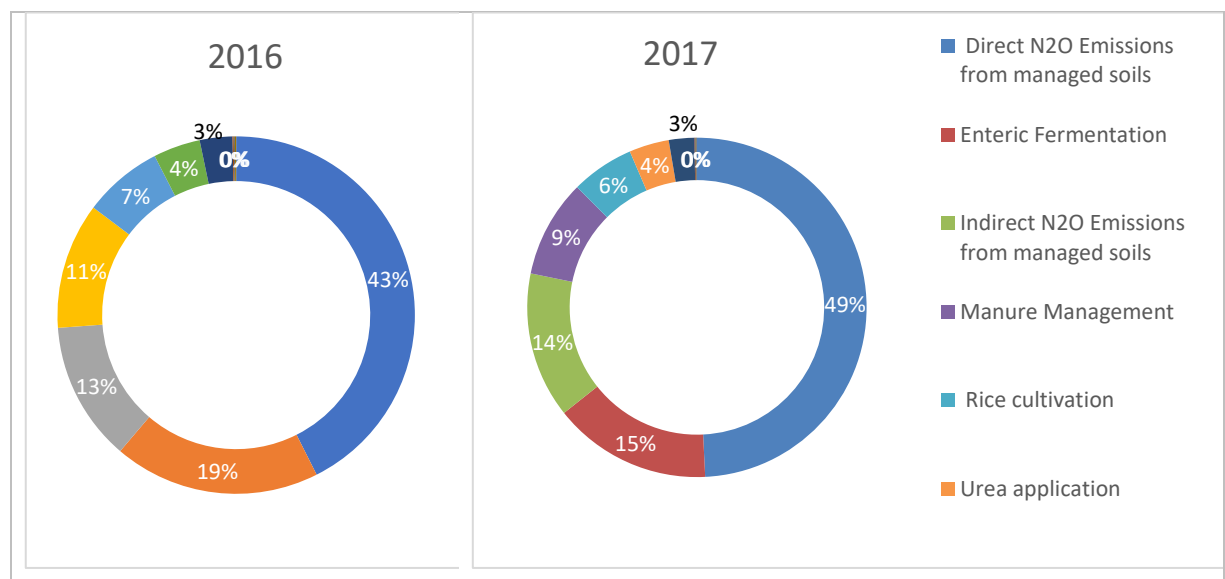


Figure 2-19: Emissions per category (%) for AFOLU sector, 2016 & 2017

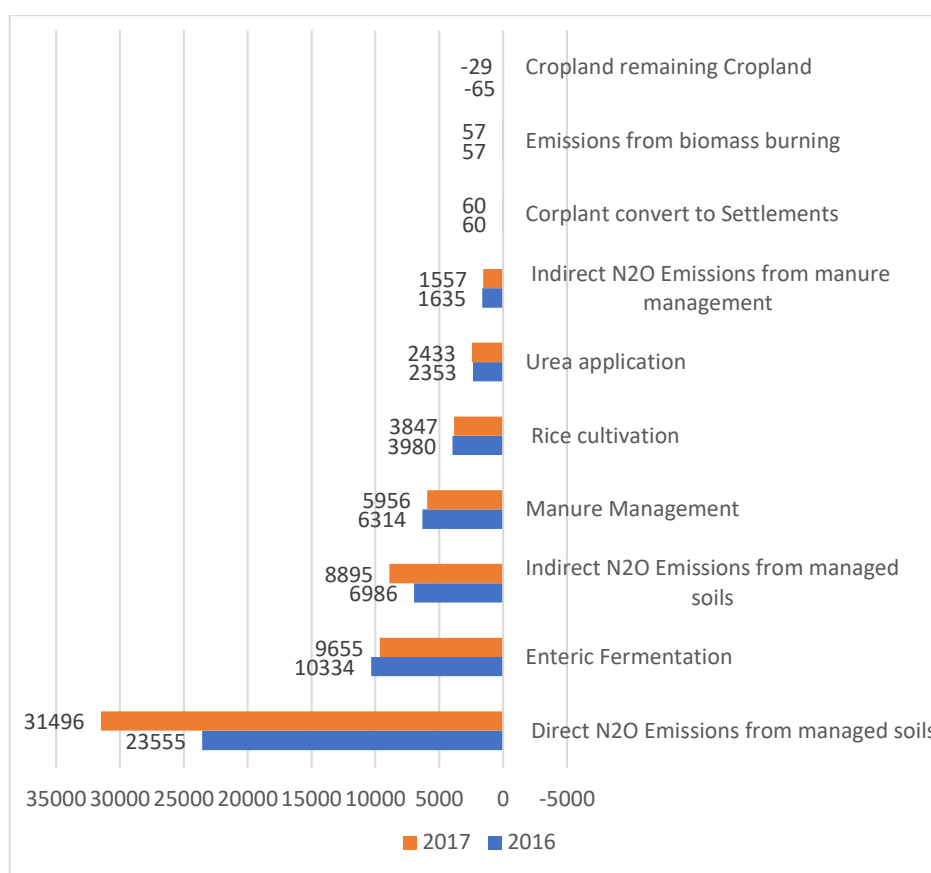


Figure 2-20: Emissions per category (Gg CO₂ eq.) for AFOLU sector, 2016 & 2017

2.5 Waste Sector

2.5.1 Overview

This section describes the preparation process and highlights the main features of the GHG inventory for the waste sector, in line with the IPCC 2006 Guidelines. The inventory presented here estimates emissions of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) from solid waste and wastewater management activities at the national level, following the category structure and coding defined in the Waste Volume of the 2006 IPCC Guidelines.

National activities that result in GHG emissions under the IPCC Waste Sector category can be summarised as follows:

4A Solid waste disposal (SWD): methane resulting from decomposition of fractions of municipal solid waste, non-hazardous industrial solid waste, and sludge resulting from wastewater treatment disposed of in managed/unmanaged/uncategorised sites. Under SWD there are three categories: 4A1 Managed Waste Disposal Sites, 4A2 Unmanaged Waste Disposal Sites and 4A3 Uncategorised Waste Disposal Sites (SWDS).

4B Biological treatment of waste: methane and nitrous oxide from composting of organic fractions of municipal and non-hazardous industrial solid waste.

4C1 Waste incineration: carbon dioxide and nitrous oxide from thermal treatment (with no energy recovery) of hazardous healthcare waste in controlled systems.

4C2 Open burning of waste: carbon dioxide, methane, and nitrous oxide from uncontrolled burning of fractions of municipal solid waste.

4D1 Domestic wastewater treatment and discharge involves the production of methane from the conversion of biological oxygen demand (BOD) and nitrous oxide from nitrogen, depending on the treatment method used and the final discharge process.

4D2 Industrial wastewater treatment & discharge: methane from conversion of chemical oxygen demand (COD) in industrial wastewater according to treatment method and final discharge

In the most recent greenhouse gas inventory prepared for the waste sector in Egypt, reported in the BUR1 for the inventory years 2006–2015, solid waste disposal (4A) and wastewater treatment and discharge (4D) together accounted for 97% of total waste sector emissions expressed in CO_{2e}. Solid waste disposal was the single largest source, typically contributing more than 55% of the sector’s emissions. Domestic wastewater treatment and discharge (4D1) accounted for around 17%, while industrial wastewater treatment and discharge (4D2) contributed about 23%, for a combined share of over 40%. Biological treatment of waste (4B), primarily composting, was responsible for around 1%, while incineration of healthcare and clinical waste, along with the open burning of municipal waste (4C), contributed about 2% of sector emissions.

Across the entire time series, including the inventory years 2016 and 2017, methane remained the dominant gas in waste sector emissions. Methane accounted for more than 92% of total emissions, while nitrous oxide contributed around 7% and carbon dioxide less than 0.2%.

2.5.2 Methodology and Assumptions

The waste sector GHGI was developed for the calendar years 2016 and 2017, continuing the time series established in Egypt’s First Biennial Update Report, which covered 2006 to 2015. For all waste sector categories except solid waste disposal, Tier 1 methodologies were applied to estimate emissions. In the case of solid waste disposal, Tier 2 methodology was used, as high-quality, country-specific activity data were available for both current and historical waste disposal. Table 2-8 presents the details of the methodologies applied to each source category.

Table 2-8: Methodological tiers for waste sector categories

Category	Tier Method Description	Tier used
Solid Waste Disposal Sites	Tier 1: The estimations of the Tier 1 methods are based on the IPCC First Order Decay (FOD) method using mainly default activity data and default parameters. Tier 2: Tier 2 methods use the IPCC FOD method and some default parameters but require good quality country-specific activity data on current and historical waste disposal at SWDS.	Tier 2 Reasonably good country-specific current and historical data is available
Biological Treatment of Solid Waste	Tier 1: Tier 1 uses the IPCC default emission factors. Tier 2: Country-specific emission factors based on representative measurements are used for Tier 2. Tier 3: Tier 3 methods would be based on facility or site-specific measurements (on-line or periodic).	Tier 1 Sufficiently reliable and available country-specific emission factors are not available
Incineration and Open Burning of Waste	The Tier 1 method is a simple method used when CO ₂ emissions from incineration/open burning are not a key category. Data on the amount of waste incinerated/open-burned are necessary. The Tier 2 method is based on country-specific data regarding waste generation, composition, and management practices.	Tier 1 National data on waste generated and waste fractions are available.
Wastewater Treatment and Discharge	The Tier 1 method applies default values for the emission factor and activity parameters. This method is considered good practice for countries with limited data.	Tier 1

Category	Tier Method Description	Tier used
	<p>The Tier 2 method follows the same method as Tier 1 but allows for incorporation of a country specific emission factor and country specific activity data.</p> <p>For a country with good data and advanced methodologies, a country specific method could be applied as a Tier 3 method.</p>	Country specific emission factors are not available.

Because solid waste disposal, industrial wastewater, and domestic wastewater typically account for around 97% of waste sector emissions, special emphasis was placed on the collection and QA/QC of activity data for these categories. Activity data for healthcare and medical waste incineration, as well as the open burning of municipal waste, was also revised and carefully scrutinised.

Given the cross-cutting nature of the subsectors defined under the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, several entities were engaged in the data collection process. Tailored questionnaires were used both to gather activity data and to consult on parameters and assumptions:

- Central Agency for Public Mobilization & Statistics (CAPMAS)
- Egyptian Environmental Affairs Agency (EEAA)
- Waste Management Regulatory Authority (WMRA)
- Select solid waste management facilities.
- Holding company for Water and Wastewater (HCWW)
- Ministry of Health and Population (MoHP)
- Ministry of Petroleum and Mineral Resources (MoPMR)

Parameters and assumptions used for preparation of the waste sector GHGI for the year 2015 in Egypt's BUR1 were reused for preparing the waste sector GHGI for this Fourth National Communication (NC4 inventory years 2016 and 2017). As was the case with the BUR1 waste sector GHGI, default emission factors as provided by the 2006 IPCC GHGI guidelines/software were used.

2.5.3 Activity Data

Sources of activity data used for the preparation of the GHGI inventory sector include:

- Waste management regulatory Authority (WMRA)
- CAPMAS
- Egyptian Environmental Affairs Agency (EEAA)

2.5.4 Emission Factors

Applicable default emission factors were used in all waste sector categories as defined by the 2006 IPCC GHGI guidelines and built into the 2006 IPCC software.

2.5.5 Trend Analysis

Trend analysis from 1990 shows that solid waste disposal has been the main contributor to Waste sector emissions, accounting for more than 60% of the total between 1990 and 2005. Wastewater treatment and discharge made up the remaining share of emissions, as illustrated in Figure 2-21.

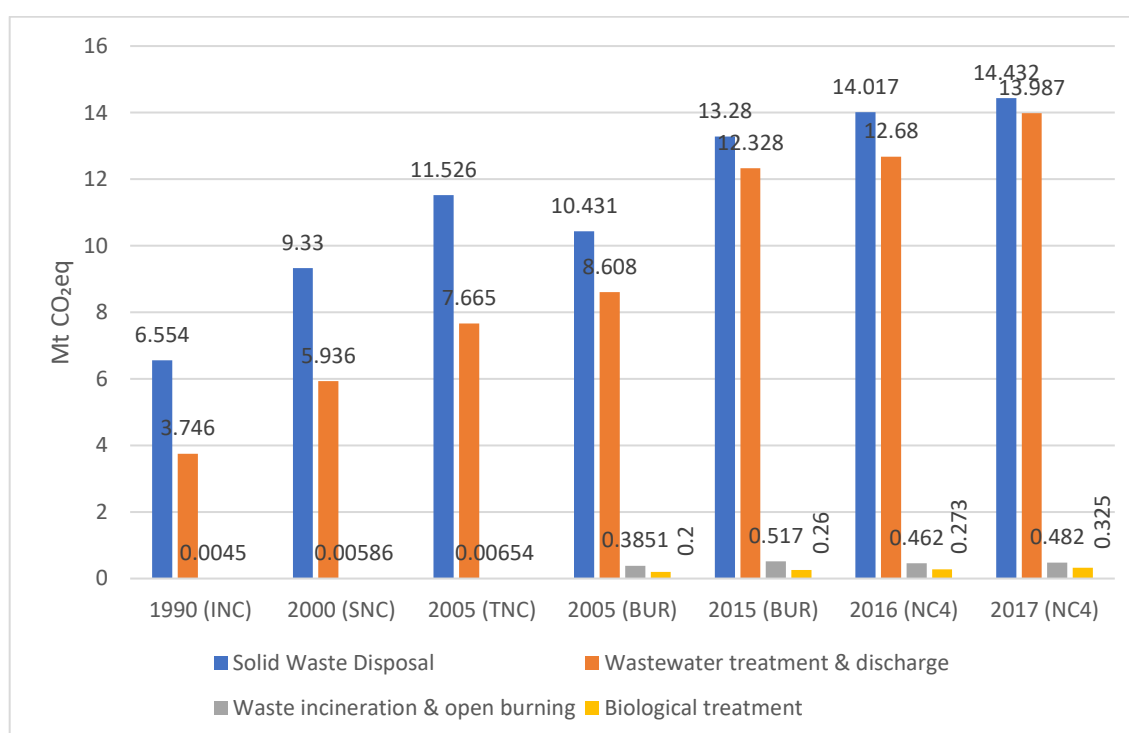
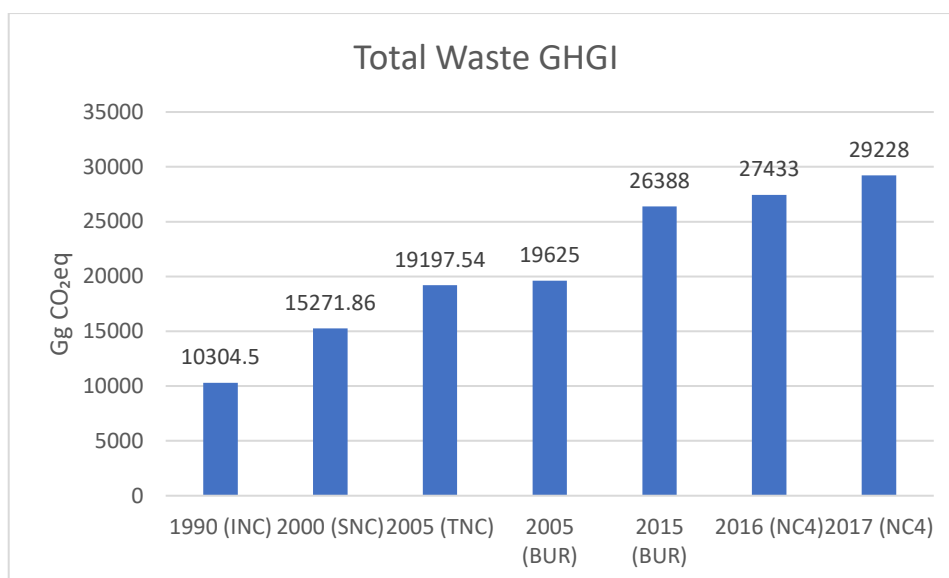


Figure 2-21: Waste sector GHG emissions 1990-2017

Starting with the 2006 inventory year, prepared for Egypt’s BUR1, waste sector emissions have been calculated using the IPCC software. The use of this software for the BUR1 also required a recalculation of emissions for 2005. In the Third National Communication (TNC), solid waste disposal was estimated to contribute 11.526 million tonnes (Mt) CO₂e in 2005. The recalculated 2005 value in the BUR1 time series was 10.431 Mt CO₂e, representing a 9.5% decrease compared to the TNC. This difference reflects changes in the parameters selected in the IPCC software, including municipal solid waste composition, the percentage deposited in SWDS, and the distribution of waste among the five SWDS types. The results for the different subsectors are presented in Table 2-9.

Table 2-9: Category shares (%) in waste sector GHGI 1990-2017

	Solid Waste Disposal	Wastewater treatment & discharge	Waste incineration	open burning of waste	Biological treatment of waste
1990 (INC)	63.60%	36.35%	0.04%		
2000 (SNC)	61.09%	38.87%	0.04%		
2005 (TNC)	60.04%	39.93%	0.03%		
2005 (BUR1)	53.2%	43.9%	0.03%	1.94%	1.02%
2015 (BUR1)	50.33%	46.72%	0.17%	1.79%	0.99%
2016 (NC4)	51.1%	46.22%	0.05%	1.63%	1.00%
2017 (NC4)	49.38%	47.85%	0.05%	1.6%	1.11%

Emissions for the inventory year 2005 were recalculated during the preparation of Egypt's BUR1 and compared to the values reported in the TNC. In this comparison, the contribution of wastewater treatment and discharge to total waste sector emissions increased slightly from about 40% to 44%, while the relative contribution of solid waste disposal decreased from 60% to 53%. The higher share of the wastewater treatment and discharge category reflects differences in calculation methods and the availability of more detailed activity data.

In addition, the decline in the relative contribution of solid waste disposal was partly due to the introduction of two new categories under the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: open burning of waste and biological treatment of waste. Together, these two categories accounted for approximately 3% of waste sector emissions.

2.5.6 Emission per Gas and Category

Figures 2-22 and 2-23 show that in 2016 and 2017, solid waste disposal was the largest contributor to waste sector emissions, accounting for 51% and 49% of the total, respectively. Wastewater treatment and discharge followed closely, contributing 46% in 2016 and 48% in 2017. The relative contributions of incineration and open burning, as well as biological treatment of waste, remained stable at 2% and 1%, respectively.

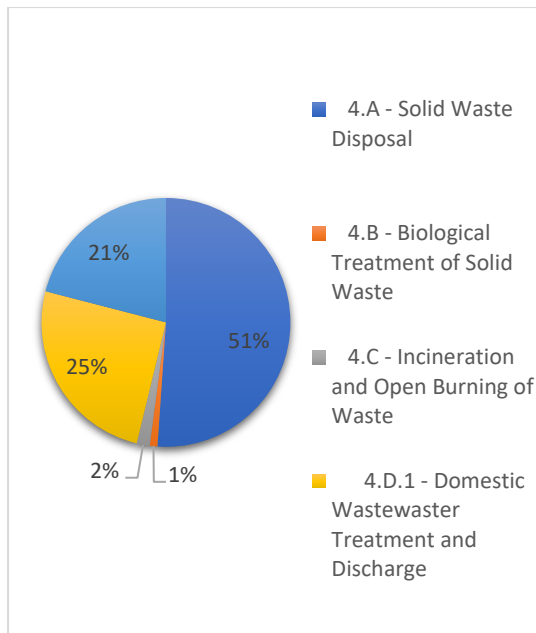


Figure 2-22: Contribution (%) to waste sector 2016 GHGI by category

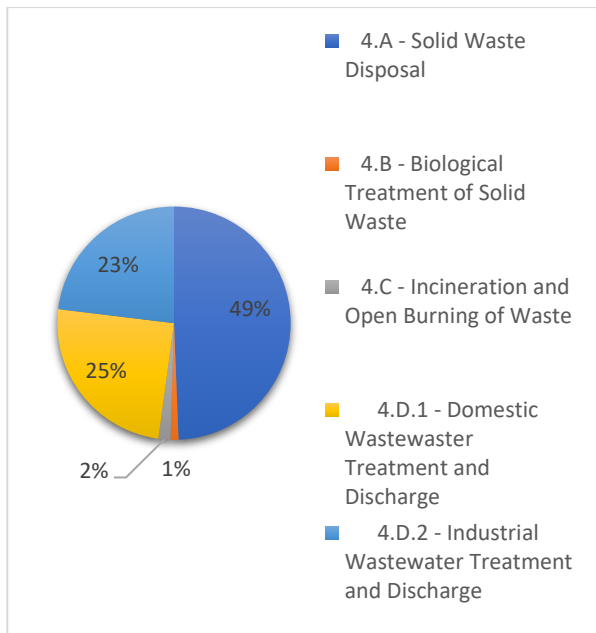


Figure 2-23: Contribution (%) to waste sector 2017 GHGI by category

Methane constituted more than 92% of waste sector emissions. Solid waste disposal was the largest source, accounting for over 55% of methane emissions, followed by industrial wastewater treatment and discharge with about 23%, and domestic wastewater treatment and discharge with about 20%. Smaller contributions came from open burning of waste and from biological treatment of waste (composting).

Nitrous oxide made up around 7% of waste sector emissions. Domestic wastewater treatment and discharge was the dominant source, contributing more than 89% of nitrous oxide emissions, followed by biological treatment of waste (composting) at about 7% and open burning of waste at around 3%. Minor emissions also arose from waste incineration.

Carbon dioxide represented less than 0.2% of waste sector emissions. Open burning of waste accounted for roughly 75% of these emissions, with incineration responsible for the remaining 25%. Figure 2-24 shows the contribution by gas to waste sector emissions in 2016, which is also representative of 2017.

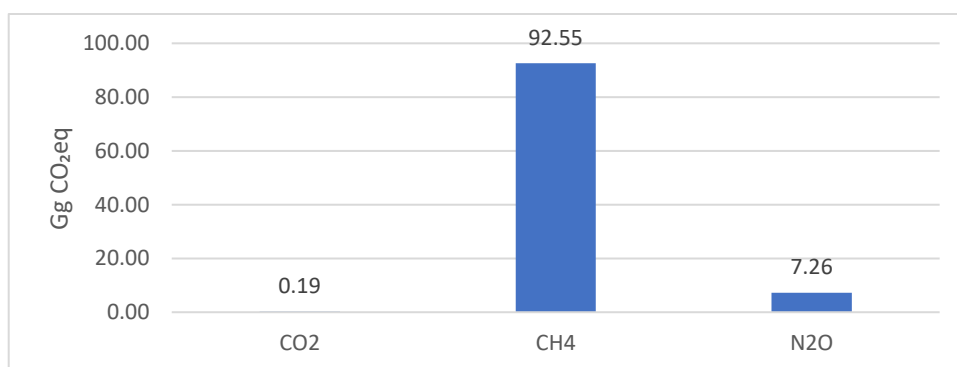


Figure 2-24: Contribution (%) to waste sector 2016 GHGI by Gas (also representative of 2017)

2.6 Recalculations

Recalculation of greenhouse gas inventories in some sectors was necessary to ensure consistency across the time series and to incorporate updated data that improve accuracy. The two sectors where recalculations were carried out are Energy and Industrial Processes and Product Use (IPPU). The following subsections describe the rationale for these recalculations and present the results.

2.6.1 Energy Sector

In the BUR1, the main source of activity data was the IEA website. However, after the report's release, the IEA updated its data for Egypt from 2012 to 2015. In addition, natural gas consumption data across all sectors were revised for the full time series from 1990 to 2017. This NC4 also includes the manufacturing of solid fuels from 1990 to 2017.

In BUR1, annual oil production values used to calculate emissions from venting and flaring during 2008–2011 were inconsistent. NC4 has resolved this issue. For this report, the source of annual oil and gas production data is the *BP Statistical Review of World Energy (2020)*. As part of this process, all BUR1 activity data were comprehensively reviewed and updated.

2.6.2 IPPU Sector

Cement production emissions were re-estimated to correct for underreporting associated with CAPMAS data, which was found to be significantly lower than other available sources, with a discrepancy of about 9 million tonnes. To address this, emissions were recalculated using the Cement Division Statistics, considered a more reliable data source and available online¹⁰. The recalculation resulted in a substantial increase in estimated emissions, as illustrated in Figure 2-25.

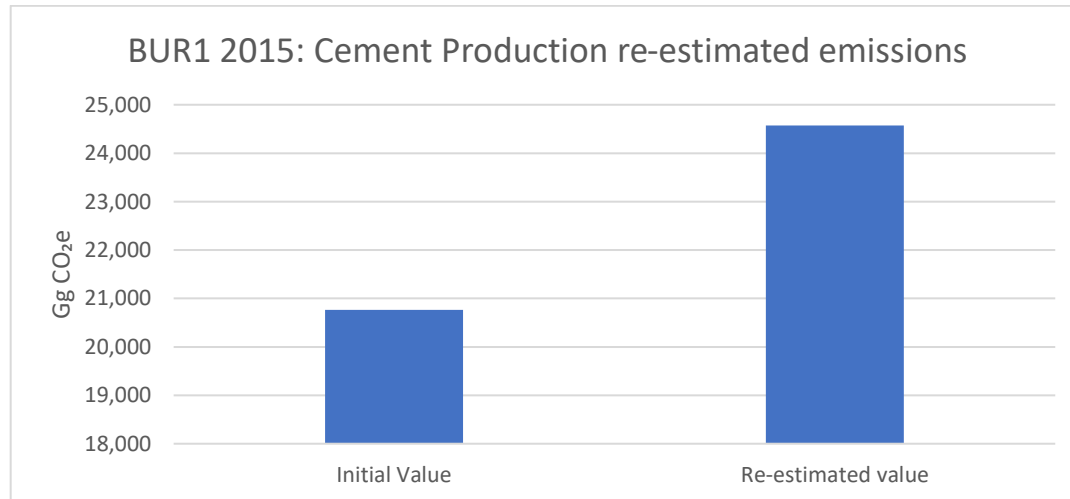


Figure 2-25: BUR1 2015, Cement Production re-estimated emissions

For the other re-estimated subcategories presented in Table 2-10, namely soda ash production, EDC production, ferroalloy production, carbon black production, lubricant and paraffin wax use, and the use of electrical equipment, no estimates were included in the BUR1 GHGI. These are therefore newly added subcategories to Egypt's GHGI and have no initial values for comparison.

For glass production, emissions for 2005–2015 were re-estimated following an adjustment to the activity data, as the original figures for total glass production were found to be overestimated. Nitric

¹⁰ <https://cementdivision.com/cement-industry-in-egypt/facts-and-figures/>

acid emissions were also recalculated because the methodology used in the BUR1 to derive production data was not available during the preparation of this report, and the reported values were much higher than the overall capacity for nitric acid production reported by the IDA. As a result, production capacity values were used for the entire time series (1990–2017).

Previously, emissions for the ODS substitutes subcategory were estimated based on gas types instead of application types, leading to an overestimation because the gases were assumed to be 100% emissive without considering banks. In this report, emissions were recalculated by application type, using data from the Ozone Unit of the EEAA, which specifies the applications associated with each chemical. This recalculation led to a significant reduction in emissions from this source, as illustrated in Figure 2-26.

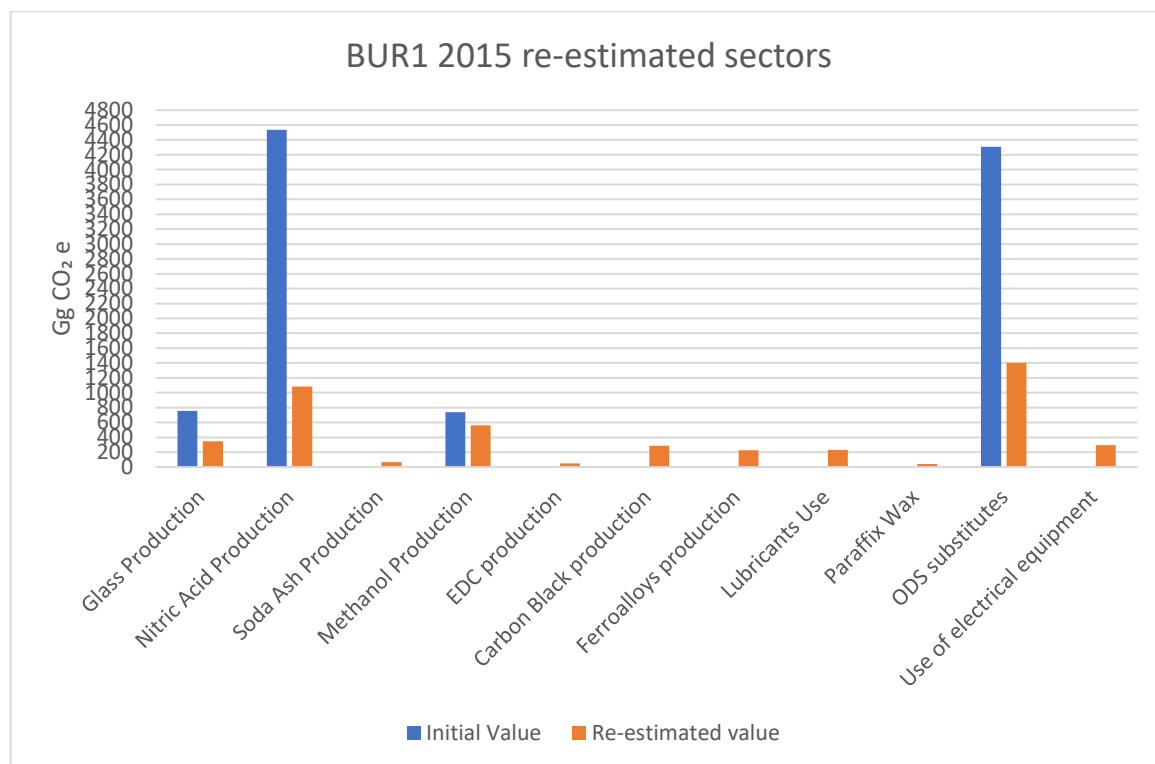


Figure 2-26: BUR1 2015 re-estimated sectors

2.6.3 Comparison of Re-estimated Sub-Categories in Previous GHGI (2015)

To improve the accuracy of the 2015 greenhouse gas inventory (GHGI), several categories were re-estimated. These revisions were required either due to the addition of new categories to the inventory or to correct over- or underestimation caused primarily by inaccuracies or unjustified assumptions in the activity data. Table 2-10 summarises all re-estimated subcategories and indicates their respective impacts on total emissions in 2015.

Table 2-10: Comparison of re-estimated sub-categories in previous GHGI (BUR1)

Subcategory	Emissions in 2015 (BUR1) (Gg CO ₂ e)	Re-calculated emissions value in 2015 (Gg CO ₂ e)	Difference		% change in total IPPU emissions
			Gg CO ₂ e	%	
Cement Production	20,762	24,569	+ 3,807	+18.3	9.4
Glass production	756	345	-411	-54.4	-1
Nitric Acid Production	4,537	1,085	-3,452	-76	-8.5
Soda Ash Production	NE	65.3	+ 65.3		+0.16
Methanol Production	740.4	562.4	- 178	-24	-0.4
Ethylene Dichloride Production	NE	49.25	+49.25		+0.12
Carbon Black Production	NE	288.34	+288.3		+0.7
Ferroalloys Production	NE	225.95	+225.9		+0.55
Lubricants Use	NE	228.78	+228.7		+0.56
Paraffin Wax Use	NE	40.7	+40.7		0.1
Refrigeration and AC	4,308.7 (Summation of all categories. Documented as “others”)	811.9	-2,905	-67	-7.15
Foam Blowing Agents		505.23			
Fire Protection		86.04			
Aerosols		0			
Use of electrical equipment (SF6)	NE	296.3	+296.3		0.73
TOTAL	40,664	38,716	-1,948		-4.8%

2.7 Comparison of GHGI with Previous Years

2.7.1 Energy Sector

A detailed GHG emissions comparison between 2015, 2016 and 2017 has been conducted by using 2019 IPCC software. Table 2-11 and Table 2-12 show the GHG emissions average annual growth rates for the years 2016 and 2017.

Table 2-11: GHG emissions average annual growth rates for the years 2015 to 2016

Categories	CO2	CH4	N2O	CO2e
1 - Energy	3.1%	-1.1%	7.4%	3.0%
1.A - Fuel Combustion Activities	3.3%	0.7%	7.5%	3.3%
1.A.1 - Energy Industries	-0.7%	0.6%	-5.4%	-0.7%
1.A.1.a - Main Activity Electricity and Heat Production	-0.7%	-2.6%	-5.7%	-0.7%
1.A.1.a.i - Electricity Generation	-0.7%	-2.6%	-5.7%	-0.7%
1.A.1.b - Petroleum Refining	0.2%	0.0%	0.0%	0.2%
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	13.4%	0.8%		1.9%
1.A.1.c.i - Manufacture of Solid Fuels	13.4%	0.8%		1.9%
1.A.2 - Manufacturing Industries and Construction	7.8%	2.6%	19.2%	7.8%
1.A.3 - Transport	7.3%	0.5%	8.4%	7.3%
1.A.3.a - Civil Aviation	-15.8%			-15.9%
1.A.3.a.ii - Domestic Aviation	-15.8%			-15.9%
1.A.3.b - Road Transportation	7.4%	0.5%	8.4%	7.4%
1.A.4 - Other Sectors	3.1%	1.4%	0.0%	3.0%
1.A.4.a - Commercial/Institutional	2.5%	1.2%	0.0%	2.5%
1.A.4.b - Residential	3.6%	1.5%	0.0%	3.6%
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	2.5%	2.8%	0.0%	2.5%
1.A.4.c.i - Stationary	2.5%	2.8%	0.0%	2.5%
1.B - Fugitive emissions from fuels	-5.2%	-4.8%	0.0%	-5.2%
1.B.2 - Oil and Natural Gas	-5.2%	-4.8%	0.0%	-5.2%
1.B.2.a - Oil	-4.8%	-4.8%	0.0%	-4.8%
1.B.2.a.i - Venting	-9.8%	-4.8%		-4.8%
1.B.2.a.ii - Flaring	-4.8%	-4.8%	0.0%	-4.8%
1.B.2.b - Natural Gas	-5.5%	0.0%		-5.5%
1.B.2.b.i - Venting	-5.5%			-5.5%
1.B.2.b.ii - Flaring	-6.1%	0.0%		-5.5%

Table 2-12: GHG emissions average annual growth rates for the years 2016 to 2017

Categories	CO2	CH4	N2O	CO2e
1 - Energy	1.4%	-1.3%	-4.0%	1.3%
1.A - Fuel Combustion Activities	1.2%	0.2%	-3.8%	1.2%
1.A.1 - Energy Industries	3.1%	0.6%	-8.6%	3.1%
1.A.1.a - Main Activity Electricity and Heat Production	3.2%	-4.1%	-9.1%	3.2%
1.A.1.a.i - Electricity Generation	3.2%	-4.1%	-9.1%	3.2%
1.A.1.b - Petroleum Refining	-1.4%	0.0%	0.0%	-1.4%
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	-4.5%	0.8%		0.2%
1.A.1.c.i - Manufacture of Solid Fuels	-4.5%	0.8%		0.2%
1.A.2 - Manufacturing Industries and Construction	2.4%	0.9%	-9.7%	2.3%
1.A.3 - Transport	-2.8%	-1.6%	-2.7%	-2.8%
1.A.3.a - Civil Aviation	-2.1%			-2.1%
1.A.3.a.ii - Domestic Aviation	-2.1%			-2.1%
1.A.3.b - Road Transportation	-2.8%	-1.6%	-2.7%	-2.8%
1.A.4 - Other Sectors	0.7%	0.8%	0.0%	0.7%
1.A.4.a - Commercial/Institutional	0.6%	0.7%	0.0%	0.6%
1.A.4.b - Residential	0.9%	0.9%	0.0%	0.9%
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	-0.2%	0.0%	0.0%	-0.2%
1.A.4.c.i - Stationary	-0.2%	0.0%	0.0%	-0.2%
1.B - Fugitive emissions from fuels	10.6%	-4.5%	0.0%	8.5%
1.B.2 - Oil and Natural Gas	10.6%	-4.5%	0.0%	8.5%
1.B.2.a - Oil	-4.5%	-4.5%	0.0%	-4.5%
1.B.2.a.i - Venting	-4.4%	-4.5%		-4.5%
1.B.2.a.ii - Flaring	-4.5%	-4.2%	0.0%	-4.5%
1.B.2.b - Natural Gas	21.3%	0.0%		21.3%
1.B.2.b.i - Venting	21.3%			21.3%
1.B.2.b.ii - Flaring	21.3%	0.0%		21.3%

2.7.2 Industrial Processes and Product Use (IPPU) Sector

2.7.2.1 Comparison of Emissions Trend

Table 2-13 presents a comparison of the GHG inventory for all IPPU subcategories in Egypt for the period 1990–2017. It also shows the average annual growth rates of emissions over six intervals: 1990–2005, 1990–2017, 2005–2015, 2005–2017, 2015–2017, and 2016–2017.

Between 1990 and 2000, total emissions increased at an average annual rate of 6%. The significant growth in emissions from the minerals industry (cement production) and the chemicals industry (ammonia production) primarily drove this rise. Broader industrialisation in Egypt also contributed, particularly through the higher consumption of lubricants, paraffin wax, and electrical equipment, which added further emissions.

Between 2000 and 2005, the average annual growth rate in total emissions was 3.5%. The largest increase came from the Other Product Manufacture and Use category (notably the use of electrical equipment), followed by the minerals industry, where cement production continued to expand and glass and ceramics production was added to the GHGI. Over the same period, emissions from the chemicals industry declined by 2.5% per year due to reduced ammonia production.

Between 2005 and 2015, total emissions increased at an average annual rate of 4.2%. The main drivers were the introduction of ODS substitutes into the Egyptian market (in refrigeration and air conditioning, foam blowing agents, and fire protection), rising national consumption of lubricants and paraffin wax, greater installed capacity of electrical equipment (2.G Other Product Manufacture and Use subcategory), and higher cement production. By contrast, emissions from the metals industry declined by around 2% during this period, reflecting reduced production of iron, steel, and aluminium.

Between the inventory years 2015 and 2016, total emissions rose by 4.5%. The largest increases were recorded in the metals industry (notably iron, steel, and aluminium production) and in the product use of ODS substitutes, which grew by 14.9% and 15.1%, respectively. However, the chemicals industry registered a 9.3% decline in emissions, mainly due to reduced methanol and ethylene production in 2016. The Other Product Uses of Fuels subcategory also showed a 2.2% decline, reflecting a slight reduction in lubricants and paraffin wax consumption.

Between 2016 and 2017, total emissions grew by 4.2%. The most significant increases occurred in the Other Product Uses of Fuels subcategory (a 31.6% rise due to higher lubricant consumption), the metals industry (a 14.2% rise from increased iron and steel production), and the product use of ODS substitutes (a 10% rise). In contrast, the chemicals industry showed an 8.4% decrease in emissions, largely due to a sharp drop in ammonia production in 2017.

Overall, emissions growth during 2005–2017 was driven by industrial expansion, the introduction of new product categories such as ODS substitutes, and higher production in energy-intensive industries. At the same time, fluctuations in chemical and metal production partially offset these increases, shaping the sector's overall emissions trajectory.

Table 2-13 Comparison of GHGI annual average growth rate per industry between 1990-2017

Average Annual Change (%/year)	2.A Minerals Industry	2.B Chemical Industry	2.C Metals Industry	2.D Other Product Uses of Fuels	2.F Product uses as substitutes for Ozone depleting substances	2.G Other Product Manufacture and Use	Total
1990 (INC) - 2000 (SNC)	8.5	14	1.7	10.2	0	6.2	6.1
2000 (SNC) - 2005 (TNC)	5.7	-2.5	2.8	4	0	6.8	3.5
2005 (BUR1) - 2015 (BUR1)	6.5	3.1	-1.9	11.2	87	4.7	4.2
2015 (BUR1) - 2016 (NC4)	2.7	-9.3	14.9	-2.2	15.1	0	4.5
2016 (NC4) - 2017 (NC4)	1.5	-8.4	14.2	31.6	10	0	4.2

2.7.3 AFOLU Sector

Figure 2-27 shows the AFOLU sector GHG emissions trend between 2005 and 2017. Total AFOLU emissions in 2015 were 6.6% lower than in 2005, mainly due to reduced fertiliser use, as per BUR1. However, emissions rose sharply in subsequent years, increasing by 14.1% in 2016 compared to 2015 and by 15.8% in 2017 compared to 2016. Greater use of synthetic fertilisers primarily drove this growth.

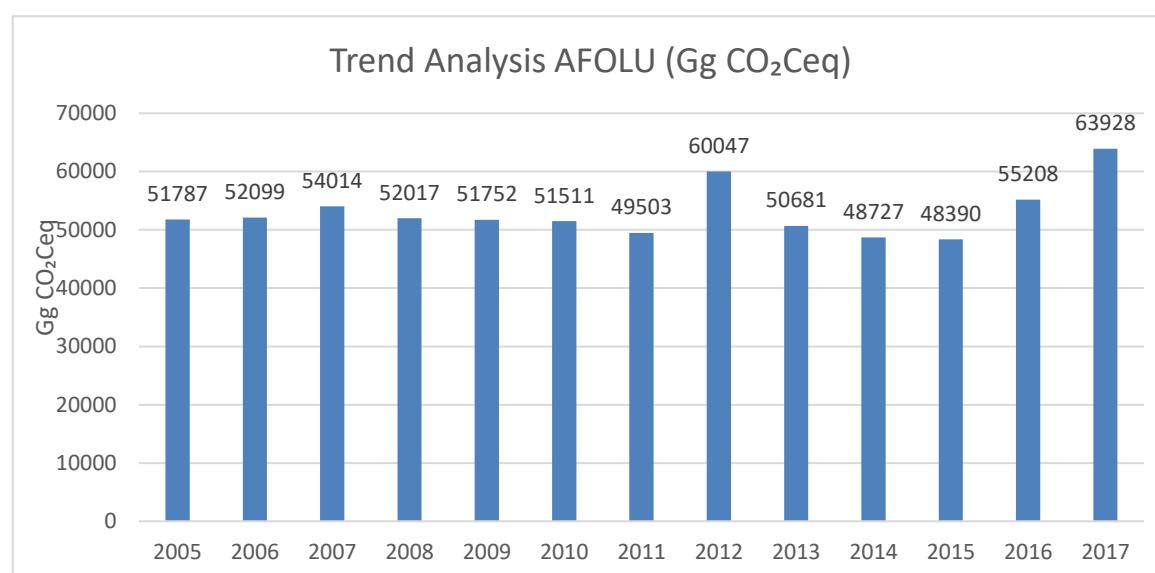


Figure 2-27: GHG emissions from AFOLU sector over the period 2005 -2017 (Gg CO₂e)

Total emissions have risen from 51,787 Gg CO₂ equivalent in 2005 to 63,928 Gg CO₂ equivalent in 2017 (Figure 2-27). N₂O accounts for the largest share of emissions and there has been an upward trend (about 68% in 2016 total emissions and 73% in 2017). Compared to the 2016 (55,208 Gg CO₂ equivalent), GHG emissions from AFOLU has increased in 2017 (63,928 Gg CO₂ equivalent) and gained an upward trend.

Table 2-14: Annual change (%) in categories and total AFOLU sector GHGI 1990-2017

	1990 (INC) - 2000 (SNC)	2000 (SNC) - 2005 (TNC)	2005 (TNC) - 2005 (BUR1)	2005 (BUR1) - 2015 (BUR1)	2015 (BUR1) - 2016 (NC4)	2016 (NC4) - 2017 (NC4)
AFOLU	7.71	4.87	31.29	-0.66	14.09	15.79
Enteric Fermentation	1.90	2.43	11.43	0.59	-3.36	-6.56
Manure Management	178.59	-11.36	14.04	2.78	8.99	-5.67
Rice cultivation	-3.78	17.40	-4.57	-1.92	11.29	-3.34
Agricultural Soils	5.62	19.18	50.83	-1.24	30.49	28.53
Emissions from biomass burning	74.47	0.24	-62.88	2.06	-92.76	1.06

2.7.4 Waste Sector

Previously uncalculated, open burning of waste (0.384 million tonnes CO₂e) was added to incineration (0.006 million tonnes CO₂e) beginning in 2005 in the BUR1 data series. This inclusion increased the total for the waste incineration and open burning category by more than 50 times. However, the overall emissions from this category remain small, reaching 0.472 million tonnes CO₂e by 2015.

Between 2015 (BUR1) and 2016 (NC4), emissions from open burning decreased by 10.64% following adjustments and recalculations of both incineration and open burning. In BUR1, emissions from waste incineration (clinical waste) had been overestimated due to misinterpretation of collected data. A subsequent review by the inventory compiler identified new information, leading to the application of a correction factor of 0.27 to the incineration activity data. As a result, incineration emissions were reduced to about 27% of the levels previously reported in BUR1. Adjustments were also made to the open burning category, with the fraction of waste burnt revised from 13% to 12% based on new data, and emissions recalculated accordingly.

Between 2016 and 2017, emissions from biological treatment of waste increased by 19%, primarily reflecting a corresponding increase in municipal solid waste (MSW) deposited during this period, as composting is assumed to represent 7% of MSW deposited annually.

Over the same interval, emissions from wastewater treatment and discharge rose by 10.31%, mainly due to a 17% increase in emissions from industrial wastewater treatment and discharge. Higher levels of industrial production activity in 2017 compared to 2016 drove this increase.

Table 2-15: Annual change (%) in categories and total waste sector GHGI 1990-2017

Average Annual Change (%/year)	Solid Waste Disposal	WW treatment & discharge	Waste incineration & open burning	Bio. Treat. of waste	Total waste sector GHGI
1990 (INC) - 2000 (SNC)	4.24%	5.85%	3.02%		4.82%
2000 (SNC) - 2005 (TNC)	4.71%	5.83%	2.32%		5.14%
2005 (TNC) - 2005 (BUR1)	-9.50%	12.30%	5788.38%		2.23%
2005 (BUR1) - 2015 (BUR1)	2.73%	4.32%	3.43%	3.00%	3.45%
2015 (BUR1) - 2016 (NC4)	5.55%	2.86%	-10.64%	5.00%	3.96%
2016 (NC4) - 2017 (NC4)	2.96%	10.31%	4.33%	19.05%	6.54%

2.8 Uncertainty Analysis and QA/QC for the Calculation of Emissions

2.8.1 Uncertainty Analysis

Uncertainty analysis was conducted using the IPCC software. For the period 1990–2016, the analysis yielded an overall inventory uncertainty of 7.7% and a trend uncertainty of 22.9%. For the extended period 1990–2017, the corresponding results were an overall inventory uncertainty of 9.4% and a trend uncertainty of 22.9%. The uncertainty values for emission factors and activity

data were based on the default ranges provided in the IPCC Guidelines, supplemented by expert judgement.

2.8.2 QA/QC for Data Collection

QA/QC measures are applied throughout the data collection process to ensure the fulfilment of Transparency, Accuracy, Completeness, Comparability, and Consistency (TACCC) principles. The following quality control (QC) activities are conducted before and during the preparation of estimates:

- Checking the specific requirements regarding the reporting guidelines.
- Review of data requirements for 2006 IPCC GHGI software & guidelines.
- Data collection from primary sources using tailored questionnaires.
- Data collection from national and sectoral published reports.
- Screening and tabulation of collected data by year, unit, and source.
- Comparison and adaptation of data collected versus data needed.
- Cross-check key activity data and parameters from different sources (the source showing the most significant variation in numbers was excluded).
- Checking the correctness of emission factors used in calculation.
- Comparison and trend analysis with data for previous GHGIs.
- Contrast data trends with sector development and realities.
- Confirmation/update of parameters and assumptions used for previous GHGI to ensure time series consistency.

2.8.3 QA/QC for the Calculation of Emissions

The following quality control (QC) activities are conducted before, during and after the preparation of estimates to ensure accurate calculation and avoid errors:

- Check for transcription errors in data input and reference.
- Check that the parameter and emission units are correctly recorded and that appropriate conversion factors are used.
- Time series emission trends: consistency checks.
- Could you please explain if there are any differences in the trend compared to previous GHGIs?
- Checking the correctness and consistency of choosing the AD, EF and methods used along the entire time series.
- Data quality assurance and, as needed, recalculation of existing data.
- Data review modification/re-entry in selected years/subsector.
- Checking the correctness of applied methods descriptions.
- Checking the key categories' persistency along the time series.
- Year-by-year checks for bugs and data misplacement by IPCC software.
- Checking the adequate qualification of individuals providing expert judgements on the uncertainty estimates and the archiving of documentation regarding the qualification and the expert judgements.
- Review and update of uncertainties entered in the IPCC 2006 software.

Table 2-16: Summary of GHG Emissions in 2016

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			Total emissions Gg CO2 equivalent)
	Net CO2	CH4	N2O	HFCs	PFCs	SF6	
Total National Emissions and Removals	257856.068	2058.19897 3	134.201208 4	1653.54414 1	4421.1 2	296.312 2	349051.5974
1 - Energy	222409.8323	112.667076 5	3.46579430 3	0	0	0	225850.2372
1.A - Fuel Combustion Activities	217686.0874	77.1446302 5	3.43429604 3				220370.7564
1.B - Fugitive emissions from fuels	4723.744913	35.5224462 6	0.03149826				5479.480745
1.C - Carbon dioxide Transport and Storage	0						0
2 - Industrial Processes and Product Use	33045.31812	2.82553677 4	3.5	1653.54414 1	4421.1 2	296.312 2	40560.63074
2.A - Mineral Industry	26080.41288	0	0				26080.41288
2.B - Chemical Industry	2737.047479	2.67308257 4	3.5	0	0	0	3878.182213
2.C - Metal Industry	3964.2655	0.1524542	0	0	4421.1 2	0	8388.587038
2.D - Non-Energy Products from Fuels and Solvent Use	263.5922667	0	0				263.5922667
2.E - Electronics Industry	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances				1653.54414 1	0		1653.544141
2.G - Other Product Manufacture and Use	0	0	0	0	0	296.312 2	296.3122
2.H - Other	0	0	0				0
3 - Agriculture, Forestry, and Other Land Use	2348.569817	733.669063 8	120.812767 6	0	0	0	55207.57811
3.A - Livestock		542.197320 4	16.9715388 1				16647.32076

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			Total emissions Gg CO2 equivalent)
	Net CO2	CH4	N2O	HFCs	PFCs	SF6	
3.B - Land	- 4.493373388		0				- 4.493373388
3.C - Aggregate sources and non-CO2 emissions sources on land	2353.06319	191.471743 4	103.841228 8				38564.75072
3.D - Other	0	0	0				0
4 - Waste	52.34776315	1209.03729 6	6.42264651 6	0	0	0	27433.1514
4.A - Solid Waste Disposal		667.475827 7					14016.99238
4.B - Biological Treatment of Solid Waste		6.188	0.4641				273.819
4.C - Incineration and Open Burning of Waste	52.34776315	16.3269363	0.21564538 1				462.0634935
4.D - Wastewater Treatment and Discharge		519.046532	5.74290113 6				12680.27652

Table 2-17: Summary of GHG emissions in 2017

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			Total emissions Gg CO2 equivalent)
	Net CO2	CH4	N2O	HFCs	PFCs	SF6	
Total National Emissions and Removals	262763.977 3	2099.70312	164.922251 1	1837.5809 1	4195.8 4	296.312 2	364313.373 7
1 - Energy	225497.540 3	111.244930 7	3.33485163 5	0	0	0	228867.487 9
1.A - Fuel Combustion Activities	220271.882 5	77.3150112 8	3.30451419				222919.897 1
1.B - Fugitive emissions from fuels	5225.6578	33.9299194 4	0.03033744 5				5947.59071 6
1.C - Carbon dioxide Transport and Storage	0						0
2 - Industrial Processes and Product Use	34747.9417 3	6.06738928 6	3.5	1837.5809 1	4195.8 4	296.312 2	42290.0900 2
2.A - Mineral Industry	26499.1091 1	0	0				26499.1091 1
2.B - Chemical Industry	2367.96009 3	5.89360248 6	3.5	0	0	0	3576.72574 5
2.C - Metal Industry	5495.28	0.1737868	0	0	4195.8 4	0	9694.76952 3
2.D - Non-Energy Products from Fuels and Solvent Use	385.592533 3	0	0				385.592533 3
2.E - Electronics Industry	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances				1837.5809 1	0		1837.58091
2.G - Other Product Manufacture and Use	0	0	0	0	0	296.312 2	296.3122

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			Total emissions Gg CO2 equivalent)
	Net CO2	CH4	N2O	HFCs	PFCs	SF6	
2.H - Other	0	0	0				0
3 - Agriculture, Forestry, and Other Land Use	2464.357804	693.303471	151.302963	0	0	0	63927.64921
3.A - Livestock		508.14182	15.9365587				15611.31142
3.B - Land	31.292811		0				31.292811
3.C - Aggregate sources and non-CO2 emissions sources on land	2433.064993	185.161651	135.3664043				48285.04499
3.D - Other	0	0	0				0
4 - Waste	54.13744235	1289.087329	6.784436479	0	0	0	29228.14666
4.A - Solid Waste Disposal		687.2370054					14431.97711
4.B - Biological Treatment of Solid Waste		7.364	0.5523				325.857
4.C - Incineration and Open Burning of Waste	54.13744235	17.07666528	0.2255072				482.6546454
4.D - Wastewater Treatment and Discharge		577.4096585	6.006629279				13987.6579

3 MITIGATION POLICIES AND MEASURES

3.1 Introduction

Egypt's commitment to sustainable development is embedded in its 2014 Constitution, which reflects the principles of the 2030 Agenda by integrating economic, social, and environmental dimensions into national planning. The policies and measures of climate mitigation that are discussed in this chapter are primarily derived from national strategies, particularly Egypt's SDS 2030 and the ISES 2035, as well as sector-specific strategies that have been adopted by suitable ministries. This ensures a coherent, cross-sectoral approach aligned with national priorities.

These mitigation measures are not standalone efforts but part of a broader, integrated development agenda. Their alignment with existing strategies enhances policy coherence, strengthens institutional ownership, and supports effective implementation. The methodology used to identify these measures, developed under Egypt's Low Emission Development Strategy (LEDS), involved reviewing national policies, assessing sectoral emissions, and modelling mitigation scenarios. This resulted in identifying and shortlisting 27 priority programmes¹¹ across seven key sectors: energy (including petroleum and electricity), industry, transport, agriculture, waste, tourism, and buildings.

Modelling was used to assess the impact of these measures and compare them with a BAU scenario, providing a clear picture of Egypt's mitigation potential and informing a strategic national response to climate change.

3.1.1 Methodological Approach

The development of Egypt's mitigation measures followed a structured approach that combined policy analysis, stakeholder input, scenario modelling, and financial assessment. The key steps included:

- a. **National Context Review:** A literature review and stakeholder consultations were conducted to assess the national context and sectoral priorities.
- b. **Scenario modelling with LEAPTM: Mitigation actions were modelled** across all sectors using the LEAP software and compared to a BAU scenario. An optimisation analysis simulated 10 reduction targets, identifying the highest Net Present Value (NPV) option for each.
- c. **Prioritisation through Stakeholder Engagement:** Stakeholders helped prioritise mitigation actions based on relevance, feasibility, and impact.
- d. **Financial Assessment:** Available financing options were identified for the shortlisted actions.

A total of 27 mitigation programmes were selected and modelled for the period 2018–2030, covering seven sectors: electricity, petroleum, industry, transport, agriculture, buildings, tourism, and waste. For each sector, the analysis included a brief status review, alignment with SDS 2030 and sectoral strategies, estimation of historical GHG-related activity data, and identification of relevant mitigation programmes.

¹¹ A mitigation programme refers to a coordinated set of activities, measures, projects—or any combination thereof—designed to reduce or limit greenhouse gas (GHG) emissions. It may target specific sectors, and can operate at national, or local levels to support climate change mitigation objectives.

These actions were then modelled against the BAU scenario using LEAP. It is noted that additional potential measures were identified but could not be modelled due to data limitations from some ministries.

3.1.2 Business As Usual (BAU) Vs Mitigation Scenarios

Under the BAU scenario—assuming none of the 27 mitigation measures are implemented—Egypt’s greenhouse gas emissions are projected to exceed 600 MtCO_{2e} by 2030. The largest contributors are the electricity generation sector (33%), followed by industry (23%) and transport (19.7%). By contrast, implementing the 27 identified mitigation programmes is expected to reduce emissions by approximately 150 MtCO_{2e} by 2030, representing a 24% reduction compared to BAU levels. The most significant reductions are expected from the electricity sector, particularly under the Renewable Energy Maximisation Scenario from Egypt’s Energy Strategy 2035, followed by gains from the energy subsidy reform and transport sector interventions. To guide the selection of optimal mitigation pathways, an optimisation model was developed with the following key features:

- Multiple emission reduction targets were evaluated, ranging from 5% to 22% below the BAU scenario. The 24% reduction represents the full implementation of all 27 programmes and thus has a single outcome.
- For each target, the model identifies the combination of mitigation programmes that achieve reduction while maximising total NPV, discounted at 12%.
- The model was run multiple times per target to generate more than one program combination, achieving the same reduction goal, offering flexibility in selection.

3.2 Sustainable Development Strategy (SDS): Egypt’s Vision 2030

Launched on the 24th of February 2016, the SDS presents a strategy and a platform for action during the period from 2015 to 2030. The strategy envisions a new Egypt that, by 2030, achieves sustainable development to ensure a better quality of life for all Egyptians. This will be realised through a competitive, balanced, and diversified knowledge-based economy grounded in justice, social inclusion, active participation, and a well-balanced, diverse ecosystem. The SDS serves as the national umbrella through which the SDGs will be implemented considering national circumstances.

Egypt Vision 2030 Objective:

By 2030, the new Egypt will achieve a competitive, balanced, diversified, and knowledge-based economy, characterized by justice, social integration, and participation, with a balanced and diversified ecosystem, benefiting from its strategic location and human capital to achieve sustainable development for a better life of all Egyptians.

3.3 Mitigation Policies and Actions

Planned mitigation actions beyond 2015 are all conditional on the provision of support from developed countries and are subject to change. The programs identified via Nationally Appropriate Mitigation Action (NAMA) mapping are indicated below.

Table 3-1: List of Planned Mitigation Policies and Actions Post 2015

No.	Mitigation Action	Sector / Subsector	Implementing	Mitigation Action	Proposed Duration
1.	Removal of energy subsidies	Electricity, oil & gas	MoERE and MoPMR	Continuation of the subsidy phase-out and reforms for the electricity sector led by MoERE. Similarly, oil products and natural gas pricing reforms*, to be led by MoPMR. This would include partial subsidy removal from the various fossil fuel types as well as plans to introduce a smart card fuel rationing system for the transportation sector.	2016 -2025
2.	Install additional renewable energy generation to reach 37% target by 2035 (later modified to reach 42% target by 2035)	Energy, Renewable Energy	MoERE	A target of 20% renewables in electricity production by 2022 had been set previously by GoE. Based on a comprehensive analysis conducted by key stakeholders in the Egyptian energy sector. In 2016 an updated target of 37% electricity production from renewable sources by 2035 was approved. These are broken down as follows: <ul style="list-style-type: none"> • 14.6% Wind Energy (61,027 GWh) • 11.8% Photovoltaic solar (49,407 GWh) • 7.6% Solar concentrators (31,843 GWh) • 3.2% Hydropower (13,589 GWh) Examples of planned projects: <ul style="list-style-type: none"> • Continuation of the renewable energy expansion program: Gabal AL-Zeit Wind Farm. • Continuation of the renewable energy expansion program: Benban Solar Park; and • Utility-scale Concentrated Solar Power (CSP), Photovoltaic (PV), wind, biomass, waste-to-energy power generation. 	2016 - 2035
3.	Renewable energy and solar water heaters in the housing sector (*)	Energy and Housing	MoH	Install solar water heaters in residential buildings.	-
4.	EE as per the Energy Strategy 2035 (all sectors) and the second National Energy Efficiency Action Plan 2019-2022 (NEEAP 2) for electricity sector	Energy, Energy efficiency	All ministries	Electricity sector would implement measures under NEEAP 2, examples are: Prepaid meters project (5 million meters) Smart meters pilot project aims to install 250,000 smart meters. Oil and gas sector would implement measures to reach energy efficiency target under Energy Strategy 2035, examples are: Energy conservation for heaters and steam boilers (6 oil refineries); Improving combustion efficiency (boilers) in power plants; and Waste heat recovery of 200 turbines. Aviation sector led by MoCA: fuel efficiency program (2016 - 2021)	2016 - 2035
5.	Sustainable transport programs and national rail system expansion	Energy, Transport	National Authority Tunnel (Nat) and Egyptian National-Railway (ENR)	Passenger: 1.Expansion of greater Cairo metro lines and Alexandria (Alex) lines: <ul style="list-style-type: none"> • Line 3 - Phase 3&4 • Line 4 - Phase 1 • Line 5 • Line 6 • Abuqir, Alex • Alex Tram 2. Expansion of national electrical railway network <ul style="list-style-type: none"> • 10th of Ramadan - administrative Capital • Ain Sokhna - Alamin (passenger - freight) 3. Expansion of public transport services Freight <ul style="list-style-type: none"> • Freight Modal shift from road to rail. 	2016 - on-wards - 6 years - 6 years - 6 years - 8 years - 6 years

No.	Mitigation Action	Sector / Subsector	Implementing	Mitigation Action	Proposed Duration
6.	Low carbon roadmap for the Egyptian cement industry including alternative fuels utilization	IPPU, Cement	MTI and EEAA	The potential for GHG's emission reductions through four main levers: 1. Lowering the clinker content in cement (from the current 89% to 80%). 2. Increasing the use of Alternative Fuels or Recyclables (Increase to 8%, of which 50% will come from biomass and 50% from fossil fuels). 3. Energy Efficiency Improvements (\geq 3620 MJ/ton clinker); and 4. Increasing the capacity utilization factors (CUF) of the clinker production installations (85%).	2016 - onwards
7.	National Solid Waste Management Programme (NSWMP)	Waste	EEAA	Integrated waste management technologies for all waste types (municipal solid waste, agricultural wastes, sewage sludge, industrial waste, animal manure, medical waste, and hazardous waste). Advanced technologies for improved sanitary landfilling, incineration with Energy Recovery, gasification, anaerobic digestion, composting and co-firing in cement kilns*	2016 - onwards
8.	Feed-in tariff for electricity generation from waste	Energy, Waste, AFOLU	EEAA	Feed in tariff for electricity generation from MSW, agricultural residues, and biogas.	-
9.	Reduction of the cultivated areas of rice	AFOLU	MALR	Design policy and economic incentives for farmers to reduce the cultivated area of the rice crop.	2017-2030
10.	Reduce GHGs emissions from livestock	AFOLU	MALR	Reduce GHGs emissions from livestock by changing feeding patterns (strategic supplementation), increasing milk productivity, and improving breeding (mainly for dairy cattle and buffalo).	2017-2030
11.	Recycling agricultural waste and manure	AFOLU and Energy	MALR	Produce compost and bioenergy from agricultural waste and manure. Previous national efforts resulted in the recycling of 2,583,338 tonnes of rice straw. The estimated rice straw produced is 3,289,558 tonnes, out of which 1 12,500 tonnes is burned.	2016 - onwards
12.	Green Growth Fund (GGF)	Crosscutting	Financial institutions	GGF aims to contribute, in the form of a public private partnership with a layered risk/return structure, to enhancing energy efficiency and fostering renewable energies to reduce CO2 emissions through the provision of dedicated financing to businesses and households via partnering with financial institutions and direct financing.	2016- onwards
13.	Implementation of a national MRV system	Crosscutting	all sectors	Establish National MRV system.	-
14.	Implementation of green hydrogen projects	Crosscutting	Financial institutions & private sector investors & concerned ministries	More than 16 projects for producing green hydrogen and green ammonia. The estimated production exceeds 8 million tonnes yearly up to 2030.	2023-2030

^(*) This mitigation action has been identified under the NAMA Mapping conducted under Low Emission Capacity Building Programme (LECB) supported by EEAA and UNDP.

3.4 Sectoral Mitigation Actions for the Period 2018-2030

Egypt has adopted a sector-specific approach to climate change mitigation, aligning national development goals with global commitments under the Paris Agreement. This section outlines key mitigation actions planned and implemented across priority sectors for the period 2018–2030, aiming to reduce greenhouse gas emissions while supporting sustainable economic growth.

3.4.1 Electric Power Generation Sector

The electric power generation sector is a key contributor to Egypt’s greenhouse gas emissions, making it a central focus of national mitigation efforts. Egypt is implementing a range of measures to improve energy efficiency (EE), expand RE capacity, and reduce the carbon intensity of electricity production in line with its climate commitments.

3.4.1.1 Strategic Goals and Prime Objectives

Egypt’s SDS 2030 addressed the electricity sector mostly in its 2nd Pillar, “Energy”, with the following strategic goals:

1. Ensuring energy security: Providing the required energy while maintaining the desired growth rates.
2. Increasing the contribution of the energy sector to GDP: Increasing the share of the energy sector's contribution to the GDP.
3. Maximising the use of local energy resources: Increasing energy production from local resources and maximising its degree of reliance.
4. Promoting the good and sustainable governance of the sector: Bringing the energy mix to international standards with.
5. Reducing energy consumption density involves decreasing the ratio of energy used across various sectors.
6. Reducing the emissions’ environmental impact in the sector: Reducing the resulting residues and contaminants from the energy sector.

Below are the highlighted programmes and projects in the SDS 2030:

1. Developing an integrated energy strategy in the medium and long terms.
2. Restructuring of the energy sector.
3. Reforming the current legislative framework.
4. Improving energy subsidy efficiency.
5. Developing the infrastructure of the energy sector, including EE.
6. Promoting innovation in the energy sector.
7. Applying environmental standards and accurate measurements.
8. Establishing a nuclear power station in Dab’aa.
9. Capacity building and skills development in the power sector.

The prime objectives of the Energy Strategy 2035, which incorporates options for combating climate change, include the following:

- Attract more investments to expand access to renewable energy sources, such as solar and wind, aiming to increase their share of total energy to 20% by 2022, with an ambitious goal of raising it to 29% by 2029/2030 and 37% by 2035.
- Launch a programme to build several nuclear power generation plants and initiate executive steps to build the first nuclear power generating plant by 2019, and develop Egypt’s expertise and capacities, collaborating with an international partner and with the IAEA in the context of transparency and respect for Egypt’s obligations under the Non- proliferation Regime.

- Increase energy production with appropriate policies for rationalising and raising the efficiency of energy uses. Such policies should reconsider the energy pricing structure in both the industrial and household sectors that distinguish between affordable and other categories to protect limited-income groups, relieving them of unaffordable burdens.
- Enhance awareness of the vital importance of energy and of the need to rationalise its uses at home, in factories and at various producing and service sites, ultimately making such awareness and rationalisation a norm of conduct and a lifestyle.
- Accelerate completion of electric interconnection networks with the Arab Mashreq and Maghreb States to realise benefits from interconnection with the European grid.
- Deliver subsidies to eligible beneficiaries to prevent subsidies from being a source of exorbitant wastage or underestimation of energy.
- Restructure the energy sector of Egypt against a comprehensive future vision, enriching the competitiveness of the sector to promote the State's role and relationship between energy producers and consumers and diversify its sources to secure its supplies.
- Raise the competitiveness of the energy sector in Egypt and adjust its legislation to realise its consistency with the world energy market in such a way as to turn Egypt into a hub for energy handling in both the Gulf and Mediterranean regions and between the Middle East and Europe.

3.4.1.2 Identified Climate Change Mitigation Programs

Electric power generation is the major source of GHG emissions in Egypt. Based on the fuel consumption data from the Egyptian Electricity Holding Company (EEHC), the GHG emissions were calculated. In 2015, the GHG emissions from this sector reached 87,694 Gg CO₂e, and it constituted about 43% of the GHG emissions from the whole energy sector in Egypt. BAU GHG emissions by 2030 would reach 214,740 Gg CO₂e. Therefore, the mitigation target by 2030 is 69,910 Gg CO₂e, which represents, compared to BAU in 2030, about 33%.

The climate change mitigation programmes or measures that have been proposed in the SDS, the Energy Strategy 2035, the first Egyptian Biennial Update Report (BUR), and the national NAMA studies and findings from relevant stakeholders' meetings are as follows:

1. Reducing losses in electricity transmission and distribution.
2. Increase the share of nuclear, wind and solar energy in electricity generation.
3. Improve efficiency of electricity generation.
4. Sustaining use of natural gas (NG) as the main available cleaner fossil fuel in Egypt.
5. Removal of energy subsidies.
6. Generate power by gasification of MSW.
7. Generate power by incinerating agricultural wastes.

3.4.1.3 Prioritised and Assessed Mitigative Actions

Future projections for electricity generation were assessed alongside the corresponding BAU scenario, which assumes no implementation of mitigation measures. In parallel, a mitigation scenario specific to the electricity sector was developed, with outcomes modelled using the LEAP tool. For consistency, it was assumed that transmission and distribution losses would remain unchanged in both the BAU and mitigation scenarios.

To guide the mitigation pathway, the "Renewables Maximisation Scenario" from Egypt's ISES 2035 was adopted. This scenario outlines the trajectory toward achieving Egypt's 2030 mitigation targets in the electricity sector. It is built upon three strategic pillars: maximising energy production from domestic resources and diversifying the energy supply mix; reducing the intensity of energy consumption; and advancing a transition toward a low-carbon electricity system. This happens through:

- ❑ Installing additional renewable energy (RE) capacities to reach the electric power contribution target of 42% by 2035 as per Egypt’s ISES 2035. By 2030, the share of RE capacities is expected to be about 40%. Reaching the target includes accelerating the scale-up of on-grid RE by reducing coal capacity in the generation mix and replacing inefficient thermal power plants. This scale-up in RE would necessitate transforming the electricity grid to a “smart grid” through modern digital technology, smart metering, and flexible solutions appropriate to the local context and expand on regional interconnections.
- ❑ Improve the EE of electricity generation by the maintenance, upgrade, and replacement programmes for obsolete power plants. This includes conversion of simple cycle gas turbines to combined cycle power plants, installation of supercritical steam units, and other measures.
- ❑ Activation of the role of electricity distribution companies in achieving EE improvements and promotion of large-scale and small-scale decentralised RE systems for subscribers by implementing Sustainable Energy Action Plans required by the Electricity Law 87/2015.
- ❑ Improve and upgrade the transmission and distribution networks, including extra high voltage substations, control centres, and smart grids. The transformation to smart grids will contribute significantly to improving electricity efficiency, reducing carbon emissions, and reducing the investment required for infrastructure for electrical networks.

By 2030, cumulative emissions reductions from the electricity sector are projected to reach around 340 million tonnes of CO₂ equivalent, largely due to decreased fossil fuel use driven by the increased share of RE. This shift is expected to save over 16,000 kilotonnes of oil equivalent (ktoe) in fuel—mainly NG—by 2030. Consequently, NG exports are anticipated to rise, particularly between 2020 and 2026, generating additional economic benefits.

3.4.2 Petroleum Sector

The petroleum sector in Egypt comprises crude oil production, refining activities to produce oil derivatives, and NG production and processing. To address the GHG emissions associated with this sector, targeted mitigation actions are required. This section outlines the proposed measures drawn from Egypt’s SDS, the First BUR, and national NAMA studies, the Petroleum Sector Strategy, as well as insights gathered through stakeholder consultations.

3.4.2.1 *Petroleum Strategic Programs*

The petroleum related programs that were mentioned in Egypt’s SDS 2030 are as follows:

- 1- Development of an integrated medium- and long-term energy strategy.
- 2- Restructuring of the petroleum sector.
- 3- Reformation of the current legislative framework.
- 4- Managing the energy subsidy.
- 5- Developing the infrastructure of petroleum sector.
- 6- Promoting innovation in the petroleum sector.
- 7- Development of skills.
- 8- Determination of the ratio of primary energy supply to the total planned energy consumption,
- 9- Determining the change in the percentage of energy intensity.
- 10- Determining the emissions from the petroleum sector and thus determining the percentage of GHG emissions to be declined.
- 11- Determining the crude oil reserved.

- 12- Establishment of a unified energy regulatory utility that includes petroleum products, gas and electricity networks that will be responsible for protecting the consumer and investor and ensuring a level of competence.
- 13- Draughting a unified law for energy that includes electricity and petroleum, to identify and organize the relationships between different parties and determining the role of private sector in production operations, transportation, distribution, and sale of energy. Besides, permitting the private sector to participate in importing and exporting of petroleum products for the purpose of energy market liberalization.
- 14- Decentralization laws are to be considered for the production and distribution of petroleum products such as micro networks.
- 15- Developing and expanding the infrastructure for transporting petroleum products, such as diesel and NG.
- 16- Technology for exploration in deep water is to be developed and improved.

3.4.2.2 Sectoral Priorities

Egypt's energy sector is predominantly dependent on NG and petroleum products, which together account for approximately 98% of total primary energy consumption. The MoPMR has devised a comprehensive strategic plan to address the increasing market demand for petroleum products and to guarantee that environmental sustainability remains a fundamental principle in national planning. The Ministry has adopted a clear strategy for energy transition and emissions reduction across all oil and gas activities, aiming to ensure a secure and sustainable energy supply. Key pillars include reforming energy subsidies; promoting NG as a transitional fuel alongside renewables; improving EE; lowering the carbon intensity of oil and gas; expanding RE and green petrochemicals; and developing low-carbon hydrogen and its derivatives.

Reducing emissions and transitioning to low-carbon, sustainable energy systems are central pillars of Egypt's petroleum sector strategy. To support this transition, the sector is advancing along six main axes:

1. Reforming energy subsidies.
2. Positioning NG as a transitional fuel alongside renewables.
3. Enhancing EE.
4. Reducing the carbon intensity of oil and gas operations.
5. Expanding RE and green petrochemical production.
6. Developing low-carbon hydrogen and its derivatives.

3.4.2.3 Identified Climate Change Mitigation Programs

We will detail the GHG emissions from petroleum products in the following sectors: industry, transport, agriculture, and household. This is because petroleum products power these industries. In addition, the fugitive emissions from the oil and NG processing (mainly from venting and flaring) amounted to 6,297 Gg CO₂e in 2015.

Programs for mitigating climate change that have been proposed in various references are summarised as follows:

1. Improve efficiency of refineries and the petrochemical sector.
2. The development of policies for air pollution reduction is underway.
3. Recovery and utilization of associated gases produced from the oil fields instead of their flaring.
4. The proposal calls for the partial removal of subsidies from various types of fossil fuels.
5. CO₂ capture and storage.
6. Fuel switching policy of NG, including using NG in the residential, industrial, and commercial sectors. Also, in vehicles and the power sector.
7. Employing RE in generating electricity, process heating and boiler feed water heating.
8. Minimisation of NG losses in transportation and distribution.

9. Using turbo-expanders for NG pressure reduction for electricity generation.

3.4.2.4 *Prioritised and Assessed Mitigative Actions*

Future predictions of oil and NG production were estimated. The corresponding business-as-usual scenario regardless of any mitigation actions that can be implemented is obtained. The following presents the mitigation scenario and the corresponding LEAP results:

□ ***Recovery and utilization of associated gases***

The recovery and utilisation of associated gases from crude oil fields is an ongoing initiative, with 17 projects already implemented and 36 more planned by 2030. Instead of flaring, these gases will be redirected to processing facilities to produce LPG, natural gas (NG), and condensates. The program is anticipated to achieve emissions reductions of approximately 1.682 MtCO₂ by 2030, which is a 65% reduction from the business-as-usual scenario. Cumulative reductions are expected to reach approximately 4.7 MtCO₂ by that year.

□ ***Additional measures will be implemented in the oil and gas sector:***

- The Decent Life Initiative's 'Hayah Karima', which was initiated in January 2021, aims to improve the standard of living for citizens by providing access to clean fuel in households. The NG pipelines were already connected to 86 villages. It is planned to extend to an additional 180 villages, serving 476,000 residents.
- Low investment EE measures in petroleum companies to reduce 5% of the sector's energy consumption. Moreover, it is planned to conduct EE audits in two refineries, one petrochemical plant, and two upstream oil and gas facilities. A voluntary annual target has been defined to conserve energy in all operations.
- To utilise natural resources, it is planned to produce medium-density wood panels (MDF) in Idku city at a design capacity of 205 thousand cubic metres annually from 250 thousand tonnes of rice straw.

3.4.3 Industrial Sector

According to Egypt's First BUR, the industrial sector in Egypt represents an important pillar of the economy, contributing roughly 34% of GDP in 2015 and being responsible for about 37% of total energy consumption. Also, according to the BUR1, the structure of Egypt's economy moved toward further industrialisation during the last decade, where the share of industry in the total GDP increased from EGP 89 billion to EGP 408 billion between 2004/2005 and 2014/2015. (This expansion has increased the energy consumption of the industrial sector as well as the GHGs emissions.)

3.4.3.1 *Present Strategies for the Industry Sector*

The SDS addresses the industry sector in several pillars. In the first pillar, "Economic Development", the foreseen strategies for the industry sector are as follows:

- Address market imbalances, promote fair competition, and allocate additional resources to support the industry sector.
- Enhancing export growth by further integrating industry with global markets.
- Combining horizontal policy that affects all the industrial activities and development of peremptory development strategies to achieve industrial development goals.
- Conserving the environment is one of the basic objectives of the industrial sector.
- Rationalisation of energy use and utilisation of RE and waste recycling.
- Enhance value addition and transition to knowledge-based products.
- Achieve geographically balanced industrial development.
- Support industries with high knowledge and technology content.
- Encourage investment in industry and facilitate the procedure for factory establishment.
- Review and develop incentives for investment in the industry sector, encourage national

- production and export support.
- Completion of road networks and infrastructure in industrial zones.

3.4.3.2 Programs Planned for the Industry Sector

The following are the planned programs in the first pillar, "economic development," for the industry sector:

- Establishment of industrial complexes nationwide for industrial clusters specialised in small and medium industries.
- Rubikki Leather City Project.
- Establishment of Damietta Furniture City.
- Supporting heavy industries by creating industrial mapping and databases for economic indicators.
- Development of industrial zones in the Suez Canal.
- The goal of the Industrial Map project is to provide adequate data on the industrial uses of all lands over the country.
- Establishing small projects in the field of mobile marketing outlets and services.
- The activation of a strategy for the shipbuilding industry is underway.
- The establishment of clusters for agro-industries is currently underway.
- Achieving a shift in the mineral industry sector.
- Helping the industrial sector adopt the green economy by encouraging energy efficiency, using alternative energy, reducing production costs, optimising resources, and ensuring environmental sustainability is more competitive globally.

Under the second pillar, "Energy", the primary strategy for the industrial sector is to develop a policy focused on rationalising energy consumption. While under the 9th pillar, "Environment", the following are the planned programmes in the industry sector:

- Implement programs to reduce water consumption during industrial activities.
- Develop policies and initiatives to limit air pollution and greenhouse gas emissions from the industrial sector.
- Introduce incentive-based policies to promote energy conservation in industry.
- Establish incentive mechanisms to support environmental compliance, particularly with air emission standards and GHG mitigation efforts.
- Promote the adoption of renewable energy (RE) in industry by implementing targeted incentive policies.

Several projects under the Industry and Trade Development Strategy (2016–2020) by the Ministry of Trade and Industry (MTI) are closely aligned with the national energy agenda for industry.

- Industries that are environmentally responsible and emit minimal levels of emissions, such as those that recycle industrial and agricultural waste, are supported by the Industrial Development Program's Green Economy Project. It emphasises enhancing environmentally compliant exports, which is now a prerequisite for market access. The project's third output introduces a specialised program to improve EE in export-oriented industries in line with international environmental agreements and market entry requirements.
- The Egyptian Exports Competitiveness Enhancement Project provides specialised technical services for energy-intensive sectors like fertilisers and cement, as well as promoting small and

medium-sized enterprises (SMEs). The objective of these services is to support the use of energy-efficient production machinery by providing adequate testing laboratories, ensure compliance with energy and environmental standards, promote alternative energy sources, particularly from recycled waste, and reduce costs.

- At the policy level, increased manufacturing drives higher energy demand, necessitating rationalised energy use in factories. With the government targeting 20% reliance on RE, the industrial sector is expected to align by expanding the use of wind, solar, and waste-based energy sources.

3.4.3.3 Identified Climate Change Mitigation Programs

Egypt's GHG emissions for 2015 were a total of 307,267 Gg CO₂e. Total GHG emissions have increased by 25% from 2005 to 2015, while the emissions from industrial processes and product use (IPPU) have increased by 49%. The IPPU constituted 13.2% of the total greenhouse gas emissions in 2015, amounting to about 40,664 Gg CO₂e. It is to be noted that as per the IPCC definition, the IPPU does not include the emissions related to energy consumption in the industrial sector; however, it is only limited to industrial process emissions and product use, as the name implies. A summary of climate change mitigation programmes in the industrial sector from various references includes the following:

1. Develop industrial EE projects,
2. Using solar heat for industrial processes,
3. Transfer of Environmentally Sound Technologies in the South Mediterranean Region,
4. Using low-carbon and climate-resilient industrial development programmes,
5. Substitution of coal currently used in cement industry by alternative fuels,
6. Lowering the clinker in cement from 89% to 80%,
7. Increasing thermal substitution rates (TSR) by alternatives fuels to 8%,
8. Reducing fuel consumption and motor optimisation projects/techniques.
9. The establishment of industrial wastewater treatment plants or the installation of industrial wastewater treatment units across all industrial sectors is one of the mitigation measures adopted to protect the environment and climate. This also includes the implementation of sewage treatment plants and the expansion of wastewater service coverage.
10. The Green Growth Project aims to manage industrial waste, SMEs, and entrepreneurship in Egypt.
11. Launching the Industrial and Agricultural Waste Exchange Platform – WEX Egypt.

3.4.3.4 Prioritised and Assessed Mitigative Actions

To decarbonise the industrial sector, efforts focus on reducing energy intensity, promoting renewable and alternative fuels, and advancing low-carbon process improvements through the following actions:

- Implement measures in the cement sector such as partial substitution with alternative fuels, reducing clinker content by up to 80% (subject to national standards), and improving EE. Ministerial Decree 49/2021 mandates partial use of alternative fuels. By 2015, the sector had reached 6.4% alternative fuel use, with targets to lower energy consumption from 3710 to 3540 MJ/tonne of cement.
- Improve electrical and thermal energy efficiency in energy-intensive sectors, which are responsible for 68.47% of industrial energy consumption, and in SMEs, which account for 11% of national electricity consumption. Key targets include a 10% reduction in thermal energy use in iron and steel, fertilisers, and ceramic industries; expanding solar heating in food, textile, and chemical industries; and promoting rooftop PV systems.

- Launch a dedicated program to replace outdated motors with International Efficiency Class 3 (IE3) or high-efficiency models. This is supported by Ministerial Decree 463/2020, which mandates compliance with national minimum energy performance standards for electric motors.
- Modernise traditional sectors, such as transitioning charcoal production from open pits to mechanized kilns, initiated by the MoE in 2016. Additional measures include substituting feedstock with green hydrogen to produce green ammonia and supporting the shift toward low-carbon nitrogen fertilizers.
- Promote the eco-industrial parks model to scale up resource efficiency, foster inter-firm synergies, and boost the environmental, economic, and social performance of industries—supporting the development of green sectors such as recycling and RE.

3.4.4 Transport Sector

The Ministry of Transportation (MoT) reflects the Egyptian transport sector priorities and GHG emissions mitigation in the following ways:

Vision: "Achieving all the state's economic development plan requirements and boosting its competitive capability on the international level in addition to achieving the best transport services at technical and economic efficiency while preserving the environment."

Mission: "Achieving sustainable, safe and faster transport service at low cost and economic effectiveness to support the national economic development plans."

3.4.4.1 Main Strategic Pillars

- Modernise and develop the network of existing roads to provide greater comfort, capacity, and safety, and expand this network to meet future needs for development.
- Development of inland waterways of the river transport service and provision of the highest levels of security.
- Making plans for the establishment, development and strengthening of railway networks on the national level.
- Develop plans to establish subway networks (Cairo Metro).
- Development of facilities and the promotion of maritime transport, in line with global developments in the shipping industry.
- Work on the development of land ports and enhancing their performance.

3.4.4.2 Sector Priorities in Egypt's SDS 2030

Egypt's SDS 2030 outlines a comprehensive vision for the transport sector, addressing the following key areas:

- The transport sector contributes to social and economic development and plays a crucial role in providing safe, high-quality services.
- Status of passenger and freight transport systems.
- Overview of road, railway, river, and maritime infrastructure.
- General and sector-specific transport policies.
- Institutional, economic, social, and environmental challenges to sustainable transport.
- Sustainable transport development, including:
 - Alignment with UN SDGs.
 - Principles and directions for advancing transport sector sustainability.
- Economic, social, and environmental benefits of sustainable transport.
- The role of the green economy in achieving transport sustainability.

- Competitive advantages of railway and river transport.
- Vision and mission of the transport sector.
- Strategic economic, social, and environmental objectives that support sustainable development.
- Sustainability priorities across economic, social, and environmental dimensions.
- Governance and institutional reforms are needed, including community participation, transparency, accountability, anti-corruption efforts, and enhanced roles for local entities.
- Policy tools required to advance sustainability, including legislation, financial mechanisms, incentives, commercial policies, R&D, private sector engagement, data systems, education, and awareness.
- Key programs and related action plans, including:
 - Increasing the share of freight transported by rail.
 - Establishing new passenger and freight rail lines, especially those linking industrial areas with dry ports.
 - Upgrading existing transport lines and metro services.
 - Expanding the share of river freight transport.
 - Road development and maintenance.
 - Enhancing efficiency of maritime ports.
 - Improving passenger and freight transport services.
- Investment and financing projections.
- MRV systems.
- Sustainable development indicators for the transport sector.

3.4.4.3 Identified Climate Change Mitigation Programs

Climate change mitigation Programs in the transport sector from various references are given below:

1. Efficient fuel utilization in all modes of transport.
2. Encourage the utilization of NG and less polluting fuels (e.g., diesel).
3. Encourage the utilization of public transport (river and buses).
4. Metro line expansion.
5. Electrification of rail line.
6. Encourage the utilization of bicycles.
7. Linking dry ports with rail lines and encouraging the establishment of logistic zones.
8. The establishment of new river ports, the development of river navigation lines and increasing its efficiency.
9. The development of the railways network and infrastructure.
10. The construction of a new and efficient road's network and infrastructure in addition to the development of the existing one.
11. The integration between various modes of transport, etc.
12. Vehicle scrapping and recycling.
13. Improving efficiency of available new vehicles to be by 1% per year.
14. A modal shift from road transport to rail transport.
15. Energy conservation measures in buildings such as 1) the usage of efficient lamps and lighting systems, 2) the use of renewable energy (PV systems) for electricity generation.

3.4.4.4 Prioritised and Assessed Mitigative Actions

Since road transport is the largest contributor to GHG emissions in Egypt's transport sector, the strategy focuses on promoting a low-carbon modal shift from private passenger and freight vehicles to mass transit through the following measures:

- Expand the Cairo Metro network, including construction and operation of:
 - Stage 3 of Line 3 (17.7 km)
 - Line 4 (42 km) connecting Nasr City, Abbassia, and Giza
 - Line 5 (25 km) from Nasr City to Shubra Al-Kheima via Heliopolis
 - Line 6 (35 km) connects Maadi to Shubra Al-Kheima, passing through the Old City Centre
 This also includes the rehabilitation of Lines 1, 2, and 3, contributing to further GHG emission reductions.
- Develop the Alexandria Metro (Abu Qir–Alexandria line) and rehabilitate the Raml tram line, targeting passenger capacities of 61,000 and 13,800 per hour per direction, respectively.
- Operate two monorail systems:
 - New Capital monorail (56.5 km, 22 stations)
 - 6th October monorail (42 km, 12 stations)
- Operate the Light Rail Transit (LRT) electric train (Al Salam–10th of Ramadan–New Capital), spanning 103 km with 19 stations, along with several rapid electric trains:
 - Ain Sokhna–New Capital–Borg Al-Arab–Alamein–Matrouh (660 km, 20 stations)
 - 6th October–Luxor–Aswan (925 km, 28 stations)
 - Luxor–Qena–Safaga–Hurghada
 - West Port Said–Abu Qir
- Transform public buses to run on lower-carbon fuels (e.g., natural gas) and adopt Bus Rapid Transit (BRT) systems to enhance efficiency. Promote bicycle use by developing dedicated lanes and infrastructure.
- Implement the National Road Project to develop 7,000 km of new roads, expanding the network to 30,000 km, and upgrade 10,000 km of existing roads. This includes:
 - Constructing 34 new Nile Road axes.
 - Building 1,000 bridges and tunnels.
 - Paving roads within governorates.
 - Introducing asphalt recycling technologies to reduce environmental impact and improve fuel efficiency through reduced commuting times.
- Green the civil aviation sector by introducing 2% biofuels in aeroplanes, converting airport vehicles and buses to cleaner fuels, installing solar PV systems, improving energy efficiency (EE) of airport facilities, and applying other resource efficiency measures.

Accordingly, Egypt aims to reduce greenhouse gas emissions from the transport sector by 8,960 Gg CO₂e by 2030, representing a 7% reduction compared to the projected BAU level of 124,360 Gg CO₂e. In comparison, the sector emitted 48,235 Gg CO₂e in 2015, making it the second largest source of GHG emissions in the country and accounting for approximately 23% of emissions from the energy sector at the time.

3.4.5 Agriculture, Forestry and Other Land Use (AFOLU) Sector

The Egyptian economy is heavily dependent on agriculture for food (crops, livestock, and fish), fibre (mainly cotton), and other products such as wood. This sector supports the livelihoods of approximately 55% of the population and employs 27.5% of the labour force. Although its contribution to GDP declined from 19.3% in 1990 to 11.18% in 2015, agriculture remains a critical pillar of the economy, contributing \$3.46 billion to GDP in 2015.

Agriculture's vulnerability to climate change stems from its strong dependence on natural resources and its close interaction with the climate system. In 2015, the AFOLU sector accounted for approximately 14.9% of national GHG emissions, totalling around 48,390 Gg CO₂e. Emission sources included direct N₂O from managed soils (42.61%), manure management (11.97%), indirect N₂O from soils (11.06%), rice cultivation (7.33%), urea application (2.80%), biomass burning (1.62%), and indirect N₂O from manure (0.45%).

3.4.5.1 Sector Priorities in SDS 2030

Egypt's SDS 2030 is founded on three strategic pillars that are interconnected: economic, social, and environmental. Priorities associated with the AFOLU sector, which includes agriculture, forestry, and land management, are primarily associated with the economic pillar within this framework. Key policies shaping the development of the AFOLU sector, including those related to irrigation and water resources, are outlined below and extend through 2030:

- **General**
 - Horizontal expansion of agriculture and agricultural localisation.
 - Rationalise the use of water resources.
 - Protect agricultural lands.
 - Develop fisheries and aquaculture.
- **Agricultural productivity for land and water**
 - Develop agricultural technology.
 - Develop an agricultural guidance system.
 - Encourage the media to engage with agricultural development issues.
 - Improve the performance of farmers' voluntary institutions.
- **Agricultural product competitiveness**
 - Encourage contract farming.
 - Develop e-commerce and electronic marketing systems for the agricultural sector.
 - Promote regional agricultural cooperation.
 - Develop an agricultural information system.
 - Develop the agricultural investment climate.
- **Water and Irrigation**
 - Develop and manage water resources and rationalise the use of water in all fields.
 - Complete and rehabilitate the national infrastructure for water systems and horizontal expansion.
 - Develop an integrated water resources management system.
 - Strengthen relations between Egypt and the Nile Basin countries.
 - Develop methods for groundwater, rainwater, and flood harvesting.
 - Desalinate seawater and brackish water.
 - Construct and rehabilitate pump stations.
 - Maintain the quality and efficiency of the High Dam and Aswan Reservoir, and protect the Nile River, its subsidiaries, and Lake Nasser.
 - Rehabilitate canal and drain networks and all irrigation facilities.
 - Execute studies and scientific research about technical and scientific applications in agriculture, using up-to-date databases and electronic government facilities.

3.4.5.2 Main Strategic Objectives

The main strategic objectives of the SDS 2030 are as follows:

- Ensure sustainable use of natural resources by improving water-use efficiency, expanding reclaimed lands, boosting crop and water productivity, supporting rain-fed agriculture, and protecting soil fertility and agricultural land.
- Increase agricultural productivity through improved crop yields, greater resilience to drought, salinity, and pests, and enhanced meat, milk, poultry, and fisheries production to meet growing protein demand.
- Enhance the competitiveness of agricultural products in domestic and international markets.

- Strengthen food security by promoting self-sufficiency, improving nutrition, reducing harvest losses, ensuring food quality and safety, and expanding food support programs.
- Foster a favourable climate for agricultural investment.
- Improve rural livelihoods and reduce poverty in rural areas.

3.4.5.3 Identified Climate Change Mitigation Programs

A summary of climate change mitigation Programs in the AFOLU sector from various references includes the following:

1. Four million acres development project: the industrial agriculture- integrated approach for specific vegetables and fruits.
2. Support the agro industrialization: moving towards sustainable agriculture.
3. Rationalization of water use: transform current practices from flood to drip irrigation and reduce land areas for rice cultivation.
4. Sustainable expansion of reclaimed areas, land, and water productivity.
5. Maintaining and protecting agricultural land.
6. Bioenergy for sustainable rural development: advance the use of renewable biomass as an energy resource.
7. Promotion of good agricultural practices and reduce GHGs emissions from: livestock, Agro-forestry & Afforestation, fertilizers, Paddy rice and poultry production.
8. Recycling of agricultural waste and manure.
9. Using climate smart agriculture, low emissions farming systems, and agricultural market development.
10. Using PV pumps for field irrigation (farm-level).

3.4.5.4 Prioritised and Assessed Mitigative Actions

The business-as-usual scenario corresponding to future predictions (regardless of any mitigation actions) was modelled in LEAP, and the resulting GHG emissions related to energy consumption were obtained. It is to be noted that these emissions are only for fuel combustion and do not include electricity consumption. The GHG emissions related to fuel combustion in 2030 exceed about 8 million tCO_{2e}. The cumulative GHG emissions from 2017 to 2030 exceed 110 million tCO_{2e}. The GHG emissions related to non-energy activities in 2030 are expected to exceed about 60 million tCO_{2e}. The cumulative GHG emissions from 2017 to 2030 are expected to exceed 700 million tCO_{2e}.

1. *Four Million Acres Development Program*

The emission reductions by 2030 will be about 220,000 tCO_{2e} and the cumulative value by 2030 is about 1,370,000 tCO_{2e}.

2. *Reduce the Cultivation Area of Rice*

the emission reductions by 2030 will be about 1,370,000 tCO_{2e} and the cumulative value by 2030 is about 9,600,000 tCO_{2e}.

3. *Reduce GHGs Emissions from Livestock*

The emission reductions by 2030 will be about 985,000 tCO_{2e} and the cumulative value by 2030 is about 6,400,000 tCO_{2e}.

4. *Using Agriculture Waste to Generate Electric Power*

The emission reductions by 2030 will be about 300,000 tCO_{2e}, and the cumulative value by 2030 is about 1.9 million tCO_{2e}. Most of the emission reduction is attributed to the savings in fossil fuels (mainly

natural gas) used for electricity generation, as they have a much higher emission factor compared to agricultural wastes, which are carbon neutral. On the other hand, minor emission reductions result from avoiding the open burning of the agricultural waste.

5. Replacement/Rehabilitation of Pumps Working with Low Efficiency

The emission reductions by 2030 will be about 550,000 tCO_{2e}, and the cumulative value by 2030 is about 2.3 million tCO_{2e}. The reduction in electricity consumption has resulted in a decrease in the use of fossil fuels for electricity generation, thereby reducing GHG emissions. The reduction in the emissions reductions compared to BAU in some middle years is attributed to removing the Concentrated Solar Power (CSP) plants; however, the model was built to enable the full dispatch of the PV plants to compensate for such a reduction and approach the fuel mix reported for Scenario 1B¹² in the Energy strategy 2035.

6. Solar PV Pumping by Replacing Existing Diesel Field Pumps

The emission reductions by 2030 will be about 750,000 tCO_{2e} and the cumulative value by 2030 is about 4.5 million tCO_{2e}. The emission reductions are solely attributed to decrease in the diesel consumption of the field pumps due to the increased share of solar energy.

This action results in a decrease in the primary requirements of diesel when compared to BAU. In 2030 for example, around 250 ktoe of diesel imports will be saved and the cumulative saved amount is about 1,500 ktoe.

7. Composting of Agriculture Waste

The emission reductions in 2030 will be about 300,000 tCO_{2e} and the cumulative value is about 1,880,000 tCO_{2e}.

3.4.6 Tourism Sector

The tourism sector in Egypt is one of the major contributors to the national economy. This sector had reached the peak for tourists' arrival to Egypt at about 14.5 million in 2010. At that time, it was announced that the targeted number of tourists should reach 20 million by 2020. However, due to the circumstances the country passed through from 2011 till now, the actual anticipated tourist arrival number has changed significantly compared to the targets set earlier in 2010. Therefore, many efforts have been devoted to revitalising the tourism in Egypt through sustainable development, performance enhancement, and image improvement of this sector.

3.4.6.1 Egypt's SDS 2030 Tourism Objectives

The Ministry of Tourism and Antiquities (MoTA) has adopted a proactive, strategic approach to sustainable tourism, positioning the sector as a vital contributor to Egypt's Vision 2030, particularly Goal 3: "Integrated and Sustainable Environmental System". This goal focuses on tackling climate change, conserving biodiversity, managing natural resources sustainably, and improving waste management. MoTA's initiatives help achieve these goals by encouraging energy efficiency, renewable energy use, and environmentally friendly practices in tourism, which results in lower emissions, better air and water quality, improved waste management, and protection of ecosystems.

Aligned with Egypt's Sustainable Development Strategy 2030, national energy reforms targeting one of the largest sources of greenhouse gas emissions are accelerating the shift toward sustainability. The hotel

¹² Is a scenario based on Egypt's Energy Strategy 2035

sector, given its high energy consumption, plays a critical role in this transition. In response, the Ministry has worked to embed sustainability into hotel operations through energy-conscious practices, adoption of green technologies, and environmental certifications. Given the hotel sector's high energy demand, it plays a key role in supporting these efforts. In response, the sector has prioritised the following:

- Enhancing operational integration to improve quality and efficiency.
- Meeting diverse visitor expectations sustainably.
- Upgrading facilities to reduce energy use and emissions.
- Aligning with international environmental standards.
- Expanding green services across hotel operations.

Accordingly, since 2013, MoTA has led the tourism sector's shift toward environmentally responsible practices and sustainable resource management. In 2015, it established the High Committee for Green Tourism to work with national and international partners on initiatives to reduce the sector's carbon footprint and build institutional capacity.

In 2018, green transformation indicators were adopted under Egypt's national program (2018–2022), with 74 out of approximately 1,200 hotels earning the internationally recognised Green Star Certification. In 2019, Decree No. 670 revised hotel classification standards were developed with the World Tourism Organisation adding sustainability benchmarks tied to environmental certifications. Ahead of the Conference of the Parties (COP) 27, Decree No. 18 of 2022 required all hotels and tourism facilities in Sharm El-Sheikh to obtain certification from accredited bodies confirming compliance with sustainable practices.

3.4.6.2 Strategy Targets of the Tourism Sector

Accordingly, the strategy targets are set to reduce the current energy consumption and determine the performance indicators of the energy consumption in the new hotels. This approach in summary is as follows:

- Data collection for existing hotels considering the capacities and categorisation based on the data of the Egyptian Hotels Association (EHA) in 2013.
- Survey on hotels' energy consumption versus hotels' occupancy and energy distribution (about 40 hotels surveyed via questionnaire by email and phone calls).
- Review of previous studies on EE/RE technologies as mitigation measures in the hotel sector and comprehensive energy audits conducted in hotels (about 30 energy audits).
- Energy consumption in the hotel sector is presented in the electricity annual reports and Egypt ERA reports.
- The analysis and calculations of the energy consumption baseline data were conducted based on the collected data.
- Assessment of the SEI per hotel category and the potential mitigation measures for EE and RE technologies.
- The calculation of the SEI is based on the proposed mitigation measures of the EE and RE technologies.
- The feasibility analysis for the LEDS implementation and the volume of investment to implement the strategy are currently underway.

3.4.6.3 Sectoral Priorities

The inefficient use of energy and water in tourism facilities has influenced the shift toward environmentally friendly and green products. In response, the Green Tourism Unit (GTU) has focused on monitoring energy and water consumption in hotels to support the Tourism Development Authority

(TDA) in meeting the sector's strategic goals. Mitigation efforts now include setting performance indicators and analyzing actions to improve resource efficiency.

A key priority is increasing the adoption of renewable energy (RE) in hotels to reduce reliance on fossil fuels and ensure the feasibility of low-carbon operations. Energy efficiency (EE) and RE are central to the sector's GHG mitigation strategy and are fully aligned with the national Sustainable Development Strategy (SDS), which positions EE/RE measures as foundational to energy sector reform and improved sustainability performance. According to the hotel sector's LEDS, the EE/RE mitigation actions in the hotel sector are:

- Efficient Lighting Systems
- Pump Speed Controls
- Efficient Chillers and Air Conditioners
- PV power supply of tie-on grid type
- Central Solar Water Heating Systems
- Combustion control for boilers and steam network

3.4.6.4 Identified Climate Change Mitigation Programs

The climate change mitigation programmes that have been proposed in various references are summarised below:

1. RE and water efficiency for Hotels/Resorts
2. Photovoltaic (PV) of tie-on grid type
3. Lighting Retrofit
4. Efficient Air Conditioning System
5. Variable Speed Drives (VSD)
6. Solar Water Heating (SWH) System
7. Combustion control for boilers and steam networks

3.4.6.5 Prioritised and Assessed Mitigative Actions

Fuel combustion-related GHG emissions in the tourism sector are projected to exceed 1.3 million tCO_{2e} annually by 2030, with cumulative emissions from 2017 to 2030 surpassing 20 million tCO_{2e}. Two key mitigation actions have been identified:

1. Implement energy-efficient actions in hotels.

The emission reductions by 2030 will be about 1 million tCO_{2e}, and the cumulative value by 2030 is about 2.5 million tCO_{2e}. Since most of the actions are concerned with electrical energy, most of the emission reductions are attributed to electricity savings, which lead to the decrease in consuming fossil fuels in electricity generation. The reduction in the emissions compared to BAU in some middle years is attributed to using the CSP systems; however, the model was built to enable the full dispatch of the PV systems to compensate for such reduction and approach the fuel mix reported in the Energy Strategy 2035.

2. Implement renewable energy systems in hotels.

The emission reductions by 2030 will be about 0.9 million tCO_{2e}, and the cumulative value by 2030 is about 8.5 million tCO_{2e}. Since the renewable energy programme displaces both electrical and thermal energy, the emission reductions are attributed to both electricity savings (which lead to the decrease in consuming fossil fuels in electricity generation) and fossil fuel savings for conventional water heating (natural gas and diesel). The reduction in the emissions compared to BAU in some middle years is

attributed to using the CSP systems; however, the model was built to enable the full dispatch of the PV systems to compensate for such reduction and approach the fuel mix reported in the Energy Strategy 2035.

3.4.7 Building Sector

Buildings in Egypt are classified into residential, commercial, governmental, and other categories. Residential building types vary widely, which necessitates a corresponding diversity in utility services. These services are provided by the relevant government entities, including electricity distribution companies, NG distribution companies, liquefied petroleum gas (LPG) and liquid fuel distribution companies, as well as subsidiaries of the Holding Company for Water and Wastewater.

Commercial buildings are defined by their function as service providers to end users; they include malls, shopping centres, shops, and office buildings, most of which are privately owned. These buildings receive utilities from the same public providers as residential buildings. Governmental buildings serve administrative and public functions, such as education, healthcare, utilities, maintenance, and more. Government entities fully own these buildings, and public utility providers also serve them. Across all building types, utility services are billed according to predefined government tariffs. In this context, tariff levels are the primary tool for encouraging conservation and efficient utility use, which in turn contributes to the reduction of related GHG emissions.

3.4.7.1 Sector Priorities

Energy efficiency and renewable energy are widely recognised as essential solutions for reducing greenhouse gas emissions and combating global climate change. At the national level, Egypt's SDS identifies EE and RE measures as critical to enhancing the energy sector's performance and achieving the strategy's long-term development goals. Efforts to mitigate climate change across various sectors have been initiated in line with the overarching directions of the national strategy. One of the key goals related to EE is to achieve an 18% reduction in current energy consumption by 2035, based on projected energy demand for that year. Buildings must adopt energy-efficient technologies to achieve this reduction.

3.4.7.2 Strategic Guidelines and Measures

The strategy could be implemented through a bundle of measures and guidelines as follows:

- General Framework for the national objectives' guidelines.
- Electrical EE measures in different sectors.
- Other EE measures need to be implemented.
- The common measures of EE among the different sectors.
- Evaluation for development in EE policies.

To support effective strategy implementation, the performance enhancement measures are organised into four key areas:

- The system provides quantified measures and makes it easy to monitor their performance.
- Measures towards the regulations, laws, and management are needed to motivate the EE technologies' implementation.
- Measures for capacity building.
- Measures for awareness among the consumers of energy and communication among the different stakeholders.

As per the National Energy Efficiency Action Plan (NEEAP), the adoption of EE technologies is intended to achieve 18% energy consumption reductions in the industrial sector, 16% in structures, and

23% in transport. In response, the buildings sector, which includes both governmental and residential structures, has implemented policies to alter energy consumption patterns. These include 1) energy-labelled household appliances, 2) efficient lighting technologies, 3) efficient building codes, and 4) reinforcement tools for EE standards.

3.4.7.3 Identified Climate Change Mitigation Programs

The Climate change mitigation Programs that have been proposed in various references are:

1. Efficient lighting in governmental buildings
2. Energy efficiency in residential buildings
3. Solar water heaters

3.4.7.4 Prioritised and Assessed Mitigative Actions

Sustainability in both existing and new buildings and in urban developments is being advanced through the adoption of low-carbon standards and programs focusing on the following:

- Implement energy-efficient lighting in government buildings. The emission reductions by 2030 will be about 1 million tCO_{2e}, and the cumulative value by 2030 is about 2.4 million tCO_{2e}. Since the action is concerned with electrical energy, the emission reductions are attributed to electricity savings, which lead to the decrease in consuming fossil fuels in electricity generation. The reduction in the emissions reductions compared to BAU in some middle years is attributed to removing the CSP plants; however, the model was built to enable the full dispatch of the PV plants to compensate for such reduction and approach the fuel mix reported for the Renewables Maximisation Scenario in the Energy Strategy 2035.
- Integrating RE and EE in buildings by prioritising interventions based on national goals. This includes rooftop PV installations, 5,300 solar water heaters, and widespread adoption of LED lighting in the residential sector by 2030.
- Expanding appliance efficiency programs through updated labels and specifications, phasing out inefficient equipment, and raising consumer awareness about energy-efficient alternatives.
- Promoting green buildings by enforcing EE codes for new construction, retrofitting existing buildings to meet energy standards, applying voluntary green building guidelines, and offering incentives to adopt advanced sustainable technologies. Work is currently underway to develop the National Strategy for Promoting Green Urban Development and Construction. The Green Building Guidelines and the Egyptian Green Pyramid Rating System (GPRS) for residential buildings have been completed. In addition, a guidance manual is being prepared for the EE Code to enhance energy use in buildings.
- The goal is to increase the number of green spaces in new cities by utilising treated wastewater for irrigation, which not only serves as carbon sinks but also enhances the quality of life and reduces health risks. Efforts also aim to raise the per capita share of green areas in existing cities, including projects like the Ahl Masr Walkway and Ain Hayah.
- Implementing the National Active Mobility Strategy to promote walking, cycling, and a gradual shift to electric vehicles (EVs) powered by clean energy, supported by appropriate urban infrastructure.
- Installing energy-efficient and solar-powered street lighting and advertisements on internal roads and intercity highways.

3.4.8 Waste Sector

The waste sector presents significant opportunities for greenhouse gas mitigation through improved waste management practices, enhanced resource recovery, and methane emission reduction. Egypt is working to implement integrated strategies for waste reduction, treatment, and diversion from landfills, aligning with national climate goals and circular economy principles.

3.4.8.1 *Solid Waste*

Integrated solid waste management remains a key challenge in Egypt. Despite gradual progress over the past 20 years in regulation, planning, technology, and financing, open dumping and burning persist due to low collection rates and limited treatment and disposal capacity. These issues contribute to environmental degradation, resource loss, and health risks. In 2016, Egypt generated 90.76 million tonnes of solid waste, with municipal (21 million tonnes) and agricultural waste (31 million tonnes) as the primary sources. The public sector primarily provides municipal waste services, with minimal involvement from the private sector.

The source separation and recovery of recyclables, including plastics, paper, glass, metals, and textiles, are significantly influenced by the informal sector, which includes waste collectors and Zabbaleen. Operating across streets, bins, transfer points, and dumpsites, they achieve recovery rates of up to 80%, which could improve further with modern recycling technologies and market integration.

1. *Industrial Waste Management*

According to the EEAA estimates, the generated industrial waste in 2001, 2006 and 2012 was 4,250,000, 4,750,000 and 6,000,000 tonnes, respectively. There are approximately eight industrial areas in Egypt generating different types and quantities of hazardous wastes. These eight areas generate up to 200,000 tonnes of hazardous waste annually.

2. *Medical Wastes Management*

In 2013, Egypt generated 3,416,254 tonnes of hazardous medical waste. Non-hazardous waste makes up at least 85% of all waste generated at medical facilities.

3. *Hazardous Wastes Management*

The Nasiriya Hazardous Waste Treatment Centre (NHWTC) is the only hazardous waste landfill in Egypt and is conceived for the treatment of inorganic hazardous waste. NHWTC provides collection, transportation, treatment, and final disposal services for hazardous industrial waste.

4. *Construction and Demolition Waste Management*

In addition to municipal and industrial waste, construction and demolition waste (CDW) is emerging as a critical component of integrated waste and resource management. The Ministry of Local Development (MoLD) estimated CDW generation at 41.75 million tonnes in 2010.

5. *Agriculture Residues Management*

In 2016, Egypt generated about 31 million tonnes of agricultural residues (around 85,200 tonnes per day). A large portion of agricultural residues is either burnt in the fields or dumped on the banks of drains.

3.4.8.2 *Wastewater*

In Egypt, municipal wastewater and sludge are treated using aerobic and anaerobic processes. The Ministry of Housing, Utilities, and Urban Communities oversees the design, construction, operation, and maintenance of these treatment facilities through affiliated entities, including the Holding Company for Water and Wastewater, the National Organisation for Potable Water and Sanitary Drainage, the Executive Agency for Potable Water and Sanitary Drainage, and the New Urban Communities Authority. Recently, the number of wastewater treatment plants has increased significantly, reflecting

growing national efforts to improve sanitation infrastructure. Complementary measures have also been introduced, such as the reuse of treated drainage water in agriculture and the development and implementation of a dedicated code for protective systems, as part of an integrated approach to sustainable water resource management.

There are about 357 operational domestic wastewater treatment plants; with a total installed capacity of 13,266,159 m³/day as of 2013. The Egyptian National Holding Company of Water and Wastewater (HCWW) oversees the operation of these wastewater treatment plants throughout all Egyptian governorates. Approximately 1 million tonnes was estimated as generation of total annual national sewage sludge in Egypt in 2014.

A. Waste Sectoral Strategy

Egypt's Sustainable Development Strategy 2030 addresses solid waste development mostly in the environmental pillar (9th pillar). Several operations regarding solid waste management (SWM) were mentioned in the strategy, which included the following:

- In the energy sector:
 - Reduce amounts of waste being generated from the energy sector.
 - Establish and implement monitoring procedures to monitor the progress in waste reduction in the energy sector.
- Industrial waste:
 - Reusing and recycling industrial waste to maximise the benefit from these wastes.
- Agricultural waste:
 - Maximizing the use agricultural wastes.
 - Recycling of agricultural wastes and producing compost.
- Solid waste:
 - Reusing and recycling waste to achieve sustainable development.
 - Maximising the benefit from MSW utilisation to reduce pollution loads resulting from the current MSW management system.
 - Improving the efficiency of the solid waste management system and supporting its sustainability.
- Hazardous waste:
 - Monitoring, developing, and enhancing the hazardous waste management system.
- Awareness and education:
 - Integration of sustainable waste management concepts in the education system.

3.4.8.3 Sector Priorities

The overall objective is demonstrated within 4 pillars, as stated below:

1. Governance Objectives:
 - Create a basic framework and build capacities at the national level by establishing a framework strategy and legislation, as well as a lead regulatory institution responsible for SWM.
 - Ensure that planning and implementation in governorates comply with national frameworks.
 - Optimally attribute responsibilities, authorities, and capacities to relevant actors, as well as monitor and improve their performance.

- Develop policies and procedures inclusive of key stakeholders, including the informal sector.
2. Economic Objective:
 - Develop SWM systems that create jobs, promote resource efficiency, generate new economic opportunities, and are properly funded.
 - Allocate available resources in a way that ensures all citizens receive basic waste management services regardless of income or location.
 - Expanding the PPP programme and incentivising SME participation in SWM service provision.
 3. Service Provision objectives:
 - Improve the efficiency of SWM activities to achieve proper collection, storage, transportation, treatment, and disposal.
 - Optimise the rate of recycling and reuse when it provides environmental, economic, and social benefit.
 - Ensure basic environmental, health and safety standards are met.
 4. Community Participation objectives:
 - Enable the participation of communities, civil society, and other stakeholders in all stages of the SWM chain, including awareness, planning, monitoring, and service provision.

3.4.8.4 Identified Climate Change Mitigation Programs

According to Egypt's BUR1, the waste sector is responsible for approximately 9% of the GHG emissions estimated in 2015 at 26,389 Gg CO₂e, with an increase of 34% in comparison to 2005. Waste sector GHG emissions are mainly generated from the following sources:

- Solid waste disposal
- Wastewater treatment & discharge
- Incineration
- Composting
- Open burning of solid waste

CH₄ accounts for 92% of total waste GHG emissions generated from the waste sector, followed by N₂O at 8%, as shown in Figure 2-173. 50% of GHG from the waste sector is generated from solid waste disposal, while 47% is generated from wastewater treatment and discharge, 2% from incineration and open burning, and 1% from biological treatment of solid waste. A summary of climate change mitigation programmes in the waste sector from various references is given below:

1. For industrial, agricultural, solid waste, hazardous waste, and energy sectors: reusing and recycling waste to maximise the benefit and improving the efficiency of waste management and creating an efficient monitoring system.
2. Developing an Integrated Solid Waste Management System through creating a basic framework and building capacities at the national level, developing policies and procedures, optimizing the rate of recycling and reuse, enabling the participation of communities.
3. Improved sanitary landfilling, incineration with energy recovery (IER), gasification, anaerobic digestion, composting and co-firing in Cement Kilns.

3.4.8.5 *Prioritised and Assessed Mitigation Action*

Integrated waste management aims to improve system efficiency across the value chain and reduce landfill dependency by recovering materials and energy through the following measures:

- Boost infrastructure and investment to enhance collection efficiency from 55% to 95% by 2025, increase recycling and energy recovery, and establish fixed and mobile transfer stations. This includes rehabilitating and constructing mechanical-biological treatment (MBT) plants to utilise at least 60% of collected waste and replacing uncontrolled dumpsites with sanitary landfills, limited to no more than 20% of collected waste by 2025.
- Increase waste-to-energy share to 20% of collected waste by 2026 through co-processing in the cement sector, biofuel production, and generating 300 MW of electricity using incineration, pyrolysis, and advanced technologies.
- Expand tertiary wastewater treatment coverage and rehabilitate existing plants to increase reuse of treated and grey water and recover sewage sludge for recycling and energy. Currently, 409 municipal wastewater treatment plants serve 59.7% of the population (90% in urban areas and 12% in rural areas). In 2021, Egypt inaugurated the Bahr Al-Baqar plant in Port Said—one of the largest globally—with a capacity of 5.6 million m³/day to recycle drainage water for agricultural irrigation. Future plans include building 215 water treatment plants (capacity: 4,365,000 m³/day) and sewage plants with a combined design capacity of 7,250,000 m³/day in three phases by 2030.

By 2030, Egypt's municipal waste-to-energy initiatives are expected to achieve an annual reduction of approximately 0.9 million tonnes of CO₂ equivalent (tCO₂e), with cumulative emission reductions reaching around 5.5 million tCO₂e. The displacement of fossil fuels, primarily coal and NG, used in electricity generation, is partially responsible for these reductions, as municipal solid waste has a lower emission factor. Additionally, emissions are reduced by avoiding the open dumping of waste, a practice that contributes significantly to methane emissions.

Simultaneously, it is anticipated that waste conversion initiatives, particularly those that involve decomposition, will generate even more substantial climate benefits. By 2030, annual emissions reductions from waste conversion are estimated at around 5 million tCO₂e, with a cumulative total of approximately 25 million tCO₂e. The primary mitigation impact comes from avoiding open dumping, although a small number of emissions is generated during the composting process itself.

3.5 *Cross-cutting Policy-Based Action: Subsidy Reform Program*

The Government of Egypt (GOE) has undertaken a subsidy-reform programme for both electricity and fuels starting in 2016. This programme is expected to result in rationalisation of energy consumption in various sectors.

The emission reductions by 2030 will be about 40 million tCO₂e, and the cumulative value by 2030 is about 264 million tCO₂e. Most of the emission reductions are attributed to the reduction in electrical energy consumption leading to a reduction in fossil fuel combustion compared to BAU. The reduction in the emissions reductions compared to BAU in some middle years is attributed to removing the CSP plants; however, the model was built to enable the full dispatch of the PV plants to compensate for such a reduction and approach the fuel mix reported for Scenario 1B in the Energy Strategy 2035.

3.6 *Summary of the National-Level BAU and Mitigation Scenario Results*

Based on the above, national GHG emissions under the BAU scenario are projected to reach approximately 630 million tonnes of CO₂ equivalent by 2030. Figure 3-1 illustrates the projected evolution of BAU emissions over time, while Figure 3-2 shows the sectoral distribution of BAU

emissions in 2030. As indicated, the electricity sector is the largest contributor at 33%, followed by the industry sector (23%) and the transport sector (20%).

Conversely, Figure 3-2 displays the projected timeline of GHG emission reductions assuming implementation of all proposed programmes. As shown in Figure 3-4, under the full mitigation potential scenario by 2030, the electricity sector accounts for the largest share of national GHG reductions at 40%, followed by energy subsidy removal (26%), and transport (15%).

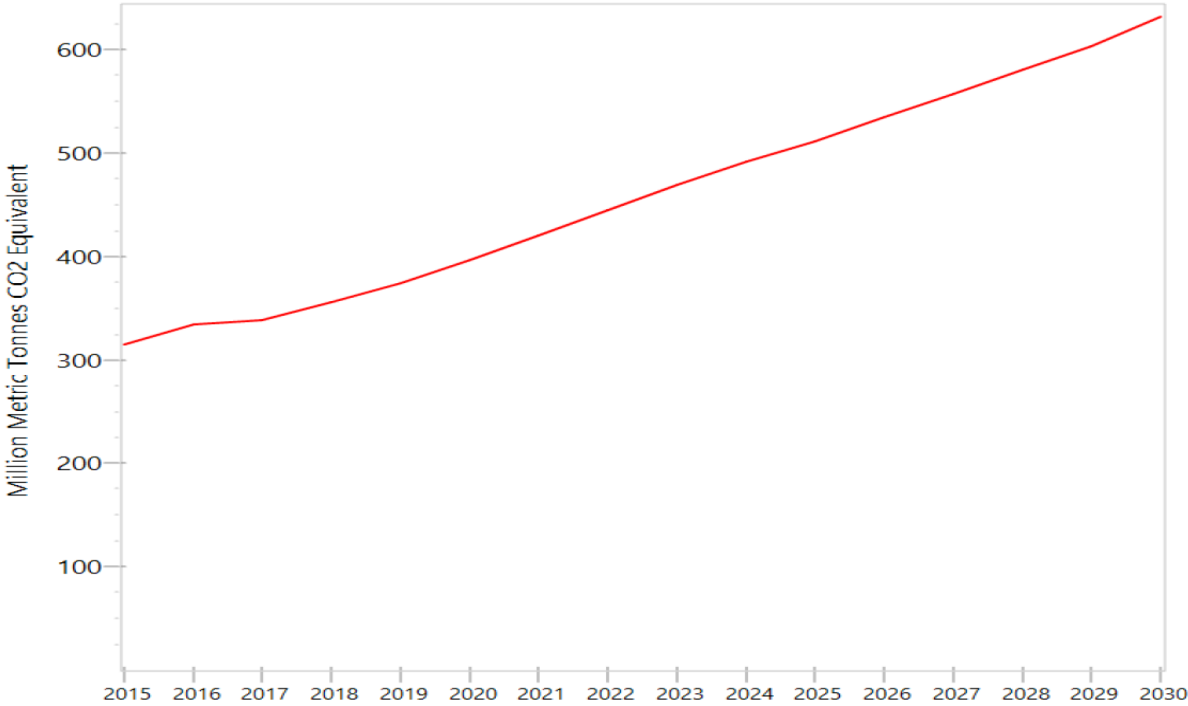


Figure 3-1: Expected evolution of BAU scenario emissions with time

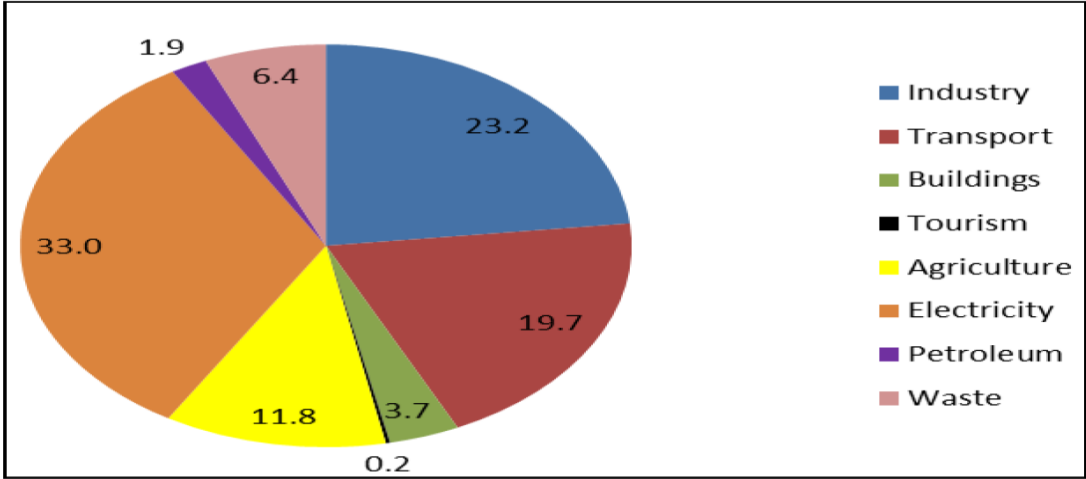


Figure 3-2: Share of the different sectors in the BAU emissions in 2030

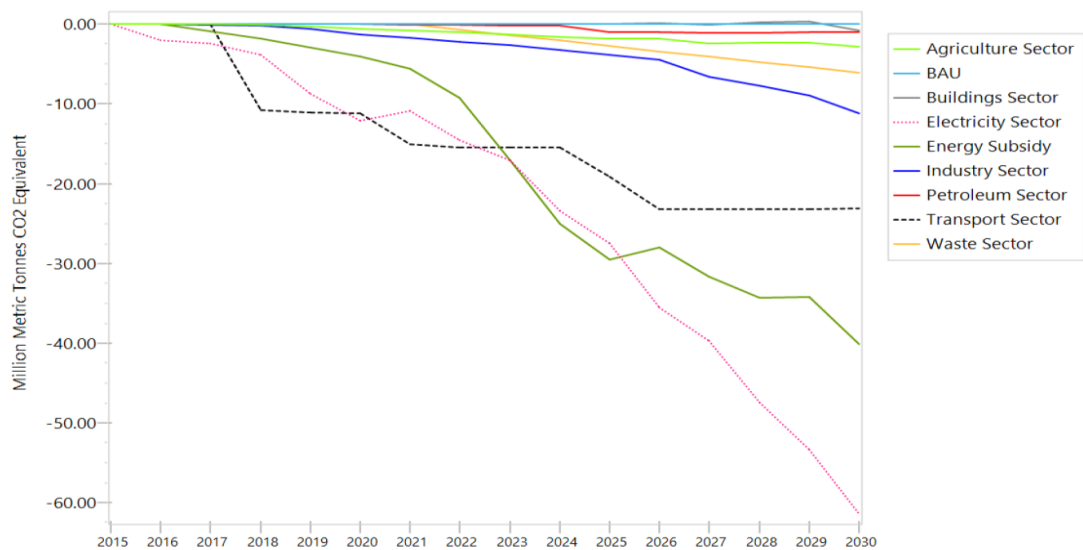


Figure 3-3: Evolution of the GHG emission reductions with time in case of applying all the mitigation Programs.

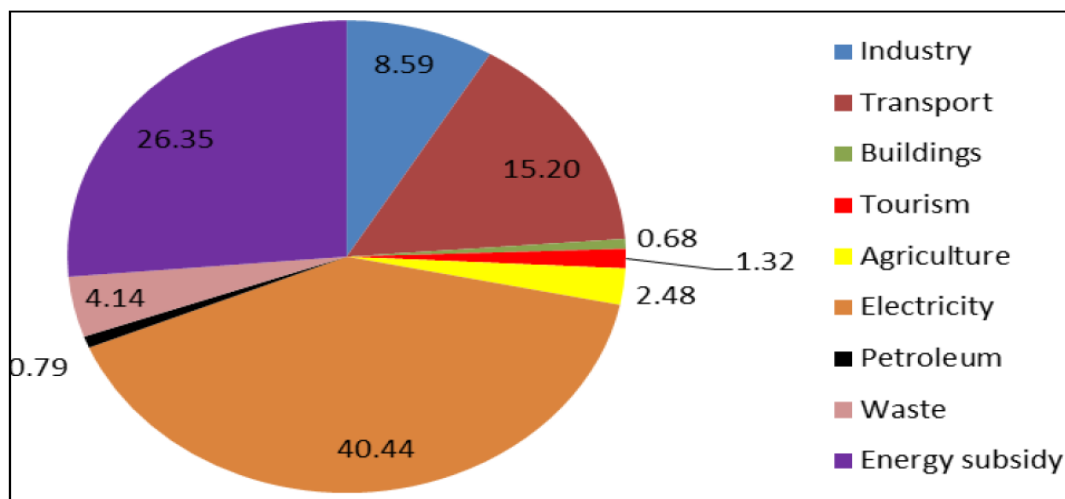


Figure 3-4: Share of the different sectors in the national GHG reductions in 2030 in case of applying all the mitigation Programs.

Implementing a low-emission development scenario within Egypt’s current economic and social context presents challenges, particularly in identifying resources and financing mechanisms for specific mitigation activities. Consequently, it is imperative to have well-defined programs and actions to facilitate the successful implementation. To attract the necessary investment, particularly from the private sector, it is necessary to provide incentives that render low-carbon initiatives more appealing than conventional alternatives. Table 3-2 below presents a summary for the planned 27 mitigation programs for the period. (2018-2030).

Table 3-2: Summary of Planned Mitigation Programs for the Period (2018-2030)

Sector	Program	Cumulative Emission Reduction M ton CO ₂ e	Domain Sector
Electricity Generation	Renewables Maximization Scenario in Energy Strategy 2035	340	PPP
Petroleum	Recovery and utilization of associated gases that are currently being flared	4.7	Public
	EE actions in petroleum companies Phase 2	2	Public
Industry	Increasing the Share of efficient motors in the Egyptian Industry	1.1	Private
	Alternative Fuel substitution in Cement Industry	15.8	Private
	Reduction of Clinker Percentage in Cement Industry	7.33	Private
	Enhancing the EE in the Cement industry	9.60	Private
	Enhancing the EE in three energy intensive sectors	10.7	Private
	Efficient Charcoal Kilns	7.81	Private
Transport	The Expansion and Development of Cairo Metro Lines	183	Public
	The Development of Abu Qir- Alexandria Railways Line	18.4	Public
	The Expansion and Development of Electric Railways Network: AL-Salam - New Administrative Capital - 10th of Ramadan Electric Railway Line	15	Public
	The Expansion and Development of Electric Railways Network: Ain Sokhna - Alamin Electric Train (Passenger and Freight)	4.2	Public
	The Expansion of Public Freight Transport Services - Freight Model Shift from Roads to Rail of 25 million Ton in 2025	7.9	Public
AFOLU	Four million acres development program	1.4	Public
	Reduce the cultivated area of the rice crop	9.6	Private
	Composting of agricultural wastes	1.9	Private
	Reduce GHGs emissions from livestock	6.41	Private
	Using Agriculture Waste to Generate Electric Power	1.9	PPP
	Replacement/Rehabilitation of Pumps Working with Low Efficiency	2.3	Public
	Solar PV Pumping by Replacing Existing Diesel Field Pumps	4.6	Private
Tourism and Buildings	Implement energy efficient lighting in Governmental Buildings.	2.4	Public
	Implement renewable energy actions in hotels	8.5	Private
	Implement EE actions in hotels	2.5	Private
Waste	Municipal waste to energy	5.5	PPP
	Waste Conversion	25	PPP
Energy subsidy reform program	Energy subsidy reform program	422.5	Public

3.7 Clean Development Mechanism (CDM)

Egypt's existing CDM portfolio comprises 20 CDM projects and 6 PoAs. Table 3-3 provides a well-balanced portfolio with a variety of project types and categories. It comprises six projects in renewable energy, two in waste management, one in transport, seven in fuel switching, six in energy efficiency and four industrial projects. The first Egyptian PoA, the Egypt Vehicle Scrapping and Recycling

Programme, registered on June 30, 2011, is the first-ever transport Programme of Activities to be registered under the CDM. The current portfolio has an estimated emission reduction of about 4.2 million tCO_{2e} per year.

Table 3-3: Egypt's Portfolio of CDM projects and PoAs

No.	Project Name	Estimated emission reductions (tCO _{2e} per year)	Registration Date
Renewable Energy			
1.	Zafarana Wind Power Plant Project 120 MW (NREA– Japan)	276,229 tonnes of CO ₂ equivalent in 2016 and 2017	22-Jun-07
2.	Zafarana 8 - Wind Power Plant Project, Arab Republic of Egypt 120 MW (NREA-Denmark)	282,204 tonnes of CO ₂ equivalent in 2016 and 2017	23- Sept-10
3.	Zafarana 85 MW Wind Power Plant Project in the Arab Republic of Egypt (NREA)	107,512 tonnes of CO ₂ equivalent in 2016 and 2017	08-Aug-11
4.	Zafarana KfW IV Wind Farm Project 80 MW (NREA)	170,438 tonnes of CO ₂ equivalent in 2016 and 2017	02-Mar-10
5.	Renewable Energy Programme of Activities in Middle East and North Africa, proposed by CES, (1st CPA in Saudi Arabia), CME: CES Carbon Services Ltd, Ireland	Did not start yet in Egypt	28-Dec-12
6.	Programme for Grid Connected Renewable Energy in the Mediterranean Region (REM) (1st CPA in Morocco)	Did not start yet in Egypt	29-Oct-12
Waste Management			
7.	Onyx Alexandria Landfill Gas Capture and Flaring Project	370,903	15-Dec-06
8.	Land Filling and Processing Services for Southern Zone in Cairo	25,053	29-Oct-12
Transport			
9.	Egypt Vehicle Scrapping and Recycling (POA)	20 (1st CPA)	20 (1st CPA)
Fuel Switching			
10.	Emissions reduction through partial substitution of fossil fuels with renewable plantation biomass and biomass residues in CEMEX Assiut Cement Plant	416,528	17-Jan-11
11.	Egyptian Brick Factory GHG Reduction Project	430,350	14-Jul-10
12.	Fuel Switching from Mazout to Natural Gas in Misr Fine Spinning & Weaving and Misr Beida	45,051	19-Jan-11
13.	Partial Fuel Switching to Agricultural Wastes & Refuse Derived Fuel (RDF) at Helwan Cement	42,615	26-Dec-12
14.	Partial Fuel Switching to Agricultural Wastes & Refuse Derived Fuel at Kattameya Cement Plant	32,320	24-Dec-12
15.	PoA for Fuel Switching at SMEs (small and medium-sized enterprises) in Egypt	155	31-Dec-12
16.	Partial Fuel Switching at Arabian Cement	70,862	28-Dec-12
Energy Efficiency			
17.	Al-Sindian 13 MW Natural Gas based Cogeneration Package Project, Egypt	25,384	10-Feb-12
18.	Waste Gas-based Cogeneration Project at Alexandria Carbon Black Co., Egypt	109,514	26-Jul-08
19.	International Water Purification Programme (1st CPA in Uganda)	Did not start yet in Egypt	16-Nov-12
20.	Gas Flare Recovery in Suez Oil Processing Company	186,230	31-Jan-13
21.	Advanced Energy Solutions for Buildings. Programme of Activities (PoA) with Saudi Arabia, Oman, and Ireland (1st CPA in Saudi Arabia)	Did not start yet in Egypt	28-Mar-14
22.	Network Energy Optimization	9,794	23-Nov-15
Industry			
23.	Catalytic N ₂ O destruction project in the tail gas of the Nitric Acid Plant of Abu Qir Fertilizer Co.	1,065,881	07-Oct-06
24.	Reduction of N ₂ O emissions from the new nitric acid plant of Egypt Hydrocarbon Corporation at Ain Sokhna	251,595	18-Oct-12
25.	N ₂ O and NOX Abatement Project at Delta-ASMEDA Fertilizer	190,000	24-Dec-12
26.	N ₂ O abatement at KIMA	120,553	20-Dec-12

3.8 Assessment of the Impacts of Response Measures

The UNFCCC recognises the responsibility of developed countries to reduce GHG emissions and mitigate the effects of climate change (Article 3). It also recognises that development nations may be

adversely affected by such mitigation efforts, particularly unilateral response measures, which can impede their sustainable development (Article 4), particularly when affecting international trade. The Convention affirms that “measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade” (Article 3).

Non-Annex Countries, especially those dependent on oil and gas revenues, are disproportionately affected by these response measures due to declines in fossil fuel demand and trade distortions, while alternative energy markets are still maturing. Understanding and evaluating the implications of response measures adopted by developed countries is critical for developing strategies to minimize their negative impacts and to foster adaptation. A study by McKay Consultants found that:

- Technology-related policies have the least adverse effects.
- Measures focusing on technology development minimally impact oil demand, reducing spillover effects on oil-exporting developing countries.
- Technologies like carbon capture and storage (CCS) offer climate solutions with fewer negative trade-offs.
- Efficiency improvements also present low-impact mitigation options.

At the sixth Carbon Sequestration Leadership Forum (CSLF) Ministerial Meeting (2015), CCS and structured carbon management roadmaps were promoted as viable responses to rising GHG emissions. Clean energy policies supporting low-carbon and other sustainable technologies were also endorsed. Successfully internalising procedural responses to such measures presents both demand-side and supply-side challenges. On the demand side, macroeconomic frameworks must be adjusted to ensure stability. On the supply side, long-term action is needed for:

- Develop human capital
- Restructure the public sector
- Correct labour market distortions
- Build an export-orientated industrial base

Effective mitigation of response measure impacts requires coordinated public and private sector efforts, long-term planning, and integrated economic and institutional reforms.

3.9 Support Received and Needs for Mitigation

Tables 3-4 and 3-5 present a summary of the international support received for mitigation programmes implemented by the GoE since 2005, reflecting the country’s engagement with global partners in advancing its climate agenda. Additionally, Table 3-6 outlines the mitigation measures planned across all sectors from 2016 onwards, highlighting the financial, technical, and capacity-building needs associated with each program, where such information is available.

Table 3-4: International Support Received for Mitigation Programs between from 2005 and Onwards

Program	Sector	Measures achieved	Donor and total funding amount and type	Other support received			Time (years)
				Technology	Capacity building	Technical Sector	
Electricity Sector Subsidy Reform Program	Electricity Generation	<ul style="list-style-type: none"> Gradual removal of subsidies on electricity starting 2014 Re-pricing of electricity in a tier- based system Establishment of social safety nets in the context of energy sector reform Modelling National Energy Sector based on 4 comprehensive long term strategic scenarios. Development of Egypt's Strategy for Integrated Sustainable Energy 2035 	<p>Energy reform Policy Support Program European union (EU): 60 M Euro</p> <p>Technical Assistance to Support Reform of the Energy Sector: Social Safety Nets World Bank (WB): 6 M USD</p>		✓	✓	2014 - 2015
Increase of energy contribution to national electricity generation	Energy, Renewable Energy	<ul style="list-style-type: none"> Setting two targets for contribution of RE in national power generation (electricity): 20% by 2022 & 37% by 2035 Implementation of utility-scale wind, solar, and hydropower projects: Nagaa Hammadi hydropower station; Kureimat Hybrid Concentrated Solar Power (CSP) plant; & Small-scale photovoltaic solar with net metering system Issuance of feed-in tariff and net- metering schemes 	<p>Kureimat Hybrid Concentrated Solar Power (CSP) plant.</p> <p>GEF/WB: 49.8 M USD</p>	✓	✓	✓	2013 - 2015
Energy Efficiency for Electricity Generation and End Users	Energy, Energy Efficiency	<ul style="list-style-type: none"> Implementation of a package of EE measures accompanying subsidy reform and RE investments. Standards and Labelling programme on home appliances for electricity rating. Promotion of LED lighting technology. Nationwide awareness campaign to reduce electricity consumption. Promulgation of Electricity Law 87/201 5 (with specific articles 45-51 for Electricity Efficiency and Energy Management). Implementation of a program for conversion of simple cycle power plants to Integrated Gasification Combined Cycle (IGCC). 	<p>Energy Efficiency Improvement and Greenhouse Gas Reduction Project (1998 - 2010) GEF: 4.110 M USD</p> <p>Improving the EE of Lighting and Building Appliances (2010 - 2015) GEF: 4.450 M USD</p> <p>Conversion of Shabab and West Damietta Power Plants from simple cycle to IGCC European Bank for Reconstruction and Development (EBRD): 190 M USD</p>	✓	✓	✓	2005 - 2015
Sustainable Transport Program and Expansion of Cairo Metro Network	Energy, Transportation	<ul style="list-style-type: none"> Egypt Sustainable Transport (STP) Program activities and pilot projects. Stage 5 of Cairo Metro Second Line. Stage 1 & Stage 2 of Cairo Metro Third Line. 	<p>STP: GEF/UNDP: 7 M USD National: 37 M USD</p>	✓	✓	✓	2009 - 2015
Industrial Energy Efficiency Project (IEE)	Energy, Industry	<ul style="list-style-type: none"> National program to define energy benchmarks and EE policy. Awareness raising on industrial EE and management in industry. Capacity Building for EE Services. 	<p>GEF: 3.95 M USD National: 24.1 M USD</p>		✓	✓	2012-2015

Program	Sector	Measures achieved	Donor and total funding amount and type	Other support received			Time (years)
				Technology	Capacity building	Technical Sector	
		<ul style="list-style-type: none"> Access to finance for EE improvement projects. Implementation of energy management systems and system optimization. 					
Egyptian Pollution Abatement Project (EPAP II) *	Energy, Environment, Industry	<ul style="list-style-type: none"> Pollution abatement measures financed for cement, brickworks, petroleum, chemical, and steel industrial facilities in Greater Cairo and Alexandria. 6 Projects involving switching from heavy fuel oil to natural gas. 	Finance: European Investment Bank (EIB): 40 M Euro Agence Française de Développement (AFD): 40 M Euro Euro Japan Bank for International Cooperation (JBIC) : 4.7 B Yen WB: 20 M USD Technical Assistance: EIB: 3 M Euro Government of Finland: 0.9 M Euro National: 17.5 M LE	✓	✓	✓	2007 - 2015
Private Public Sector Industry Project (PPSI)*	Energy, Environment, Industry	<ul style="list-style-type: none"> Pollution abatement measures financed for industrial facilities in Upper and lower Egypt (excluding Greater Cairo and Alexandria) 	KfW: 7.26 M Euro (grant)	✓	✓	✓	2008 - 2012
Egyptian National Solid Waste Management Programme (NSWMP)	Waste, Environment	<ul style="list-style-type: none"> Established National waste management authority (WMRA) Issued Strategic Directives on Integrated Solid Waste Management Holds an annual national forum on waste management for knowledge transfer and networking. Established an internet platform for solid waste related issues. Drafting a solid waste management law which addressed planning, finance, standards for implementing integrated solid waste management systems in the context of social inclusion, cost recovery, the Polluter Pays, Extended Producer Responsibility (EPR) principles. Piloted operator models for primary collection and recycling of municipal solid in 4 governorates Supporting the implementation of holistic solid waste management systems in 4 governorates 	German Credit Institute for Reconstruction (KfW) German Agency for International Cooperation (GIZ) European Union (EU) State Secretariat for Economic Affairs of Switzerland (SECO)	✓	✓	✓	2012 - 2015
Bioenergy for Sustainable Rural Development	Energy, AFOLU, Waste		GEF: 3 M USD Co-financing: 12.4 M USD	✓	✓	✓	2010 - 2015

Table 3-5: International Support Received for Renewable Energy Programs (Agreements Signed between 2005 - 2015)

Program/Project	Donor	Agreement Date	National Recipient	Currency	Amount
Loans					
Zafarana wind farm- phase 3	Germany	2003	New and Renewable Energy Authority (NREA)	Euro	15
West Gulf of Suez wind farm	Spain	2008	MoERE	Euro	119
Gabal El-Zeit 220 MW wind farm	Japan	2010	NREA	Yen	388
Wind farm	WB	2010	EETC	USD	70
Wind Farm	Clean Technology Fund (CTF) - WB	2010	EETC	USD	150
Aswan 20 MW Photovoltaic Power Plant	AFD	2015	NREA	Euro	40
Grants					
Wind farm	CTF-WB	2010	EETC	USD	0.25
Wind energy potential	Arab Fund for Economic and Social Development	2011	NREA	Kuwaiti Dinars	0.3
Feasibility study for a 20 MW PV power plant	AFD	2012	NREA	Euro	0.8

Source: Ministry of Investment and International Cooperation.

Table 3-6: The Needs of Future Mitigation Programs (Post-2015)

Program	Specified Measures Needed	Stakeholders	Estimated	Support Required			Time (years)
				Technology	Capacity building	Technical Sector	
Removal of energy subsidies	<ul style="list-style-type: none"> Support on estimation of GHG emission reduction due to subsidy reform actions. 	<ul style="list-style-type: none"> MoERE and MoPMR 	Not Estimated		✓	✓	2015-2022
Install additional renewable energy generation to reach 37% target by 2035	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of RE policies & programs. Support on developing bankable NAMAs. Support on establishing MRV systems. 	<ul style="list-style-type: none"> MoERE 	Not Estimated	✓	✓	✓	2015-2035
Renewable energy and SWH in the housing sector	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of residential/commercial RE/SWH policies & programs. Support on developing bankable NAMAs. Support on establishing MRV systems. 	<ul style="list-style-type: none"> MoHUUC 	Not Estimated	✓	✓	✓	2015-Onwards
Energy Efficiency as per the Energy Strategy 2035 (all sectors) and Second National Energy Efficiency Action Plan 2019 - 2022 (NEEAP 2) for Electricity Sector	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of national EE policies & programs. Support on developing bankable NAMAs & establishing MRV systems for programs. 	<ul style="list-style-type: none"> Multiple 	\$7,125 million for EE in 6 refineries	✓	✓	✓	2018-2020 & onwards
Sustainable transport programs and national rail system expansion	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of sustainable transport and rail network expansion programs. Support on developing bankable NAMAs and establishing MRV systems for programs. 	<ul style="list-style-type: none"> MoT 	\$18.26 billion for metro lines and national railway network	✓	✓	✓	2015- On wards
Low carbon roadmap for the Egyptian cement industry including alternative fuels utilization	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of a low carbon cement industry roadmap. Support on developing bankable NAMAs and establishing MRV systems for programs. 	<ul style="list-style-type: none"> MTI and EEAA 	Not estimated	✓	✓	✓	2015 - Onwards
National Solid Waste Management Programme (NSWMP)	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of the national solid waste management sector. Support on developing bankable NAMAs and establishing MRV systems for programs. 	<ul style="list-style-type: none"> EEAA, MTI, MoLD 	Not estimated	✓	✓	✓	2015- On wards
Feed-in tariff for electricity generation from waste	<ul style="list-style-type: none"> Support on planning, finance, implementation, regulation of a feed-in tariff scheme for electricity generation from waste-to-energy processes. Support on developing bankable NAMAs and establishing MRV systems. 	<ul style="list-style-type: none"> MoERE 	Not estimated	✓	✓	✓	2015- On wards

Program	Specified Measures Needed	Stakeholders	Estimated	Support Required			Time (years)
				Technology	Capacity building	Technical Sector	
	<ul style="list-style-type: none"> • Technology, technical, and capacity building support in techno-economic assessment, tendering, implementation, and regulation of waste-to-energy systems. 						
Reduction of cultivated rice areas	<ul style="list-style-type: none"> • Support on planning, finance, implementation, regulation of reduction of rice cultivation. • Support on developing bankable NAMAs and establishing MRV systems for programs. 	<ul style="list-style-type: none"> • MALR 	Not estimated	✓	✓	✓	2017-2030
Reduce GHGs emissions from livestock	<ul style="list-style-type: none"> • Support on planning, finance, implementation, regulation of reduction of GHG emissions from livestock. • Support on developing bankable NAMAs and establishing MRV systems for programs. 	<ul style="list-style-type: none"> • MALR 	Not estimated	✓	✓	✓	2017-2030
Recycling agricultural waste and manure	<ul style="list-style-type: none"> • Support on planning, finance, implementation, regulation of compost and bioenergy production from agricultural waste. • Support on developing bankable NAMAs and establishing MRV systems for programs. 	<ul style="list-style-type: none"> • MALR 	Not estimated	✓	✓	✓	2015- On wards
Implementation of national and sectoral MRV systems	<ul style="list-style-type: none"> • Support on planning, finance, implementation, regulation of national, sectoral, and facility specific MRV systems for GHGs inventories & mitigation actions. 	<ul style="list-style-type: none"> • Multiple 	Not estimated		✓	✓	2015- On wards

4 Vulnerability and Adaptation to Climate Change

4.1 Introduction

The purpose of this chapter is to implement an integrated methodology for the vulnerability and adaptation assessment (V&A) of climate change in Egypt. This methodology involves the identification and analysis of critical risk areas, which are then connected to sectoral impacts. This approach is distinct from that of previous national communication reports. Climate change risks in Egypt include sea level rise (SLR), temperature increase, heatwaves, droughts, increased precipitation, and flash floods, with multiple sectors such as water, agriculture, housing, biodiversity, tourism, and human health being directly affected.

The assessment of climate change impacts was based on the level of available data, with a focus on highlighting adaptation efforts at both governmental and community levels. Planned and potential adaptation measures were outlined to support the mobilisation of funding. Economic evaluations were also conducted to assess the extent of climate change impacts and to estimate the financial needs for implementing adaptation actions across priority sectors and risk areas.

Priority risk areas were selected through national Expert Group Meetings and include SLR, temperature increases, heatwaves, heavy precipitation, flash flooding, and droughts. The compounded effects on vulnerable sectors of overlapping risks, such as the interlinkages between temperature increase and heatwaves or heavy precipitation and flash flooding, were the focus of particular attention.

A brief sectoral assessment was conducted for water resources, agriculture, coastal zones, ecosystems and biodiversity, public health, urban and human settlements, tourism, energy, industry, infrastructure, and transportation. Evidence of rising temperatures, SLR along the Mediterranean coast, and the growing frequency and geographical spread of flash floods was emphasised. Urban expansion and climate factors may be equally responsible for some areas' vulnerability to these risks, underscoring the need for further analysis.

Despite significant government investments in adaptation, climate change has already imposed considerable economic costs, and further funding is required to realise all planned actions. This chapter also aims to provide initial estimates of adaptation financing needs while identifying areas where more detailed studies are necessary to refine vulnerability assessments, quantify impacts, and develop costed adaptation plans. Establishing robust monitoring and early warning systems remains a national priority to support evidence-based policymaking and enhance resilience across all key economic sectors.

4.2 Climate Change Vulnerability

Egypt is not immune to the global rise in temperatures and its associated climate change impacts. A clear upward trend in temperature is observable, with the rate of increase in Alexandria's daily air temperature between 2001 and 2011 exceeding that of the 1973–2012 period, which in turn was higher than the rate between 1957 and 1966.

This temperature rise has also affected sea surface temperatures in the Mediterranean along the Nile Delta and further west, showing an increase of 1 to 2°C between 2001 and 2011. This warming trend has coincided with a decline in seawater pH value. The inverse relationship between temperature and oxygen solubility means that warmer waters hold less oxygen, a critical factor influencing fisheries and marine ecosystems.

The implications of rising sea temperatures on Egypt’s marine biodiversity and fisheries warrant thorough investigation—particularly for species inhabiting the country’s northern and eastern coastal waters. Similarly, freshwater fish in the Nile River System, including its main reaches, the Rosetta and Damietta branches, and major irrigation canals, require targeted assessment. The Northern Lakes, which are connected to the Nile, agricultural drainage, and the Mediterranean, also warrant consideration due to the potential for more elevated water temperatures than the open sea. Similarly, the inland fisheries and aquaculture in Wadi El-Rayan and Lake Qaroun may be threatened. According to FAO (2018) Report 627, freshwater and brackish water fisheries in Egypt are highly vulnerable.

Globally, increased snowmelt and thermal expansion from higher temperatures have driven sea level rise (SLR), with an average increase of 3.5 mm per year recorded between 1993 and 2006. Figures 4-1 & 4-2 present approximate maps showing in blue lowlands which are inundated in the lower Nile Delta of Egypt being susceptible to impacts of SLR.

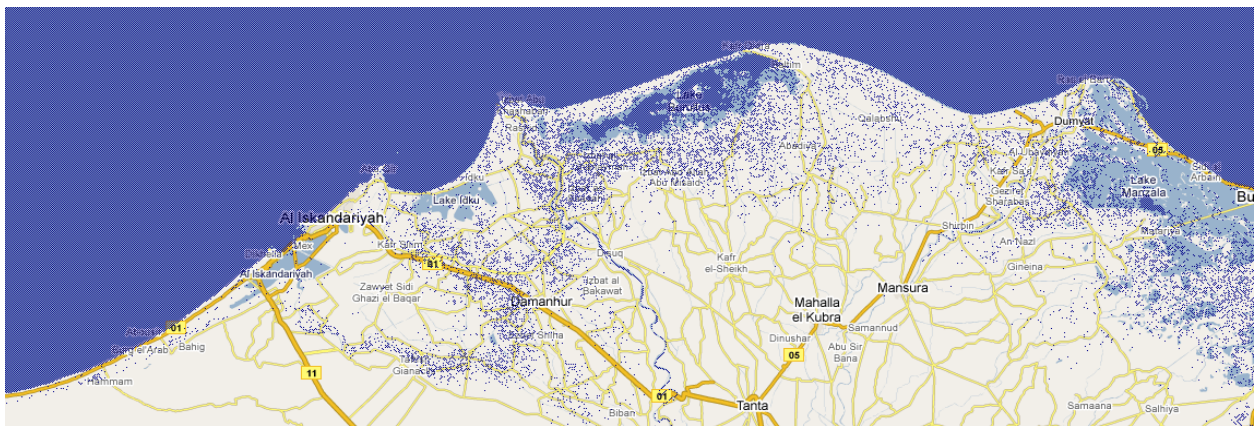


Figure 4-1: Current Situation of Nile Delta Inundation, AbuZeid, K., 2012

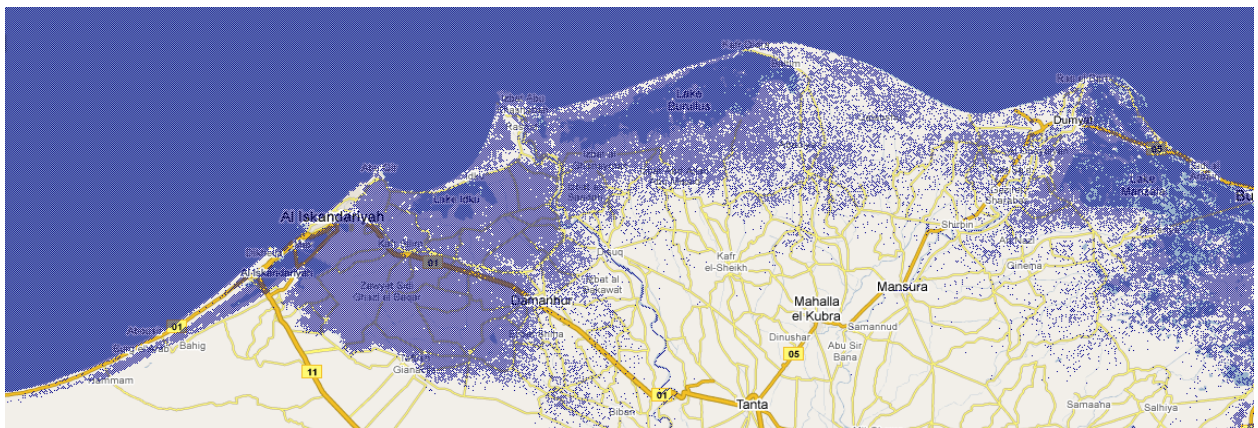


Figure 4-2: Simulation of Nile Delta Vulnerability to 1m Sea Level Rise Inundation, AbuZeid, K., 2012

Systematic observations have shown a decreasing trend in annual precipitation depth (mm/year) between 1900 and 2013 across several Egyptian regions, including the Northern Coast, Middle and South Sinai, and along the Red Sea.

Figure 4-3 illustrates an increase in the frequency of flash floods in Egypt between 2010 and 2015, with another spike in 2019. It also depicts a rising number of affected areas over time. While this trend may suggest a link between flash flood frequency and climate change, it is essential to consider the influence of expanding urbanisation and reduced land surface permeability, which intensify runoff in urban zones.

Moreover, the development of newly inhabited areas has improved access to information and media coverage, making flood events in those regions more visible.

To accurately distinguish the contributing factors to flash floods, whether from increased precipitation intensity and duration or from urban expansion, rainfall patterns must be thoroughly studied. This calls not only for further research but also for an extensive monitoring system, along with open access to data for researchers and relevant government authorities. Regardless of the underlying causes, adaptation to flash flood impacts remains essential.

Another area that needs additional study is the trends in droughts, increased precipitation, and flash floods and the links between the three. This is an area that requires scrutinising to provide consistent information among the three phenomena.

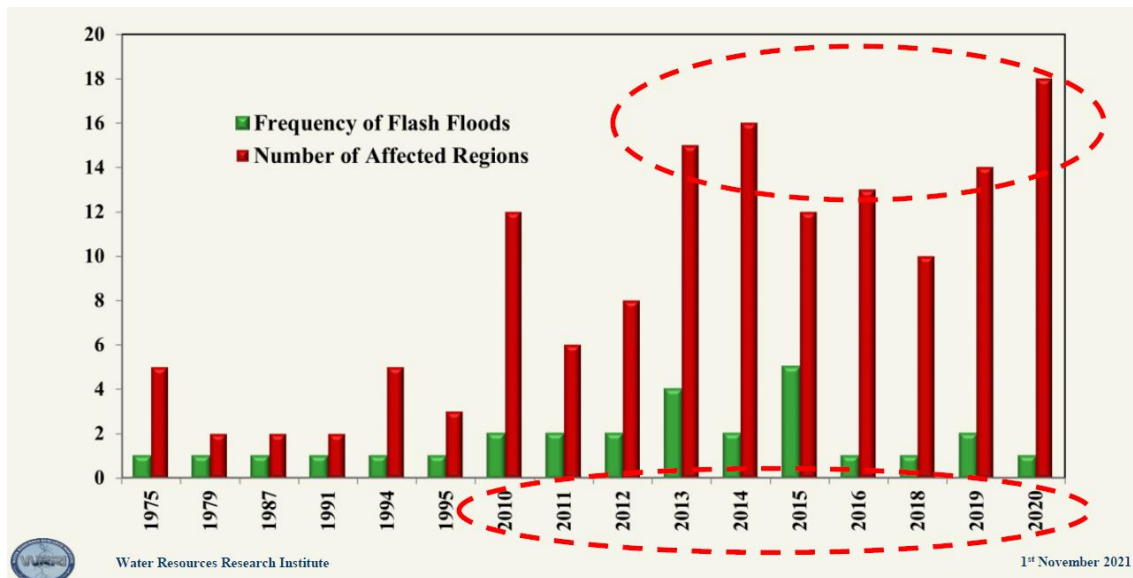


Figure 4-28: Number of flash floods in Egypt (2010 – 2020), WRRRI, et al., 2021

One key adaptation measure is enhancing rainfall forecasting systems. Figure 4-4 presents the forecasted rainfall storm distribution by the Water Resources Research Institute alongside the actual rainfall distribution observed through remote sensing data for events that occurred in 2010.

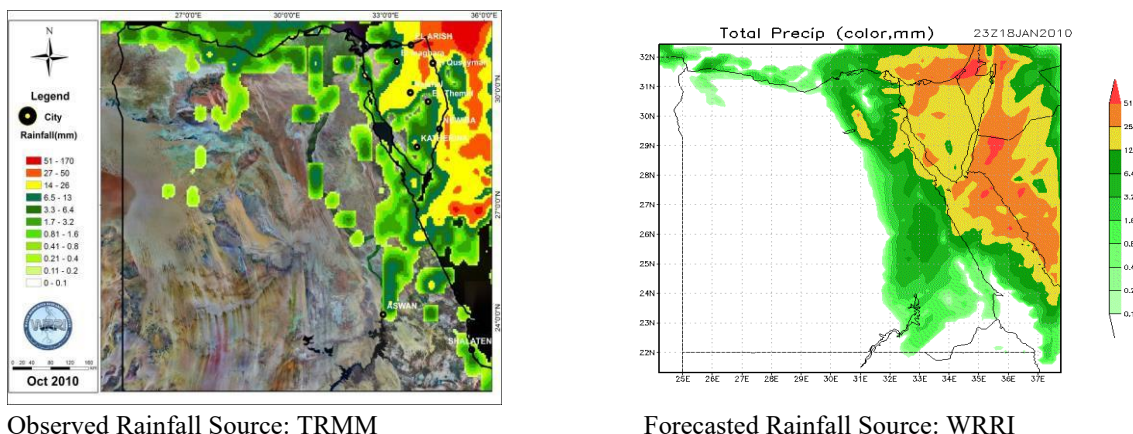


Figure 4-4: Observed & Forecasted Rainfall Storm distributions in 2010, WRRRI, et al., 2021.

Figure 4-5, developed by the Water Resources Research Institute, identifies areas vulnerable to flash floods along Egypt’s Red Sea Coast in the Eastern Desert, as well as in the Sinai region.

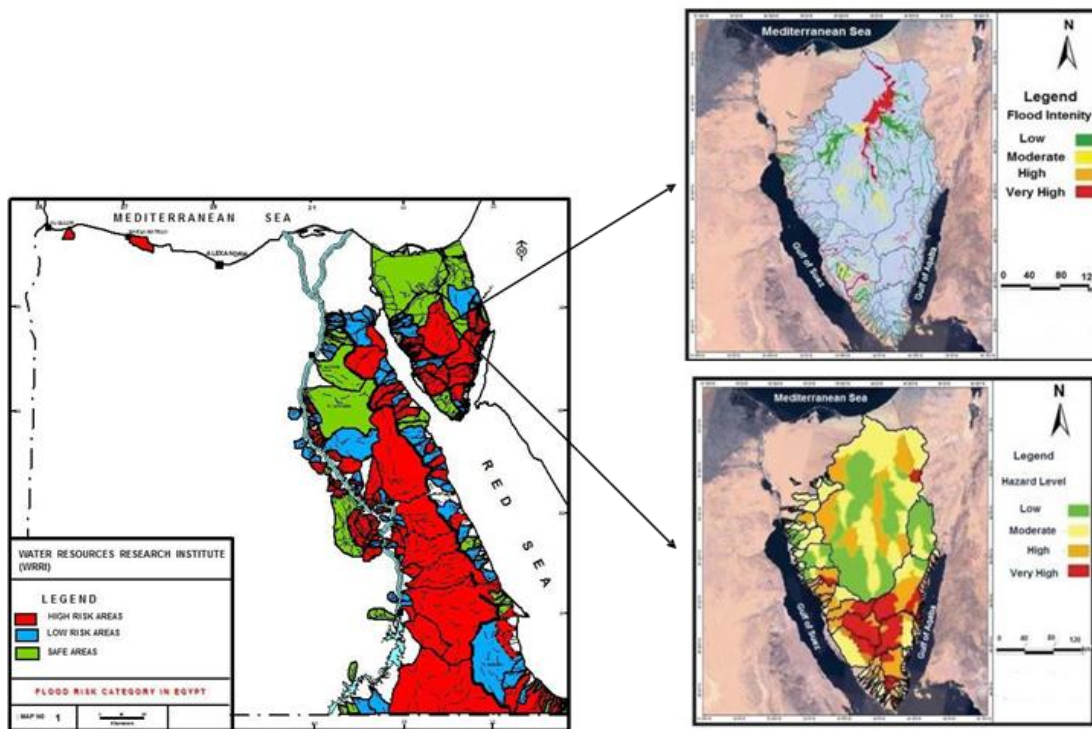


Figure 4-29: Vulnerable Areas to flash floods in Red Sea Coast, Eastern Desert and Sinai, WRRl, et al., 2021

Urban areas such as New Cairo have recently experienced intense rainfall storms, resulting in flooded streets and homes and causing property damage. Table 4-1 presents data from four different stations in Cairo, showing that the historical maximum daily rainfall depth is around 20 mm/day. In recent years, daily rainfall patterns have increased, with their impacts worsened by expanding urbanisation and the spread of impervious land cover. It is important to see if climate change projections will have an impact on these types of rainfall events.

Table 4-18: Rainfall storm at 4 different stations, WRRl, et al., 2021

Station	No. of storms	Max. rainfall (mm/day)	Min. rainfall (mm/day)	Average rainfall (mm/day)
Helwan	22	7.5	0.3	2.48
Cairo Airport	46	20	0.1	2.58
Katamia	19	7.1	0.2	2.45
Abbassia	35	10.8	0.1	2.36

An unusually intensive storm with a long duration had also hit Egypt in March 2021, where some people called it the “Dragon Storm”. Observed rainfall data at the Water Resources Research Institute stations during that storm are shown in Figure 4-6, where the maximum rainfall depth occurred in Saint Catherine and reached 83.2 mm for that single storm.

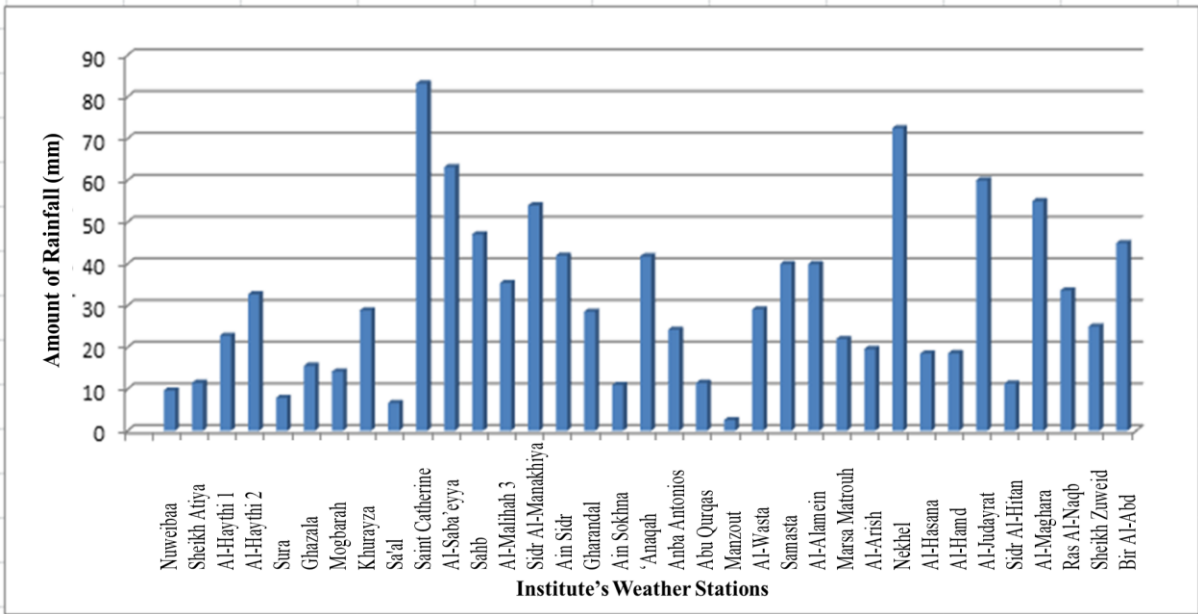


Figure 4-6: Observed precipitation during (12-14) March storm, WRRRI, et al., 2021.

All weather stations' data below show a decrease in the rx3day (Figure 4-7) and r10mm (Figure 4-8) indicators of precipitation which indicates an increasing trend in **droughts** in the majority of Egypt.

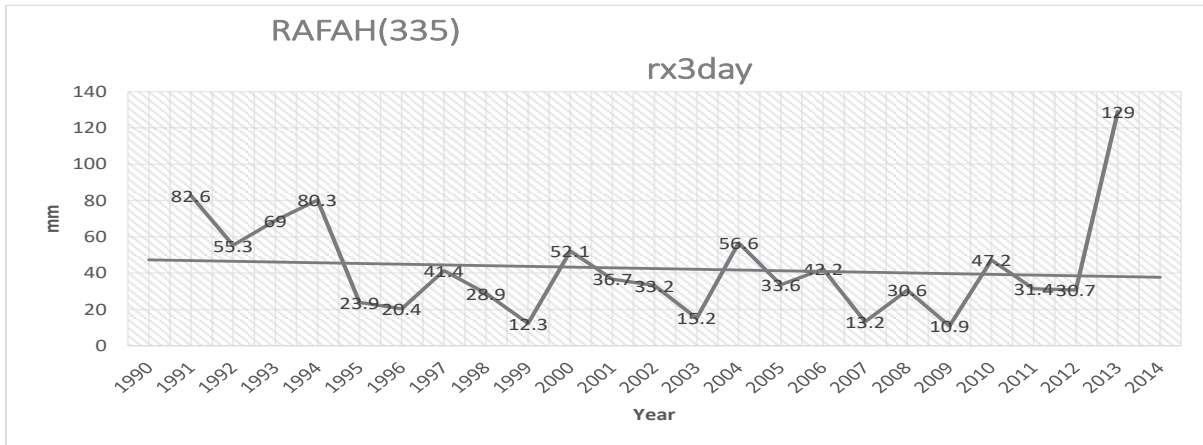


Figure 4-7: Evaluation of meteorological drought using rx3day drought indicator at Rafah (335), Ministry of civil aviation (MoCA) - Egyptian Meteorological Authority (EMA), 2021

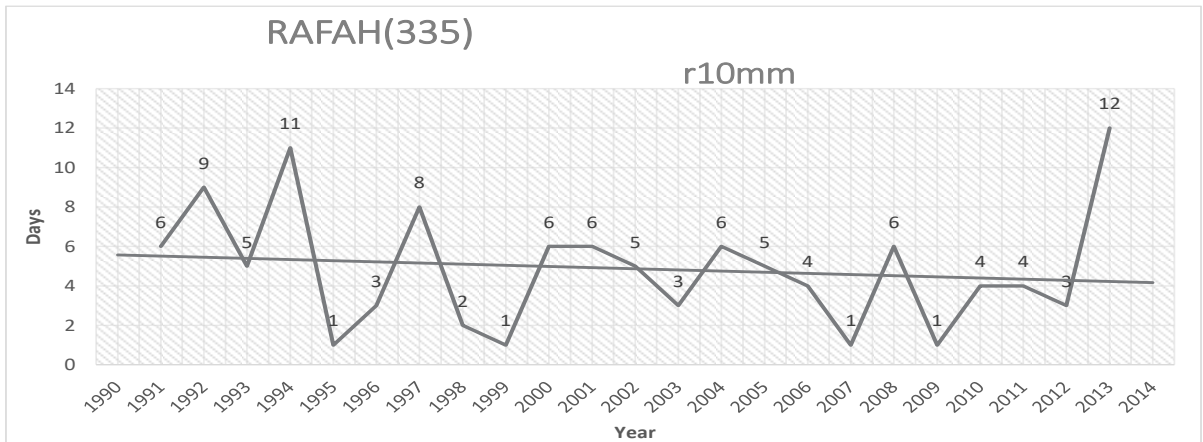


Figure 4-8: Evaluation of meteorological drought using r10mm indicator of precipitation at Rafah (335), Ministry of civil aviation (MoCA) - Egyptian Meteorological Authority (EMA), 2021

On the other hand, examining the Blue Nile, which serves as the main water source for the Nile River, over a 105-year period from 1911 to 2015, reveals that the driest 10 successive years occurred between 1978 and 1987, with an average Blue Nile flow of 38.5 billion cubic metres (BCM) per year. The driest 6 successive years were recorded between 1982 and 1987, during which the average flow dropped to 36 BCM/year. It is worth noting that the dry single year in this entire period was 1913, when the Blue Nile flow reduced to a mere 19.8 BCM/year. Nevertheless, this year was not included in either the lowest 10-year or 6-year successive drought periods. This highlights that droughts can occur either as isolated events or as prolonged periods, with both having potentially severe effects, although the required response may vary depending on each country's resilience and preparedness.

Historical records from the 1978–1987 drought period indicate significant risks, including reduced hydropower generation, food shortages, and broader socio-economic impacts in Egypt. Utilising natural groundwater storage during droughts can help mitigate such impacts, while diversification through solar or thermal power generation reduces dependence on hydropower and thus vulnerability to drought. However, the potential impacts of natural droughts on downstream countries have been exacerbated by the rising water demand and increased upstream pressures, which are the result of uncoordinated actions and unilateral decisions in the upstream areas of the transboundary Blue Nile. These actions have also given rise to what may be described as anthropogenic, or human-induced, drought risks, leading to major socio-economic impacts that could develop into upstream-downstream conflict.

The effects downstream are especially worrying because natural droughts could get worse due to extra evaporation and seepage losses from the big 74 BCM reservoir behind the dam. Additional uncertainty surrounds the rules governing the dam's filling and operation, as well as the possibility of further upstream uses of Blue Nile waters by Ethiopia. (AbuZeid, K. 2021, GAR 2021)

Figures 4-9, 4-10 & 4-11 show an increasing trend of **heat waves** and **number of hot days** in all weather stations in Egypt.

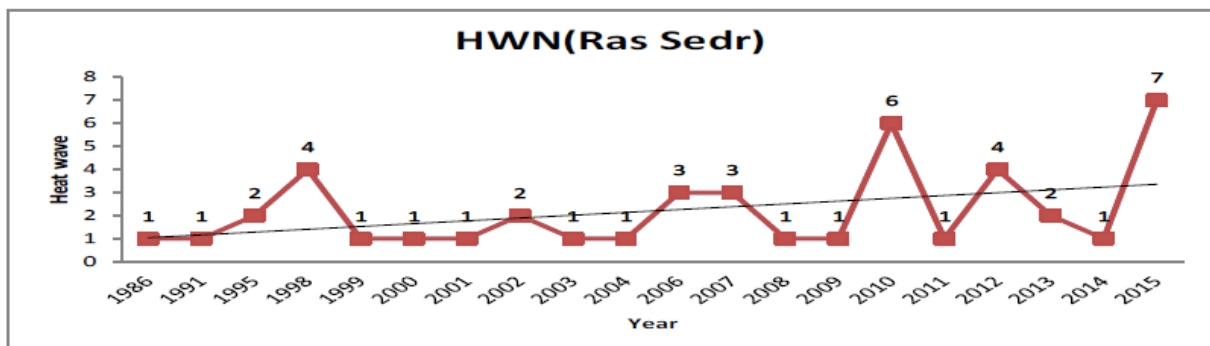


Figure 4-9: Heat Waves Number (HWN) (Ras Sedr), Eman, 2021

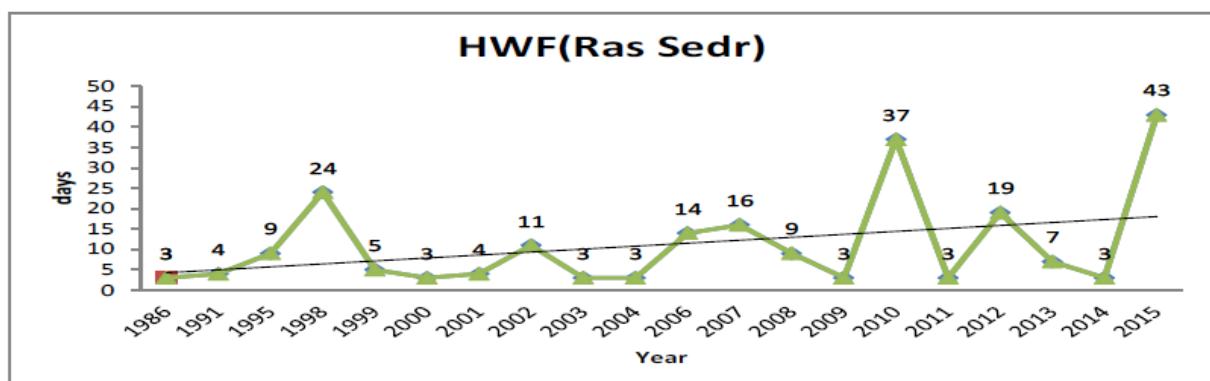


Figure 4-10: Heat Waves Frequency (HWF) (Ras Sedr), Eman, 2021

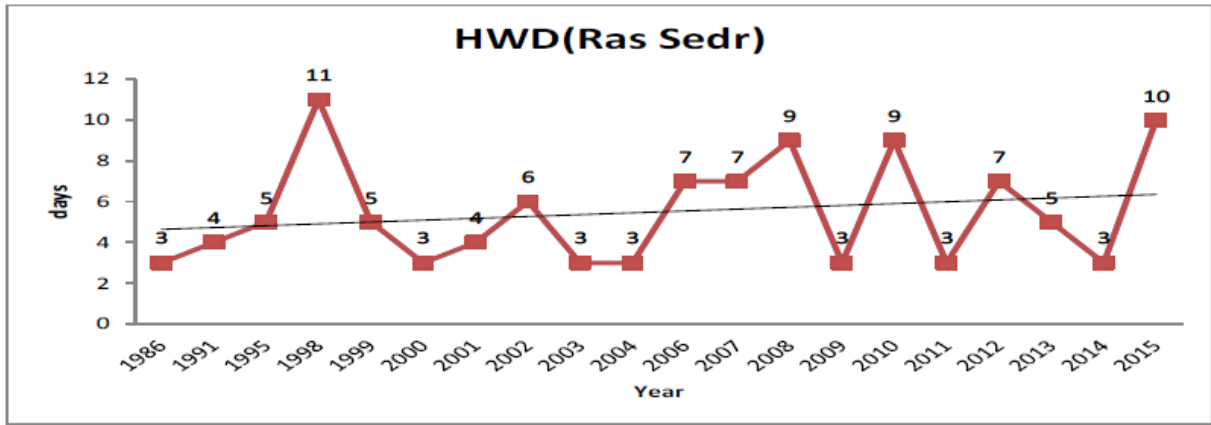


Figure 4-11: Heat Waves Duration (HWD) (Ras Sedr), Eman, 2021

4.3 Climate Change Projections & Scenarios

Figures 4-12, 4-13, and 4-14 present projections of heat waves and rising temperatures across various locations in Egypt for the period 1980 to 2100. All the locations examined exhibit an increasing trend in projected temperatures, except for Aswan in Upper (Southern) Egypt, which shows a slightly decreasing trend.

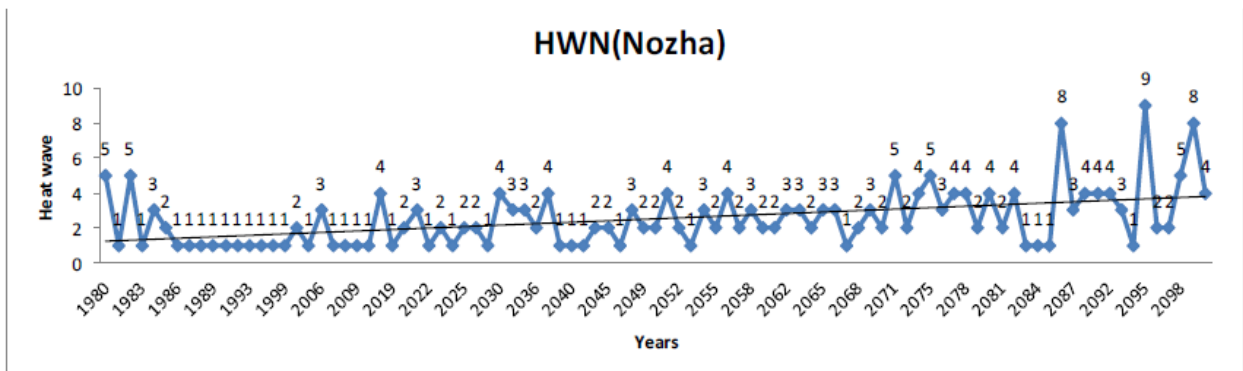


Figure 4-12: Heat Waves Number (HWN) (Nozha) (1980 – 2100)), Eman, 2021

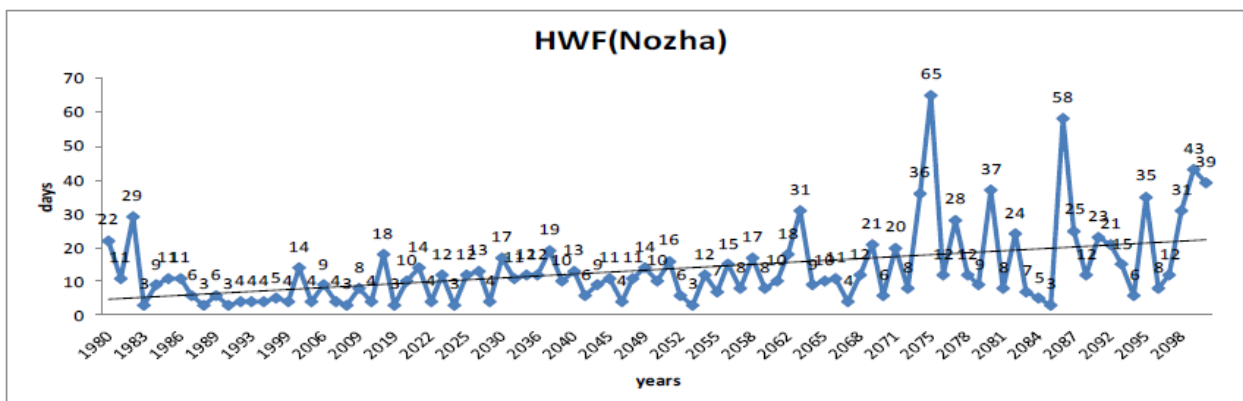


Figure 4-13: Heat Waves Frequency (HWF) (Nozha) (1980 – 2100)), Eman, 2021

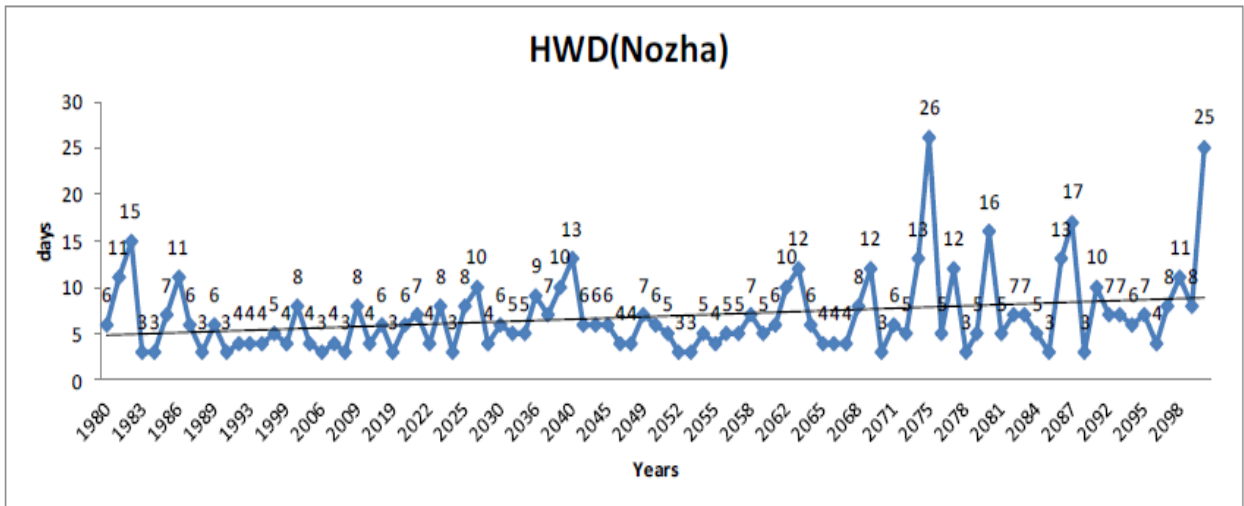


Figure 4-14: Heat Waves Duration (HWD) (Nozha) (1980 – 2100)), Eman, 2021

Figure 4-15 indicates the projected impact on SLR based on several modelling scenarios.

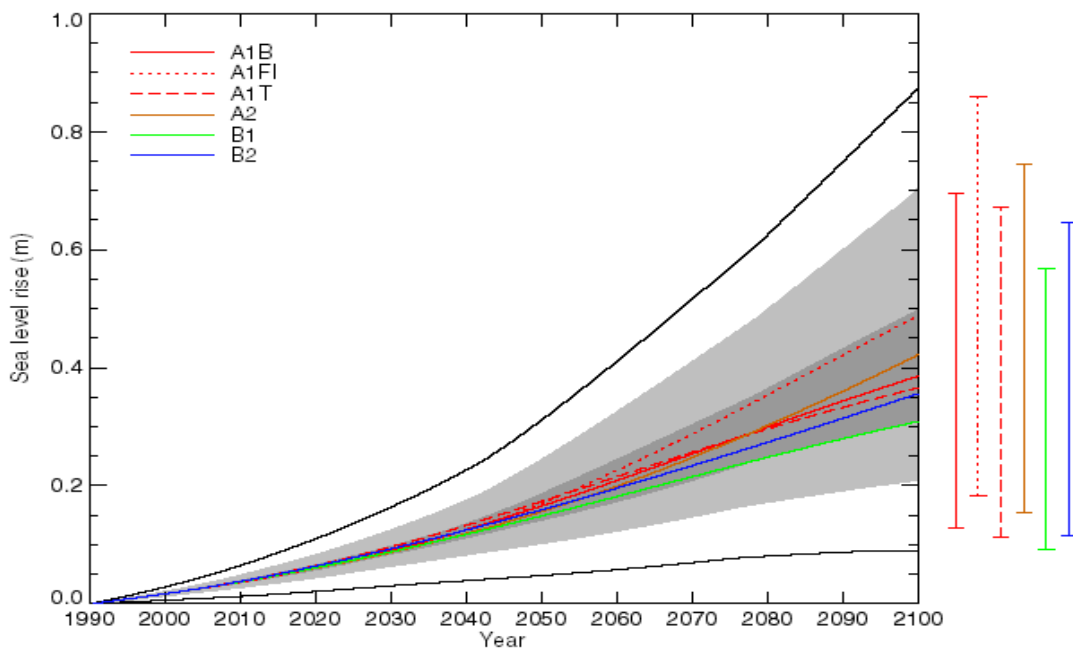


Figure 4-15: 1990-2100 sea level rise scenarios, Houghton et al., 2001

On the other hand, the Blue Nile is the largest tributary of the Nile River, which is the main source of freshwater for Egypt. The United Nations Economic and Social Commission for Western Asia (UN-ESCWA)'s (2017) projections for climate change impacts on the discharge of the Blue Nile have shown a wide range from a decrease to an increase. The average of these scenarios shows a decrease of about -8% for the RCP 8.5 scenario and about -25% for RCP 4.5.

Table 4-2 below indicates the projected increase in annual flows and volumes in Wadi Aish Al-Malaha due to the increase in rainfall in the Wadi for the projected maximum rainfall and the 100-year storm.

Table 4-2 Wadi Al-Malaha, Project Flash floods, WRI, et al., 2021

	Rainfall (mm)/day	Flow (m ³ /s)	Volume (Mm ³)
Max. Storm in base (1979-2010)	39	213	12,400
Max. Storm in RCP4.5 (2036-2100)	100	1500	82,600
Max. Storm RCP8.5 (2036-2100)	57	550	30,300
The Storm for 100-year return period	43	235	13,680

Except for the Ras Al-Tin and Tanta weather stations, projections by the EMA indicate a decreasing trend in the *Rx3day* and *r10mm* precipitation indicators at the remaining weather stations. Additionally, the Standardised Precipitation Index (SPI) suggests an increase in drought conditions projected through to 2100.

Projections for the Arab Region, which includes Egypt, suggest an increase in the number of dry periods, as indicated by the number of consecutive dry days, under the RICCAR Programme, which is coordinated by UN-ESCWA (Figure 4-16). These projections estimate that Egypt could experience an additional 6 to 8 dry days per year by 2100 under both RCP 4.5 and RCP 8.5 scenarios.

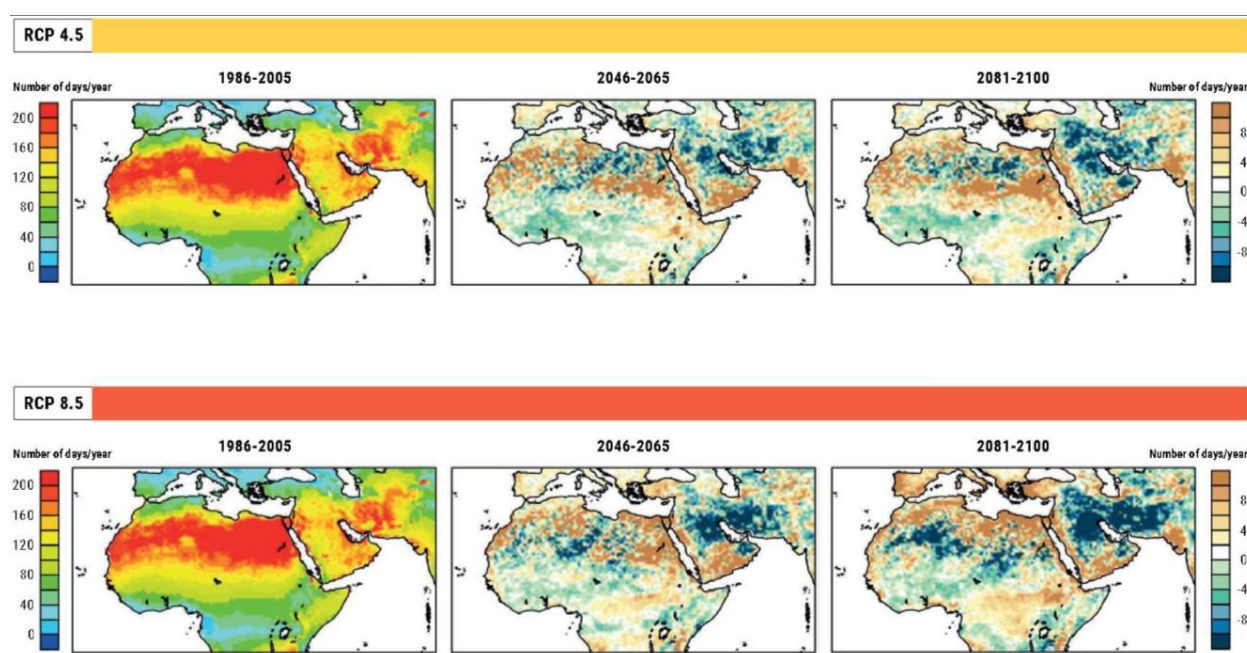


Figure 4-16: Projected number of Consecutive Dry Days in the Arab Region (including Egypt), ESCWA, 2015

The Ethiopian Plateau, located within the Nile Basin, is the primary source of the Nile River, which in turn is Egypt's main water source. Alternative precipitation projection scenarios for Addis Ababa show differing trends for the *Rx3day* and Standardised Precipitation Index (SPI) compared to those presented earlier in this chapter, indicating an increase in projected precipitation. However, the *r10mm* indicator is projected to show a decreasing trend until 2100.

Projected impacts of climate change on the agriculture sector are shown in Figure 4-17 below. The figure shows reductions in crop yield by up to 28% for all presented crops in Egypt except for cotton. It also shows an increased water demand of up to 8%.

Forecasted Changes in Yield and Water Use

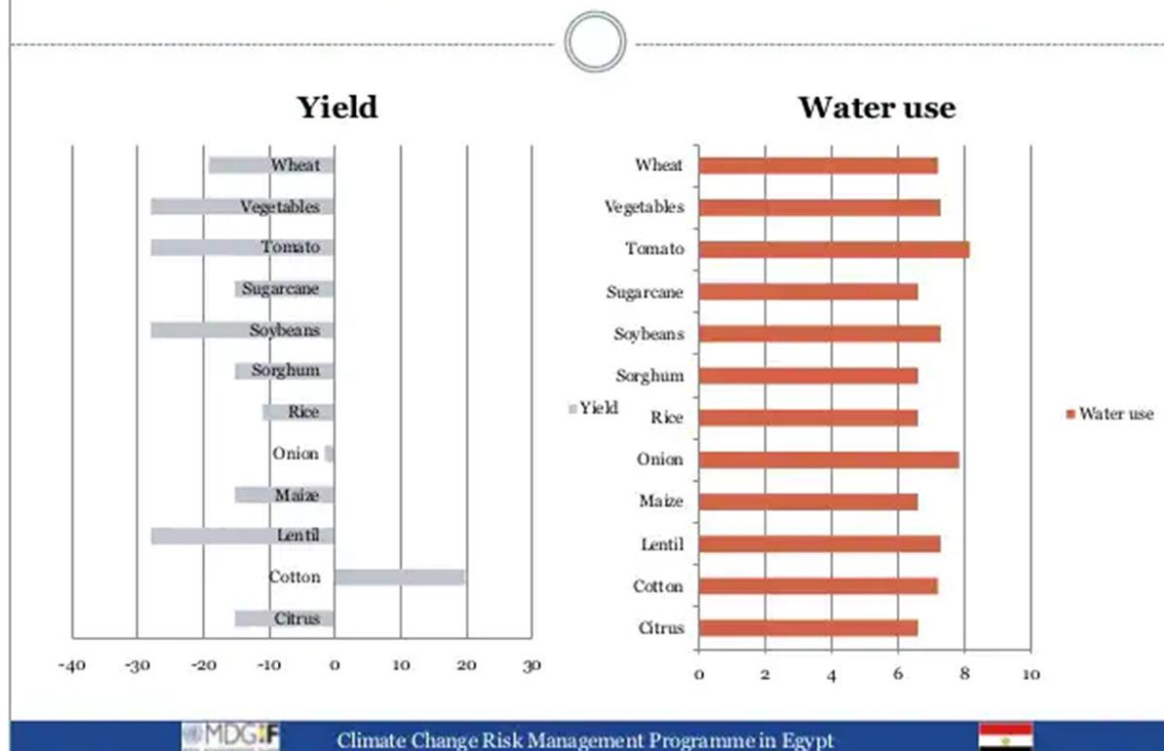


Figure 4-17: Forecasted Changes in Yield and Water Demand, CCRMP. (2013)

Tables 4-3 through 4-4 show the impact of climate change on agriculture due to reduced Nile flows scenarios as per the CCRMP studies (2013).

Table 4-3: Effects on Agriculture Production: 2030 % Change, CCRMP (2013)

Nile flow	Small decreased flow (52.5)	Large decreased flow (45.5)
	A1	A1
SRES (SLR + crops)	A1	A1
Protection from SLR	Unprotected	Unprotected
Agriculture water use	-5.9	-18.3
Agriculture land use	-3.6	-9.7
Agriculture labor hours	-3.9	-5.7
Production	-11	-17
Consumer prices	+26	+38
Agriculture consumption by consumers	-6	-8

Table 4-4: Change in Agriculture Annual Welfare 2030 (billions EGP), CCRMP. (2013)

Nile flow	Small decreased flow (52.5)	Large decreased flow (45.5)
SRES (SLR + crops)	A1	A1
Protection from SLR	Unprotected	Unprotected
Consumer surplus	-55	-65
Producer surplus	29	37
Trade surplus	1	1
Total welfare (consumer and producer surplus)	-25	-26

CCRMP also projected annual mortality due to heat waves as follows under different scenarios.

Table 4-5: Effect of Increased Heat Stress on Mortality, CCRMP (2013)

Estimated increase in annual mortality

	2030			2060		
	CGCM63	ECHAM	MIROC-M	CGCM63	ECHAM	MIROC-M
Optimistic	662	662	736	1,662	1,579	1,924
Pessimistic	722	722	802	2,302	2,187	2,665

Annual welfare loss (million EGP)

	2030			2060		
	CGCM63	ECHAM	MIROC-M	CGCM63	ECHAM	MIROC-M
Pessimistic	3,291	3,291	3,657	24,999	23,749	28,937
Optimistic	2,437	2,437	2,708	14,186	13,476	16,420

Moreover, coral bleaching (Figure 4-18) resulting from climate change and rising temperatures may affect tourism, given that biodiversity is a major draw for scuba diving and snorkelling in Egypt.

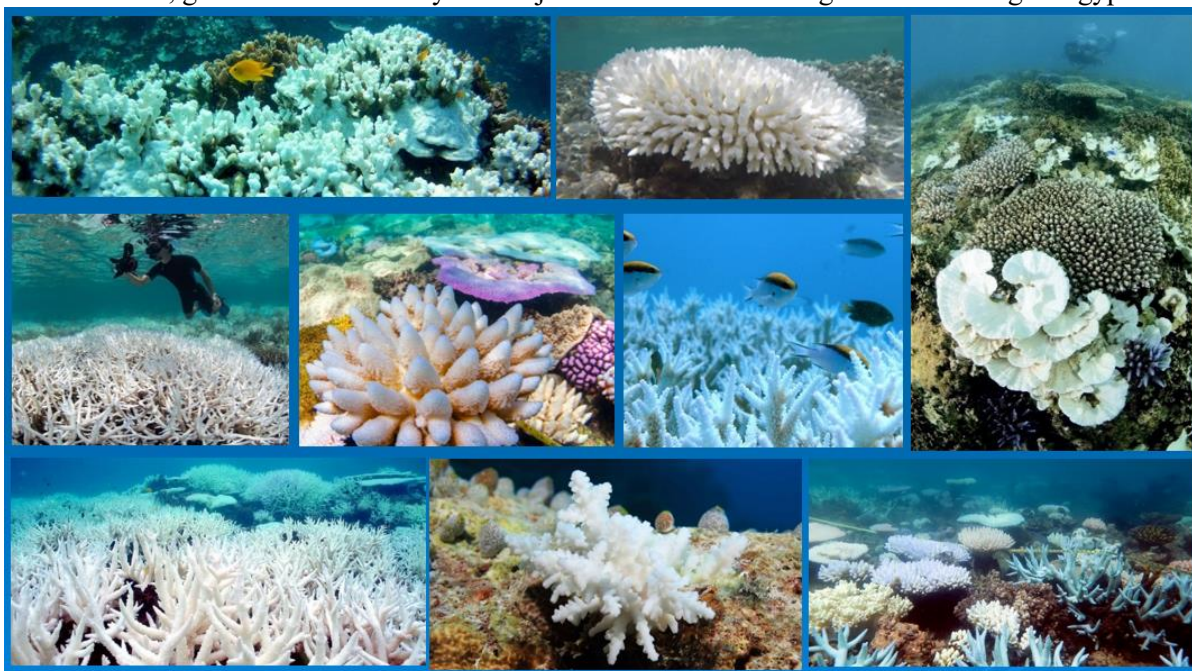


Figure 4-18: Impact of Climate Change on Coral Bleaching, CCRMP (2013)

While, projected Impacts of Climate Change on the Tourism Sector in Egyptian Pounds are given in Table 4-6 below.

Table 4-6: Annual total losses due to climate change: Estimated Impacts on Tourism, CCRMP (2013)

Climate change losses (million EGP)		
	Optimistic	Pessimistic
2030	22,168	19,265
2060	102,897	84,729

The Combined Economic Impacts by 2030 (EGP) were Estimated by the Climate Change Risk Management Program in Egypt. Table 4-7 gives impact of small and large reduction scenarios of Nile flows with Nile Delta unprotected from SLR and different socioeconomic scenarios.

Table 4-7: Combined Economic Impacts 2030 (EGP), CCRMP (2013)

Socioeconomic scenario	High population; low GDP	High population; low GDP	Low population; high GDP
Nile flow scenario	Large reduction (CGCM63)	Small reduction (ECHAM)	Small reduction (ECHAM)
Welfare loss in agriculture	26	25	20
Annual coastal property losses (excluding agriculture)	1	1	2
Value of deaths from air pollution (using VSL)	3–6	3–6	3–7
Value of deaths from heat stress (using VSL)	2–3	2–3	3
Reduction in annual tourism revenues	19	19	22
Total of selected impacts	51–55	50–54	50–54
Percent of GDP	2.2–2.4	2.2–2.4	1.6–1.8

RICCAR climate change projections were estimated for the Arab Region, including Egypt. Figures 4-19 through 4-21 show the change in the mean annual temperature, the number of summer days greater than 25 degrees Celsius and the number of hot days greater than 35 degrees Celsius. The figures show that by 2100, according to the RCP 4.5 model, there will be an increase of 2-2.5°C and an increase in the summer days of 20 days with temperatures greater than 25°C and an increase in the hot days of about 25 days with temperatures greater than 35°C.

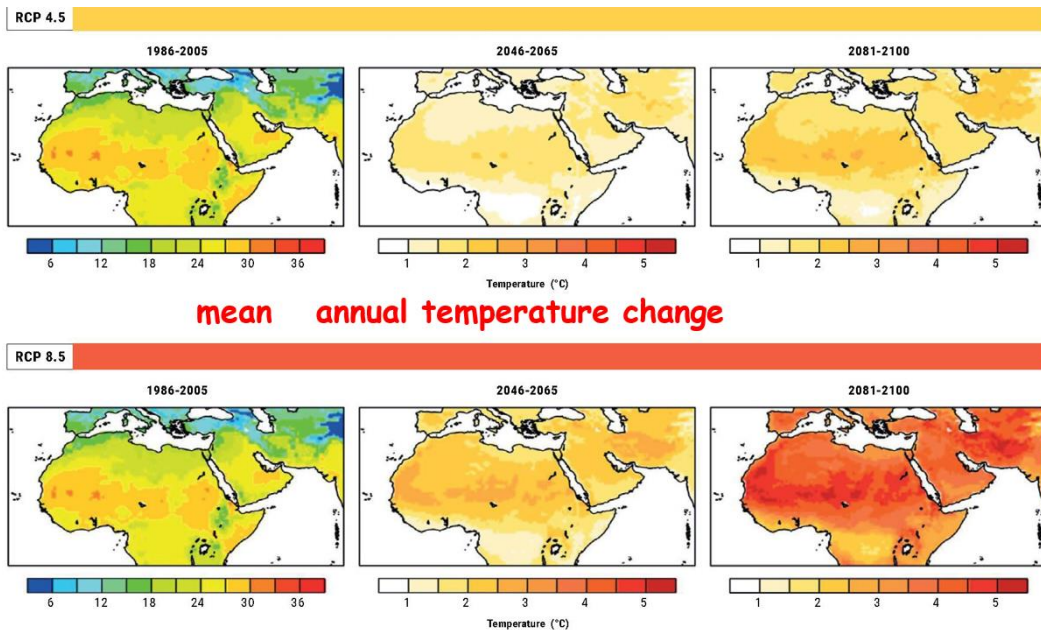


Figure 4-19: Future Projections – Temperature, RICCAR (2015)

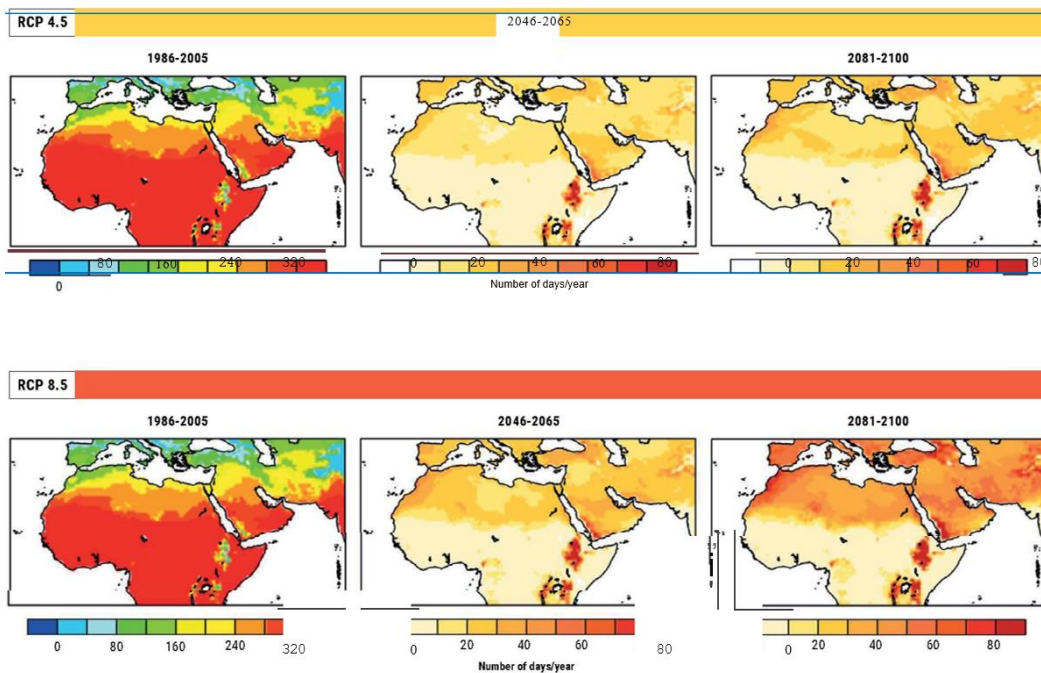


Figure 4-20: Temperature – Change in "Summer" days (>25°C), RICCAR (2015)

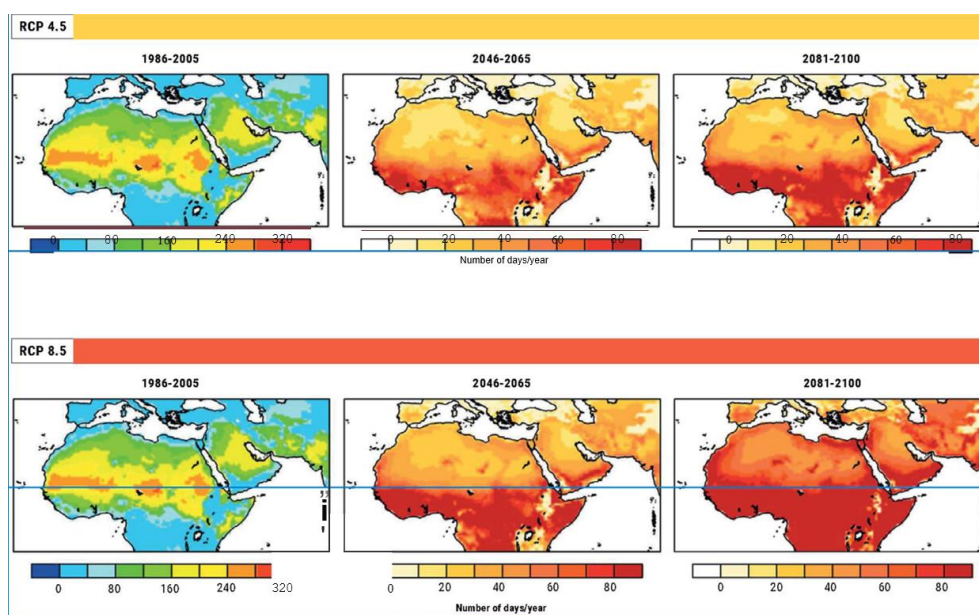


Figure 4-21: Temperature - Change in "Hot" days (>35 C°), RICCAR (2015)

4.4 Assessment of Climate Change Risks and Adaptation Measures

In this section, Tables 4-8 to 4-12 exhibit the five priority risk areas that have been identified, as well as preliminary assessments of the physical climate change impacts, which encompass both direct and indirect effects, and proposed adaptation measures that are consistent with the SDGs. The analysis draws on the “Overview & Analysis of Climate Change Risks” study and national expert consultations. The identified impacts include both slow-onset, long-term risks such as SLR and rising average temperatures, as well as short-term, immediate effects from extreme events like heat waves, droughts, flash floods, and heavy precipitation.

4.4.1 Risk 1: Sea Level Rise (SLR)

Table 4-8: Sea Level Rise SLR, Modified by AbuZeid, K. from Mohamed M. Abdel Wahab et al., 2020.

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
R1: Sea Level Rise SLR ¹²	<ul style="list-style-type: none"> North coast (particularly East- west-north coast, Delta, and Sinai coast) governorates <ul style="list-style-type: none"> Damietta Port Saied Kafr Elsheikh Dakahlia Cities <ul style="list-style-type: none"> Manzala Lakeshore, oTarh area, oeast and west of Rosetta City, 	Agriculture Land and human settlements inundation	<ul style="list-style-type: none"> Loss of houses and lands Land degradation soil salinization and sodification Loss of agricultural lands Changes in cropping pattern Reduction in crop yield Hunger and food security reduction Job losses in agricultural sector and fisheries Migration to the South Threatening of wildlife, biodiversity, and ecosystems Deserted human settlements, utilities, and services Increased risks of 	<ul style="list-style-type: none"> Efforts to compensate lost jobs in agriculture sector Goals 1 and 2 Efforts to increase food production Goals 2, 3 and 12 Relocation of migrated people Goal 11 High investment in new human settlements Goals 8 Compensation for reduced revenues from agriculture, agro-industries and inundated industrial infrastructure Goals 8 and 9 Increase rate and amounts of the loans Goals 1,2 and 13 Increase investment in farming and land reclamation Goals 1 and 13 	<ul style="list-style-type: none"> Ministry of Agriculture & Land Reclamation Ministry of Water Resources & Irrigation Ministry of Environment Ministry of Finance Ministry of Planning & Economic Development Ministry of Investment & International Cooperation Ministry of Health and Population Ministry of Transportation Ministry of

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
	<p>othe area between Gamasa</p> <ul style="list-style-type: none"> ○ Al-Gameel, ○ Sahl Al-Tina (Sinai Coast) 		<p>inundation, injury, and displacement</p> <ul style="list-style-type: none"> ● increased expenses in farming and land reclamation 	<ul style="list-style-type: none"> ● Building seawalls Goals 8,9 and 13 ● Improving societal awareness, preparedness, and warnings Goals 4, 13 and 15 ● Rethinking roads Goals 8, 9, 11, 13 and 15 	<p>Housing, Utilities and Urban Communities</p> <ul style="list-style-type: none"> ● Ministry of Defense ● Ministry of Manpower ● Ministry of Interior ● Ministry of Social Solidarity
		Saline Water Intrusion	<ul style="list-style-type: none"> □ Underground water contamination □ Increase soil salinity and sodicity □ Changes in cropping pattern □ Reduced food production □ Soil erosion and degradation □ Change in coastal plant life □ Infrastructure damage □ Deserted human settlements □ Reduced aquifer storage □ Increased risks of inundation, injury, and displacement □ Increased risk of hypertension 	<ul style="list-style-type: none"> ● Efforts to compensate reduced food production Goals 2, 3 and 12 ● Relocation of migrated people Goal 11 ● Increase Expenses in Farming Goals 1, 2 and 13 ● Building seawalls Goals 8,9 and 13 ● Increase freshwater supply Goals 3 and 6 ● Increase number of health Centers & qualified health care providers Goal 3 ● Increase robustness of infrastructural designs and long-term investments. Goals 8, 9 and 17 	<ul style="list-style-type: none"> ● Ministry of Agriculture and Land Reclamation ● Ministry of Water Resources & Irrigation ● Ministry of Environment ● Ministry of Finance ● Ministry of Planning and Economic Development ● Ministry of Investment and International Cooperation ● Ministry of Health and Population ● Ministry of Housing Utilities and Urban Communities ● Ministry of Defense ● Ministry of Manpower ● Ministry of Interior ● Ministry of Social Solidarity
		Disruption of economic activities	<ul style="list-style-type: none"> ● Decreased GDP ● Job losses ● Reduced crop yield ● Reduced food production ● High investment in coastal protection ● Demand for new settlements, facilities, and services ● Increased risks of inundation, injury, and displacement ● High investment in new human settlements ● Increased rate of loans ● Reduced income from tourism 	<ul style="list-style-type: none"> ● Compensation for lost jobs in agriculture sector Goals 1,2 and 8 ● Finding alternatives for reduced food production through agriculture expansion and/or imports Goals 2, 3 and 12 ● Increase investment in coastal protection Goals 9,13 and 17 ● Increase investment in new human settlements Goals 8 and 11 ● Compensation for reduced GDP Goals 8 and 9 ● Increased rate of loans Goals 1, 8 and 13 ● Increase Investment in Farming measures Goals 1, 8 and 13 ● Increase robustness of infrastructural designs and long-term investments. Goals 8, 9 and 17 	<ul style="list-style-type: none"> ● Ministry of Agriculture and Land Reclamation ● Ministry of Environment ● Ministry of Finance ● Ministry of Planning and Economic Development ● Ministry of Investment and International Cooperation ● Ministry of Health and Population ● Ministry of Transportation ● Ministry of Housing Utilities and Urban Communities ● Ministry of Defense ● Ministry of Manpower ● Ministry of Interior ● Ministry of Social Solidarity

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
		Flooding biodiversity habitats	<ul style="list-style-type: none"> <input type="checkbox"/> Loss of ecosystems <input type="checkbox"/> Lost jobs in fishing and tourism sectors <input type="checkbox"/> Reduced food production <input type="checkbox"/> Degradation of natural habitats <input type="checkbox"/> Threatened wildlife populations <input type="checkbox"/> Need for protection <input type="checkbox"/> Reduced ecosystem services <input type="checkbox"/> Loss of Eco-Tourism potential 	<ul style="list-style-type: none"> • Compensation for reduced Eco-Tourism Goals 8 and 15 • Coping with reduced ecosystem services Goals 14 and 15 • High investment in coastal protection Goals 9,13 and 17 • Investment in Habitat Restoration projects Goal 13, 14, and 15 • Compensation for reduced GDP Goals 8, 9 and 17 	<ul style="list-style-type: none"> • Ministry of Tourism and Antiquities • Ministry of Finance • Ministry of Planning and Economic Development • Ministry of Investment and International Cooperation • Ministry of Environment • Ministry of Health and Population

4.4.1.1 Risk 2: Temperature Increase

Table 4-9: Temperature Increase, Modified by AbuZeid, K. from Mohamed M. Abdel Wahab et al., 2020.

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation and Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
R2: Temperature increase ³⁴	<ul style="list-style-type: none"> • Most governorates especially <ul style="list-style-type: none"> ○ Alexandria ○ Cairo ○ Asyut ○ Aswan ○ Red Sea ○ South Sinai • Cities <ul style="list-style-type: none"> ○ Mansoura ○ Al-Farafra ○ Hurghada ○ Luxor ○ Awan ○ Sharm Al-Sheikh ○ 	Agriculture production	<ul style="list-style-type: none"> • Reduced crop yield • Change in planting dates • Decrease in livestock and fish production • Damage in seed stocks • increased plant diseases and pests • Reduced work times in the agriculture field • Earlier onset of migration, egg- laying and breeding for birds and insects. • Expanded desert ecosystems, • Increased mortality rate for livestock and fisheries • Increased risk of heat stroke for livestock • Increased malnutrition 	<ul style="list-style-type: none"> • Compensation for reduced agriculture production (crops, livestock, and fisheries) Goals 2, 3, 12, 15 and 17 • Adapting to changes in cropping pattern Goals 2, 13 and 15 and 17 • Curing Malnutrition Goals 2 and 3 • Changing schedules due to reduced daylight work times in the agriculture field Goals 8, 9 and 13 • Investment in agriculture expansion and food imports to cope with reduced food security and food self-sufficiency Goals 2,12 and 15 • Compensation for reduced income from agriculture Goals 8,9 and 17 	<ul style="list-style-type: none"> • Ministry of Agriculture & Land Reclamation • Ministry of Finance • Ministry of Planning and Economic Development • Ministry of Investment & International Cooperation • Ministry of Environment
		Impacts on Water	<ul style="list-style-type: none"> • Increased evapotranspiration and agriculture water demand • Increased domestic water consumption • Increased sea water temperature • Water scarcity & Reduction in water availability for all sectors • Coral bleaching • Fish migration from coastal areas • Decrease in number of tourists • Impacts on health and hygiene • Increased infections • Possible decrease in fish population and number of fish species 	<ul style="list-style-type: none"> • Investment to adapt to reduced agriculture production (crops, livestock) Goals 2, 3, 12, 13 and 15 • Investment in finding additional water supply for Agriculture, and domestic use Goals 2, 11 and 6 • Compensation for loss of jobs in tourism, industry, and other sectors Goals 1, 6, 8, 9, 12 and 13 • Investment in health care and compensations to cope with Increase in disease and death rates Goals 3 and 13 • Investment to reduce GHG emissions Goals 11 and 13 • Investment in alternative water resources to adapt to water scarcity Goal 6 	<ul style="list-style-type: none"> • Ministry of Agriculture & Land Reclamation • Ministry of Water Resources and Irrigation • Ministry of Finance • Ministry of Planning and Economic Development • Ministry of Investment and International Cooperation • Ministry of Environment • Ministry of Health and Population • Ministry of Housing, Utilities and Urban

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation and Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
					<ul style="list-style-type: none"> Communities Ministry of Tourism and Antiquities Ministry of Trade and Industry
		Energy consumption	<ul style="list-style-type: none"> Increased electricity consumption for cooling Reduced efficiency of power generation stations Increased CO₂ emissions Air pollution Biodiversity impact 	<ul style="list-style-type: none"> Investment in renewable energy to cope with Increased pressure on fossil fuel Goal 7, 8, 12 and 13 increase health care investment to adapt to potential health risks Goal 3 Compensation for reduced GDP Goals 8, 9, and 17 Rethinking Buildings and Industries Goals 9, 11, 13 and 15. 	<ul style="list-style-type: none"> Ministry of Electricity and Renewable Energy Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment Ministry of Health and Population Ministry of Trade and Industry

4.4.1.2 Risk 3: HEAT WAVES

Table 4-10: Heat Waves, Modified by AbuZeid, K. from Mohamed M. Abdel Wahab et al., 2020.

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
R3: Heat waves ⁵⁶	<ul style="list-style-type: none"> Mediterranean area North, Lower, and upper Egypt 	Agriculture production	<ul style="list-style-type: none"> Reduced agricultural production Reduced livestock production Increased prices of food Increased agriculture water consumption increased plant diseases and pests 	<ul style="list-style-type: none"> Investment to adapt to reduced food security and food self-sufficiency Goals 2, and 13 Compensation for reduced GDP, economic growth, and increased poverty from agriculture (Crops, Livestock, and fisheries) Goals 1, 8, 9, 12 and 12 Increased Public spending for Imports Increase Goals 1, 8, 9 and 12 Compensation for Farmer income reduction Goals 1, 2 and 8 Investment to compensate Impact on Fisheries Goals 14 and 13 Investment to combat plant diseases and pest Goals 13 and 15 	<ul style="list-style-type: none"> Ministry of Agriculture & Land Reclamation Ministry of Water Resources and Irrigation Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment
		Biodiversity & Energy	<ul style="list-style-type: none"> Fish migration from coastal areas Reduction in valuable biodiversity Coral bleaching Impact on scuba diving and snorkelling tourism and decrease in number of tourists Loss of jobs in tourism Increased electricity and energy consumption Increased CO₂ emissions 	<ul style="list-style-type: none"> Compensation for reduction in Biodiversity Goals 13, 14 and 15 Compensation for reduced tourism revenue Goals 1, 8 and 12 Developing renewable energy to compensate for increased energy and electricity consumption and demand Goals 7, 12 and 13 Adaptation to Increased GHG emissions Goals 7, 9 and 13 	<ul style="list-style-type: none"> Ministry of Health and Population Ministry of Electricity and Renewable Energy Ministry of Health and Population Ministry of Environment Ministry of Electricity and Renewable Energy Ministry of Tourism and Antiquities

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
		Impacts on Water	<ul style="list-style-type: none"> Increased evapotranspiration Increased water consumption in domestic and agriculture sectors Increased energy consumption in developing alternative non-conventional water resources 	<ul style="list-style-type: none"> Increase energy consumption for developing alternative water resources Goal 7 and 8 Developing alternative water resources to compensate for Water shortage in domestic and agriculture sectors Goal 6 Develop additional energy sources to fulfill Increased energy consumption Goal 8 Adapt to Increased GHG emissions Goals 9 and 13 	<ul style="list-style-type: none"> Ministry of Water Resources and Irrigation Ministry of Agriculture & Land Reclamation Ministry of Housing, Utilities and Urban Communities Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment Ministry of Electricity and Renewable Energy
		Health Risks	<ul style="list-style-type: none"> Increased Hospital admissions Increased mortality risks from various causes (e.g., heatstroke and cardiovascular disease, accidents, hypertension, chronic diseases ...etc.) Malnutrition 	<ul style="list-style-type: none"> Investment to adapt to increase in health risks Goals 3 and 13 Investment to adapt to Malnutrition Goals 2 and 3 Compensation to reduce diseases and death rates Goals 3 and 13 Increase the number of health Centers and health care providers Goal 3 and 13 	<ul style="list-style-type: none"> Ministry of Health and Population Ministry of Finance Ministry of Planning and Economic Development Ministry of Environment

4.4.1.3 Risk 4: HEAVY PRECIPITATION & FLASH FLOODING

Table 4-11: Heavy Precipitation & Flash Flooding, Modified by AbuZeid, K. from Mohamed M. Abdel Wahab et al., 2020.

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
R4: Heavy precipitation ⁷⁸	<ul style="list-style-type: none"> Most governorates especially coastal areas <ul style="list-style-type: none"> Alexandria Kafr Al-Sheikh Cairo Giza Red Sea Sohag Assiut Aswan South Sinai North Sinai Matrouh Gharbia Cities <ul style="list-style-type: none"> El Ain Sokhna Zafarana Ras Gharib Taba Kom Ombo Luxor ... 	Reduced food security and food self sufficiency	<ul style="list-style-type: none"> Loss of agricultural crops and livestock Degradation of agriculture land Damage in seed stocks Reduction in industrial food production Increased poverty and affected small farmers Changes in cropping pattern Increased pests and diseases. 	<ul style="list-style-type: none"> Compensation for reduced crops, livestock production Goals 2,3, 12 and 15 Increase agriculture land to compensate for lost land and reduced food security and food sufficiency Goals 2, 12 and 15 Compensate lost jobs in the agriculture sector Goals 1,2 and 7 Compensate reduced income Goals 1,2 and 8 Investment for Malnutrition and combating pests and diseases Goals 2 and 3 Make up for Increased Expenses Goals 1 and 13 	<ul style="list-style-type: none"> Ministry of Agriculture and Land Reclamation Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment Ministry of Health and Population Ministry of Water Resources and Irrigation
		Damage in livelihood	<ul style="list-style-type: none"> Disruption in transport and communications (e.g., road, rail, aviation, and telecommunications) Cut off in electricity supply Reduction in Health care and education 	<ul style="list-style-type: none"> Compensation for the affected homes Goal 8,11,15 Increase the number of health Centers to reduce health risks and water borne diseases and flood affected mortalities Goal 3 	<ul style="list-style-type: none"> Ministry of Finance Ministry of Planning and Economic Development Ministry of

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
			<ul style="list-style-type: none"> services Loss of billions of pounds due to damage to infrastructure and personal properties. Reduced Utility supplies Damage in housing, health, and family assets Damage to buildings, contents of buildings and Infrastructure 	<ul style="list-style-type: none"> Compensation for Reduced income growth Goals 8 Increase investment in water flood protection measures and infrastructure Goals 6, 8, and 13 Reinstate electricity infrastructure, Goals 7, 13 	<ul style="list-style-type: none"> Investment and International Cooperation Ministry of Environment Ministry of Health and Population Ministry of Transportation Ministry of Housing, Utilities and Urban Communities The Ministry of Electricity and Renewable Energy Ministry of Water Resources and Irrigation
		Economic growth	<ul style="list-style-type: none"> Seasonal and/or permanent migration Landslides Increased water logging Increased water contamination Increased mortality rate Increased risks for drowning, injury, and displacement. Increased risk of vector-borne and diarrheal disease 	<ul style="list-style-type: none"> Develop Emergency action plans and early warning systems based on monitoring and response systems Goals 13 and 15 Compensate lost jobs in the agriculture sector Goals 1,2 and 8 Relocation of migrated people Goal 11 High investment in new human settlements Goals 8 and 13 Compensate for Reduced GDP Goals 8 and 13 Directing investment allocated to economic growth to building protection walls and storm drainage Goals 6, 8, 9 and 13 Rethinking roads design (using culverts, pervious pavement) Goals 9,13 and 15 	<ul style="list-style-type: none"> Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Health and Population Ministry of Transportation Ministry of Housing, Utilities and Urban Communities The Ministry of Electricity and Renewable Energy Ministry of Water Resources and Irrigation
R4b: Flash flooding ⁹¹⁰	<ul style="list-style-type: none"> Governorates <ul style="list-style-type: none"> Sinai Red Sea Alexandria Cairo Aswan ... Cities <ul style="list-style-type: none"> Dronka Meet Ghamr New Cairo ... 	Agriculture land	<ul style="list-style-type: none"> Loss in crop production Soil erosion Degradation of agriculture land Reduction in Livestock and fish production Damage in seed stocks Increased diseases and insects Increased poverty of affected small farmers Changes in cropping pattern Reduced Food security 	<ul style="list-style-type: none"> Increase Expenses in farming Goals 1 and 13 Increase agriculture production (crops, livestock, and fisheries) Goals 2, 12 and 15 Increase food security and food self-sufficiency Goals 2, 12 and 13 Improve cropping pattern Goals 2, 12 and 13 Compensate for lost jobs in the agriculture sector Goals 1, 2 and 8 	<ul style="list-style-type: none"> Ministry of Agriculture & Land Reclamation Ministry of Water Resources and Irrigation Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment
		Economic activities	<ul style="list-style-type: none"> Loss of billions of pounds through damage to the infrastructure, road, and transport. Damage to infrastructure Seeking alternative income sources 	<ul style="list-style-type: none"> High investment in water Goals 6, 8, 12 and 15 Emergency action based on monitoring, warning, and response systems Goals 11, 13 and 15 Relocation of migrating people Goal 11 	<ul style="list-style-type: none"> Ministry of Water Resources and Irrigation Ministry of Finance Ministry of Planning and Economic

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
			<ul style="list-style-type: none"> Seasonal migration Disruption in transport and communications (e.g., road, rail, and telecommunications) Cut off in electricity supply Increase in the number of homeless 	<ul style="list-style-type: none"> Compensate Reduced GDP Goals 7, 8, 9, 12 and 13 Increase the rate of loans Goals 1, 2 and 13 Building flood protection structures Goals 6, 8, 9 and 13 Increase robustness of infrastructural designs and long-term investments Goals 8, 9 and 11 Rethinking roads design (using culverts, pervious pavement) Goals 9, 13 and 15 	<ul style="list-style-type: none"> Development Ministry of Investment and International Cooperation Ministry of Transportation Ministry of Housing Utilities and Urban Communities The Ministry of Electricity and Renewable Energy Ministry of Environment
		Health crises	<ul style="list-style-type: none"> Increased water contamination Increased mortality rate Increased risks of drowning, injury, and displacement. Increased risk of water borne diseases 	<ul style="list-style-type: none"> Increase health care Goal 3 and 13 Increase the number of health Centre Goal 3 Improving societal awareness, preparedness, and warnings Goals 4 	<ul style="list-style-type: none"> Ministry of Health and Population Ministry of Water Resources and Irrigation Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment

4.4.1.4 Risk 5: DROUGHTS

Table 4-12: Droughts, Modified by AbuZeid, K. from Mohamed M. Abdel Wahab et al., 2020.

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
R5: Drought ¹¹²	<ul style="list-style-type: none"> North, Lower, and upper Egypt 	Degradation of agricultural land	<ul style="list-style-type: none"> Reduced crops, livestock, and fisheries production Increased livestock and fisheries mortality rates Increased soil erosion and land degradation Increased plant diseases Reduced agricultural land Increased food prices Changes in cropping pattern Reduced rainfed agriculture in North Coast Reduced food security and Malnutrition 	<ul style="list-style-type: none"> Compensate Farmer income reduction; Goals 1, 2 and 8 <ul style="list-style-type: none"> Compensate lost jobs in the agriculture sector; Goals 1, 2, 8 and 10 Increase food Imports; Goals 2 and 8 Increase water supply by non-conventional water resources and reuse; Goals 2, 6 and 15 Increase investment in recycled water treatment; Goal 6 and 8 Establish monitoring and early warning systems and response; Goals 4, 13 and 15 	<ul style="list-style-type: none"> Ministry of Agriculture & Land Reclamation Ministry of Water Resources and Irrigation Ministry of Finance Ministry of Planning and Economic Development Ministry of Investment and International Cooperation Ministry of Environment Ministry of Health and Population

Climate Risk	Geographical Impacts	Physical Impacts	National Direct/ Indirect Impact Results	Adaptation & Sustainable Development Goals (SDGs) Linkage	Relevant Stakeholders
		Reduction in water resources availability	<ul style="list-style-type: none"> • Degradation of water resources quantity and quality, • migration of people and Livestock • Competition for water • Increased water demand • Increased risks of drought impacts • decreased hygiene and infections 	<ul style="list-style-type: none"> • Compensate for Water shortage Goal 6 • Compensate for declined food production Goals 2 and 12 • High investment in water desalination Goals 6, 8 and 12 • Increased water conversation Goals 6, 8, and 12 • Increased investment in water conservation & reuse Goals 6, 8 and 12 • Relocation of migrated people Goal 10 and 11 	<ul style="list-style-type: none"> • Ministry of Agriculture & Land Reclamation • Ministry of Water Resources and Irrigation • Ministry of Finance • Ministry of Planning and Economic Development • Ministry of Investment and International Cooperation • Ministry of Environment • Ministry of Health and Population • Ministry of Housing Utilities and Urban Communities

4.5 Analysis of Impacts of Climate Change Risks on Vulnerable Sectors

Some sectors are more vulnerable to climate change than others, with particularly significant risks for Egypt’s water sector. This vulnerability is the result of the complex interplay of influencing factors, including climate change, population growth, development requirements, and the uncertainties associated with the Nile River's transboundary nature, as well as the insufficient supply of natural water to meet the increasing demand.

The water sector in Egypt is particularly vulnerable due to the country’s reliance on the Nile River, its primary water source. Egypt lies at the far downstream end of a river shared by 11 countries: Burundi, Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, and Uganda. Egypt’s annual share of Nile water is 55.5 BCM. Climate change impacts on this vital resource must be assessed not only within Egypt but also upstream, beyond its political boundaries. These risks are further compounded by upstream activities and unilateral infrastructure developments, such as the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile, illustrated in Figure 4-22.



Figure 4-22: GERD Dam in Ethiopia during the early stage of construction on the Blue Nile, AbuZeid, K. 2021

The impact of the GERD on the Nile water shares of Egypt and Sudan has been analysed in a study (AbuZeid, 2019), which presents projections of water levels in the HAD over the next 100 years, as shown in Figure 4-23. By simulating historical Blue Nile flow records, the study demonstrates how reservoir levels could significantly decline during drought years, potentially affecting Egypt’s allocated share of 55.5 BCM/year and Sudan’s 18.5 BCM/year. Climate change-induced droughts or reductions in Blue Nile flows could further exacerbate these effects.

However, Egypt’s share of water is threatened by unilateral & uncoordinated development projects built in the Nile Basin countries, such as GERD. It is worth noting that Egypt, Ethiopia & Sudan signed, in 2015, the “Declaration of Principles”, which obliges Ethiopia to reach an agreement on the rules governing the processes of filling and operation of the GERD. It is an agreement that preserves common rights and interests while not taking any unilateral decisions or actions that negatively impact the water resources of Egypt and affect stability in the region. Unfortunately, such an agreement has not been reached to date, and Egypt is keen to continue negotiation in good faith, aiming at reaching that balanced and binding agreement governing the filling and operation of the GERD.

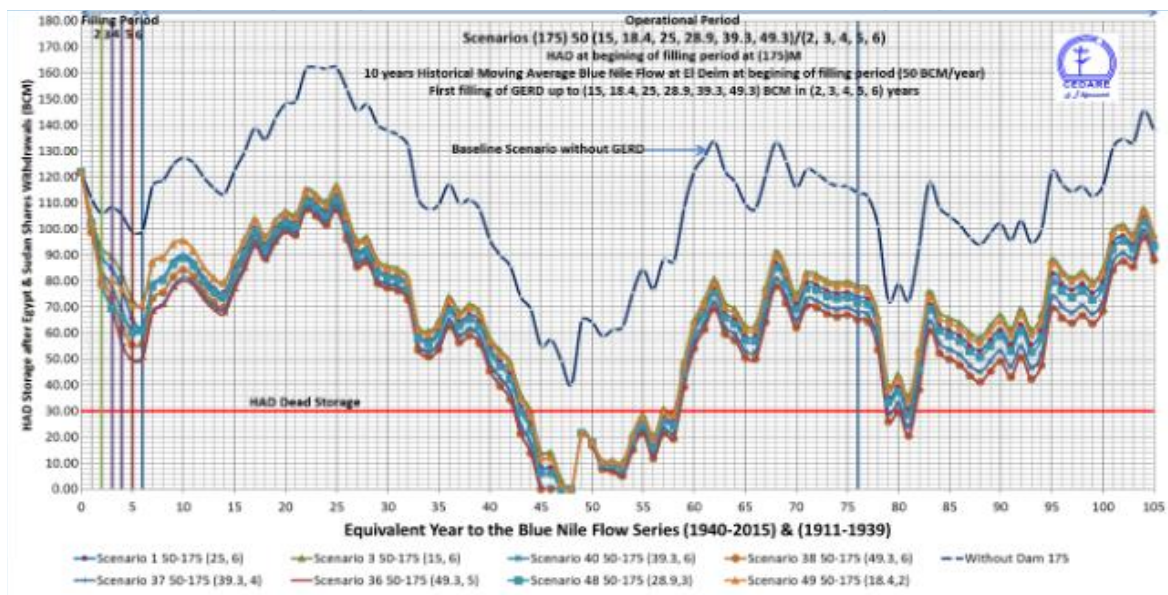


Figure 4-23: Impact of the GERD on Egypt and Sudan Nile Water Shares, AbuZeid, K. 2019

In summary, the primary challenge that the GERD poses to Egypt lies in the agricultural sector. A reduction in agricultural output will undermine Egypt’s food self-sufficiency, requiring increased food imports—placing an additional burden on the national economy. In addition to agriculture, GERD will affect hydropower generation at the High Aswan Dam (HAD). Under normal operation, GERD’s main impact results from increased evaporation losses, either from its reservoir or from irrigation systems. While GERD itself, as a hydropower dam, does not consume water, its reservoir does. Heightened evaporation from both the GERD and Sudanese reservoirs will affect the overall water balance. GERD will enable Sudanese reservoirs to operate at higher levels, further increasing evaporation losses in the Eastern Nile.

We expect reduced agricultural production and job losses to escalate poverty, trigger social tensions, and worsen public health conditions. These deteriorating local conditions may drive migration—both internally from rural to urban areas and externally, including irregular migration. An increase in crime rates is also anticipated. While quantifying these effects is complex due to overlapping drivers beyond GERD alone, an expert opinion approach has been adopted to assess them across different strategic

scenarios. The outcomes are closely tied to water availability at Aswan, with corresponding recommendations applied for GERD's first filling and operational strategies.

In both normal operation and during the first filling, reduced water availability will worsen the salinity problem in the Nile Delta, due to insufficient water for flushing and leaching salts from the soil. If the first filling occurs under drought conditions, Delta salinity could increase by 31%. Public water supply will also suffer; where currently 69% of the supply is of good quality, this figure may drop to 55%. These projections assume a reduction in irrigated areas to accommodate the increased irrigation demand required for salt leaching. The resulting decrease in agricultural output from reduced irrigation will further compound the economic and social damages to Egypt.

The agriculture sector is another one of those important sectors that are also very vulnerable to climate change risks. Issues of food security are susceptible to population growth and could be exacerbated by the impact of climate change on crop productivity as well as water availability for agriculture. There is also an impact on farmers' income due to climate change impacts. Table 4-13 shows the net return per acre (in Egyptian pounds) for some staple commodities under current weather conditions and future climate change conditions and the rate of change between them.

Table 4-13: Climate Change Impact on Crop Yield, Abou Hadid, 2006

Some Key Commodities	Net yield/acre Under Current Weather Conditions		Net yield/acre Under Future Climate Change Conditions		Change Rate	
	Owning the Land	Land Rent	Owning the Land	Land Rent	Owning the Land	Land Rent
Wheat	2784	1956	2076	1248	-25.4	-36.2
Rice	4127	2458	3440	1771	-16.7	-28.0
Maize	2768	1611	1835	678	-33.7	-57.9
Sugar Cane	7194	5436	4327	2569	-39.8	-52.7
Summer Tomato*	7753	6696	2194	1137	-71.7	-83.0

Figure 4-24 illustrates the results of another study which shows the reduction in crop productivity by 2050 due to climate change impact in Egypt.

Change percent in major crop production in Egypt by the year 2050 due to climate change.

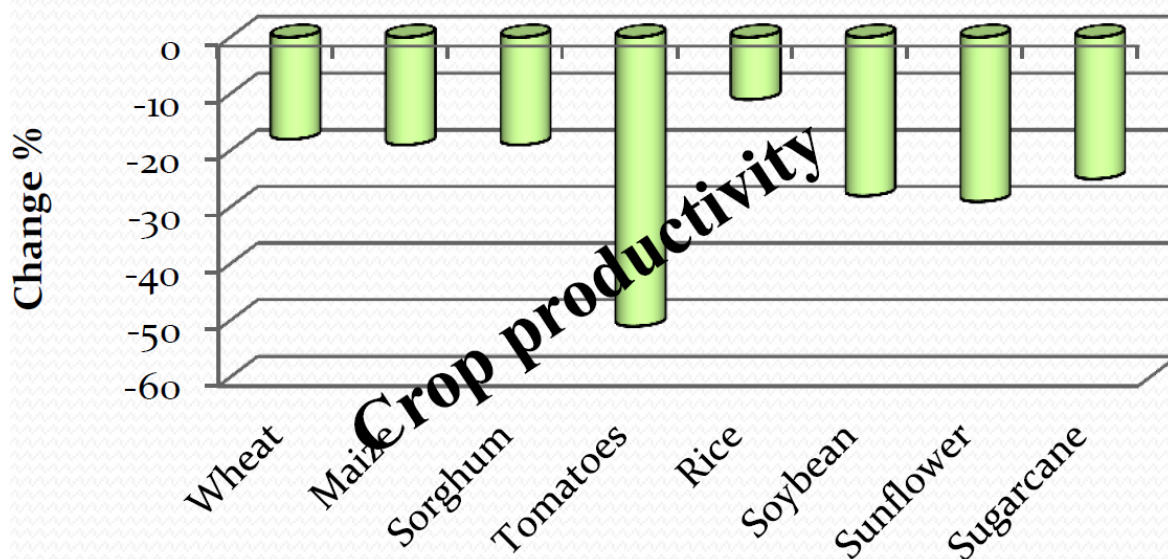


Figure 4-24: Reduction in crop productivity by 2050 due to climate change in Egypt, Samia El-Masrafawy, 2021

The impact of climate change on agriculture can be attributed to several factors, including heat waves, cold waves, increased temperature, droughts, water shortages, windstorms, unexpected hailstorms, and heavy precipitation incidents. In recent years, the combination of these extreme events has demonstrated their negative impacts on agriculture in Egypt.

Figure 4-25 illustrates the improvement in wheat grain yield in Egypt over the past three decades. However, it also shows that in certain years, the yield declined due to climate change-induced extreme events, despite the overall upward trend.

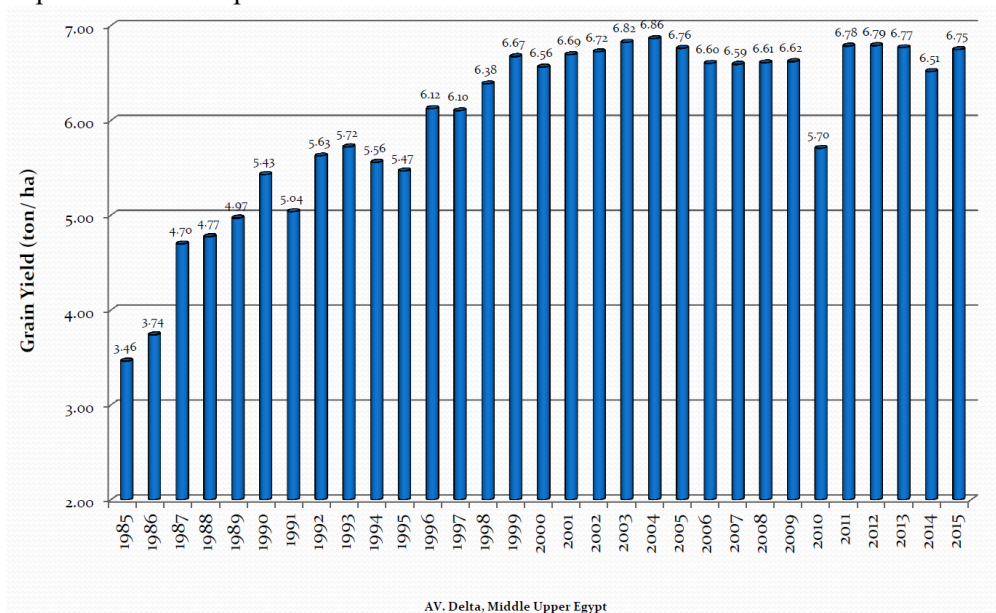


Figure 4-25: Wheat production in Egypt in 3 decades (1985 - 2015), Samia El-Masrafawy, 2021

Maize production showed similar trends for upper, middle, and lower Egypt where lower Egypt showed higher yield than middle and upper Egypt.

Winter tomatoes showed similar impacts with less impacts in Lower Egypt than upper and middle Egypt as shown in the Figure 4-26 below.

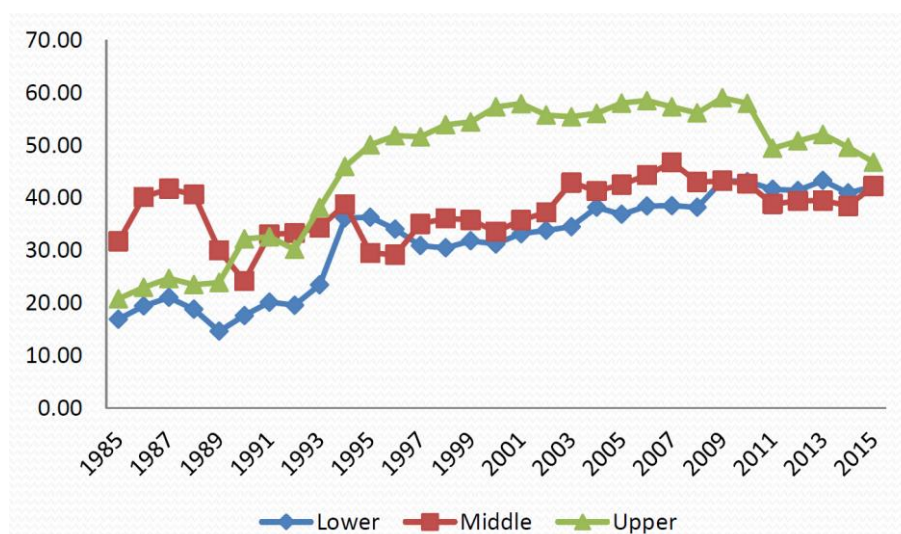


Figure 4-26: Winter tomato production in northern, central & southern Egypt, tonnes/ha, Samia El-Masrafawy, 2021

Sugarcane has experienced similar climate-related impacts, with effects being more pronounced in Upper and Middle Egypt compared to Lower Egypt. This is notable given that sugarcane generally achieves higher yields in Upper and Middle Egypt.

In contrast, mangoes have shown a long-term decline in productivity, highlighting their greater vulnerability to gradual and frequent climatic and weather fluctuations rather than to extreme events. Mangoes are among Egypt’s most prominent fruit varieties.

Biodiversity is another important sector that is affected by the increase of sea and ocean water temperature, which is currently triggering the spread of many invasive alien species. Some species are causing human health hazards (such as the toxic puffer fish), and others are causing economic impacts and environmental impacts (e.g., temperature). The link between climate change and biodiversity is well established, with significant impacts observed on both terrestrial and marine ecosystems. In Egypt, coral bleaching and marine life have been impacted by the rising water temperatures and increased acidity in the Red Sea, one of the country's main tourist destinations. This has the potential to have an indirect negative impact on tourism. Protected areas can play a role in mitigating climate change by contributing to CO₂ reduction. Several studies on coastal lakes and mangrove ecosystems along the Red Sea have demonstrated substantial carbon sequestration in these shallow environments, which are both influenced by and vulnerable to climate change.

The Nile Delta is the most vulnerable coastal region in Egypt to SLR and extreme weather events driven by climate change. SLR will have severe socio-economic impacts on infrastructure, loss of livelihoods, people migration, unemployment increase, spread of diseases, and loss in food production, in addition to saltwater intrusion into coastal groundwater aquifers causing soil salinisation, loss of crop productivity and freshwater fisheries. The tourism sector is also affected by climate change impacts on biodiversity, fisheries, and especially marine life habitat when it comes to snorkelling, scuba diving, and fishing-based tourism in the Red Sea with long coastal lines hosting cities such as Dahab, Taba, Sharm El-Sheikh, Hurghada, Marsa Allam, and others. Table 4-26 shows estimates of economic impacts of climate change on the tourism sector, which is closely affected by impacts on biodiversity.

Human Health

Climate change significantly threatens human health in Egypt, with rising temperatures contributing to increased cases of heat stroke, cardiovascular complications, and respiratory infections, particularly among vulnerable groups such as the elderly, children, women, and those with chronic illnesses. The 2015 heatwave, for example, led to notable increases in heat-related illnesses. Higher humidity and poor ventilation also contribute to fungal infections, while mental health challenges are on the rise due to extreme weather events and climate-induced stress.

Indirect impacts are equally critical. Climate-driven migration has introduced infectious diseases like schistosomiasis and tuberculosis into new regions. Flooding, such as that in Alexandria in 2015, disrupted clean water supplies and increased diarrhoeal disease risk. Changing climate patterns are also altering the spread of vector-borne diseases like dengue. With a large portion of Egypt's population classified as health-vulnerable, strengthening healthcare systems and improving climate-health awareness is essential. Figure 4-27 shows potential impacts of climate change on human health.

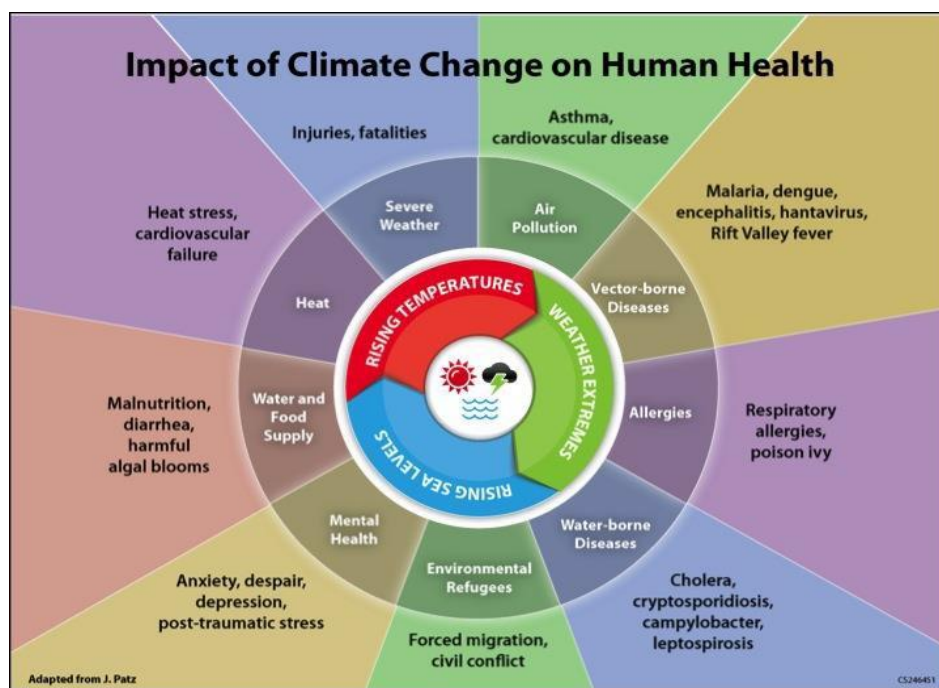


Figure 4-27: climate change Impact on human health, Amal Saad-Hussein, 2021 & (who.int), 2018

Human health impacts due to climate change can be divided into direct and indirect impacts as shown in Figure 4-28.



Figure 4-28: Human health impacts due to climate change, Amal Saad-Hussein, 2021, & (who.int), 2018

The effect of high temperatures on chronic diseases, through their impact on various medications, is illustrated in Figure 4-29 below.

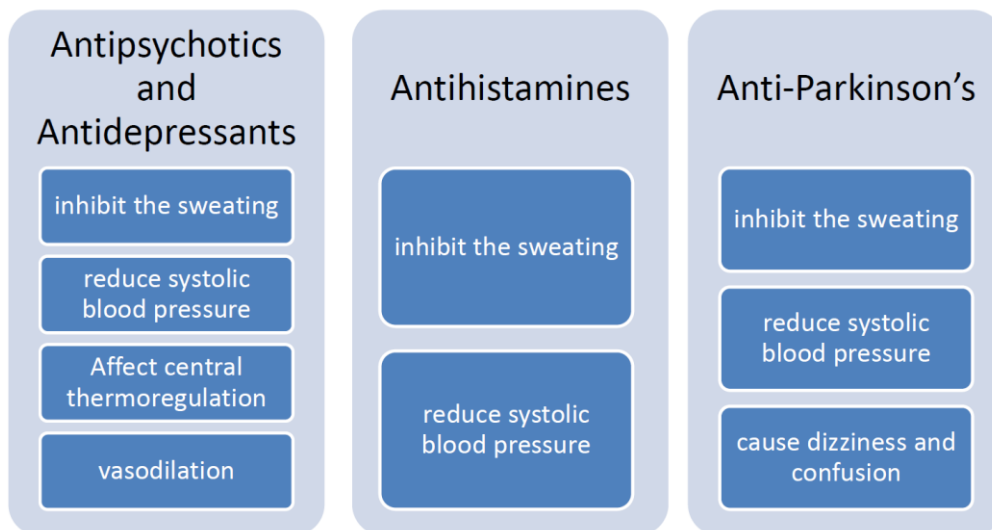


Figure 4-29: Heat Impact on Medicine Use, Amal Saad-Hussein, 2021

The following diagram (Figure 4-30) shows the relationship between different climate change risk areas and diarrheal diseases.

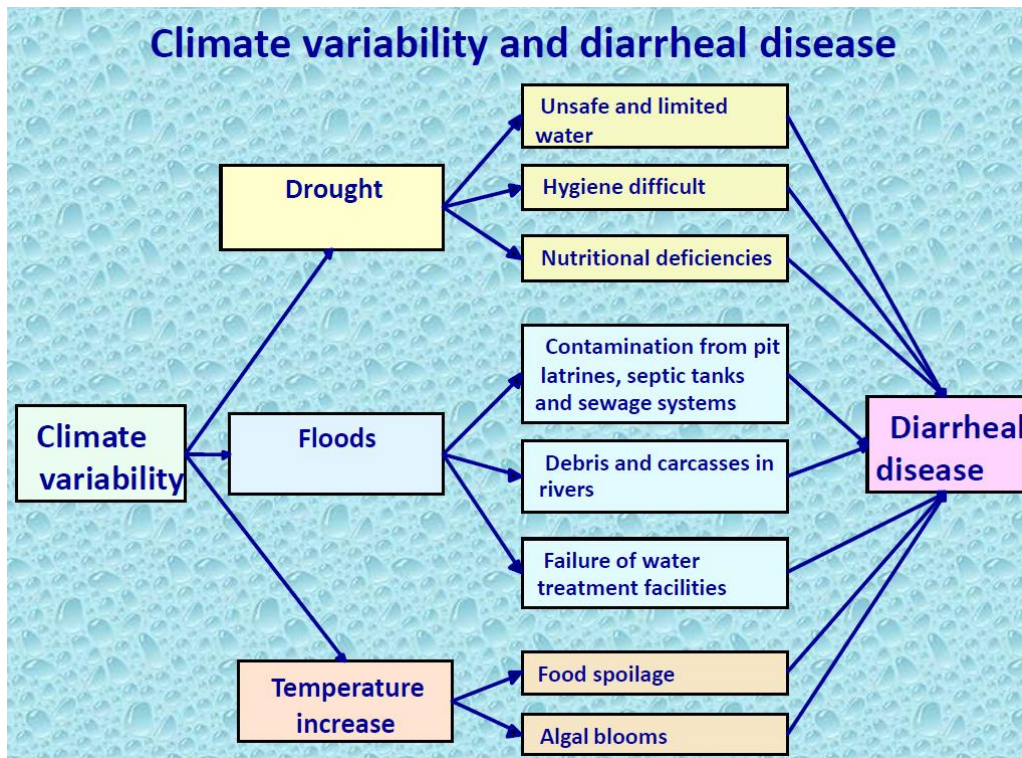


Figure 4-30: Relationship between different climate change risks & diarrheal diseases, Amal Saad-Hussein, 2021

Diarrhoeal diseases are directly affected by climate change due to increased occurrence and survival of bacterial agents, toxic algal blooms, and viral pathogens in water, compounded by the *lack of safe water*, which undermines hygiene (WHO, 2012).

The time series trend of bilharzial bladder cancer in Egypt and its connection to *climate change* is reflected in a study showing that, between 1995 and 2005, the relative frequency of bilharzial bladder cancer significantly declined across most of urban, upper, and lower Egypt, attributed to rising air temperatures (Ahmed, S.A., et al., 2014).

The energy sector is also vulnerable to climate change. Hydropower production from the High Dam, Aswan Dam power plants, Esna Barrage, Naga Hamadi Barrage, and Assiut Barrage may be impacted by reduced Nile flows and increased evaporation. Moreover, energy consumption for air conditioning is expected to rise due to higher temperatures and more frequent heat waves.

4.6 Government & Community-Based Adaptation

There are several adaptation projects that Egypt is implementing; some of these projects include:

- “Building Resilient Food Security Systems to Benefit the Southern Egyptian Region”, funded by the Adaptation Fund and implemented by the Ministry of Agriculture and Land Reclamation (MALR), aims to enhance the adaptive capacity of Southern Egypt, which is particularly vulnerable to reduced food production.
- “Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions of Egypt (ECCADP)”, funded by approximately USD 31 million through the GCF in partnership with UNDP since 2017, is currently being implemented by the MWRI. This project is built on a prior GEF study funded at USD 4 million, with additional government contributions of USD 8 million to the GEF phase and USD 76 million to the GCF phase. The “Development of a

Climate Resilient ICZM Plan for the North Coast of Egypt”, a core component of the ECCADP project, supports climate change adaptation along the North Coast, particularly in the Nile Delta. Key actions under this component include:

- Assessing baseline conditions of the coastal zone
- Establishing a temporary Geographic Information System (GIS) web-based platform
- Identifying the existing legal and institutional setup
- Developing detailed climate scenarios
- Creating a strategy to divide the coast into Coastal Management Units

Several adaptation measures were implemented to protect the North Coast from SLR as shown in Figure 4-31.



Figure 4- 31: Shore Protection Techniques against Sea Level Rise, Kafr Al-Sheikh Governorate, Mohamed A. Ali, 2021

Two main adaptation approaches are being implemented by MALR and the Agricultural Research Centre (ARC), in collaboration with the farming community, to address the effects of weather fluctuations on agricultural productivity and to prevent or minimise potential damage.

The first approach focuses on optimising irrigation management and selecting the most suitable planting dates for each crop, tailored to the conditions of different climatic regions. This is supported by national awareness campaigns, agricultural extension services, field schools, and training seminars, which play a vital role in educating farmers on climate adaptation strategies.

The second approach involves the use of short-term forecasting, early warning systems, rapid notification, and the dissemination of preventive measures to prepare for and respond to extreme weather events.

The agricultural extension sector currently plays a major role in providing advice starting from preparing the land for planting to harvesting to advocating specific adaptation efforts in the agriculture sector including:

1. Breeding new varieties that are tolerant to high temperature, salinity, and drought.
2. Introducing new breeds with short growing seasons to reduce water requirements.
3. Changing planting times to adapt to new weather conditions.
4. Choosing cropping patterns that achieves maximum yield per unit of land and water.
5. Maintaining high productivity of land resources and protection from degradation and low productivity.
6. Confronting extreme events with speedy responses.
7. Supporting scientific and applied research and technology transfer in adaptation to climate change.
8. Raising awareness on climate change impacts and adaptation at all levels.

In the **water sector** especially vis-à-vis the **agriculture sector**, adaptation measures include:

1. Laser ground levelling
2. Encouraging planting on terraces
3. Cultivation of alfalfa by dry methods instead of glossy
4. Implementation of modern irrigation systems (sprinkler - drip)
5. Irrigation at the appropriate times and with the appropriate amount of water.
6. Raising efficiency of farm irrigation systems
7. Increasing efficiency of rainwater use
8. Increasing efficiency of groundwater use for agricultural uses.

In the water sector in general, the following are considered potential adaptation measures:

- Water Demand Management Policies
- Heat, Drought & Salt Tolerant Crops
- Upper Nile Projects to increase Nile River Yield
- Upper Nile Joint Management Plans
- Evaporation Losses Reductions Schemes
- Water Reuse Strategies
- Early Warning Systems
- Emergency Warning Systems
- Farmers Awareness & Training Programs
- Building Codes for Cool Building Temperatures
- Agriculture Farmers Protection Climate Fund

Some of the adaptation measures in the water sector may need to be implemented upstream of the Nile River. For example, reducing the Ethiopian GERD Dam design storage capacity can reduce the drought risk in downstream countries due to the reduction of evaporation and seepage losses from the Dam reservoir (AbuZeid, K., 2017a). The GERD dam is the largest on the Blue Nile, with a capacity of 74 BCM, being more than 1.5 times the size of the annual average flow of the Blue Nile. If the dam is operated at low annual average levels, the water surface area in the dam reservoir will be less, and the evaporation and seepage losses will be less, which decreases the negative impacts of filling & operating the dam on Egypt and Sudan.

On the other hand, the Egyptian government has initiated a new approach to developing non-conventional water resources by treating agricultural drainage water for reuse in agriculture. This effort addresses the freshwater shortages Egypt is facing, as well as climate change-induced droughts that may impact agriculture and food production, in addition to rising water demand due to increasing temperatures. The Mahsama Agricultural Drainage Treatment Plant, with a capacity of 1 million m³/day; the Bahr El-Baqar Plant, the largest in the world, with 5.6 million m³/day; and the New Delta Plant, expected to reach 7.5 million m³/day, are examples of such facilities inaugurated in 2020 and 2021 and expected in 2022, respectively. These projects have received giant investments, estimated in the tens of billions of Egyptian pounds.

The reuse of treated wastewater in agriculture is considered a key adaptation measure, providing an essential source of water to help augment Egypt's overall water budget. The Al-Gabal Al-Asfar Plant, with a capacity of 2.5 million m³/day, is one of the largest wastewater treatment facilities in both Egypt and the world and is currently being expanded to reach 3.5 million m³/day.

On the other hand, seawater and brackish water desalination represent another important unconventional water resource that can help offset climate change-induced water shortages and address natural water scarcity. The Galala Desalination Plant, located on the Red Sea, is one of the newly constructed facilities, with a capacity of approximately 150,000 m³/day. Egypt has set a target to expand desalination capacity to around 1.5 million m³/day by 2030.

In the human health sector, adaptation measures to infectious diseases include the following:

- Providing vaccinations against vaccine-preventable diseases.
- Controlling emerging infectious diseases by developing new vaccines.
- Providing chemotherapy and prophylaxis.
- Quarantine procedures for returnees from affected countries.
- Raising public health and environmental awareness of climate change and ways to protect them from its health impacts.

4.7 Cost of Climate Change Damages & Adaptation Measures

Assessing the cost of adaptation measures required across different sectors is essential. Equally important is the evaluation of the avoided damage costs and the benefits resulting from the implementation of such measures. To illustrate the potential value of adaptation, Figure 4-32 presents an assessment of the economic costs of damages linked to climate change-induced extreme events that have affected Egypt in recent years, along with estimated lives lost during these events.



Figure 4-32: Human losses resulting from heavy rains and floods 2018 -2020, Egyptian Cabinet, 2021

Figure 4-32 provided by the Information and Decision Support Centre (IDSC) shows that lost lives and injuries due to heavy rains and flash floods reached as many as 33 deaths and 73 injuries in 2020, with a total of 52 deaths and 82 injuries during the 3 successive years between 2018 and 2020.

The total cost of damages in the agriculture, transportation, electricity and RE, tourism, and antiquities sectors, along with compensations provided by the Ministry of Social Solidarity to support affected low-income groups, amounted to approximately 328 million Egyptian pounds during the period from 2018 to 2020. It is important to highlight that this figure excludes additional damage costs related to private property losses incurred by wealthier citizens, such as damaged cars and homes resulting from urban flooding events caused by isolated incidents of intense, short-duration rainfall. Figure 4-33 shows that in 2018 damage costs reached about 15 million EGP and another 14 million EGP in 2019, whereas they reached 298 million EGP in 2020.

Additional damage costs are incurred in other sectors, particularly from infrastructure damage caused by SLR, shoreline erosion, and seawater intrusion into coastal cities. These impacts are especially evident during high wave storms affecting areas such as Alexandria, Abukir, Port Said, Damietta, Ras Al-Bar, and the North Coast Highway in the middle Delta. Strengthening national capacity to assess both direct and indirect damage costs is essential for generating more accurate and comprehensive estimates of total losses, covering all sectors, including private property.

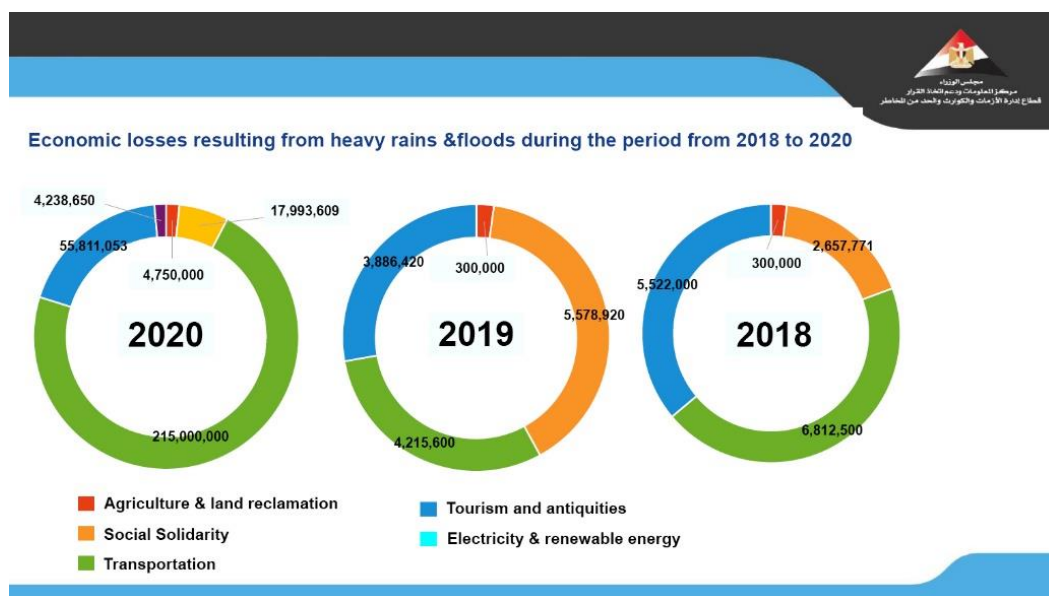


Figure 4-33: Economic losses resulting from heavy rains and floods 2018 - 2020, Egyptian Cabinet, 2021

The Climate Change Risk Management Program (CCRMP) reports (2013) indicate that the potential impacts of climate change on the Egyptian economy could reach hundreds of billions of Egyptian pounds, as shown in Figure 4-34.

Estimates for Egypt suggest that the combined impact of climate change on water resources, tourism revenue, coastal resources, agriculture and human health through air pollution and water stress represents between 2% and 6% of Egypt's GDP by 2060. Coastal flooding in Alexandria, which supports 40% of Egypt's industrial capacity, is projected to result in annual losses of between US\$504 and \$580 million by 2050. Coastal flood risk in Alexandria highlights the need for a comprehensive ICZM to institutionalise coordination among national ministries and governorate- and city-level agencies in 36 cities and urban bodies in the coastal zone. Estimates suggest that by 2050, climate

change may bring about daily losses to tourism revenue in the Red Sea’s Sahl Hasheesh and Makadi Bay in excess of US\$350,000. (World Bank Group, 2022).

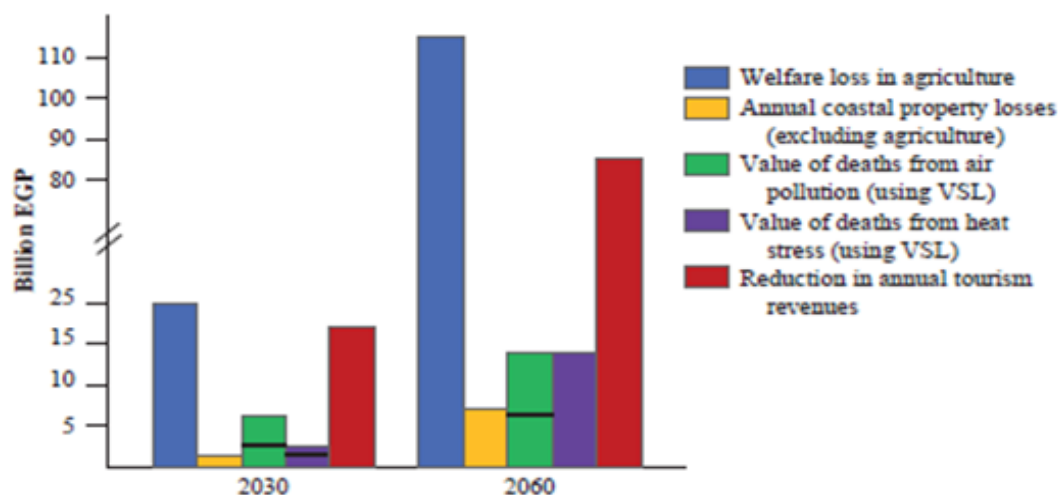


Figure 4-34: Climate Change Economic Valuation, CCRMP 2013

On the other hand, Table 4-14 shows the estimated adaptation costs to be spent between 2020 and 2030 for 7 sectors as per the “Overview & Analysis of Climate Change Risks Study in Egypt”.

Table 4-14: Cost of Adaptation, Mohamed M. Abdel Wahab et al., 2020

Adaptation Measures Sector	Adaptation Measures Cost Estimate (EGP Billion)		
	2015 Estimate	2020 Estimate based on change in Currency Exchange rate	2020 Estimate based on change in Currency Exchange & Inflation
Research, Studies, Projects, and Programs	0.03	0.06	0.07
Coastal Zone Sector	8.61	17.45	19.16
Water resources and Irrigation Sector	3.35	6.79	7.46
Agricultural & Fishery Sector	7.93	16.07	17.65
Health Sector	1.16	2.35	2.58
Rural Areas, Housing and Roads Sector	31.80	64.46	70.78
Tourism Sector	0.19	0.39	0.42
Total EGP Billion	53.07	107.57	118.11

Another adaptation cost estimate for adaptation for the period (2010-2035) is shown in Table 4-15 below totalling 28.9 billion USD.

Table 4-15: Adaptation cost estimate for adaptation for the period (2010-2035)

Sector	Estimated cost (billion US \$)
Protecting coastal zone ¹	3.96
Water resource and irrigatio ²	2.11
Agricultural ²	2.96
Rural areas, population and roads ²	5.9
Health ²	2.01
Tourism ²	0.04
Energy ¹	8.02
Extreme climate events ³	3.9
Total cost	28.9

- 1 NEEDS report (2010)
- 2 National strategy framework (2011)
- 3 Preliminary study

These adaptation cost estimates remain lower than the projected economic losses and damages from climate change impacts if no action is taken. According to studies conducted under the CCRMP in 2012, and as shown in Figure 62, total annual losses due to climate change by 2030 are estimated at approximately 50 billion EGP. This represents less than 2% of GDP under an optimistic scenario and over 2% of GDP under a pessimistic scenario.

We expect both absolute and relative economic impacts to significantly increase by 2060, with total annual losses ranging between 200 and 350 billion EGP. In the pessimistic scenario, welfare losses amount to nearly 4% of GDP under the small Nile flow reduction scenario, and around 6% of GDP under the large reduction scenario. Across both timeframes, the agriculture sector is projected to suffer the largest economic losses, followed by the tourism sector. It is important to note that these estimates do not capture the full range of economic consequences from climate change. Additional impacts such as air and water pollution, SLR effects on urban areas, and the negative effects of reduced water flows, increased water temperatures, and SLR on fisheries, as well as biodiversity loss and other direct and indirect effects, would also contribute to significant economic damage. (UNDP, 2012)

5 Capacity Building, Education, Information, Training, Networking, Public Awareness and Gender

5.1 Introduction

Egypt considers capacity building, education, information, training, public awareness, networking, and gender inclusion as fundamental to addressing climate change mitigation and adaptation. These elements enable informed decision-making, strengthen institutions, and promote inclusive engagement, particularly among youth and women. As reflected in its Vision 2030 and the NDCs, Egypt has advanced these priorities through climate-integrated education, technical training, public campaigns, and gender-responsive initiatives.

This FNC builds on the Third National Communication (TNC), which set forth key recommendations: enhance capacity building; increase public awareness and participation; integrate climate change into the education system; reinforce Egypt's role as a regional climate action leader; and develop a national pool of climate experts. The FNC responds to these priorities by documenting the progress made across these areas, showcasing national programmes and partnerships that have advanced education, training, institutional capacity, and inclusive public engagement as integral components of Egypt's climate strategy.

In line with Article 6 of the UNFCCC, Egypt has made notable progress through a range of programmes and cross-sectoral efforts. Capacity building remains central to Egypt's approach to climate mitigation, adaptation, and reporting and is key to fulfilling national and international commitments.

Egypt's capacity development follows a multi-tiered approach involving government-led initiatives, donor-supported programmes, and civil society. Projects such as the Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions (CB3) Project and the NC4 Project have improved governance, stakeholder participation, and integration of Multilateral Environmental Agreements (MEAs) into national planning. Parallel actions, such as vocational and technical training, curriculum reform, and youth engagement, demonstrate growing momentum to embed climate literacy and competencies across all levels of society, supported by universities, Non-Governmental Organisations (NGOs), and international partners.

However, challenges remain, including: limited technical expertise in areas like GHG inventories, MRV systems, and modelling; coordination gaps; and insufficient sustainable financing. As Egypt moves forward under the Paris Agreement and the Enhanced Transparency Framework (ETF), a unified national capacity-building framework is essential. This chapter outlines key achievements, identifies ongoing needs, and presents strategic directions to strengthen Egypt's climate capacities.

5.2 Integration of Climate Change Issues into Social, Economic, & Environmental Policies

The TNC Report identified the need for enhanced coordination and harmonisation of policies across economic sectors and among all relevant public stakeholders as a key policy concern.

In response, the Egyptian government, led by the MOE, has taken on a proactive role in championing a nationally integrated, cross-sectoral approach to policy development and implementation. This approach has gained broad consensus as essential for aligning economic, social, and environmental priorities with the UN 2030 Agenda for Sustainable Development and its 17 SDGs. It also represents a strategic step toward more effectively fulfilling Egypt's voluntary commitments under the three Rio Conventions on Biodiversity, Climate Change, and Desertification.

The Ministry of Planning and Economic Development serves as the principal custodian of the national policy framework, tasked with ensuring that sectoral and local strategies are aligned through cross-sectoral integration and institutional coherence. In close collaboration, the Ministries of Environment and Planning have worked jointly to develop a national integrated policy framework. This framework is designed to be implemented both horizontally, across various economic sectors and vertically, across local governorates ensuring comprehensive engagement of all relevant stakeholders.

5.2.1 National Integrative Policy Framework

As has been mentioned throughout this report, Egypt has launched its SDS Egypt Vision 2030. The overarching objective of this strategy was to balance Egypt's growth ambitions with the well-being of future generations by integrating the three fundamental pillars of sustainable development—the environment, social, and economic. Egypt Vision 2030 is also fully aligned with the 17 UN SDGs and the African Union (AU)'s Agenda 2063: The Africa We Want. It also serves as the central framework guiding all government development programmes and projects through to 2030. The strategy has undergone two comprehensive reviews to reflect evolving socio-economic dynamics and mitigate the impacts of the COVID-19 pandemic.

Among the strategy's national priorities is the commitment to a sustainable environment, recognised as a key strategic objective. To achieve this, Egypt aims to preserve both developmental gains and environmental integrity through the efficient and rational use of natural resources. This includes addressing climate change impacts, strengthening ecosystem resilience, managing natural disasters and hazards, expanding the share of renewable energy (RE), and promoting sustainable consumption and production patterns. To support these goals, the strategy identifies several enabling factors, including the availability of reliable data, access to finance, technological innovation, digital transformation, and a conducive legislative environment. The UNFCCC's highlighted capacity-building areas directly align with these enabling conditions.

Within this enabling context, the Ministry of Planning and Economic Development, in collaboration with the Ministry of Environment (MoE), introduced the Environmental Sustainability Standards Guide in 2020. This guide aims to inform the identification and development of green projects to be included in the national investment plan and to support the implementation of the sustainable development strategy. More recently, a decree by the Prime Minister mandated the establishment of climate change units across various ministries and public institutions. This complements the work of the National Council for Climate Change and its High-Level Supreme Committee, which were previously established to guide integrated climate policy.

In parallel, the MoE has been advancing a participatory approach to policymaking. It plans to continue leveraging this model to update and develop national strategies that foster intersectoral coordination and prioritise climate-related and sustainable consumption and production objectives. Notably, in 2018, the ministry signed a cooperation protocol with the Ministry of Water Resources and Irrigation (MWRI) to enhance climate policy coordination through data sharing and joint capacity-building initiatives. This collaborative and integrated approach is being applied in the implementation of the National Climate Change Strategy 2050, launched on the sidelines of COP26 in Glasgow.

5.2.2 Sector-Specific Policy Planning

- Various ministries and public institutions have established sustainable development and climate change units and departments in alignment with Egypt's integrative policy approach. These entities serve as coordination hubs, tasked with developing and implementing sector-specific strategies in accordance with the overarching SDS 2030. Their role also extends to facilitating inter-ministerial coordination and monitoring efforts. This institutional setup has helped embed sustainability considerations into sectoral planning and operations. Several strategies have already benefited from this integrated model, including:
 - The National Strategy for Science and Technology for Sustainable Development 2030 (the Ministry of Higher Education and Scientific Research).
 - Integrated Energy Strategy 2035 (the Ministry of Electricity and Renewable Energy).
 - The Housing strategy for 2030.
 - The National Strategy of Artificial Intelligence (the Ministry of Communications and Information Technology).
 - The National MSME & Entrepreneurship Development Strategy (the Micro, Small and Medium Enterprise Development Agency - MSMEDA).

5.2.3 Fostering International & Regional Policy Alignment Efforts

In conjunction with its ongoing endeavours to harmonise national policies, the Egyptian government has been playing an active role to present the interest and highlight the challenges faced by developing countries within the global arena and among broader global platforms and coalitions.

5.2.3.1 Highlights on international efforts

- Egypt's President Abdul Fattah El-Sisi continuously contributes to global climate summits and general assembly meetings, addressing partners and countries and stressing the importance of climate change, for example, the Climate, Biodiversity, and Oceans Session in the 2019 G7 Summit held in France's Biarritz, the UN General Assembly on Security, Peace, and Climate Change 2019, and the 26th session of the COP 26 in Glasgow.
- Egypt has a proactive contribution and proven track record in the international climate negotiations, including its chairing of the G-77 & China and African Groups and co-chairmanship of a ministerial high-level dialogue on climate finance during the 24th COP to the United Nations Framework Convention on Climate Change hosted by Poland in December 2018.
- The country hosted the 14th COP meeting of the Convention on Biological Diversity (CBD) in Sharm El-Sheikh, Egypt, from 17 to 29 November 2018. On the sidelines of the meeting, Egypt introduced an initiative to accelerate coordination between the three Rio Conventions under the theme "Investing in Biodiversity for People and Planet". The Conference adopted several decisions on a series of strategic, administrative, financial, and ecosystem-related issues in connection to the implementation of the Convention and its proposals.
- During its three-year presidency, an electronic platform, "The Sharm El-Sheikh to Kunming Action Agenda for Nature and People", was launched in November 2018, in coordination with the UN

Environment Programme, to enhance commitments and contributions to biodiversity conservation. It also drafted the post-2020 global biodiversity framework, the 2050 Vision, and prepared the UN Decade on Ecosystem Restoration (2021-2030). Egypt also joined the Metz Charter on Biodiversity. The initiative aims to promote the coherent implementation of the three Rio Conventions on climate, desertification, and biological diversity.

- Egypt also co-led the "Resilience and Adaptation Coalition" at the 2019 Climate Change Summit in September 2019 with the UK. The coalition was formed in June 2019 and aimed to raise funds to implement resilience and adaptation strategies that address climate change impacts in developing countries and promote technology transfer as well.
- In September 2020, Egypt agreed to join the Cyprus Government Initiative for Coordinating Climate Change Actions in the Eastern Mediterranean and Middle East and discuss ways to establish a regional organisation concerned with climate change that includes a number of countries in the region with similar climate challenges.

The government is also championing regional collaborative efforts among Arab and African countries to foster a climate policy aligned with addressing priority needs for adaptation and mitigation actions. It has also introduced a host of regional initiatives and platforms that facilitate knowledge sharing, in addition to striking strategic partnerships and mobilising common resources, leading to the scaling of cross-border climate action-orientated activities and projects.

5.2.3.2 Regional and African Level

- In 2015, Egypt's president was selected to be the coordinator of the Committee of African Heads of State and Government on Climate Change (CAHOSCC). During this time, the AU endorsed two initiatives on climate change in Egypt.
- In 2019, Egypt won the chair of the AU. It has identified several priorities for the African continent's development during its presidency of the AU within the framework of the AU Agenda 2063. These include environmentally sustainable and climate-resilient economies and communities, biodiversity, conservation, and sustainable natural resource management.
- Egypt had established the track for the African Renewable Energy Initiative and presented it in the context of its presidency as a committee of African leaders concerned with climate change.
- The three thematic focus areas of the 2019 Africa Regional Ministerial Conference on Green Economy are improving regulatory and policy frameworks for a green economy, promoting innovative green investment through public-private partnerships, and advancing national-level capacity development for holistic green action.
- In 2020, Egypt extended its support and interest to engage in the new Green Middle East Initiative launched by Saudi Arabia. The MoE stated that Egypt has stressed the importance of such initiatives to counter the adverse impacts of climate change in the Middle East by reducing atmospheric carbon levels and protecting natural lands, including marine and coastal environments, and decreasing carbon emissions.
- In April 2021, Egypt's MoE attended the UAE Regional Dialogue for Climate Action. Participating countries issued a statement affirming their commitment to ensure the success of the Paris Agreement and enable the MENA region to initiate a new low-carbon development path.
- In June 2021, the country hosted a meeting in Sharm El-Sheikh for the African Group of Negotiators on Climate Change (AGN) to unify climate policy dialogue in Africa. The meeting aims to support a stronger positioning of the continuity in international platforms and build a comprehensive outlook on the opportunities and challenges facing Africa in fighting climate change. Forty senior negotiators participated in the meeting to help create a unified African negotiating position ahead of the COP 26 held in Glasgow.

- In November 2022, Egypt will be hosting COP27 in Sharm El-Sheikh and is planning to work towards engaging all parties through working on building bridges of cooperation, removing differences and finding a common ground that helps in making progress in the decisive issues.

5.2.3.3 Key Findings

Significant progress has been achieved in the areas of policy design, implementation, and enhancing overall national policy coherence. Looking ahead, the next critical step involves intensifying coordination efforts to evaluate the effectiveness of climate change policy integration through this cross-cutting approach. The recently developed unified guidelines and standards designed to identify sustainable projects represent a vital instrument in advancing the objectives of coherence and coordinated policy action. This integrative policy framework is expected to significantly accelerate Egypt's efforts to address climate change. It will also facilitate the systematic mainstreaming of climate mitigation and adaptation priorities at the national, local, and sectoral levels, resulting in extensive and mutually reinforcing effects. These efforts are currently being advanced through:

- Increasing the rate of implementing projects that directly and indirectly lead to mitigation.
- Creating a common taxonomy for defining green and climate mitigation and adapting projects.
- Facilitating the ease and effectiveness of implementation of new climate-related strategies in different sectors and at a national level.
- Meeting international commitments and obligations in climate change.

An evidence-based example of this new policy approach is the recent integration of sustainable rural community creation guidelines within the framework of Egypt's 'Decent Life' national project. The project aims to upgrade the social and economic conditions of Egypt's disadvantaged rural villages and areas. This marks the integration of the environmental dimension for the first time in a social and economic development project initiated by the government. It is expected to lead to the implementation and setting up of green buildings in the neediest rural communities, enabling them to adapt to the negative impacts of climate change and achieve the necessary flexibility in this context. The project also considers the distinctive characteristics of the rural, geographical, demographic, economic, social, and cultural communities. It is also set to improve the lives of the most vulnerable population categories in rural areas, especially women and youth, through improving the living conditions and the quality of life and contributing to advancing the level of daily services provided to citizens. The project will help to support women who are expected to be negatively impacted by the adverse effect of climate change.

5.3 Capacity Building

The cross-sectoral impacts of climate change underscore the need for ongoing capacity building within a coherent national framework. This framework must account for diverse components, including GHGI measurement, vulnerability assessments, and the identification of adaptation and mitigation priorities. Equally important is the continuous engagement and informed participation of officials and decision-makers.

While capacity-building efforts are gaining momentum, significant challenges persist. These include securing adequate funding, ensuring scalability, and developing the technical expertise required to address a wide range of climate-related topics and data needs. Such challenges are commonly faced by emerging economies and countries across Africa. Table 5-1 presents an overview of capacity-building measures undertaken to date.

5.3.1 Developing Capacity for Cross-Cutting Climate Policy and Governance

The NC4 Project (January 2019–December 2022) and the “Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions” CB3 Project (September 2017–December 2022) are two major capacity-building initiatives addressing cross-cutting dimensions of climate

change, including mitigation, adaptation, and GHGI. The NC4 Project aims to support Egypt in preparing and submitting its FNC to the Conference of the Parties (COP) of the UNFCCC. In parallel, it focuses on strengthening the technical capacities of national experts and institutions to regularly produce future national communications, which serve as key references for shaping climate-related policies and measures across critical economic and social sectors.

Meanwhile, the CB3 Project targets priority capacity gaps to enhance stakeholder participation in the implementation of Egypt’s commitments under the MEAs, particularly the Rio Conventions. It also aims to build the ability of stakeholders to utilise environmental data in policy and decision-making processes, while strengthening national consultative mechanisms from the local to the national levels. Additionally, the project seeks to improve public understanding of MEAs and their role in sustainable development and to foster partnerships that support the integration of global environmental priorities into Egypt’s education system. Several educational and awareness-raising activities under this project will be detailed in the following sections.

Both projects are funded by the GEF Trust Fund and overseen by UNDP Egypt, while the EEAA is responsible for their implementation. The two projects have had a significant impact on climate-related capacity building through:

- *Increasing climate awareness and understanding among different line ministries and public institutions.*
- *Supporting ongoing efforts for policy cohesion and integration.*
- *Increasing the capacity of decision makers and officials to coordinate, integrate climate policy and strategy formulation and report on obligations as required; and*
- *Empowering government institutions to introduce and lobby for climate change priorities and impacts to other community stakeholders that are also expected to play a role in combating climate change.*

Table 5-1 provides more details on capacity building for cross-cutting climate activities under these two projects.

Table 5-1: Capacity building related measures.

GHG Inventory	<ul style="list-style-type: none"> - Training of governmental stakeholders on data collection and calculation of GHGI emission from energy, industry, agriculture, and waste using 2006 IPCC software. - Training covered the guidance for data entry into software of the Energy, Industry, Agriculture, Health and Waste sectors. 	NC4
Cross-cutting Climate Policy	<ul style="list-style-type: none"> - Training of governmental stakeholders on fundamentals of climate change in Egypt and institutional arrangement, risks, and opportunities of climate change in all sectors, climate finance, the road to sustainability in the Non-Banking Financial Sector (NBFS). - Organizing an awareness session targeting government stakeholders from the Ministry of Planning and Economic Development and the Ministry of Finance on how to integrate climate change into policy planning. 	NC4
	<ul style="list-style-type: none"> - Co-Organizing two joint workshops to raise the capacity and awareness of Senior Officials from the MoT, and the Ministry of Electricity and Renewable Energy (MoERE) on Rio Conventions including Climate Change. 	NC4 CB3
	<ul style="list-style-type: none"> - Strengthening Institutional Capacities for mainstreaming concerns of MEAs into national plans and programs through extensive consultations with key stakeholders. - Developing and approving a four-tire capacity building program: i. Executive Level Training, ii. Introductory Training, iii. Basic Training, and iv. Sector-specific Training. - Creating a comprehensive document on roles and responsibilities and national commitments towards MEAs for targeted line ministries to provide officials and focal points with access to information. - Media and journalist trainings on climate change policy and Egypt’s preparation for the COP 27. 	
	<ul style="list-style-type: none"> - Training of governmental stakeholders on mitigation action potentials and populating available data into the Mitigation Actions Database. The training covered data entry for 	NC4

Mitigation	mitigation actions in the sectors of (Power Generation, RE, Transport, Industry, and Agriculture). - Organizing and designing two mitigation expert meetings for knowledge sharing on important technical issues for designing the content of GHGI and mitigation policies and measures.	
Adaptation	- Organizing and designing two adaptation expert meetings for knowledge sharing on methodological approach for developing the vulnerability and adaptation assessment and listing the national measures and actions for adaptation to climate change in different sectors as well as social and economic issues and gender resilience.	NC4

An earlier initiative, the “Capacity Building on MRV of GHG Emissions and Actions in Africa” project—funded by the European Union (EU) and implemented between 2015 and 2017—focused on strengthening the capacities of selected African countries to meet UNFCCC reporting requirements. The project delivered targeted support in areas related to general climate action, specifically an effective MRV system to track greenhouse gas emissions and emission reductions. It also supported the preparation of National Communications (NCs) and BURs, as well as the planning, design, implementation, and MRV of mitigation measures within the broader context of LEDS. Comprehensive capacity-building plans were developed for Egypt, especially for the Central Agency for Public Mobilisation and Statistics (CAPMAS), with the aim to provide training on:

- Development of national MRV system
- Preparation of GHGI Inventories (including data collection and quality assurance/quality control)
- MRV of Mitigation Actions and Policies in the context of NDCs and NAMAs

5.3.2 Developing Capacity for Climate Mitigation Interventions

Building national capacity is essential for the effective planning, implementation, and monitoring of climate mitigation interventions in Egypt. Efforts focus on strengthening institutional frameworks, enhancing technical expertise, and promoting cross-sectoral coordination to ensure the successful delivery of low-emission development strategies.

5.3.2.1 Building Capacity for national mitigation actions

The Low Emission Capacity Building (LECB) Programme (2011–2018), funded by the European Commission along with the governments of Germany and Australia, was implemented in 25 countries, including Egypt. The programme aimed to strengthen national capacities to design and implement low-emission development policies through targeted mitigation actions in both the public and private sectors. In Egypt, it was executed by the EEAA in cooperation with the MoE and the UNDP. The programme focused on the energy, water, and tourism sectors, aiming to build the technical and institutional capacity needed to develop and implement effective mitigation action plans. As a result, five NAMAs were developed in the energy and transport sectors, alongside the establishment of an MRV system and the formulation of new LEDS.

The LECB Programme placed strong emphasis on building capacity across a wide range of stakeholders. A key component of this effort was the training and mentorship of young professionals, designed to ensure the long-term sustainability of the programme’s outcomes and to establish a solid foundation for continued climate mitigation efforts in the future. As a result:

- 238 members of the EEAA in the governorates of Greater Cairo, Fayoum, Sharqia, Aswan, Qena, Luxor, Suez, Red Sea, Alexandria, Assiut, Menia, and Sohag in four national capacity buildings that provide training on understanding climate change, its impacts in Egypt, its aspects of mitigation, and adaptation. These workshops introduced NAMA mapping reports in the tourism, oil & gas, housing, agriculture, and health sectors.

- Another nine workshops benefiting around 500 members of nine different ministries were also conducted.
- Three training of trainers (ToTs) workshops were organised on the introduction to the LEAP software programme, Advanced LEAP and MRV systems, and NAMA Finance for around 70 experts.
- A workshop for about 54 environmental journalists on climate change awareness and information on mitigation was also organised.

5.3.2.2 Sector-specific Interventions

Several projects have incorporated mitigation-focused capacity-building activities across key economic sectors such as energy, transport, agriculture, and housing. These interventions are designed to generate dual benefits—driving sustainable economic development while addressing climate change impacts through targeted mitigation.

The following section provides a brief overview of mitigation-related capacity-building efforts, particularly in industries focused on energy efficiency (EE), renewable energy (RE) technologies, and sustainable transport.

Several significant projects have been actively promoting the reduction of greenhouse gas emissions by promoting a continuous improvement of EE in industries and investments in renewable technologies. The Industrial Energy Efficiency Project (IEE) 2012-2019, Utilising Solar Heating in Industrial Processes in the Egyptian Industry (SHIP Project), and the Egyptian Programme for Promoting Industrial Motor Efficiency (2018–present) have capacity-building components within the context of climate mitigation. These projects are either fully or partially funded by the GEF Trust Fund and implemented by the United Nations Industrial Development Organisation (UNIDO). Executing partners of these projects include MTI and the National Cleaner Production Centre (ENCPC), the Ministry of Environment (MoE), and the National Renewable Energy Authority (NREA). These projects contribute to:

- Building a cadre of well-trained and equipped experts in system optimisation and energy management to help industries in developing, financing, and implementing EE improvement projects.
- Introducing heat system optimisation measures in select sectors complemented with the installation of solar thermal technologies through technical assistance and investment activities while building the national capacity on the system design, installation, servicing, and maintenance.
- Developing a conducive legal and regulatory environment for improved efficiency of Electric Motor Driven Systems (EMDS) and building awareness and capacity on energy-efficient (EE) motor systems. While providing technical assistance for technology demonstration and upscaling.

Capacity-building activities within these projects include:

- Training 50 banks on energy efficiency financing.
- Training 700 consultants on Energy Management System (EnMS) implementation for EE and emission reductions.
- 14 organisations were enabled to implement certifications-compliant energy management systems.
- 75 companies received technical support on achieving EE.
- Training 1500 local cadres on solar water heater systems, including consultants, industrial representatives, bankers, entrepreneurs, technicians, and governmental representatives.
- Road map for strengthening the quality of locally manufactured products and components related to solar water heaters and solar thermal technologies in Egypt.

- Training 700 local cadres on system optimisation, specifically motors, compressed air, and pump systems.

Another project spearheaded by UNDP Egypt and the Ministry of Electricity and Renewable Energy (MoERE) and funded by the GEF Trust Fund was the “**Improving Energy Efficiency of Lighting and other Building Appliances Project (2010–2019)**”. The objective of the project was to facilitate a transformation of the Egyptian market towards the use of more energy efficient electric appliances at a level where cost-efficiency is proven through the combination of regulatory tools, enhanced public awareness, capacity building, and attractive financing mechanisms. Some of the related capacity building activities included:

- Organising 10 training courses covering energy audits & EE in buildings for different ministries, private sector companies, and the hotel sector.
- Organising seven training courses on green and sustainable procurement for governmental purchases to train 80 participants from the electricity distribution companies.
- Organising 14 training courses on energy-efficient street lighting, targeting 327 engineers from governmental entities and the electricity distribution companies.
- Capacity building to train engineers working in the EE testing laboratories of efficient household appliances on how to perform EE tests representing the MoERE, NERA, the Egyptian Organisation for Standardisation and Quality (EOS), and the General Organisation for Import & Export Control (GOIEC).
- A seven-month training was provided to 1,166 shop managers, salesmen, customer service managers, and managers of appliance shops and stores from different appliance stores to increase their level of knowledge of EE labelling affixed to the appliances and how to understand the impact of EE level on electricity consumption.

In addition to these projects and activities, the Egyptian German Joint Committee on Renewable Energy, Energy Efficiency and Environmental Protection (JCEE) initiative aims to support structural transformation within Egypt’s energy sector. JCEE works to establish a framework that enables the reduction of CO₂ emissions from electricity generation and production. The joint committee provides institutional capacity building and technical advisory services, including the collaborative preparation of international climate finance proposals and the establishment of NAMAs. It also supports the development of climate-related MRV systems and the quantification of the climate impact of sectoral strategies. The project is being implemented between 2019 and 2023 and is commissioned by Germany’s Federal Ministry for Economic Cooperation and Development (BMZ) to support the following institutions:

- The Ministry of Electricity & Renewable Energy
- The Ministry of Environment
- The Federation of Egyptian Industries (FEI)
- The banking and insurance sectors

Meanwhile, capacity-building activities implemented under the Grid-Connected Small-Scale Photovoltaic Systems (PVs) project, “Egypt-PV”, have focused on enhancing the skills of individuals and companies through a range of initiatives carried out between 2018 and 2021. The project aims to disseminate information and raise awareness about renewable solar energy, its advantages, and the technical aspects related to small-scale PV systems. These efforts include:

- Delivering professional training to 235 trainees of various backgrounds, such as students, engineers, bankers, and journalists, across different governorates of Egypt. More importantly, females represent 60% of the trainees, believing in women's empowerment in solar energy through capacity building.

- The project designs training material and plans training sessions and workshops tailored to suit diverse types of targets. It provides not only technical knowledge but also green employment skills, which are a prerequisite for accelerating Egypt's green transition. Some of the conducted training sessions were held in one of Egypt's remote governorates (Al-Wadi Al-Gadid) in the Western Desert.

In accordance with the government's dedication to the promotion of sustainable transport, which is primarily focused on the reduction of emissions and the limitation of air pollution, substantial progress has been achieved in the areas of awareness-raising, capacity-building, and institutional support for this transition. The Sustainable Transport project was funded by UNDP, the GoE, the Government of the Netherlands, and the GEF Trust Fund. It was implemented by UNDP in collaboration with the EEAA from January 2009 to March 2021.

The Egypt Sustainable Transport Project (STP) aimed to reduce transport-related GHG emissions by promoting a modal shift from private car use to public transport and non-motorised transport modes, such as walking and cycling. The project organised four training sessions covering both theoretical principles and practical examples of sustainable transport, as well as the infrastructure requirements for sustainable transport systems. A total of 50 young urban planning engineers from 17 cities, including governorate capitals and new urban areas participated in the training program. This was the first training of its kind and focus to be organised for young urban planning engineers in Egypt. As a direct outcome, the training fostered a professional network among urban planning engineers across different cities.

5.3.3 Developing Capacity for Climate Adaptation Interventions

Given the broad range and complexity of adaptation options—spanning multiple sectors, diverse communities, and geographic locations—and the wide array of stakeholders involved from both the public and private sectors, the current capacity-building efforts remain insufficient. These efforts often fall short in addressing the depth of technical knowledge, the scale of implementation, and the strategic coordination required to design and deliver impactful adaptation policies and measures. Due to the escalating climate risks and vulnerabilities, it is essential to establish capacity at the local, national, and institutional levels to ensure that adaptation initiatives are both sustainable and effective. Some of the current capacity-building interventions about climate adaptation include:

5.3.3.1 Empowering Local Communities to Address Adaptation.

Through the Sustainable Management of Kharga Oasis Agro-Ecosystems in the New Valley Governorate project, the Desert Research Centre (DRC) of the Egyptian Ministry of Agriculture and Land Reclamation (MALR) has been actively supporting local communities and smallholders by enhancing their technical capabilities, financial resources, knowledge base, and access to institutional support. The goal is to empower them to plan for and sustainably manage their land, water, and agro-biodiversity resources. Funded by the GEF Trust Fund, the project began in 2018 and is currently ongoing. It is being implemented by the DRC in collaboration with the New Valley Governorate and the FAO. The project focuses geographically on the areas of Al-Moneera, Nasr, and Al-Thawra within the Kharga Oasis of the New Valley Governorate.

The project's activities are designed to build the capacity of local producers by providing them with technical support and facilitating a shift in their behaviours and mindsets through targeted awareness-raising, training, and learning initiatives. These initiatives also seek to cultivate a culture of change within governmental institutions that are responsible for the administration and development of oasis agro ecosystems, both at the national and New Valley Governorate levels.

In addition, the project promotes the introduction of innovative practices and technologies that are piloted, assessed, and scaled up by producers to sustainably enhance productivity while addressing the impacts of climate change and environmental degradation. Smallholder farming communities in the

three pilot sites of the Kharga Oasis agro-ecosystem receive training on selected practices, as well as on the conservation and monitoring of agro-biodiversity. This is carried out through the Farmer Field School (FFS) approach, which includes the development of tailored educational materials, hands-on training, and Training-of-Trainers sessions to ensure local knowledge transfer and long-term sustainability.

Another project with potential impact on strengthening agricultural resilience is the “*Building Resilient Food Security Systems to Benefit the Southern Egypt Region – Phase 2.*” Initiated in 2020, this three-year project is funded by the Adaptation Fund and jointly implemented by the World Food Programme (WFP) and MALR. The project aims to build institutional capacities among a wide range of stakeholders and enhance the adaptive capacity of farming communities, enabling them to become more resilient and adopt innovative farming solutions that contribute to food security.

The project supports increased productivity of staple crops such as wheat and maize, while also promoting crop diversification through intercropping practices. It focuses on water resource management by introducing low-cost water-saving techniques, organizing awareness-raising events, and providing community training on climate change and adaptation practices. In addition, the project offers technical assistance and training tailored to the specific needs of female-headed households. Youth-focused capacity building is also prioritized through cultural and educational activities. The project will further establish village climate information centres in collaboration with local civil society organizations to support access to localized climate data and informed decision-making.

Addressing vulnerable urban communities is equally important as targeting rural areas when it comes to building resilience. Through the “Participatory Development Programme / Participatory Infrastructure Project,” the Ministry of Housing, Utilities and Urban Communities, the MoE, and the Governorates of Giza and Cairo collaborated to strengthen urban adaptation resilience. Implemented between 2016 and 2019 and funded by German Agency for International Cooperation (GIZ) and the KfW, the project focused on introducing small-scale adaptation measures in informal urban areas. These measures included:

- Development of a participatory and community-based adaptation strategy for informal areas in collaboration with national and local partners.
- Building the capacity among residents, civil society, ministries, public agencies, and local administration on climate change adaptation, and urban resilience.
- Implementation of small-scale development measures in informal areas in a participatory approach with the residents to enhance their resilience to climate change and environmental challenges.

5.3.3.2 Enhancing Climate Change Adaptation Against Coastal Flooding

The UNDP, in collaboration with MWRI, is working on the "Enhancing Climate Change Adaptation in North Coast and Nile Delta in Egypt" project to mitigate the hazards of coastal flooding on Egypt's North Coast, which are anticipated to be exacerbated by the occurrence of more frequent and severe storms and the rise in sea level. The GCF and the UNDP fund the initiative, which runs from 2019 to 2025. A core component of the project is the development and implementation of an ICZM plan covering the entirety of Egypt's North Coast.

To achieve this, the project includes a robust capacity-building component aimed at strengthening the national capabilities of experts, relevant government officials, and institutions. These endeavours are centred on the facilitation of long-term, iterative evaluations of climate change-related hazards, vulnerabilities, and risks, with a particular emphasis on those that are linked to coastal erosion and inundation. Training will be provided in areas such as marine dynamics characterisation, database

development, and the use of tools for modelling shoreline dynamics. In addition, high-resolution hazard, exposure, vulnerability, and risk assessments will be conducted. Technical assistance and training will support the execution of these assessments across different scenarios, including the current baseline and long-term projections that factor in climate change and anticipated coastal development.

5.3.3.3 Supporting Regional Climate Adaptation Efforts

- Egypt is participating in the Lima Adaptation Knowledge Initiative (LAKI), a joint action pledge under the Nairobi Work Programme led by the UNFCCC Secretariat and the UN Environment Programme (UNEP) through its Global Adaptation Network (GAN). The initiative is centred on knowledge sharing, capacity building, and the development of technical expertise to identify, categorise, and prioritise climate change adaptation knowledge gaps across specific subregions, sectors, and thematic areas. LAKI then collaborates with global and regional partners to initiate targeted actions aimed at bridging these identified knowledge gaps.
- In 2017, the North Africa subregion, which encompasses seven countries, partnered with Bibliotheca Alexandrina to organise an initial workshop. The workshop was designed to facilitate the identification and prioritisation of the adaptation knowledge gaps that are pertinent to the region. The workshop convened eight experts representing non-governmental organisations, the private and public sectors, research institutions, and international organisations working on adaptation and climate finance. As a result, the workshop identified a total of 45 adaptation knowledge gaps across four key areas: water resources, coastal zones, agriculture, and desertification.
- In 2018, the Egyptian Meteorological Authority (EMA) hosted a workshop in collaboration with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the State Meteorological Agency of Spain (AEMET), and the Barcelona Supercomputing Centre (BSC). Additionally, from 10 to 12 February 2018, the UN-ESCWA, in partnership with the League of Arab States (LAS), the World Meteorological Organisation (WMO), and the UNEP, organised a Regional Training Workshop on Sand and Dust Storms in the Arab Region, held in Cairo, Egypt.

The workshop aimed to strengthen the technical capacities of operational and research meteorologists from Arab States in analysing, predicting, and projecting sand and dust storms. It focused on the application of ground-based and satellite observations, dust storm modelling and forecasting, dust classification, and the integration of data through assimilation in dust models. These efforts supported a deeper understanding of the multi-dimensional impacts of sand and dust storms, including their effects on socio-economic sectors and ecosystems. The workshop also explored opportunities to enhance regional collaboration on sand and dust storms, with the goal of fostering coordinated joint activities across the Arab region.

- Four Egyptian hydrometeorologists took part in a regional training workshop on the use of remotely sensed precipitation data through artificial neural networks. The workshop was held in Beirut in October 2019 and was organised by the UNESCO Cairo Office in collaboration with the American University of Beirut, UN-ESCWA, and the Centre for Hydrometeorology and Remote Sensing in the United States (US). It aimed to build the capacity of 35 professionals from Arab hydrometeorological services in applying satellite-based 20 mm observation technologies.

As part of the same broader capacity-building effort, several Egyptian water professionals also participated in additional regional training workshops covering a variety of key topics. These included the Water-Energy-Food Security Nexus, gender mainstreaming in integrated water

resources management, wastewater treatment and management, and the protection of cultural heritage from water-related disasters.

- Within the context of the Cairo Water Week annually organised by Egypt’s Ministry of Water and Irrigation, the Third African Young Water Professional Forum was organised and launched from 19 to 21 October 2020 (online) with the support of UN-ESCWA and the ICID African Regional Working Group. The forum was launched in collaboration with the Arab Centre for the Study of Arid and Drylands (ACSAD), the Islamic Development Bank (IsDB), and the Global Water Partnership-Mediterranean (GWP-Med). The online forum built the capacity of over 60 young water professionals engaged in the water and agricultural sectors to conduct technical assessments using climate data. It also contributed to better understanding mechanisms for mobilising finance in the water sector and incorporating gender issues in agricultural water management. The forum’s training workshops included:
 - Introduction to the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR).
 - Overview of water, agriculture, and climate data.
 - Using remote sensing datasets and crop coefficients to estimate actual crop evapotranspiration, historical to near present.
 - Irrigation scheduling using software.
 - Deficit irrigation scheduling using software.
 - Supplementary irrigation scheduling using software.

Through its Meteorological Authority affiliated to the Ministry of Civil Aviation, Egypt is an active contributor to the Arab Climate Outlook Forum (ArabCOF). The forum is mainly dedicated to data, experience and knowledge exchange on climate modelling, adaptation forecasts and early sensing data, climate monitoring, and seasonal weather forecasting. The last ArabCOF meeting was held in June 2021. During the online convening of the forum, the EMA presented the interactive climate change mapping efforts that are currently underway. The forum is part of UN-ESCWA’s Regional Initiative for the RICCAR.

5.3.4 Capacity Building Needs and Considerations

There is an urgent need to scale up global capacity-building efforts for developing and emerging countries, especially as the world moves to accelerate commitments under the Paris Agreement and support the global shift toward a net-zero economy. Current efforts remain inadequate in scope and scale to address the pressing challenges of climate change, particularly in Africa and among vulnerable communities.

The transition to new commitments by Non-Annex I countries, including the adoption of the ETF, further highlights the necessity of expanding capacity-building support. These evolving obligations demand stronger technical, institutional, and human capacities to ensure effective implementation and reporting.

In Egypt, various capacity-building initiatives are underway, supported by international organisations and national institutions. However, despite this progress, critical needs persist. Addressing these gaps requires targeted, sustained action to strengthen the country’s ability to meet current and future climate challenges effectively.

- Continued Capacity Building for Deeper Policy Coordination and Integration

Capacity-building initiatives reviewed in this chapter have successfully enhanced coordination among public sector institutions and laid the foundation for a potential coordination mechanism under the National Council for Climate Change. However, sustaining and operationalising this coordination requires strengthened resources and targeted capacity development. Key emerging needs include:

- Adequate human, financial, and technical support, particularly for data and coordination systems.
- Training and institutional development:
 - Data management and standardized collection protocols
 - Creation of institutional memory and documentation systems
 - Automated monitoring and evaluation mechanisms
 - Integration of climate into public policy frameworks
 - Stakeholder mapping and engagement strategies
 - Participatory strategy development methods
 - Systems thinking for cross-sectoral policy design
- Institutional Capacity Development and Infrastructure for Climate Policy Implementation

One of the persistent barriers to effectively implementing climate change plans and measures is the limited impact of capacity-building efforts at the institutional level. Addressing this challenge requires a more strategic, system-wide approach, supported by adequate resources and coordination. Key gaps and recommendations include:

Key Area	Description
Institutional Capacity Planning	A national, annually updated capacity-building plan is needed for all relevant public institutions to ensure alignment, consistency, and sustained knowledge development.
Technological and Financial Needs	Beyond funding constraints, there is a need to develop or share technological infrastructure to support capacity-building and implementation efforts.
Unified Project Database	A centralized, accessible database of all climate adaptation and mitigation projects is essential to enhance visibility, coordination, and information sharing across sectors.
Addressing Awareness & Reporting Gaps	Many efforts by municipalities, private sector actors, and non-aligned institutions remain underreported due to limited awareness and fragmented reporting, hindering national climate tracking efforts.
Nationwide Institutional Assessments	Periodic evaluations of institutional capacity and readiness are necessary to identify and address gaps, promote knowledge exchange, and guide targeted interventions.
Stakeholder Partnerships & Innovation	Strengthening partnerships with the private sector, innovators, and civil society is key to designing accessible, practical, and scalable capacity-building solutions.
Training Content and Delivery	Developing robust, regularly updated training content is essential, including the potential for e-learning platforms to ensure broad access and continuous learning for public sector employees.

- Technical Capacity Building for Climate Resilience

A closer examination of technically advanced capacity-building efforts reveals a substantial gap in training and education for GHGI, carbon capture, forestry, and climate modelling. Furthermore, the lack of more specialised skills continues to hinder the country’s ability to develop cost-effective technologies and establish the foundational expertise necessary to generate innovative adaptation solutions or foster community-driven climate initiatives. The challenges identified in Egypt’s BUR1 and TNC remain relevant, particularly in relation to GHGIs across key sectors of concern, including:

- Improvement of existing or developing MRV systems.
- Lack of reliable data is another significant barrier that undermines the effectiveness and feasibility of scientific measurement of climate effects and understanding of the best solutions upon implementation and performance.

- There is a need to target capacity building to the entities that collect data, especially in major sectors such as energy, agriculture, industry, and waste, on data reliability and methodology.
 - There is a need to develop data management and measurement protocols that can be distributed to unify methodologies and data validity.
 - Keep climate negotiation staff abreast of up-to-date information and knowledge.
 - Developing digital platforms to link different stakeholders and to cumulatively report on different related initiatives and efforts.
- Proposing a National Climate Change Capacity Building Framework:

A unified climate change capacity building framework is a necessary step to ensure that trainings provided by projects, partnerships or by the government have a longer impact, a wider scale and are reaching beneficiaries that can then utilise learnt and retained skills to implement more efficient climate action measures in different sectors of the economy. This framework can also provide assessment and monitoring and evaluation to ensure the quality of training and that these trainings have a ripple impact. Institutionalising the offering of capacity building through local institutions, universities, and centres could be cost-effective and ensure the long-term continuity of knowledge updates and sharing.

5.4 Education

Article 6 of the UNFCCC encourages parties to promote, develop, and implement educational, training, and public awareness programmes on climate change and its effects. The importance of mainstreaming climate change information in different educational levels cannot be emphasised enough, especially regarding the ability to address a wide scale of the population through students, their parents, and their immediate communities. Thus, achieving gradual universality in introducing climate change information and knowledge to the public is a crucial factor in combating climate change and accelerating climate mitigation and adaptation efforts. This could be implemented through:

- Changing behaviours and attitudes could lead to the daily mainstreaming of energy and resource saving.
- Integrating nature and environment as part of human wellbeing and sustainable development.
- Supporting the creation of new markets and investment opportunities led by the private sector.
- Development of community-based adaptation solutions and cheaper technologies through a bottom-up approach.
- This has led to increased research and development as well as interest in scientific disciplines, data management, and technology.

Consequently, the recognition of climate change and environmental literacy through education as a "deep structural" intervention is essential in addressing the systemic risks posed by climate change. Equally important as introducing climate change education is the approach taken in developing curriculum content. In this context, the MoE and the EEAA have made significant efforts to advance climate education. However, these efforts remain in the early stages and have yet to achieve the level of maturity, scalability, and measurable medium- to long-term impact.

More systemic initiatives are now underway as part of broader educational reform aimed at fostering innovation, promoting blended learning, and integrating climate change into the curriculum. The official websites of both private and public schools, colleges, and universities are increasingly disseminating climate-related knowledge.

5.4.1 Formal Education

The Ministry of Environment holds training courses for teachers and educational inspectors on how to simplify the climate change phenomenon for students and teach them positive behaviours with a group of ideas and teaching aids. Annual seminars and activities to introduce climate change are organised by

the ministry in public schools. In addition, the ministry has developed an education corner on its website to provide children with access to information.

Currently, review and development of the new primary school curricula from grade 1 till grade 4 are underway by introducing environmental education and awareness related to responsible consumption practices, water stress, and savings, among other relevant topics. Similar actions have taken place for secondary education with more advanced educational content. The revised education curricula expose students to more environmental experiences, including those associated with climate change. Moreover, experts have prepared a resource book containing a wide range of information to help introduce environmental concepts into the curricula for both formal and non-formal education.

Through “The Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions” Project (CB3 Project), the detailed high-level consultations with the Ministry of Education have culminated in mandating the CB3 Project to produce three school educational packages tailored for schoolteachers (basically from grades 6 to 9) in agreement with the Education Ministry’s Curriculum Development Committee. It was agreed to deliver the pre-agreed upon global environmental messages linked to the national context and supported by knowledge sources, reference material, PowerPoint presentations with annotations, illustrations, and ideas for extracurricular activities.

The three packages for Climate Change, Biodiversity, and Environmental Sustainability have been completed, evaluated, and delivered to the Ministry of Education’s Curriculum Department, and they are awaiting the scheduling for training of selected teachers. Within the context of the educational package on climate change, a total of 17 messages on climate change have been prepared to be incorporated into pre-university education systems. These messages include a definition of climate change, understanding its signs and impacts, Earth’s climate throughout its history, climate resilience, mitigation and adaptation, carbon footprint, greenhouse gases, socioeconomic impacts of climate change, and its impacts on Egypt, among others.

It also includes listing case studies in Egypt and neighbouring countries, and interactive activities aimed at raising awareness and changing behaviour. The main aim of such packages is to provide the instructor or/and the teacher with the necessary background information, material, and knowledge related to each message, along with practical tools that guide him towards efficient, effective, and well-received conveyance of the message. They include descriptions on interactive student exercises and illustrations to facilitate teacher understanding. The CB3 Project also conducted an awareness-raising campaign on these messages in participation with five international schools.

On the other hand, the project implemented a ToT for the personnel of the EEAA’s Student Awareness Unit covering a wide spectrum of Egyptian governorates (Fayoum, Aswan, and Cairo) and national schools. Moreover, the project provided another ToT for international schools and launched a pilot experiment for an international school competition, which is a one-class initiative for five schools to mainstream environmental dimensions and knowledge of MEAs in the education systems.

5.4.2 Higher and Vocational Education

Higher education also has a vital role in promoting climate action and policies. It helps people understand and address the impacts of the climate crisis and empowers them with the knowledge, skills, values, and attitudes needed to function as agents of change. Additionally, higher education is a key source to prepare new generations for employability amid a fast-paced, changing world marked with the need to transit businesses, economies, and markets towards circular, green, and net-zero trajectory paths.

Against this background, there is a growing need for universities and higher educational institutes in Egypt to be agile and adaptive to global changes that require new degrees and specialisations to

accelerate these transition trajectories. It is also necessary to prepare skilled young Egyptians with the following qualities:

- Abreast of state-of-the-art technologies and digitalisation tools.
- Able to work and be successful in green and clean jobs.
- Able to integrate environmental needs and priorities into their daily work operation.
- Able to be innovative and creative to produce appropriate climate action solutions.
- Able to identify new sustainable business opportunities and create responsible business models.

Relatedly, a growing number of universities in Egypt are now offering new degree programmes aimed at equipping students to address climate change across environmental, research, and industrial sectors at the local, regional, and international levels. Many of these programmes focus on environmental engineering, energy, and related fields. Some of these degrees include:

- Masters of Sustainable Development at the American University in Cairo (AUC).
- Master's Program on Integrated Urbanism & Sustainable Design (IUSD) at Ain Shams University in collaboration with Stuttgart University. The IUSD Lab serves as a platform for interdisciplinary and intercultural academic exchange. The IUSD-Lab has established itself as a joint and cross-institutional centre at Stuttgart University and Ain Shams University, involving several faculties and departments within these universities.
- The Egyptian Chinese University offers degrees in energy and renewable energy engineering. Zewail University of Science and Technology provides undergraduate degrees in environmental engineering and renewable energy engineering.
- Helwan University also offers an undergraduate degree in Energy Engineering and a post-graduate degree in Environmental Engineering. The Egypt-Japan University of Science and Technology has also a School of Energy Resources, Environment, Chemical and Petrochemical Engineering which provides undergraduate university technically specialised programmes.

Furthermore, an interdisciplinary master's degree programme titled "Smart Environment and Climate Change Management" was launched in Egypt under the Climate Change Management Through Mitigation and Adaptation (ADAPTM) project—an Erasmus+ Capacity Building initiative in higher education that ran from 2017 to 2020. The EU funded the project to develop the curriculum and academic content, which Egypt's Supreme Council of Universities has since accredited. The program was established through collaboration between four European countries (Italy, Greece, Lithuania, and Slovenia) and four Egyptian universities: Alexandria University, Suez Canal University, South Valley University, and the Arab Academy for Science, Technology, and Maritime Transportation (AASTM).

Offered over two years, the programme integrates natural and applied sciences to explore the causes and impacts of climate change and strategies for adaptation and mitigation. It is designed to equip graduates with the knowledge and skills required for careers supporting local, regional, and international climate efforts. The curriculum includes courses such as Introduction to Climate Change Meteorology and Climate Observation, Marine Resources and Sustainability, Environmental Risk Assessment and Management, Climate Change Management, Numerical Modelling and Tools, GIS and Remote Sensing, and Data Analysis.

Another initiative targeting higher education is the "Wind Engineering Skills in Egypt and Tunisia" project, supported by the Erasmus+ program under Key Action 2: Capacity Building in Higher Education. Running from 2018 to 2021, the project aims to enhance the modernisation, development, and internationalisation strategies of Egyptian and Tunisian institutions. It focuses on aligning master's degree programs with the evolving needs of industry and society while also strengthening partnerships with European institutions in the field of renewable wind energy.

The project seeks to address the shortage of engineers specialised in wind engineering in both countries—a key barrier to leveraging wind as a reliable, cost-effective, and clean energy source. To this end, dedicated wind engineering modules are being developed and integrated into existing Master

of Engineering programmes. In addition, the project supports the creation of training materials and the establishment of laboratories in Egypt and Tunisia, helping to equip master's graduates with the practical and technical skills required to thrive in the wind energy sector. On the other hand, five universities in Egypt have been partners in the project, including:

- *Arab Academy for Science, Technology, and Maritime Transport*
- *Ain Shams University, Faculty of Engineering*
- *The British University in Egypt*

As a result of this project, the Faculty of Engineering of Ain Shames University designed an MSc programme in New and Renewable Energy Engineering. The Institute of Graduate Studies & Research in Alexandria University created an MSc programme in Technologies and Materials for Renewable Energy. And the College of Engineering and Technology of AASTM in Abu Kir Campus, Alexandria, designed an MSc programme in Renewable Energy and Environmental Engineering. Additionally, the partnering universities have established wind energy centres.

An increasing number of think-tanks and research centres are also being established in universities specialized in climate change-related issues or energy or other topics linked to sustainable development. Part of the mandate of these centres is to provide capacity building and education for students and professionals. These centres include:

- The Centre of Excellence for Energy Scholarship – Ain Shams University
- The Centre for Applied Research on the Environment and Sustainability - AUC.
- The Centre for Renewable Energy and the Research Centre for Innovation, Governance and Green Economy – the British University in Egypt
- The Carbon Footprint Centre and the Centre of Excellence for Education for Sustainable Development - Heliopolis University
- In 2021, Ain Shams University created a Green Transition Unit at the Faculty of Higher Studies and Environmental Research, the first of its kind in the Egyptian universities

Along the same lines, several public and private universities have been organising seminars and workshops and hosting events and conferences on climate-related topics. These activities witnessed engagement of not only students but also other community stakeholders as well.

On the other hand, the CB3 Project has been working on mainstreaming environmental issues in the university education systems. In this regard, the MoE and the Ministry of Higher Education and Scientific Research signed a Memorandum of Understanding (MoU). The MoU aims to mainstream environmental concepts related to international agreements in education as well as sustainable management of medical and electronic waste. The CB3 Project has also launched an Initiative of Environmentally Friendly Universities. The Academy of Scientific Research has announced a student contest that addresses MEAs and their related implications. The project, in cooperation with the Ministry of Higher Education and Scientific Research, launched the environmental cultural competition for students at universities and technical institutes for the academic year 2019/2020.

The CB3 Project is also currently developing and launching a postgraduate programme addressing natural resources management, which fulfils the obligations of MEAs and effectively introduces behavioural change. Concurrently, the project, in collaboration with Bibliotheca Alexandrina, implements a major programme for boosting environmental awareness among the students at Alexandria University and Damanhur University, under the title of “Back to Nature” and under the slogan of “Environmental Conservation: Human Obligation and Lifestyle.”

On the front of vocational education, the United States Agency for International Development (USAID), through its Workforce Improvement and Skills Enhancement (WISE) project, has established

two diploma programmes in technical schools, including the Benban Solar Technical School. Designed in cooperation with private sector stakeholders, the two programmes are in the fields of renewable energy and logistics. Students graduating from technical secondary schools are now able to get jobs immediately after graduation. Alcazar Energy, a leading independent renewable energy provider, offers a summer training programme for the students and teachers of the Benban Solar Technical School, located in the Upper Egypt governorate of Aswan, in collaboration with the WISE project.

The summer training programme further supports professional development of participants in the field of RE, specifically utility-scale solar photovoltaic power facilities. The programme has two main components. The ToT entails a week of theoretical in-classroom training combined with first-hand training and guided tours at Alcazar Energy's solar PV facilities within the Benban Solar Park.

5.5 Public Awareness

The Ministry of Environment has been actively spearheading several awareness campaigns targeting the public in addition to managing events and awareness sessions in different universities and conferences. Capitalising on these events, the ministry seeks to raise the public awareness on the importance of environmental literacy and climate change. Moreover, the civil society, for the first time, has become an active player in raising awareness on environmental issues relevant to the Egyptian context. This comes in line with the country's mitigation efforts and achieves the 17 UN SDGs. In addition, universities and institutions and international organisations have been active as well in providing public awareness activities.

5.5.1 Youth Engagement Via Extracurricular Activities

In 2020, the MoE, in partnership with the Friedrich Ebert Foundation (FES), initiated the first round of the Young Environmental Leadership Program (YELP), which targeted around 50 youth from different governorates. The FES provided youth with leadership training to enable them to become environmental advocates in their communities and civil societies. The training included a full-fledged program with webinars, workshops, and events to tackle different topics, including climate change impacts, their mitigation methods, and adaptation approaches.

Meanwhile, the world-renowned Bibliotheca Alexandrina has been significantly active in raising awareness and engaging different stakeholders through its Centre for Sustainable Development Studies, Youth Capacity Building, and African Relations Support Program. Through the African League of Young Master's Program, Bibliotheca Alexandrina hosted the Egyptian Minister of Environment in a live webinar with the students of Africa in 2021 to discuss environmental issues and priorities, including climate change. Participant students are studying at Alexandria, Ain Shams, Cairo, Tanta, and Zagazig Universities and specialise in the fields of engineering, commerce, veterinary medicine, pharmacology, and nursing. The students are from several African countries, including South Sudan, Malawi, Uganda, Sudan, the Comoros Islands, Burundi, Liberia, Madagascar, and Egypt. Other activities offered by the Bibliotheca Alexandrina centre include the Youth for Environmental Sustainability and Better Understanding Program (for students aged 13–18).

Moreover, a host of student awareness campaigns were conducted via the climate change awareness campaigns launched by the Centre of Excellence for Research and Applied Studies of Climate Change and Sustainable Development under the umbrella of the National Research Centre. The initiatives led by the Centre include:

- Climate Change Youth Fellowship Network to empower youth to conduct awareness campaigns and develop their skills.
- Water Conservation Awareness Program, which educates college and school students about water conservation and how to conserve water in their communities.

- Climate Change Awareness Program, which educates school students about climate change and how they can be effective in combating its consequences.
- Water Conservation Awareness Program for small villages and communities to educate them on how to make the best use of their water and conserve it as much as possible.
- Climate Change Consequences Awareness Program for institutes and establishments to educate them about the predicted consequences and how they can mitigate their effects in the best manner.

Additionally, the Egypt Local Conference of Youth (LCOY) has been held twice, in 2019 and in 2021, with the aim of engaging and educating youth on different topics, including climate justice, climate change mitigation, adaptation, climate change & agriculture, climate change and health, climate policy & advocacy, and the SDGs. LCOY is an event under the umbrella of YOUNGO, the official youth constituency of the UNFCCC, and around 500 young Egyptians have attended the two events. At LCOY Egypt, young individuals share their voices with each other and the world and become an efficient part of national and regional movements. They also learn about:

- Methods to raise awareness on climate change.
- Create networks for knowledge and skills sharing.
- Develop policy papers on climate change.

5.5.2 Engagement Via Ideation and Entrepreneurship

Egypt is fast becoming a regional hub for entrepreneurship and digital innovation. Driven by the unstable economic situation that unfolded at the beginning of 2011 and the chronic unemployment rate, entrepreneurship has become an opportunity to absorb unemployment and create new markets, which is much needed to revitalise the economy. Several incubators and accelerators have dedicated programmes for eco- or sustainable start-ups. Although the majority of which is usually in clean energy and renewables, start-ups with recycling, reuse, and upcycling are also on the rise. Meanwhile, NGOs with a green and sustainable focus offer eco/sustainable entrepreneurship programmes. It is also worth mentioning that many start-ups with a green or sustainable focus enter and compete in mainstream incubation and acceleration programmes that do not necessarily concentrate only on eco or green topics. In the medium and long run, these start-ups and innovative ideas will create new business opportunities and employability and enable the creation of local and cost-effective solutions for climate adaptation and mitigation.

Some of these programs have been offered via:

- ❖ Youthinkgreen Egypt - NGO
- ❖ Nahdet AL-Mahrousa's Green Arm
- ❖ GESR Incubator
- ❖ Cleantech Arabia
- ❖ HIVOS Green Hackathon by Rise-up
- ❖ Change Labs
- ❖ Start Egypt
- ❖ Green Economy startup FEPS Business Incubator

Examples of ongoing and emerging initiatives include the Call for Green Innovators and Start-ups launched in January 2021 by the Green Impact MED Project: Positive Investments for Positive Impacts (GIMED) project in the Southern Mediterranean region. In Egypt, the initiative is implemented in partnership with the Alexandria Business Association. The call aimed to engage young and women entrepreneurs with sustainable business ideas, offering them the opportunity to participate in a comprehensive training and coaching programme, culminating in a pitch event with the chance to win one of four grants.

In total, 19 green business ideas were selected in Egypt, targeting key areas related to climate change mitigation and the circular economy. These include sustainable mobility, RE, resource management, cleaner production, EE, waste management, and recycling.

Additionally, an acceleration programme has just been launched in Egypt with the aim of boosting the operational performance of green start-ups. The programme is initiated in 2021 by start-up accelerator Change Labs and funded by the GGF Fund. Called “Scale Up to Green”, the program aims to spur start-ups which introduce innovative solutions to create new products. Each admitted start-up will be considered for investment by the GGF and will receive technical assistance.

Relatedly, ‘Youthinkgreen’ Egypt, an active NGO engaged in sustainable and green initiatives, has been organising the Climate Launchpad competition annually for the third consecutive year. As part of a global initiative, winners from Egypt advance to compete at the international level. The competition is designed to promote sustainability and entrepreneurship among youth through educational programmes and events, placing hundreds of young entrepreneurs on the path to innovation by developing clean, climate-focused solutions.

Young entrepreneurs are also being engaged through the Affordable Resources for Egypt's Industrial Growth (RIndustry) project. Launched in 2020, RIndustry is an EU-funded initiative implemented by the British University in Egypt in collaboration with NREA, the Regional Centre for Renewable Energy and Energy Efficiency (RCREEE), the Central Metallurgical Research and Development Institute, and ISIS for Food Industries. One of the project's key objectives is to raise awareness and build capacity in energy and resource management, specifically targeting young entrepreneurs to inspire innovative ideas and support the creation of new green businesses.

5.6 Awareness and Public Outreach Initiatives

In 2019, the MoE launched “Live Green”, a national three-year public awareness campaign under the National Sustainable Development Strategy (SDS): Egypt Vision 2030. The campaign includes a structured framework to ensure continuous stakeholder engagement and aims to raise environmental and climate change awareness while promoting behavioural change to reduce greenhouse gas emissions.

Activities include live webinars, expert meetings, social media campaigns, tree planting, and outreach in schools and universities. The Ministry and EEAA also organise an annual World Environment Day event, focusing each year on a specific theme related to climate change mitigation and adaptation. Additionally, a separate campaign has been launched to promote biodiversity, green tourism, and ecotourism.

Also, The FEI, in partnership with the FES Egypt, launched an awareness campaign “Renewable Energy –Towards a Better Energy Future,” which focuses on solar energy with its applications in the local market. In addition, the campaign provides information to encourage investment in this vital sector by highlighting successful case studies and lessons learned through a series of events with the purpose of knowledge sharing and benefiting from international experiences in technology transfer.

Furthermore, three awareness and dialogue events were conducted in 2021. The FEI, in partnership with GIZ, has also organised a series of energy efficiency (EE) workshops and seminars in 2021 to introduce practices and information on EE for small and medium enterprises in the chemical industry.

In the fields of energy, climate change, and environment, the Cairo Climate Talks (CCT) has initiated the organisation of monthly talks, public events, and expert workshops. It provides a platform to exchange experiences, raise awareness, and foster cooperation between policymakers, business, the

scientific community, and civil society. The CCT is a collaboration between the German Embassy in Cairo, the MoE, the German Academic Exchange Service (DAAD), and GIZ.

5.6.1.1 PUBLIC PARTICIPATION

The participation of civil society and the private sector and greater coordination with other ministries are gradually becoming normalised steps to validate and amend potential new policies, incentives, and strategies. Currently, the Ministry of Planning and Economic Development has adopted a nationwide participatory approach with community dialogues involving the private sector, experts, NGOs, and youth. It seeks to update the 2030 Sustainable Development Vision and its strategic goals.

The ministry has also supported the creation of the Egypt Youth 2030 Initiative, where youth and volunteers initiate and organise events about the sustainable development vision 2030 for youth and the community at large. The Egypt Youth 2030 Initiative aims to enhance youth participation in shaping the future of their country by contributing to sustainable development through a series of seminars, gathering ideas and projects, and organising various activities and events.

In September 2020, the Ministry of State for Information, in partnership with the Ministry of Planning and Economic Development, the MoE, and the Ministry of Youth and Sports, has launched the first phase of the national development initiative, called Tanmaya (“Development”). It aims to highlight Egypt Vision 2030 and the national agenda for sustainable development, in line with the 17 SDGs implemented by the UN through a competition for individuals, companies, civil society organizations, and media professionals. The competition aimed at creating community dialogue on the 17 SDGs.

Furthermore, the Ministry of Planning and Economic Development launched the ‘Participatory Budget’ initiative in September 2020, marking the first step to involve citizens in planning the country’s budget. It launched several mechanisms to activate the participatory budgeting, such as the “Minister Answers” application to communicate with citizens, especially youth. The app encourages citizens to present their ideas and proposals and get involved from across the nation in the decision-making process on certain budgetary issues, including citizens from each governorate in discussions on national and municipal projects listed in the state’s budget, and solicit their opinions on budgeting priorities.

In 2020, the Ministry of Communications and Information Technology and the MoE launched the E-Tadweer application. The E-Tadweer application is designed to engage the public by promoting the safe recycling of outdated electronic items, in collaboration with the private sector, allowing people to drop off defunct electronics at designated points in exchange for vouchers that can be used to purchase new devices at partner stores.

Another important development is the creation and launch of the Greenish Environmental Festival by the civil society, marking the first green cultural event in Egypt with a focus on youth and families. The first edition of the festival was launched in 2021 and organized by Egyptian social enterprise Greenish.

The event strives to raise awareness of sustainable development and the effects of climate change through an array of workshops related to eco-friendly practices, such as compost manufacturing and creative recycling, along with talks and panel discussions on pressing environmental issues such as achieving sustainable cities, ecotourism, and waste management. On the recreational side, the festival included musical and artistic performances as well as environmentally sustainable product exhibitions by companies, associations, and individuals.

5.7 Information Sharing and Networking

Effective climate change management and community sustainability require strong collaboration among all community stakeholders, including public institutions, the private sector, civil society, academia, and international organizations. Partnerships for sustainable development and climate action should be viewed as essential foundations for driving structural economic transformation.

To bolster these objectives, the government is urging stakeholders to adopt a "proactive climate action" approach on a voluntary basis. This approach is intended to serve as a paradigm for others and bolster mitigation and adaptation efforts. Additionally, Egypt continues to play a key role in climate-related knowledge sharing and technical assistance, particularly across the African continent.

5.7.1 Private Sector and NGO Engagement

In 2021, a private sector-led charter for recycling plastic waste was initiated by a consortium of eight leading companies working in Egypt on the recycling and safe disposal of materials containing single-use plastic components. The signing of the charter, which helps in protecting the environment and achieving sustainable development, was under the auspices of the MoE. The Charter for Recycling Plastic Waste is meant to guarantee sustainable recycling by creating a system in which plastic is not turned into waste but is safely reused, recycled, or converted to packaged fertilisers and other products. Similarly, the number of companies that adopt practices of resource efficiency is on the rise, while NGOs have also been engaged to promote anti-plastic campaigns and encourage responsible patterns of consumption.

For example, the Hurghada Environmental Protection and Conservation Association (HEPCA), an NGO working primarily with marine and land conservation in the Red Sea Governorate, engages in many environmental awareness-raising activities targeting the local community, schools, tourism industry, and service providers. HEPCA also provides environmental educational campaigns and research around biodiversity in the Red Sea region in a bid to ensure proper long-term management of natural resources. It is also active in lobbying against single-use plastics and works on waste management activities as well.

Within the same context, several youth-led groups and NGOs, with the support of the MoE, have joined hands to fight plastic pollution. In this regard, the Coalition Egypt Ban Plastic was formed on the 4th of July of 2019. The coalition includes a total of 20 NGOs, businesses, and artists, like Bassita, Greenish, Nile Taxi, Mobikya, Very Nile, Kefaya Plastic, Bekia, Go Green Network, Re-Solutions, Drumstick, Safareya, Envarious, Up-Fuse, Roo'ya, Banlastik, and FES Egypt.

In addition, the Youth Love Egypt (YLE) Foundation is another organisation that is playing a role in promoting environmental activism. YLE aims to raise awareness of environmental issues and natural reserves. In January 2020, the foundation organised a major campaign to remove waste from the banks of the Nile River. It also launches clean-up campaigns in a few governorates and areas, including the Nile River and Botanical Garden in the Aswan and Luxor governorates.

The Upper Egypt governorate of Assiut also witnessed the launch of two cleaning and awareness campaigns, along with the introduction of several campaigns in Port Said, Damietta, the Red Sea, and South Sinai, with the participation of about 2,250 volunteers. Another similar move is made by the Very Nile initiative, which organises clean-up campaigns in the Nile and works to raise awareness about environmental protection in the private sector companies as part of their Corporate Social Responsibility (CSR) activities.

5.7.2 International And Regional Cooperation & Knowledge Sharing

Egypt has been actively seeking to support climate change policy and efforts in Africa and the Nile Basin through managing climate change actions and providing forecasts of flood and heavy rain, which are posing problems for many African countries. In 2021, the Egyptian Minister of Water Resources and Irrigation inaugurated the Rain and Climate Change Forecast Centre in Kinshasa, the capital of the Democratic Republic of the Congo (DRC). The Centre was funded by an Egyptian grant exceeding \$10 million. The Centre's work is expected to help protect the DRC's citizens from sudden climatic disasters.

The Centre will capitalise on the latest information and data collection technology on the back of using the latest rain forecasting systems. This will enable the Centre to study the effects of climate change on the DRC and to set measures to protect citizens from the sudden risks of climate change. Undoubtedly, climate forecasting will play a vital role in directing the agricultural sector through a better understanding of the seasons and managing river water. Egypt has also trained the Congolese Centre staff to use rain and flood forecasting systems, analyse aerial imagery, operate GIS systems, apply hydrologic modelling, and draft technical reports.

In Juba, the capital of South Sudan, Egypt established a central laboratory for water quality analysis. The laboratory is the first of its kind to be established in South Sudan. It aims to reduce water pollution, rehabilitate and renovate the main stations, monitor river levels, and follow the behaviour of rivers in South Sudan. The Centre also aims to forecast floods, mitigate their effects, and increase water levels. Through the National Authority for Remote Sensing and Space Sciences (NARSS), Egypt hosts many specialists from African countries and trains them on relying on space sciences and the capabilities available in the Egyptian Space Agency, especially in the field of forecasting climate change.

At the global level, Egypt has been actively contributing to the reporting mechanism of the Voluntary National Report (VNR) to track progress toward the 17 SDGs on a voluntary basis. The VNR reports are presented at the annual High-Level Political Forum on Sustainable Development (HLPF). Egypt has volunteered three times to submit a VNR report, the latest of which was presented in 2020, highlighting progress on all 17 SDGs, including scoped challenges and gaps, as well as achievements and success factors. It is Egypt's third report that includes reporting on activities and development to achieve Goal 13, which seeks to combat climate action. This reflects the country's efforts to lead by example in the region and its voluntary steps towards measuring progress towards the SDGs.

5.8 Gender Responsiveness

As stated in the Third National Report, Egypt's government recognises the importance of mainstreaming gender equality and supporting the empowerment of women due to two main undeniable facts:

- Climate change not only causes danger, vulnerability, and risk to life and property but also contributes to increasing the gap between the rich and the poor, especially for women.
- Climate change causes different impacts on men and women. It has a key impact on the relationship that people have with their environment, their knowledge in relation to the environment, their social and economic positions and the power relationships between men and women in the society.

The gender-differentiated impacts of climate change, particularly those affecting women, are of growing importance due to the critical roles women play in food production and in meeting household energy and water needs. Women are central to livelihood support in poor communities and play a key role in natural resource management, making them powerful agents of change with essential knowledge and skills to build climate resilience and implement adaptation and awareness actions. In Egypt, women have contributed to adaptation efforts such as the construction of straw walls to help guard against SLR.

By the end of 2011, Egypt developed its first "National Strategy for Mainstreaming Gender in Climate Change", which aims to consider a gender perspective in policy development, decision-making, and the development and implementation of strategies concerning mitigation and adaptation. It was developed through a collaboration between the Global Gender Office of the International Union for Conservation of Nature (IUCN), the IUCN Regional Office for West Asia (ROWA), the Centre for Environment and Development for the Arab Region and Europe (CEDARE), and other key national institutions in Egypt. The strategy aimed to create a national policy framework on gender and climate change and was strategically integrated into Egypt's TNC.

This strategy outlines eight priority focus areas that can be enhanced through women's leadership, including integrated coastal management, agriculture, water, tourism, health, energy and transport, urbanisation, and waste management. Each priority comprises subsections on women as agents of change, a situation analysis, and the state of gender, along with a set of recommendations. The main premise of the strategy is especially important:

“Recognising women as change agents and having a primary role in reducing the effects of climate change, rather than just being an affected, vulnerable, passive group.”

The strategy proposed a set of measures to:

- Integrate gender considerations in reports on policies and measures to mitigate climate change.
- Include gender considerations in the assessment of climate changes, vulnerability to climate change and measures to adapt to climate change.
- Incorporate gender-disaggregated socio-economic data in long-term climate change scenarios.
- Include gender consideration, collect gender-disaggregated data, and include gender analysis in the assessment of vulnerability to climate change in priority areas of agriculture, water, coastal zones, and new areas and economic sectors such as tourism, health, energy and transportation, urbanisation, and waste.
- Consider new policies and research on adaptation to climate change with a gender perspective.
- Integrate gender considerations in the Vulnerability and Adaptation Chapters of National Communication Reports. Involve gender experts in the review of medium-term and long-term scenarios for all priority areas and in the national workshop to highlight findings from V&A studies.
- Include the National Strategy on Gender and Climate Change in Egypt in briefings for decision-makers on integrating gender in adaptation.
- Compile and synthesise information relevant to Article 6 of the UNFCCC (education, training, and public awareness) and Article 4 (technology transfer), with gender considerations, and integrate climate change into new national policies on women.
- Identify and hire appropriate national gender experts to conduct research on climate change impacts, vulnerability & adaptation.
- Include women and women’s organisations as stakeholders participating in the Projects Steering Committees and expert groups.

However, the scale of activities that implement this strategy until now has been relatively limited. But Egypt’s current policies of women empowerment and rapid changes introduced to close the gender gap in the country are ushering in a promising era of accelerating the issue of gender and climate change and bringing it at the forefront of climate policy measures.

Egypt has introduced "The National Strategy for the Empowerment of Egyptian Women 2030", which aims to increase women's participation in government. The country has also issued a raft of regulations to promote female participation on the boards of directors and created programmes for access to finance, inclusion, and microfinance to support women as breadwinners in their families, especially in rural and remote vulnerable areas. All these efforts are in line with providing women with equal opportunities, information, and tools to earn better income and lead better lives for them and their families. These efforts are central in mitigating the economic and social impact of climate change, especially in vulnerable areas. Therefore, these activities provide a baseline for any future or ongoing planned activities to protect women against expected impacts of climate change.

Focusing on climate change and sustainable development, international organizations in partnership with public institutions are increasingly adopting gender-responsive approaches. These aim to boost female participation and apply gender-specific strategies to enhance project effectiveness and impact.

Moreover, the Women Empowerment and Equal Opportunity Unit of the MoE, established in 2002, has played an active role in inserting a provision on climate change and women empowerment in the country’s Women Empowerment Strategy 2030. The move is a culmination of the unit’s continuous

engagement with the National Council for Women (NCW). The unit also signed a protocol with the NCW to provide it with information and awareness on the impact of climate change that can hinder the economic progress of women, especially among vulnerable populations and in rural and informal settlements. This is particularly important because women are the main income-generating family members of many agricultural communities that are more vulnerable to climate change. The unit also works on forging partnerships with international stakeholders to promote gender and align it with the environmental priorities of the country.

Capitalising on its different branches spread across the country and the creation of a national committee to engage different governorates, the Women Empowerment and Equal Opportunity Unit has organised a series of seminars and activities in different governorates with various institutions to educate and raise awareness of women, especially in rural and remote areas. These seminars addressed potential impacts of climate change and how women can become more resilient through adaptation solutions and mitigation measures such as EE and water savings. The seminars also highlighted the importance of setting up government policies to address climate change. In 2021, more than 30 seminars were held in the governorates of Aswan, Alexandria, Mansoura, Behera, Tanta, and Giza.

There is a mounting need to accelerate efforts to promote gender parity and women's empowerment within the national climate policy framework. Accordingly, it is necessary to:

- Develop expertise for collecting and identifying gender-disaggregated data.
- Develop expertise for gender analysis, assessments, and gender-responsive policymaking.
- Develop advanced technical training for women in relevant institutions and create gender-awareness and skills-training opportunities for both men and women in different systems and institutions, with the intention to redistribute care work and cultivate alternative views of care for people and environment; and
- Update existing strategies and design relevant action plans for gender mainstreaming and climate change.
- Development of guidelines that promote gender equality mainstreaming within public institutions and through strategy design, policy formulation and decision-making.
- Increase public awareness on the importance of women empowerment considering the adverse impacts of climate change. Designing activities to highlight the need to enable and educate women and youth and vulnerable citizens from the negative economic and health impacts of climate change by providing access to information and, increase their readiness to address the diseases arose from climate change, conducting studies, and training relevant stakeholders.
- Increasing the rate of engaging partners, including youth, academia, civil society, and international organisations, to support the launching of projects and events to raise awareness of gender equality and to normalise mainstreaming efforts in activities related to climate change resilience.

5.9 Key Enablers

Climate change has steadily gained prominence on Egypt's national agenda, increasingly recognised as a cross-cutting priority requiring a coordinated, multi-institutional response. Government institutions and decision-makers now view climate action as central to sustainable development. Regionally, Egypt plays a leading role in advancing climate capacity building, policy coordination, and integrated planning through numerous adaptation and mitigation initiatives.

However, critical enablers must be strengthened to ensure the effective implementation and reporting of climate policies and actions. While progress has been made, including Egypt's preparation of its FNC, achieving the objectives of the National Climate Change Strategy 2050 will require enhanced institutional capacity, stronger data systems, and continuous knowledge exchange. Some of the identified gaps and needs include:

5.9.1 Technical Capacity and Training Gaps:

- Limited technical training in GHG inventory development, measurement, and data management.
- Insufficient use of advanced forecasting models and scientific tools to inform policy decisions.

5.9.2 Education and Skills Development Needs:

- A shortage of formal climate-focused degrees, diplomas, and vocational programs.
- Uneven progress in climate education across public and private institutions.
- Need to align education and training with green job creation and climate-smart entrepreneurship.

5.9.3 Data and Measurement Limitations:

- Inadequate availability of reliable, timely, and harmonized data for national reporting.
- Absence of standardized data formats and digital platforms for reporting and analysis.
- Weak institutional memory and limited mechanisms for integrating findings from past reports.

5.9.4 Coordination and Governance Gaps:

- Lack of a centralized coordination mechanism for climate data and reporting.
- Fragmented institutional roles and absence of binding reporting standards for stakeholders.
- Need for an empowered institutional home for MRV coordination with a clear mandate.

5.9.5 Human Resource and Leadership Needs:

- Limited number of trained individuals within institutions dedicated to reporting functions.
- Absence of internal champions to drive institutional awareness and documentation quality.

5.9.6 Alignment with International Requirements:

- Need for sustained access to international training, tools, and guidance.
- Preparing for the Enhanced Transparency Framework (ETF) and meeting the 2024 deadline for biennial transparency reports

6 Financial Support, Technology Transfer, Capacity Gaps and Constraints

6.1 Introduction

Building on the findings of previous chapters, this chapter focuses on three key enablers for effective climate action: financial support, technology transfer, and capacity-building. These elements are essential to advancing Egypt's climate commitments under the UNFCCC, Kyoto Protocol, and Paris Agreement, particularly considering the country's exposure to climate risks and development needs.

As stated by the Intergovernmental Panel on Climate Change (IPCC, 2014), meaningful climate action begins with understanding that risk arises where people, livelihoods, ecosystems, infrastructure, and resources are exposed to adverse climate impacts. Egypt's TNC similarly

emphasised that financial and technical support, alongside research, are critical investment instruments for achieving mitigation goals across sectors. However, in the context of rapid global changes, there is now an urgent need for innovative financing mechanisms and adaptive technology transfer tools that are tailored to the specific needs of each sector and subsector.

This chapter explores the legislative and institutional frameworks that underpin Egypt's climate response, highlighting areas of progress and persistent gaps in coordination, enforcement, and alignment with climate priorities. It also examines capacity-building challenges, knowledge management constraints, and the limited integration of inclusive and gender-responsive approaches.

Additional sections analyse the climate finance landscape, including current support, funding shortfalls, and opportunities for resource mobilisation scaling, and provide identified pressing technology requirements. The chapter emphasises the necessity of a climate response framework that is coherent and amply resourced, supported by strong partnerships, innovation, and evidence-based planning, to guarantee that Egypt's development is sustainable, inclusive, and climate-resilient.

6.2 Legislative Framework

While Egypt has established a solid legislative and institutional foundation for addressing climate change, further efforts are needed to enhance enforcement, modernize outdated provisions, and clarify institutional roles to improve overall coherence and responsiveness. Strengthening regulatory reporting systems and more fully integrating climate considerations into licensing, planning, and sectoral strategies will be key to supporting effective and coordinated implementation of climate action across all levels.

6.2.1 Enabling Policies, and Legislations

According to Egypt's 2014 Constitution, Articles 45 and 46 affirm that every individual has the right to a healthy, sound, and balanced environment. The protection of this right is considered a national duty, with the state obligated to take all necessary measures to safeguard the environment, prevent harm, and ensure the rational use of natural resources in a manner that supports sustainable development and protects the rights of future generations.¹³

As have been previously mentioned, Egypt ratified UNFCCC in 1994, signed the Kyoto Protocol in 2005, and the Paris Agreement in April 2016, which it ratified in September 2017¹⁴. The UNFCCC stipulates (Article 12, paragraph 1) that developed country Parties must provide new and additional financial resources to cover the full costs incurred by developing countries in fulfilling their obligations. It also mandates financial support, including technology transfer, to meet the incremental costs of implementing climate measures. Articles 4.3 and 4.5 further call on developed countries to facilitate and finance access to environmentally sound technologies. Article 4.7 adds that developing countries' ability to fulfil their commitments depend on the support provided by developed countries. Similarly, Article 10.1(c) of the Kyoto Protocol states that developing countries should have access to environmentally sound practices and technologies, including support for relevant policies and programmes. The Protocol also outlines priority technologies for mitigation and adaptation, as follows:

- **Prioritized Technologies for Mitigation**
 - Solar photovoltaic
 - Biomass/biogas electricity generation

¹³ National Voluntary Review on the Sustainable Development Goals: Input to the 2016 High-level Political Forum (HLPF) on Sustainable Development.

¹⁴ Egypt National Climate Change Strategy 2050, October 2021.

- Efficient lighting
 - Waste to energy
 - Wind turbines
 - Hydropower
- **Prioritized Technologies for Adaptation**
 - Biotechnologies, including technologies related to crop improvement, new varieties, and drought resistant.

Egypt's environmental legislative framework is anchored in Law No. 4 of 1994 (amended in 2005) and Law No. 102 of 1983 on Natural Protected Areas, later updated by Law No. 9 of 2009. These laws define the main principles of environmental management and aim to strengthen institutional, legal, and technical capacities across all governance levels. Complementary laws include the 1947 Environment Protection Law (covering air, land, and marine environments), Law No. 48 of 1982 on Nile River protection, Law No. 12 of 1982 on irrigation and drainage, and Law No. 93 of 1962 on wastewater discharge. Together, they reflect Egypt's growing legal response to environmental risks, as highlighted in the Global Risk Report 2021. The MoE leads policy coordination in collaboration with other ministries via the Cabinet.

Egypt's legislative approach is also shaped by its constitution and international environmental commitments, particularly from the 1992 Rio Earth Summit and the 2015 Paris Agreement. These commitments, along with Egypt's participation in numerous bilateral, regional, and global environmental conventions, have significantly influenced the integration of environmental concerns into national laws and policy frameworks.

The Ministry of Environment is responsible for compiling data for Egypt's National Climate Change Communications, while the NCCC has led the National Adaptation Plan (NAP) process. The NCCC launched Egypt's National Adaptation Strategy in 2011 to address sector-specific climate risks and build resilience to expected climate-related disasters.

The Industrial Development Authority (IDA) was granted the authority to issue comprehensive licenses to industrial establishments, including environmental requirements, for the first time under Law No. 15 of 2017 on the Facilitation of Licensing Procedures. Under this law, the IDA is responsible for reviewing environmental impact assessments, monitoring compliance, and conducting inspections throughout the licence period. It also introduced new enforcement and verification mechanisms, distinct from those outlined in Law No. 4 of 1994.

As a result of these legal reforms, the EEAA's responsibilities concerning industrial establishments were transferred to the IDA. Additionally, the issuance of Law No. 202 of 2020 created a dedicated legislative and institutional framework for waste management. This law established the Waste Management Regulatory Agency, which assumed all EEAA functions related to waste management and now operates as an economic agency reporting to the Minister of Environment.

As outlined in earlier chapters, Egypt has also developed the SDS: Egypt Vision 2030, which serves as the national roadmap for achieving the UN SDGs. The strategy incorporates climate action as a cross-cutting priority, with relevant projects focused on sustainable agriculture, coastal zone protection, and the efficient management of water resources. In line with its long-term climate commitments, Egypt also updated its LEDS 2050 in October 2021, building upon the original strategy developed in 2016.

6.2.1 Related Gaps and Constraints

To strengthen the enforcement of environmental and climate-related legislation, the following priorities should be addressed:

Enhance legislative authority and enforcement:

- Accelerate the development and implementation of legal measures, including the imposition of fines and additional fees on carbon-intensive industries.

Ensure EEAA focal point participation:

- Actively involve designated EEAA focal points in all activities that may affect climate change adaptation and mitigation efforts, ensuring institutional oversight and coherence.

Allocate resources to improve legal frameworks:

- Provide dedicated resources to assess and enhance the current legal infrastructure governing environmental protection, promoting a more effective and responsive system.

Expedite legal procedures for climate violations:

- Streamline and accelerate judicial and administrative processes related to environmental and climate change violations to reflect the urgency of climate action.

Build capacity among legal professionals:

- Strengthen the knowledge and skills of legal professionals in both jurisdiction and investigation to support the enforcement and evolution of climate-conscious legislation.

Establish specialized education and training:

- Develop a postgraduate diploma or professional training programme in climate change law and environmental governance, including coverage of international obligations, to support legal practitioners and policymakers.

Moreover, Egypt’s existing set of environmental laws and policies must be thoroughly updated and aligned with modern legislative standards to address emerging and non-conventional environmental risks, including the impacts of diverse waste streams and hazardous materials that contribute to climate change.

Other Suggested relevant recommended steps for improving the Legislative Framework:

- Set Regulatory reporting systems from all industries to closely monitor impact on climate change national plans and strategies.
- Enhance decentralization in legislations relevant to emission of GHG and to create focal points reports to the local authorities as well as directorates of Climate Change.
- Monitor Environmental Law abidance from all sectors locally and centrally.
- Strongly adhere to approval of EEAA / Climate Change authorities beforehand any establishment whether agricultural, or infrastructural.
- Ensure climate change and environment considerate clauses in all agreements, projects, and initiatives.
- Enforce profoundly the role of the licensing authority/agency from the environmental and climate change mitigation and adaptation plans on micro and macro levels.
- Establish specific “Tariff” to those GHG emitting industries to be directed to climate change adaptability and mitigation national plans. This came as recommendations through IMF in CO₂6; however, for Egypt this must be carefully analysed so as not to affect the investment attraction leverage in Egypt.

6.3 Knowledge Management and Capacity Building

In the lead-up to COP26, the IMF¹⁵ emphasized that facilitating climate finance hinges on “better data, better decisions.” It identified three foundational elements for strengthening the climate information architecture: (1) high-quality, reliable, and comparable data; (2) harmonized and consistent climate disclosure standards; and (3) a globally recognized taxonomy. Together, these can help “unlock trillions of dollars in green finance” and enable more effective mobilization of funding for climate action. The IMF also supports advancing data systems, disclosure practices, and taxonomies to help investors better price and manage climate risks. The absence of systematic and publicly accessible knowledge management continues to create ambiguity, hindering the ability of stakeholders to identify best practices, build on project successes, and replicate or scale up effective climate solutions. Identified key weaknesses in the current climate change landscape as follows¹⁶:

- Lack of awareness and weak infrastructure in many areas exposed to the negative impacts of climate change.
- Weak application of laws and policies because of weak institutional capacities and enforcement mechanisms.
- Limited government funding for mitigation and adaptation measures.
- Obsolete environmental laws, legislations and standards and the absence of their update to cope with the local, regional, and international development.
- Weak private sector participation in mitigation and adaptation programs.
- The absence of a mechanism to ensure the integration of environmental dimensions and principles of sustainable development into sectoral plans, programs, and policies.

These weaknesses can be addressed through the following measures:

- Integrating climate vulnerability maps into the planning process to guide the siting of new developments, including residential and industrial areas.
- Conducting studies by the Ministry of Health and Population on the anticipated health impacts of climate change and formulating a targeted response plan.
- Prioritizing, through the Ministry of Planning and Economic Development, infrastructure upgrading projects, particularly aging systems and expanding service coverage such as sewage treatment in highly vulnerable areas.
- Building on the “National Water Resources Development and Management Strategy 2050” (MWRI) to prepare a time-bound action plan for maximizing wastewater treatment and reuse across domestic, industrial, and agricultural sectors.
- Designing policies and programs to strengthen rural community resilience, particularly in areas affected by land use change, agricultural production shifts, and migration pressures on urban areas.
- Ministry of Education to put climate change topics and raise awareness of its effects as essential parts of school education programs.
- Ministry of Higher Education and Scientific Research to include the field of climate change in undergraduate and postgraduate university programs.
- Encouraging the establishment of more research institutes and centres specialized in climate change issues, whether at the sectoral level or from multidisciplinary research groups.

¹⁵ International Monetary Fund, (September 2021) FINANCE & DEVELOPMENT

¹⁶ Executive Summary of Egypt’s National Climate Change Strategy, October 2021.

Officials and decision-makers across all sectors need to significantly strengthen their awareness of climate change impacts and their relevance to national climate action. A large proportion of public officials currently lack updated, evidence-based knowledge about climate change and its cross-sectoral implications. To address this, local institutions should establish robust knowledge management systems that allow institutional memory and expertise to be retained, even as individuals transition out of roles.

There remains frequent confusion between the concepts of mitigation and adaptation, and many climate-relevant sectors—such as transport, construction, aviation, agriculture, energy, and fuels—are not equally prioritised or understood due to limited sector-specific expertise. Capacity-building efforts must therefore extend beyond technical specialisation to also include broad-based public awareness. Integrating climate change, mitigation, and adaptation concepts into the national education system is essential. Furthermore, foundational concepts such as the green economy and blue economy should be actively promoted across various workforce segments nationwide.

Those involved in designing and preparing international development projects need to significantly strengthen their capacity building and information management skills. The relatively low number of new projects receiving international assistance reflects Egypt's limited ability to develop climate-relevant proposals. Although the UNFCCC obliges developed countries to support developing nations across a range of sectors, Egypt's access to international climate finance remains constrained and does not align with the scale of its needs or its vulnerability to climate impacts.

Moreover, the inconsistent level of climate awareness among key stakeholders poses risks to economic development, as many businesses are not adequately preparing for the physical and financial implications of climate change across their operations and value chains. The limited scale-up of knowledge management best practices in Egypt continues to hinder effective knowledge transfer among stakeholders and weakens the country's ability to mobilise substantial funding from major international finance mechanisms.

6.3.1 Mitigation

Egypt's NDCs stress the need to reduce emissions by developing and implementing a robust, economically viable mitigation programme with targeted reductions by 2030. A foundational step toward effective mitigation is the establishment of comprehensive national monitoring and verification systems. On the ground, Egypt is actively addressing climate change through a range of measures, including air pollution control, expansion of renewable energy (RE), and emissions reduction across multiple sectors.

Gender considerations, as have been presented in the last chapter, are also receiving increased attention, recognising that women are often disproportionately affected by climate change. National strategies now explicitly aim to mitigate climate impacts on women. In this context, the EEAA has launched a dedicated strategy for gender mainstreaming in environmental efforts, with a particular focus on women's roles in climate action.

6.3.2 Adaptation

According to Egypt's Human Development Report, the National Strategy for Adaptation to Climate Change and Reduction of Disaster Risks aims to strengthen the country's capacity to address climate risks and build national resilience. The strategy aligns with international projections of a 2°C temperature rise and anticipates two sea-level rise scenarios through 2100—0.5 metres and 1 metre. It prioritises adaptation efforts in the most vulnerable sectors, including coastal zones, water resources, agriculture, health, and urban and touristic areas. A parallel effort focuses on disaster risk reduction, including the development of an interactive vulnerability map for Egypt.

The agriculture sector is already confronted with a variety of challenges, including environmental degradation, disease epidemics, high input costs, and issues related to land rights and inequality. To

address these, Egypt is implementing adaptation measures such as climate-smart agriculture, improved water management, early warning systems, and decision-support tools. Efforts also include developing drought-resistant crops, adopting new livestock breeding practices, expanding water harvesting techniques, and reallocating land to higher-value crops to increase productivity and resilience.

Additionally, Egypt is committed to enhancing biodiversity in livestock, fisheries, and poultry to strengthen food security. Investments in agro-economic systems and improved land management aim to reduce degradation and build the agricultural sector's capacity to withstand climate-related stress.

6.4 Technology Needs

The term '**climate technology**' encompasses a much broader scope than commonly perceived. Recently, the deployment of climate technologies has expanded globally at an unprecedented rate. Several RE technologies have become cost-competitive with fossil fuel-based electricity generation. A critical role is played by scientific research that concentrates on the observation of climate change in the development of predictive models and monitoring systems in a variety of sectors, including water resources, agriculture, forestry, oceans, human health, ecosystems, infrastructure, and disaster risk reduction. These efforts also support the development of assessment methodologies, adaptation theories, and demonstration projects targeting vulnerable regions and sectors.

In the context of mitigation, significant research has been directed toward:

- Developing and marketing non-fossil fuel and clean coal technologies.
- Advancing energy-saving and high-efficiency technologies in critical sectors (e.g., industry, buildings, and transport).
- Innovating forestry carbon sink solutions and industrial carbon sequestration methods.
- Reducing the costs and scaling up market-oriented applications of technologies like carbon capture, utilization, and storage (CCUS).
- Establishing comprehensive carbon emissions monitoring and statistical systems to support national CO₂ and energy intensity targets.

Equally important is the establishment of comprehensive technological support systems to enable low-carbon, sustainable development. These systems not only underpin mitigation and adaptation efforts but also serve as valuable tools for raising public awareness and encouraging broader participation in climate action. For instance, the application of early warning systems in coastal zones is crucial to assessing and mitigating climate-related environmental hazards. Similarly, designing integrated monitoring and early warning mechanisms is essential for addressing climate vulnerability more effectively.

The first step taken by the Ministry of Trade and Industry (MTI) to support and promote the principles of the green economy was the establishment of the Egyptian National Cleaner Production Centre (ENCPC) in 2005 by MTI in cooperation with UNIDO as a service provider to Egyptian industry. The centre operates as one of the 52 national cleaner production centres worldwide and is also one of the technology and industrial innovation centres affiliated with the MTI. The centre is considered the entity mandated to implement and support the United Nations mechanisms for sustainable development. Its scope of work includes promoting resource efficiency and cleaner production, EE, green industry, circular economy practices, and the adoption of environmentally sound technologies. It also supports the development of eco-friendly industrial zones and the integration of low-carbon and green chemistry technologies in manufacturing processes, as well as the application of new and RE solutions within the industrial landscape.

In addition, future research should investigate non-conventional climate mitigation challenges. One instance is the recent discovery that the indirect depletion of essential resources, including water, energy, and agricultural inputs, in exporting countries can result from international food trade,

regardless of whether it is in processed or unprocessed form. Various other commodities, both imported and exported, are affected by this issue. In addition, it is imperative to further develop and implement technologies that facilitate adaptation, including genetic engineering for resilient crop varieties, enhanced livestock breeding to utilise low-cost fodder, and low-cost tools for agricultural recycling and soil restoration.

Technology also plays a key role in monitoring specific climate risks. For Egypt, this includes tracking sea-level rise and desertification hazards in coastal regions, as well as monitoring increased evapotranspiration through expanded meteorological data collection in harbours and coastal zones. Moreover, advancing technologies to reduce air and water pollution and manage solid waste can contribute to improving performance in petrochemical refining, catalysts, and polymer production.

Special focus is required in the areas of:

- Solar energy technologies
- Fuel cell development
- Energy storage systems
- Renewable energy economics
- Infrastructure for clean electricity

Parallel research, development, deployment, and scale-up of technologies that can significantly reduce the cost of CO₂ capture are vital. Technology roadmaps and assessment tools help governments identify appropriate solutions while creating enabling environments for domestic and international investment.

Diplomatic collaboration is necessary to ensure the long-term sustainability of water resource management, a strategic domain for Egypt, since the Nile's source is situated beyond national borders. An ongoing dialogue with regional countries, such as Sudan, Uganda, and Ethiopia, is indispensable. In this sector, Egypt has implemented numerous national adaptation measures, such as:

- Promoting water conservation across agriculture, industry, and municipal services.
- Upgrading water quality and sanitation infrastructure to reduce pollution.
- Constructing water harvesting systems in flood-prone areas such as Sinai, the Red Sea region, and Upper and Middle Egypt.
- Expanding the use of solar and wind energy in desalination.
- Increasing storage of drainage and freshwater in coastal lakes.
- Conducting public awareness campaigns on water scarcity and responsible use.

The government is also committed to investing in modern irrigation systems, developing policies to promote efficient water use, and collaborating with Nile Basin countries to minimise evaporation and safeguard river flows.

6.4.1 Examples of Specific Technology Needs:

Examples of specific technology needs have been identified as essential for advancing Egypt's climate change mitigation and adaptation goals across key sectors.

6.4.1.1 Power Generation:

Nuclear power offers a carbon-free source of electricity, but challenges related to safety and cost remain. Nuclear fusion technology is a promising solution that emits no greenhouse gases, only harmless helium, and poses no danger of meltdown or long-lived radioactive waste. Additionally, fusion energy requires significantly less land compared to other RE technologies, making it a potentially transformative option for sustainable, large-scale power generation.

6.4.1.2 *Transport*

The transport sector accounts for approximately 23% of global energy-related CO₂ emissions, and demand is projected to grow with population increases. Transitioning to EVs is a critical mitigation strategy; however, this requires significant advancements in battery efficiency, charging technologies, and the development of comprehensive supporting infrastructure.

Ongoing research by several universities has yielded promising new materials that may outperform conventional batteries, offering higher power capacity and EE. If proven scalable, these technologies could significantly accelerate the shift toward low-emission transportation systems and support broader climate goals.

6.4.1.3 *Control of CO₂ Produced by Manufacturing and Food Processing:*

Innovations to reduce CO₂ emissions are rapidly advancing, particularly in the field of CCUS. One notable example is the Net Zero Teesside (NZE) initiative, which, while not inexpensive, represents a bold and sustainable approach to industrial decarbonisation. NZE aims to capture CO₂ emissions from industrial facilities and power plants, transport them via pipelines, and store them securely in geological formations several kilometres underground. Once sequestered, this carbon is prevented from contributing to the greenhouse effect and, in the future, could potentially be converted into synthetic fuels to power low-emission transportation systems.

6.4.1.4 *Household energy efficiency*

One of the most effective technological responses to climate change is the reduction of overall energy consumption, particularly in residences. Many modern appliances already offer significant energy savings. The EU's energy labelling scheme guides consumers by rating products like refrigerators, washing machines, and light bulbs based on efficiency. While individual savings are small, their cumulative impact across households can substantially lower national energy demand.

6.4.1.5 *Plastic Recycling into more economically value-added Products:*

A zinc-based catalyst with methanol can break down bisphenol A-polycarbonate beads in 20 minutes at room temperature, recovering bisphenol A and dimethyl carbonate for infinite recycling without quality loss. Unlike traditional energy-intensive methods, this process enables efficient, low-impact recycling and supports a circular economy. Though currently demonstrated only at a small scale, its use of affordable, industrially relevant catalysts makes it a promising solution for sustainable plastic management.

6.5 *Climate Change Finance*

Despite limited public funding, Egypt is directing resources toward climate-related projects. The 2020/2021 investment plan identified 691 green projects with a total value of EGP 447 billion (USD 28.5 billion). Within that fiscal year, USD 2.3 billion was allocated, which accounts for 14% of the total public investment. The transport sector led with around 50% of the projects, followed by housing and utilities at 29%. Public green investment is set to rise to 30% of total public investment in 2021/2022, with a focus on prioritising sustainable projects and phasing out unsustainable ones¹⁷.

¹⁷ Ibid

This shift reflects Egypt's strong commitment to climate finance. In 2019, the Financial Regulatory Authority issued guidelines for green bonds, aligned with the Green Bond Principles of the International Capital Markets Association. Eligible projects include RE, EE, wastewater treatment, emissions reduction, waste-to-energy, circular economy solutions, and climate adaptation measures¹⁸.

In September 2020, the Government of Egypt issued USD 750 million in green bonds—the region's first sovereign offering of climate-friendly securities. The issuance was nearly five times oversubscribed, attracting USD 3.7 billion in orders from 220 investors, including 16 first-time participants in Egypt's USD bond market. Investor interest came primarily from Europe (47%), the US (41%), East Asia (6%), and the Middle East (6%).

Proceeds from the green bonds will finance Egypt's portfolio of environmentally sustainable projects, including clean transportation, RE, and sustainable water management. According to Egypt's Human Development Report, the funds will support pollution control, EE, and climate adaptation initiatives, in alignment with the national sustainable development strategy that prioritises green investments.

The Cairo Monorail Project, which connects the New Administrative Capital to 6 October City, the El-Dab'aa water desalination plant, and wastewater treatment facilities in Arab Abu Saed and Port Said are among the key projects that will benefit from this financing.

6.6 Financial Tracking

Tracking climate finance is essential to ensure transparency, accountability, and the effective allocation of resources toward climate mitigation and adaptation goals. Robust financial tracking systems help assess whether funding is aligned with national priorities, supports vulnerable sectors and communities, and contributes to Egypt's long-term climate targets. To strengthen climate finance measurement, reporting, and verification (MRV), the following foundational steps are recommended:

- Develop a comprehensive mapping of climate finance requirements and track financial flows from domestic and international sources, with clearly defined responsibilities across stakeholders.
- Implement an audit system to assess the efficiency, equity, and impact of climate-related expenditures, with sector-specific benchmarks based on greenhouse gas emissions and vulnerability.
- Formulate a national vision and action plan that integrates climate finance into broader fiscal planning and sustainable development strategies.
- Disaggregate climate finance tracking to distinguish between mitigation and adaptation investments, ensuring tailored resource allocation and performance monitoring.
- Set up subnational units tasked with tracking and reporting local climate finance flows to the central climate finance authority, to enhance data granularity and accountability.
- Direct funding toward strategic priorities such as urban upgrading, slum rehabilitation, and the relocation of polluting industries, aligning financial decisions with national climate and development goals.

6.7 Level of Support Received

Egypt, through the Ministry of Environment (MoE), has developed clear and actionable policies to advance sustainable development, protect the environment, and address climate change. The Sustainable Development Strategy (SDS), Egypt's Vision 2030, and both Africa's Agenda 2063 and the

¹⁸ Egypt National Human Development Report, 2021.

UN Agenda 2030 serve as the foundation for these efforts. The goal is to position Egypt as an active global partner in a rapidly evolving environmental landscape.

Recent projects have focused on air pollution control and climate change adaptation. This commitment is reflected in the significant rise in official development assistance for environmental initiatives, which increased by 68% in 2019/2021¹⁹, reaching USD 56.5 million, up from USD 23 million the previous year. Led by the MoE and its partners, several key initiatives are now underway to deliver on these priorities. In addition, there are other projects are being implemented in cooperation with development partners supporting with financing and technical expertise, such as:

- In 2018, the Ministry of Environment implemented a project in cooperation with MWRI funded by the GCF to “Enhance Climate Change Adaptation in the North Coast and Nile Delta Regions”. This is a capacity-building project in cooperation with the UNDP in the field of monitoring, reporting and verification of GHG emissions and adaptation & mitigation measures.
- In September 2020, the GoE and the WB signed a USD 200 million project to support Egypt’s initiatives to reduce air and climate pollution from critical sectors and increase resilience to air pollution in Greater Cairo. The challenge of air pollution remains one of the city’s most significant environmental issues, with an estimated annual economic cost of air pollution on health in Greater Cairo of about 1.4% of Egypt’s GDP, as per a 2019 WB study.
- In December 2020, the Ministry of Investment and International Cooperation announced the start of the implementation phase of Converting Climate Finance Systems with Agence Française de Développement (AFD). The project aims to provide long-term loans and technical support to small and medium enterprises, at the cost of USD 182 million. Specific focus will be on four sectors: sustainable tourism, waste management, water and sanitation, and transportation. This loan will be managed by national banks, with the AFD providing a grant of USD 1.8 million to support the Egyptian banking sector in keeping pace with international best practices regarding not financing projects that directly contribute to the severity of climate change.
- Along with the GCF, the EBRD and the EU are responding to the impact of the coronavirus pandemic on the Egyptian economy by boosting green finance and the development of value chains for the private sector. This partnership with local banks resulted in launching two programs, cumulatively worth €220 million.

6.8 Level of Support Needed

Despite the existence of green energy financing roadmaps, significant funding gaps remain for broader climate mitigation and adaptation efforts. The UN estimates that developing countries will need between USD 140 and 300 billion annually to meet 2030 adaptation goals far exceeding current available funding. According to the Global Risk Report, most climate investments remain within wealthy nations, and only a limited number of developing countries have set quantifiable climate finance targets, with few extending beyond 2020, limiting their long-term relevance. Egypt is actively working to mobilise international climate finance to support its mitigation and adaptation goals. Key efforts include:

- Leveraging global climate funds and facilities to finance emission reduction and climate adaptation projects.

¹⁹ Egypt Human Development Report 2021

- Prioritising technology transfer and capacity-building as essential components of climate project implementation.
- Engaging with the GCF, a global fund established through the cooperation of 194 governments, to support low-emission development and enhance resilience in vulnerable communities.
- Securing GCF funding through the MoE for projects focused on EE and RE.
- Collaborating with environmental and business networks to raise awareness and promote climate action across sectors, highlighting the role of multi-stakeholder platforms in advancing environmental priorities.

To prevent the most severe impacts of climate change, global emissions must decline rapidly—by an estimated 7.6% annually between 2020 and 2030, requiring an additional USD 460 billion in clean energy investment each year. Achieving this will demand transformative policies across sectors, including industry, transport, agriculture, and land use, as well as shifts in consumer behaviour.

Aligned with this global vision, Egypt’s Vision 2030 proposes a transition from a heavy reliance on oil and gas (currently at 92%) to a more diversified energy mix. While recent natural gas (NG) discoveries between 2016 and 2018 and the construction of three gas power plants (14.4 GW capacity) by Siemens have boosted gas dependency, the global momentum for renewables and declining oil prices highlight the need for Egypt to accelerate its clean energy transition.

In addition to decarbonizing power generation, Egypt can achieve further emissions reductions by decreasing transmission and distribution losses from 15% currently to 12% by 2022 and 8% by 2030. Enhancing energy efficiency (EE) at the end-user level will also reduce demand. For example, replacing 400W sodium streetlamps with 150W LED alternatives could cut public lighting’s energy share from 6% to around 2%, with even greater potential savings in residential lighting. However, clean energy investments and financing over the next decade are critical, as current actions remain insufficient to meet global emission reduction targets.

Egypt continues its efforts to enhance environmental quality and safeguard public health. However, addressing the root causes of persistent environmental challenges, particularly in the following areas, requires several urgent policy reforms:

- Solid waste management: Enhancing systems for collection, recycling, and disposal.
- Sustainable consumption and production: Promoting efficient resource use across sectors.
- Greening the financial sector: Integrating environmental and climate risks into financial decision-making.
- Internalising environmental costs: Reflecting environmental externalities in national economic planning and pricing mechanisms.
- Strengthening the water–energy–food–climate nexus: enhancing integrated policy and planning across these interdependent systems.

The COVID-19 pandemic offers a unique chance to shift global development toward a more sustainable and inclusive path that addresses climate change, biodiversity loss, and long-term human and environmental health. Although lockdowns briefly reduced global emissions, this decline is temporary and insufficient to halt climate change. To encourage this transition, carbon-intensive energy must become significantly more expensive in comparison to low-carbon alternatives and other products and services.

The pandemic has also led to a surge in hazardous waste, particularly medical waste like masks, gloves, and chemicals. In countries like Egypt, inadequate waste management increases water pollution risks, threatening vulnerable communities and aquatic ecosystems, with serious implications for food security. Moreover, travel restrictions and economic disruptions have severely affected trade, investment, and tourism. In Egypt, the tourism decline has had a direct impact on low-income groups who rely on the sector for their livelihoods.

Nevertheless, this represents a policy quandary. It emphasises the pressing necessity of a strategic framework that adopts a novel perspective on climate change, while also promoting public health protection and pandemic resilience. The framework in question could be represented as: In order to encourage this transition, carbon-intensive energy must become significantly more expensive in comparison to low-carbon alternatives and other products and services.

Nevertheless, this raises a policy quandary. It emphasises the pressing necessity of a strategic framework that adopts a novel perspective on climate change, while also promoting public health protection and pandemic resilience. This framework may manifest as:

- Income generation opportunities for vulnerable communities in rural and protected areas.
- Promotion of the reuse of agricultural residues to alleviate the socio-economic impact of the pandemic.
- Support to the enhancement of municipal and medical waste management to reduce risks of contracting COVID-19 from infected waste.
- Promotion of local food to local markets by shortening the food supply chain.
- Enhancement of local competitiveness, preparedness, recovery, and resilience.

Climate change impacts in Egypt are not gender neutral. Women make up around 45% of the agricultural workforce, often as seasonal labourers with unstable incomes and a heightened vulnerability to food insecurity. The employment opportunities of women beyond agriculture are restricted by their high illiteracy rates, which affect an estimated one-third of adult women when compared to 15% of men. Only 5% of women own land, a fact that is primarily attributable to inheritance practices, despite their active participation in agricultural labour. These gender disparities underscore the pressing necessity for climate interventions that are gender-responsive to guarantee equitable adaptation and resilience outcomes.

7 Research and Systematic Observations

7.1 Introduction

This chapter highlights Egypt's national efforts in climate change research and systematic observation, showcasing the institutional framework, research initiatives, and collaborative projects driving adaptation and mitigation strategies. Key sectors—including water, agriculture, energy, coasts, biodiversity, and public health—are supported by specialised research centres and national institutions applying regional climate models, vulnerability assessments, and policy-relevant studies to inform sustainable development planning.

Alongside research, Egypt has invested in systematic climate observations through a broad network of meteorological, hydrological, and marine monitoring systems. These include weather radars, tide gauges, satellite data, and early warning systems that support risk reduction and resilience-building. Together, these efforts form the scientific foundation for climate-responsive governance and reinforce Egypt's commitment to evidence-based adaptation aligned with national priorities and global climate goals.

7.2 Research

Advancing climate-related research is fundamental to informing evidence-based policies and enhancing national capacity to respond to climate change challenges. In Egypt, targeted research across sectors seeks to play a critical role in developing adaptive solutions and low-emission pathways.

7.2.1 Climate Change Research Institutional Structure

Since the early 1990s, Egyptian authorities have recognised the vulnerability of the nation's coastal zones to climate change impacts. In response, the government established the National Centre for Land Use and the National Committee for Integrated Coastal Zone Management (ICZM), composed of representatives from various ministries, tasked with coordinating and implementing integrated coastal planning. As part of efforts to strengthen environmental legislation, the National Assembly enacted Law 9/2009 as an addition to Environmental Law 4/1994, reinforcing the application of ICZM. Furthermore, to advance scientific research, foster technical collaboration, and support the dissemination of adaptation policies, a prime ministerial decree created a dedicated institutional mechanism for climate change adaptation within the Information and Decision Support Centre, the cabinet's official think tank.

The EEAA and the MoE lead and coordinate national efforts on climate change adaptation and resilience. The National Committee on Climate Change, initially established in 2007 and restructured in 2019 under the leadership of the Prime Minister, oversees the full implementation of climate action and represents Egypt in the UNFCCC. Implementation and mitigation measures are carried out in collaboration with key national entities, including the Ministries of Foreign Affairs; Water Resources and Irrigation; Agriculture and Land Reclamation; Electricity and RE; Industry, Trade and Small Industries; Planning and Economic Development; and Defence. The following are key research institutions in Egypt actively engaged in climate change-related work:

- **The Central Laboratory for Agricultural Climate (CLAC)** conducts research on the impacts of climate change on crop production, pest and disease outbreaks, and water requirements under current and projected climate conditions.
- **The Climate Change Information Centre and Renewable Energy (CCICRE)**, through its Department of Climate Change and Renewable Energy, supports climate research by providing data and assisting research sectors in adaptation and mitigation efforts.
- **The Soil, Water and Environment Research Institute (SWERI)** contributes by carrying out applied research focused on soil, water, and environmental issues in the context of climate change.
- **The Centre of Excellence for Research and Applied Studies on Climate Change and Sustainable Development (C3SDI)** at the National Research Centre (NRC) focuses on developing robust national and regional models and proposing practical solutions to support climate adaptation and mitigation while minimising projected damages.
- **The Environment and Climate Change Research Institute (ECRI)**, under the National Water Research Centre, specialises in assessing the long-term impacts of climate change on water resources and environmental systems. It also identifies optimal water management practices and adaptation policies under various climate scenarios.
- **Alexandria Research Centre for Adaptation to Climate Change (ARCA)**, established in 2011 with support from IDRC-Canada, serves as a sustainable centre of excellence for policy-orientated climate adaptation research. It fosters researcher capacity-building and encourages knowledge exchange and collaboration.

7.2.2 Regional Climate Modelling

Climate modelling serves as a vital scientific tool for projecting future climate conditions and informing evidence-based adaptation and mitigation strategies. Regional Climate Models (RCMs), which use dynamical downscaling of Global Climate Models (GCMs), offer higher-resolution outputs tailored to local and regional contexts. As emphasised in the Intergovernmental Panel on Climate Change Sixth

Assessment Report (IPCC AR6), there is a growing demand for precise climate data at the regional level to effectively guide policy and planning.

Regional climate modelling has been conducted by various academic and institutional research centres in Egypt, including but not limited to the Egyptian Meteorological Authority (EMA), Cairo University, MWRI, and the Agricultural Research Centre (ARC). The outputs of these models have been utilised to project future climate conditions and assess their potential impacts across key sectors at the local level.

Mostafa et al. (2019) recently presented a comprehensive description of the historical and projected temperature and precipitation profile and extremes in Egypt as conducted from an ensemble of six Coordinated Regional Climate Downscaling Experiment (CORDEX) models forced by two Representative Concentration Pathways (RCP45 and RCP85).

In recent years, climate change has garnered growing research attention in Egypt, with a notable increase in studies addressing its multifaceted impacts. Key areas of ongoing and completed research include regional climate modelling and sector-specific assessments covering water resources (e.g., Mostafa et al., 2021), agriculture (e.g., Perez et al., 2021), coastal vulnerability (e.g., Shaltout and Tonbol, 2018), forestry, marine biodiversity, public health, and energy (e.g., Abdrabo et al., 2018).

Several research projects in Egypt have utilised RCM outputs to support sectoral planning and adaptation. One such initiative is the "Regional Climate Change Database for the Agriculture Sector in Egypt", funded by the Science and Technology Development Fund (STDF), which compiles RCM-based climate data to improve data availability for agricultural research and planning. Another notable project, "Optimising Management of Water Resources for Prioritised Cultivated Lands through Spatial and Temporal Analysis of Remote Sensing Data and Climate Change Scenarios" (Opti-Med), funded by the Academy of Scientific Research and Technology (ASRT), employs outputs from four climate models to simulate the effects of climate change on water demand and productivity for strategic crops in Egypt.

Additional projects and studies have been carried out by various academic and research institutions in Egypt, not only to assess climate change impacts but also to identify appropriate adaptation measures. For instance, the EMA, Coastal Research Institute, Research Institute of Climate Change, and Military Space Administration recently collaborated on the development of the "Interactive Map for Risks and Threats of Climate Change in the Arab Republic of Egypt." Funded by the MoE, the project aims to support decision-makers in identifying areas vulnerable to climate-related risks, guiding national development planning, informing sector-specific adaptation actions, and facilitating access to international climate finance. The initiative relies primarily on outputs from numerical weather prediction models combined with future climate change scenarios.

Another noteworthy project, funded by the ASRT, explores the effects of monsoon changes in East Africa on the Nile and water resources in Egypt in combination with the Asian monsoon system, considering global warming. This initiative investigates variations in the Kiremt monsoon over the East African Highlands and their implications for water security, agriculture, and economic conditions along the Nile River across Ethiopia, Sudan, and Egypt. The project places particular emphasis on understanding the coherence between the East African and Asian monsoon systems and how these interactions may evolve under medium and high emission scenarios, such as RCP 4.5 and RCP 8.5.

7.2.3 Coastal Vulnerability

Egypt's Mediterranean coast stretches from Rafah in the east to Salloum in the west and hosts numerous economic and industrial hubs, beaches, and tourist resorts. Annual precipitation along this zone ranges from 130 to 170 mm, decreasing further inland (Michel and Pandya, 2010). The region faces multiple challenges, including rapid population growth, Delta land subsidence, severe erosion, saltwater intrusion, soil salinisation, pollution, and weak institutional management. As a vital economic and

population centre, this coastal zone has drawn considerable research attention due to its vulnerability to climate change. According to the IPCC Fourth Assessment Report (2014), sustained global warming could trigger near-total melting of the Greenland ice sheet, causing up to 7 metres of global sea-level rise. In Egypt, subsidence in the Nile Delta would worsen these impacts, leading to greater risks of submergence, flooding, and erosion. These threats are expected to intensify with continued urbanisation and economic growth, placing more people and assets at risk.

Egypt's Mediterranean coastline, stretching approximately 1,000 kilometres, has been evaluated for its exposure to climate-related hazards such as sea level rise (SLR), storm surge, and coastal erosion through the application of the Climate Improved Coastal Vulnerability Index (CCVI). According to a study conducted by Torresan et al. (2020), around 1% of the coastline—equivalent to about 43 square kilometres—is categorised as highly or extremely vulnerable, while approximately 80%, or 4,652 square kilometres, is considered to have very low vulnerability. Urbanised coastal areas were found to be more prone to inundation and erosion. The Nile Delta emerged as the most at-risk region for both permanent and seasonal flooding, while the Western Desert appeared less vulnerable due to its rocky coastal features and steeper slopes. The CCVI proved to be an effective tool for the preliminary identification of national coastal risk hotspots. The study's outcomes, including detailed vulnerability maps and indicators, offer important input for developing climate adaptation strategies and advancing ICZM.

The coastal systems of the Gamasa–Ras El-Bar area in the Nile Delta have been assessed for their vulnerability to SLR, with particular attention to the impact of rising groundwater levels. According to research by Elshinnawy and Almaliki (2021), approximately 271 square kilometres—around 60% of the study area—are expected to be negatively affected. This vulnerable area encompasses about 70% of the local communities. The projected increase in groundwater levels is anticipated to raise discharges from the sub-drainage system by roughly 10%, while the open drainage system is expected to experience a more modest increase of less than 1.2%.

The vulnerability of Egypt's Mediterranean coast to SLR has been analysed using the Coastal Vulnerability Index (CVI), which is based on the geological and physical features of the shoreline. Findings from Mohamed (2015) revealed that more than one-third of the 1,000-kilometre coastline is highly vulnerable, with the most at-risk areas located along the densely populated Nile Delta. Given the severity of exposure in these regions, there is a clear need for national-level action to protect threatened coastal zones and reduce future risks.

Sea level rise (SLR) along Egypt's Mediterranean coast has been measured using tide gauge data, which reveals regional variations in elevation change. According to findings by El-Geziry (2020), the station at Sidi Abdel-Rahman recorded an SLR of 1.0 millimetre per year, while Alexandria Western Harbour and Marsa Matrouh registered 2.2 and 2.4 mm per year, respectively. In the central Nile Delta region, Burullus observed a rate of 3.8 mm per year. Higher rates were recorded in Port Said and Abu-Qir at 4.8 and 6.4 mm per year, respectively. The analysis also confirmed that the Nile Delta coastal zone is particularly vulnerable to SLR, whereas the western section of the coastline shows varying degrees of vulnerability, ranging from moderate to high.

7.2.4 Water Resources

Climate change poses a significant and growing threat to Egypt's water sector, which is among the most vulnerable to its impacts. With a large and increasing population that depends almost entirely on the Nile River, the country has already reached the water poverty threshold. Any reduction in Nile flow—whether due to climate variability or regional developments such as the construction of upstream dams (Mostafa et al., 2021)—is expected to have serious economic consequences. While Egypt also faces water challenges from urban expansion, land-use change, and environmental demands (Sugita et al., 2017), climate change has introduced more complex and far-reaching effects (Sutcliffe et al., 2016), with the GERD standing out as a major concern (Abdelhaleem and Helal, 2015). Research assessing the impact of climate change on irrigation water demands indicates that for winter crops, needs may

rise by 6.1 to 7.3% by 2050, and by 11.7 to 13.2% by 2100. For summer crops, demand is projected to increase by 4.9 to 5.8% by 2050 and by 9.3 to 10.9% by the end of the century.

For Nile crops, irrigation water demand is projected to rise by 5.0 to 5.1% by 2050 and by 9.6 to 9.9% by 2100. This growing demand, driven by climate change, will place additional pressure on Egypt's already limited water resources, further exacerbated by rapid population growth. Ensuring water security under these conditions requires effective and forward-looking management strategies. Although limited in number, several strategic research efforts in Egypt have contributed to decision-making in water resource management. These studies have developed and adapted numerical models that offer practical solutions to mitigate water shortages and assess the economic impacts of climate change at both the national and governorate levels.

These studies employed generic models to simulate various configurations, institutional settings, and management challenges within Egypt's water resource system. They also assessed the impacts of different management options and explored a range of future scenarios. In parallel, the Egyptian government has been advancing water conservation efforts, most notably through the launch of its second National Water Resources Plan in 2017. The plan aims to invest 50 billion USD by 2037, with about one-third of the funding already committed. Recent enforcement measures include fines for farmers using inefficient irrigation methods. However, financial constraints and reluctance to abandon traditional techniques limit the broad adoption of drip irrigation. As part of the National Project for Developing the Egyptian Countryside, the government is also implementing a canal rehabilitation initiative to improve water management and distribution, ensure consistent delivery to canal endpoints, and reduce pollution.

7.2.5 Agriculture

Climate change is projected to affect Egypt's agricultural output and food security through the loss of farmland, reduced labour productivity, declining crop yields, and displacement-related labour shortages (Fawaz & Soliman, 2016). In Mediterranean zones, gross irrigation requirements may increase by 4 to 18% due to climate impacts. By 2030, water demands for rice, soybean, tomato, cotton, corn, sunflower, sorghum, wheat, and sugarcane are expected to rise by 16, 15, 14, 10, 8, 8, 8, 2.5, and 2.5 per cent, respectively, while barley may see a 2 % reduction. An integrated biophysical and economic model used to assess the effects of temperature and rainfall changes on agriculture projects a 10 % average decline in food crop yields by 2050, driven by heat stress (4.9 %), water stress (4.1 %), and salinity (1.6 %).

By crop type, the greatest biophysical yield declines are projected for maize at 16.2%, followed by sugar crops at 12.0%, and fruits and vegetables at 11.7%. Among the three stress factors—heat, water, and salinity—increased temperature has the largest impact, contributing to yield losses of 12.9% for maize, 7.0% for oilseeds, and 6.7% for sugar crops. Wheat is expected to experience a smaller decline of 2.8%, while the model indicates modest yield gains for roots and tubers (Perez et al., 2021).

In a worst-case scenario characterised by increased water demand and declining crop yields, Yosri Nasr Ahmed et al. (2020) estimate that agricultural production in Egypt could fall by 10 to 18% across key commodities. This decline may lead to significant job losses among agricultural workers. The study also indicates notable price increases, with consumer prices expected to rise by 7 to 24% and producer prices by 12 to 22%. In addition, agricultural value-added is anticipated to drop by 29%, while overall agricultural income could decrease by 12% compared to baseline figures. To address these challenges, the study recommends enhancing water-use efficiency and prioritising the development of crop varieties that are resilient to drought, heat, and salinity to sustain or improve yields under future climate conditions.

An alternative project titled *Optimizing Management of Water Resources for Prioritized Cultivated Lands through Spatial and Temporal Analysis of Remote Sensing Data and Climate Change Scenarios* (Opti-Med), funded by the ASRT, utilized outputs from four climate models to simulate the impacts of

climate change on water requirements and projected productivity for key crops in Egypt. The initiative also utilised satellite data, including optical and microwave data, to monitor the water status, vegetation cover, and changes in soil moisture over time. This approach improved comprehension of the water cycle in arid regions.

The Smart Agriculture Based on Meteorological Big Data project, funded by STDF through the Egypt-China Cooperation Program (CERF), aims to improve farming support by using big data technology to analyse weather information. It aims to create a platform that integrates large volumes of multisource meteorological observations to enhance climate services for Egypt's agricultural sector.

Sea level rise is expected to increase the vulnerability of Nile Delta coastal zones to saltwater intrusion and inundation, with serious implications for aquaculture. Climate change may directly reduce fish stocks and production efficiency and indirectly raise input costs and fish prices, threatening food security in Egypt (Naglaa, 2017). To address these challenges, Egypt inaugurated the El-Fayrouz Fish Farm in Port Said, the largest in the Middle East. Covering 15,000 feddans and offering 10,000 jobs, the project aims to close the production-consumption gap, reduce imports, boost exports, and promote economic self-sufficiency.

7.2.6 Marine Biodiversity

Egypt's coastal and marine biodiversity faces significant threats from habitat loss, pollution, overexploitation, invasive species, and climate change. Marine ecosystems are particularly vulnerable to unregulated tourism, illegal fishing, and industrial pollution. With 20% of the population living in coastal areas and over 40% of industrial activity concentrated there, pressure on ecosystems is high. Egypt's rich biodiversity includes over 5,000 marine species, among them marine mammals, turtles, sharks, coral reefs, mangroves, and numerous invertebrates. In 2018, during its hosting of the UN CBD COP14, Egypt launched an initiative to address biodiversity loss, climate change, and land degradation in an integrated manner.

The Egyptian Initiative titled "A coherent approach for addressing biodiversity loss, climate change, and land and ecosystem degradation" aims to contribute to the realisation of the Strategic Plan for Biodiversity's 2050 Vision, which envisions a world where biodiversity is valued, conserved, restored, and used sustainably to maintain ecosystem services, sustain a healthy planet, and deliver essential benefits for all people.

Research on Egypt's endemic plant species underscores the urgency of conservation efforts in the face of climate change. In the case of *Primula boveana* Decne ex Duby, a study by Omar and Al-Gamal (2021) found that the species is rapidly moving toward extinction due to drought and climate stress. The authors stressed that ex-situ conservation—such as seed collection, storage, and cultivation in greenhouses and botanical gardens—has become critical, as in-situ methods may no longer ensure its survival. Similarly, a study by Serag et al. (2018) focused on *Phlomis aurea* in Southern Sinai, examining its current condition and vulnerability to climate change, and highlighted the need for targeted conservation actions to protect this endemic species.

Phlomis aurea is expected to show strong resistance to increased drought; however, under more severe climate change scenarios, its population may face significant decline if proactive measures are not taken. Research by Abdelaal et al. (2020) on *Primula boveana* Decne ex Duby focused on assessing the current population status, predicting its present and future distribution, and using advanced modelling tools to guide field sampling and forecast habitat shifts under two climate scenarios. Broader biodiversity studies have also examined the impacts of climate change on Egypt's terrestrial fauna. For the first time, El-Gabbas et al. (2016) used species distribution models to assess current and future habitat suitability for 75 reptile species across Egypt. Their analysis applied the Maxent model to project habitat changes under two emissions scenarios, incorporating three future time slices and two

assumptions of dispersal ability, providing valuable insights into the vulnerability of reptiles to a changing climate.

Projections of future range shifts for Egypt's reptile species show significant variation, with outcomes ranging from complete habitat loss to substantial range expansion, depending on the scenario. El-Gabbas et al. (2016) found that two species are likely to face extinction under at least one future projection, while eight others could lose more than 80% of their current range. Although protected areas generally offer better conservation outcomes than unprotected zones, the study suggests they may still fall short in safeguarding Egypt's reptiles under projected climate change conditions.

In a separate study, Kaky and Gilbert (2019) assessed the extinction risks of medicinal plants in Egypt by combining species distribution models with IUCN Red List criteria. While most species are currently considered of Least Concern, future climate change scenarios indicate that many may face varying levels of extinction risk, depending on underlying assumptions. The study concluded that even in data-scarce countries, regional risk assessments are feasible and essential. Integrating species distribution modelling with IUCN frameworks provides an effective approach for informing conservation planning and protecting vulnerable species.

7.2.7 Public Health

Egypt has made progress in public health but remains highly vulnerable to climate change, especially in the Nile Delta, where SLR threatens key sectors. Climate change is expected to worsen health conditions by increasing heat stress and the spread of diseases, including skin cancer, respiratory illnesses, and vector-borne infections. Events like the 2015 heatwave already demonstrated climate-related health impacts. Future increases in heatwaves, dust and sandstorms, and extreme weather will pose serious risks, particularly to vulnerable groups such as the urban poor, the elderly, and those with chronic diseases. These environmental hazards are linked to both infectious and non-infectious diseases, adding to the country's health burden.

Egypt is facing substantial risks due to the increased frequency of heatwaves and the rise in temperatures, which disproportionately impact vulnerable populations, including the elderly, children, and outdoor labourers (World Bank, 2020). The same factors that contribute to climate change, such as polluting energy and transport systems, also contribute to severe air pollution, a significant global health threat that is responsible for approximately seven million deaths year-round. The implementation of policies that simultaneously address public health and climate change is facilitated by this overlap (WHO, 2015).

While air quality in Greater Cairo has recently improved, ambient air pollution remains the city's most pressing environmental health issue, negatively impacting both well-being and the economy. The annual health-related economic cost of air pollution in Greater Cairo alone is estimated at around 1.4% of Egypt's GDP.

The six-year Greater Cairo Air Pollution Management and Climate Change Project supports Egypt in its efforts to reduce air pollution and climate emissions, aligning with the Sustainable Development Strategy: Egypt Vision 2030. The project targets a 50 % reduction in particulate matter pollution and aims to establish a cost-effective mitigation program to meet Egypt's 2030 climate goals.

According to the Minister of Investment and International Cooperation, Dr. Rania Al-Mashat, the project advances the Green Recovery Plan by promoting integrated climate solutions that improve health, resilience, and productivity. Minister of Environment Dr Yasmine Fouad highlighted that the partnership with the WB seeks to protect future generations from the long-term risks of pollution and climate change.

The COVID-19 pandemic has prompted a global rethinking of healthcare priorities and systems, illustrating the importance of more resilient, equitable, and high-quality health services. In response to

this shift, Mohamed (2020) conducted a study titled A view of the health services after COVID-19: an Egyptian perspective, which outlines the core components of a strategic health plan aimed at enhancing the quality and efficiency of medical care in Egypt's post-pandemic future.

i. Energy Sector

Unsustainable energy use continues to drive environmental degradation in Egypt, while energy scarcity and rising costs strain national budgets and threaten economic competitiveness. Climate change is expected to worsen these challenges, with higher temperatures and reduced rainfall increasing demand for cooling and water desalination. Current infrastructure is ill-equipped to meet these pressures, risking system failures, outages, and brownouts due to limited capacity (EEAA, 2016). Moreover, upstream dam projects aimed at improving regional energy access may further reduce Nile River flows, adding to Egypt's energy and water security concerns.

This could impact not only agricultural, industrial, and domestic water consumption but also cut hydropower generation at the Aswan Dam, the country's largest. Climatic and international pressures on the Nile River also have high potential to not only affect economic activity and water availability in Egypt but also to raise tensions amongst users of the river. The projected decrease in precipitation and change in seasonal rainfall patterns is likely to reduce hydropower potential, coupled with revenue losses. Increased evaporation rates from existing water storage facilities will also increase production costs, costs that will inevitably be transferred to the consumer (World Bank, 2020).

Climate change is projected to significantly affect seasonal residential electricity consumption in Alexandria by 2050, with rising temperatures contributing to higher energy demand, particularly during the summer months. This has been explored in a study by Abdrabo (2018), which assessed future consumption patterns under RCP 2.6 and RCP 8.5 scenarios. The findings revealed a marked growth trend and clear seasonal variation, with a substantial increase in summer electricity use. The study also identified and evaluated a range of soft and hard adaptation measures to address these challenges. In response to growing domestic energy needs, Egypt is working to diversify its energy mix, with a focus on expanding RE sources, especially wind and solar power.

Egypt is also advancing its nuclear energy programme to diversify its energy sources. However, electricity consumption continues to grow faster than generation capacity, prompting a rise in coal imports to meet short-term needs. To address these challenges, the country is exploring innovative regulatory models aimed at boosting energy production and efficiency, particularly in the utilities sector, through energy-saving initiatives and improved transmission and accounting systems (Egypt, 2016). Additionally, the MoERE has signed an agreement of intent with Germany's Siemens to conduct studies for a pilot project on green hydrogen production, with the potential to expand into export-orientated green hydrogen development in the future.

Gulf of AL-Zayt Wind Power Plant Project Inaugurated by H.E. President Abdel Fattah AL-Sisi in July 2018, this power plant is adding approximately one % of the total power production capacity in Egypt, curbing CO₂ emissions by 494,000 tonnes per year as compared to CO₂ emissions resulting from an equivalent of power produced utilizing fossil fuels. The objective of this project is to increase electricity power supply and save fossil fuel consumption, thereby contributing to the fulfilment of the demand for electricity, to mitigation of climate change through the reduction of greenhouse gas emission, and to economic and social development and preservation of the environment in Egypt.

7.3 Systematic Observation

In Egypt, strengthening observation networks is vital for improving climate resilience and supporting science-based decision-making.

7.3.1 Climate Observation Stations

Systematic climate observations in Egypt are carried out by the EMA for meteorological and atmospheric data and by the ARC for agrometeorological data. EMA's meteorological network includes 106 stations: 49 for surface measurements, 6 for upper air data, 44 military stations, and 7 serving the forecast centre (EMA, 2018). The Central Laboratory for Agricultural Climate (CLAC) operates 56 stations, while the Information Centre for Climate Change and Renewable Energy (CICCRE) manages 6 stations. Agrometeorological data are collected from these stations.

These stations record surface agro-climatic variables such as 2-metre air temperature, wind speed and direction, humidity, air pressure, evapotranspiration, soil temperature, and soil moisture. In addition to synoptic meteorological stations, EMA has launched a project to install three weather radars across different regions of Egypt. These aim to monitor areas vulnerable to extreme events like heavy rainfall and thunderstorms, especially along the northeast and northwest borders, providing early warning of incoming weather phenomena. The installed Doppler radars can detect the location, intensity, and movement of precipitation, thunderstorms, and sandstorms.

The installation of weather radar marked a major advancement in strengthening Egypt's multi-hazard early warning system, responding to the recent surge in extreme weather events across various regions to help protect lives and property from diverse weather-related threats. In addition, several other ministries and governmental entities in Egypt carry out supplementary climate-related observation activities as part of their official functions. These include monitoring air quality and oceanographic parameters along the Mediterranean and Red Sea coasts, using instruments such as tide gauges, automatic tide gauges, wave gauges, the Coastal Acquisition System Wave Recorder (CIAS), the Opera Wave Suspended Recorder (OSPOS), and the S4DW Wave-Current Recorder.

7.3.2 Hydrology Observation Stations and Flood Warning System

The Nile is Egypt's main hydrological resource, flowing through a narrow valley before expanding into the Nile Delta, which spans the last 160 km of the river and 250 km along the coast. Egypt's semi-desert climate brings hot, dry summers, mild winters, and limited rainfall, though North Egypt and Sinai may see moderate to heavy winter rains, with coastal averages between 100 and 200 mm annually. The Ministry of Water Resources and Irrigation (MWRI) oversees hydrological monitoring and forecasting, while the EMA supports warnings related to rainfall-induced hydrological risks. MWRI operates 40 hydrological stations (30 automated), primarily located along the Nile, its Rosetta and Damietta branches, and smaller Delta distributaries.

Water levels are recorded every 30 minutes and reported either hourly (automated) or daily (manual). Meteorological and hydrological data undergo quality control upon entry, including cross-checks with nearby stations, outlier detection, and consistency reviews during instrument replacement or recalibration. Data is stored in databases, with some publicly accessible (Skøien et al., 2018). The EMA handles meteorological monitoring, forecasting, and warnings, using models such as ECMWF, COSMO, and customised versions of COSMO and WRF. MWRI employs several rainfall-runoff models for research, training, and operational forecasting along the Nile, using rainfall over Ethiopia, Lake Tana, and observed discharge. Hydrological model-based warnings are uncommon due to the Nile's limited flood risk, which the Aswan High Dam largely mitigates. EMA therefore leads flood warnings, primarily based on heavy rainfall forecasts.

To further improve flood monitoring and early warning, there is a need for more meteorological and hydrological stations, mainly to improve the spatial distribution. It is also necessary to continue upgrading manual weather stations to automatic ones. Radars would also be significantly useful. Although the staff number is high, there is a need for staff that can improve hydrological modelling and verification and for optimising the use of weather forecast and climate forecast models. A project for a flash flood early warning system for Egypt was conducted in the Nile Forecast Centre. The project aims to expand the dissemination of rainfall maps and predictions regularly through using a mobile application to alert the executive agencies in local areas of the storm. Which gave them the chance to take actions leading to less damage and absorb the storm safely. an example of actions is closing high

roads, reduce the release from the dam to lower the level in canals and drains, stop irrigation pumps, and prepare the equipment needed in such emergency.

7.3.3 Drought Information and Warning System

Challenges in measuring precipitation across Nile Basin countries hinder accurate assessment of natural flow trends to downstream nations like Egypt and Sudan. Rain gauge coverage is limited and poorly distributed, often overlooking critical catchments and sub-basins. Difficulties in data sharing among Nile Basin states further constrain analysis and future projections. Additionally, key hydro-meteorological variables—such as streamflow, soil moisture, and actual and potential evapotranspiration—are often unmeasured or inadequately monitored. Potential evapotranspiration is typically estimated using parameters like solar radiation, relative humidity, and wind speed.

Data records are often short and limited to a few countries or regions, hindering comprehensive analysis of drought-related changes. Groundwater monitoring is insufficient, and models of depletion and recharge—especially in fossil aquifers, which serve as strategic reserves during prolonged droughts—remain underdeveloped. An agricultural drought atlas for Egypt based on satellite data has been published (Khalil, 2015). Using MODIS on the Terra satellite, indices such as NDVI and land surface temperature were applied to derive the Vegetation Condition Index (VCI), Temperature Condition Index (TCI), and Vegetation Health Index (VHI) for Egypt from October to May across 14 seasons (2000/01–2013/14). The Drought Monitoring Atlas is structured into three parts:

- Part one presents monthly VHI maps for Egypt, covering October to May over 14 years (2000/01–2013/14), providing nationwide drought monitoring.
- Part two focuses on seasonal VHI maps for Egypt’s agricultural lands during the same period, offering insights into seasonal drought patterns.
- Part three assesses drought impact on agriculture at the governorate level, detailing the total area of farmland affected by drought from 2000/01 to 2013/14.

7.3.4 Sea-level Monitoring

Egypt’s coastline spans over 3,500 km and includes diverse coastal types and activities. It comprises 1,150 km along the Mediterranean, 1,500 km along the Red Sea (including the Gulfs of Suez and Aqaba), 550 km of secondary Mediterranean coast (lagoon shorelines), and 450 km around the Suez Canal and adjacent lakes. While coastal characteristics vary widely, the lower Nile Delta coast receives the most focus due to its strategic significance.

Egypt’s coastal zone faces several challenges, including rapid population growth, land subsidence, high erosion rates, waterlogging, soil salinity, land use conflicts, ecosystem degradation, pollution, weak institutional management, and insufficient meteorological, oceanographic, and data systems. Coastal monitoring is led by the Institute of Graduate Studies and Research (IGSR) at Alexandria University for the Mediterranean and by the National Institute of Oceanography and Fisheries (NIOF) for the Red Sea.

The monitoring institutions also participate in a laboratory quality assurance programme supervised by an independent reference laboratory at the Faculty of Science, Ain Shams University. The following parameters have been monitored on a bimonthly basis over the past 10 years:

- Bacteriological parameters: Total coliforms, ISO 56679; *E. coli*, ISO 9308-1; faecal streptococci, ISO 78992.
- Physical Parameters: Depth, salinity, conductivity, pH, temperature, dissolved oxygen, transparency.
- Chemical Eutrophication Parameters: Nitrite; nitrate; total phosphorus; total nitrogen; ammonia; reactive phosphate, and chlorophyll-a. EEAA has established a website where the

listed data is published. It has also established requirements for the quality of data in proficiency tests to have uniform evaluations of the results of all participating laboratories. The physical parameters monitored by this network verify and complement satellite measurements of Sea Surface Temperature (SST) to provide useful information on changes of SST at various localities of the coastal zone. Data include:

- Metrological and oceanographic data of the Mediterranean and Red Sea petroleum platform's sites.
- Data provided by earth observation satellites and various airborne sensors. Maps and spatial data for the evaluation and monitoring of natural resources and natural hazards.
- The Environmental Information and Monitoring Program (EIMP) aims at establishing a national environmental monitoring programme for ambient air and coastal waters.
(<http://www.eeaa.gov.eg/arabic/main/achievements.asp>"www.eeaa.gov.eg/arabic/main/achievements.asp)

The Survey Research Institute (SRI), operating under the National Water Research Centre, has implemented a sea-level monitoring programme along the Mediterranean and Red Sea coasts in recent years, in collaboration with the Egyptian Marine Forces.

7.3.5 Marine Environment Monitoring

The EIMP aims to establish a national monitoring system for ambient air and coastal waters. A reference laboratory supports national institutions in developing quality assurance systems. A key output of the programme is the generation of environmental quality data and databases, integrated into the EEAA's Environmental Information Centre. One of EIMP's core components is coastal water monitoring.

This component has enhanced EEAA's capacity to collect and manage data on coastal water pollution along Egypt's Mediterranean and Red Sea coasts, including the Gulfs of Suez and Aqaba. It resulted in the establishment of a dedicated coastal water pollution database at EEAA. The program aims to build baseline knowledge of coastal water quality and ensure continuous monitoring through regular surveys. Its outputs support the identification of quantitative and causal relationships between pollution sources and their impacts. The proposed water sampling program targets marine water quality measurements in the vicinity of:

- Identified major industrial pollution sources along the Egyptian coastal waters.
- Pollution from sewage discharges from the major coastal cities.
- Pollution from sewage discharges at the major tourist resort areas.
- Outlets from the River Nile and the major lakes.

The EIMP Coastal Water Monitoring Project aims to sample marine waters at approximately 45 sites along the Mediterranean coast and 38 sites in the Red Sea region, analysing basic water quality, eutrophication, and bacterial parameters. Standardised sampling and analysis procedures will be applied, with results evaluated annually and integrated into the EIMP coastal water database at EEAA.

Additionally, the Coastal Research Institute, operating under the National Water Research Centre (NWRC), manages four research stations along the Mediterranean and Red Sea coasts. These stations serve general monitoring and research purposes related to coastal processes, environmental conditions, and marine dynamics. The general purpose of the stations is as follows.

- a. Conducting all marine environmental measurements.
- b. Monitoring of the shoreline changes of some areas in Alexandria.
- c. Conducting the environmental measurements of the marine depositions

One of Egypt's oldest governmental entities, the Egyptian Authority for Maritime Safety (EAFMS) was originally known as the Ports and Lighthouses Administration (PLA). It was established in 1830 to supervise the preparations for the arrival of large vessels at the Port of Alexandria. EAFMS is

committed to the preservation of fisheries and the prevention of coral reef damage, which is one of the Red Sea's defining features. One of its primary objectives is to monitor and report marine pollution incidents along the coast.

The Egyptian National Oceanographic Data Centre (ENODC) is an active member of the IOC's Oceanographic Data and Information Exchange Programme (IODE). Its goal is to enhance ocean services and assist marine research by offering current and past ocean data and products to decision-makers, researchers, and those involved in marine activities, helping to manage coastal and marine resources sustainably.

7.3.6 Public Health

It is becoming increasingly important to comprehend the intersection between public health and climate change to protect the well-being of the Egyptian populace. The healthcare system of the nation is already confronted with a dual burden of diseases: those that are linked to poverty and underdevelopment, as well as those that have arisen because of accelerated urbanisation and lifestyle changes. The potential for climate variability and extreme weather events to impact the spread, seasonality, and geographic distribution of diseases presents new hazards that necessitate robust research and data integration as they become more prevalent.

Egypt has made significant progress in health monitoring, as the Ministry of Health and Population systematically monitors critical health indicators and conducts disease surveillance in partnership with international organisations, including the U.S. CDC. Concurrently, the ministry maintains a Centre for Environmental Monitoring, which conducts continuous assessments of the quality of air, water, and radiation. The institute, which is backed by sophisticated networks, offers real-time data on radiation exposure, water composition, and air pollutants. This data is essential for comprehending the environmental factors that influence health outcomes in the context of climate change.

While satellite and climate data have shown correlations between weather patterns and disease incidence, there remains a critical need to consolidate and expand research on the linkages between climate change and infectious disease dynamics, particularly their ecological adaptation and potential resurgence. Strengthening this knowledge base is essential for informing public health planning, enhancing early warning systems, and developing climate-resilient healthcare strategies.

References:

1. Ministry of Environment, Egyptian Environmental Affairs Agency (EEAA), 1999, Egypt 1st National Communication Report
2. Ministry of Environment, Egyptian Environmental Affairs Agency (EEAA), 2010, Egypt 2nd National Communication Report, UNDP, GEF, May 2010
3. Ministry of Environment, Egyptian Environmental Affairs Agency (EEAA), 2016, Egypt 3rd National Communication Report, UNDP, GEF, March 2016
4. Ministry of Environment, Egyptian Environmental Affairs Agency (EEAA), 2018, Egypt 1st Biennial Update Report
5. Ministry of Environment, Egyptian Environmental Affairs Agency (EEAA), 2022, Egypt's Climate Change Interactive Vulnerability Map
6. FAO (2018), Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.
<http://www.fao.org/3/i9705en/i9705en.pdf>

7. Houghton et al., 2001, Climate Change 2001: The Scientific Basis, Contribution of Working Group to the Third Assessment Report of the Intergovernmental Panel on Climate Change, UNEP, WMO
8. IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896
9. IUCN, et al., (2011), National Strategy for Mainstreaming Gender in Climate Change in Egypt, Produced through a multi-stakeholder process on behalf of the Egyptian Environmental Affairs Agency (EEAA), in collaboration with the Centre for Environment and Development for the Arab Region and Europe (CEDARE), June 2011
10. Joel B. Smith, et al., 2014, Climate Research (Clim Res), Published online December 2, 2014, “Egypt’s economic vulnerability to climate change”, Vol. 62: 59–70, 2014, DOI: 10.3354/cr01257
11. Ministry of Civil Aviation (MCA) - Egyptian Meteorological Authority (EMA) 2021, Department of studies and climate reports, Evaluation of meteorological drought using the standardized precipitation index (SPI) in Egypt, 2021
1. A Saad-Hussein et al., 2011. “Climate change and predicted trend of fungal keratitis in Egypt”, *La revue de santé de la Méditerranée orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit* 17(6):468-73, DOI: 10.26719/2011.17.6.468, Eastern Mediterranean health journal, June 2011
12. Ahmed, S. A., Saad-Hussein A, El Feel, A., Hamed, M.A. (2014). Time series trend of Bilharzial bladder cancer in Egypt and its relation to climate change: A study from 1995-2005. *International Journal of Pharmaceutical and Clinical Research*; 6(1): 46-53
13. Amal Saad-Hussein, 2021, The effects of high temperature episodes and increasing average temperatures on the rate of disease and mortality and the adaptation measures taken and planned, Amal Saad-Hussein, Stephane Alfaro, et al. - (2017- 2019), “Health mapping of infectious diseases vulnerable to climate change”, IMHOTOP; funded by Ministry of State of Scientific Research, with the collaboration with LISA institute, France.
14. Amira N. Mostafa, et al. (2019). “Past (1950–2017) and future (–2100) temperature and precipitation trends in Egypt”, *Weather and Climate Extremes*, Volume 26, December 2019, 100225
15. AbuZeid, K. (2012). The Watercourse/Blue Water and River Basin/Green Water Approach to Win-Win Solutions in Transboundary River Basin Management.” *The Official Journal of the Arab Water Council*, Pages 1-15, Volume 3, No. 1, July 2012, ISSN 1996-5699. (2012).
16. AbuZeid, (2017a). Potential Impacts of the Grand Ethiopian Renaissance Dam on the Nile Water Availability to Egypt and Sudan, *Water Resources Management Program – CEDARE*, 2017a.
17. AbuZeid, K., (2017b). “Chapter IV: Impacts of the Operation of the Renaissance Dam, Water Resources Program (Center for Environment & Development for Arab Region & Europe - CEDARE), “Economic Impacts of the Renaissance Dam on Water, Agriculture and Egypt’s National Security”, *Institute of Research and Strategic Studies on the Nile Basin Countries (Fayoum University)*, 2017b, pages 63-82, chapter 4.
18. Mohamed M. Abdel Wahab et al., 2020, Overview and Analysis of Climate Change Risks in Egypt
19. National Environmental, Economic and Development Study (NEEDS) for Climate Change
20. National Plan for facing Extreme Weather Events, Central Directorate for Climate Change, (to be approved by Cabinet of Ministers)
21. National Strategy for Mainstreaming Gender in Climate Change, CEDARE (2012)
22. Nationally Determined Contribution Report – NDCs (2015)
23. Overview and Analysis of Climate Change Risks in Egypt Study (2020)
24. Past (1950–2017) and future (2100) temperature and precipitation trends in Egypt

25. Potential Transboundary Impacts of the Grand Ethiopian Renaissance Dam under Climate Change and Variability, Book Chapter #16, Water Resources Management in the Climate Change Context in Africa, Springer International Publishing AG, (Khaled AbuZeid, 2021).
26. The Council of Ministers, Information and Decision Support Center, Crisis and Disaster Management Sector, Efforts and challenges to face the repercussions of heavy rains and torrential rains.
27. UNDP/EEAA Potential economic impacts of climate change in Egypt (2013)
28. UNDP 2012, Potential Impact of climate change on the Egyptian Economy, UNDP, Egypt, 26 June 2012
29. United Nations Economic and Social Commission for Western Asia (ESCWA) (2017a) Chapter 4: Findings for selected shared water basins in the Arab region, 4.1: Nile River Basin, Arab Climate Change Assessment Report Main Report. Beirut, E/ESCWA/SDPD/2017/RICCAR/ Report, p.125.
30. United Nations Economic and Social Commission for Western Asia (ESCWA) (2017b) Chapter 5: Nile River: Blue Nile headwaters”, Arab Climate Change Assessment Report, Technical Annex. Beirut, E/ESCWA/SDPD/2017/ RICCAR/Report/Annex, p.70.
31. UNDP (2021). Official website of the United Nations Development Programme in Egypt, accessed in October 2021, website: <https://www.eg.undp.org/content/egypt/en/home/projects.html>
32. UNIDO (2021). Official website of the UNIDO Regional Office in Egypt, accessed in October 2021, website: <https://www.unido.org/who-we-are/unido-worldwide/arab-states/offices/egypt>
33. IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
34. <https://sdgs.un.org/2030agenda>.
35. <https://au.int/en/agenda2063/overview>.
36. <https://www.sis.gov.eg/?lang=en-US>.
37. <https://www.egypttoday.com/Article/16/96908/Egypt-s-planning-ministry-signs-cooperation-protocol-withECOonsult-to>
38. <http://www.eco-fei.org/>
39. <https://www.bibalex.org/en/Project/Details?DocumentID=291&Keywords>
40. <https://archive.unescwa.org/tags/arab-centre-climatechange-policies>.
41. <http://www.riccar.org/>.
42. <http://new.gov.eg/>
43. <https://www.greenclimate.fund/>
44. <https://www.adaptation-fund.org/>
45. Integrated Energy Strategy 2035 (the Ministry of Electricity and Renewable Energy); <http://nrea.gov.eg/test/en/About/Strategy> .
46. The Housing Strategy 2030; https://unhabitat.org/sites/default/files/2020/09/egypt_housing_strategy.pdf.
47. The National Strategy of Artificial Intelligence (the Ministry of Communications and Information
48. Technology); https://mcit.gov.eg/en/Publication/Publication_Summary/9283
49. CBD (Convention on Biological Diversity)Egypt’s Fifth National Report 2014
50. EEAA, Egyptian Environmental Affairs Agency (2016). Egypt Third National Communication under the United Nations Framework Convention on Climate Change <https://unfccc.int/sites/default/files/resource/TNC%20report.pdf>
51. Egypt (2016). Nationally-Determined Contributions <https://www4.unfccc.int/sites/ndcstaging/>
52. Published Documents/ Egypt%20First/Egyptian%20INDC.pdf

53. EMA: Egyptian Meteorological Authority. (2018). Annual statistical guide
<http://ema.gov.eg/wp/images/pdf/sg.pdf>
54. Skøien, J., Salamon, P., Alagic, E., Alobeiaat, A., Andreenko, A., Bari, D., Ciobanu, N., Doroshenko, V., El-Ashmawy, F., Givati, A., Kastrati, B., Kordzakhia, M., Petrosyan, Z., Spalevic, M., Stojov, V., Tuncok, K., Verdiyev, A., Vladikovic, D. and Zaimi, K., Assessment of the capacity for flood monitoring and early warning in Enlargement and Eastern/ Southern Neighbourhood countries of the European Union, EUR 29073 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-77772-1 (print); 978-92-79-77771-4 (pdf), doi:10.2760/18691 (online),10.2760/356400 (print), JRC108843
55. Sugita, M., Matsuno, A., El-Kilani, R., Abdel-Fati, A., 2017. Crop evapotranspiration in the Nile Delta under different irrigation methods. *Hydrological Sciences Journal* 62 (10), 1618–1635.
<https://doi.org/10.1080/02626667.2017.1341631>.
56. Sutcliffe, H., Hurst, S., Awadallah, A., Brown, E., Hamed, K., 2016. Harold Edwin Hurst: The Nile and Egypt, past and future. *Hydrological Sciences Journal* 61 (9), 1557–1570.
<https://doi.org/10.1080/02626667.2015.1019508>
57. Torresan S., Furlan E., Critto A., Michetti M., and Marcomini A. (2020). Egypt’s Coastal Vulnerability to Sea-Level Rise and Storm Surge: Present and Future Conditions. *Integrated Environmental Assessment and Management* – Volume 16, Number 5—pp. 761–772.