Ministry of Climate Change,
Environment and Energy

MALDIVES' FIRST BIENNIAL TRANSPARENCY REPORT

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC) UNDER THE PARIS AGREEMENT

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Ministry of Climate Change, Environment and Energy

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The Ministry extends its sincere appreciation to all the agencies including government, public and private agencies for their contributions and active involvement in the BTR process. The data for analysis and assessments were provided by respective stakeholders and from published reports. The Ministry acknowledges the critical role of the contributors in supplying and verifying data and information essential for the report's development.

The Ministry is also grateful for the project funding support from the Global Environment Facility and the implementation support from the United Nations Environment Program for the completion of this report.

ACRONYMS AND ABBREVIATIONS

AOSIS	Alliance of Small Island States
ADB	Asian Development Bank
AR6	Sixth Assessment Report
BAU	Business-As-Usual
BTR	Biennial Transparency Report
CRT	Common Reporting Table
CCD	Climate Change Department
CO2eq	Carbon dioxide equivalent
EF	Emissions Factor
EIA	Environmental Impact Assessment
ENEA	Italian National Agency for New Technologies, Energy and Sustainable Economic Development
ENSO	El Niño-Southern Oscillation
FAO	Food and Agricultural Organization
FNC	First National Communication
GCF	Green Climate Fund
Gg	Giga Grams
GHG	Greenhouse Gas
GWP	Global Warming Potential
HPA	Health protection Agency
IOD	Indian Ocean Dipole
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
kWh	Kilo Watt Hour
LDC	Least Developed Country
LPG	Liquefied Petroleum Gas
LEAP	Low Emissions Analysis Platform
MBS	Maldives Bureau of Statistics
MCCEE	Ministry of Climate Change, Environment and Energy
MMRI	Maldives Marine Research Institute
MMS	Maldives Meteorological Services

MoU	Memorandum of Understanding
MoAAW	Ministry of Agriculture and Animal Welfare
MoFAOR	Ministry of Fisheries and Ocean Resources
MoHLUD	Ministry of Housing, Land and Urban Development
MoT	Ministry of Tourism
MoTCA	Ministry of Transport and Civil Aviation
MPGs	Modalities, Procedures, and Guidelines
MSW	Municipal Solid Waste
MWSC	Male' Water & Sewerage Company
NA	Not Applicable
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NC	National Communication
NDC	Nationally Determined Contribution
NDMA	National Disaster Management Authority
NDA	National Designated Authority
NDC	National Determined Contribution
NE	Not Estimated
NIR	National Inventory Report
NO	Not Occurring
PV	Photovoltaic
QA/QC	Quality Assurance/ Quality Control
RWMF	Regional Waste Management Facility
SDG	Sustainable Development Goal
SIDS	Small Island Developing State
SNC	Second National Communication
TNA	Technology Needs Assessment
toe	Tons of Oil Equivalent
UNCBD	United Nations Convention on Biological Diversity
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WTE	Waste to Energy

FOREWORD

H.E. Thoriq Ibrahim
Minister of Climate Change,
Environment and Energy

The Government of Maldives is proud to present the Maldives' First Biennial Transparency Report to the United Nations Framework Convention on Climate Change under the Paris Agreement. This report includes information on our national greenhouse gas inventory, progress towards achieving our Nationally Determined Contributions, adaptation and mitigation efforts, the support required and received, as well as other means of implementation that are crucial to building our resilience and a low-emission development pathway.

The report also provides valuable information on our climate actions, despite the challenges we face as a vulnerable Small Island Developing State with limited means to adapt to and mitigate the climate crisis. Our efforts towards building the resilience of our island communities and addressing the adverse impacts of climate change remains a costly endeavour, requiring ever-increasing public resources.

Although our contribution to the global greenhouse gas emissions is just 0.004%, we are fully committed to being part of the solution. Since our First National Communication in 2001, the Maldives has made significant progress in addressing the climate challenge. We have invested significant resources in adaptation and resilience building measures, including enhancing food and water security, coastal protection, and building resilient infrastructure in island communities. We have made strides in transforming our energy sector towards renewables. This has been given further impetus with the pledge by H.E. President Dr. Mohamed Muizzu at COP28 to ensure 33 percent of electricity generated is through renewables by 2028. We are mobilizing public and private partnerships for investments in low-emission, climate-resilient development.

While we are committed to our obligations under the Convention and the Paris Agreement, it should be noted that the transparency framework and its reporting has added an extra burden on the already resource-constrained, vulnerable Small Island Developing States like the Maldives. As such, the provision of adequate and timely support remains the cornerstone towards building a sustainable transparency regime under the Convention and the Paris Agreement. This support should extend beyond the preparation of the BTR and other communication vehicles, to include sustainable capacity building initiatives.

I extend my sincere gratitude to all ministries, government organisations, the private sector, and other stakeholders for their generous contribution, commitment and support provided for the successful completion of this report in a timely manner. This report underscores our unwavering commitment to transparency and accountability in the global battle against climate change. We remain committed to continue this route.

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NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

CHAPTER 1: NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1 Geophysical Characteristics

The Maldives is an archipelago of islands in a double chain of coral atolls scattered between 7° 6' 35" N to 0° 42' 24" S, lying in a narrow band of 72° 32' 19 E to 73° 46' 13" E.

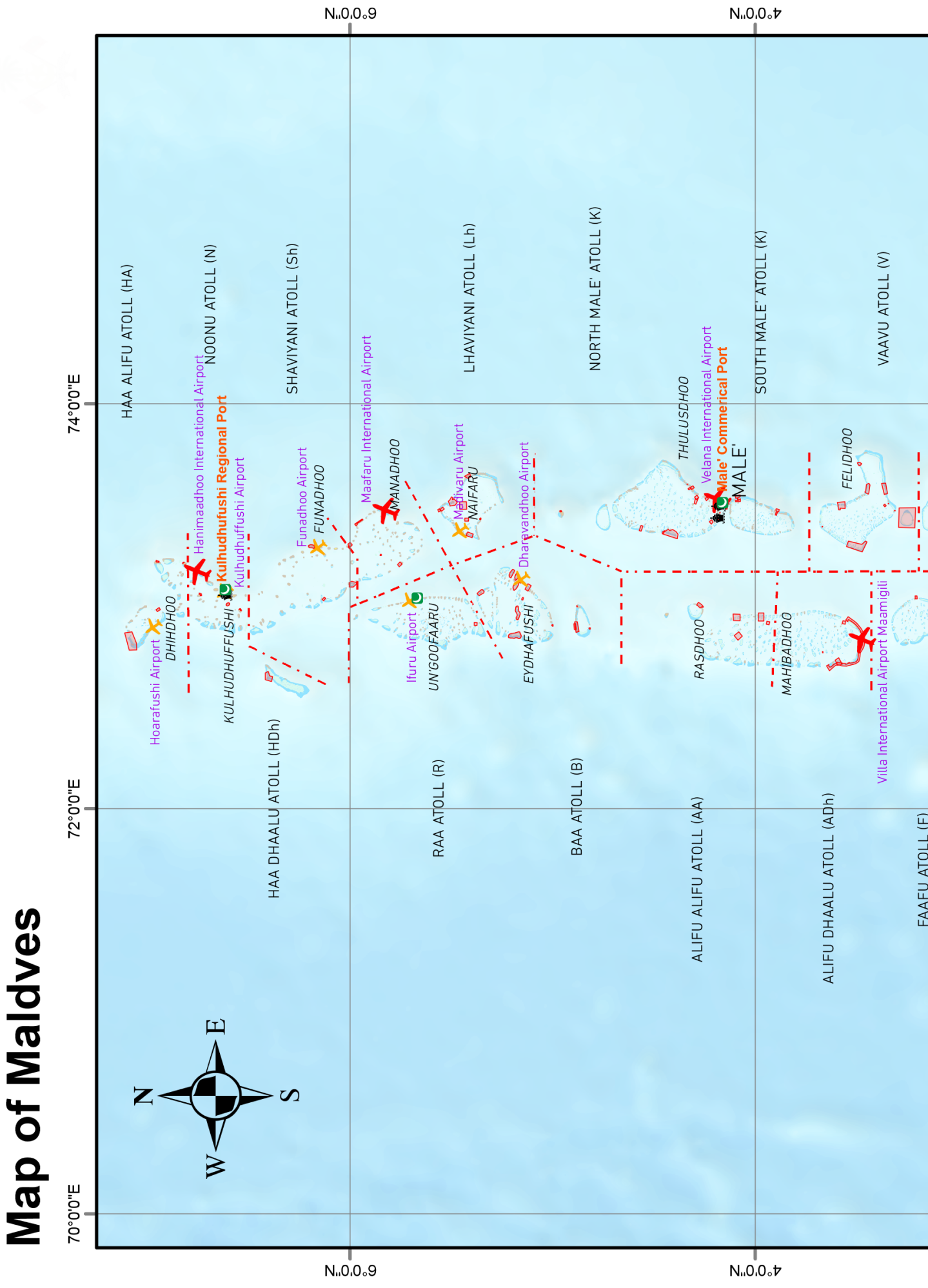
The country has approximately 1,192 coral islands grouped into 26 natural atolls, stretching over 860 km from north to south and 80 to 120 km from east to west. It is composed of 187 inhabited islands, 20 administrative atolls, with Male', the capital city, located in Kaafu Atoll.

A typical Island in the Maldives demonstrates its low elevation. **Photo:** Water Solutions

Characterised by its low-lying nature, the average elevation of the islands is 1.5 meters above mean sea level, with approximately 80% of the islands having an elevation of less than 1 meter. This makes the Maldives one of the lowest-lying countries in the world and extremely vulnerable to climate change and its associated impacts, particularly sea level rise (MEEW, 2007a).

Surrounded by warm sea temperatures, the Maldives is rich in marine flora and fauna, and hosts around 583 species of vascular plants, including 323 cultivated and 260 naturalised species. Among these are 14 species of mangroves found on over 150 islands, with mangrove wetlands covering approximately 1.41 sq km across 74 islands. Wildlife is sparse, with a few species of reptiles, amphibians, 167 species of birds, and two native subspecies of fruit bats. Notably, one species of reptile, the black turtle, appears on the IUCN Red List. Most of the country's biodiversity is concentrated in its coral reef and mangrove ecosystems, which are vital for ecological stability and serve as essential sources for livelihood and economic activities, particularly fishing and tourism. These ecosystems also act as natural barriers against coastal erosion and extreme events.

Ocean currents, influenced by monsoon winds, play a crucial role in the dispersion of marine species and nutrients, contributing to the ecological balance of the region. However, rising sea


Map of Maldives
70°0'0"E
72°0'0"E
74°0'0"E
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4°0'0"N
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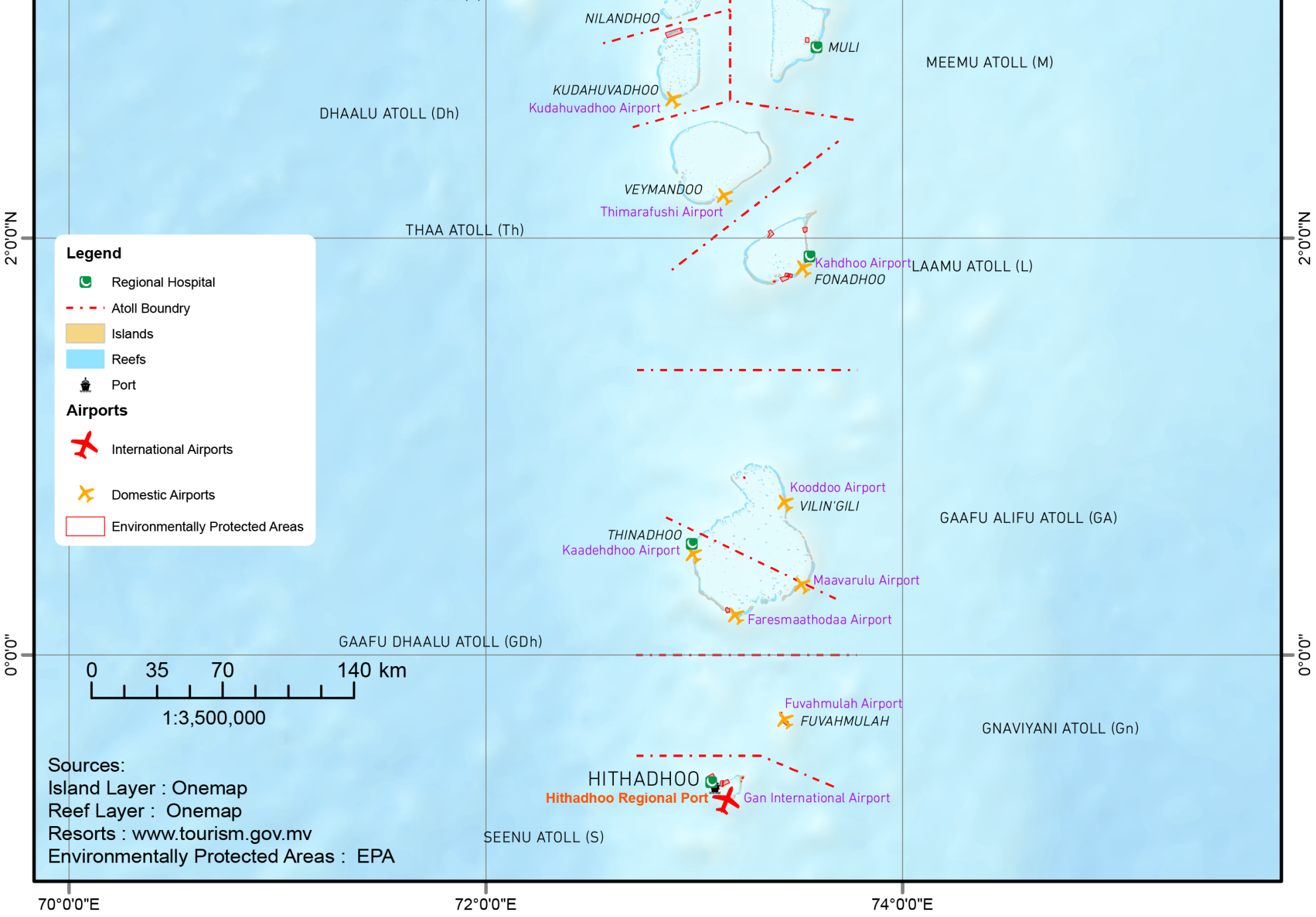
SHAVIYANI ATOLL (Sh)
LHAVIYANI ATOLL (Lh)
NORTH MALE' ATOLL (K)
SOUTH MALE' ATOLL (K)
VAAVU ATOLL (V)
HAA DHAALU ATOLL (HDh)
RAA ATOLL (R)
BAA ATOLL (B)
ALIFU ALIFU ATOLL (AA)
ALIFU DHAALU ATOLL (ADh)
Hoarafushi Airport
DHIHDHOO
Hanimaadhoo International Airport
Kulhudhufushi Regional Port
KULHUDHUFFUSHI
Kulhudhuffushi Airport
Funadhoo Airport
FUNADHOO
Maafaru International Airport
MANADHOO
Ifuru Airport
UNGOOFAARU
Maldivaru Airport
NAIFARU
Dharavandhoo Airport
EYDHAFUSHI
THULUSDHOO
Velana International Airport
Male' Commerical Port
MALE'
FELIDHOO
RASDHOO
MAHIBADHOO
Villa International Airport Maamigili


NILANDHOO
MULI
MEEMU ATOLL (M)
KUDAHUVADHOO
Kudahuvadhoo Airport
DHAALU ATOLL (Dh)
VEYMANDOO
Thimarafushi Airport
THAA ATOLL (Th)
Kahdhoo Airport
FONADHOO
LAAMU ATOLL (L)
Legend
Regional Hospital
Atoll Boundry
Islands
Reefs
Port
Airports
International Airports
Domestic Airports
Environmentally Protected Areas
Kooddoo Airport
VILIN'GILI
GAAFU ALIFU ATOLL (GA)
THINADHOO
Kaadehdhoo Airport
Maavarulu Airport
Faresmaathodaa Airport
GAAFU DHAALU ATOLL (GDh)
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Fuvahmulah Airport
FUVAHMULAH
GNAVIYANI ATOLL (Gn)
HITHADHOO
Hithadhoo Regional Port
Gan International Airport
SEENU ATOLL (S)
Sources:
Island Layer : Onemap
Reef Layer : Onemap
Resorts : www.tourism.gov.mv
Environmentally Protected Areas : EPA
2°0'0"N
0°0'0"
70°0'0"E
72°0'0"E
74°0'0"E

surface temperatures and ocean acidification pose significant threats to coral reefs, leading to widespread bleaching and degradation.

While the country's marine biodiversity and geographic features are significant assets, its vulnerability to climate change presents serious challenges to maintaining them. Understanding these geophysical factors is crucial for developing effective strategies and interventions to ensure the adaptation and resilience of the Maldives in the face of ongoing climate challenges.

1.2 Climate Profile

The Maldives, has a warm, humid monsoon climate, with an annual rainfall ranging from 1,779 to 2,218 mm. Temperatures typically range between 23°C and 31°C year-round, with monsoon seasons significantly influencing weather patterns. The southwest monsoon (wet season), locally known as *Hulhangu*, lasts from mid-May to November, while the northeast monsoon (dry season), locally known as *Iruvai*, occurs from January to March, with December and April serving as transition months. Seasonal variations in rainfall and wind are driven by these monsoon patterns, resulting in consistently warm temperatures year-round.

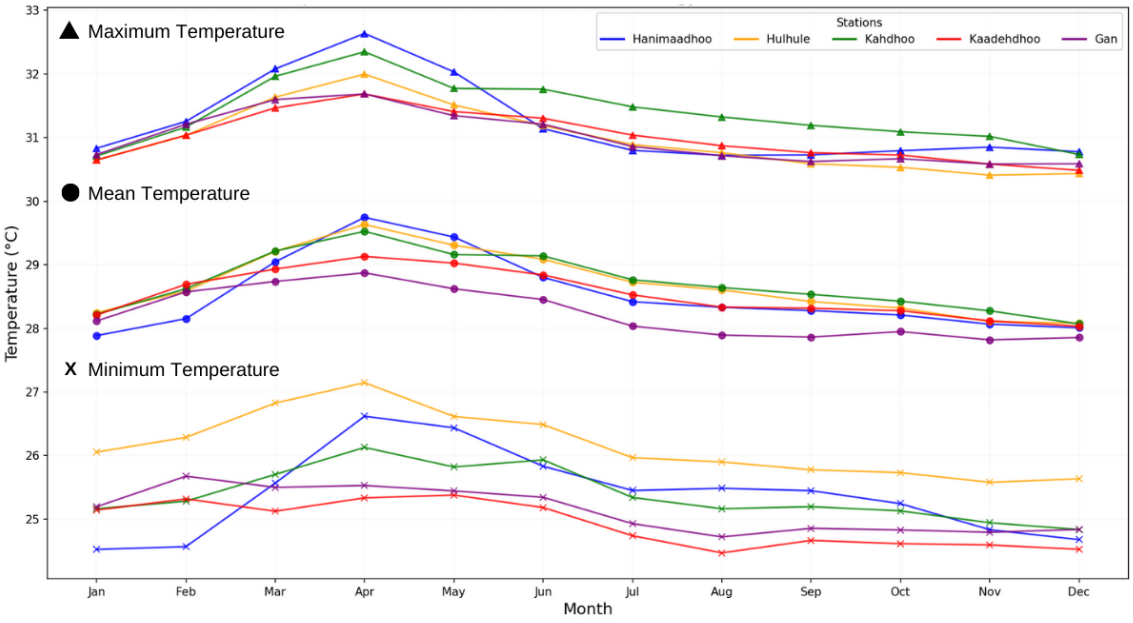


Figure 1 : Annual Temperature (max, mean and min) Climatology (1991 – 2020) Across Maldives

Data from five Maldives Meteorological Service stations shown in Figure 1, covering the period from 1991–2020 reveal regional differences. The north receives less rainfall but experiences stronger winds, while the south has the highest rainfall and gusts, but lower average wind speeds. Central Maldives exhibits moderate conditions in both rainfall and wind. These patterns highlight the country's diverse weather, shaped by monsoon influences.

Temperatures remain fairly stable throughout the year, with the hottest months in April and May, and the coolest during January and February. Regional temperature differences are minimal, though the southern atolls are slightly warmer than the north.

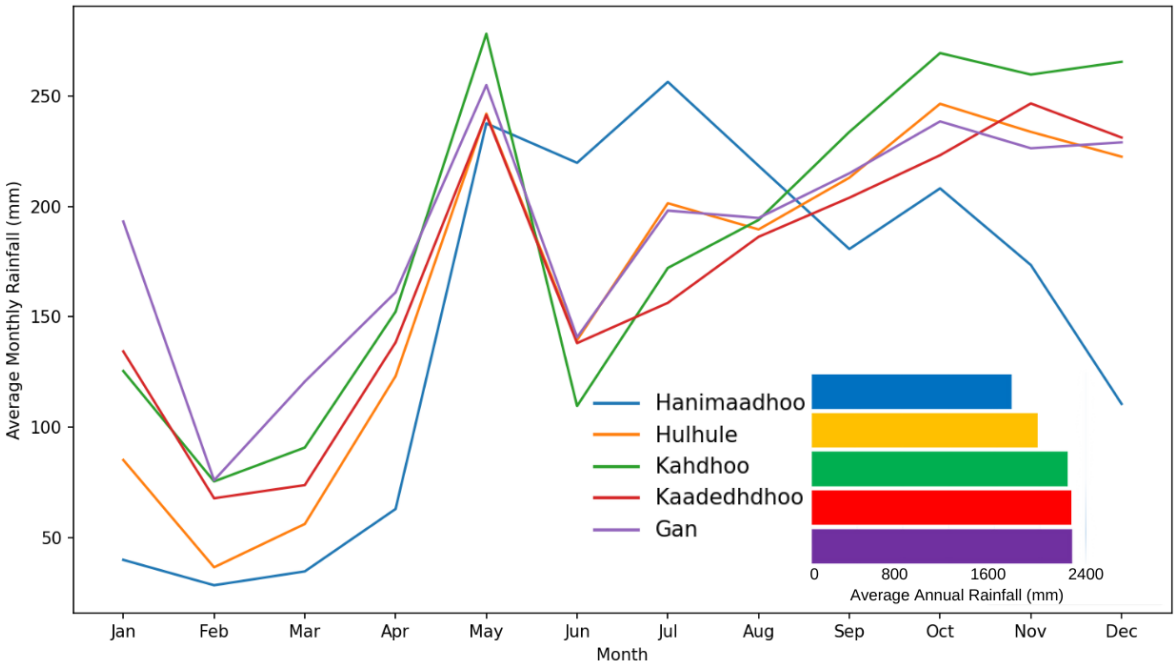


Figure 2 : Monthly Climatology of Rainfall across Maldives (1991 – 2020)

Rainfall is seasonal, with the majority of it occurring during the southwest monsoon. The southern atolls receive the most rain, while the north experiences less intense rainfall but still peaks during this period. The dry season brings minimal rain, with February being the driest month.

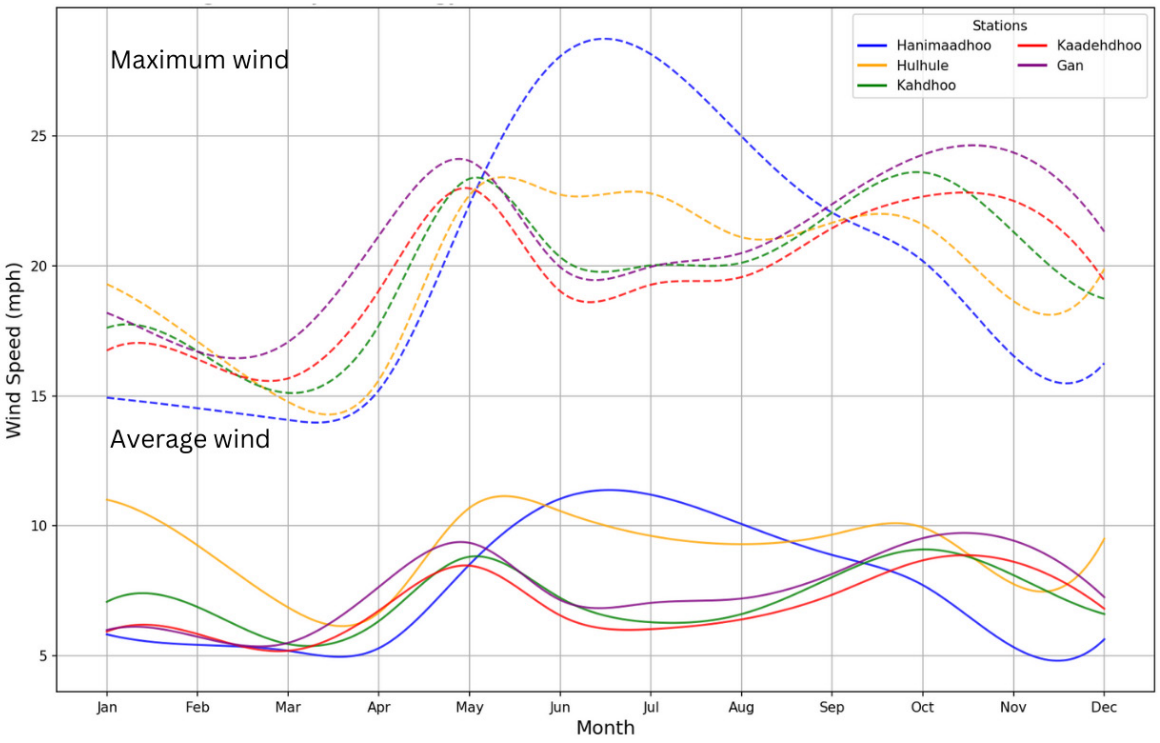


Figure 3 : Average Monthly Climatology of Wind (Max and Mean) (1991 - 2020) across Maldives

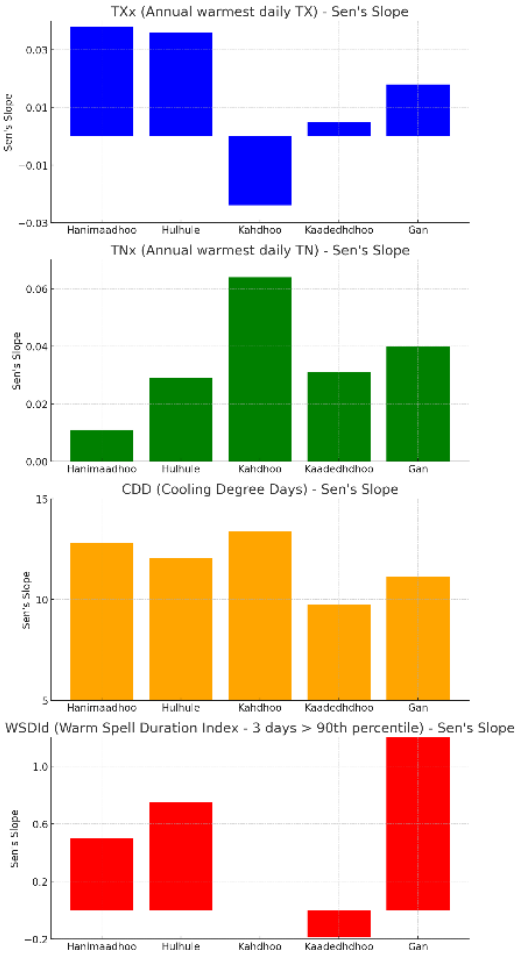


Figure 4: Climate trends

Winds are strongly influenced by the monsoon seasons. The southwest monsoon brings stronger winds, particularly in the north, where sustained wind speeds are higher. The southern atolls experience the strongest gusts, especially during storms. The northeast monsoon brings calmer winds across all regions.

Considering the climate trends, and their analysis, the results are as shown below.

- The Maldives is experiencing a clear warming trend, with significant increases in both maximum and minimum temperatures, particularly in daily minimum temperatures in the southern regions, resulting in more warm nights.
- There is a marked increase in hot days where the maximum temperature exceeds the 90th percentile, especially in the southern region.
- Cold days where the minimum temperature is less than the 10th percentile are decreasing, consistent with the overall warming trend.
- Cooling degree days (CDD), which measure the need for cooling when temperatures exceed 20°C, are rising, particularly in Hulhule and Kahdhoo, indicating higher temperatures and increased energy demand for cooling systems.

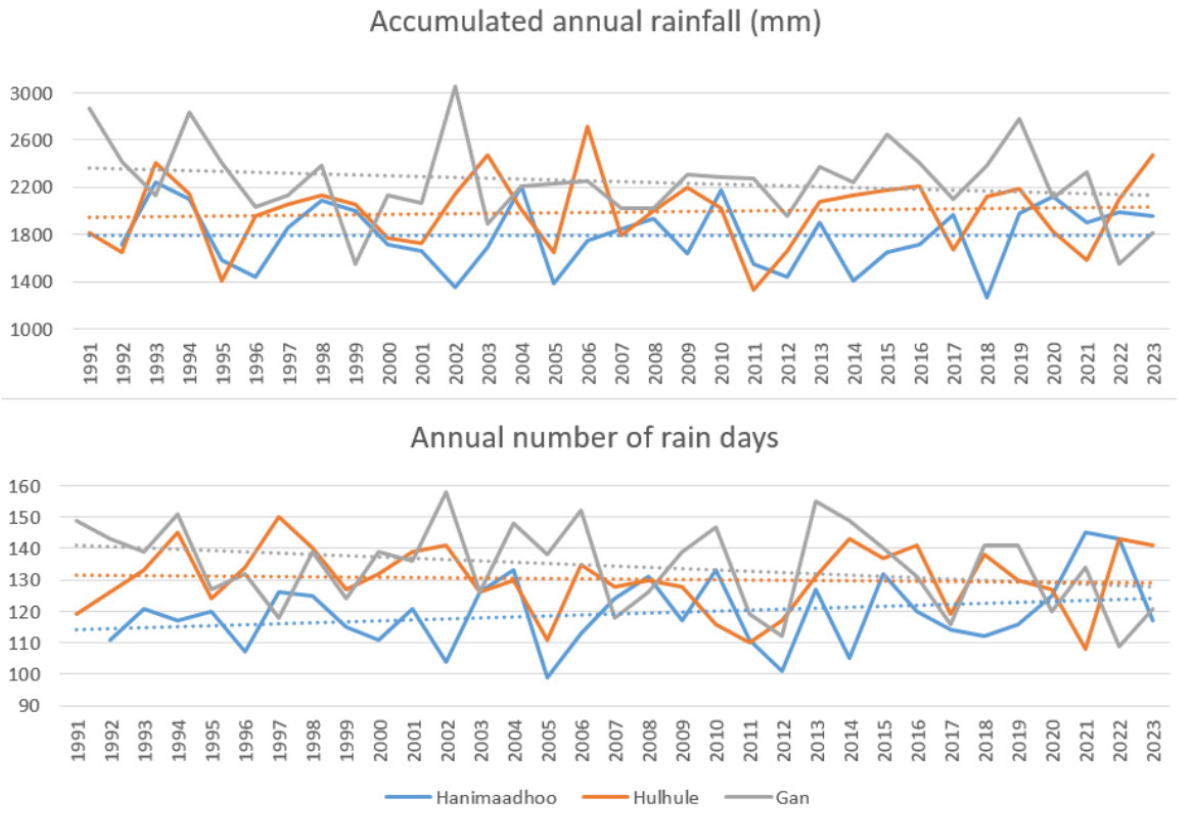


Figure 5 : Accumulated Annual Rainfall (mm)

The climate extreme indices for rainfall do not show statistically significant results. Linear trend analysis of annual rainfall and the number of wet days shows very slight trends which are not statistically significant. The small number of data points is not sufficient enough to draw a conclusive inference on rainfall over the whole country.

Table 1 : Linear trend analysis of Annual rainfall and Wet days per year for five stations

	Annual Rainfall				Wet Days per year			
	Linear Trend		Kendall Test		Linear Trend		Kendall Test	
Station	Slope	P Value	K	P Value	Slope	P Value	K	P Value
Hanimaadhoo	-0.1	0.98	0.01	0.94	0.3	0.16	0.14	0.25
Hulhule	2.9	0.61	0.09	0.47	-0.08	0.67	-0.006	0.96
Kahdhoo	-3.85	0.59	-0.08	0.55	0.03	0.89	-0.01	0.94
Kaadedhdhoo	-3.64	0.67	-0.04	0.78	-0.46	0.15	-0.25	0.06
Gan	-6.97	0.26	-0.1	0.45	-0.41	0.09	-0.19	0.13

Analysis of climate drivers shows that the El Nino Southern Oscillation (ENSO) generally has a weak negative influence on rainfall, with La Nina conditions leading to a slight reduction in rainfall. Despite the weak correlation with average rainfall, El Nino is associated with a higher probability of extreme rainfall events. The Indian Ocean Dipole (IOD) shows a moderate positive relationship with rainfall at all stations, particularly during positive IOD phases, when rainfall tends to increase. Despite these trends, the weak correlations, low R-squared values, and

lagged effects indicate that SOI and IOD alone are not strong predictors of rainfall variability at these stations. This suggests that other factors or more complex climate interactions play a role in local rainfall patterns.

1.2.1 Future Climate Projections

Future climate projections for the Maldives were made using global climate models (GCMs) from the Coupled Model Intercomparison Project Phase 6 (CMIP6) dataset. The CMIP6 dataset is a collection of climate change projections derived from multiple GCMs developed by various research institutions worldwide. The Intergovernmental Panel on Climate Change (IPCC) AR6 Shared Socioeconomic Pathways (SSPs) were used to determine the impact under various socio-economic scenarios. From an initial 26 GCM, 5 GCM were selected after considering their performance, geographical coverage, data frequency which capture the daily signals and using scenarios SSP2-4.5, SSP3-7.0 and SSP5-8.5. The global climate model outputs were downscaled using a statistical technique. Physical downscaling was not used due to high costs.

Projections were based on the baseline period from 1995 to 2014, with the selected analysis periods, 2021-2040 (2030s) and 2041-2060 (2050s). Data projections were made for three stations, depicting 3 regions in the Maldives: Hanimaadhoo (Northern region), Hulhule (Central region), and Gan (Southern region).

SSP2-4.5: This scenario envisions a world with moderate socio-economic progress and a balanced approach to climate mitigation, resulting in stabilisation of emissions after mid-century.

SSP3-7.0: This scenario envisions a fragmented world with limited climate action, resulting in high emissions and significant global warming.

SSP5-8.5: This scenario envisions a world with rapid economic development driven by fossil fuels, leading to very high emissions and severe global warming.

1.2.1.1 Rainfall projections

Annual precipitation is projected to increase under all scenarios across the northern and southern regions, while it is expected to decrease at in the central region.

The most pronounced increase is projected for the northern region, with precipitation expected to rise by 4-5% by mid-century under SSP 2-4.5, from the baseline (Figure 6). Meanwhile, about 3-4% decrease is projected in the central regions.

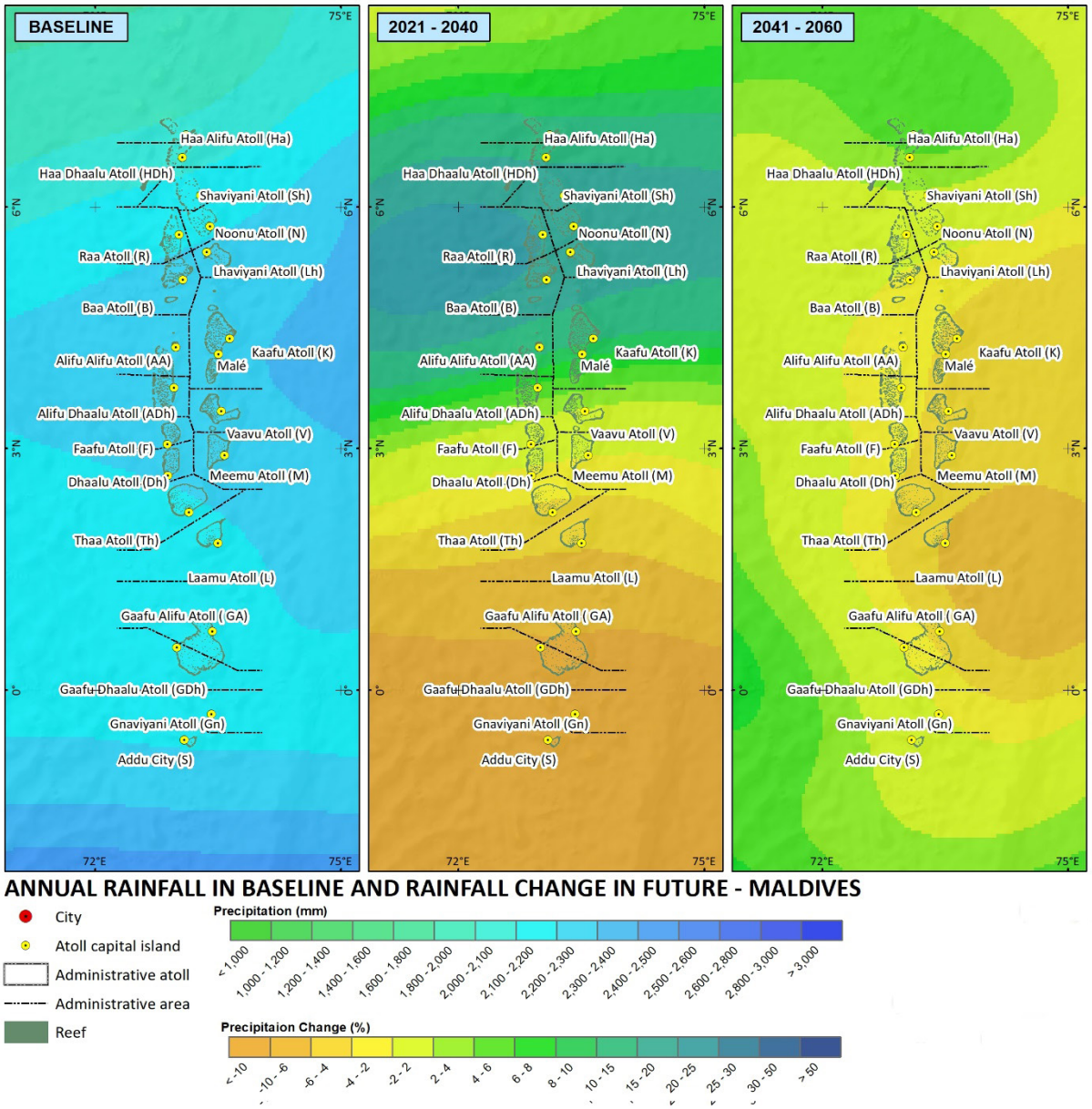


Figure 6 : Baseline and projected annual precipitation (mm), for SSP2-4.5 (baseline period: 1995-2014; future projection: 2021-2100)

Seasonal variations are also notable. Under all scenarios, the northern and southern regions are expected to see an increase in precipitation during the wet season and a decrease during the dry season.

1.2.1.2 Temperature projections

Climate models project a uniform increase in average maximum annual temperatures across the Maldives, with the northern region experiencing a more pronounced rise compared to central and southern regions.

By the 2030s, temperatures are expected to increase by +0.60°C to +0.65°C nationwide from a baseline of 31.0°C across all SSPs. For the 2050s, projected increases range from +1.10°C to +1.43°C under SSP 2-4.5 (Figure 7), with the northern region experiencing the highest increases

and the lowest in the central region.

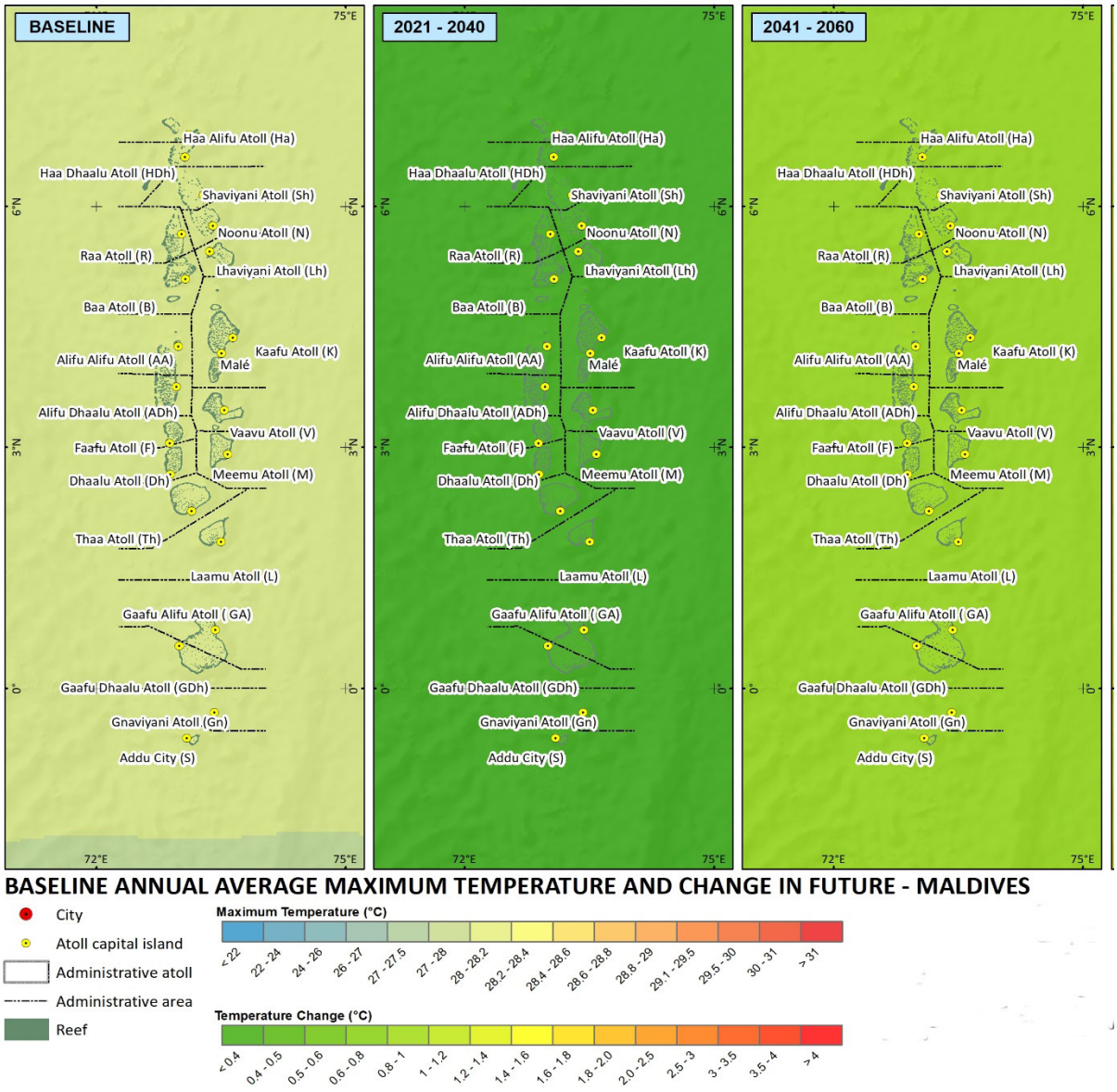


Figure 7 : Baseline and projected change in annual average maximum temperature per year (°C), for SSP2-4.5 (baseline period: 1995-2014; future projection: 2021-2100

The projected average maximum temperatures overall are expected to peak in April-May and reach their lowest in January under all three SSPs, with the lowest temperatures in July.

1.2.1.3 Sea level change projections

The average sea level is projected to rise between 0.15m to 0.31m by 2050 under the SSP2-4.5 scenario in the mid-century, as shown in Figure 8. Sea levels are projected to rise in all regions with a slightly higher increase in the northern and central regions compared to southern region under all three SSPs.

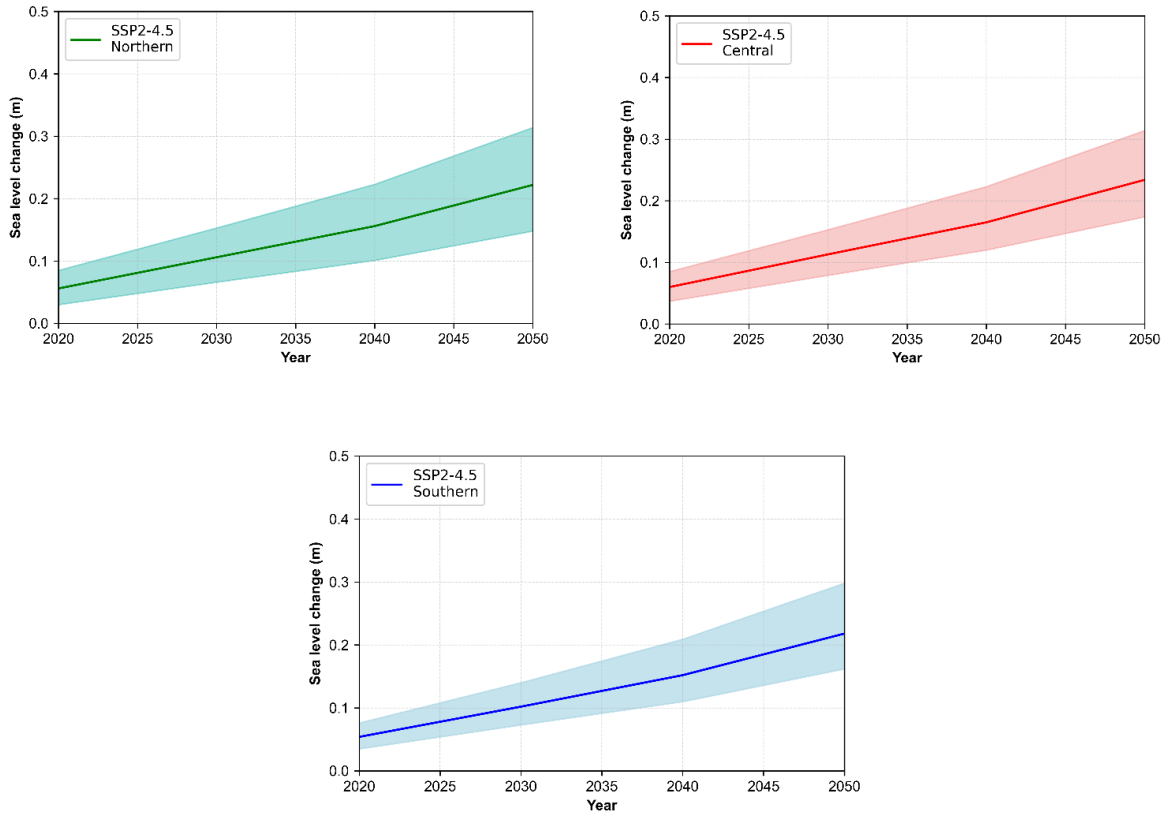


Figure 8: Projected Sea Level Rise under SSP2-4.5 scenarios in northern, central and southern regions.

1.3 Socioeconomic Profile

1.3.1 Population and Demographics

As of 2022, the Maldives has a resident population of 515,132, including registered expatriate. The majority of this, about 41%, resides in the capital, Male', while 46% live in the outer islands, 10% in resorts with the remaining 3% residing in industrial islands (MBS, 2024a).

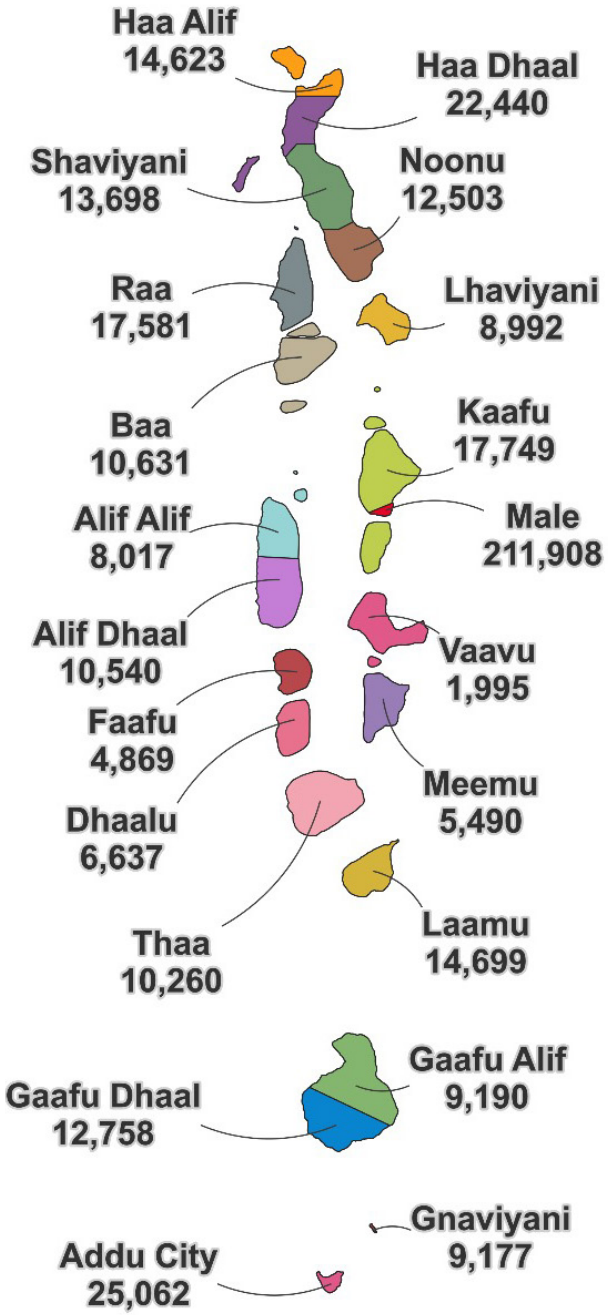


Figure 9 : Resident Population by Atoll (Census 2022)

Population density in the Greater Male' region is notably high, driven by substantial migration from outer islands to Male' due to better economic, health, and educational opportunities. This urban concentration leads to challenges such as overcrowding and infrastructure issues, while residents of the outer islands often encounter difficulties in accessing services and economic prospects (MBS, 2023a).

The Maldives has a youthful population, with a substantial proportion under the age of 30. Approximately 20% of the population is under 15 years old, while those aged between 15 to 64 constitute for about 76% (MBS, 2023b). The aging demographic is relatively small, with only around 4% of individuals aged 65 or older. This youthful demographic presents opportunities for economic growth but also necessitates significant investment in education and employment to effectively leverage the potential of the younger generation.

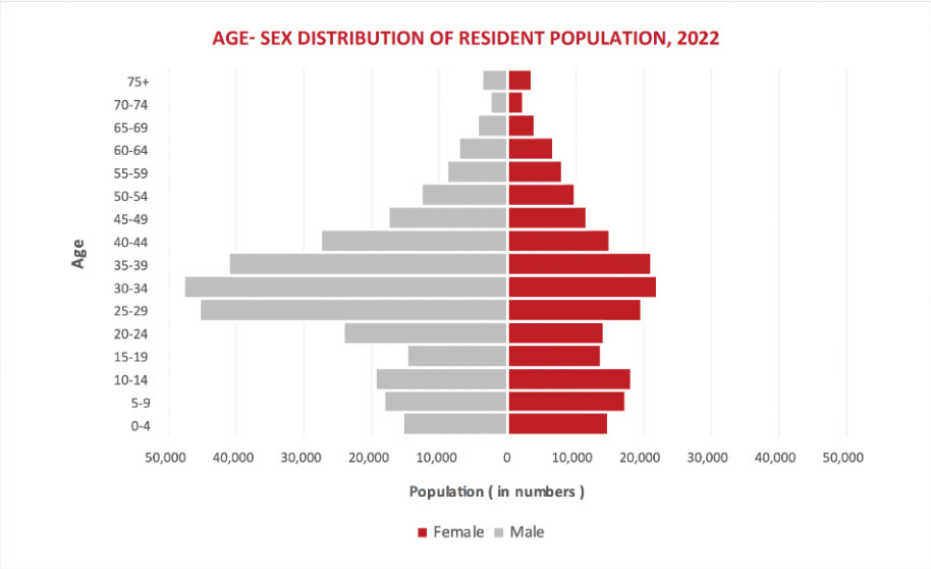


Figure 10 : Age-Sex Distribution of Resident Population (2022)

In recent decades, the country has experienced steady population growth, with an average annual growth rate of around 1.56% (MBS, 2023a). However, the country is observing a declining birth rate. There were 7431 recorded births in 2012, which has decreased to 5914 births in 2022. The Total Fertility Rate (TFR), as indicated by Census 2022, stands at 1.7 births per woman, which is a significant decline from the 2.5 births recorded in Census 2014. This marks the lowest TFR observed over the past five censuses and signifies that the population's fertility has fallen below the replacement level of 2.1 children per woman (MBS, 2023c).

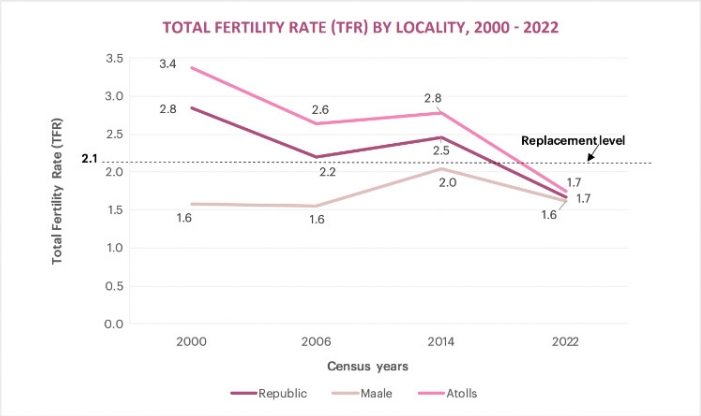


Figure 11 : Total Fertility Rate (TFR) By Locality (2000 - 2022)

1.3.2 Human Development

As of 2022, the Human Development Index for the Maldives is approximately 0.762 (UNDP, 2024), indicating that the country falls under the high human development category. This score indicates a steady improvement in the country's overall human development, reflecting advancements in key areas such as life expectancy, education, and per capita income. Driven by economic development across the key sectors, the employment rate in the Maldives stands at

approximately 80% as of 2024 (MBS, 2024b). This figure reflects a relatively robust labour market in the country. However, income disparity remains a critical issue, with approximately 6.7% of the population reported to be living below the national poverty line as of 2023 (WB, 2022).

The overall literacy rate is very high at an estimated 97.1 percent in 2022 (MBS, 2023d). The government prioritises education as a cornerstone of national development, investing in human resources, quality infrastructure, and other areas to improve access to and the quality of education.

Healthcare in the Maldives has also improved significantly. As of 2022, life expectancy is approximately 80.8 years (UNDP, 2024). Key health indicators, such as child and maternal mortality rates, have shown positive trends, though challenges remain in addressing non-communicable diseases like diabetes and cardiovascular conditions, which are becoming more prevalent due to lifestyle changes (WHO, 2024). To enhance affordability and access to health care, the Maldives operates a state-sponsored universal health insurance program called "Aasandha" for all citizens. Private health insurance schemes are also available, primarily targeting the corporate sector.

The country has made strides in closing gender gaps in education and health, with equal access for both women and men. The Gender Equality Act (Law No. 18/2016) includes provisions to achieve key milestones in national priority areas related to gender equality.

1.3.3 Governance

The Maldives has been a multi-party democracy since 2008. The political structure of the nation is a multi-party constitutional democracy, operating as a republic with a presidential system encompassing three branches, the executive, legislative and judicial. The constitution enshrines the state's fundamental duty to protect and preserve the natural environment, biodiversity, resources and beauty of the country for the benefit of present and future generations.

The country is run through a decentralised administration which allows for independent decision-making in a democratic and accountable manner, aimed to improve living standards through social, economic and cultural development and create an environment conducive for peace and prosperity. Each administrative unit includes representatives elected by the islands, atoll and cities. Decentralisation Act (Law No. 07/2010), enacted in 2010, provides the framework for governing the country in a decentralised manner.

1.3.4 Economy

The main contributors to the Maldives' economy are tourism, construction, wholesale and retail trade, electricity, water and waste management. According to MBS (2024a), the GDP per capita at current prices for Maldives in 2023 was MVR 171,799 (approximately 11,141.31 USD).

The economy is heavily reliant on tourism for domestic employment and foreign exchange. As of 2022, it accounted for approximately 22.5% of the GDP, marking the highest contribution by any

sector in the Maldives (MOT, 2023a). More than one-third of government revenue is generated from tourism, providing employment opportunities for a significant portion of the population (MBS, 2024c; MOT, 2023a). The indirect contributions of tourism-related sectors such as transportation, construction, real estate, wholesale and retail trade further bolster this sector's importance.

The fisheries sector contributes up to 6% of the GDP (MBS, 2022a) and is central to the Maldivian economy, engaging both men and women, and serving as the primary industry for many Maldivians. Fish is the main source of protein for Maldivians, and is also among the main export industries of the country, highlighting its importance for foreign exchange. According to MMA (2024), the Maldives' domestic exports, which predominantly comprise of fish exports accounting for 93%, rose by 2% (US$3.2 million) and totalled US$162.2 million at the end of the year.

Agriculture contributes about 1% to the GDP of the Maldives(MBS, 2023e) due to limited arable land, limited freshwater resources, challenging growing conditions, and a heavy reliance on food imports to meet the population's needs. Maldives imports over 90% of its food supplies. Agricultural produce has not reached sustainable production numbers due to challenges such as limited access to finance, and small economies of scale.

Maldives relies almost entirely on fossil fuels to meet its energy demand and to drive its economy. According to data from the Maldives Customs Services, fossil fuel import expenses for 2022, at the cost, insurance, and freight (CIF) price amounted to USD 806,937. This is approximately 13% of the GDP (current price) value.

At a macro-level, a close relationship is observed between total greenhouse gas (GHG) emission and Gross Domestic Production (at constant price) in the Maldives. Similarly, total energy consumption is closely related to Gross Domestic Product (Current Price Purchasing Power Parity) (MEE, 2016).

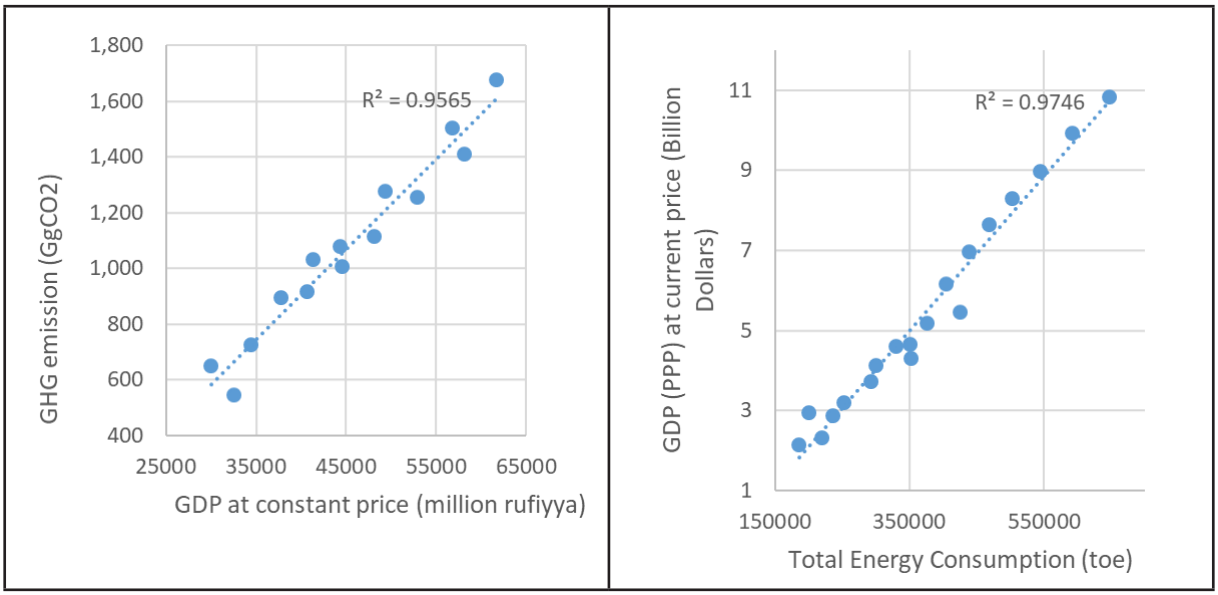


Figure 12 : Correlation between GHG emission and GDP in Maldives (2003-2015) (Ministry of Environment, 2019) and correlation between GDP and Energy consumption

The major fuel types imported are diesel, petrol (gasoline), aviation fuel (Jet A-1) and liquefied petroleum gas (LPG) as shown in Figure 13.

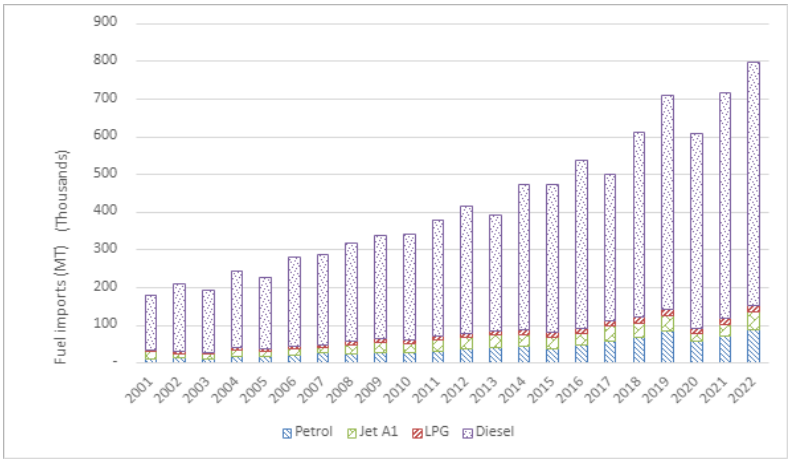


Figure 13 : Fuel imports (2001 – 2022), (data source: Maldives Customs Services)

The Maldivian economy is extremely vulnerable to external shocks due to high import dependency and limited diversification of economic activities. The heavy reliance on imports, scarcity of land, limited resources and geographical dispersion limits the development of other sectors like agriculture and manufacturing, which further exacerbates the country's vulnerability to external shocks.

This was also evident during the COVID 19 pandemic (see Figure 14 below) which created a significant decline in foreign exchange reserves with the brunt to tourism - the main source of foreign currency - leading to a deterioration of the balance of payments. Additionally, the crisis exposed the severe dependency on imports for food security, with the Maldives having to charter flights to larger importer countries to mitigate food shortages (MOED and UNDP, 2020). Despite the many challenges, the Maldives was able to contain the health crisis and prevent a full-blown fiscal crisis by adopting a multi-sector approach with the engagement of all relevant stakeholders. However, the economic burden and impact of the pandemic are yet to be fully recovered.

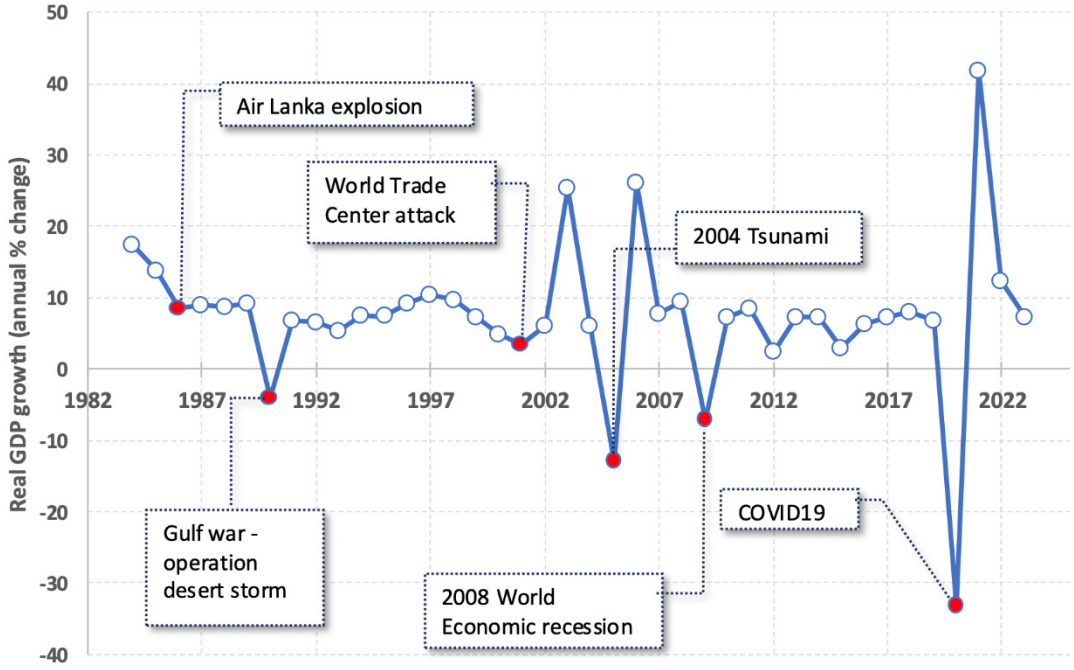


Figure 14 : Effect of External Shock to Real GDP Growth

To build resilience against such shocks, the government has initiated various diversification efforts, including investments in renewable energy (RE) to enhance energy security and reduce dependence on costly fuel imports. Additionally, strategic investments in the tourism sector are crucial for fostering economic stability.

1.4 Key Mitigation Sectors

1.4.1 Electricity Generation

Maldives relies almost entirely on fossil fuels to meet its energy demand. Emissions by energy industries are the largest contributor to national emissions mainly due to fuel combustion for electricity generation, accounting for 64% of all energy consumption as of 2022. Due to the dispersed nature of the islands, the country operates on standalone grids and power generation systems on each island, resulting in costly electricity services.

Maldives successfully achieved universal access to electricity in 2008, providing 24-hour electricity services in all inhabited islands and resorts. With the increasing population and growth in economic industries, the demand for power production is increasing. Two state owned companies, State Electric Company (STELCO) and FENAKA Corporation Limited provide electricity services to inhabited islands. Resorts and large industries have their own power generation facilities. Figure 15 shows the share of electricity generation by the various actors in the sector.

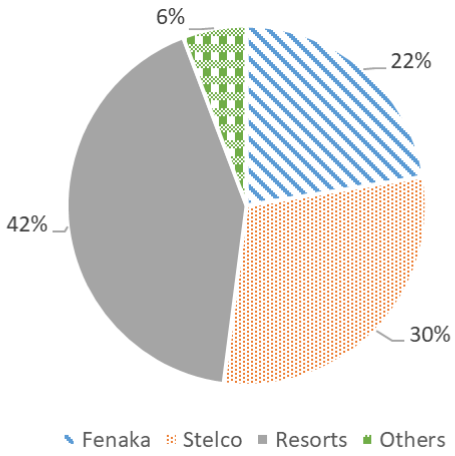


Figure 15 : Share of electricity generation in Maldives

Renewable energy integration to electricity generation began in the late 1990s, utilising solar PV to power essential communications equipment and solar powered cold devices for outer island vaccination in remote islands. Currently Maldives has 68 MW of renewable energy installed in the country.

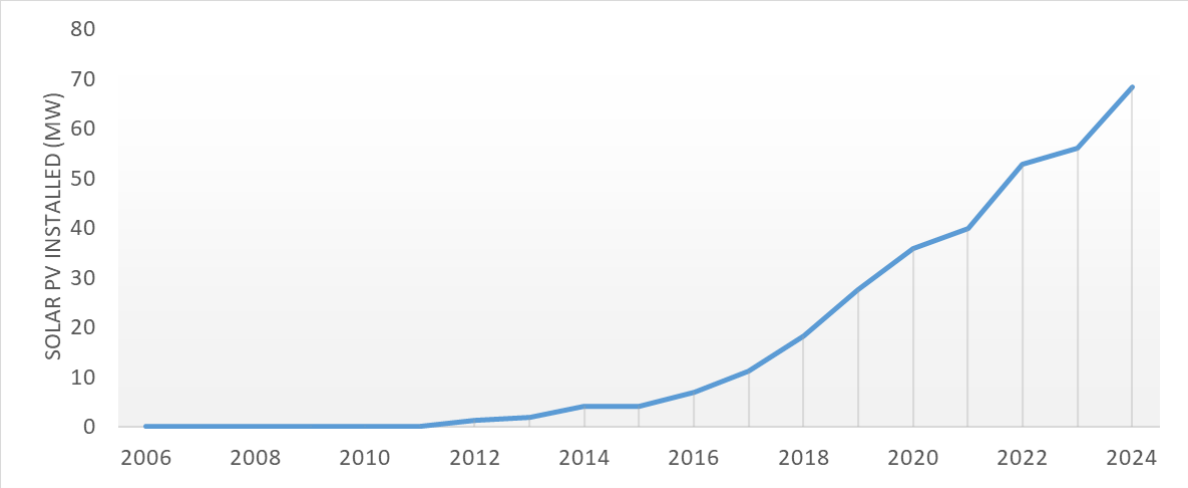


Figure 16 : time series of Solar PV installations in Maldives

1.4.2 Transport

The dispersed nature of the islands makes sea transport the most prominent mode of transport in the Maldives between the islands. According to data from the Ministry of Transport and Civil Aviation and the Maldives Bureau of Statistics, the number of registered vehicles and vessels has been continuously increasing due to socio economic growth. For instance, with the growing number of resorts and the guesthouse industry, the number of high- speed vessels have increased at a rate of 8.8 percent annually. In comparison, the traditional dhoni (mostly diesel based) increased by 2.3 percent annually.

Due to population growth and an under-developed public transport system, coupled with rapid urbanisation, the total fleet size has increased drastically over the years.

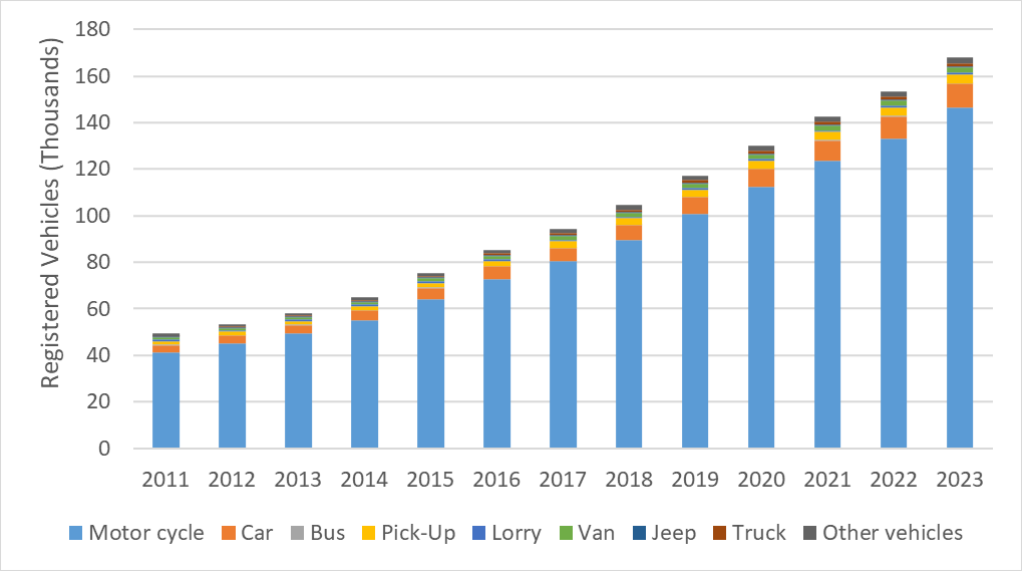


Figure 17 : Increase in Land Vessels over the years (data source: MBS and Ministry of Transport and Civil Aviation)

As demonstrated in Figure 17, the land transport system in the Maldives is dominated by motorcycles and cars, with numbers tripling during the period 2011-2023 (See Figure 17), with most of the vehicles concentrated in the Capital, Male'.

The air transport infrastructure has also developed rapidly over the years, mainly due to the expansion of tourism resulting in the establishment of domestic and international airports around the country. There are currently five international airports and fourteen domestic airports in the Maldives.

1.4.3 Waste

Considering the limited land area of the islands, solid waste management has been one of the biggest environmental threats the country faces. The islands' limited sizes, combined with increasing socio-economic activities, create extreme pressure on land availability. As a result, dumpsites and waste management centres are located along the coastal periphery, away from urban areas. The geographic distribution of islands further complicates waste management due to long sea transfer distances and the associated high cost.

The waste management system in the Maldives has a decentralised orientation and is implemented through the Island Waste & Resource Management Centres (IWRMC), linked to Regional Waste Management Facilities (RWMF). Currently 118 out of 187 inhabited islands have IWMRCs with installed equipment, such as plastic shredders, glass crushers, compactors (metal/plastic), woodchippers, and weighing scales. There are 3 regional waste management facilities catering to all inhabited islands. This includes R. Vandhoo for all islands in Haa Alif, Haa Dhaalu, Shaviyani, Noonu, Raa, Baa and Lhaviyani atolls; Thilafushi for all islands in Kaafu, Alifu, Vaavu, Faafu, Dhaalu, Thaa and Laamu and the Addu RWMF catering to Fuvahmulah and Addu. The state-owned company WAMCO, established in 2016, collects and disposes waste

in the Greater Male' Area, the entire Zone 3, Addu City and Fuvahmulah City, and operates the Vandhoo Regional facility.

Waste reduction and recycling efforts such as "Recycling on the Go" and source separation of commercial waste are a challenge due to the lack of space in Greater Male' Area. The prevailing method of waste management is open burning with composting and small-scale incineration in some islands. In the Greater Male' Area, open burning of waste has been stopped to initiate the establishment of waste management facilities and to reduce the associated health hazards.

The estimated waste generated in the Maldives is 432,795 tonnes in 2019 (MBS, 2021a). The breakdown of this waste by source is illustrated in Figure 18 below. A significant amount of waste (47%) is produced by households, while the construction industry is the second largest source with 42% of waste produced.

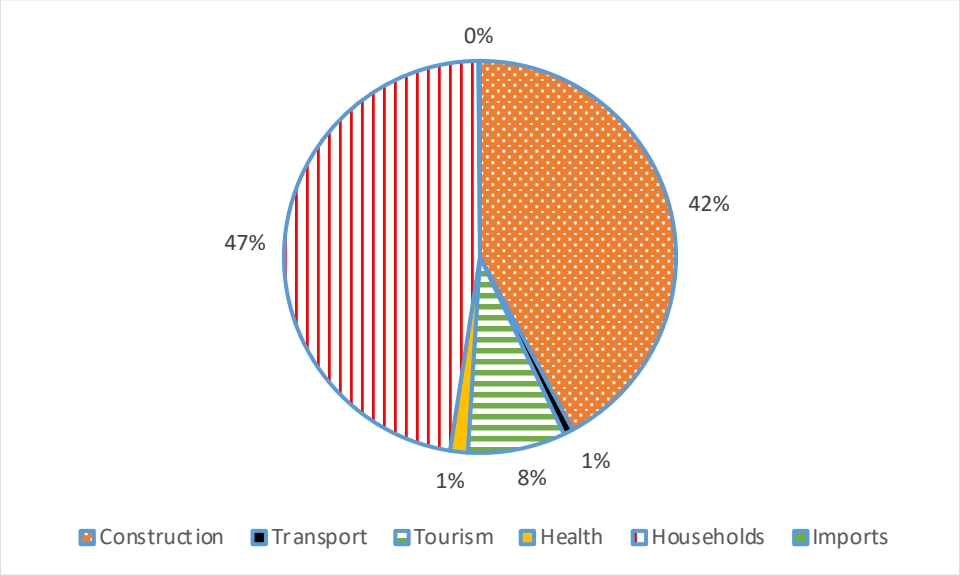


Figure 18 : Sources of Waste, (Maldives National Waste Accounts 2018 & 2019

1.5 Climate Change Vulnerabilities and Adaptive Capacity

The Maldives faces significant challenges from climate change due to its low-lying geography and socio-economic vulnerabilities. As a small island nation, it is particularly exposed to rising sea levels, coastal erosion, extreme weather, and changes in marine ecosystems, all of which threaten the livelihoods, key infrastructure, and cultural heritage of its people. The economy, largely reliant on tourism and fisheries, is at risk from climate change-driven coral reef degradation, which exacerbates existing vulnerabilities. Additionally, limited arable land and freshwater resources further strain the country's capacity to ensure food security and sustainable development. Chapter Four of this report provides details on the key priority sectors affected by climate change in the Maldives and the corresponding national adaptation measures to address the risks.

Addressing the climate challenges requires building adaptive capacity, which is currently hindered by limited access to finance, human resources, and technology tailored to local

needs. Nonetheless, the Maldives has made significant strides in enhancing resilience through a coordinated, multisectoral approach led by the Ministry of Climate Change, Environment, and Energy. This approach includes actively engaging various stakeholders within established national frameworks, as well as collaborating with local councils in accordance with the Local Government and Decentralisation Act (Law No. 7/2021). The key adaptation initiatives focus on managing coastal erosion, safeguarding freshwater resources, promoting sustainable tourism and fisheries, and reinforcing infrastructure against extreme weather events. Adaptation strategies are implemented at both national and local levels, with active community participation that leverages local knowledge.

To further strengthen adaptive capacity, the Maldives invests in education, training, and public awareness. Academic programmes at institutions like the Maldives National University emphasise environmental management, while government-led training enhances officials' skills in climate adaptation and disaster management. Despite financial constraints, the government through the national budget and with support from international donors and the Green Climate Fund, invests in adaptation projects to enhance climate resilience.

1.6 Financial Technology and Capacity Building Support Needed and Received

Estimating climate finance needs is a complex and challenging task due to the dynamic nature of climate impacts and the extensive financial requirements involved in building resilience and supporting low-emission development. The *National Strategic Framework to Mobilize International Climate Finance to Address Climate Change in the Maldives 2020-2024* provides some estimates of immediate support needs. This framework estimates that approximately USD 0.5 billion is necessary to fund resilience-building initiatives and low-emission development projects during the 2020-2024 period (ME, 2020a). These estimates underscore the magnitude of resources required to address climate challenges, though precise calculations remain difficult. Furthermore, the Climate Emergency Act (Law No. 9/2021) mandates the mobilisation of climate finance, and the establishment of a financial architecture aligned with international best practices, aiming to streamline funding flows through a special climate change fund currently under development.

The Maldives has long collaborated with international donors and financiers on several initiatives and projects that address climate change impacts in the areas of adaptation, mitigation and means of implementation. Despite the continuous flow of support received over the decades, the country continues to face significant challenges in meeting its climate finance needs, and a large portion is met through the national budget.

Details of support needed and received are presented in chapter 5.

1.7 Institutional Arrangements

The Ministry of Climate Change, Environment and Energy is the designated focal ministry

responsible for the climate change portfolio in the Maldives. Hence, the compilation of the BTR and other climate reporting are mandated to the Ministry. To fulfil these mandates, the Ministry, through its Climate Change Department (CCD), prepares national climate reports and reports that are required under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement in collaboration with other necessary stakeholders.

The institutional setup for national climate change reporting, which is dynamic and has evolved and improved over time, was implemented for the development of this BTR report. This BTR was prepared with support from the GEF and UNEP. The Ministry's CCD established a small PMU for the BTR. The BTR process was headed and guided by a Project Director from the CCD. The overall conduct and coordination of activities was undertaken by the Project Technical Coordinator with support from the CCD, national experts, and administrative and financial personnel who ensured the day-to-day implementation of the activities. Two working groups consisting of mitigation, adaptation, and cross cutting sectors already established for national reporting, were utilised for seeking technical expertise during the BTR preparation.

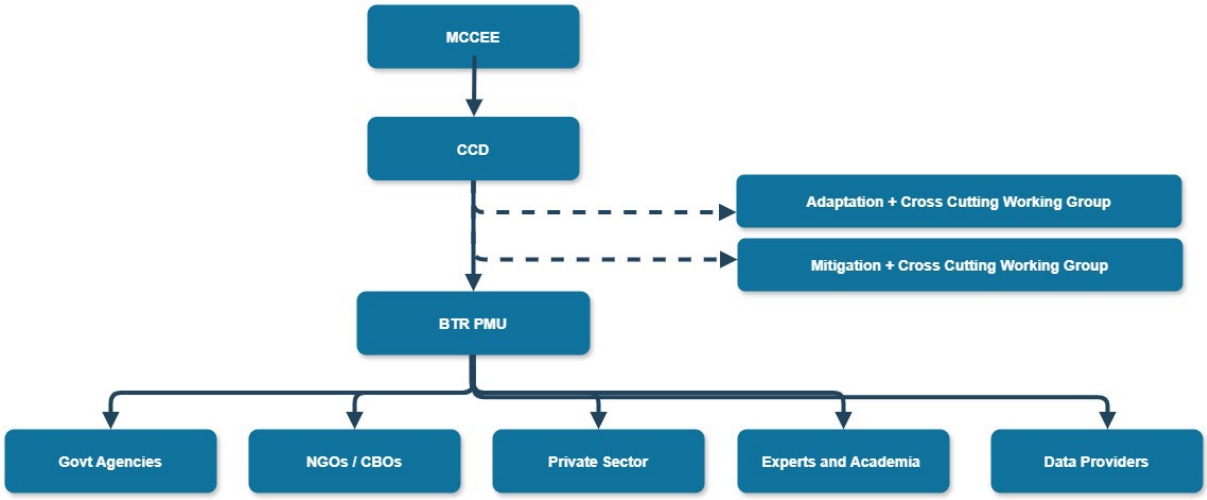


Figure 19: BTR Institutional Arrangements

The Maldives has established a fairly comprehensive framework for climate reporting, which promotes coordination among government entities, local councils, and other stakeholders. However, engagement of stakeholders is challenging due to the dispersed nature of the country, challenges in retaining institutional memory, and limited institutional capacity. Despite these challenges, there is a strong coordination between government agencies.

Local councils and community-based organisations play a crucial role in engaging communities, integrating local knowledge into adaptation and resilience building interventions on the ground. In the development of the adaptation chapter, community consultations were conducted, one in northern Maldives and one in southern Maldives. Additionally, the MCCEE collaborates with other government institutions, the private sector, local NGOs, and international partners to enhance support for adaptation efforts, particularly in areas such as conservation of fragile ecosystems. The activities pertaining to the GHG inventory and National Determined Contribution (NDC)

tracking were undertaken with close stakeholder collaborations from the mitigation working group and the expert group on projections. GHG inventory and NDC tracking consultations were conducted through stakeholder groups. Stakeholders and their roles and responsibilities, especially in relation to GHG inventory and NDC tracking activities, are provided in the GHG inventory chapter. The tracking of climate finance received was conducted through an existing tagging mechanism. The Ministry of Finance is in a position to track support received from international donors and expenditure from domestic sources.

To ensure the rigor and relevance of the findings, consultations were conducted with sectoral agencies. Despite the short duration available for the production of the report, it was further validated through a national workshop attended by relevant stakeholders including NGOs, fostering collaboration and consensus among stakeholders. Following established governmental procedures, the final report was made publicly accessible for feedback by the MCCEE via its website.

1.7.1 Legal, Policy Frameworks and Regulations

A Climate Emergency Act (Law No. 9/2021) was enacted in 2021 granting MCCEE the overall legal authority to establish the legislative and administrative framework required to formulate and implement the policies necessary to protect the Maldives, its citizens, and residents from the adverse effects of climate change. It promotes the Maldives as a leading advocate for raising awareness on the dangers of climate change on a global scale. The Act also identifies the measures required to achieve net zero carbon emissions and stipulates the guidelines for the country to improve its climate resilience capacity.

The Ministry has the powers under its assigned mandate to prepare the BTR and other climate reporting. These reporting processes require collecting data for greenhouse gas emissions inventory and NDC tracking. They also involve gathering information about adaptation and climate finance. However, legal tools are needed to strengthen and institutionalise these processes in the country. To address this, several regulations and guidelines are being developed. These will enhance both inventory development and other climate reporting processes. Similar regulations and legal tools developed by sectoral agencies are being used to collect information and data to prepare climate reports. Hence, a close collaboration and coordination with all stakeholders remains a major priority for preparing these reports. Building the capacity of these stakeholders and institutionalising the existing process has become a key priority towards building the national institutional capacity towards sustainable climate reporting in the country.

The Maldives Energy Act (18/2021), the Waste Management Act (24/2022), the Utility Regulatory Authority Act (26/2020), and the Maldives Statistics Act (Act no: 16/2021) stipulate the requirements for collecting, processing and analysing data. For example, the URA Act also mandates that service providers submit information and data to the URA. These service providers include utility service providers, independent power producers such as hotels, resorts and industries, as well as city and island councils.

Legislations in the Maldives encompass a range of laws, regulations and policies aimed at managing key industries, including environment, fisheries, tourism, public health and transport. These regulatory frameworks promote sustainable practices, ensure resource protection, and enhance economic development while addressing environmental challenges. To strengthen climate resilience across sectors, government agencies are also developing sector-specific climate adaptation plans. For instance, the Maldives introduced the Tourism Climate Action Plan in 2023 to focus on adaptation in the tourism industry, while a Health National Adaptation Plan is underway to mitigate climate-related health risks through system interventions.

1.7.2 Key Sectoral Policies, Plans and Strategies

The key policies, strategies and development plans that were implemented after the Maldives' SNC to the UNFCCC in 2016 are summarised in the table below.

Table 2: Summary of key sectoral strategies and plans

Title	Year	Objectives/Priorities
Nationally Determined Contributions (NDC)	2020-2025	The Maldives' commitment under the Paris Agreement to reduce greenhouse gas emissions and enhance climate resilience, targeting net-zero emissions by 2030.
Maldives National Biodiversity Strategy and Action Plan (NBSAP)	2016-2025	A plan for the conservation of biodiversity, focusing on protecting ecosystems, species, and promoting sustainable use of resources.
Energy Policy and Strategy	2024-2029	A policy to promote the use of renewable energy sources, enhance energy efficiency, and reduce reliance on fossil fuels.
National Waste and Resource Management Policy and Strategy	2024 - 2028	A policy aimed at improving waste management practices, reducing waste generation, and promoting recycling and sustainable disposal methods.
National Water and Sewerage Strategic Plan	2020-2025	A policy focused on ensuring sustainable water resource management and improving sanitation infrastructure.
National Disaster Management Authority Strategic Plan	2024 - 2029	A strategic plan to strengthen capacity for emergency preparedness and response for increased national resilience.
Fifth Tourism Master Plan	2023-2027	A comprehensive plan to guide the development of tourism, focusing on sustainable practices, environmental conservation, and community engagement.
National Fisheries and Agricultural Policy	2019-2029	A policy for managing and conserving fishery resources, promoting sustainable fishing practices, and ensuring the health of marine ecosystems.
Maldives Health Master Plan	2016-2025	A strategic plan for improving healthcare services, addressing climate-related health risks, and promoting public health resilience.

1.7.3 Institutional Arrangements for the GHG Inventory and Tracking NDC Progress

1.7.3.1 Institutional Structure

The Ministry of Climate Change, Environment and Energy holds the lead responsibility for estimating greenhouse gas emissions and compiling the National Inventory Report (NIR). Stakeholders involved in GHG inventory and NDC tracking include both public and private institutions engaged in emission and mitigation activities. The table below outlines the roles and responsibilities of these stakeholders.

Table 3: Summary of major stakeholders for BTR

Stakeholders	General roles and responsibilities	Data provided for BTR
Ministry of Climate Change, Environment and Energy	Overall responsibility for data collection and compilation of the BTR	Oversee the process
Energy Department, Ministry of Environment	Tasked with formulating and implementing renewable energy policies and projects in the Maldives. Responsible for providing data on electricity generation and financial information related to renewable energy projects.	Information and guidance on energy production within the country as well as ongoing project information related to energy sector
Maldives Utility Regulatory Authority (URA)	Regulates utility services across the country, including electricity, water, waste management, and sewerage. The URA ensures efficient and safe delivery of these services in line with national standards, while protecting consumer rights and promoting transparency. Also manages critical datasets, such as power generation, fuel consumption, billing, appliance imports, and records of approved net metering and renewable energy projects supporting the development of utility infrastructure and renewable energy initiatives	Electricity generation data, fuel consumption, and waste generation data. Also provide renewable energy installation registered at URA.
Maldives Bureau of Statistics (MBS)	Accountable for the nation's core statistical activities, including the execution of population censuses and surveys, as well as the compilation and dissemination of essential economic and social statistical data.	Information on population census and population projection. Some activity data on energy and waste generation by the tourism industry

Stakeholders	General roles and responsibilities	Data provided for BTR
Ministry of Tourism	The designated policymaking institution responsible for the development of the tourism sector in the Maldives. Oversees the strategic planning and implementation of policies to support sustainable growth within the sector. Includes monitoring sector-specific data, such as electricity consumption and waste management in resorts, as well as financial information on climate-related projects and adaptation needs within the tourism industry. Aimed at ensuring the sector's resilience to climate change while promoting environmental sustainability and economic development.	Provides data on tourist occupancy (bed-nights), fuel usage by the industry and waste generation
Ministry of Finance	Primary financial institution of the country; responsible for overseeing national budgeting and the management of domestic and external financial resources. Plays a key role in the allocation of financial resources and ensures the effective execution of the national budgeting process. Also manages financial data related to climate-relevant development projects and provides critical information on development planning and budgeting processes, supporting sustainable economic growth and climate resilience.	Information on financial assistance provided and received by both domestic and international sources.
Maldives Monetary Authority (MMA)	Central bank of Maldives; responsible for regulating the financial economy of the country.	Provides data on GDP and inputs on macro-economic projections
Waste Management Corporation (WAMCO)	State-owned company mandated to deliver sustainable waste management solutions across the country. Specifically responsible for overseeing waste management operations within the Greater Male' Region. Collects and manages grassroots-level data on waste quantity and composition, which is critical for effective waste management planning and implementation across the region	Information and data on waste generation in Male' and within the atolls

Stakeholders	General roles and responsibilities	Data provided for BTR
Ministry of Transport and Civil Aviation	The principal policymaking body for the transport sector; tasked with developing and regulating policies for both land and sea transport. Responsible for maintaining critical sector data, including comprehensive records on land and sea transport vessels, and providing sectoral overviews.	Information and data on vehicle and vessel registration
Ministry of Fisheries & Ocean Resources	Mandated to oversee the development and sustainable management of the Maldives' marine and ocean resources. Ensures the conservation, sustainable use, and strategic planning of oceanic and marine ecosystems to support long-term environmental health and economic viability in line with national and international standards	Information and data on number of fishing vessels and fishing trips.
State Electric Company (STELCO)	State owned enterprise; responsible for the generation and supply of electricity to customers across the Maldives. Oversees the production and distribution of electricity, ensuring reliable access to energy throughout the country. Also manages grassroots-level data related to electricity generation and distribution, critical for monitoring performance, optimising operations, and planning future energy needs.	Electricity production data and fuel usage data for all the islands under STELCO
FENAKA Cooperation	Government-owned utility company; provides island communities with essential services, including electricity, water, and sewerage. Responsible for ensuring the reliable delivery of these services to support sustainable island development. Also maintains data on electricity generation, vital for monitoring energy production, and planning future capacity to meet community needs.	Electricity production data and fuel usage data for all the islands under FENAKA

Stakeholders	General roles and responsibilities	Data provided for BTR
Maldives Transport and Contracting Company (MTCC)	State-owned enterprise; responsible for overseeing and operating public transportation services across the country. Manages the operations of both land and sea transport, ensures efficient and reliable public transport services. Also collects and maintains activity data on fuel consumption by vessels and vehicles, essential for optimising operations and supporting sustainability initiatives within the transport sector.	Fuel usage for power generation, vehicles and vessels
State Trading Organization (STO)	The primary importer of oil LPG; responsible for ensuring the steady supply of essential energy resources to meet national demand.	Fuel use for power generation, vehicles, vessels, import of fuel, export and fuel stock information
Maldives Ports Limited (MPL)	Operates the Male' Commercial Harbour and two regional ports	Fuel use for power generation, vehicles, vessels
Maldives Customs Services (MCS)	Independent entity; responsible for carrying out all necessary activities pertaining to the import and export of goods to and from Maldives, and maintaining all the relevant accounts	Fuel Import Data, fuel re-export data
Maldives Airports Company Limited (MACL)	International aviation fuel bunkering services	Fuel data regarding domestic and international aviation. Fuel use for power generation, vehicles, vessels. Fuel import and storage
Maldives Industrial Fisheries Company (MIFCO)	Operates energy intensive fish processing plants and freezing systems	Electricity generation data and fuel usage, vehicles and vessels
Domestic airlines including sea plane flights	National Airline of Maldives; domestic airplane services including sea plane operators providing domestic airplane services mainly for tourism.	Fuel usage information for domestic and international flights

The above table include major stakeholders in the inventory working group. In addition, there are other stakeholders, such as those from the private sector. The working group comprises focal points from each stakeholder who serve as the primary liaison collecting information and data required to estimate emissions.

Working group meetings are held to address the necessity and significance of establishing a national greenhouse gas inventory. These sessions focus on discussing methodologies and emission factors utilised for emissions estimation. Additionally, the meetings cover activity data, quality control measures implemented by stakeholders, and future plans for enhancing data and information services to support the inventory process. Stakeholders provide updates on their ongoing efforts to improve data accuracy and the overall effectiveness of information management in the context of the national inventory.

1.7.3.2 Archiving and Documentation

The datasets used for inventory preparation and mitigation assessment are archived in a central storage system managed by the MCCEE. Historical data from previous National Communications and Biennial Update Reports (BUR) have also been archived and are utilised for reanalysing the current inventory.

The IPCC inventory software is employed to compile and archive inventory data. This software is initially used to estimate emissions and generate Common Reporting Tables (CRT) which are then uploaded to the UNFCCC ETF tool for further processing. Additionally, cloud storage facilities are used to provide redundancy and ensure data security.

Raw and processed data from stakeholders are stored in Excel sheets, with analysis sheets documented with comments to indicate assumptions and approximations where applicable. The IPCC software's commenting feature is also utilised to input remarks in relevant fields, ensuring continuity and enabling future improvements to the inventory process.

Low Emissions Analysis Platform (LEAP), developed by the Stockholm Environment Institute is used for GHG scenario projections. The LEAP file which includes the baseline and mitigation scenarios, will be archived in the central storage system. In addition, the CTF tables reported will also be included in the archive along with the LEAP file.

1.7.3.3 Official Considerations and Endorsement of the Inventory

Once the inventory is compiled, it undergoes a thorough review within the MCCEE. Additionally, a third-party technical review is normally conducted to further improve the inventory and the accompanying report. Both the inventory and the report are revised as necessary before finalisation.

1.7.4 Use of Flexibility Provisions from the MPGs

In this BTR, the Maldives utilises the flexibility provisions provided under the Modalities, Procedures, and Guidelines (MPGs). Flexibility has been applied in specific areas, as outlined in Table 4. Further details on the use of these provisions, along with plans to address them in future reports, are explained in a dedicated section to ensure clarity and transparency.

Table 4: Flexibility provisions used

Part of reporting	Flexibility provisions	Para of MPGs	Flexibility used
GHG Inventory			
Key category analysis	Option to identify fewer key categories; use of less complex methodologies to estimate GHG emissions and removals for non-key categories	25	N
Uncertainty assessment	Option to omit reporting of quantitatively uncertain information if data is not available	29	Y
Completeness	Option to omit estimation of more insignificant categories	32	N
QA/QC	Option to neither develop a formal QA/QC plan nor provide information on general QC procedures implemented	34, 35	N
Gases	Option to report fewer GHGs	48	Y
Time series	Option to report a shorter time series and an earlier "latest reporting year"	57, 58	Y/N
Mitigation policies and measures, actions and plans			
Estimates of expected and achieved GHG emissions reductions	Option to omit reporting these estimates	85	Y
Projections			
Projections of GHG emissions and removals	Option to omit reporting projections, or report less details	92, 95 & 102	N

02

NATIONAL INVENTORY REPORT OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES

CHAPTER 2: NATIONAL INVENTORY REPORT OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES

Monitoring national emissions is a critical component of the country's planning and emissions reduction strategies. Although the Maldives contribution to global emissions is negligible (ME, 2020a) the nation's emissions are on an upward trajectory due to expanding national development efforts.

As per the decision 18/CMA.1 under the UNFCCC, all country parties should submit their first Biennial Transparency Report (BTR) by 31 December 2024 and every two years thereafter. The BTR should provide an update of the GHG inventories, mitigation efforts, support provided and received, gaps and constraints and information on the climate change vulnerability and adaptation. According to decision 18/CMA.1, the latest reporting year for the BTR shall be no more than two years prior to the submission of its NIR. If a Party wishes to use flexibility in reporting, the MPGs allow the Party to use flexibility. Therefore, this BTR will cover the GHG inventory upto 2022 with flexibility provisions due to various capacity constraints as explained in the respective sections.

This chapter serves as the NIR of anthropogenic emissions by sources and their removals by sinks of greenhouse gases, in line with the MPGs as specified in the decision 18/CMA.1.

2.1 Overview of Past National GHG Inventories

The Maldives initiated its first emissions estimate in 1994 as part of its initial national communication to the UNFCCC. Due to data limitations, this estimate used the reference approach rather than the sectoral approach. A second inventory was produced for the 2011 under the Second National Communication, marking the first time emissions were estimated using both the sectoral and reference approaches. Both inventories adhered to the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines.

The national emissions inventory for 2015 was developed as part of the Maldives' First Biennial Update Report (BUR)(ME, 2019a) employing both the reference and sectoral approaches in accordance with the 2006 IPCC guidelines. Additionally, the BUR included emission estimates for the period 2001-2010 using the reference approach, enabling the establishment of a national emissions trend. A summary of the key inventory years is outlined below:

Table 5: Total emissions

	1994	2011	2015
Emissions (kt CO_2eq)	152.98 (reference approach)	1,152.87	1,536.04

2.2 Overview of GHG Inventory Process

This Biennial Transparency Report (BTR) builds on previous inventories submitted by the Maldives. In this submission, the Maldives presents GHG inventories for the 2001-2022 period. The most recent inventory, covering years 2001-2015, was included in the Maldives' first Biennial Update Report (BUR). The BUR (ME, 2019a) noted that due to data unavailability for the years 2001 to 2010, emissions were estimated using the reference approach. For the remaining years, both the reference and sectoral approaches were employed. The following table provides a summary of the years covered and the methodologies applied in this BTR.

Table 6: Summary of years and approaches used

Approach	2001 – 2010	2011 – 2022
Reference approach	✓	✓
Sectoral approach		✓

2.2.1 Definitions & Scope

The definitions and scope for establishing the inventory are aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The scope of the Maldives' inventory is outlined as follows:

1. Gases covered
2. Sectors covered
3. Geographic scope
4. Temporal coverage

The gases covered in this inventory are:

1. CO_2 (carbon dioxide)
2. CH_4 (methane)
3. N_2O (nitrous oxide)

As per the MPGs, Parties are required to report on seven gases CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). However, Maldives uses the flexibility provided in the MPGs to report only on the 3 gases listed above.

The sectors covered in the inventory are the energy and waste sectors. The table below outlines the sectors, categories, sub-categories, and the gases covered.

Table 7: Sectors and gases covered

Sector, category & sub-category	Gases		
	CO_2	CH_4	N_2O
1. Energy	✓	✓	✓
1.A. Fuel combustion	✓	✓	✓
1.A.1. Energy industries	✓	✓	✓
1.A.2. Manufacturing industries and construction	✓	✓	✓
1.A.3. Transport	✓	✓	✓
1.A.4. Other sectors	✓	✓	✓
5. Waste	✓	✓	✓
5.C. Incineration and open burning of waste	✓	✓	✓
5.D. Wastewater treatment and discharge		✓	✓

The geographic scope of the inventory includes the entire national territory. Temporal coverage for this inventory is shown in Table 6.

2.2.2 Sectors Not Estimated or Not Occurring in the Inventory

Maldives having a small economy and limited land space with small islands, the following sectors are not covered in the Maldives greenhouse gas inventory.

2.2.2.1 Industrial Processes & Product Use

The Industrial Processes and Product Use (IPPU) sector includes greenhouse gas (GHG) emissions resulting from industrial processes, the use of GHGs in products, and the non-energy use of fossil fuel carbon. Emissions in the IPPU sector can arise from various industrial activities and the use of different product applications, both within industry and by consumers.

In the Maldives, the IPPU sector is relatively small bordering on non-existent compared to other sectors, primarily due to the country's limited industrial base. However, certain activities, such as construction material production, refrigeration, and air conditioning, do contribute to emissions in this sector. There is currently no activity data collected to estimate emissions from use of refrigeration and air-conditioning. In the IPPU sector in the CRT, under "2.F. Product Uses as Substitute for ODS", the activity data is represented with the notation key NE, FX for HFC gases, indicating that while emissions occur they are not estimated. The government is planning to implement further efforts and plans to estimate emissions in this category in the future.

2.2.2.2 Agriculture

Agriculture is not a major industry in Maldives due to the limited availability of arable land, poor soil quality, and saline groundwater. The main agricultural activities consist of small-scale cultivation of fruits, vegetables, and coconut palms. There is no livestock or animal farming.

Although fertilisers are used, emissions from agriculture are not significant enough to be covered in the inventory. Given these are envisaged to be minor emissions, less priority is given to collect activity data to estimate emissions. Therefore, it is denoted by the notation key NE.

2.2.2.3 Land Use, Land-use Change & Forestry

Some islands have undergone land-use changes due to the demand for urban development and land reclamation. These changes have the potential to generate emissions from soil and vegetation changes. However, due to the small size of the islands, the associated emissions are minimal and negligible compared to other sectors, and are considered insignificant. As per the IPCC guidelines, there are areas which will fall into category of forests. However, due to technical and human capacity limitations, the changes in the land use and forest activity are not monitored and recorded. In addition, the emission associated with land use changes and forestry is envisioned to be small compared to other sectors. Therefore, less priority is given to collect this data and these sectors are reported as NE in the CRT.

2.2.3 Methodologies

Emissions were not directly measured by individual sectors; instead, they were derived using activity data collected from the respective sectors following a sectoral approach. This data was compiled to create a national GHG inventory, with emissions calculated using methods outlined in the 2006 IPCC Guidelines for National GHG Inventories. The Tier 1 methodology from the IPCC guidelines was applied to all sectors, with a combination of Tier 1 and Tier 2 methods used in the transport sector for more detailed estimates. Throughout the inventory process, measures consistent with the IPCC principles of Transparency, Accuracy, Consistency, Comparability, and Completeness (TACCC) were implemented to ensure adherence to international best practices.

Country-specific emission factors (EF) were not available for this inventory, so default IPCC emission factors were applied. Precursor and indirect emissions, such as CO, NMVOC, NOx, and SOx, were not estimated due to the lack of applicable methods within the Tier 1 approach. Table 8 summarises the methods and emission factors used for the 2022 estimations.

Energy consumption emissions were estimated using the reference approach, which relies on data related to imports, exports, and stock changes. To ensure accuracy, emissions estimated via the reference approach were validated by comparison to those derived from the sectoral approach.

Before estimating emissions, the data underwent comprehensive analysis and quality control procedures. In sectors where data gaps or inconsistencies were detected, statistical techniques such as filtering, smoothing, interpolation, and extrapolation were applied to address these issues. The final emission estimates were compiled and archived using IPCC GHG Inventory Software version 2.93, ensuring accurate and reliable results. Additionally, the UNFCCC's ETF tool was used to generate the final CRT.

A description of the sectors along with the QA/QC procedures are explained in Section 2.2.8 QA/QC.

Table 8: Method and emission factors used

Sector, Category, Sub-category	CO_2		CH_4		N_2O	
	Method	EF	Method	EF	Method	EF
1. Energy	D,T1,T2	D	D,T1,T2	D	D,T1,T2	D
1.A. Fuel combustion	D,T1	D	D,T1	D	D,T1	D
1.A.1. Energy industries	D,T1	D	D,T1	D	D,T1	D
1.A.1.a. Public electricity and heat production	T1	D	T1	D	T1	D
1.A.2. Manufacturing industries and construction	D,T1	D	D,T1	D	D,T1	D
1.A.2.g. Other	T1	D	T1	D	T1	D
1.A.2.g.iii. Mining (excluding fuels) and quarrying	T1	D	T1	D	T1	D
1.A.3. Transport	D,T1,T2	D	D,T1,T2	D	D,T1,T2	D
1.A.3.a. Domestic aviation	T1	D	T1	D	T1	D
1.A.3.b. Road transportation	T1,T2	D	T1,T2	D	T1,T2	D
1.A.3.b.i. Cars	T1,T2	D	T1,T2	D	T1,T2	D
1.A.3.b.ii. Light duty trucks	T1,T2	D	T1,T2	D	T1,T2	D
1.A.3.b.iii. Heavy duty trucks and buses	T1,T2	D	T1,T2	D	T1,T2	D
1.A.3.b.iv. Motorcycles	T1,T2	D	T1,T2	D	T1,T2	D
1.A.3.d. Domestic Navigation	T1,T2	D	T1,T2	D	T1,T2	D
1.A.4. Other sectors	T1	D	T1	D	T1	D
1.A.4.a. Commercial/institutional	T1	D	T1	D	T1	D
1.A.4.a.i. Stationary combustion	T1	D	T1	D	T1	D
1.A.4.a.ii. Off-road vehicles and other machinery	T1	D	T1	D	T1	D
1.A.4.b. Residential	T1	D	T1	D	T1	D
1.A.4.b.i. Stationary combustion	T1	D	T1	D	T1	D
1.A.4.c. Agriculture/forestry/fishing	T1	D	T1	D	T1	D
1.A.4.c.i. Stationary	T1	D	T1	D	T1	D
1.A.4.c.iii. Fishing	T1	D	T1	D	T1	D
5. Waste	T1	D	T1	D	T1	D
5.C. Incineration and open burning of waste	T1	D	T1	D	T1	D
5.C.2. Open burning of waste	T1	D	T1	D	T1	D
5.D. Waste water treatment and discharge			T1	D	-	-
5.D.1. Domestic wastewater			T1	D	-	-

2.2.3.1 Tier 1 methodology

The emission formula outlined in the IPCC 2006 guidelines was applied to estimate emissions using the Tier 1 methodology. Fuel usage activity data was obtained from relevant stakeholders. The equation used for the emission estimation is as follows:

Fuel consumption = fuel consumption in energy units (TJ) calculated as a product of Net Calorific Value (NCV) and fuel mass. The NCV values provided in the IPCC guidelines are used.

The following Table 9 provides the NCV values used for the respective fuels.

Table 9: Net Calorific Values and Emission Factors

		Emission factor (EF) kg/TJ		
Fuel	**NCV**	**CO_2**	**CH_4**	**N_2O**
Gas/Diesel Oil (Stationary combustion)	43	74100	3	0.6
Gas/Diesel Oil (Off-road)	43	74100	7	2
Gas/Diesel Oil (Mobile combustion)	43	74100	3.9	3.9
Gas/Diesel Oil (Water-borne navigation)	43	74100	7	2
Motor Gasoline/Petrol (Water-borne navigation)	44.3	69300	7	2
Motor Gasoline/Petrol	44.3	69300	33	3.2
LPG	47.3	63100	5	0.1
Jet A1	44.1	71500	0.5	2

2.2.3.2 Tier 2 methodology (transport)

Since the inventory was established in 2011, fuel usage data for the transport sector has not been available. To address this, the **Vehicle Kilometre Travelled (VKT)** method has been used to estimate fuel consumption for both land and marine transport. Once fuel usage is estimated through the VKT method, it is then multiplied by the default emission factors for fuel and gas, as outlined in the IPCC guidelines, to calculate emissions using the above equation.

It is important to note that off-road transport emissions have been calculated using the fuel-based Tier 1 approach, as fuel usage data for off-road vehicles has been available since 2016. Below is a description of the VKT method used to estimate fuel consumption in the transport sector.

The number of registered vehicles was sourced from the Ministry of Transport and the National Bureau of Statistics. The vehicles and vessels most frequently registered over the years assumed to be the most actively used, and this information was used to determine the types of vehicles and vessels included in the VKT method. Specifically, vehicles and vessels above the 60th percentile of the total number were considered active and included in the calculations.

Active and non-active vehicles and vessels, along with their respective fuel types, were identified using data from the Ministry of Transport. To refine fuel usage estimates, the number of non-active vehicles and vessels was subtracted from the yearly accumulated totals. The types of vehicles considered in the VKT method are detailed in Table 10. Additionally, a separate category, "Taxi," was included, representing 8% of the total cars. Taxis were accounted for separately due to their potential for higher total kilometres travelled compared to regular cars.

Table 10: Types of vehicles used in the estimation

Major vehicles	Other vehicles	Not considered in 60th percentile
Motor cycle	Ambulance	Battery Scooter
Car	Crane	Battery Car
Bus	Fork-Lift	Battery tricycle
Pick-Up	Excavator	Electric bicycle
Lorry	Dumper	
Van	Tractor	
Jeep	Loader	
Truck	Fuel tank truck	
Taxi* (as explained above)	Bouser	

The total kilometres per day parameter was based on data from a survey conducted for the report titled “Revision of Vehicle Emissions Standards,” published by the Ministry of Environment, Climate Change, and Technology (MECCT) in 2020. The parameters from this survey were used in the VKT method to estimate the total kilometres travelled by various vehicle types. The fuel type fractions were determined using data from the vehicle registration database. These parameters are detailed in Table 11, which provides the reference values for estimating fuel consumption across different transport modes.

Table 11: Proxies used to estimate the total kilometre travelled for vehicles

Vehicle	Fuel	Fraction for type of gas	Km/day	Km/year	Km/Litre	Litre/km
Motor cycle	Petrol	1	13	4745	15	0.0667
Car ★	Petrol	1	22	8030	12	0.11
Taxis ★	Petrol	1	100	36500		0.11
Bus ❖	Petrol	0.023	40	14600	5	0.164
	Diesel	0.977	40	14600	8	0.42
Pick-up Δ	Petrol	0.3208	20	7300	7	0.143
	Diesel	0.678	20	7300	10	0.125
Lorry ❖	Petrol	0.021	40	14600	5	0.22
	Diesel	0.979	40	14600	8	0.3
Van Δ	Petrol	0.4819	40	14600	5	0.142
	Diesel	0.5178	40	14600	8	0.125
Jeep Δ	Petrol	0.7337	20	7300	7	0.142
	Diesel	0.2663	20	7300	10	0.125
Truck ❖	Petrol	0.0383	40	14600	5	0.22
	Diesel	0.9616	40	14600	8	0.3
Other vehicles ❖	Diesel	1	5	1825	8	0.3

★ = Passenger cars with 3-way catalyst

Δ = Light duty trucks with 3-way catalyst

❖ = Heavy duty trucks and buses

The following formula is used to calculate the total fuel use using VKT method.

Total fuel use (L)= N.V*R.T.F*K.D*365*L.K

where,

N.V = Number of vehicles (by type of vehicle)

R.T.F = Ratio by type of fuel of the vehicle (ratio of vehicles using petrol or diesel by the same category of vehicles. e.g., pick-up using petrol and diesel)

K.D = Kilometres per day (proxy from Table 11)

L.K = Litres per kilometre

Marine transport

Use of vessel run hours is similar to the Vehicle Kilometres Travelled (VKT) method. This approach uses the proxy, fuel consumption litres per hour established via a survey (BUR 2015). Table 12 provides the type of vessels and parameters used to estimate the total fuel consumption by vessels.

Table 12: Parameters used for fuel estimation by marine vessels

	Vessel type	Fuel type	Fraction of active vessels	Fraction of operating vessels per year	Fuel consumption (l/hr)	Annual Hours of operation
Passenger	Dhoni$^{\Delta}$	**Diesel**	0.95	0.50	39.00	625.00
	Passenger ferry	**Diesel**	1.00	1.00	39.00	3650.00
	Speed boats	**Petrol**	0.19	0.70	65.00	1200.00
Cargo	Dhoni*	**Diesel**	0.95	0.60	39.00	871.20
	Bahtheli	**Diesel**	0.92	0.50	27.00	871.20
	Barge	**Diesel**	0.93	0.50	57.00	580.80
	Oil barge	**Diesel**	1.00	0.50	32.00	580.80
	Oil tankers	**Diesel**	0.60	0.50	32.00	580.80
	Landing craft	**Diesel**	0.91	0.50	32.00	580.80

Δ %20 of Dhoni should be applied as passenger dhoni

* 3% of Dhoni should be applied as cargo dhoni

To calculate the total fuel use, the following formula is used:

Total fuel use (L)= N.V*A.F*O.F*L.H*T

where,

N.V = Number of vessels (by type of vessel). For the dhoni, above fractions with special marks should be applied

A.F = Active fraction of vessels among the total registered vessels

O.F = Fraction of operating vessels

T = Total annual hours of operation

Off-road transportation includes dredgers and the vehicles associated with them, alongside vessels and vehicles used in port and airport operations. These modes of transport fall under the off-road category. A Tier 1 fuel-based methodology is employed for these operations, as fuel consumption data was directly provided by the respective sectors. This approach enables more accurate emissions estimation for off-road activities based on actual fuel usage.

2.2.4 Key Category Analysis

Key category analysis was conducted to identify categories requiring focused data collection for emissions estimates. Both a level approach and a trend assessment were carried out for the year 2022 to determine the key categories in the inventory. According to the MPGs, the key category analysis must be performed both with and without Land Use, Land-Use Change, and Forestry (LULUCF). However, since the Maldives does not experience significant land or associated land-use changes, emissions from this sector were not estimated. As a result, the key category analysis was conducted and reported without LULUCF.

Table 13 presents the findings of the key category analysis, using the level assessment for the base year 2011 and both level and trend assessments for the year 2022.

The results indicated that both the level and trend methods identified the same categories and gases, with the exception of "Other Transportation Liquid Fuels for CO_2", which was identified as a key category only in the trend analysis. Consequently, additional focus was placed on data collection procedures for these specific categories to enhance the accuracy and reliability of the inventory. Detailed results of the key category analysis for other years are available in the Annex of this report.

Table 13: 2022 Key Category Analysis

IPCC code	Category	Greenhouse gas	2011 Level	2022 Level	2022 Trend
1.A.4	Other Sectors - Liquid Fuels	CO_2	X	X	X
1.A.1	Energy Industries - Liquid Fuels	CO_2	X	X	X
1.A.3.d	Water-borne Navigation - Liquid Fuels	CO_2	X	X	X
1.A.3.b	Road Transportation - Liquid Fuels	CO_2	X	X	X
1.A.3.a	Civil Aviation - Liquid Fuels	CO_2	X	X	X
1.A.3.e	Other Transportation - Liquid Fuels	CO_2	-	-	X
4.C	Incineration and Open Burning of Waste	CH_4	X	X	X

2.2.5 Time Series Consistency

As noted earlier, the Maldives' first emissions estimates were made for 1994 in the First National Communication, utilising the reference approach due to the lack of data for a sectoral approach. Sectoral approaches became available from 2011. However, in the first BUR of the Maldives (ME, 2019a), a time series of emissions was calculated using the reference approach from 2001 onwards. This has resulted in a consistent time series for emissions from 2001, based on the reference approach, and a consistent time series from 2011 onwards using both reference and sectoral approaches. The results of this time series are presented in the chapter detailing the 2022 inventory.

2.2.6 Uncertainty

The uncertainty assessment requires detailed information on the data collection process, data quality control measures, and the assumptions used by sectors in processing and analysing data. However, such detailed information is not currently collected by the sectors for activity data. During stakeholder meetings, it was noted that stakeholders do not prioritise collecting information related to activity data uncertainty in their operations. They were informed of the importance of obtaining activity-level data uncertainty to enhance the data collection process and improve overall data quality.

In the absence of this specific data and the use of the Tier 1 methodology for emissions estimation, the default uncertainty values for emission factors provided by the IPCC were applied in the calculations. Based on these default values, the uncertainty in the total inventory for 2022 is 3.01%, while the trend uncertainty stands at 2.96%.

2.2.7 Metrics

In accordance with the MPGs, estimated emissions are presented in CO_2 equivalent using the Global Warming Potential (GWP) values from the IPCC 5th Assessment Report, based on effect of greenhouse gases on a 100-year horizon (GWP_{100}). The GWP_{100} values used are provided in Table 14.

Table 14: GWP_{100} used in conversion

	Methane	Nitrous oxide
Formula	CH_4	N_2O
GWP	28	265

2.2.8 Quality Assurance (QA) and Quality Control (QC)

Significant emphasis was placed on quality assurance and quality control (QA/QC) in both the data collection and analysis processes. Some sectors have their own established procedures for data collection, particularly in electricity production, which is widely monitored and archived for operational and maintenance purposes, especially by public utility companies. In well-established industries like aviation, robust systems are in place for archiving fuel usage information.

Fuel use data was cross-referenced with proxy data, such as electricity generation and vehicle counts, and compared with alternative sources where available (for example, aviation data from airports was compared to import and usage data from airlines). Additionally, comparisons across different years was conducted to identify any inconsistencies and minimise errors in data collection and archiving. When significant issues with the data were found, discussions were held with the respective data providers, and the information was re-verified for accuracy.

Moreover, previous literature and expert opinions were used to ensure the quality of the data. The following sections detail the QA/QC processes employed across the different sectors. In addition, when international support such as the UNEP Global Support Program (UNEP GSP) is available, the inventory reports undergo independent reviews.

2.2.8.1 Electricity Production

Electricity production data from the public power producers, STELCO and FENAKA, were provided in various formats, with each stakeholders following their own internal procedures to ensure data quality control. The data was collected monthly, which offered more information and data to review for consistency, enabling the identification and correction of errors, enhancing the accuracy and reliability of the provided information. The monthly data allowed to check for consistency of the data provided and correct any errors in data.

For power stations that provided both fuel volume and units produced (kWh), the number of units produced per litre (kWh/l) was used as a key indicator of data quality. Additionally, the overall growth trend in fuel usage was analysed to assess consistency and to identify potential outliers. Any issues detected were discussed with the data providers for rectification. In cases where data were incomplete or gaps were identified, proxy data, such as billed amounts and per capita indices were used, along with interpolation, to fill in missing information. A statistical analysis of long-term data sets was conducted to examine the lower (2 kWh/l) and upper (4.5 kWh/l) bounds of the kWh/L indicator, ensuring the robustness of the data quality. Further details of the methods applied in this analysis are provided in the annex of this report.

Limited electricity production data was available in the Tourism sector. To manage this, established thresholds were applied to filter and perform quality control on the datasets. The quality-controlled data was then used to estimate fuel usage per bed night, based on bed night statistics from the resorts for electricity generation. The parameter used - litres/bed-night for electricity generation - was obtained through a resort survey sample conducted for the Maldives First BUR. This estimate was extrapolated to the total number of annual resort bed nights to calculate fuel usage for the entire resort sector, based on the assumption that fuel consumption per bed night is consistent across the sector. Similarly, for the fuel use by safaris operations, the parameter litres/bed-night was obtained from the energy balance 2010-2012 (MEA, 2014) . Using this parameter will introduce potential uncertainty in the inventory. It is recommended that this issue be addressed systematically in future inventories to improve accuracy.

2.2.8.2 Transport Sector

Vehicle registration data collated by the MBS was used as a proxy for activity data. Due to limited information on the number of retired or decommissioned vehicles and vessels, it was assumed that all registered vehicles listed in the statistics were still in use which introduces some uncertainty in the data. However inactive vehicles and vessels were removed wherever

possible based on the available data. The vehicle registration data from the MBS was compared with data from the Transport Authority's database, which contained information on registered vehicles and vessels.

A Vehicle Kilometres Travelled (VKT) method was adopted for GHG estimation in land and marine transportation. The method relies on km/day and km/litre estimates, used alongside the number of vehicles and vessels to calculate emission. km/day and km/litre indices were initially developed for energy balances from 2002 and had since been used for all energy balance and GHG estimation till date. For this estimation these values were revisited.

The vehicle and vessel registration database provided key information such as type, model/ make, engine type, size and fuel types of the vehicles/vessels, enabling assessments on the state of the vehicle and vessel fleet including the distribution of different makes, models and age of vehicles. Once vehicle model and makes were identified, they were crossed referenced with mileage data of comparative vehicle models from US Department of Energy's fuel efficiency database (https://www.fueleconomy.gov). Based on the composition of Maldivian vehicle fleet, mileage (km/litre) values were adjusted. Details of this is included in Transport sector baseline assessment in Mitigation Chapter of this report. Similar comparisons were done for available information on marine vessels. However, the findings did not merit a modification of the mileage information for it.

Fuel usage information for resort transportation was collected in 2015 from a survey of sample resorts, along with occupancy data from those resorts during the survey period. Fuel usage per bed-night calculated from this survey was then multiplied with total resort bed nights to estimate emissions from resort transportation. The data was cross-referenced with previous estimates used in the 2010-2012 energy balance, and information from the 2009 carbon audit(Bernard et al., 2010).

Aviation fuel consumption data was provided by MACL which maintains records of aviation fuel use for both domestic and international aviation. This data was used as the activity data source. For verification and reference, comparative, fuel import data was obtained by STO. The consistency of data was from year to year from both STO and MACL data.

2.2.8.3 Other Sectors (Fuel Combustion)

Other sectors considered for fuel combustion activities are as follows:

Other sectors	Diesel	LPG
Domestic & Commercial use	✓	✓
Fishing vessels	✓	✓
Fish processing facilities	✓	

The number of fishing trips by fishing vessels are collated by the MBS. Emission estimates for fishing (mobile) was calculated by multiplying the fuel usage per trip - used in the previous energy balances - by the number of trips reported by the MBS.

Import data of LPG obtained by the Maldives Customs Service was used in the reference approach. Activity data was provided by the two suppliers Maldive Gas and Villa Gas. They provided information segregated to domestic and commercial use. Use of LPG and kerosene in fishing vessels (for purposes other than transport) were estimated based on the 2010-2012 energy balance. Stock change information was not used, as suppliers indicated that no storage is kept. As part of the QA/QC procedure, total import statistics was compared with the total sales reported by the two suppliers where they showed reasonable accuracy (within 5 %).

2.2.8.4 Waste Sector

For waste sector emissions, it was assumed that all combustible waste is disposed of through open burning as it is estimated that 90% of waste generated is combustible materials, including both organic and inorganic waste. The lack of large landfills and large-scale incineration facilities in the Maldives, further reinforces the assumption that open burning is the predominant waste disposal method. Limited data availability made it difficult to accurately quantify waste produced by industrial activities. The spatial variation in waste volume and composition across the country is influenced by the varying levels of tourism and industrial activity in different regions. This variability in waste production presents challenges in estimating emissions, particularly in the absence of detailed data on waste generation and disposal practices areas with high industrial and tourism activity.

Previous studies have attempted to assess waste production per capita for both Greater Male' and atoll populations.

The estimates for waste generation in greater Male' and the atolls differ due to variations in the nature of waste. The estimate used for Male' is 2.8 kg/cap/day while for the other atolls, it is 1 kg/cap/day. This estimate was based on a Waste sector diagnostic study funded by ICAT, which collated all waste related information collected from different projects to provide an overview of waste generation and management practices across the country. These estimates were used

with the population data for the Male' and Atolls, and the resort bed night data from the tourism sector to determine waste sector emissions. For quality assurance and consistency, available audits were compared, and expert judgment were sought to finalise the estimate.

2.2.9 Data Collection

The initial data collection process was guided by the 2015 inventory key categories, as reported in the first BUR1. After the initial emission estimations were completed, a key category analysis was conducted for the years 2016-2022 to confirm and refine data collection requirements. Data was primarily sourced from key providers, including the Maldives Customs Service, utility companies (MWSC, STELCO, and FENAKA), airports, resorts, and fuel wholesalers and retailers. Where primary data was unavailable, proxy data such as GDP, population statistics, tourist bed nights, and other relevant metrics from sectoral agencies and the National Bureau of Statistics were utilised. This was further complemented by additional data provided by the sectors, as well as existing literature specific to various sectors.

2.2.9.1 Sources of Activity Data

The date sources used are similar to the data sources in the previous inventory, as the key categories are similar. They are detailed in Table 15.

Table 15: Summary of data sources

Sectors	Data sources
Electricity production	- Power production data from STELCO and FENAKA; Power production data from MACL - Power production data from regional airports - Power production data from MWSC - Power production from resorts (limited data) - Tourist bed-nights from tourism statistics year books - Population data from National Bureau of Statistics - Energy Balance Reports 2010 - 2012
Aviation data	- Fuel statistics from MACL - Fuel imported by State Trading Organization - Fuel import and re-export data, Maldives Customs Service
Transport (land and marine)	- Vehicle and vessels numbers from National Bureau of Statistics - Vehicle and vessel registration from Ministry of Transport and Civil Aviation - Resort transport from resorts (limited data) - Tourist bed-nights from tourism statistics year books
Other energy usage	- Fuel usage data from fish processing factories and cold storages - LPG usage from Maldive Gas and Villa Gas - LPG imports from Maldives Customs Service - Energy balance reports 2010-2012

Sectors	Data sources
Waste	- North Province Regional Waste Management Project: Technical and Financial Feasibility Report (2011) - Male' waste audit 2008 - ICAT waste sector diagnostic assessment - Population data from National Bureau of Statistics - Assessment of solid waste management practices and its vulnerability to climate risks in Maldives Tourism Sector, 2013

2.2.9.2 Assumptions and Uncertainty

Throughout the inventory process, various assumptions were made within different sectors, contributing to the overall uncertainty of the estimates. While the exact magnitude of this uncertainty was not quantitatively assessed, default uncertainty values were applied in line with established guidelines. The key assumptions made during the estimation process are outlined below.

Sector	Assumptions
Energy industries (Emissions from electricity generation, desalination and LPG for cooking)	Emission factors (EF) at individual island powerhouses can vary significantly due to differences in energy generation efficiency and transmission losses. As a result, specific emission factors for each island were not available. Consequently, the Tier 1 emission factors from the IPCC guidelines were applied to ensure consistency in the emission estimations. Information on fugitive emissions has not been assessed or recorded by the relevant sectors and is deemed insignificant. Therefore, they were not included in the estimations.
Transport (Emissions from land, sea and domestic air transport)	The usage of road vehicles was based on a small sample population, which was then extrapolated to represent the larger population. This assumption has been utilised since the 2011 inventory estimations. The estimation of marine transport emissions in the tourism sector was based on data from a small sample population, which was extrapolated to represent the entire sector.
Waste sector	It was assumed that all waste was opened burned. Per capita waste generation figures used from the ICAT diagnostic study based also based on a small population size.

2.3 National Greenhouse Gas Inventory of 2022

A more detailed look into the inventory of 2022 is presented in this NIR. The definition of sectors, categories and sub-categories are aligned with those in the IPCC guidelines. The relationship between the activity data from the sectors and IPCC categorisations can be found in Annex 7.1.

2.3.1 Total Emissions

Total emissions for the year 2022 amount to 2359.71 kt of CO_2 equivalent. Table 16 provides a detailed breakdown of emissions by sources and sinks. Consistent with previous greenhouse gas (GHG) inventories, the main sectors contributing to emissions in the Maldives are the energy and waste sectors. The energy sector accounts for 96.33% of the total emissions, while the waste sector contributes 3.67%, as illustrated in Figure 20. Emissions from international bunkering are presented but are excluded from the national totals. Complete emissions data for the years 2011 to 2022 can be found in the CRTs.

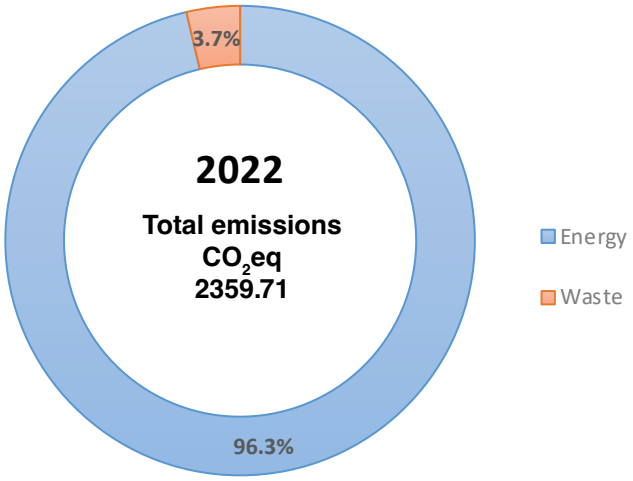


Figure 20: Total emission, 2022.

Figure 21 presents a detailed breakdown of emissions by sub-categories. The Other Sectors account for the largest share by 33.4% (see 7.1 for details of Other sectors). The second largest contributor are the energy industries which account for 32.6% of the total emissions. Transportation is the third contributor at 29.8% while accounts for 3.7%. Manufacturing industries contribute to 0.6%. Details of the sub-categories are explained below.

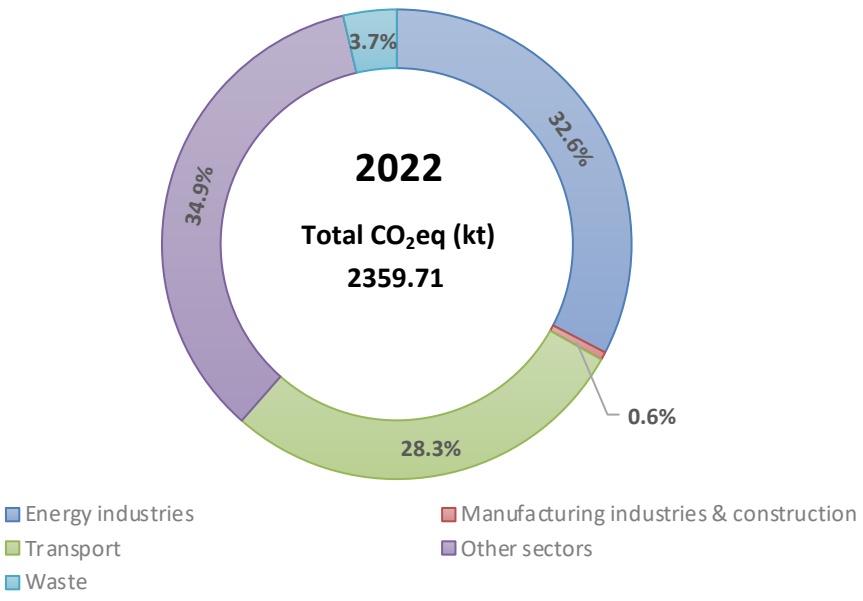


Figure 21: Emissions by IPCC sub-categories

Table 16: Maldives emissions for 2022 (emissions by sources)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	Total GHG emissions/removals
	(kt)			CO_2 eq (kt)
Total national emissions and removals	2,269.03	2.48	0.08	2,359.71
1. Energy	2,255.98	0.17	0.05	2,273.07
1.A. Fuel combustion	2,255.98	0.17	0.05	2,273.07
1.A.1. Energy industries	767.28	0.03	0.01	769.80
1.A.2. Manufacturing industries and construction	12.88	0.00	0.00	13.01
1.A.3. Transport	659.36	0.10	0.02	667.89
1.A.4. Other sectors	816.47	0.04	0.02	822.38
5. Waste	13.04	2.31	0.03	86.64
5.C. Incineration and open burning of waste	13.04	1.88	0.03	74.62
5.D. Wastewater treatment and discharge		0.43		12.02
Memo items:				
1.D.1. International bunkers	481.46	0.01	0.01	485.27
1.D.1.a. Aviation	411.33	0.00	0.01	414.45
1.D.1.b. Navigation	70.13	0.01	0.00	70.82

Among the three greenhouse gases estimated, CO_2 is the most emitted, accounting for 96.2% of the total emissions. CH_4 contributes 2.9%, and N_2O accounts for 0.9% of the total emissions,

as illustrated in Figure 22. This distribution highlights CO_2 as the dominant greenhouse gas in the emissions profile.

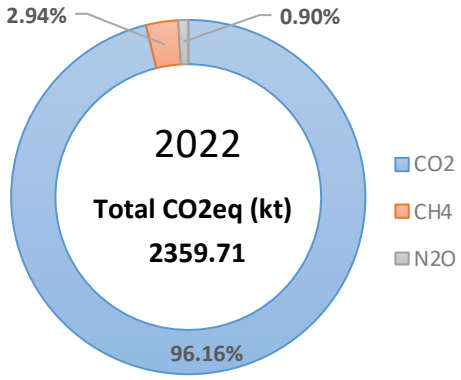


Figure 22: Emissions by gases, 2022

2.3.2 Energy Industries

As per the IPCC guidelines, energy industries include emissions from public electricity and heat generation, as well as emissions from the manufacturing of solid fuels. Unlike many other countries, the Maldives does not have large manufacturing industries or solid fuel production facilities that require significant fuel combustion. Thus, only emissions due to public electricity production is covered under this category.

2.3.2.1 Public Electricity Generation

The primary source of energy generation in the Maldives is from diesel-based fossil fuel generators used for electricity production. Every island, including resorts, operates its own power facility. As the population grows and economic sectors expand, the demand for electricity continues to rise.

Two state-owned companies, STELCO and FENAKA provides public electricity while FENAKA also provides water and sanitation services to some islands. 32.6% of the national emissions come from public electricity generation.

2.3.3 Transport Sector

The transport sector contributes 29.8% of the national total emissions, accounting for 667.89 kt of CO_2eq. Figure 23 breaks down emissions within the transport sector, of which domestic navigation accounts for 50.9%. They include public and cargo marine transport, resort transportation (passengers and recreation) and liveaboard boats. Domestic aviation contributes to 23.1% encompassing both public aviation services and private (tourism) aviation services. Among land transport, motorcycles contribute 14.9% of emissions, as they represent the most significant portion in the national vehicle fleet. With increasing numbers of resorts and domestic airports, increase in emissions are envisaged.

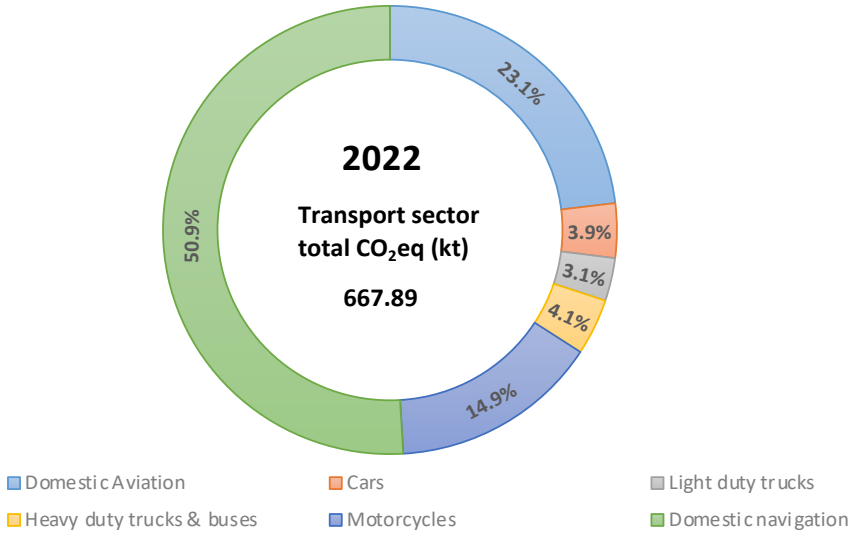


Figure 23: Emissions from the transport sector

2.3.4 Other Sectors

The Other Sectors category is the largest contributor to national emissions, totalling 822.38 kt of CO_2eq, representing 33.4% of the national emissions. Energy combustion in other sectors includes various sub-categories, as detailed in Annex 7.1.

The commercial/institutional sub-category accounts for the majority, contributing 86.2% of the emissions within other sectors. This includes emissions from commercial electricity generation (by MACL, resorts, MWSC) and commercial LPG usage (Maldive Gas and Villa Hakatha).

The second-largest source of emissions in this category comes from off-road vehicles and other machinery, which contribute 4.2% of other sectors emissions. This includes off-road vehicle use by MACL, MPL, STO, and MTCC for construction, port, and airport operations.

The Residential sub-category contributes 3.7%, which is solely from LPG usage by households, as residential electricity generation is accounted for under public electricity generation.

Fishing and mobile combustion emissions arise from the operation of fishing vessels, while emissions from Fishing stationary sources are due to electricity generation at fish processing plants. Figure 24 shows the breakdown of emissions in Other Sectors.

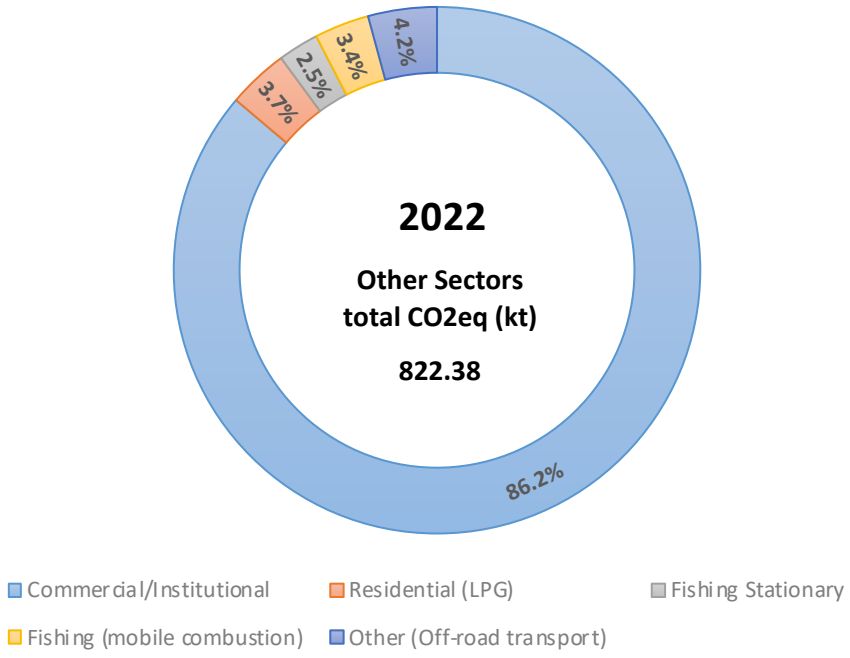


Figure 24: Breakdown of emissions from Other Sectors

2.3.5 Manufacturing Industries & Construction

The Maldives does not have large-scale manufacturing industries, such as sugar production, textiles, or aluminium manufacturing, which typically contribute to emissions through direct fuel usage in manufacturing processes, as outlined in the IPCC guidelines. However, emissions related to Mining (excluding fuels) and quarrying, categorised under 1.A.2.g.iii., are reported here. These emissions amount to 13.01 kt of CO_2eq, representing 0.6% of total national emissions. This includes emissions associated with dredging activities, with data collected from the Maldives Transport and Contracting Company (MTCC). Currently, only information from the public sector, specifically MTCC, was available for this inventory. As the activity data is not available from 2011-2017, it is reported as NE (Not Estimated) in the CRT tables.

2.3.6 Waste

Waste management has become a significant environmental challenge for the Maldives in recent years, particularly due to the growing population. Improper disposal and management of solid waste has exacerbated this issue. In the absence of adequate waste management facilities, much of the waste produced is improperly disposed of or openly burned.

Waste generated in Male' City, nearby islands, and most resorts is transported to Thilafushi Island, where it is typically disposed of through open burning. Consequently, emissions from the waste sector are primarily attributed to this open burning practice. In additionally, methane (CH_4) emissions from domestic wastewater treatment and discharge are also estimated based on population data and default emission factors.

Figure 25 shows the breakdown of the emissions from the waste sector. A total of 86.64 kt of CO_2 equivalent is emitted from the waste sector. Most of the emissions (86.1%) from the waste is generated by the burning of waste, while emissions by wastewater treatment and discharge account for 13.9% of the total waste emissions.

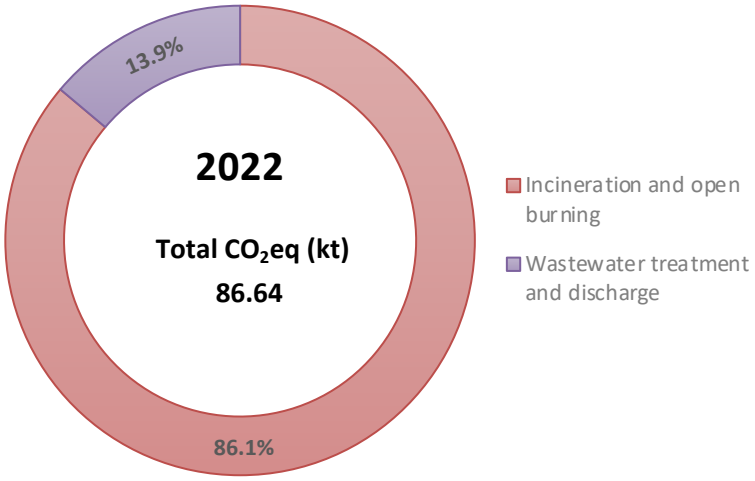


Figure 25: Emissions contribution by the waste sector

2.3.7 Fugitive Emissions

Fugitive emissions refer to the unintentional or irregular releases of gases that occur as leaks or other emissions commonly from storage, venting, and flaring at oil and gas refineries. In the Maldives, the most likely source of fugitive emissions would be from fuel storage. However, stakeholders responsible for fuel storage do not measure these emissions, as they are considered negligible due to the small storage capacity and the quick turnover of fuel volumes. As a result, emissions from this category are not estimated in this inventory.

2.3.8 International Bunkers

International bunkering refers to the fuel used for international flights and shipping vessels. Emissions from international bunkering are not included in the national total emissions but are reported separately. These emissions, from both international flights and vessels, are listed in the emissions table (Table 16) as memo Items for record-keeping and reporting purposes.

2.3.9 Reference and Sectoral Approach

For comparison purposes, emissions were calculated using the reference approach as well. This comparison was conducted only for the years where both the reference and sectoral approaches were estimated. The differences between these two approaches vary depending on the quality and completeness of the data, as shown in Figure 26. For 2022, the overall difference in consumption between the approaches is 11.55%. The variation of this difference over time is

shown in Figure 27. The discrepancy was significantly larger in 2020 due to data unavailability and uncertainty due to COVID across most sectors.

Variations between the reference and sectoral approaches can arise from several factors. One key reason could be the timing of fuel usage. For example, fuel that is imported and recorded as an emission in the reference approach for a particular year may be utilised in various sectors in subsequent years, which would then be captured in the sectoral approach as activity data in the following year. Additionally, the Maldives Customs Service has indicated that there may be delays in recording fuel imports, which can also contribute to these differences.

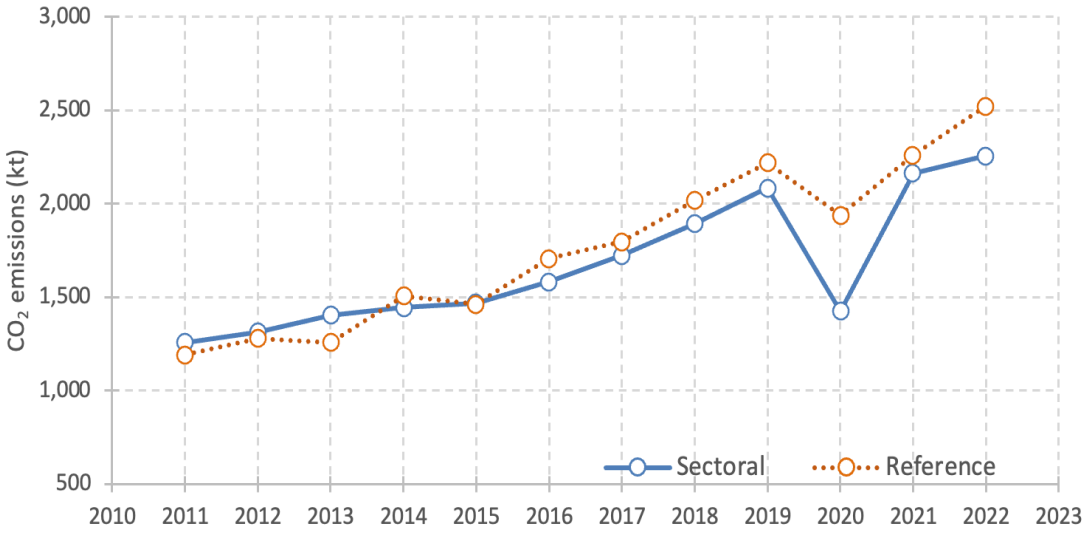


Figure 26: Sectoral vs Reference approach for 2011 – 2022

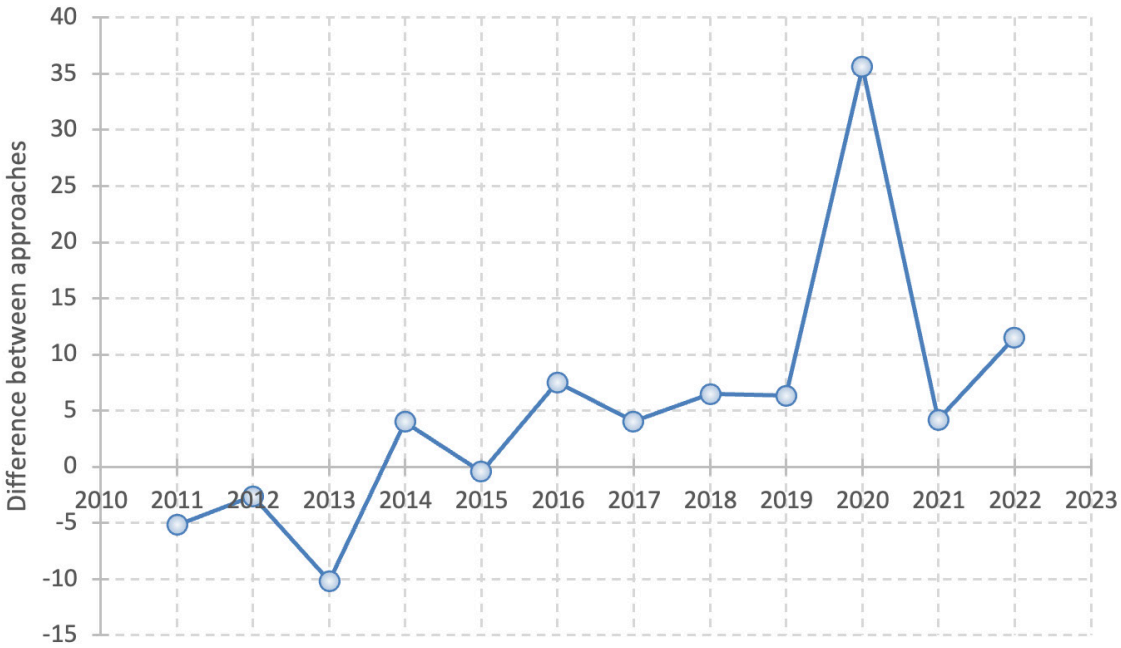


Figure 27: Variation of the difference between the approaches over time

2.3.10 Time Series of Greenhouse Gas Emissions

Data for the sectoral approach for years 2001 - 2010 are unavailable as mentioned above. In addition to this, the reference approach excludes emissions from the waste sector.

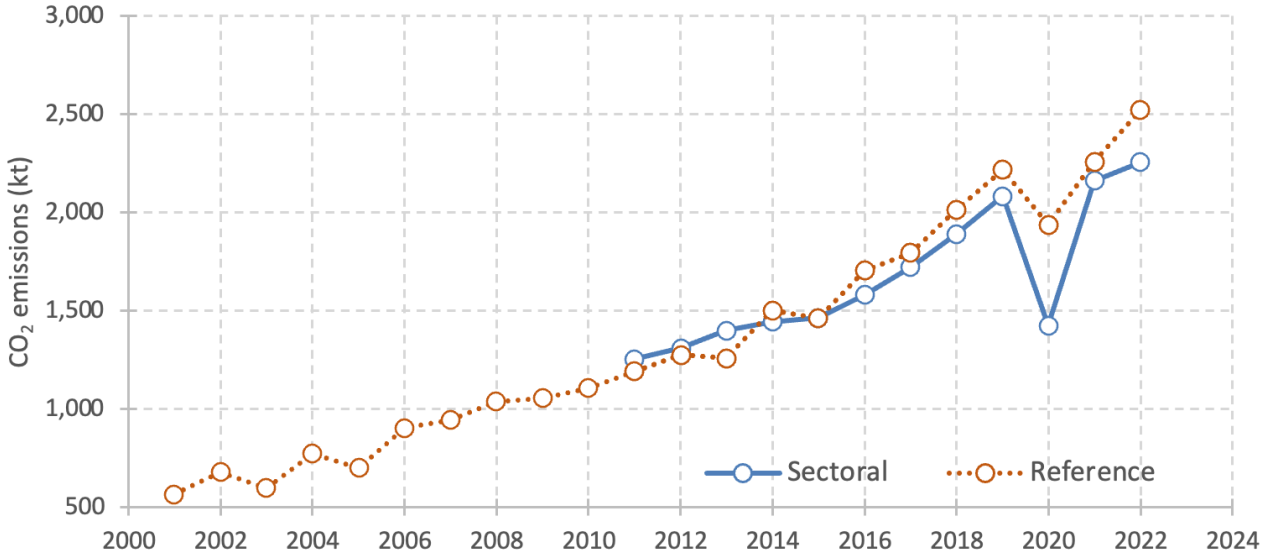


Figure 28: Timeseries of CO2emissions (excluding waste) reference vs sectoral approach.

Figure 28 shows the time series of CO_2e emissions from fuel consumption, comparing the reference approach with the sectoral approach. The profile shows a clear upward trend in national emissions over time. It also shows that emissions in 2020 fell to levels comparable to those of 2013, due to hampering of economic activities during the COVID-19 crisis in 2020. Considering 2011 as the base year, the emission trend is at 5.47% at 2022.

2.3.11 Emission Trends

The following sub chapters analyses the emissions by sectors and by gases.

2.3.11.1 Sectoral Trends

Figure 29 depicts the trend in the total emissions across various sectors from 2011 to 2022. All sectors show a rising emission trajectory. Contrary to other sectors, energy industries (specifically public electricity generation) did not dip due to the COVID impact, as public services continued uninterrupted during the pandemic.

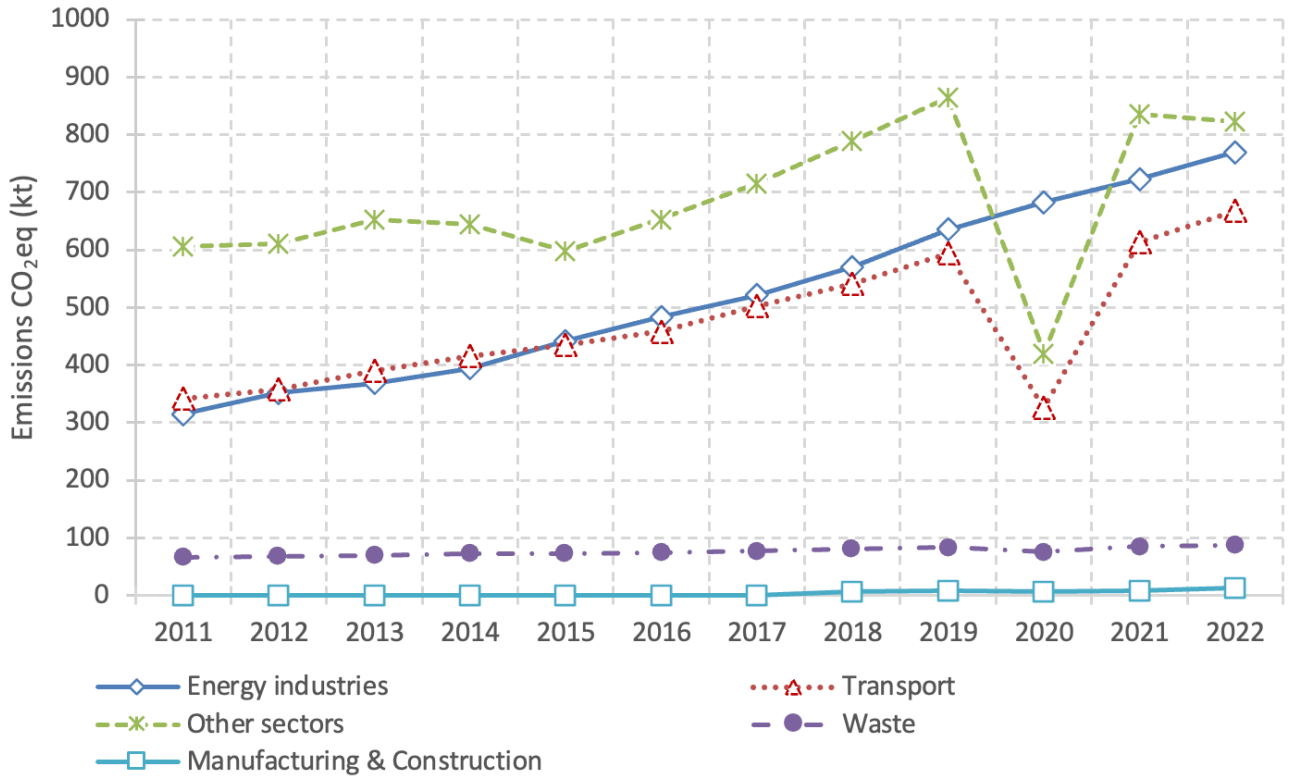


Figure 29: Emission trends by sectors

2.3.11.2 Energy Industries

Figure 30 illustrates emissions trends from the energy industries from 2011-2022. The Maldives relies on public electricity generation within this category. With the growing population and economic demand, the emissions show a continuous rising trend.

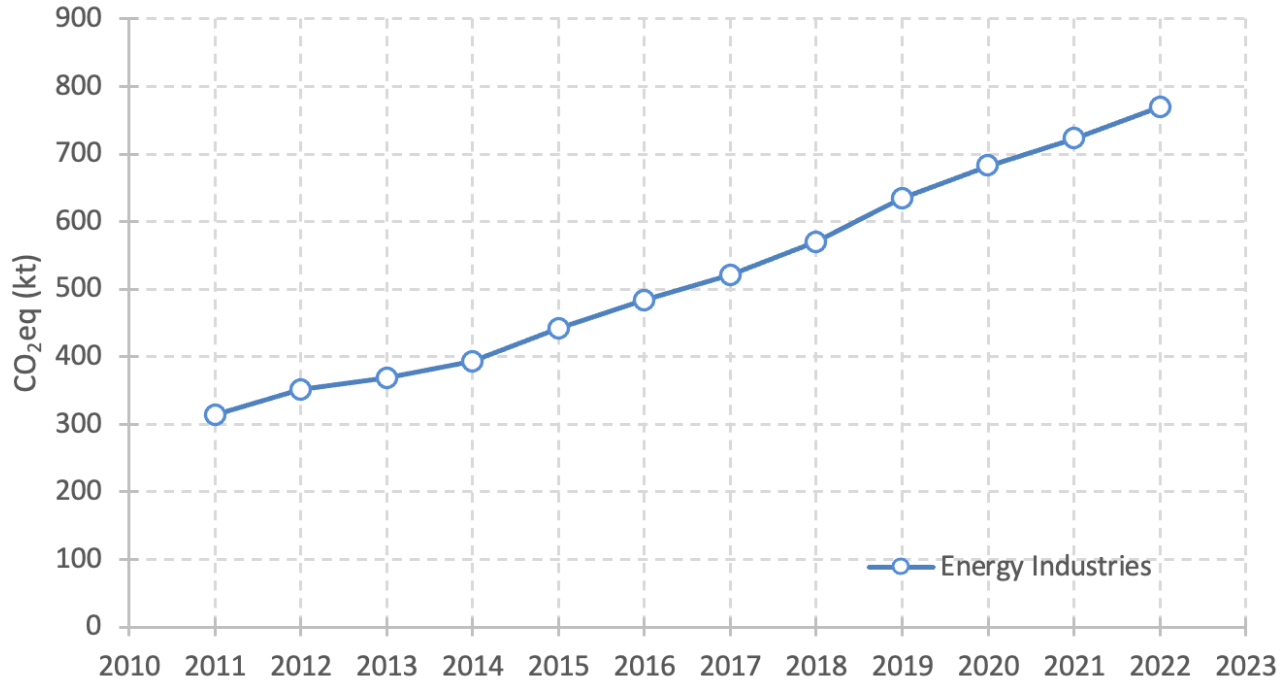


Figure 30: Emissions by energy industries (public electricity generation)

2.3.11.3 Manufacturing Industries and Construction

Figure 31 shows the emissions trend from the manufacturing industries and construction sectors with data from 2018 onwards. These emissions are associated with fuel consumption for dredging, as explained above. In recent years, an increase in dredging operations have contributed to the upward emissions trend. As data is unavailable for years 2011 to 2017, the category is marked "NE" in the CRT tables.

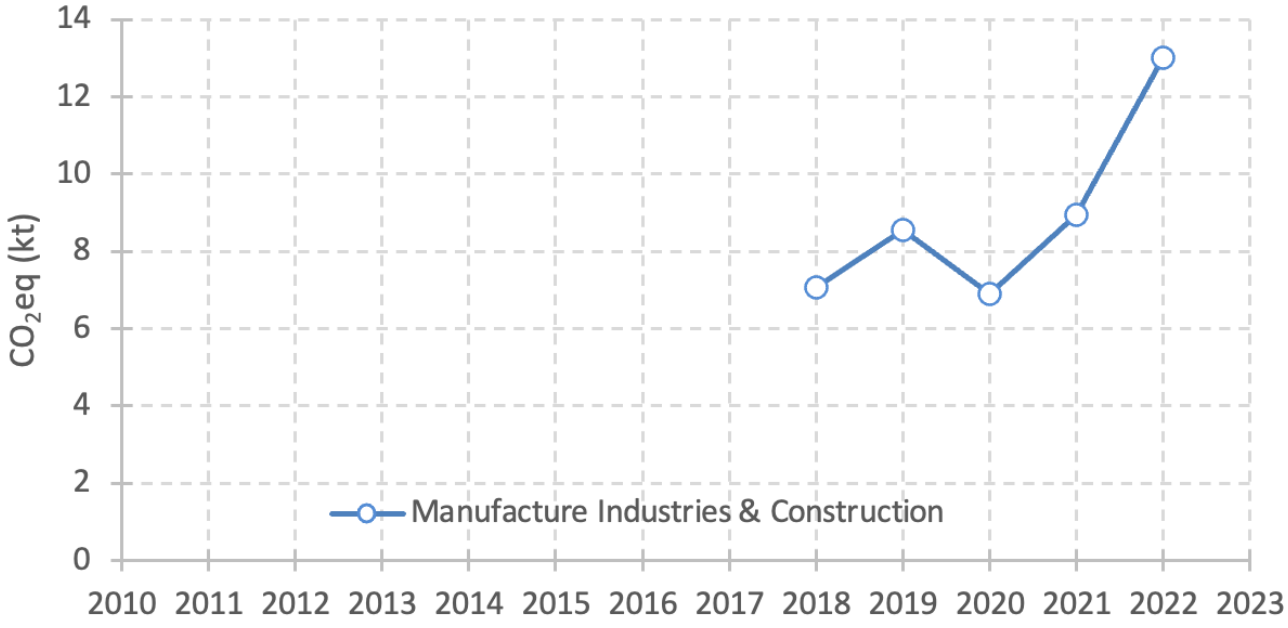


Figure 31: Emissions due to manufacturing & construction. This is associated with dredging.

2.3.11.4 Transport Sector

Figure 32 breaks down of emissions from the transport sector where the bulk of emissions originate from waterborne navigation, encompassing all marine transport, and domestic aviation. These two categories are represented on the secondary axis on the right due to their significantly higher emission levels compared to other modes of transport. The third-largest source of emissions stems from motorcycles, which comprise the largest portion of the national vehicle fleet.

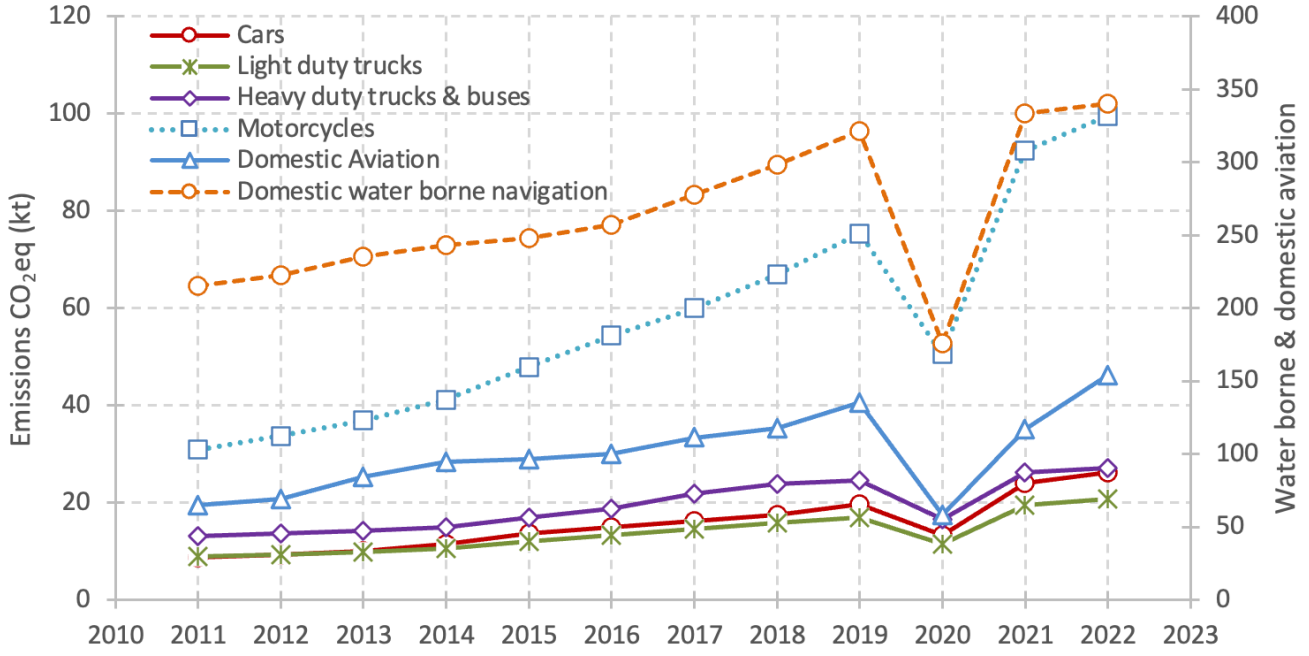


Figure 32: Breakdown of transport sector. Emissions from water borne navigation & domestic aviation are on the secondary axis

2.3.11.5 Other Sectors

Figure 33 shows the emissions from the other sectors with the commercial/institutional sector being the biggest contributor. This sector includes electricity generation from resorts and other commercial institutions, and the LPG usage in the commercial sector (represented on the secondary axis). The second largest source of emissions come from off-road modes of transport which includes ports and airport operations. A decline in emissions is observed in fishing (mobile combustion) correlating with fuel consumption by fishing vessels.

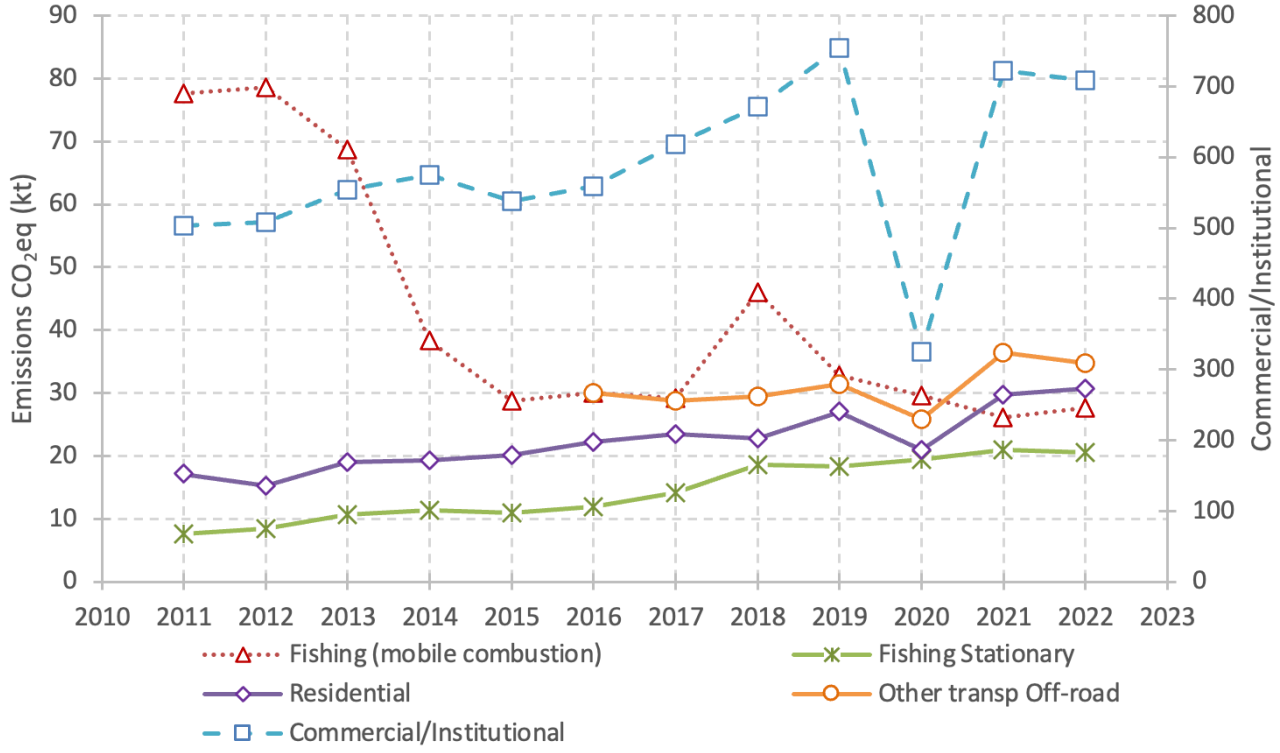


Figure 33: Emissions from Other Sectors in CO2eq. Commercia/Institutional represented on the secondary axis.

2.3.11.6 Waste Emissions

Waste emissions are mainly generated from the open burning of waste. Additionally, emissions from domestic wastewater treatment and discharge are also estimated in this inventory, calculated using population data and default emission factors. Figure 34 shows the emissions trend from waste categories.

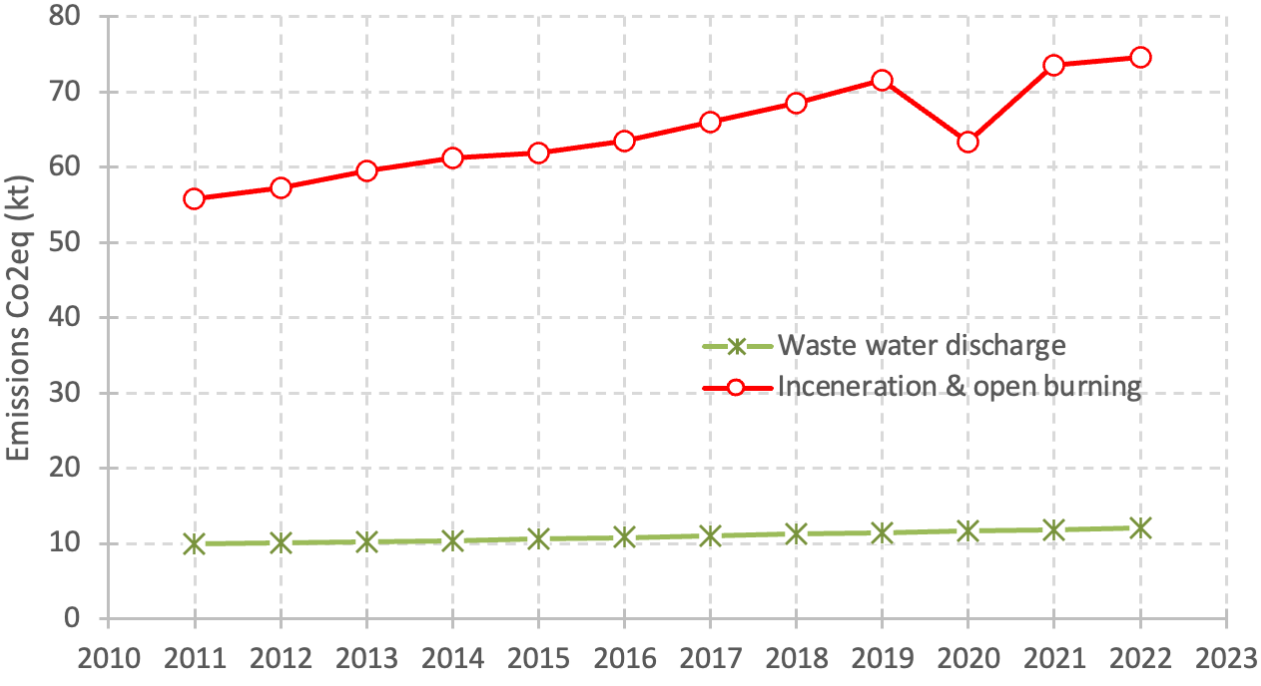


Figure 34: Trend of emissions from waste sub-categories

2.3.11.7 Emissions by Gases

Figure 35 shows the trend in the emissions trend of individual greenhouse gases with all gases showing an upward trajectory. The most dominant gas is CO_2, primarily from fuel combustion.

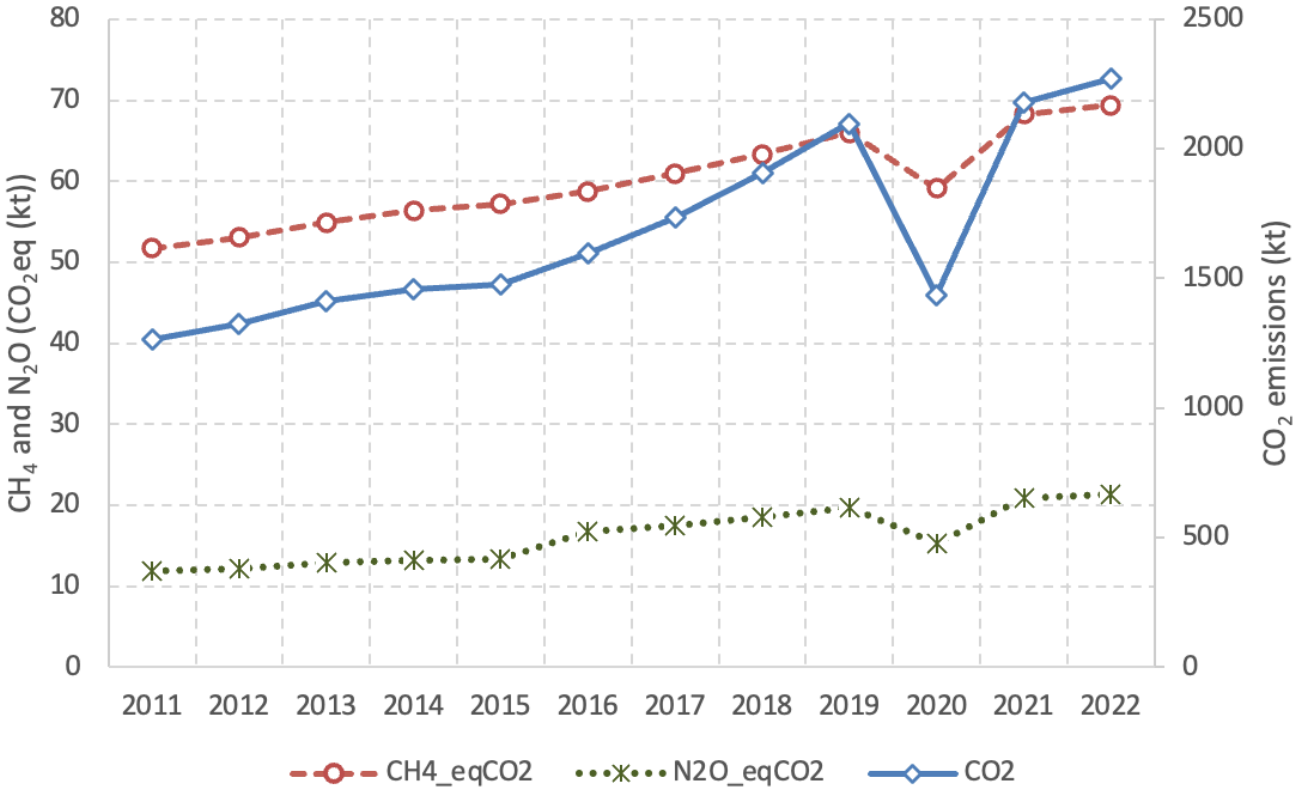


Figure 35: Trend in the emission of gases (CO2eq). CO2 emissions are depicted on the secondary axis on the right.

2.4 Flexibility and Indicative Improvement Plan

As noted in Chapter 1.7.5, Maldives applied the flexibility provisions as allowed under the MPGs. According to these provisions, parties should provide details of planned improvements for reporting over time.

The following table provides information about the Maldives' improvement plan with indicative timelines subject to national circumstances and resources availability. Table 16 shows the flexibility provisions and the corresponding indicative improvement plan.

Table 17: Flexibility provisions and the potential improvement plan

Sector/Sub-category	Data & information gap identified	Capacity constraints	Action for Improvement	IPCC code - Key Category	Indicative timeframe for improvement
Energy/ electricity generation in public and other sectors	Since there is no established national emissions factor, default emissions factors are used to estimate emissions. Consequently, Tier 1 method has been used to estimate emissions from electricity generation for both public electricity generation and commercial/institutional under the other sectors.	Information about fuel is not collected systematically, which limits the ability to establish a national emissions factor. A proper inventory of the different types of power-plants used and their operating conditions is unavailable, due to limited human resource capacity.	Needs institutional strengthening, human resource capacity development with further research on developing national emissions factors.	1.A.1 - Energy Industries - Liquid Fuels 1. A.4 - Other Sectors - Liquid Fuels	2025-2045
Transport/ Land and marine transport	There is currently no integrated mechanism for collecting data on fuel usage by the transport sector (marine and land). A national emissions factor has not been established.	Limited institutional and human resource capacity to process and maintain an updated registry of vehicle and vessel information including their technical specifications and status changes. Currently, there is no system in place to connect fuel dispensing data with vehicle and vessel types and by use.	Current method used is a model-based approach. The model needs to be updated to reflect of the changes in the fleet composition and usage patterns, for better estimates of the fuel use, if the model is to be employed in the future to determine the total fuel used for transportation.	1.A.3.d - Water-borne Navigation - Liquid Fuels 1. A.3.b - Road Transportation - Liquid Fuels 1. A.3.e - Other Transportation - Liquid Fuels	2025-2045

Sector/Sub-category	Data & information gap identified	Capacity constraints	Action for Improvement	IPCC code - Key Category	Indicative timeframe for improvement
Transport/ Civil Aviation	There are no country specific emission factors established for the aviation sector. Challenges in data provision by the stakeholders.	Limited institutional and human resource capacity in data management.	Establish mechanisms to strengthen and improve collaboration between the relevant stakeholders on data and information sharing, including capacity building	1.A.3.a - Civil Aviation - Liquid Fuels	2025-2045
Waste	The limitations in available waste data, including tourism sector waste data, does not allow proper analysis in accordance with the IPCC guidelines,	Limited resources to conduct waste audits.	Conduct necessary assessments to improve data collection processes and data management to facilitate necessary analyses in accordance with the IPCC guidelines.	4.C - Incineration and Open Burning of Waste	2025-2045
Uncertainty assessment/ all sectors	Activity data uncertainty is not collected in any sector and therefore not estimated. IPCC default values are utilised instead.	Limited understanding and knowledge on data uncertainty by the stakeholders.	Provide sector specific trainings on how to collect data and information to establish uncertainty.	All sectors	This time could be longer and needs to be gradually built while capacity building and training on respective sectors are conducted

Sector/Sub-category	Data & information gap identified	Capacity constraints	Action for Improvement	IPCC code - Key Category	Indicative timeframe for improvement
Gases	Potential emissions from HFC gases may arise in refrigeration and air-conditioning equipment. However, these emissions are not yet reported due to unavailability of activity data.	Limited institutional and human resource capacity in data management and conducting assessments on the use of refrigeration and air-conditioning equipment.	Conduct necessary assessments to collect information on types and use of refrigerant and air-conditioning equipment.	IPPU sector	2025-2045
Time series	There is no activity data to establish sectoral emissions from 1990 to 2010.	No data is available with the sectors to establish emissions from sectoral approach from 1990 to 2010.	It has been determined that establishing this historical record for the country is ineffective considering the time and resources required, as the associated emissions are expected to be negligible or minimal. However, Maldives will keep the time series from 2011 onwards.	All sectors and categories	N/A

03

INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING NATIONALLY DETERMINED CONTRIBUTIONS UNDER ARTICLE 4 OF THE PARIS AGREEMENT

CHAPTER 3: INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING NATIONALLY DETERMINED CONTRIBUTIONS UNDER ARTICLE 4 OF THE PARIS AGREEMENT

The Maldives submitted its first NDC in 2015 followed by an updated NDC in 2020, intending to achieve the targets, contingent upon receiving the necessary international support. Although emissions produced by the Maldives is negligible, emission reductions will contribute to increasing resilience and achieving sustainable development. The Maldives' NDC also places equal importance on further enhancing adaptation and building a climate-resilient future to reduce climate risks on communities and their livelihoods.

3.1 Description of the Maldives NDC

The Maldives' NDC target is to achieve a 26% reduction of emissions in 2030 under a Business-As-Usual (BAU) scenario, in a conditional manner, in the context of sustainable development and supported and enabled by availability of financial resources, technology transfer and capacity building. Additionally, the NDC also provides a secondary target to reach net-zero emissions by 2030 contingent on extensive support and assistance from the international community.

The NDC target is a single year target with an implementation period from 2020 to 2030. The target is relative to projected emissions for 2030 under a BAU scenario with 2011 as the base year of emissions. In the NDC projection, emissions in 2030 under the BAU are estimated at 3,284,92 GgCO2e. For the purpose of this BTR, the BAU projection was revised to reflect the updated national context and economic growth, with the new BAU estimate being 4,414.42 GgCO2e. This was due to changes in circumstances where underlying assumptions in the initial projection have evolved over the years prompting new projections to reflect the changes. The methodology for deriving the revised baseline is included in the Projection Methodology (Annex).

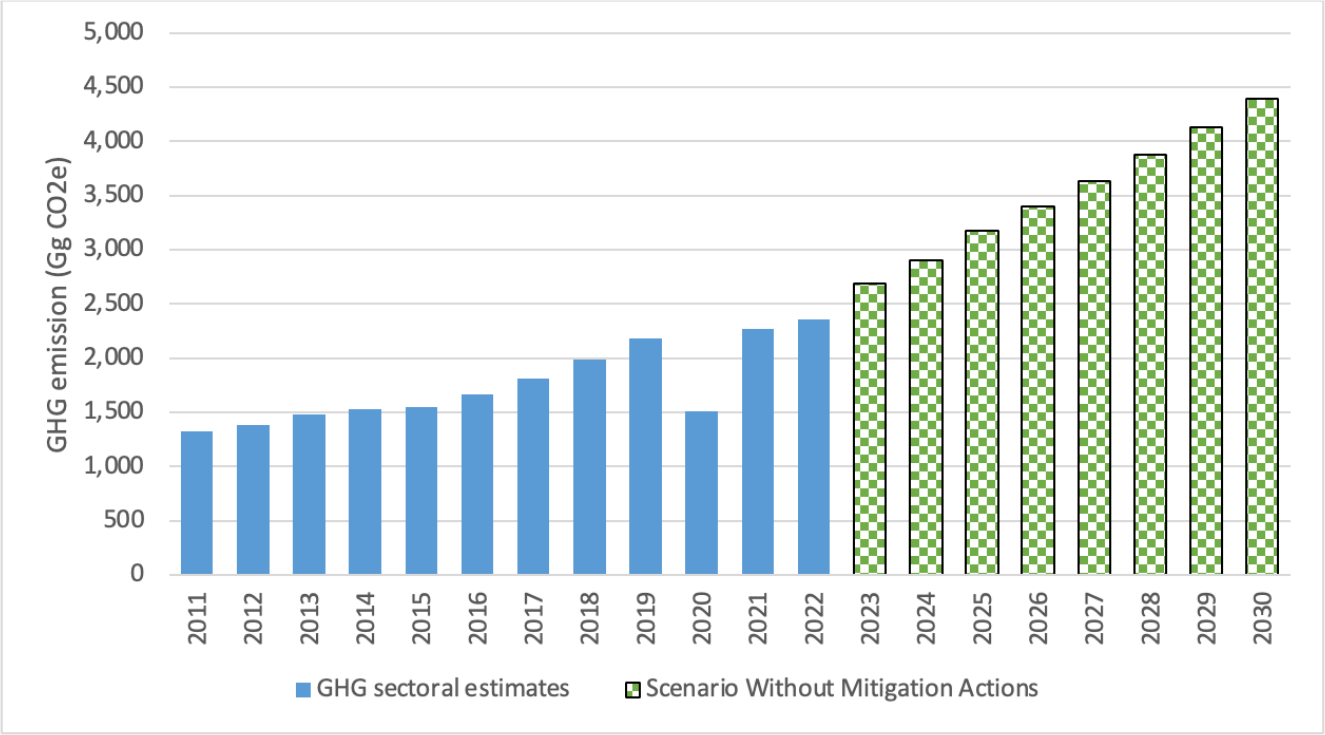


Figure 36: Projection scenario without mitigation actions (green checkered bars)

In the NDC, Maldives lists key mitigation actions to achieve the 26% reduction from BAU. The mitigation actions listed in the NDC include:

- Increase of electricity production by renewable energy (RE) with storage and grid stabilisation. Efforts will be made to increase the installed RE share to 15% of the energy mix, which includes the public and private sector.
- Increase supply and demand side efficiency. Increase of efficiency of generators and upgrading the grids to minimise grid loss would be essential. Significant upgrading of the existing power production infrastructure needs to be done via routine scheduled maintenance, synchronisation and optimisation of power production and reducing grid loss to at least 5% is required. In addition, demand side management would include implementation of the standard labelling program and improvement of building standards for energy efficiency.
- Waste to energy. The planned installation of 8 MW in Thilafushi and 1.5 MW in Addu City will be completed. These systems will be optimised for grid connection and electricity production.
- Establishment of vehicle/vessels emissions standard and establishment of efficient transport management system and promotion of hybrid-vehicles.
- Use of Liquefied Natural Gas (LNG) for electricity generation within greater Male' region. The diesel used for power production could be replaced with LNG for the greater Male' region with the proposed LNG plant in Thilafushi and the interconnectivity bridge.

It must be highlighted at this juncture that some of the mitigation actions listed in the NDC have been updated to reflect current circumstances. This will be discussed further in the section on implementation progress.

The conditionality for the net-zero target does not only depend upon financial and technical support to the Maldives, but also on development, maturity and commercialisation of low-emission technologies - such as aviation and sea transport - becoming readily available within the NDC implementation period.

3.1.1 Scope and Coverage

The NDC covers emission reductions from energy and waste sectors. These two sectors have been identified as a key category for emissions. The gases targeted for mitigation is carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). In tracking NDC progress, Maldives had indicated that it will account for any mitigation co-benefits from adaptation and economic diversification as mitigation actions, in accordance with the established assumption and methodological approaches. The Maldives intends to increase the coverage of categories in the future NDC gradually as the capacity to address data gaps for including additional sectors and establishing an enabling environment to collect the data in a systematic way for the new sectors.

3.1.2 Methodology and Planning the NDC

The Maldives NDC was prepared by the Ministry of Climate Change, Environment and Energy in consultation with relevant stakeholders from the public and private sector. During the process, available development plans and ongoing activities within these sectors were taken in to account. Key best practices applied in devising the NDC include:

- Taking into account the financial and technical capabilities of the country
- Conducting a socio-economic analysis of the mitigation actions
- Engaging stakeholders to clarify their roles and responsibilities in achieving the target.
- Briefing policymakers on the technical and financial implications of reaching the NDC target
- Use of existing national reports across various sectors

The Maldives used the tier 1 methodology from *2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories*, and *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* to account for anthropogenic GHG emissions and removals. This includes use of default emission factors and aggregation of GHG emissions using the 100-year time-horizon GWP values from the IPCC Fifth Assessment Report. The LEAP models applied projects the amount of energy used for every national sector based on population and economic growth. The same emission factors from

GHG emission estimation were used in the model to generate projected emissions. Detailed descriptions of the model parameters used for the projections are included in the annex.

The Maldives intends to participate in the mechanisms under the Article 6 of the Paris Agreement. However, at the time of the NDC submissions, the Article 6 rules had not been not finalised and hence their contribution to the target had not been determined. Thus, the target is set exclusive of article 6 contributions.

3.1.3 NDC's Fairness and Ambitions

As a Small Island Developing State at the frontline of the climate emergency with high Debt to GDP ratio, the Maldives using domestic resources for any mitigation should be considered ambitious. Thus, it is fair for a country like the Maldives to put forward a conditional target while aiming to enhance the target significantly based on availability of finance, technology and capacity.

However, achieving these targets are constrained by limited land area, the geographic isolation of islands and geographic dispersion of population and small economies of scale. Additionally, limited capacity and challenges associated with transforming already established power generation systems remain as barriers to increasing the share of renewable energy in the energy mix. Apart from solar energy, ocean currents and waves surrounding the islands can be considered potential renewable energy sources. However, the technologies to harness them are still not yet fully mature, at pilot stages globally and are commercially unavailable. As a result, the Maldives remains heavily dependent on imported fossil fuels despite government policies that promote and implement renewable energy technology adoption.

Given these constraints, along with high vulnerability to climate change impacts, as well as its miniscule share of global GHG emissions and the need to pursue sustainable development without overburdening the population, the Maldives' NDC is both highly equitable and ambitious.

3.2 Tracking NDC Progress

The main method of tracking progress on the NDC is through measuring GHG emissions. The NDC describes specific mitigation actions and some sectoral targets, as indicated in section 3.1. Each of those actions and targets includes a number of initiatives, programmes and projects designed to achieve NDC target.

The identification of mitigation actions reported in this BTR is based on the same criteria listed in the Maldives First BUR. They are as follows:

- Projects and programmes that include components that lead to emission reductions
- Projects and actions which have quantifiable indicators (e.g. power generation or power consumption) which can be utilised to compute emission reductions.

- Projects that are concrete in terms of their objectives, timelines and scale.
- Projects and programmes that are either completed, ongoing or planned since 2010 to the present day.

The planned projects and programs identified are used to build scenarios with mitigation actions. In developing these projections, historical trends associated with similar projects have been taken into account.

3.2.1 Renewable Energy Projects

The NDC initially outlined mitigation actions to meet 15% of the total electricity requirements through renewable energy sources. Since 2023, the sectoral target has been revised to meet 33% (PO, 2023) of all electricity generation from renewable energy sources. Many existing projects have been further scaled-up through additional financing from the national budget and from development partners, and new initiatives have been developed.

The main renewable energy technology deployed in Maldives is Solar PV. For solar PV projects information was collected from the energy department and verified through historical documentation available for public projects. For private projects the information was solely verified by service providers and utilities for these installations.

First utility use of renewable energy occurred in mid-2000s with number of pilot projects using solar PV and wind turbines to integrate into local utility grids. Following these pilot programs with assistance from development banks, the commercial deployment of solar PV started from 2015 onwards. Since then, solar installations have grown exponentially (Figure 37).

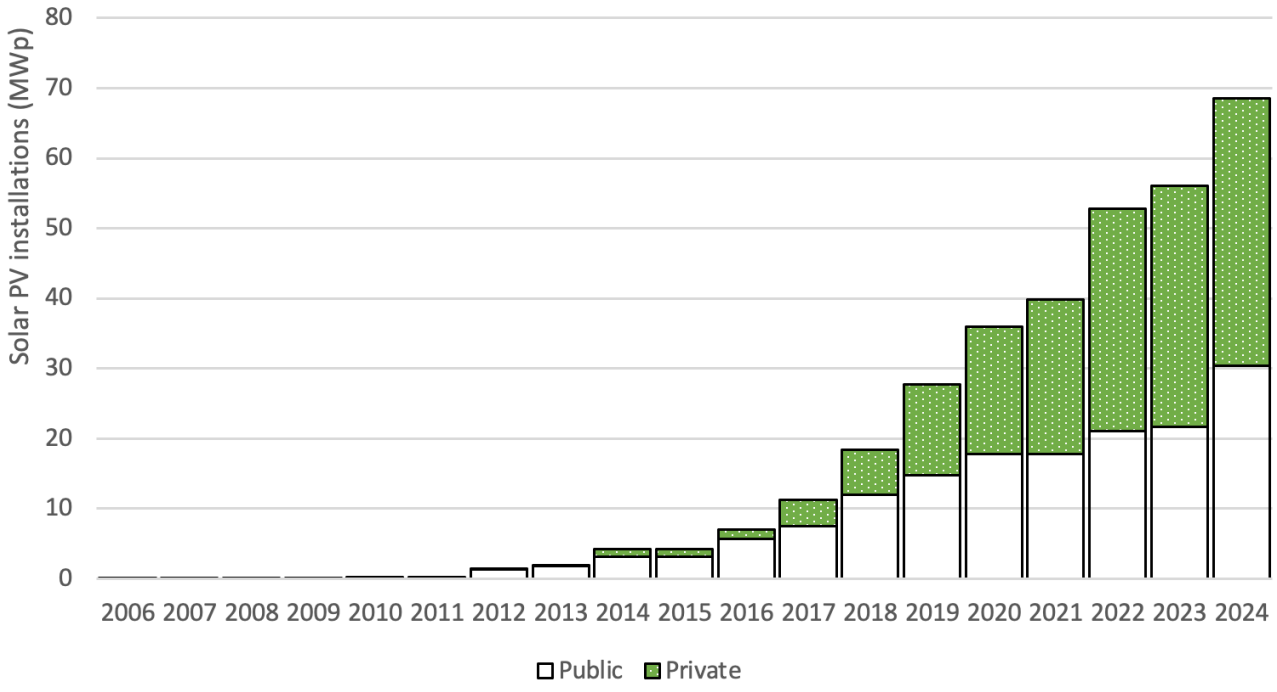


Figure 37: Solar PV installation across Maldives from public and private investments

The Government also launched a net-metering guideline in 2015 and established a financial assistance mechanism namely Home Solar Programme for net-metering in 2021 to encourage private investments in Solar PV. A follow-up financial assistance initiative for net-metering named *Magey Solar* programme was introduced in 2024. The amount of private solar PV installations for self-consumption surged after 2017 driven by lower cost of technology and increased amount of service providers. By 2020, privately invested solar PV installation had overtaken solar PV installations through public investments. As of mid-2024, the total installed solar PV stands at 68.5MWp, producing approximately 4.65% of the total electricity generated in Maldives.

All projects completed from 2010 to 2024 are summarised in Table 18 and are included in the projections to understand the impacts of these projects on the 2030 target. In addition to completed projects, ongoing projects and planned projects are summarised in the table below with detailed information listed in the CTF tables. Based on the information provided by stakeholders on their future projects and the expected growth of private sector investments, the installed capacity is expected to reach close to 310MW (~165 MW by public sector investment and 145 MW by private sector) by 2030, accounting for up to 13.5% of total electricity generation in 2030.

In addition to these projects, Government is also exploring large scale solar investments in the country under the Special Economic Zone Act. Maldives issued its first initial permit for investment proposals for 150MW of Solar PV in the Male' region. However, as of this report's formulation, the project remains at the feasibility stage, and thus this potential 150 MW of Solar PV has not been included in the projections, as the project specific target may be revised following the feasibility outcomes.

Table 18: Solar PV projects in Maldives

Project Name	Project Brief	Status	Solar PV installed	Solar PV Planned	Annual emission reduction achieved (2024)
Resort PV installation	PV installations invested by resorts for self use	Ongoing	31.45MWp	Data not available	33962 tCO2e
Net-Metering	PV installations through net metering	ongoing	1.275 MWp		1377 tCO2e
Home Solar/Magey Solar	PV installations under net metering through the Home Solar Assistance Programme	ongoing	5.4MWp	10MWp	5832 tCO2e
Project for the Clean Energy Promotion in Male'	Introduction of Clean Energy by solar electricity generation systems, implemented by Japan International Cooperation Agency (JICA) in 2010, which installed a total of 740kW of Solar PV systems in the greater Male' area completed in 2014.	Completed	0.74 MWp	NA	799 tCO2e
Clean Energy for Climate Mitigation Project	Installation of 558 kWp of PV with automated monitoring and control technologies to support grid operations and PV-diesel optimisation.	completed	0.56 MWp	NA	605 tCO2e
Dhiffushi Solar Ice Project	installation of a 40 kW grid-connected photovoltaic system (PV)	Completed	0.04MWp	NA	43 tCO2e
Support of the Climate Neutrality Strategy of Maldives	Diesel-solar-hybrid systems built on two pilot islands (324kW)	Completed	0.324MWp	NA	350 tCO2e
Low Emission Climate Resilient Development (LECReD)	installation of a 66kW grid-connected photovoltaic system (PV)	Completed	0.07 MWp	NA	76 tCO2e
Preparing Outer Islands for Sustainable Energy Development (POISED)	Installation of ~29 MW grid connected PV systems in inhabited islands. Enhance capacity of MCCEE, STELCO, and FENAKA to implement renewable energy grid interventions	Ongoing	13.36MWp	14.65MWp	14929 tCO2e
Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE)	ASPIRE project aims to scale-up solar PV in Maldives, through private sector investment with an overall target of 17.5MW of Solar PV installations	Ongoing – final batch to be completed in 2025	6.5MWp	11MWp	7020 tCO2e
Accelerating Renewable Energy Investments and Sustainable Energy (ARISE)	Follow up project to ASPIRE to supplement the private investment scale-up, through increasing the grid RE absorption capacity of large islands of Maldives. A combination of Solar PV investments from private sector, and public sector investments in Grid Modernisation and Battery Energy Storage Systems (BESS) is the major scope.	Tendering- Ongoing : expected to complete in 2026		25MWp	-

Project Name	Project Brief	Status	Solar PV installed	Solar PV Planned	Annual emission reduction achieved (2024)
Accelerating Sustainable Clean Energy Investments for Net Zero Transition (ASCENT)	The ASCENT Project will increase the generation capacity of new and existing energy infrastructure in Maldives through increased solar PV generation, storage capacity and system reliability.	Planned		50MW	-
Accelerating Sustainable System Development Using Renewable Energy (ASSURE)	ASSURE project which includes the installation of 20MW solar power systems across 20 islands through power purchasing agreements, a 44MW solar battery energy storage system to enhance grid stability in the designated islands and pilot wind and marine RE technology initiatives	Ongoing	-	20 MWp	-
Development of Low-carbon resilient fisheries production and processing sector	Installation of 10MWp solar PV at MIFCO operational sites and 5-10% energy efficiency improvement in MIFCO operations leading to up to 15 ktCO2eq and de-risk low emission investments in fisheries sector while improving industry profitability.	Planned		10 MWp	

3.2.2 Energy Efficiency Mitigation Action

For energy efficiency measures, two nationwide mitigation initiatives are ongoing: the FAHI-ALI programme and Hakathari Programme (Standard Labelling Programme). The methodology applied for these energy efficiency measure that involves identifying avoided energy or fuel from improved energy efficiency is detailed in methodology annex.

FAHI-ALI programme focuses on replacing existing light fixtures with LED lights. The programme involves distribution of 737,750 LED lights (270,250 tube lights and 467,500 bulbs) received as assistance from China, India and Germany. This distribution has triggered a market shift towards LED lights across all sector, which is accounted for in the mitigation scenario.

The Hakathari Program focuses on developing comparative labels based on energy consumption and efficiency of the products. It currently focuses on refrigerators, air conditioners and washing machines. The voluntary use of the label was initiated in 2022, and although the voluntary uptake has been slow, there are plans by the government to boost the programme. With full implementation, the expected goal of the programme is to improve the overall efficiency of air conditioners, refrigerators and washing machine by 24%, 33% and 28% respectively.

Based on this goal, the avoided electricity consumption due to improved energy efficiency by implementation of both the Hakathari Programme and Fahi-Ali programme is shown in Figure 38.

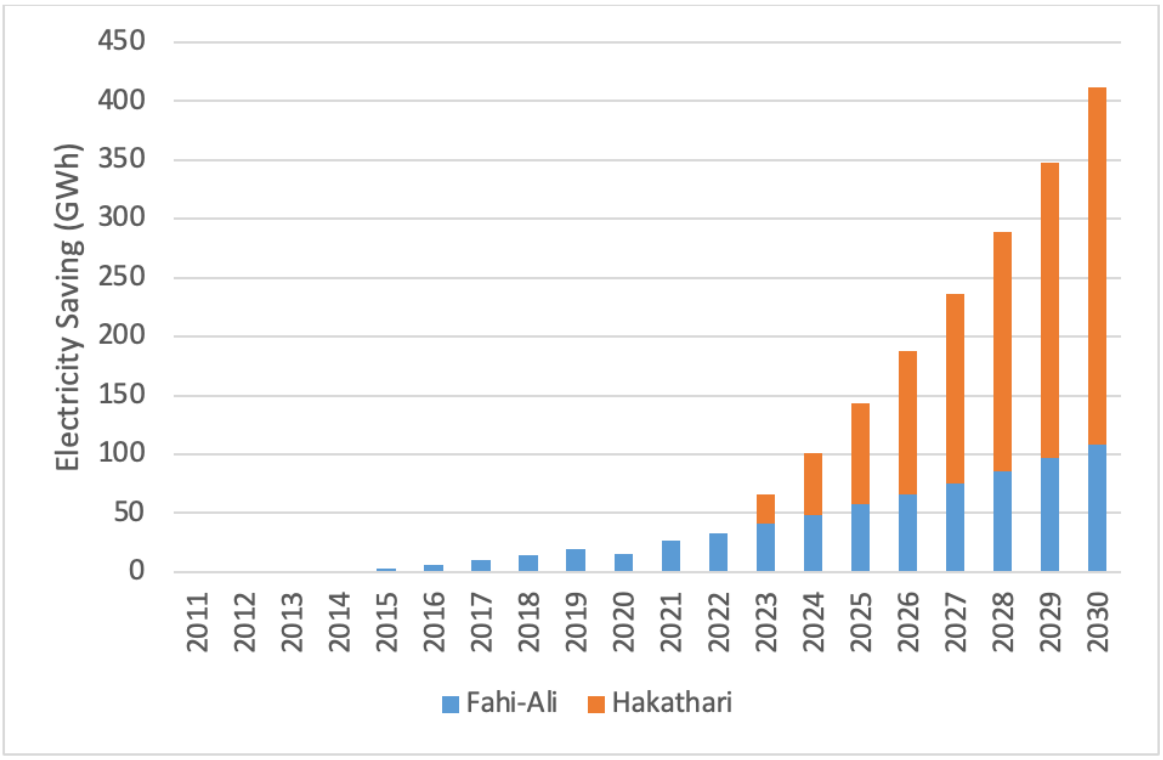


Figure 38: Avoided electricity (annually) from the implementation of Hakathari and Fahi Ali programme

Other energy efficiency measures like behavioural change for energy conservation and building sector energy efficiency have not been included due to lack of data needed for projection. Energy efficiency resulting from supply side interventions are also not considered as the scope and extent of those interventions are unavailable for the projection. However, the Government has developed voluntary guidelines to encourage energy efficiency in the building sector.

3.2.3 Waste to Energy

Waste to Energy Projects are also considered key mitigation measures with three projects currently in progress:

- Greater Male' Waste-to-Energy Project
- Converting Waste to Energy in Addu City
- Small Scale Waste to Energy Project at Vandhoo

These projects are funded by the National Budget along with loan and grant assistance from multilateral donor agencies.

Greater Male' Waste to Energy Project focuses on building a 500 tonnes per day (TPD) incineration plant at Thilafushi catering to current waste that is deposited there from the Male' region and other islands and resorts of the central region. It is designed to generate 13 MW of power and is capable of providing the full energy requirement of Thilafushi Industrial operations. Waste to Energy facility DBO contract was signed in October 2021, concept design in August 2022 and foundation work starting in Q3 of 2023. The project is scheduled to be completed in 2027. The project is funded through grant assistance from ADB supplemented by loan assistance from ADB, IsDB and AIIB.

Converting Waste to Energy in Addu City Project focuses on developing a waste to energy plant at Addu City catering to the waste generated from the four southern atolls (Gaafu Alifu, Gaafu Dhaalu, Fuvahmulah, Addu City). The plant will generate 1.5 MW of electricity and the energy produced would be fed into the Combined Power System Grid at Addu City. This project is scheduled for completion in 2024. The Government of the Republic of Maldives receives loan funding from the Abu Dhabi Fund for Development (ADFD) towards implementing the project.

Additionally, a smaller waste to energy facility was established at the Vandhoo waste management facility with the addition of a 0.5 MW thermal turbine in the North. As of the submission of this report, the facility is not yet operational and is estimated that operations will start in 2025.

3.3 Scenario with Mitigation Action

The results of the assessment show that the currently planned mitigation actions will result in a 17% reduction from BAU in 2030 (Figure 39). However, there still remains a gap between the NDC target of 26% from current mitigation actions. Measures not included in these assessments due to lack of data would likely bridge this gap. Some key mitigation measures not considered due to substantial uncertainty and insufficient information include:

- 150MW solar PV under Special Economic Zone Act
- 200MW LNG power production in Greater Male' region
- Vehicle emission control standards
- Improvement of supply side energy production from diesel.

These projects are promising and their realisation would contribute to achieving the 26% target reduction by 2030.

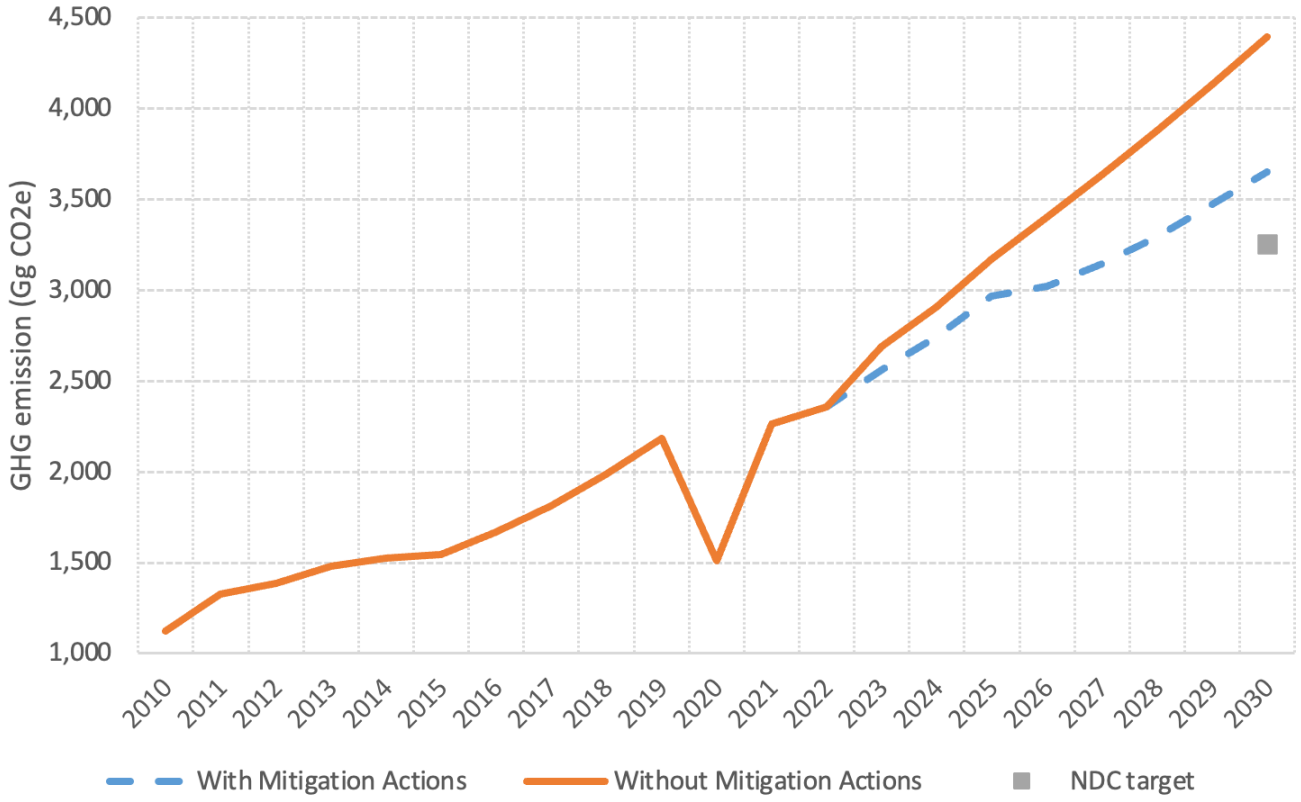


Figure 39: Emission scenario illustrating the progress towards the NDC targets from Mitigation Actions

To achieve the net-zero target, it is clear that Maldives must accelerate mitigation actions and explore innovative and new approaches of emission reduction. It requires significant support in terms of finance and access to technology. Key technology needs for net-zero target includes:

- A net-zero technology to meet baseload demand,

- Affordable and sustainable energy storage solutions,
- Net-zero technology for marine and air transport.

Additionally, the Maldives would need to explore new and innovative approaches to enhance resource use efficiency in order to reduce emission from waste and minimise energy consumption while maximising productivity and gain a quantitative understanding of available carbon sinks in Maldives.

04

INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION UNDER ARTICLE 7 OF THE PARIS AGREEMENT

CHAPTER 4: INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION UNDER ARTICLE 7 OF THE PARIS AGREEMENT

As a low-lying island nation, the Maldives faces considerable challenges from climate change, which threatens its ecosystems, vital economic sectors, and the well-being of its people.

This chapter provides a comprehensive overview of the sectors deemed national priorities in climate policy, highlighting their significance and specific vulnerabilities to climate impacts. The priority sectors examined include: (a) Agriculture, focusing on food security; (b) Infrastructure, including land loss, beach erosion, and the resilience of critical infrastructure; (c) Public Health; (d) Water Security; (e) Coral Reefs and Biodiversity, aimed at conserving natural resources; (f) Tourism; (g) Fisheries; and (h) Early Warnings and Systematic Observation, crucial for effective monitoring of weather, climate, and disaster management.

Furthermore, this chapter explores the effects of climate change on each of these key sectors in the Maldives, investigates the adaptive measures being implemented, and identifies the barriers that impede progress toward enhancing resilience.

4.1 Methodology and Approach

The methodology employed for the adaptation chapter of the BTR adopts a systematic approach to assess the impacts, risks, and vulnerabilities posed by climate change across eight critical sectors identified in the Maldives' national communications: Agriculture, Infrastructure, Public Health, Water, Coral Reefs and Biodiversity, Tourism, Fisheries, and Early Warnings and Systematic Observation.

This comprehensive assessment synthesises scientific literature, existing national reports, and studies previously conducted for national communications, complemented by stakeholder consultations across both northern and southern regions of the country. Additionally, a thorough analysis of relevant government policy documents and sectoral plans enabled the identification of national adaptation policies, strategies, and actions. Details of the institutional arrangements and the BTR process including stakeholder consultations and validation is addressed in Chapter 1.

4.2 Enhancing Agriculture and Food Security

The agriculture sector in the Maldives is primarily homegrown and semi-commercial, focusing on the cultivation of tropical fruits, and vegetables in homestead gardens. Root crops are commonly grown in the southern atolls. These crops are integral to the local food system, playing a crucial role in dietary sustenance and contributing significantly to food security. A narrow category of cash crops such as chilli, watermelon, cucumber and collard greens (local kale) are commercially grown for local markets. Despite the challenges of limited land, inherent poor soil, and climate

change impacts, agriculture remains vital for local livelihoods and food supply. An estimated 8000 farmers are registered across the country, with women comprising 54% of this group. However, the sector faces an ageing workforce and low youth participation (MOFMRA, 2019), with only 6.9% of farmers being young people (MBS, 2023f).

Agriculture in the Maldives face challenges from limited land, soil fertility and changing climatic conditions. Cash crop cultivation in the agricultural island of Thoddoo. **Photo**: Adam Adheel

Agriculture contributes about 1% to the GDP of the Maldives (MOT, 2023a) due to limited arable land and freshwater resources, challenging growing conditions, and a heavy reliance on food imports to meet the population's needs. Both public and private investment is minimal, with the country heavily dependent on food and agricultural imports. In 2022, imports of fresh agricultural crops totalled approximately USD 216.2 million (MCS, 2024), with over USD 38.1 million worth of those crops potentially producible locally.

The Maldives has approximately 4,000 hectares of arable land (FAO, 2012). Currently, around 670 hectares or 2.82% of the land cultivated for agriculture (ADB, 2020a). Islands are leased for agriculture and fisheries to promote local agricultural production and food security. In response to the COVID-19 crisis, the Maldivian government prioritised 17 essential crops and initiated an import substitution program to enhance food security and revenue through different mechanisms, including contract farming (Sun.mv, 2022).

Due to insufficient local production of agricultural staples, the Government assigned the State Trading Organization (STO) to import staple foods like wheat, rice, and sugar, and distribute through its retail outlets and authorised agents to ensure food security. Private businesses also

import food and agricultural products to meet the country's needs. Over the years, efforts have been made to enhance storage facilities, distribution networks, and supply chains. Currently, there are three storage and distribution centres which are operational in the northern, central, and southern regions, ensuring around 2-3 months' supply of staple foods. Additional storage facilities are needed across the country with necessary climate proofing for long-term food security.

4.2.1 Climate Change Impacts, Risks and Vulnerabilities

The following risks and challenges are highlighted from assessments conducted for the on-going National Communications and BTR consultations, which highlight the vulnerability of Maldivian agriculture and the need for enhanced resilience and adaptive strategies to ensure food security.

Limited food production, driven by scarce cultivable land and insufficient fresh water for irrigation on small islands, has been identified as a significant challenge for the Maldives (MEE, 2016). Low production subsequently led to food imports to enhance supply. However, as a result, food costs remain high for the community, with households spending an average 23% of monthly income to meet their dietary requirements (MBS, 2019).

Main climate-related risks affecting the sector include strong winds, torrential rains, floods, and storm surges along with rising ambient temperatures and prolonged dry periods (NDMA, 2022). Sea swells and surges contribute to the salinisation of agricultural lands, degrading soil quality and impacting production. The sector is also experiencing climate variability, further complicating farming conditions.

The agriculture sector mainly depends on sufficient precipitation to meet water and food needs. However, some climate scenarios predict that parts of the Maldives may experience droughts leading to challenges in water sourcing (ADB, 2020b, 2020c, 2020d). Similarly, due to lack of infrastructure and awareness, farmers face challenges in water collection and distribution to irrigate agricultural lands.

The Maldives is highly vulnerable to food supply disruptions due to extreme weather and fluctuations in supply and demand in import markets. Local distribution challenges, particularly delays in sea transport from rough weather, can also lead to food shortages on some islands and disrupt the availability of agricultural inputs like seeds and fertilisers. A significant challenge to food availability is also the limited space and insufficient quality storage on various atolls, which restricts the ability to stockpile essential supplies.

Assessments conducted in the North and South Maldives identified challenges for farmers in the islands, including limited finance, insufficient technical knowledge, pest control issues, difficulty accessing fertilisers, lack of awareness of best practices in fertiliser and pesticide use, crop loss due to heavy wind, rain, and droughts, lack of irrigation techniques and poor-quality groundwater with high salinity (Island Communities, 2024). Reliance on unregulated, unskilled labour further exacerbates these issues.

Research and extension support is vital for the sector development, capacity building, improving the quality of crops and to address climate change impacts facing the sector. Currently, this service is centrally managed by the Ministry, but a decentralised extension support mechanism is needed to enhance the efficiency and effectiveness of services provided to the agricultural community. The existing Hanimaadhoo Agriculture Centre (HAC) under the Ministry of Agriculture and Animal Welfare (MoAAW) needs further support and capacity building to effectively deliver their services.

Farmers face frequent pest outbreaks during prolonged dry periods. Increase in temperatures alter the behaviour of pests and diseases in terms of their capacity to adapt and pest severity. Favourable conditions for pests can accelerate the development of resistance, leading to increased reliance on chemical pesticides.

4.2.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

Efforts to enhance agricultural productivity and sustainability are being undertaken by MoAAW, and stakeholder agencies. The government's focus is on improving crop yields, diversifying agricultural production, and adapting to climate variability. Concerted efforts are required to enhance agricultural infrastructure, improve pest management practices, promote sustainable water management, and strengthen resilience against climate impacts. Supporting local farmers in adopting climate-resilient agricultural practices and reducing dependency on imports are also crucial steps towards advancing the agricultural sector in the Maldives. The government has undertaken several activities in the past to enhance food security through agricultural productivity and improved storage and distribution. This includes a National Fisheries and Agricultural Policy (2019-2029) developed to synergise the different adaptation measures.

Adaptation strategies of the Maldives agriculture sector include;

- Implementation and promotion of contract farming and programmes to produce crops to enhance food security by reducing the dependence on agricultural imports, thus decreasing the vulnerability to shocks in food production and supply chain of exporting markets. Integrating agricultural programmes with the tourism sector is also planned to boost agricultural development and enrich community tourism experiences.

- Increasing the number of islands with strategically established food storage facilities aims to prevent shortages during extreme weather events. Solar-powered cold storage facilities and distribution centres have been developed in nine islands.

- Sustainable diversification of agricultural practices, including urban agriculture and products for the environment, economic and social benefits to the surrounding communities, especially women and youth and enhancing food security and nutrition (FAO, 2022). Such a pilot was initiated in Hulhumale' in the Greater Male' region following the COVID19.

Small scale farmer using AutoPot System in a greenhouse. Photo: Adam Adheel

- Enhancing and expanding e-agriculture information dissemination, training and extension system for the delivery of agriculture advisory services for sustainable management of resources and protect vital ecosystems (FAO, 2022).
- Implementation of agroforestry and coconut re-plantation programme aimed to decrease import of agricultural products and rejuvenate the ageing coconut plantations. The programme will potentially support food security, enhance the forested areas thereby improving the microclimatic condition in the islands and contribute to overall climate resilience.

- The training, extension, and research system needs to be strengthened by integrating climate-adaptive research, enhancing R&D infrastructure, and establishing food quality standards, such as Good Agricultural Practices (GAP).
- Agriculture legislation and regulations are needed to strengthen the domestic farming community by overseeing farmers, farmland, and agricultural assets. This framework will enhance economic and social incentives for cultivating local staple crops and poultry production, which, in turn, improve food security and bolsters climate resilience by reducing dependency on imported food supplies.

4.2.3 Adaptation Priorities and Barriers

Some of the key barriers and constraints to climate adaptation in the agriculture sector include:

- The lack of adequately sized and fertile land hampers agricultural development and food production. Addressing this requires support to identify and implement alternative technologies, such as vertical farming, hydroponics, and soil enhancement techniques. These innovations can optimise land use, improve soil fertility, and boost productivity, contributing to food security and sustainability in challenging environmental conditions.
- Technological and financial constraints in developing modern climate-smart agriculture

facilities to produce high yield crops to meet the local demand and increase food security.

- To enhance nutritional security and promote local farming, it is essential to focus on branding and marketing local organic agricultural products and high-quality produce.
- The lack of awareness and inadequate climate finance mechanisms hinders efforts to address the impacts of extreme weather and damage to agricultural livelihoods. Potential solutions are needed to market and expand on the existing mechanisms such as Crop Takaful, and by the introduction of parametric and other insurance schemes to provide farmers with timely payouts based on predefined weather conditions or events, helping to mitigate losses and support recovery.

4.3 Infrastructure Resilience (Including Land Loss, Beach Erosion and Human Settlements)

Due to the low-lying nature of the islands and other inherent vulnerabilities, the Maldives faces significant risks from climate change, including rising sea levels, coastal erosion, and extreme weather events. Infrastructure plays a crucial role in the country's development and economic well-being, yet the physical characteristics as a coral atoll nation make its critical infrastructure especially vulnerable. Given the small size and natural layout of coral islands, key infrastructure and facilities are often built near the shoreline, increasing its exposure to climate-related impacts. Coastal hazards such as sea swells, storm surges, and flooding present significant threats.

Both the First and Second National Communications (FNC and SNC) have identified the key infrastructure at risk, including airports, utility and health facilities, ports and harbours, communication infrastructure, and human settlements. Since these critical infrastructure and service facilities are situated close to the shoreline, they are highly susceptible to coastal hazards. Any disruption to such critical infrastructure could severely affect the daily functioning of society.

Velana International Airport, the primary gateway to the Maldives, requires robust shoreline protection to enhance resilience against climate change impacts and rising sea levels. **Photo:** MACL

4.3.1 Climate Change Impacts, Risks and Vulnerabilities

This section outlines the critical vulnerabilities faced by the Maldives in terms of land loss and beach erosion, impacts on key infrastructure, and risks to human settlements, drawing on a combination of government reports, scientific studies, and climate assessments.

4.3.1.1 Land Loss and Beach Erosion

The Maldives' islands are made of coral limestone, rendering them among the least defensible against sea-level rise. Over 80% of the country's land is less than one metre above mean sea level(MHAHE, 2001), and projections suggest that even a modest rise of 1 metre could submerge a significant portion of the islands (IPCC, 2018). Many islands, particularly smaller ones, are at risk of being inundated from sea level rise.

Beach erosion is a significant concern for the Maldives due to its geographic nature, posing an ongoing challenge, especially in densely populated islands (MEE, 2016). Over 60% of inhabited islands face severe beach erosion, threatening both biodiversity and human settlements (MEE, 2015a). The nation's small size, combined with strong tidal and current patterns, makes its beaches highly dynamic, with shifts occurring seasonally and increasingly influenced by climate change. These trends have been documented since the late 1980s, with the frequency of severe erosion rising significantly (MEE, 2015b). Current rates of sea level rise are widely believed to exacerbate the problem, contributing to widespread erosion(Webb and Kench, 2010).

4.3.1.2 Impact on Human Settlements

The Maldivian population is dispersed across 187 islands, (MBS, 2022b) with the majority of settlements, including 47% of all housing structures (representing 42% of the population (MEEW,

2007a)) and critical infrastructure located within 100 metres of the shore. Additionally, about 80% of the land is less than 1.5 metres above mean sea level (MPND, 2007). Due to this low elevation and low setback from the shore, residential areas are highly vulnerable to coastal erosion and inundation. Future climate scenarios predict that critical infrastructure on many islands will be exposed to flooding and damage under projected sea level rise scenarios (MEE, 2015b). Furthermore, the small size of the islands, along with historical settlement patterns that placed homes and essential facilities near the shorelines due to a traditional reliance on fishing, (Husny, 2013) has resulted in inherent vulnerability.

4.3.1.3 Impact on Critical Infrastructure

The international airports, ports and harbours, tourist infrastructure and accommodation, telecommunication infrastructure, and utility facilities are largely located within 100 metres of the shoreline, as are 70% of fisheries and over 75% of communication infrastructure, putting them at high risk of climate impacts (MEE, 2015c). Due to land scarcity, many airports are also built on reclaimed land in the Maldives, requiring careful planning and strong shoreline protection against extreme weather events. This was evident on 14 May 2021, when torrential rain, strong gusts of wind, and tidal surges caused significant damage to the airport terminal, runway, and connecting causeway in HA. Hoarafushi island, halting airport operations for almost a month (Abdulla, 2021).

In April 1987, extraordinary high sea waves during a storm caused significant damage to Male' International Airport and its surrounding areas, including the capital Male'. As the only international gateway at the time, the airport on Hulhulé Island was severely impacted, with its facilities damaged, seawalls overwhelmed. Private property in Male' was also affected. The total damage was then estimated at over USD6 million (Orishimo, 2022), with repairs to the airport alone costing around USD4.5 million (MEEW, 2007b). The devastating impact of the Indian Ocean tsunami in 2004 incurred further damage to the airport estimated at over USD4.9 million.(MNPD, 2005)

The Maldives relies heavily on desalination systems for freshwater, particularly in Male', where over 41% of the population lives (MBS, 2022b). Disruptions to these facilities can lead to severe water shortages, as seen during the December 2014 crisis, when damage to the MWSC facility led to the declaration of a state of disaster (IFRC, 2014). Meanwhile, flooding from heavy rains is a growing issue in Male', with inadequate drainage causing business disruptions, property damage, and threats to its critical infrastructure. Coastal flooding on other islands, such as GA Villingili, has also led to health crises, with 30% of water services on the island disrupted during a monsoon event (JICA, 1987). The vulnerability of these critical facilities illustrates the urgency for integrated adaptation measures across the islands of the Maldives.

Coastal hazards have also consistently caused significant damage to utility and transport infrastructure. The 2004 Indian Ocean tsunami highlighted the extreme vulnerability of the Maldives' ports and harbours, telecommunications, and water systems, causing an estimated

Torrential Rains in Male'— Impacts Critical Infrastructure and Water Security

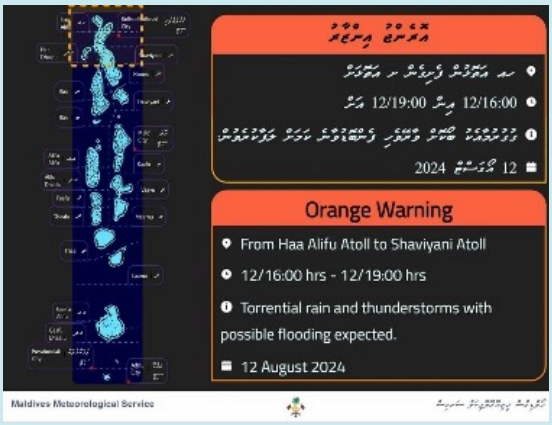
Male', the capital and home to over a third of the population, is the Maldives' business and administrative hub. Since 1969, population growth, housing demands, and urbanisation, has led to the expansion of land are of Male'. This, combined with the island's low ground elevation, has increased the island's vulnerability to wave action and flooding, a risk worsened by climate change and extreme weather events.

Aerial view of Male' City. Photo: Water Solutions

Record Heavy Rain and Flooding Events

Frequent heavy rains and sea surges cause flooding, property damage, and business disruptions, especially during the monsoon season when rainfall averages 150-230 mm per month. Despite MMS early warnings and NDMA advisories, drainage systems are often overwhelmed, disrupting daily life and economic activities. Male' saw a record 200 mm of rain on 11 December 1998. It was surpassed on 5 December 2018 with 223.5mm, severely flooding the city, damaging 117 homes and cutting power to 168. In December 2023, another extreme weather event recorded 179.7 mm of rainfall in 24 hours (Data source: MMS).

In August 2024, intense Southwest Monsoon rains led to severe flooding, especially in the northern atolls. On 12 August, Kelaa in Haa Alif Atoll recorded a new 24-hour local island high of 231.5 mm. Rains spread to the central atolls by 13 August, escalating weather alerts from yellow to orange, with



warnings of heavy rain and thunderstorms from Kaafu to Alifu Dhaalu. Hulhule recorded 47 mph gusts. With prolonged rainfall exceeding 89 mm on 13-14 August, severe flooding impacted all neighbourhoods in Male', with some areas knee-deep in water. Boreholes supplying water to desalination plants risked clogging, threatening the city's water supply, while sewage overflowed, raising health concerns (MCCEE, 2024a). A crisis was declared, with a national emergency task force activated. Water was pumped out, but around 200 properties remained affected, while some households were relocated.

This event highlighted infrastructure vulnerabilities of Male', reminiscent of the 2014 water crisis when a fire at the desalination plant led to a citywide water shortage and calls for international assistance. It highlights increasing climate risks, emphasising the urgent need for investments in drainage systems, flood control, and water security measures. Without them, the city remains vulnerable to worsening extreme weather events and water shortages, which are predicted to become more frequent and severe due to climate change.

USD 20.3 million in damages to transport infrastructure alone (ADB and WB, 2005). By 2005, it was estimated that coastal harbour infrastructure valued at approximately USD 200 million had been constructed on inhabited islands across the Maldives. However, a significant number of those harbours were not designed to endure severe weather events or the anticipated impacts of future sea level rise (A Shaig, 2006). Since then, improvements have been made in newer harbour designs (MCI, 2024). Designing, engineering, and implementing climate-proofing measures for such infrastructure can result in significant savings as it mitigates risks from extreme climate conditions. However, this is extremely costly and place additional strain on public funds.

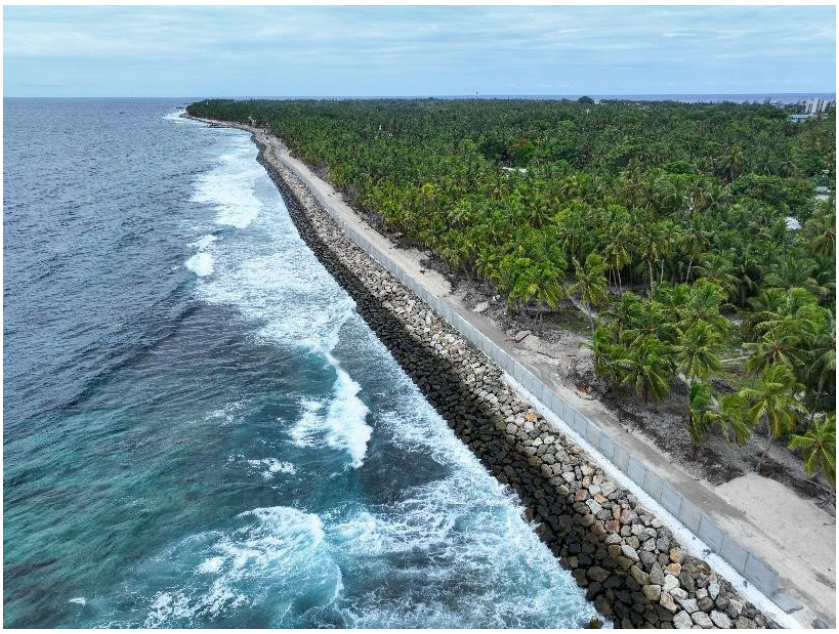
While the Maldives experiences fewer cyclones than other countries in the region, it is still affected by cyclonic disturbances during the southwest monsoon season, from October to January (MEE, 2016). An analysis of cyclone tracks reveals that 11 cyclones crossed the Maldives over a span of 128 years, from 1877 to 2004 (UNDP, 2006). Beyond that period, the strongest cyclone to impact was on 30 May 1991, which disrupted sea transport for nearly two weeks, caused widespread damage to property across 13 atolls and displaced people from their homes. More recently, on 29 October 2012, another cyclone severely affected the northern and central atolls (EHA et al., 2006). Extreme weather continues to disrupt public transport services and logistics, hindering access to essential services like healthcare and the delivery of vital goods, including food and other necessary supplies.

4.3.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

In recent years, Maldives has been experiencing high frequency, low-impact hydro-meteorological events due to changes in weather patterns, causing storm surges and often, coastal flooding. To address these challenges, the country has embarked on various adaptation measures across different sectors, including infrastructure protection, coastal resilience, early warning systems, and systematic research. A key priority for the Government is to strengthen adaptive capacity and build climate-resilient infrastructure and communities to address current and future vulnerabilities.

4.3.2.1 Managing Land Loss and Beach Erosion

To address climate adaptation needs for land, beaches, and human settlements, key priorities include strengthening land-use planning, building capacity in coastal protection, management, flood control, protecting beaches through soft and hard-engineering solutions, and safeguarding island house reefs to maintain natural defences for enhanced resilience. Additionally, improving building designs and regulations, as well as integrating climate change adaptation into national planning processes and disaster management are key priorities. The beach systems in the Maldives are also highly dynamic which has made land loss and beach erosion a concern for many islands. This has driven both the Government and the private sector to implement immediate coastal protection measures.



Often, hard engineered measures are seen as the only viable solution for protection from extreme conditions. Revetments in Fuvahmulah. **Photo:** Water Solutions

Due to the lack of physical space and the absence of high ground, implementing international best practice strategies like retreat, accommodation, and protection is highly challenging on small coral islands. As a result, hard protection structures are often the only feasible solution. The most common erosion prevention measures in the Maldives include revetments and seawalls, followed by nearshore breakwaters and groynes (MHE, 2011). In 1987, the Maldivian government, with Japanese assistance, constructed concrete tetrapod-design breakwaters and seawalls around the capital, Male', to protect critical infrastructure, where over 25% of the population resided at the time (JICA, 1987). The project's estimated cost was about 41% of the GDP in 1987 and 10.4% of the GDP upon its completion in 2001.[1] In the past, coral stones were used for shore protection, but after coral mining was restricted in 1992 (Naseer, 1996), sand-cement bags have gained popularity as a temporary or semi-permanent measure for controlling erosion. However, these also proved inadequate against severe weather. After the 2004 Indian Ocean tsunami, the policy shifted to using rock boulders for breakwaters and revetments as a better solution. Furthermore, newer designs of breakwaters and groyne have incorporated additional functional features, such as a green buffer along breakwaters which enriches the coastal landscape, serves as roosting sites for marine birds and as platforms for recreation.

Soft coastal protection measures, such as beach replenishment, coastal vegetation, and raised ridges, are used to enhance the natural environment. Other methods include building structures on stilts, creating artificial reefs for reef regeneration, and preserving seagrass beds and mangroves to prevent erosion. However, harsh environmental conditions and design limitations often hinder effective implementation. Tourist resorts frequently combine these soft measures with hard engineering solutions to maintain the natural coastline's aesthetic appeal.

1 Estimation based on GDP in 1987 and 2001, and value of Seawall Construction Project for Male' Island (USD 58 m) in FNC (MCPW, 2001)

4.3.2.2 Critical Infrastructure and Climate Resilience

Given that critical infrastructure assets are located near the shore in the Maldives, adaptation measures are crucial for addressing the risks posed by sea-level rise and extreme weather events.

As the main gateway to the Maldives, Velana International Airport (VIA) requires risk minimisation with hard engineered shoreline defences. Protecting VIA is deemed critical for maintaining the country's economic activities. Given the potential risk to the Maldives' international connectivity, efforts are being made to upgrade airports in HDh. Hanimaadhoo and Seenu Gan to accommodate international flights and as well as to be used as alternative gateways in case of emergencies. Additionally, there is a need to collect comprehensive elevation data for future development projects to assess the impacts of sea-level rise effectively (MEE, 2015d).

The Maldives is protecting settlements and critical infrastructure by expanding habitable land through reclamation projects in urban centres, while raising ground elevation between 1.5 and 1.75 meters above mean sea level (Amores et al., 2021). To safeguard the shoreline and climate-proof critical infrastructure, a combination of hard and soft engineering methods is employed.

4.3.3 Adaptation Priorities and Barriers

The Maldives faces several barriers in adapting to the impacts of climate change on critical infrastructure, land loss, and beach erosion. These include financial, technical, institutional, environmental, and social challenges:

- Limited access to affordable financial resources poses a significant barrier to the implementation of climate change adaptation efforts in the Maldives. Coastal protection measures, such as seawall construction are expensive, and the country's small GDP makes these investments difficult without international support. This reliance on external funding also raises concerns about the long-term sustainability of such projects (MECCT and JICA, 2023). Due to the gravity of the problems, even with these challenges, the Government spends a significant portion of the national budget annually on climate actions. An estimate from 2017 suggests that at least 35% of climate-related investments are funded from the national budget, though this figure likely falls short of the actual funding levels (ME, 2019a).

- Well-designed coastal protection and weather forecasting require technical capabilities often unavailable locally, such as expertise and skills to formulate necessary interventions addressing climate change impacts and climate related issues, leading to a reliance on external expertise and technology transfer. Furthermore, the low-lying, scattered islands limit options such as retreat or raising infrastructure above projected sea level rise (MECCT and JICA, 2023). Insufficient long-term monitoring of sea level rise, erosion, and other climate impacts has limited data-driven decision-making (MMS, 2023).

- Limited human resources and institutional capacity hinder the implementation of large-

scale adaptation projects (MECCT and JICA, 2023), as well as the enforcement of environmental regulations aimed at balancing development with environmental protection (MEE, 2015b), considering the impacts of climate change.

4.4 Public Health

The Maldives' healthcare delivery system is organised in three tiers, where island-level health facilities refer patients to secondary or some tertiary health-care services in the atolls, or more specialised tertiary care services in Male'. This multi-tiered approach ensures a broad reach, though the reliance on sea transport for inter-island referrals and services can be challenging, especially during adverse weather conditions. Due to the population being dispersed across small islands, the government faces challenges related to the diseconomies of scale in providing healthcare (MOH, 2016). There are 188 government-run health facilities, of which 183 are located in the outer islands, the remainder being in the Greater Male' Region (Male', Hulhumale' and Vilimale') (MOH, 2024). Since 2014, the government has formed a partnership with the State Trading Organisation (STO), outsourcing the provision of medical supplies for the public healthcare system (MOH, 2016).

The health of the Maldivian population has significantly improved over the years, with notable increases in life expectancy and reductions in fertility and mortality rates. However, the country faces an epidemiological transition, shifting from communicable diseases to a growing burden of non-communicable diseases (NCDs). Cardiovascular disease risk affects 13.6% of the population aged 40–64 (MOH et al., 2022), and malnutrition, particularly among children and adolescents, remains a concern. Micronutrient deficiencies, such as anaemia, are prevalent, with 50% of children and 63% of women affected (MOH and DHS, 2018).

The Ministry of Health, mandated by the Public Health Protection Act (Law No. 7/2012), serves as the government agency overseeing the regulation of public health services. As part of its commitment to improving and expanding health services, the government has focused on increasing accessibility at the peripheral levels. Due to the geographic challenges posed by the dispersed islands of the Maldives, timely access to tertiary medical services necessitates land, air and sea ambulance support. To provide reliable and accessible health services, a sea ambulance service was introduced in 2014 (PO, 2014) while an air ambulance service was introduced in 2024 (MFR, 2024). A National standard for Ambulance Services was established in 2023 (MOH, 2023). To enhance affordability and access to health care, the Maldives introduced a state-sponsored universal health insurance program called "Aasandha" for all citizens. Private health insurance schemes are also available, primarily targeting the corporate sector.

4.4.1 Climate Change Impacts, Risks and Vulnerabilities

Climate models have shown that the rise in mean atmospheric temperature, increase in the number of warm days, increased precipitation and extreme weather events are the main climate drivers that are likely to impact health in the Maldives (WHO and UNFCCC, 2016). The impacts

of climate change on public health have been identified and documented in this BTR using national statistics, reports, and literature reviews. These include an increased risk of vector-borne as well as waterborne diseases. Increasing frequency and intensity of extreme events such as storm surges and rough seas hinder access to healthcare facilities in the Maldives. The existing surveillance systems, while robust, do not yet fully integrate climate-related data, limiting the country's ability to monitor and respond to the climate change and health impacts effectively.

4.4.1.1 Impacts on Public Health

Flooding incidents in the Maldives have increased, contributing to outbreaks of waterborne diseases (MEE, 2016; MHAHE, 2001). This confirms WHO assessments, which highlight that many of the world's most dangerous infections are climate-sensitive. Factors such as temperature, precipitation, and humidity directly influence the life cycles of vectors and pathogens, as well as the transmission of waterborne and foodborne diseases. Climate change exacerbates these conditions, potentially hindering progress in controlling disease spread (WHO and UNFCCC, 2016).

The re-emergence of eradicated diseases, such as malaria, is an anticipated impact of climate change on health in the Maldives. Although malaria has been eradicated in the country since 1984 (WHO, 2016) and has not been a significant issue historically, climate projections indicate a resurgence (WB and ADB, 2021). Dengue fever has been endemic in the Maldives since 1979, with outbreaks occurring almost annually. According to Health Protection Agency (HPA)'s disease surveillance data, some years have seen particularly significant outbreaks, with notable instances recorded in 1988, 1998, 1999, and more recently in 2006, 2007, 2011, 2015 and 2019. The association between climate change and health is highlighted by the link between ENSO cycles (Nino 3.4 region) and these dengue outbreaks (Figure 40). Most outbreaks occurred during La Nina years, but a 2019 outbreak emerged in a weak El Nino year, suggesting that all ENSO phases may trigger dengue. Data from 2020–2021 is an outlier because of limited human-environment interactions during the COVID-19 pandemic.

Maldives health data shows dengue fever among the top five causes of child mortality in 2020 (MOH, 2024). Research has also established connections between dengue outbreaks and ENSO events in various other regions. Depending on the intensity of the ENSO event, outbreaks tend to follow with a time lag (Gagnon et al., 2001). Similarly, national disease surveillance data from HPA indicates that other climate-sensitive diseases are also becoming more prevalent in the Maldives.

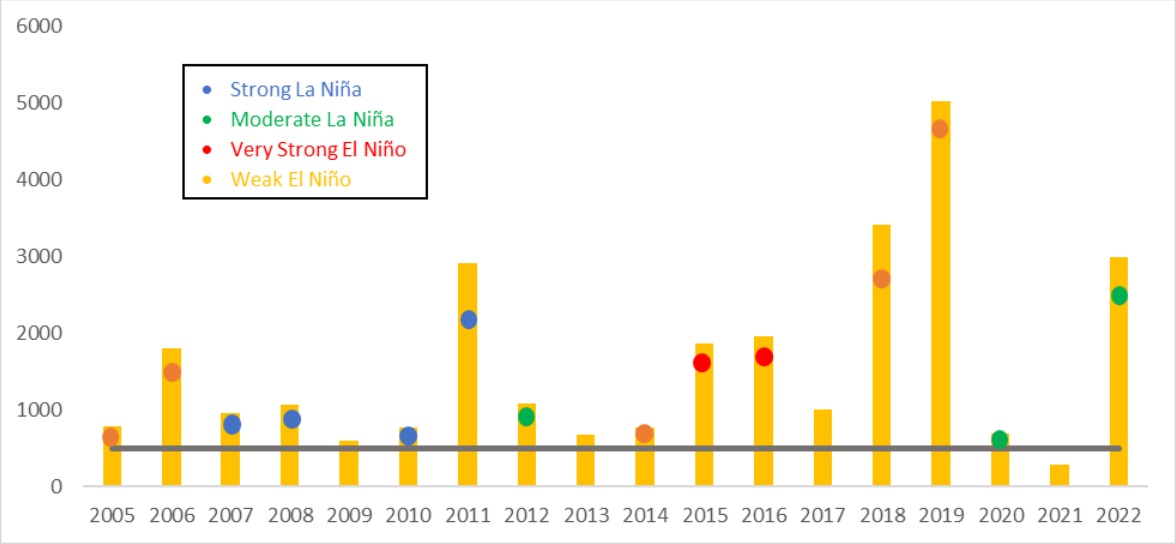


Figure 40: No. of dengue outbreak cases and ENSO years (adopted from Health Assessment conducted for TNC)

Under the high-emissions global warming scenarios, based on Shared Socio-economic Pathways (SSPs), the Maldives is projected to experience a significant rise in the annual average number of days with a Heat Index exceeding 35°C (Figure 41) (WBG Climate Change Knowledge Portal, 2021). Research indicates that the human body's ability to regulate its internal temperature becomes critically compromised once the wet bulb temperature exceeds 35°C. Beyond this threshold, even short-term exposure can lead to severe heat stress, heat stroke, and potentially death, as the body can no longer cool itself effectively (Sherwood and Huber, 2010). However, even temperatures below this survivability threshold pose serious risks to health. Rising temperatures are expected to increase the number of people vulnerable to heat-related conditions, especially among high-risk groups. Thus, MMS, in coordination with the HPA, issues public health alerts on extreme heat and related health hazards through the Common Alert Protocols. For instance, on 12 March 2024, public health warnings and advice were issued by both the MMS and HPA, as temperatures surged above normal, coinciding with the El Niño event (Public Service Media, 2024). While there are challenges in making precise localised climate projections, research highlights the significant public health benefits of adopting lower emissions pathways, making climate action a critical aspect of public health protection (Mitchell et al., 2018).

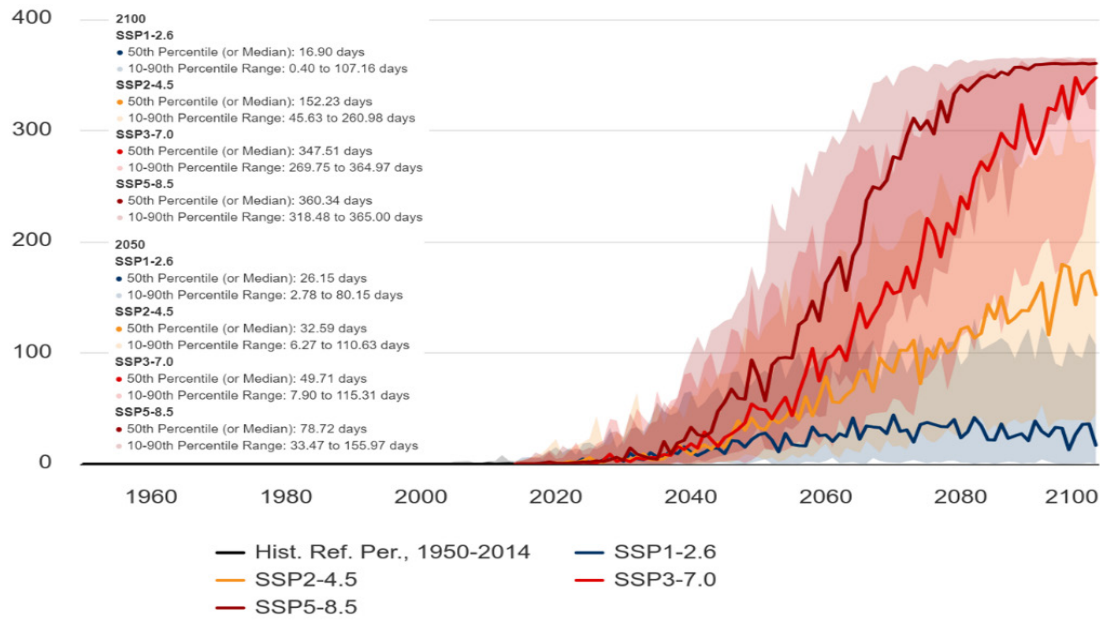


Figure 41 : Projected Number of Days with Heat Index >35°C. Maldives: (Ref. Period 1995-2014), Multi-Model Ensemble

Source: WBG Climate Change Knowledge Portal 2021.

Climate change exacerbates health conditions, including newborn health issues, mental disorders, and nutritional deficiencies, further illustrating its broad impact on the nation's health (IHME, 2023; MOH, 2021). Though local research on the impact of climate factors on non-communicable diseases (NCDs) is limited, rising heat and dry weather patterns are likely to worsen the NCD burden in the Maldives (Nugent and Fottrell, 2019). Air quality is influenced by the monsoon cycle, including rainfall patterns and air-mass transport pathways (Budhavant et al., 2015)especially during the dry winter period. However, in addition to the strong sources on mainland South Asia, there are also local Maldivian emissions. The local contributions to the load of fine particulate matter (PM2.5. In 2022, data showed deteriorating air quality in the northern region towards the year's end. Previous studies indicated that the average annual particulate matter, PM2.5 levels in Male' (19 μg/m^3) were higher than in the northern region, Hanimaadhoo (13 μg/m^3), with local emissions more prominent during the rainy monsoon (Budhavant et al., 2015)especially during the dry winter period. However, in addition to the strong sources on mainland South Asia, there are also local Maldivian emissions. The local contributions to the load of fine particulate matter (PM2.5. These PM2.5 levels, which are double the WHO-recommended threshold of 5 μg/m^3, are considered a significant contributor to NCDs.

Additionally, rising sea surface temperatures (SST) are causing coral bleaching, which disrupts the marine ecosystem and affects the availability of fish, a vital protein source for Maldivians. Sea level rise and flooding also negatively impact crop production. Malnutrition is a concern in the country, with high rates of micronutrient deficiencies like anaemia affecting 50% of children and 63% of women (MOH and DHS, 2018). Climate change is expected to exacerbate nutritional security. However, the connection between nutrition and the climate-related effects on fisheries

and agriculture remains unestablished due to a lack of data, highlighting the need for further research in this area.

4.4.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

According to the health sector assessments conducted for the TNC, several strategies and plans are being developed across the government, with updates underway at the time of this BTR.

The draft Health National Adaptation Plan (HNAP) focuses on reducing health risks posed by climate change through health system interventions, along with targeted intersectoral actions and public awareness initiatives. A key priority is building resilience in the health sector using green, climate-smart technologies which include installation of solar panels, transitioning to digital equipment such as x-ray machines and blood pressure monitors, and implementing environmentally friendly waste management solutions.

The Maldives' NDC highlights health sector adaptation strategies as a core component of national development planning. It emphasises a holistic approach to managing risks from a wide range of weather, climate, and oceanic hazards, including both extreme events and long-term climate change. This integration ensures that health adaptation strategies are part of broader national efforts to mitigate and adapt to climate impacts.

National strategies for achieving lower emissions and stronger climate resilience in the health sector include surveillance of climate-sensitive diseases, research and analysis, control of vector-borne diseases, nutrition and non-communicable diseases (NCDs), and ensuring access to healthcare during extreme weather events (MCCEE, 2022a). These strategies aim to strengthen the health system's ability to respond to climate-related challenges.

4.4.3 Adaptation Priorities and Barriers

Some of the key barriers to effective adaptation planning and implementation in the health sector are:

- The Maldives has made progress in epidemiology, but there is a need to strengthen its surveillance capacity to improve detection and response to emerging health threats linked to climate change. Priority areas include enhancing data collection, laboratory facilities, and healthcare professional training.
- Building institutional and human capacity is essential for the health sector to tackle climate challenges. Investments in staff training, legal framework strengthening, and research enhancement are critical for securing climate finance and advancing adaptation efforts.
- Integrating climate-smart solutions into the health sector poses challenges. However, initiatives like the Green Climate Smart Hospital Policy and Strategy aim to empower

communities and promote sustainable development by enabling healthcare facilities to deliver low-carbon, resilient services.

4.5 Enhancing Water Security

The Maldives, due to its coral island geology, lacks surface water resources like rivers, lakes, and streams, with the exception of a few wetlands containing brackish water. Groundwater and rainwater are the primary freshwater sources in the Maldives, but factors such as climate change, population growth, urbanisation, and pollution impact these resources. Groundwater, found 1 to 1.5 metres below the surface, traditionally accessed via open wells, is increasingly contaminated due to saltwater intrusion, improper waste disposal, and over-extraction (MEE, 2016). A 2022 study of 13 inhabited islands indicate groundwater quality is deteriorating, with freshwater availability severely limited. Most aquifers experience significant stress by mid-to-late dry season, and the thin lenses are highly vulnerable to prolonged, intense pumping (MECCT, 2022a).

With annual average rainfall ranging from 1779 mm in the northern atolls, 1966 mm in the central and 2218 mm in the southern (MMS, 2024), rainwater is a key source of potable water, particularly on outer islands where it serves as the main supply for drinking and cooking (MECCT, 2022a). Traditionally stored in ferrocement and steel tanks, rainwater storage transitioned to more durable High-Density Polyethylene (HDPE) tanks in 1994, with household tanks holding 2500 litres and community tanks 5000 litres. By 2009, total rainwater storage capacity reached 116,865 cubic metres. After the 2004 Indian Ocean tsunami, the Maldivian government distributed household and community water tanks to meet the water needs of affected communities, as the water lens on many impacted islands had been salinised due to saltwater intrusion (MEE, 2016).

Desalinated water was first introduced to the Maldives in the capital Male' in the 1980s (MECCT, 2021) and since then, the service has expanded to densely populated islands, particularly after the Indian Ocean tsunami, which severely damaged groundwater aquifers and storage facilities. Piped desalinated water has been installed in 125 islands, accounting an estimated 90% of the total population, while 134 islands have installed piped sewerage systems covering around 92% of the population (MCCEE, 2024a). The target of the government is to provide access to piped water and sewerage facilities to all the inhabited islands across the country. Additionally, bottled water is widely consumed in the Maldives.

4.5.1 Climate Change Impacts, Risks and Vulnerabilities

The key climatic stressors on freshwater resources in the Maldives include sea-level rise, which causes saltwater intrusion into aquifers, and changing rainfall patterns, marked by fewer rainy days and more intense storms, leading to water shortages. The increased frequency of storms and flooding also contaminates freshwater sources, while higher temperatures deplete limited freshwater resources, particularly during extended dry periods. Changes in the temporal and

spatial patterns of rainfall due to climate change are believed to impact water resources in islands like the Maldives (Falkland, 1992). Data from NDMA shows that precipitation-related precipitation-related floods and water scarcity have increased across many atolls in recent years. Rainfall in the Maldives varies between monsoon seasons, with the southwest monsoon bringing more rain.

The non-climatic stressors on freshwater resources are population growth, population concentration and point source pollution on the island's freshwater aquifer (MEE, 2016), with studies confirming widespread groundwater contamination from domestic sewage due to the absence of an appropriate sanitation system and uncontrolled pumping of groundwater from wells across the Maldives (Falkland, 2001). However, ensuring that water demand is consistently met through sustainable and affordable means remains a critical priority for the Maldivian people. As for tourist facilities, resort islands produce their own desalinated water, harvest rainwater from only limited buildings, and stores approximately 5 days' supply of freshwater on the island (MOT and UNDP, 2015).

For the purpose of this report, two assessments were reviewed to evaluate the impacts of climate change on water resources: vulnerability assessments conducted for the SNC on four islands (3 inhabited and 1 uninhabited) (MEE, 2016), and a baseline assessment conducted on 13 inhabited islands for the project to support vulnerable communities in Maldives to manage climate change-induced water shortages (ME, 2020b). These assessments focused on groundwater quality, rainwater availability, and their vulnerability to climate change. The islands studied represent a range of characteristics, including land cover, population density, island size, shape, location, and water use patterns, all of which influence water quality and geophysical factors.

4.5.1.1 Groundwater

Key factors affecting groundwater in the Maldives include climate, hydrology, sea level changes, island stratification, and human activities. Saltwater intrusion due to land inundation reduces freshwater availability, and the porous soil makes groundwater vulnerable to pollution from solid waste and other contaminants.

Analysis of groundwater in the islands that were assessed revealed that inhabited islands indicated contamination from human activities and salinisation. The assessments also found that areas near shorelines and low-lying regions are particularly vulnerable to salinisation from climate change-induced flooding and inundation.

Freshwater lenses, crucial for groundwater supply, are shallow and stressed, ranging from 2.00m to 8.75m. Over-extraction has led to groundwater depletion and saline intrusion. Soil permeability varies, with sandy soils supporting higher infiltration and clayey soils leading to low infiltration and water ponding during storms. Infiltration rates range from 1.13 m/day to 27.53 m/day, reflecting differences in water absorption across the islands.

Overall, the findings of both studies emphasise the need for improved groundwater management due to high population densities, over extraction by pumping, limited infrastructure, and the compounded vulnerability of low-elevation coral islands.

4.5.1.2 Rainwater

From the SNC assessments on four islands it was identified that rainwater is primarily harvested from rooftops, with more storage capacity in northern and southern Maldives compared to the central region. Dry periods, especially in the north and central areas with dry days: 56, 38 and 32 in the north, central and southern atolls respectively (Falkland, 2002), pose a challenge due to limited per capita water storage, making these regions vulnerable to extended dry spells. The assessments also revealed that rainwater storage tanks remained disconnected due to capacity issues and lack of awareness.

Additionally, trans-boundary air pollution, including the Asian Brown Cloud, can further contaminate rainwater with pollutants such as SOx, NOx, and ammonium, leading to decreased pH levels, as observed during December and January at the Maldives Climate Observatory in Hanimaadhoo (Das et al., 2011). Therefore, safe rainwater harvesting practices and robust monitoring mechanisms are essential to ensure the quality of rainwater, which is critical for the communities relying on it.

4.5.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

The combined risks and vulnerabilities highlighted in the case studies place significant pressure on water security in the Maldives, emphasising the need for sustainable management and adaptation strategies. The FNC identified groundwater protection, enhanced rainwater harvesting and storage, and stormwater management as key adaptation measures, while the SNC added desalination as an additional strategy to address water shortages and improve water security. Reverse osmosis (RO) technology, widely used to provide clean water to tourist resorts, industrial sites, and inhabited islands in the country, has seen an increase in use. However, operating RO plants in small island communities presents significant challenges.

To enhance economic viability and sustainability, the Maldives is adopting an Integrated Water Resource Management (IWRM) approach. This strategy combines the use of groundwater, rainwater, and desalinated water to create a reliable and cost-effective water supply system. By integrating these resources, the Maldives aims to ensure a sustainable water future while effectively addressing the challenges posed by climate change and water scarcity. Under the initiative, four IWRM systems and 25 Rainwater Harvesting (RWH) systems were established across 29 islands (UNDP, 2022). The government is expanding the implementation of the IWRM systems in additional islands. These systems provide a localised, innovative, and climate-smart solution to address water shortages, utilising solar energy for water production to minimise costs and carbon emissions. The systems also include piped networks with metered household

connections, where water is supplied on a tariff system. Water quality testing laboratories are integrated into the IWRM facilities, and system operators receive training to ensure the safe delivery of water.

4.5.2.1 Increasing rainwater harvesting and storage capacity

Rainwater harvesting is a traditional practice in the Maldives. However, recent studies show that the existing water storage capacity is insufficient to meet demand on some islands. To ensure island-wide water security, it is crucial to maximise rainwater harvesting and storage capacity. Beyond collecting rainwater from individual household roofs, efforts are being made to include public buildings. Safe harvesting practices and monitoring mechanisms are also essential to maintain rainwater quality.

4.5.2.2 Groundwater protection and recharge

Groundwater is vital for small coral islands, and protecting it is essential for enhancing water security and availability, particularly for agricultural communities in the Maldives. Key protection measures include developing island-wide sewerage systems within five years (ME, 2021) to reduce pollution, using efficient technologies for water extraction and aquifer recharge, directing excess rainwater into groundwater wells, and promoting skimming galleries for extraction. A water infiltration gallery system is being piloted in HDh. Nolhivaranfaru (CTCN, 2021) to promote sustainable groundwater for irrigation and safeguard aquifers against climate change.

Furthermore, increasing groundwater demand could be met sustainably by enhancing the recharge rate of water lenses. Designating football grounds and parks, alongside appropriate land-use changes, can improve groundwater recharge by acting as catchment or recharge areas. Given that water quality and detailed hydrogeological analysis are essential for assessing this option (MHAHE, 2001), baseline assessments have been conducted on 17 inhabited islands and 1 uninhabited island (MECCT, 2022a).

4.5.2.3 Stormwater Management

Stormwater management is a crucial adaptation measure needed to maximise rainwater use, address groundwater contamination from flooding, and protect livelihoods. The government is implementing adaptation measures for flood management in urban centres and flood-prone islands, including HDh. Kulhudhufushi, GDh. Thinadhoo, Gn. Fuvahmulah, and Addu City. Additionally, stormwater management is being developed in conjunction with road development projects in other islands.

The most recent flooding in Male' City on 13 August 2024, due to heavy torrential rain, overwhelmed the city's stormwater drainage systems. Despite advance forecasts from the MMS, NDMA reported that more than 200 homes impacted from the flood in the capital, necessitating

the relocation of some families while over 20 islands across the Maldives also suffered damage from the downpour (Zalif, 2024).

4.5.2.4 Desalination

Desalination is a critical climate adaptation strategy for addressing freshwater shortages in the Maldives, but it faces some challenges. The process is highly energy-intensive, relying on diesel fuel, which raises both carbon emissions and costs. Additionally, brine discharge poses environmental risks to marine ecosystems if not treated properly. Integrating desalination into the IWRM framework allows for a continuous supply of freshwater, supplemented by other available water resources, and helps lower operational costs. While reverse osmosis is the primary desalination technology in the Maldives, desalination methods that use waste or solar heat remain underutilised. Investing in energy-efficient technologies, such as those that harness waste or solar heat, is essential to provide sustainable, safe water for all inhabited islands.

4.5.3 Adaptation Priorities and Barriers

Some of the key barriers and constraints to climate adaptation in the water sector include:

- Technological and financial constraints in acquiring appropriate solutions for managing severe climate events, such as heavy rainfall and stormwater management in heavily urbanised small islands, which affect water security and resilience to climate change impacts.
- Inadequate household connections to sewage systems, coupled with the decommissioning of septic tanks and insufficient sewage treatment facilities on the islands contribute to groundwater pollution. This situation poses public health risks and leads to marine pollution, as untreated wastewater can contaminate ground water and coastal ecosystems.
- A lack of awareness and technical capacity for sustainable water resource management, along with space constraints and congestion in urban centres, poses challenges to adopting and maintaining rainwater harvesting (RWH) systems in households and public buildings. Addressing these issues necessitates further planning and the development of regulatory frameworks for the effective implementation of IWRM systems.

4.6 Safeguarding Coral Reefs and Biodiversity

The Maldives, being a coral island nation, is largely characterised by its marine ecosystems and biodiversity. The islands support rich coastal vegetation, but the diversity of terrestrial flora is limited due to the uniform topography, soil, and climate (Sujanapal and Sankaran, 2016). The country hosts around 583 species of vascular plants, including 323 cultivated and 260 naturalised species (Adams, D, 1984). Among these are 14 species of mangroves found on over 150 islands

(Saleem and Nileysha, 2011), with mangrove wetlands covering 1.41 sq km across 74 islands (MEE, 2017). Wildlife is sparse, with a few species of reptiles, amphibians, 167 species of birds (Ash and Shafeeg, 1994), and two native subspecies of fruit bats (Anderson and Baldock, 2001). Notably, one species of reptile, the black turtle, appears on the IUCN Red List.

In contrast, the Maldives is renowned for its rich marine biodiversity, making it a global hotspot for marine life. The Maldives is home to an estimated 4495 km² of reef area, distributed across 25 geographic atolls (Naseer and Hatcher, 2004). It is the seventh largest reef system in the world and represents about 3.14% of the global reef area (Spalding et al., 2001). The reefs of the Maldives support one of the most biologically diverse and vibrant marine ecosystems in the world. The key marine species types and numbers are presented in Table 19 (MEE, 2015a). The Maldives is also a critical feeding ground for several endangered species.

Table 19: Key marine species in the Maldives Source: Data from National Biodiversity Strategy and Action Plan 2016-2025. Maldives: Ministry of Environment and Energy.

Type of Species	Number
Reef Fish (Demersal and Epipelagic)	1090+
Hard Corals	250+
Algae	258+
Marine Turtles	5
Sharks	40+
Whales and Dolphins (Mega fauna)	20+

Coral reefs, along with lagoons, beaches, and mangrove habitats in the Maldives, are vital for maintaining the country's ecological balance and supporting diverse marine life. Despite challenges like coral bleaching, these ecosystems are crucial to the economy, particularly for key sectors such as tourism, fisheries, and agriculture, which together account for about 71% of employment, 89% of GDP, and 98% of exports (Emerton et al., 2009). Coral reefs support reef fishery in the Maldives providing marine food, nutrition and livelihoods for the communities. Coral reefs also provide natural coastal protection, essential for human settlements. The cost of constructing artificial structures to protect all the inhabited islands in the Maldives was estimated to be over USD 8.8 billion (MEE, 2016).

Maldives is renowned for its marine biodiversity. Soft corals and sea fan. **Photo:** Water Solutions

4.6.1 Climate Change Impacts, Risks and Vulnerabilities

4.6.1.1 Biodiversity

Biodiversity in the Maldives faces emerging threats, primarily driven by climate change and human activity. The National Biodiversity Strategy and Action Plan (NBSAP) 2016-2025 identified the following key threats and vulnerabilities to the biodiversity of the Maldives:

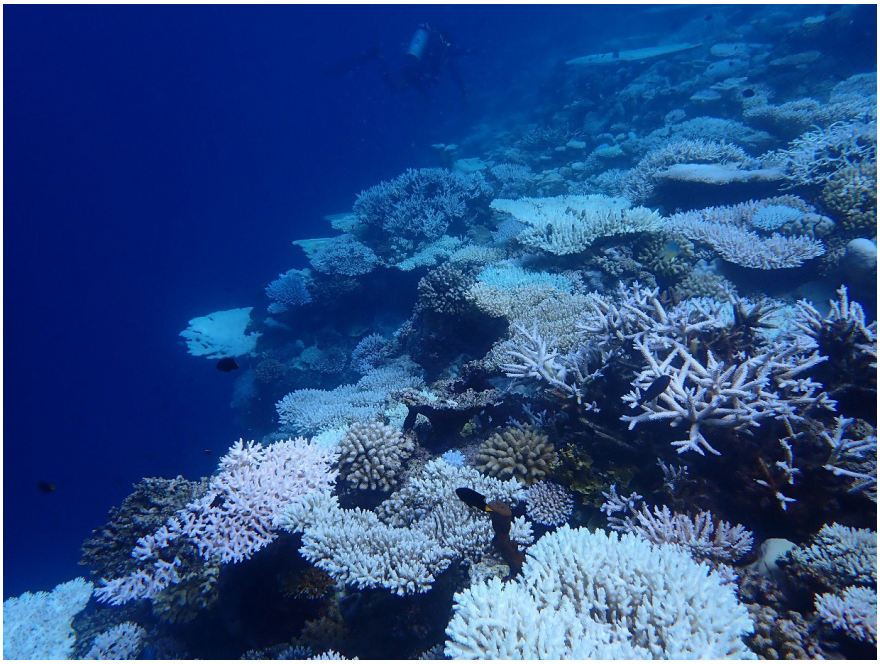
- Climate change has intensified threats like sea surface temperature rise, ocean acidification, and increased frequency of extreme weather events, causing severe impacts on biodiversity, livelihoods and consequently the adaptive capacity of people to climate change. Over 60% of inhabited islands report severe beach erosion threatening biodiversity and human settlements.

- Habitat destruction – Coastal development and human activity have led to significant modification of reefs, lagoons, beaches, and mangroves, negatively impacting these natural ecosystems and their associated biodiversity.

4.6.1.2 Coral Reefs

One of the major threats to coral reefs due to climate change is the rise in sea surface temperature (SST), which has resulted in coral bleaching and mortality (Ali and Manik, 1989; MRC, 1998; Riyaz et al., 1998). The Maldive-Chagos archipelago, being the warmest region in the Indian Ocean (Rosen, 1971), has experienced multiple coral bleaching events, most severely in 1998 (Zahir et al., 2006). Despite these events, the Maldives is confirmed to have a high coral species diversity (Wallace and Zahir, 2007). Following the unprecedented coral bleaching event of 1998, live coral cover plummeted to an average of 2% across the country. In response to the critical

impacts on the reefs, a National Coral Reef Monitoring (NCRM) program was established and is maintained by the Maldives Marine Research Institute (MMRI).



Massive coral bleaching has been observed in the reefs following warming of SST in the Maldives. Bleaching event in Coral Garden at Dhiffushi, June 2024. **Photo:** Samarey

Figure 42 shows patterns of change to coral community from 1997 to 2021 located in depths of 1–5 meters, based on the long-term coral reef monitoring sites established by MMRI. Arrows show major coral bleaching years where SST anomalies (monthly temperatures above long-term average) have been reported as per NOAA satellite-based data and tsunami 2004.

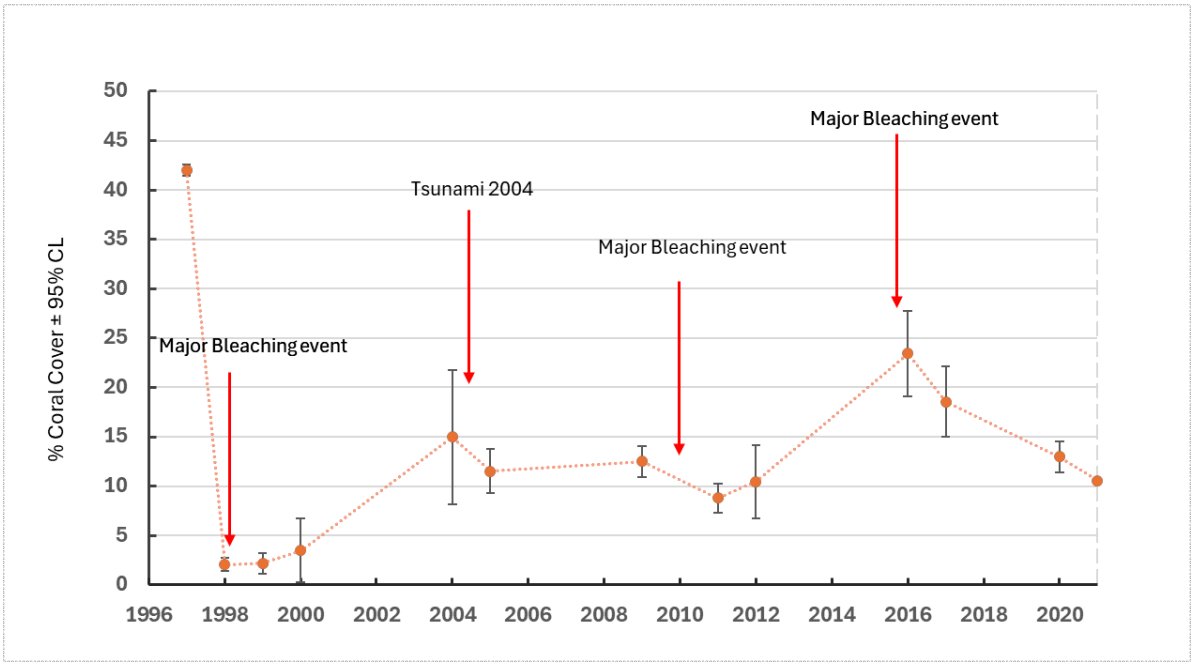


Figure 42 : National coral cover trends (1997–2021) based on MMRI long-term monitoring sites established since 1998, with major bleaching years marked. Values are % hard coral cover measures for the years where data were collected with 95% CL as error bars (Data Source: MMRI, (Zahir, 2007)).

Coral bleaching is expected to become more severe across the Maldives with future SST projections inclined to rise with global temperatures in the future. This poses significant challenges to the long-term health of coral reefs (MEE, 2015e). Ocean acidification poses an additional threat to coral reef communities in the Maldives, and its long-term impacts are not yet fully understood, making it a critical area for future research.

4.6.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

4.6.2.1 Biodiversity Conservation and Protection

The Maldives has made significant strides in expanding both protected and managed areas to conserve its rich biodiversity. Under the Environmental Protection and Preservation Act (Law no. 4/93), a total of 93 protected areas covering over 64,095 hectares, including 03 UNESCO Biosphere Reserves (BR) and 5 managed areas, 104 bird species, and 14 marine species have been granted legal protection (MCCEE, 2024b). Beyond the legally protected regions, the government is working to establish Other Effective Area-Based Conservation Measures (OEACMs). This initiative targets the reefs of islands leased for tourism, which are already well-managed and contribute to ecosystem conservation (MEE, 2015a).

The UNESCO Biosphere Reserve in Baa Atoll, established in 2011, serves as a prime example of the economic benefits derived from reef conservation in the Maldives. The area showcases how protecting coral reefs and biodiversity - with its globally significant population of whale sharks (Rhincodon typus) and the largest known aggregation of manta rays (Mobula alfredi) in the world (Harris et al., 2020; MEE, 2015f), - can enhance the tourism industry and sustain local livelihoods.

It is a priority of the government to understand the effectiveness of these marine managed areas. As such, pilot Protected Area Management Effectiveness (PAME) evaluations have been conducted at three sites: Hanifaru Marine Protected Area (MPA) in the Baa Atoll Biosphere Reserve, an OEACM site in a tourist resort, and a protected grouper aggregation site in Dhaalu Atoll (OCPP, 2023). In 2024, the Government also published the Maldives National Framework for Management of Protected & Conserved Areas 2024-2029. The Government aims to establish a network of Protected and Conserved Areas (PCAs) across the Maldives and expand the biosphere reserve network to additional atolls in the future. Developing management plans for all the designated protected areas and increasing the number of managed protected areas, including MPAs, will further safeguard the reef system and biodiversity.

4.6.2.2 Coral Reefs Monitoring

The Maldives' approach to climate change adaptation emphasises the conservation and management of coral reefs, which are essential to both the ecosystem and the economy.

Key strategies include continuous monitoring of reef health, expanding conservation efforts, minimising human impact, and raising public awareness about the importance of coral reefs. The National Coral Reef Monitoring (NCRM) program, which originally covered 16 sites from 6 administrative atolls across the Maldives in 1998, has been now expanded to almost all the atolls in the Maldives totalling 31 sites (Amir, 2022), as shown in Figure 43. This reflects a significant increase in efforts to track and address the health of coral reefs.

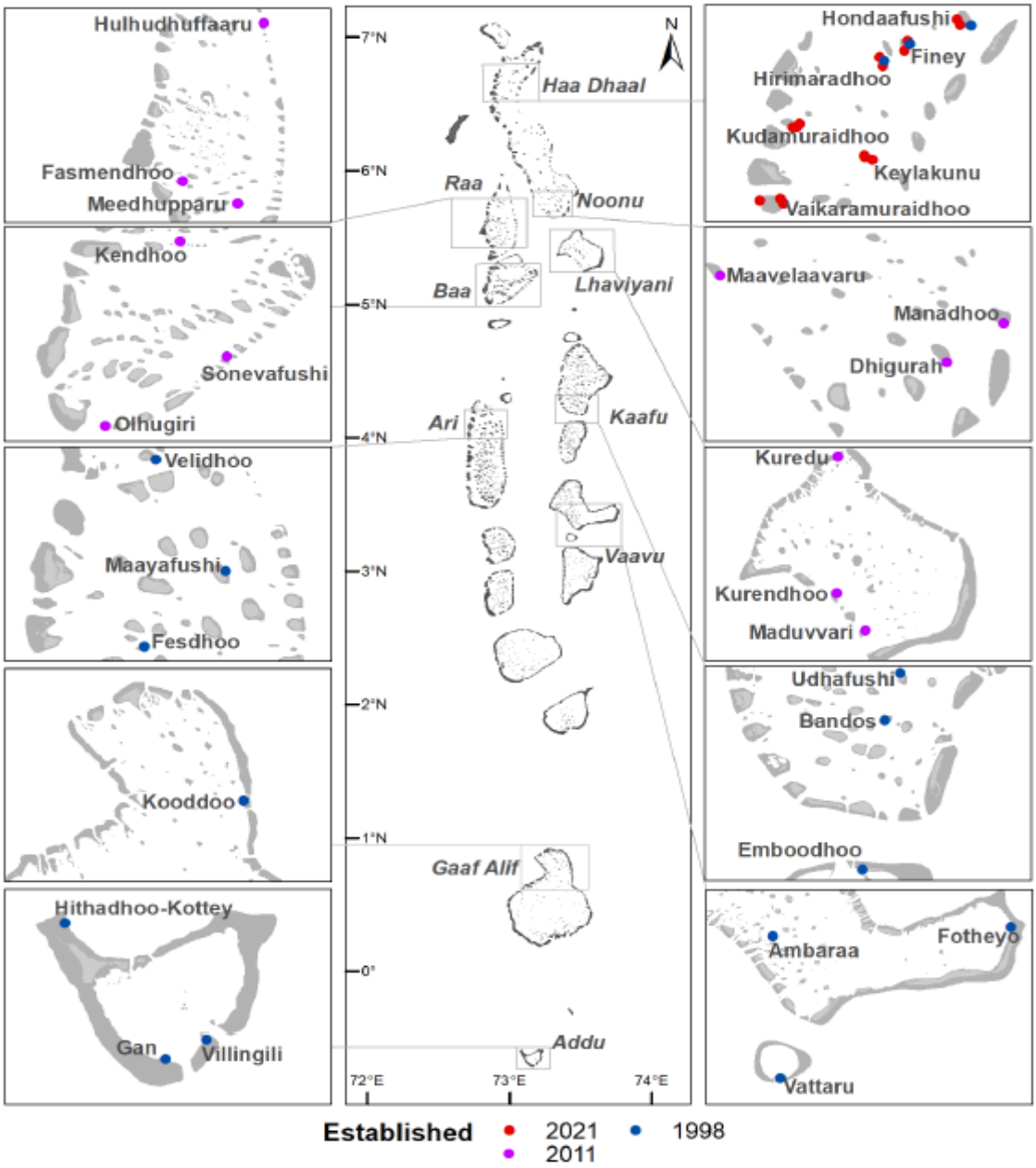


Figure 43 : Long-term monitoring sites established throughout the Maldives, with their locations in each administrative atoll and the year of establishment shown in the insets. (Amir, 2022)

4.6.2.3 Coral Reefs and Ecosystems Restoration

Coral reef restoration projects have gained momentum across the Maldives, some of which are collaborative efforts between tourist resorts, NGOs, and the Government. These projects use innovative techniques, such as attaching coral fragments to metal frames, to accelerate

coral growth using 3D printed structures (Boissonneault, 2018) to restore degraded reef areas. The MMRI initiated a national coral reef restoration and rehabilitation programme in 2019 with the aim of working towards scalable, cost-effective methods of restoration through larval-based techniques. Currently, two projects are being carried out by MMRI, with support from the Coral Research & Development Accelerator Platform (CORDAP) and in collaboration with Australian research partners, to build local capacity and scale up reef restoration efforts (Naeem, 2024). Furthermore, a large-scale coral reef restoration project was initiated in 2023 by the Environment Protection Agency (EPA) to restore 8,867 cubic metres of the reef around Rasfari Island after a ship ran aground in 2021 (EPA, 2024). Since 2020, efforts are also being made to regulate coral restoration through Projects Permit Regulations and by developing guidelines for monitoring fragment-based restoration (Naeem, 2024). In addition to reef conservation and restoration, there is increasing attention on preserving other key ecosystems. Although less widespread, seagrass conservation and restoration initiatives are being implemented in tourism areas, with the potential to maintain marine biodiversity, sustain ecosystem services (East et al., 2023), and promote climate resilience.

4.6.2.4 Biodiversity Research and Valuation

Biodiversity valuation studies have demonstrated the high value of coral reefs and marine wildlife for tourism and fisheries, highlighting their importance for conservation in the Maldives. Whale shark excursions in the South Ari Marine Protected Area (SAMPA) generated an estimated USD 7.6 million in 2012 and USD 9.4 million in 2013 annually (Cagua et al., 2014). Manta ray snorkelling and dive excursions in the Maldives contributed about USD 8.1 million per year in direct revenue between 2006-2008 (Anderson et al., 2011). A 2023 study on shark-watching scuba diving in Fuvahmulah Island estimated annual revenues between USD 2.52 million and USD 3.15 million, while scuba diving in Addu Atoll in 2019 estimated to generate between USD 16.4 million to USD 94.6 million in direct revenue for dive operators (WS, 2022).

Mangrove ecosystems are a vital part of the island geography. The uninhabited island of Farukolhu in Shaviyani atoll. **Photo:** Water Solutions

Research is underway on threatened species identification for the development of a national red list, which will support national decision-making for species protection, management, and other conservation measures. Marine turtles and coral species have already been included in this effort, while mangrove species are currently under evaluation (MCCEE, 2022b). Furthermore, pilot work in Laamu Atoll under the ENDhERI project, aims to integrate natural capital accounting into new environmental policies, promoting sustainable, green growth for atoll development. This initiative seeks to preserve marine natural capital and enhance the resilience and recovery of reef ecosystems (MCCEE, 2021). Further research on reef ecosystems and biodiversity remains a key government priority.

4.6.3 Adaptation Priorities and Barriers

Several key barriers and constraints hinder the effective safeguarding of coral reefs and biodiversity in the Maldives. These are:

- Limited financial resources and manpower to conduct comprehensive coral reef monitoring and conservation efforts at national level.
- Technological and financial constraints pose significant challenges to implementing and maintaining large-scale conservation programs, managing protected areas and developing effective management plans for designated protected areas.
- Lack of technical expertise and institutional capacity to effectively conduct critically needed research, monitor, and enforce biodiversity conservation measures.
- Limited public awareness and understanding of ecosystem value have led to prioritising activities that potentially harm the natural environment over conservation and protection efforts.

4.7 Tourism

Tourism is the cornerstone of the Maldivian economy, contributing 22.5% to the GDP in 2022 and accounting for over a third of Government revenue (MOT, 2023a). In that year, tourism generated USD 4.5 billion in receipts - a 28% increase from 2021 (MMA, 2023). The Government target is to reach USD 6 billion in tourism receipts by 2027 (MOT, 2023b). The economy is reliant on tourism, which also supports related industries and provides crucial foreign exchange. Tourism is also the major driver of foreign direct investment (FDI) in Maldives followed by information and communication technology, and transport services. In 2022, FDI flows from tourism reached USD 722 million in 2022, a 12.3% increase from 2021 (UNCTAD, 2023). Under the sixth amendment to the Maldives Tourism Act, a green tax is imposed on tourist resorts, hotels, vessels, and guest houses, with the revenue directed into a 'green fund' for environmental projects in the country.

Tourism serves as both a catalyst for economic development and a means of safeguarding the Maldives' natural beauty and cultural heritage. Community tourism, through guesthouses, liveaboards, and island excursions, provides an avenue for locals to share their traditions, making it a key source of livelihood (NBS, 2013), particularly for the youth. In 2022, tourist resorts alone provided over 55,874 jobs (MBS, 2024c), accounting for approximately 18.6% of national employment and a third of Maldivian workforce (MBS, 2022b).

The sector has experienced substantial growth since the introduction of international tourism in 1972, driven by the natural beauty of the uninhabited islands developed into resorts - majority of which are rated five-star by booking engines due to white sandy beaches, crystal clear lagoons, abundant marine life and the reef ecosystems. Tourist arrivals have grown significantly, from just 1,000 in 1972 to over 1.8 million in 2023, with generally steady annual growth. Similarly, the registered bed capacity has expanded through both local and foreign investments, reaching 62,496 by the end of 2023. These beds are distributed across 180 tourist resorts, 14 hotels, 809 guesthouses on local islands, and 146 liveaboard vessels (MOT, 2024). Additionally, 143 tourist properties, including islands, lagoons, and lands, are in various stages of development (Ministry of Tourism, 2024), while further growth of tourist facilities is anticipated on local islands.

4.7.1 Climate Change Impacts, Risks and Vulnerabilities

The Maldives' tourism industry is highly susceptible to natural disasters, external shocks, and global crises. This vulnerability was starkly illustrated by the 2004 Indian Ocean tsunami, which resulted in a 33% decline in visitor numbers in 2005, over USD 230 million in damages to tourism infrastructure and businesses, and a total asset loss estimated at 62% of GDP (MNPD, 2005). The 2008 global financial crisis further impacted the industry, which experienced a contraction in 2009 as a result (MTAC, 2012). The COVID-19 pandemic marked the steepest decline in tourist arrivals in over 15 years, with visitor numbers returning to pre-pandemic levels only in 2023 (Figure 44). The economy faced a severe downturn due to border closures and travel restrictions, leading to a major economic recession with a contraction of 32.0% and registering negative inflation of -1.4% in 2020 (MMA, 2022, 2021).

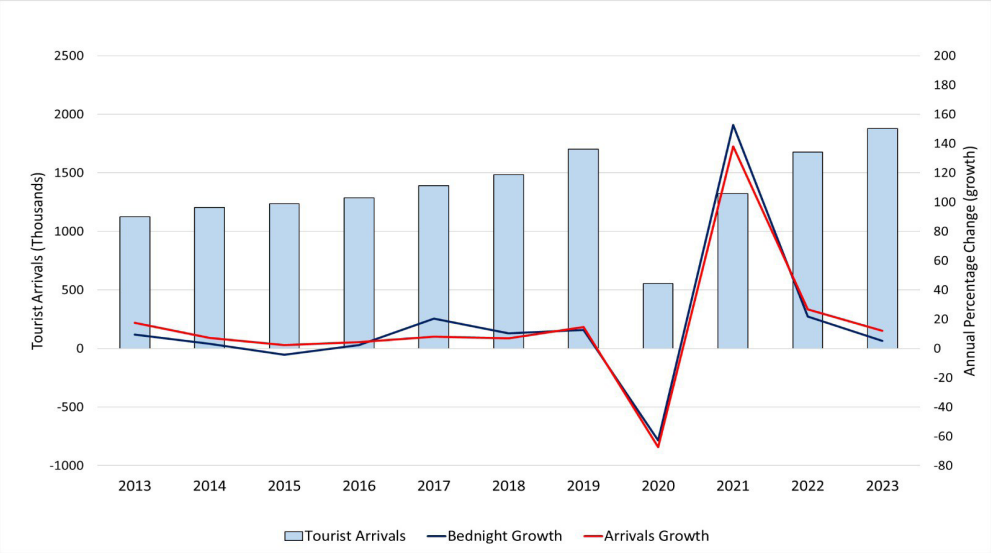


Figure 44: Tourism Indicators (2013-2023): Tourist Arrivals and Annual Percentage Change in Bednights and Arrivals, Data Source: MoT

4.7.1.1 Impacts of Climate Change

Major climate change impacts on the Maldives tourism industry, as reported in the SNC and studies (MOT and UNDP, 2013) conducted for the Maldives Tourism Adaptation Project (TAP) include:

- **Rising temperatures cause** seasonal changes and unpredictability, which may impact tourist arrivals, raise cooling costs for tourism operations, heighten heat stress for visitors, and could lead to a surge in infectious diseases, thereby reducing the destination's appeal.

- **Increasing frequency and intensity of extreme events** damage tourist infrastructure and private property, has the potential to increase insurance costs or result in loss of insurability, cause business interruption costs, and impact tourist transportation and logistics.

- **Sea level rise** leads to coastal erosion in islands causing loss of beach area, and damage to coastal infrastructure, resulting in higher costs to protect and maintain valuable beaches and infrastructure.

- **Rising sea surface temperatures** lead to increased coral bleaching and shifts in marine biodiversity, diminishing the visual appeal of dive and snorkel sites. This reduction in aesthetic value is expected to lower tourist satisfaction leading to high economic losses.

The Maldives' geography makes it highly vulnerable to natural disasters and extreme climate events (UNDP, 2006). As an identified tourism vulnerability hotspot, the Maldives faces multiple challenges from climate change impacts (Scott et al., 2008). A significant 64% of inhabited islands and 45% of tourist resorts have reported experiencing severe beach erosion (Ahmed Shaig,

2006). Tourist resorts in the Maldives demand substantial investments, generally at USD 10 million for an average resort(MHAHE, 2001) and escalating between USD 32 million and USD 217.8 million for high-end properties, with an average cost per key of over USD 1 million (RCA and CBRE, 2022). Due to limited island size and high tourist appeal, accommodations are often situated within 100 metres of the shoreline (MHAHE, 2001), and sometimes as close as 5 metres from the vegetation line. This proximity makes 99% of resort accommodations highly vulnerable to rising sea levels and intense wave action. Similarly, liveaboard safari vessels require secure anchorages and protective measures against extreme weather to minimise business disruptions, prevent damage, and avoid increased insurance costs or loss of insurability (MOT, 2015).

In 2022, 80% of visitors to the Maldives were primarily attracted by its beaches, with other popular draws including underwater beauty (59%), favourable weather (44%), unique small islands (44%), and encounters with marine life such as manta rays, whale sharks, and tiger sharks (22%) (MOT, 2022). However, with 45% of resort islands facing varying levels of beach erosion (MBS, 2020) and increasing SST affecting coral reefs, the loss of these natural assets could greatly diminish the Maldives' tourism appeal, leading to substantial economic losses, as demonstrated by the 1998-99 coral bleaching event, which resulted in an estimated loss of USD 3 million (Westmacott et al., 2000).

4.7.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

The Maldives' tourism industry is regulated by the Ministry of Tourism, as mandated by the Maldives Tourism Act (Law No. 2/99). This act ensures that all registered tourist facilities adhere to established standards, promoting sustainable tourism development. A key provision of the act is the requirement for environmental impact assessments (EIAs) for resort development projects. Under the Tourism Act regulations for the Protection and Conservation of Environment in the Tourism Industry was produced which included among others, rules on vegetation clearance for development, built-area footprint limits on resort islands, coastal modifications regulations, and standards for waste management and recreational scuba diving. Furthermore, the Ministry of Tourism developed "Environmental Guidelines for Tourist Resort Development and Operations in the Maldives" in 2005 (MOT, 2005) which was updated in 2016. In 2014, the Government issued a national Guidance Manual for Climate Risk Resilient Coastal Protection in the Maldives (MEE, 2015d) to guide coastal developments and protection. In 2024, the gazetted 'Regulation on Determining Boundaries of Leased Islands for Tourism Development (R-7/2012)' aims to further assist the tourist resorts in their mandated areas to be better managed, including establishment and monitoring of OEACMs. These regulatory measures and guidelines help mitigate potential environmental disruption from tourism developments, and promote environmental sustainability, which is essential for maintaining the Maldives' brand image.

Tourism in the Maldives is highly dependent on the quality of the natural environment, offering "sun, sand and sea" as its brand image, promoted worldwide under the brand "Maldives" and the slogan "Maldives… The Sunny Side of Life". From the onset of tourism development, the

Government's policy and strategy has focused on planned and sustainable growth, carefully considering the fragile environment. The first tourism masterplan was developed in the early 1980s and the Maldives is currently on its Fifth Tourism Master Plan 2023-2027, which has set fifteen goals for sustainable tourism development including building climate resilience and protecting natural assets, enhancing energy security through low carbon development and establishing transformational tourism industry standards. The tourism industry has embraced energy-efficient technologies and extensively adopted solar energy and heating solutions in the tourist resorts.

A resort island in the Maldives integrates both soft and hard engineering solutions, solar energy, and reef conservation to enhance adaptation and resilience. **Photo:** Swimsol

In 2012, the Tourism Adaptation Project (TAP) was initiated by the Ministry of Tourism with United Nations Development Programme (UNDP) and supported by GEF to address key adaptation issues, and attempted to formulate necessary policies, standards and regulatory guidance which would eventually facilitate necessary investments to increase the resilience of tourist infrastructure and tourism dependent communities to the impacts of climate change. This included support for the Fourth Tourism Master Plan, the development of a strategic plan and marina development standards with climate change adaptation measures (UNDP and MOT, 2016a) and identification of potential climate insurance mechanisms (UNDP and MOT, 2016b).

In 2021, the Ministry of Tourism initiated a Re-imagining Tourism project (UNDP, 2021) to enhance sustainable tourism in Laamu Atoll and the Maldives, partnering with MCCEE and UNDP. The project included research to assess Laamu's tourism situation and establish sustainability thresholds, focusing on community empowerment and infrastructure improvements. A sustainable management course was developed to educate locals on tourism practices aligned with Community-Based Tourism (CBT) principles and Sustainable Development Goals (SDGs), meeting Maldives Qualification Authority (MQA) certificate III standards. The project also introduced the Blue Seal Standard as a sustainability certification for guesthouses, promoting responsible practices. Additionally, a small grants program enabled the twelve councils of Laamu Atoll to propose tourism development initiatives (MOT and UNDP, 2023).

Following the COVID19 crisis, the government undertook a Tourism Diversification and

Localisation Programme to strengthen local island capacities and increase tourism resilience. The program aimed to expand local tourism in the islands and facilitate direct benefits of tourism to residents. Under the programme, extensive consultations were held with all atoll and local island councils and homestay tourism was initiated, backed with a regulatory framework. Furthermore, to enhance access to information and markets, the MOT launched a website (https://islands.mv/) to promote inhabited islands to showcase their tourism offerings and services.

Furthermore, the Maldives Tourism Climate Action Plan was launched in 2023, envisaging the development of a sustainable and resilient tourism sector through five key objectives: integrating community experiences, products, and priorities; protecting destination assets; regenerating natural environments; diversifying business models; and aligning with national and global initiatives (USAID and MOT, 2023). Consequently, the Ministry of Tourism has developed an Ecotourism Framework and Road Map in 2024 (MOT et al., 2024), with the vision for Maldives to be a globally renowned ecotourism destination through identification of potential ecotourism activities. Programmes are underway with MCCEE, MOT and Island Councils to develop management plans for ecotourism and nature-based tours and products in the local islands, including the development of a sustainable tourism destination plan for Goidhoo Atoll. An ongoing project Enhancing Sustainable Climate Adaptation PracticEs (ESCAPE) supported by the USAID Climate Adaptation Project (CAP) aims to carry out research to develop a set of designs and guidelines that guesthouse designers, developers, and builders, as well as the Government, can utilise to improve the resiliency and adaptive capacity of tourist guesthouses (Small Island Geographic Society, 2023).

4.7.3 Adaptation Priorities and Barriers

Some of the priorities and strategies for the tourism sector identified through Government policies and plans include:

- Building climate resilience and protect natural assets including increasing the number of resort island house reefs managed as Other Effective Area–based Conservation Measures (OEACM), establishing more beaches with successful management plans and minimising waste generated from the sector, especially single use plastics and food waste.

- Establishing comprehensive standards for resorts, hotels, vessels, and other tourist establishments to ensure sustainable development of the sector (MOT, 2023b). This includes creating sustainable criteria for islands and atolls, certifying transport providers and tour operators, and developing guidelines for some tourism recreational activities.

- Establishing carrying capacity and planning standards for islands to mitigate negative impacts on local communities. This involves creating sustainable tourism development guidelines that align with the physical, social, and cultural capacities of islands, along with developing quality standards and regulations.

- The following key obstacles have been identified as factors that have limited progress in climate change adaptation within the Maldives' tourism sector (UNDP and MOT, 2016b):

- Gaps in expertise and know-how on adaptation focusing on tourism, climate change and environment among all key stakeholders, including insufficient awareness on relevant government policies and regulations. As well as a lack of institutional capacities for monitoring policy implementation, insufficient coordination, enforcement and cooperation between the Government and tourism operators in adaptation efforts.

- Need for developing and investigating reduction strategies, technology and guidance that encourage climate insurance providers to reduce premiums, such as improving early warning systems; developing hazard resistant infrastructures; developing disaster preparedness plans; and encouraging a culture where prevention and resilience are prioritised.

- Due to the geographically dispersed nature, Maldives has yet to develop a convenient and effective nationwide waste management system to support the tourism industry (MOTAC, 2015). Other challenges include identifying a safe harbour and berthing location in Male' atoll for the tourism liveaboard fleet (UNDP and MOT, 2016a), as well as guidance on climate resilient tourism building codes.

4.8 Fisheries

The fisheries sector has always been a significant component of the Maldivian economy, providing livelihoods, export revenues, and a staple protein source for the Maldivian population. Its significance extends beyond economics and is deeply intertwined with the nation's culture and identity. In 2015, the fisheries sector employed around 11% of the country's labour force. By 2021, it contributed approximately 6% to the national GDP (MBS, 2022a). The Maldives also has one of the highest per capita fish consumption rates globally, reflecting the cultural and dietary importance of fish to Maldivians. Furthermore, the sector is a crucial contributor to foreign exchange, with over 90% of Maldivian exports consisting of fish and fisheries-related products (MCS, 2023).

Pole-and-line tuna fishing in the open sea by a Maldives fishing vessel. **Photo:** A Riyaz Jauharee

The Maldivian fisheries sector relies heavily on tuna, with skipjack tuna (*Katsuwonus pelamis*) and, more recently, yellowfin tuna (*Thunnus albacares*) making up 98% of the total catch. Sustainability has always been at the core of Maldivian fisheries, and fishing methods used in the Maldives are known to have minimal impacts on the ecosystem compared to other fishing gears around the world. The Maldives employs pole-and-line and handline fishing methods, mainly targeting free-swimming schools of tuna, which significantly reduces bycatch.

The Maldives applies stringent laws and regulations that prohibit harmful fishing practices, such as net fishing and the use of destructive gear. These sustainable practices have allowed the country to maintain its rich marine biodiversity while continuing to support the livelihoods of many Maldivians. Maldivian tuna fisheries have received international recognition for their sustainability, such as the Marine Stewardship Council (MSC) certification and Fair-Trade Certification for its pole-and-line skipjack tuna fishery since 2014, contributing to the country's growing reputation as a responsible steward of marine resources.

A distinguishing feature of Maldivian fisheries is the separation between the harvesting and processing sectors. The fish harvesting sector, composed of small-scale and artisanal fishers using traditional methods, operates independently of the fish processing sector. This structural division ensures that fishing remains a community-based activity, while the processing sector, which prepares fish for export, adheres to modern standards and regulations that allow Maldivian products to compete in international markets. This division allows both sectors to specialise and ensures a robust and efficient supply chain from the sea to the market, contributing to the global recognition of Maldivian fish products, particularly tuna.

In recent years, reef-based fisheries have also become increasingly popular, adding diversity to the Maldivian fishing industry. While tuna dominates the export market, reef fish are gaining attention, particularly in tourist establishments and local markets. However, the export of reef fish is still developing, and sustainable management of these fisheries will be crucial to ensure that catering for this growing demand aligns with sustainability principles enshrined in the Maldives Constitution and the Fisheries Act (Law No. 14/2019) of the Maldives.

4.8.1 Climate Change Impacts, Risks and Vulnerabilities

As a Small Island Developing State with an economy depending substantially on the fisheries sector, the Maldives is especially vulnerable to oceanographic changes due to climatic variability. These impacts are especially keenly felt in the tropics, where both physical and biogeochemical changes due to climate change are projected to surpass natural variability. Research indicates that stocks of tropical species could decline by as much as 40% by the 2050s under the RCP8.5 emissions scenario (Lam et al., 2020). Furthermore, these cumulative impacts of climate change are further exacerbated by global events that disrupt international markets. Additionally, with the transition of the Maldives from the United Nations' list of Least Developed Countries (LDCs) to a Developing Country in 2013, the country has also lost its duty-free access to the European markets. This has placed the Maldives at a competitive disadvantage compared to other Small Island Developing States (SIDS) and Indian Ocean countries, with an import duty of over 24% (PO, 2024) when competing in these markets.

Ocean warming and ocean acidification are identified as the primary climate change factors likely to affect fisheries in the Maldives, with IPCC assessments noting significant shifts in marine species' geographic ranges, seasonal activities and migration patterns.[2] These shifts adversely affect food production from aquaculture and fisheries (IPCC, 2023), stressing the urgent need for adaptive strategies to mitigate these impacts and safeguard the fisheries sector and its dependent communities. The Maldivian fishery sector, which is predominantly dependent on tuna fishery, is expected to face the same challenges.

Since 2006, a notable decline in total fish catch has been recorded for the country, influenced by a combination of overfishing in the Indian Ocean region, seasonal monsoons, and broader oceanographic and climatic variations. The recent study underscores the significant vulnerability of Maldivian fisheries to climate change, especially in comparison to other SIDS. The findings reveal that the Maldives is likely to suffer the most substantial decrease in maximum catch potential (MCP) among its SIDS counterparts, with a predicted 75% decline by the end of the century under the most severe climate scenario. This drastic reduction is accompanied by expected steep decreases in fisheries net revenue, averaging annual declines of 78% compared to 2020 (Cheung et al., 2024).

4.8.1.1 Impact of Increased Sea Surface Temperatures on Fisheries

Sea surface temperature (SST) variations are among the most significant factors affected by climate change, posing serious concerns for marine ecosystems. These variations significantly affect the Maldivian fisheries sector by influencing the distribution, abundance, and critical life history characteristics of tuna and other socio-economically important food fish species.

SST variations have led to significant shifts in fish distribution, with species migrating to cooler or deeper waters in search of optimal conditions. For instance, large-scale shifts in skipjack tuna distribution observed in the Pacific have been associated with ENSO events (Lehodey et al.,

2 IPCC, 2014b; IPCC, 2014c

1997), while similar patterns have been observed with the Indian Ocean Dipole (IOD).

In the Maldives, tuna catch data reveals spatial variations in abundance, with differences noted from north to south along the atoll chain (Anderson, 1992). This variation is influenced by oceanic upwellings, particularly around seamounts and ridges that enhance productivity through nutrient enrichment (Boehlert and Genin, 1987). Additionally, monsoonal winds also contribute to nearshore productivity, although tuna catches do not always directly reflect these patterns. Seasonal monsoons and other oceanographic variations, including El Niño and La Niña events, significantly impact tuna fisheries in the Maldives by causing noticeable fluctuations in the catch rates of skipjack and yellowfin tuna.

Given the significant dependency of the Maldives on marine products, particularly tuna, any significant changes in tuna abundance due to climate factors could have serious economic consequences. Additionally, as one of the highest consumers of fish per capita, a decline in seafood availability would affect both the health of the population and the nation's food security.

4.8.1.2 Impact of Ocean Acidification on Fisheries

Projections indicate that atmospheric CO_2 concentrations, currently at 380 ppm, could rise to between 540 and 970 ppm by 2100 (IPCC, 2001). This significant increase is expected to alter seawater pH (Orr et al., 2005), and carbonate concentrations due to CO_2 exchange with seawater (Kleypas et al., 2005). Predictions suggest a decrease of 0.5 pH units over the next 50 to 100 years, which could profoundly impact marine ecosystems. The impact of ocean acidification on fisheries and the marine environment represents important gaps for future research in the Maldives.

4.8.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

The Ministry of Fisheries and Ocean Resources (MoFAOR) is responsible for overseeing and regulating the fisheries industry in the Maldives, ensuring sustainable practices are followed. In 2019, a new Fisheries Act, 14/2019 was enacted to support sustainable growth and increasing the resilience of the sector. MoFAOR also established the National Fisheries and Agricultural Policy (NFAP) 2019-2029, aligned with SDGs, focusing on ecological resilience, value-chain coordination, food security, community empowerment, research, and partnerships.

To enhance fisheries management, the Ministry of Fisheries and Ocean Resources (MoFAOR) conducts research and monitoring through the MMRI, established in 1985. MMRI focuses on marine scientific research for fisheries management and economic growth by conducting resource surveys, maintaining marine databases, and publishing research. MMRI plays a crucial role in researching marine aquaculture technologies and facilitating technology transfer through mariculture training programs. In collaboration with local and international partners, MMRI also surveys and monitors coral reefs to assess their health and provide advice to the government on sustaining marine ecosystems and fisheries (MMRI, 2014). Meanwhile, MoFAOR conducts fishery

data collection using various tools such as logbooks, electronic reporting, real-time web enabled databases, vessel monitoring systems and Electronic Monitoring Systems (EMS) (MOFA, 2015). In 2024, the government also established a College of Fisheries and Ocean Sciences under the Maldives National University (MNU) to promote higher education, skills development and training to develop professionals for the fisheries industry.

The fisheries sector in the Maldives is highly vulnerable to climate change, particularly due to rising sea surface temperatures. Six key adaptation measures are identified for the fisheries sector (MEE, 2016). These include improving fish finding, harvesting, and handling techniques; promoting aquaculture and mariculture to mitigate the economic and social impacts of fluctuating tuna populations; conducting research and sharing information on fisheries and climate change; exploring new species and methods for live bait breeding and handling; and implementing integrated reef fishery management strategies.

4.8.2.1 Improvement in Fish Finding and Fish Handling

To strengthen the resilience of the fisheries sector in the face of climate change, the Maldives is prioritising innovations in fish finding and fish handling technologies as key adaptation strategies. These advancements aim to increase the efficiency of fishing operations, improve the quality of catch, and enhance the profitability of the fisheries sector, while also promoting sustainable practices. A key initiative is the creation of a digital platform providing real-time fish tracking data to help fishermen optimise operations and reduce fuel consumption. Using satellite data and oceanographic models, it will guide efficient fishing efforts. The Ministry of Fisheries is also promoting a new generation of fishing vessels with automated systems for sorting, chilling, and storing fish, improving catch quality and energy efficiency. To further support the sector, plans are underway to provide financial support to upgrade live-bait stocking systems, crucial for the pole-and-line method. These innovations aim to strengthen the economic and environmental resilience of Maldivian fisheries by combining modern technology with traditional practices.

4.8.2.2 Establishing an Aquaculture Sector

Historically, the Maldives has relied on capture fisheries, mainly targeting skipjack and yellowfin tuna. To alleviate pressure on wild fish populations and enhance food security, employment, and economic growth, the Maldives aims to develop its aquaculture sector. The MMRI began aquaculture research in the 1990s to improve rural livelihoods and support the sector's sustainability. Despite gradual growth, the government remains committed to aquaculture development, prioritising it in national plans. Major projects, such as the Mariculture Enterprise Development Project (MEDEP) supported by the International Fund for Agricultural Development (IFAD), aim to establish a comprehensive mariculture industry. This includes value chain support, establishing quarantine facilities, and a multi-species hatchery. Subsequent initiatives, such as the Sustainable Fisheries Resources Development Project (SFRDP) supported by the World Bank, have continued this work. Recent MMRI efforts include spawning trials for sea cucumbers (*Holothuria fuscogilva*), and larval rearing of the Brown Marbled Grouper (*Epinephelus fuscoguttatus*) (Naeem et al., 2024). Additionally, MMRI is developing a stock enhancement program for sea cucumbers,

focusing on improving survival rates and sourcing investments. Supported by the Transforming Fisheries Sector Management in South-West Indian Ocean (SWIO) Region and Maldives Project (TransFORM, SWIOFish5), the Government has designated four mariculture production zones for leasing to potential investors.

4.8.2.3 Integrated Reef Fishery Management

Increased demand for reef fish from the tourism industry and expanding overseas markets have led to heightened exploitation of many ecologically important species. The status of reef fish stocks and the extent of their impact require further study. In response, management strategies have prioritised the protection of vulnerable species at risk of overexploitation, including the establishment of marine protected areas since 1995 (MCCEE, 2024c), focusing on the most affected atolls. The Environment Protection and Preservation Act (Law No. 4/93) initiated early protection efforts, which expanded over time. A key milestone was the prohibition of shark fishing in the Maldivian EEZ in 2010, followed by the protection of all sharks under the General Fisheries Regulation (R-75/2020) and explicit protection for cetaceans under the Fisheries Act (Law No. 14/2019). To enhance sustainability, the Ministry of Fisheries and Ocean Resources (MFOR) has designated closed areas for essential fish habitats, including five grouper spawning sites since 2013 (Ministry of Fisheries Marine Resources and Agriculture, 2013). Management plans have been developed for various fisheries, such as tuna, billfish, and commercial species like grouper, sea cucumber, and reef fish. A catch certification scheme for all commercial fishery exports has been implemented to improve regulation and catch traceability (Burns, E. et al., 2022). Additionally, the *Keyolhu* mobile application allows fishers to access fishery services, apply for licences, submit logbook data, and manage their registration. These measures aim to ensure long-term sustainability by reducing fishing pressure on vulnerable species and improving data collection, compliance, and enforcement in the Maldives' fisheries.

4.8.2.4 Value-addition and Promoting Sustainability

In recent years, the average annual catch for the Maldives pole-and-line skipjack tuna fishery has been around 100,000 tonnes. However, local processing capacity is limited, with Maldivian companies able to process about 34,000 tonnes. Consequently, the country has been exporting large quantities of raw, unprocessed tuna - an average of 50,000 tonnes annually over the past five years. Last year alone, 62,795 tonnes were exported without value addition. This presents a significant opportunity for climate adaptation through economic resilience. By adding value to tuna products locally, the Maldives could double its revenue from fisheries and create new jobs. To address this, the government aims to develop two 100-tonne canneries through public-private partnerships, creating cold storage units capable of holding 3,000-4,000 tonnes of tuna, ensuring product stability and access to global markets.

Additionally, the government plans to convert 35% of the electricity used in these processing plants to renewable energy. This shift will reduce operational costs, lower carbon emissions, and promote the sustainability of the fisheries sector.

4.8.2.5 Improving Monitoring Control, and Surveillance Capabilities

As climate change affects ocean conditions and tuna populations face increased pressure, Illegal, Unregulated, and Unreported (IUU) fishing poses a significant challenge. It is estimated that 10,000 to 15,000 tonnes of tuna are caught illegally each year by foreign vessels in Maldivian waters, jeopardising the sustainability of fish stocks and local livelihoods. With quotas set for many tuna species in the Indian Ocean, enhancing Monitoring, Control, and Surveillance (MCS) systems is essential for the future of Maldives' fisheries. To combat IUU fishing and adapt to climate-related uncertainties, the Maldives has implemented a Vessel Monitoring System (VMS) for its commercial tuna fleet and is trialling an Electronic Monitoring System (EMS) for near real-time observation of fishing activities, enabling better oversight and sustainable resource management.

4.8.3 Adaptation Priorities and Barriers

The key challenges and priorities identified by the Maldives fisheries sector in relation to climate change include:

- **Decline in Fish Catches**: Climate change is intensifying environmental and economic challenges in the Maldives' fisheries sector, particularly by reducing fish stocks and making them less accessible to traditional pole-and-line fishing methods. Rising ocean temperatures and changing currents are affecting the distribution and availability of tuna, while the impacts of warming seas and coral bleaching are significantly reducing the catchability of live bait from reefs. These issues, combined with increased operational costs for fishing vessels and insufficient storage and processing capacity, along with youth recruitment challenges, have contributed to a decline in fish catches and limited export opportunities.

- **Diversification Challenges**: The growth of the aquaculture sector has been slow in the country, given the lack of a stable value chain that will support the industry, as well as the limited availability of financial and technical capacity. Increased tariffs and lack of market access for seafood products is another significant challenge to kick-starting a new fishery and diversifying the sector.

- **Enforcement Challenges**: Due to the large ocean areas for management, the Maldives faces financial and human resource capacity challenges for the enforcement of fisheries management policies and regulations, including controlling IUU fishing by foreign vessels.

- **Marketing and Export Barriers:** Despite adopting eco-friendly practices in tuna and reef fisheries and producing fish products that are renowned for their sustainability, the fisheries sector faces difficulties with competing in the highly industrialised global market. This is exacerbated by the high import tariffs imposed by the major premium markets for tuna such as the EU and UK.

Tuna caught by pole and line on deck of a Maldives fishing vessel. **Photo:** A Riyaz Jauharee

4.9 Early Warnings and Systematic Observation

Early warning systems and systematic observation are critical components of climate resilience, enabling timely and effective responses to climate-related risks. Early warning systems provide advance notice of extreme weather events, while systematic observation ensures ongoing monitoring of environmental changes, helping decision-makers to plan adaptation and mitigation strategies.

The Maldives climate and weather information services have made significant strides since the Meteorological Office adapted to international standards in 1974. Continuous meteorological data recording began in 1968, and Maldives joined the World Meteorological Organization (WMO) in 1978, marking a major milestone in its global integration. Key advancements came in the 1980s, with the creation of a 24/7 National Meteorological Centre and the first local weather forecasts in 1984. The 1990s saw further development with the installation of tide gauges, satellite data systems, and the introduction of seismic and oceanographic monitoring. Following the 2004 tsunami, Maldives Meteorological Services (MMS) upgraded its disaster response capabilities, introducing real-time earthquake monitoring and early warning systems. In 2007, the installation of Doppler Weather Radar enhanced weather tracking and MMS was formally established in 2008, while continuing to improve automatic weather stations and advanced forecasting tools (MMS, 2021). Maldives is also a member of the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) (MEE, 2016), collaborating on early warning information.

Enhancing forecasting accuracy and improving the accessibility of climate data is a key priority for the Government. Currently, MMS delivers hazard forecasts, informing the public about the duration, location, and intensity of rainfall. However, they do not yet predict the potential impacts of these events. Through the Maldives Impact-Based Forecasting (IBF) program, MMS intends

to shift from hazard-based to impact-based forecasting. This transition to multi-hazard impact-based forecasts and warnings will mark a significant transformation in MMS's approach to climate service delivery (MCCEE and USAID, 2024).

Automatic Weather Station installed in S. Hithadhoo. **Photo:** Ahmed Waheed

4.9.1 Climate Change Impacts, Risks and Vulnerabilities

Due to its low-lying geography and dependence on climate-sensitive sectors like tourism, fisheries, and agriculture, the Maldives is extremely vulnerable to the impacts of climate change. In this context, early warning systems and systematic observation are vital for protecting lives, infrastructure, and ecosystems, particularly in vulnerable island nations.

In the Maldives, the natural hazards identified as risks include earthquakes, tsunamis, cyclones, thunderstorms, rain-induced flooding, droughts from prolonged dry periods, storm surges, strong winds, and waterspouts (tornadoes) (UNDP, 2006). These risks are influenced by both climatic and non-climatic factors. Climate factors include change in precipitation, temperature, wind direction and speed, while non-climatic factors are influenced by natural processes and are often exacerbated by malpractices and insufficient planning (MCCEE and USAID, 2024). Rising sea levels and changing weather patterns due to climate change exacerbate the intensity and frequency of hydrometeorological hazards, posing significant threats to livelihoods and well-being (ME, 2020a). During the BTR stakeholder consultations, key climate change impacts and vulnerabilities were discussed, along with the need for improved climate monitoring and early warning systems. These include:

- **Monitoring Climate**: Systematic climate observation is key for monitoring environmental changes like sea levels, temperature, and precipitation. This data helps to assess long-term climate impacts on the Maldives. Stakeholders stressed the need for diversified weather alert communication beyond mobile messaging, improved data accessibility, enhanced capacity at the island level, and improving climate vulnerability assessments to prevent issues like flooding caused by poor road and infrastructure designs.
- **Extreme Events Monitoring**: The Maldives faces frequent extreme climate events such as storms and floods. To improve disaster preparedness and resilience, enhanced monitoring is necessary. Stakeholders emphasised the need for better communication with vulnerable communities, and more proactive engagement of first responders.
- **Impact-Based Weather Forecasting**: The Maldives is planning for transitioning to Impact-Based Forecasting (IBF), which predicts the consequences of weather events to better inform emergency responses, infrastructure planning, and public health measures. While weather alerts are issued, they currently lack impact-specific information to adequately prepare for weather events. Future efforts were suggested to focus on communicating these impacts, tailored to specific localities in early warning alerts.
- **Tools and Technology**: Advanced tools like remote sensing, satellite data, and climate modelling are essential for monitoring and predicting climate impacts. Stakeholders emphasised the need for more Automatic Weather Systems (AWS) to support specific communities, such as farmers, and to integrate early warning systems with mobile technologies and community outreach to help overcome mobile messaging limitations and ensure contact information is kept updated for application in the common alerting protocol.

4.9.2 Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

The Maldives has adopted a comprehensive approach to climate resilience, prioritising research, systematic observation, and early warning systems. Central to this effort are the National Adaptation Plan (NAP) and the Updated Nationally Determined Contributions (NDC) (Mohamed, 2023), which focus on expanding the meteorological network and improving early warning systems and climate data collection across the archipelago.

Projects such as the Automation and Integration of Meteorological and Climatological Information and Decision Support System with support from the Italian government, and the launch of the local mobile app Moosun, along with the introduction of common alerting protocols have improved real-time weather and climate data dissemination. Currently, the MMS collects data from 43 AWS with plans to establish additional stations in the future. The Government is also working on improving climate and weather forecasting tools, supported by a two-year project supported by

UNESCAP and UNDP to integrate Disaster Risk Reduction and Climate Change Adaptation into development planning.

Ongoing efforts include the Systematic Observations Financing Facility (SOFF) project being developed to secure support for establishing an additional AWS; upgrading four others; replacing outdated technology, and modernising MMS's Corobor data management system (SOFF, 2023). Efforts to strengthen early warning systems and risk management tools are underway following the selection of Maldives among the first 30 focus countries for the UNSG's "Early Warnings for All" initiative. The initiative aims to enhance resilience and improve risk data collection. Additionally, Scaling Up Early Warning Systems Implementation Roadmap for 2023-2027 has been prepared which includes plans to expand the existing radar network, establish a marine buoy network as a receptor for marine and relevant hydro-meteorological hazards, and establish Impact Based Forecasting (NDMA et al., 2024), once the required sources of funding are identified. The Government is further upgrading real-time monitoring systems for extreme weather events like storms and tsunamis, with alerts disseminated via SMS, radio, and social media platforms. Additionally, the Government is developing the project "Toward Risk-Aware and Climate-resilienT communities" (TRACT) for GCF support, to strengthen climate services and impact-based multi-hazard early warning systems (MHEWS), which are crucial to building the climate resilience of Maldives and its vulnerable communities (ME, 2018).

Research into climate trends and impacts is a major focus, with projects such as wave forecasting modelling, the installation of air quality monitoring stations in Male' region, and a customised research vessel by the Environmental Protection Agency for environment and climate research. The Maldives is also addressing gaps in infrastructure, particularly in remote islands, through initiatives like the Green Climate Smart Island Project, which aims to integrate localised early warning systems and improve community access to climate data.

4.9.3 Adaptation Barriers

Despite progress, several constraints hinder the implementation of effective early warning and systematic observation systems in the Maldives including technical, financial and other barriers:

- Financial resources are required to expand and maintain the early warning and meteorological forecasting capacity. These include increasing AWS coverage, provision of Doppler radar, supporting line agencies in collecting socio-economic and geophysical data for IBF generation, enhancing the integration of meteorological observation systems, establishing data-sharing protocols, and strengthening the national Geographic Information System (GIS) for more efficient data management.
- Many remote islands do not have adequate monitoring stations, leaving significant gaps in data collection and observation within the distribution network. Additionally, the absence of detailed impact-based forecasting systems limits the ability to predict and respond to extreme weather events effectively. The MMS requires upgrades to its

existing weather stations and establishing new ones to meet Global Basic Observing Network (GBON) standards, thus closing the gap between stations.

- The lack of adequate infrastructure hampers data processing, with no reliable system for data management, backups, or AWS integration. Upgrading the ICT infrastructure is crucial to address these limitations and improve data handling and analysis.
- There is a shortage of trained personnel with the technical expertise to operate, maintain, and interpret data from advanced weather and climate monitoring tools. Investment in training for MMS staff and partnerships with international agencies are needed to build local expertise in climate science and technology.
- A unified system that integrates climate, ocean, and disaster data is lacking. This leads to fragmented efforts in climate monitoring and early warning.
- While early warning systems are being developed, there is limited public awareness of how to respond to weather alerts, particularly in the island communities, due to a lack of impact-based forecasting. The development of disaster management plans is an ongoing effort across the islands. However, successful implementation will require strengthening both capacity and awareness at the local level.

4.10 Information Related to Averting, Minimising and Addressing Loss and Damage Associated with Climate Change Impacts

Loss and damage and climate related hazards pose significant threats to the Maldives due to its fragile ecological profile, low elevation and narrow economic base. The country's limited capacity to address the increasing frequency and intensity of extreme events further exacerbate these vulnerabilities. The Maldives scored 72.2 in the Multidimensional Vulnerability Index (MVI) as the second most vulnerable country, which comprehensively takes into account its structural vulnerability and lack of structural resilience. These inherent vulnerabilities have been apparent predominantly in slow-onset events, but are more damaging during extreme events.

In recent history, there have been numerous events in which the country faced disastrous situations, such as the 1987 event known locally as the Great Wave or *Bodu Raalhu*, when a tidal surge affected 66 islands across 13 atolls, with most of the damage reported in the capital, Male'. It resulted in the loss of livelihoods and damaged critical infrastructure such as the country's sole airport, breakwaters, harbours, and radio antennae among others (UNDRO, 1987).The 2004 Indian Ocean tsunami, while not climatic in nature, illustrated the level of destruction and demonstrated the magnitude of the threat that sea level rise poses to the country. With 26 people missing, 82 dead and over 2000 homes destroyed, the tsunami caused an unprecedented level of destruction in the Maldives. Total damages from the event amounted to 62% of the country's GDP (MEE, 2016).

Severe tidal swells in 2007 affected 88 islands, impacting all basic services such as water, electricity, and sanitation in affected households (NDMC, 2007). Similar events are recurrent and have a debilitating effect on the affected communities and their livelihoods. However, due to the limited availability of information and a lack of historical data, it is challenging to quantify the loss and damage experienced in the country.

Since the 1980s, severe erosion has become more frequent across the country (MEE, 2016), and land loss to sea level rise has been among the most significant losses observed in the Maldives. Coastal erosion continues to be a daily reality for many Maldivian island communities, and with land already being a limited resource, this poses a multitude of challenges. Given the frequency and severity of erosion, the Government expends large portions of the limited domestic budget to undertake coastal adaptation measures such as revetments and sea walls among others. The 2004 tsunami was a turning point in the Maldives' work towards coastal adaptation. While the Government has long been reinforcing coastlines in the country, its experience with the tsunami signaled the need for more resilient and sustainable measures for coastal adaptation. However, these preferred methods come at a greater cost, with some studies indicating a cost of approximately USD 4,100 per linear metre in 2015 (MEE, 2015g). The cost of these critical investments has increased significantly over time; for example, the ongoing coastal protection project in Gn. Fuvahmulah costs USD 8,000 per linear metre.

Measures to address land scarcity in the country consider current and future climate impacts, largely in line with the projected sea level rise scenarios by the IPCC, as considered in the development of Hulhumale'. The island was developed to a height of 1.8 metres above mean sea level, whereas 80% of the natural islands lie less than 1 metre above mean sea level. While land expansion is a costly investment, the additional elevation required to withstand climate impacts necessitates an even greater investment. However, these costly efforts are observed to have been worthwhile investments, as coastal flooding is not reported in these islands.

The issue of land loss and coastal inundation also raises the matter of loss of culture and heritage. The Maldives' centuries long history is evident in its unique local language, cultural heritage sites, and traditional food and attire. The identity of the country and its people are tied to these cultural elements, which in turn, are connected to their ancestral islands that are facing coastal erosion due to sea level rise. There are cases where entire communities in the Maldives have been relocated from their original islands to other inhabited islands due to environmental degradation and climate challenges, causing their distinctive cultural features to fade.

A case study looking at loss and damage in the Maldives from a cultural perspective also found that various sites of historical and cultural significance are at risk due to coastal erosion. This includes the country's oldest cemetery, which is located near the eroding coastline of S. Meedhoo, featuring ancient carved coral gravestones and other elements of significant historical, cultural and communal value. Its location and the worsening erosion in the island have gradually exposed the cemetery to storm surges and tidal swells (MCCEE and SLYCAN Trust, 2023). The Government has enacted emergency coastal protection measures around the area, but it

is observed that these are insufficient, and sustainable measures are required to safeguard the site. Parts of a mosque complex in N. Kuredhivaru in the north of the country have already been submerged due to coastal erosion (Maritime Asia Heritage Survey, 2022), underscoring that the loss of heritage to climate change is not only forthcoming, but a present reality that requires urgent attention. Much like the highlighted cases, there are several sites of heritage and cultural significance threatened by climate change, which need to be protected for the sake of preserving them for future generations.

Aerial view of Koagannu Cemetery, the oldest in the country. **Photo:** Ashwa Faheem, **Copyright:** SLYCAN Trust and Ministry of Climate Change, Environment and Energy

The Maldives is experiencing a higher frequency and intensity of extreme weather events, including heavy rainfall, storm surges and flooding due to rain. In August 2024, extremely heavy rainfall resulted in extensive damage to households, businesses, livelihoods and personal property, severely disrupting daily life and transportation throughout the country. Due to the unprecedented weather conditions, a state of crisis was also declared on 14 August 2024. The NDMA and relevant agencies worked together to provide relief efforts, immediate financial support, and temporary shelters for those affected by the heavy rains. Similarly, in early 2024, the northern atolls were also hit by heavy rain and floods, causing extensive damage and the temporary relocation of affected families. With extreme flooding events predicted to become more frequent in the future, loss and damage due to these events is expected to increase significantly. Given the lack of proper insurance mechanisms, there is no formal arrangement to compensate for such climate change related loss and damage, and the afflicted individuals and communities struggle to recover, highlighting the need to bring in parametric and other forms of insurance to address this issue and enable faster recovery.

Koagannu Cemetary demonstrates generations of history and heritage including the unique Maldivian coral stone workmanship which is critically vulnerable to the predicted impacts of climate change. **Photo:** Ashwa Faheem, **Copyright:** SLYCAN Trust and Ministry of Climate Change, Environment and Energy

The Maldives' vibrant marine flora and fauna are intricately intertwined with its people, their livelihoods and the country's economy, providing the resource base for the country's tourism and fisheries sectors. As a traditionally fishing-dependent nation dating back countless generations, Maldives has been heavily reliant on its tuna fisheries, with fish remaining as the main source of protein in the local diet. The rise in sea surface temperatures and ocean acidification may affect tuna fisheries which in turn would affect nutritional and food security in the country (MEE, 2016).

Similarly, climate impacts are also deteriorating the rich marine biodiversity of the Maldives. The unprecedented 1998 coral bleaching event caused bleaching in 80% of corals in the country, while the 2016 event resulted in 73% of bleaching (MRC, 2016). Most recently, in response to the severity of bleaching expected during the 2024 El Niño event, the government halted all coastal developments to limit the stress on the coral reefs and slow down the rate and severity of the bleaching. These impacts have compounding losses on the economy and food security which are already being observed. However, it is challenging to quantify these losses due to limitations in data availability.

Climate change has also been linked to a wide range of mental health outcomes, from anxiety and sleep disturbances to depression, post-traumatic stress, and suicidal thoughts (Cianconi et al., 2020). In the Maldives, the inherent vulnerability and exposure of communities to climate challenges and the impacts on their lives and livelihoods also affects their psychosocial well-being, particularly among the most vulnerable groups within the afflicted communities. Although data and information on this aspect are limited in the Maldivian context, observations from some extreme events indicate this to be a growing concern in the country. In the case of the 2007 tidal wave events in 88 islands, children and the elderly were observed to have post-traumatic stress disorder (NDMC, 2007), and with the frequent recurrence of these events, the resultant impacts of climate change on mental health and well-being are expected to increase as well.

Several measures have been taken to address the loss and damage, which includes strengthening legal and institutional frameworks, such as building the capacity of national institutions and improving their coordination. A Climate Emergency Act (Law No. 09/2021) was enacted in 2021, which stipulates actions to address the climate emergency and serves as an overarching policy document which also guides the country's national efforts in averting, minimising and addressing loss and damage.

With the frequency and intensity of extreme events increasing, the country is also working to enhance its disaster preparedness and response measures. In 2015, the country enacted its Disaster Management Act (Law no. 28/2015), under which several efforts are being made to enhance the country's resilience and disaster preparedness, such as trainings and capacity building programs at the local level to facilitate community-based disaster risk management among other measures.

Despite its limited resources, the Maldives has also invested in gradually enhancing its early warning capacities over the years, undertaking various efforts to ensure community safety, such as the improvement of observations by the Maldives Meteorological Service (MMS) and timely dissemination of alerts and expansion of outreach via different forms of media, including the utilisation of social media. However, gaps still remain, particularly in marine forecasting. As one of the lowest lying countries surrounded by the ocean and heavily reliant on its ocean resources, building the MMS's capacity for marine meteorology is a priority. Additionally, to facilitate better coordination on early warning within the country, the government has formulated an Early Warnings for All (EW4All) roadmap, which serves as a blueprint for short- and medium-term measures towards enhancing its early warning system, with ongoing efforts at the sectoral level working to bridge the identified gaps.

Following the 1987 *Bodu Raalhu* event, the Maldives has long been vocal about sea level rise and its devastating impact on itself and other similar nations. It was also in Male' in the year 1989 that the Male' Declaration on Global Warming and Sea Level Rise was adopted. Shortly thereafter in 1990, the Maldives, together with Trinidad and Tobago and Vanuatu, founded the

Alliance of Small Island States (AOSIS), which now serves as the collective voice of SIDS across the world highlighting the issue of loss and damage.

The country actively negotiated at the 1992 Earth Summit in Rio de Janeiro, Brazil, where the Rio Declaration, the UNFCCC and the UN Convention on Biological Diversity (CBD) were established. Going forward, the Maldives has been active in climate change negotiations under the UNFCCC. In its capacity as Chair of the AOSIS, the Maldives played a particularly key role with AOSIS members, in anchoring loss and damage within the Paris Agreement. More recently, it was a vocal advocate for the establishment and operationalisation of the Fund for responding to Loss and Damage (FRLD).

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FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER, AND CAPACITY BUILDING NEEDED AND RECEIVED UNDER ARTICLES UNDER ARTICLES 9-11, AND ARTICLE 13 OF THE PARIS AGREEMENT

CHAPTER 5: FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER, AND CAPACITY BUILDING NEEDED AND RECEIVED UNDER ARTICLES UNDER ARTICLES 9-11, AND ARTICLE 13 OF THE PARIS AGREEMENT

Maldives has long collaborated with international donors and financiers on several initiatives and projects that address climate change impacts in the areas of adaptation, mitigation and means of implementation. Despite the continuous flow of support received over the decades, the country continues to face significant challenges in meeting its climate finance needs. The Maldivian Government bears a disproportionately significant share of the financial burden to achieve its climate action goals, covering approximately 44.07% of its climate finance expenses from domestic sources during this reporting period, as demonstrated in Table 20.

Table 20: Summary table showing the overall climate finance landscape of Maldives including both donor funded and own contributions

Funding Sources	Climate Change Actions Cointained in BTR					Of Which			
	Finance	Capacity	Tech Support	Techtrans	Total	Grants	Concessional Loans	Guarantees	% of Total
Global Environment Facility	2,350,571.25	1,087,652.78	2,497,019.60			5,935,243.63			
Green Climate Fund	15,975,757.78	630,865.46				16,606,623.24			
Adaptation Fund	248,000.00					248,000.00			
ICAT		83,333.33				83,333.33			
Other UN									
UNEP		122,000.00				122,000.00			
UNICEF		75,000.00				75,000.00			
Subtotal	**18,574,329.03**	**1,998,851.57**	**2,497,019.60**	**0.00**	**23,070,200.20**	**23,070,200.20**	**0.00**	**0.00**	**5.25%**
Multilateral Finance Institutions									
World Bank	6,666,666.67							6,666,666.67	
SREP	4,868,333.33					4,868,333.33			
CTF	7,666,666.67						7,666,666.67		
ESMAP		805,000.00				805,000.00			
IDA	17,404,166.67					17,404,166.67			
Strategic Climate Fund	5,000,000.00					2,400,000.00			
Asian Development Bank	61,702,083.33		18,372,222.22			56,193,055.55	23,881,250.00		
AIIB	31,666,666.67						31,666,666.67		
European Investment Bank	20,833,333.33						10,000,000.00		
Islamic Development Bank	4,166,666.67						4,166,666.67		
Subtotal	**159,974,583.34**	**805,000.00**	**18,372,222.22**		**179,151,805.56**	**81,670,555.55**	**77,381,250.01**	**6,666,666.67**	**40.74%**
Annex II and other Developed Parties									
Grants									
Italy		1,714,337.25	1,190,125.00			2,904,462.25			
Japan	9,444,444.44	126,667.00	3,939,471.00	2,475,000.00		15,985,582.44			

Funding Sources	Climate Change Actions Cointained in BTR					Of Which			
	Finance	Capacity	Tech Support	Techtrans	Total	Grants	Concessional Loans	Guarantees	% of Total
USAID		3,500,000.00				3,500,000.00			
EU			1,684,000.00			1,684,000.00			
Netherlands	4,474,641.88					4,474,641.88			
Concessional Loans									
Kuwait	5,461,494.76						5,461,494.76		
UAE	9,727,272.73						9,727,272.73		
Subtotal	**29,107,853.81**	**5,341,004.25**	**6,813,596.00**	**2,475,000.00**	**43,737,454.06**	**28,548,686.57**	**15,188,767.49**	**0.00**	**9.95%**
Party Contribution									
In-kind Support		1,720,900.00							
Indicative Co-financing									
PSIP - Waste	10,320,000.00								
PSIP - Environmental and Coastal	38,880,000.00								
PSIP - Water and Sanitation	133,620,000.00								
Private	9,235,110.80								
Subtotal	**192,055,110.80**	**1,720,900.00**	**0.00**	**0.00**	**193,776,010.80**				**44.07%**
Grand Total	**399,711,876.97**	**9,865,755.82**	**27,682,837.82**	**2,475,000.00**	**439,735,470.62**	**133,289,442.33**	**92,570,017.49**	**6,666,666.67**	
% of Total	**90.90%**	**2.24%**	**6.30%**	**0.56%**	**100.00%**				

Climate finance tracking of support received to the government is conducted through an existing tagging mechanism. This system enables government agencies to tag financial support received by the government in the area of climate change. The Ministry of Finance is in a position to track support received from international donors and expenditure from domestic sources.

There are several strategies by the government to address immediate climate finance needs. One such strategy was the National Strategic Framework to Mobilize International Climate Finance to Address Climate Change in the Maldives 2020-2024 (ME, 2020c), which estimated USD 0.5 billion was required for initiatives that promote resilience and support low-emission development during the period 2020 – 2024 (ME, 2020c). Additionally, the Climate Emergency Act (Law No. 09/2021) stipulates the government to mobilise climate finance and institutionalise financial architecture aligned with international best practices in order to establish a mechanism that facilitates the flow of climate finance specifically through establishment of a special climate change fund, which is currently being developed.

Developing a comprehensive climate finance landscape for the Maldives is hindered by several significant challenges, including limited access to consistent, reliable, and detailed data on climate finance flows, which complicates the comprehensive tracking of funding from both domestic and international sources. Additionally, support received and implemented directly by certain donor agencies are unavailable within the official financial reporting framework, further complicating efforts to accurately quantify total climate finance. Institutional and capacity constraints within various government agencies and private sector entities involved in managing climate finance pose further obstacles to effective reporting.

In addition to these challenges, there are significant gaps in tracking climate finance channelled through the private sector entities. Private sector investments are neither recorded nor systematically accounted for within national climate finance frameworks. This lack of integration into official financial reporting frameworks complicates efforts to capture the full scope of climate finance being mobilised, making it difficult to assess the true scale of investments and their alignment with national climate priorities.

5.1 Underlying Assumptions, Definitions and Methodologies

For the purpose of this report, information available on support and finance from 2018 to 2022 has been compiled from government sources and publicly available documentation, such as donor agreements, MOUs, and official project documents to determine overall climate finance mobilised during this period. Where applicable, the information was mapped with other public sources, such as project reports and government publications, to estimate both international and domestic climate finance flows. All financial figures were evaluated based on contributions from various financing mechanisms, including grants, loans and technical assistance.

For estimating the climate finance landscape, projects that received financing routed through official government channels have been considered. This means that climate finance mobilised

by the private sector directly was not considered due to a lack of available information. For programs and projects that began before or are continuing beyond the 2018 to 2022 timeline, a pro-rata methodology is applied to estimate financial mobilisation specific to this period. In some cases, actual disbursements may differ from the estimates due to factors like delayed payments or uneven financial distributions across years, but the methodology used provides a high degree of accuracy for the scope of this assessment.

5.2 Financial Support Needed

Although a quantified amount of the support required for climate priorities is not available, various policy documents outline areas in which support is needed to transform ambition into action, build resilience and meet the country's low-emission development goals.

In Maldives's updated NDC (ME, 2020a), the targets of reducing emissions by 26% and reaching net-zero by 2030, are conditional on receiving adequate support from the international community. Achieving net-zero will require significant investment in key sectors of energy generation, waste management and transport. To achieve this by 2030 will require substantial financial investments across various sectors amounting to billions of dollars over the next decade.

To effectively implement the NDC, assistance is required to transform the energy infrastructure towards low carbon development. In addition to this, capacity building gaps need to be filled to fully implementation the NDC, and enable the uptake of new technologies.

Additional support is required for climate proofing critical infrastructure and integration of climate considerations into national development processes. Furthermore, enhancing early warning systems for climate-related disasters is a priority, as the Maldives is highly vulnerable to extreme weather events. Strengthening data collection and improving forecasting tools will enable more effective disaster risk management and resilience-building across the country.

According to the UNFCCC's Needs Based Financing (NBF) Project (UNFCCC, 2020), there is an estimate of the joint needs of the six countries of Island States of the Indian Ocean (ISIO) which includes the Maldives, amounting to USD 49.6 billion up to 2030. This covers mitigation efforts in the energy, transport, industry, forestry, land use, and waste sectors, as well as adaptation actions in critical areas such as infrastructure, tourism, water supply and sanitation, health, biodiversity, food security (agriculture, livestock, fisheries), coastal zone protection, marine resources, and disaster risk reduction.

To climate-proof critical infrastructure and provide sustainable and effective solutions for coastal protection of the islands, a significant amount of support and finance is required, exceeding the Government's capacity. For example, an estimated USD 8,000 is needed per linear metre, based on the coastal protection project of Gn. Fuvahmulah being implemented by the Government through loan financing (MEE, 2015g)

5.3 Financial Support Received

An internal analysis of the available information from the first Biennial Update Report of the Maldives shows that international climate finance mobilised in the country is significantly inadequate with respect to the funding required.

In many cases, blended financing has been utilised to implement climate actions. In these instances, the Maldivian government's financial contributions often exceed those of external funders, placing further strain on its already limited resources. Additionally, the government also finances nearly all immediate coastal protection needs for inhabited islands mostly through its Public Sector Investment Programme (PSIP), since building and maintaining these infrastructures is vital for the safety of the islands and its communities.

Of the international climate finance received, over 40% is received in the form of concessional loans that will eventually have to be repaid. Additionally, more than 87% of the total investments are directed towards development of critical infrastructure, including coastal protection and improving access to essential services in the islands. The annual climate finance received from international sources represent slightly over 1.5% of the country's GDP, which was USD 6.2 billion in 2022, while domestic contributions account for 6.5% of the GDP.

Table 21: Financial Support Received in the climate change adaptation, mitigation and cross-cutting areas and government contribution shown under “Co-Finance”.

							Support Received (USD)				Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implement-ing Entity	Supporting Entity	Grants	Loans/ Guaran-tees	Co-Finance	Total	2018-2022 (in pro-rata basis)
					Climate Adaptation						
Climate Change Adaptation Project	CCAP focused on implementing integrated, multi-sectoral climate adaptation interventions includ-ing wetland conservation, coral reef monitoring, solid waste man-agement and capacity building in Addu City and Fuvahmulah. Climate Change mainstreaming in island development planning was supported via national scale capacity building programmes	2015	2019	Climate Change Trust Fund (EU and Australia)	MCCEE	World Bank	10,000.00	-	100,000.00	4,310,000.00	1,724,000.00
Support of Vulnerable commu-nities in Maldives to Manage Climate Change-induced Water shortages	This project aims to deliver safe and secure freshwater to 105,000 people in the islands of Maldives in the face of climate change risks, through scaling up an integrated water supply system to provide safe water to vulnerable households, Introduction of decentralised and cost-effective dry season water supply systems and groundwater quality improved to secure freshwater reserves for long term resilience	2015	2023	GCF	MCCEE	UNDP	23,736,364.00	-	4,493,940.00	28,230,304.00	15,683,502.22
ORIO Coastal Protection Project	This project aims at remedying the coastal erosion faced by the populations of Gn.Fuvahmulah, by protecting the threatened shorelines.	2020	2025	Invest International (ORIO) and Kuwait Fund for Arab Economic Development	MOCI	MOF	8,949,283.76	10,922,989.51	5,139,762.98	25,012,036.25	12,506,018.13

							Support Received (USD)				Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implementing Entity	Supporting Entity	Grants	Loans/ Guarantees	Co-Finance	Total	2018-2022 (in pro-rata basis)
Scaling up the National Capacity for Disaster Risk Reduction and Management in the Maldives	This project seeks to increase capacities especially at the island level. It will directly result to: a) Enhancement of island level capacity for disaster response in 20 islands; b) Strengthening early warning systems in 4 island level; and c) Improve capacity of stakeholders through NDMC to report progress according to Sendai Framework 1 for DRR by making the stakeholders aware on their mandate on the Sendai Framework, what needs to be reported by when to NDMC	2016	2018	Government of Japan	National Disaster Management Authority	UNDP	380,000.00	-	-	380,000.00	126,666.67
Japan's Non-Project Grant Aid for Provision of Japanese Disaster Reduction Equipment (FY2014) for the Republic of Maldives	Japanese Non-Project Grant Aid by the Government of Japan was extended to the Government of Maldives in response to the Male' Water Crisis event of December 2014. Through the grant aid NDMC procured disaster management equipment that would enhance and increase the disaster response capacity of the Maldives. This equipment would be used to establish disaster response	2015	2018	Government of Japan	National Disaster Management Authority	Japan International Corporation System	9,900,000.00	-	-	9,900,000.00	2,475,000.00
Establishment of the Regional Emergency Response Centre in Faafu Nilandhoo	This project was undertaken by NDMC in collaboration with the MNDF Fire and Rescue (FRS) and supported by the United Nations Children's Fund (UNICEF) to establish a Regional Emergency Response Centre which compliments efforts of NDMC to strengthen the capacity of island communities to prepare for and respond to emergencies.	2017	2018	Emergency Preparedness: Fund allocation from UNICEF Regional office	National Disaster Management Authority	UNICEF	150,000.00	-	-	150,000.00	75,000.00

							Support Received (USD)				Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implement-ing Entity	Supporting Entity	Grants	Loans/ Guaran-tees	Co-Finance	Total	2018-2022 (in pro-rata basis)
Enhancing National Development through Environmentally Resil-ient Islands (ENDhERI)	To enhance reef ecosystem integrity and resilience through sustainable management, reducing development impacts and integrating natural capital accounting into development planning	2021	2024	GEF	MCCEE	UNEP	3,532,968.00	-	22,934,073.00	26,467,041.00	13,233,520.50
Building Climate Resilient Safer Islands in the Maldives (BCSRI)	Enhancing coastal management, including the protective functions of natural sandy beaches and coral reefs. The project will do this through integrated coastal zone management, early warning and early action, and knowledge sharing	2022	2030	GCF, JICA	MCCEE	JICA	60,555,238.94		5,486,520.00	66,041,758.94	7,337,973.22
USAID Climate Adaptation Project (USAID CAP)	To build the capacity of the private sector, civil society, and government to respond and adapt to climate change in ways that contribute to sustained, inclusive, market-based growth	2021	2026	USAID	MCCEE		10,500,000.00	-	-	10,500,000.00	3,500,000.00
Climate Smart Resilient Islands (CSRI) Initiative [Readiness Support]	The aim of the Climate Smart Resilient Island (CSRI) Initiative is to help SIDS become more resilient to future challenges by unlocking the great potential of mutual learning experiences on an inter-regional scale, as well as the climate financial resourc-es needed for the implementa-tion of larger projects	2019	2024	GCF, GIZ	MCCEE	GIZ	639,160.74			639,160.74	426,320.21
Development of a Wave fore-casting system for the Maldivian Archipelago (WAVE4M)	The project involves the creation of a wave motion forecasting system in the Maldives archi-pelago, which will be provision of the Maldives Meteorological Service, (MMS), in Malé.	2018	2024	Government of Italy	MCCEE	ENEA, MMS	668,572.00	-	-	668,572.00	477,551.43

							Support Received (USD)				Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implementing Entity	Supporting Entity	Grants	Loans/ Guarantees	Co-Finance	Total	2018-2022 (in pro-rata basis)
Implementation of an integrated metereological and climate information and decision support system Maldives	The project aims to create an integrated system of meteorological and climate information, due to the use of a single database that can make use of the observation tools currently available to the Maldives Meteorological Service, (MMS), guaranteeing the quality of the data and their easy use	2018	2024	Government of Italy	MCCEE	MMS	997,603.00	-	-	997,603.00	712,573.57
Establishment of a skimming well gallery system for agricultural use in HDh.Nolhivaranfaru	Installation of an infiltration gallery system for groundwater extraction to ensure sustainable use of limited water resources with minimum impact on the aquifers in HDh.Nolhivaranfaru Island	2021	2022	Adaptation Fund	MCCEE		248,000.00	-	-	248,000.00	248,000.00
Enhancing weather and climate monitoring and data management capacity of MMS for reducing vulnerabilities of climate change Maldives	The project will strengthen the meteorological monitoring, early warning and disaster prevention network, through the installation of 25 meteorological stations. The stations are solar powered with battery backup and can measure air temperature, relative humidity, air pressure, wind direction and speed, volume and intensity of precipitation. The data received from the meteorological stations is collected, processed and addressed, in real time, from remote areas to the Maldives Meteorological Service, (MMS), in Male'	2016	2020	Government of Italy	MCCEE	ENEA, MMS	1,475,925.00	-	-	1,475,925.00	885,555.00
Ocean Energy Resources Assessment for Maldives (OpERATE) Maldive	Study of the energy potential produced by sea currents and identification of the most appropriate technological solutions for exploiting it.	2016	2020	Government of Italy	MCCEE	ENEA, MMS, MRC, EPA	952,870.00	-	-	952,870.00	571,722.00
Total							**126,895,985.44**	**10,922,989.51**	**38,154,295.98**	**175,973,270.93**	**59,983,402.94**

							Support Received (USD)				Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implement-ing Entity	Supporting Entity	Grants	Loans/ Guaran-tees	Co-Finance	Total	2018-2022 (in pro-rata basis)
					Climate Mitigation						
Preparing Outer Islands for Sustainable Energy Development (POISED)	The project will install solardiesel hybrid grids on outer islands and the greater Male region. Skills development support will also be given to the Ministry of Environment and Energy and the main power utilities State Electricity Company and FENAKA Corporation Ltd. for the hybrid rollouts	2014	2025	Grant: ADB, Strategic Climate Fund and Japan Fund for Joint Crediting Mechanism Loan: European Investment Bank and Islamic Development Bank	MCCEE, FENKA and STELCO		55,000,000.00	60,000,000.00	-	115,000,000.00	23,000,000.00
Accelerating Sustainable Private Investment in Renewable Energy (ASPIRE)	The project development objective of ASPIRE Project is to increase PV generation in Maldives through private sector investments	2014	2025	IDA/ World Bank	MCCEE		11,684,000.00	16,000,000.00	-	11,535,000.00	5,536,800.00
Strengthening Low Carbon Energy Island Strategies (LCEI)	The overall objective of this project is to mainstream energy efficiency measures into housing policies, guidelines, standards and building practices in the Maldives and to achieve a substantial reduction of GHG emissions as a result of improved buildings and building management practices and to leverage substantial investment in activities leading to increased energy efficiency in the Maldives	2015	2022	GEF	MCCEE	UNEP	3,760,914.00	-	29,630,434.00	33,391,348.00	20,869,592.50
ESMAP Renewable Energy Resource Mapping Project	The project focuses on solar resource mapping and measurement services as part of a technical assistance in the renewable energy development	2014	2019	ESMAP & ASTATE	World Bank		2,415,000.00	-	-	2,415,000.00	805,000.00
Converting waste to energy in Addu City	Installation of 1.5MW waste to energy plant at Addu as a solution for regional waste management	2021	2024	ADFD	MCCEE			14,000,000.00	20,436,883.07	34,436,883.07	17,218,441.54

							Support Received (USD)			Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implement-ing Entity	Supporting Entity	Grants	Loans/ Guaran-tees	Co-Finance	Total	2018-2022 (in pro-rata basis)
Small scale waste to energy project at Vandhoo	Installation of 0.5MW waste to energy plant at Vandhoo as a solution for regional waste management	2015	2025	ADFD	MCCEE			6,000,000.00	6,000,000.00	12,000,000.00	5,454,545.45
Greater Male Environmental Improvement and Waste Man-agement Project	The project will establish a sustainable solid waste manage-ment system in the Greater Male capital region and its inhabited outer islands by (i) establishing a modern waste collection, transfer, and disposal system; (ii) improving community-based outer island waste management systems; (iii) building institutional capacity for sustainable services delivery; and (iv) raising public awareness in reduce, reuse, recycle behaviors. Physical and non-physical investments are designed to curb climate change and disaster impacts while creating a cleaner environment in Maldives, one of the world's lowest-lying nations	2018	2026	ADB, JFPR	MCCEE		35,070,000.00		4,930,000.00	40,000,000.00	22,222,222.22
Greater Male Waste to Energy Project		2018	2025	ADB, JFJCM, AIIB			45,180,000.00	78,210,000.00	27,740,000.00	151,130,000.00	94,456,250.00
Accelerating Renewable Energy Integration and Sustainable Energy Project (ARISE)	The project aims to expand solar power generation in locations in and out of the Greater Male' re-gion and strengthen the capacity of the power system for integra-tion of electricity generated from solar power	2021	2026	IDA/World Bank, CTF, AIIB,	MCCEE	World Bank	19,400,000.00	43,000,000.00	45,000,000.00	107,400,000.00	35,800,000.00
Integrated, Sustainable and Low Emissions Transport in the Maldives (ISLET)	To mitigate greenhouse gas (GHG) emissions, promote energy security, and improve air quality through integrated, sus-tainable low-emissions transport systems in the Maldives	2021	2025	GEF	MCCEE	UNEP	1,826,339.00		4,408,484.00	6,234,823.00	2,493,929.20
Total							**174,336,253.00**	**217,210,000.00**	**138,145,801.07**	**529,692,054.07**	**227,856,780.91**

							Support Received (USD)				Total budget allocated for reporting period
Project	Description of project	Start Year	End Year	Donor	Implementing Entity	Supporting Entity	Grants	Loans/ Guarantees	Co-Finance	Total	2018-2022 (in pro-rata basis)
					Cross-cutting						
Maldives Readiness Project; Establishing and strengthening NDA and Developing Strategic Framework for Engagement with the GCF Maldives	Establishing and strengthening the National Designated Authority (NDA) and developing strategic framework for engagement with the GCF In Maldives	2017	2020	GCF	MCCEE	UNEP	272,727.00	-	27,273.00	300,000.00	119,370.00
Maldives Clean Environment Project	The development objective of Clean Environment Project for Maldives is to improve solid waste management in selected zones	2017	2024	IDA/ World Bank	MCCEE		17,500,000.00	-	-	17,500,000.00	10,937,500.00
Preparation of the Biennial Update Report to the UNFCCC	To prepare and submit the 1st Biennial Update Report of Maldives to the UNFCCC	2017	2019	GEF	MCCEE	UNEP	342,000.00	-	48,000.00	390,000.00	260,000.00
Maldives Climate Change Act	To develop a Climate Change Act in the Maldives	2017	2021	UNEP	MCCEE		15,000.00	-	-	15,000.00	12,000.00
Capacity Building for Improved Transparency of Climate Change Mitigation and Adaptation Actions in the Maldives (CBIT Maldives)	To strengthen institutional capacity for tracking mitigation and adaptation actions and establish climate finance tracking system in the Maldives	2022	2025	GEF	MCCEE	UNEP	1,457,500.00	-	440,000.00	1,897,500.00	474,375.00
Preparation for Technology Needs Assessment (TNA) to the UNFCCC	Identification and prioritisation of technologies needed for climate change adaptation and mitigation in different sectors of developing countries	2020	2024	GEF	MCCEE		125,000.00	-	-	125,000.00	75,000.00
Initiative for Climate Action Transparency (ICAT)	To strengthen national institutions to meet enhanced transparency requirements of the Paris Agreement.	2019	2024	ICAT	MCCEE	UNEP and UNOPS	125,000.00	-	-	125,000.00	83,333.33

							Support Received (USD)				Total budget allocated for reporting period
Project	**Description of project**	**Start Year**	**End Year**	**Donor**	**Implement-ing Entity**	**Supporting Entity**	**Grants**	**Loans/ Guaran-tees**	**Co-Finance**	**Total**	**2018-2022 (in pro-rata basis)**
Support Programme for Climate Change 2017-2018 – AOSIS	Training project for 4 young negotiators from AOSIS member countries which aims to build capacity, both at an individual and political level, in the context of negotiations on international processes, with particular attention to issues such as: oceans, climate change, sustainable development and implementation, in the Small Developing Islands	2018	2018	Government of Italy	AOSIS	MCCEE	257,060.25	-	-	257,060.25	257,060.25
Preparation of the Third National Communication under the UN Framework Convention on Climate Change (TNC)	To provide Support to the Maldives in development of the countries 3rd national Communications to the UNFCCC	2018	2026		MCCEE	UNEP	500,000.00	-	100,000.00	600,000.00	333,333.33
Preparation of the First Biennial Transparency Report under the UN Framework Convention on Climate Change	To provide Support to the Maldives in development of the countries First Biennial Transparency Report to the UNFCCC	2022	2025		MCCEE		570,000.00	-	-	570,000.00	142,500.00
Total							**21,164,287.25**	**-**	**615,273.00**	**21,779,560.25**	**12,689,971.92**

5.4 Technology Development and Transfer Support Needed

The Technology Needs Assessment (TNA) for the Maldives(MECCT, 2022b) identifies several critical technology requirements across various sectors to support climate adaptation and resilience. For instance, in the Coastal Adaptation and Disaster Management sector, technology needs such as habitable coastal structures combining soft and hard infrastructure are emphasised as essential to mitigate coastal erosion and protect them against storm surges. Additionally, geospatial technologies such as drone mapping, satellite imagery and GIS for Integrated Coastal Zone Management (ICZM) are considered crucial for better planning and risk management in coastal areas. Advanced multi-hazard early warning systems will enhance disaster preparedness through systemic observation, while there is also a need to centralise environment and disaster-related data for better decision-making and coordination.

In the water resources management sector, rainwater harvesting, and floodwater recovery systems are necessary to improve water security, especially during periods of extreme weather.

For agriculture and food security, climate-smart agriculture technologies focusing on community farming, agritourism, and integrated pest management will improve local food production, reduce dependence on imports, and increase resilience to climate impacts. These technologies will address the challenges of limited agricultural land, poor inherent soil conditions, and water scarcity in the Maldives.

In the fisheries sector, improved fish harvesting and handling technologies, including better boat design, were identified to help the sector adapt to climate change. These innovations will reduce post-harvest losses, improve fish quality, and address changes in fish stock distribution due to rising sea temperatures. Continuous marine ecosystem monitoring technologies will also play a key role in tracking coral reef health and managing fish stocks.

For coral reef and biodiversity conservation, ecosystem-based approaches and monitoring technologies are recognised as essential for mitigating the impacts of climate change on coral ecosystems. Technologies aimed at reducing marine pollution, especially the phasing out of single-use plastics, will further protect the biodiversity that supports the Maldives' economy and enhances coastal protection.

In the tourism sector, the adoption of climate-friendly utilities for electricity, waste management, and water systems is necessary for creating sustainable resort infrastructure. Additionally, climate-proofing tourism infrastructure is critical to maintaining the Maldives' position as a top tourist destination, especially in the face of rising sea levels and extreme weather events.

The health sector requires green, climate-smart healthcare facilities that are energy-efficient and resilient to extreme weather. Furthermore, emergency response technologies are needed to ensure that healthcare services remain functional during extreme events, especially in outer island communities.

In the critical infrastructure sector, technologies that enable the climate-proofing of essential infrastructure—including airports, ports, and hospitals—are essential to protect against sea-level rise and severe weather. The integration of climate risk assessment tools into national development planning will ensure that future infrastructure projects are designed to withstand climate impacts.

The TNA also covers the technology needs for climate change mitigation in the Maldives. Under the electricity generation and consumption needs, rooftop solar photovoltaics (PV) with energy storage capacity have been highlighted. Such systems will require hybrid configurations in various islands with diesel power plants to enhance power supply generation. Floating solar panels are an innovative approach to address Maldives' renewable energy commitments despite challenges faced by limited land area. Pilot projects for on-shore wind energy and small-scale vertical axis wind turbines in the northern region of Maldives are also mentioned, as well as wave-to energy converters that can be scaled up.

The technology needs for waste management include waste-to-energy facilities in various regional waste management facilities of the Maldives. Biogas production from organic waste was also listed as a means reduce methane emissions from waste decomposition and providing a renewable energy source. Composting technologies, including in-vessel aerobic composting, were listed to reduce landfill use and increase efficiency in processing waste in controlled settings.

A final category for TNA's mitigation focus was the transport sector. Electric vehicles were identified as a priority investment area, with the inclusion of the charging infrastructure, vehicle standards and grid integration. Since marine transport is a major contributor to Maldives' emissions, hybrid solar boats were also identified as a key area, where design and operation support will be required.

In addition to these sector-specific technologies, the TNA emphasised the importance of policy and regulatory interventions to promote energy efficiency and renewable energy adoption. For instance, an energy efficiency labeling program, *Hakathari*, was launched to encourage the use of energy-efficient appliances, requiring technological expertise for testing and implementing the standards, and potential expansion in the future. Furthermore, the Maldives Energy Act (Law no.18/2021) mandates increasing renewable energy's share in the national energy mix, and technical support is needed for grid stabilisation and integration of renewable technologies. Furthermore, following the pledge made by H.E. President Dr. Mohamed Muizzu at COP28 in the United Arab Emirates to expand Maldives' renewable energy to provide 33% of electricity needs by 2028, significant financial and technological investments will be required to fulfil this pledge.

5.5 Information on Technology Development and Transfer Support Received

Table 22 summarises some of the recorded support received in terms of technology development and transfer. Approximately 50% of the reported activities are for mitigation while 35% is for adaptation and 15% is for cross cutting. A significant number of activities are from energy and waste sectors.

Table 22 : Technology development and transfer support received under Article 10 of the Paris Agreement

Program / Project	Type of technology	Time frame	Recipient / Implementor	Type of support	Sector	Status
Preparing Outer Islands for Sustainable Energy Development (POISED) - POISED Project is installing energy management and control systems; energy storage; and improvements in distribution networks, in order to significantly reduce the need for diesel to generate electricity.	Solar PV	2015-2025	MCCEE / MCCEE	Mitigation	Energy (Electricity Generation)	Ongoing
Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) - ASPIRE was designed to scale-up solar PV in Maldives, through private sector investments. There is a overall target to install 17.5MW of Solar PV	Solar PV	2014-2025	MCCEE / MCCEE	Mitigation	Energy (Electricity Generation)	Ongoing
Accelerating Renewable Energy Investments and Sustainable Energy (ARISE) - ARISE Project was designed and implemented as a follow up project to ASPIRE to supplement the private investment scale-up, through increasing the grid RE absorption capacity of large islands of Maldives. Thus a combination of Solar PV investments from private sector, and public sector investments in Grid Modernisation and Battery Energy Storage Systems (BESS) was the major scope of the project.	Solar PV	2021-2026	MCCEE / MCCEE	Mitigation	Energy (Electricity Generation)	Ongoing
Greater Male' Waste-to-energy Project - Modern technology of waste to Energy is adopted to manage waste and produce energy	Waste to Energy	2018-2025	MCCEE / MCCEE	Mitigation	Waste (Waste to Energy)	Ongoing

Program / Project	Type of technology	Time frame	Recipient / Implementor	Type of support	Sector	Status
Converting waste to energy in Addu City - Installation of 1.5MW waste to energy plant at Addu as a solution for regional waste management	Waste to Energy	2018-2025	MCCEE / MCCEE	Mitigation	Energy,Waste (Waste to Energy)	Ongoing
Small scale waste to energy project at Vandhoo - Installation of 0.5MW waste to energy plant at Vandhoo as a solution for regional waste management	Waste to Energy	2015-2023	MCCEE / MCCEE	Mitigation	Waste (Waste to Energy)	Completed
Support of Vulnerable communities in Maldives to Manage Climate Change-induced Water shortages - Deliver safe and secure freshwater to 105,000 people in the islands of Maldives in the face of climate change risks, through scaling up an integrated water supply system to provide safe water to vulnerable households, Introduction of decentralised and cost-effective dry season water supply systems and groundwater quality improved to secure freshwater reserves for long term resilience	Meteorological stations,Integrated Water Resources Management system	2017-2023	MCCEE / NDMA, MCCEE, MMS	Adaptation	Water and sanitation (Water security and resilience)	Completed
Enhancing National Development through Environmentally Resilient Islands (ENDhERI) - This project aims to assist the government of the Maldives in its implementation of new environmental policies and transition towards national adoption of Green Growth atoll development that will sustain marine National Capital and strengthen the resilience and recovery of reef ecosystems	Digital Infrastructure, Natural Capital Accounting, Sustainable Practices	2020-2025	MCCEE / MCCEE	Adaptation	Forestry,Fisheries and Marine,Waste,Protected area management	Ongoing

Program / Project	Type of technology	Time frame	Recipient / Implementor	Type of support	Sector	Status
Building Climate Resilient Safer Islands in the Maldives (BCRSI) - Shift to a new paradigm of coastal conservation and protection to maintain its natural resilience through establishment of the Integrated Coastal Zone Management (ICZM) , implementation of coastal conservation/protection measures against coastal disasters, development of disaster warning and information dissemination and development of basic data collection and sharing system related to climate change	Integrated Coastal Zone Management,Early warning system	2022-2030	MCCEE / MCCEE	Adaptation	Disaster Risk Reduction, Coastal Protection (Monitoring and Early Warning Systems, Integrated Coastal Zone Management)	Planned
USAID Climate Adaptation Project (USAID CAP) - Build the capacity of the private sector, civil society, and government to respond and adapt to climate change in ways that contribute to sustained, inclusive, market-based growth. Focusing on the tourism, fisheries and agriculture sectors, the activity helps identify and scale up innovative solutions to climate-related challenges, strengthen governance to address climate-related risks, and improve access to high-quality information for decision-making to reduce vulnerability to climate change		2021-2026	/	Cross-cutting		Ongoing
Development of a Wave forecasting system for the Maldivian Archipelago (WAVE4M) - Creation of a wave motion forecasting system in the Maldives archipelago, which will be provision of the Maldives Meteorological Service, (MMS), in Male'	Wave motion forecasting system	2018-2023	MCCEE / MMS ,ENEA	Adaptation	Disaster Risk Reduction (Monitoring and Early Warning Systems)	Completed

Program / Project	Type of technology	Time frame	Recipient / Implementor	Type of support	Sector	Status
Enhancing weather and climate monitoring and data management capacity of MMS for reducing vulnerabilities of climate change - Strengthen the weather monitoring, early warning and disaster prevention network	Meteorological stations	2021-2022	MCCEE / MMS	Adaptation	Disaster Risk Reduction (Monitoring and Early Warning Systems)	Completed
Ocean Energy Resources Assessment for Maldives (OpERATE) - Study of the energy potential produced by sea currents and identification of the most appropriate technological solutions for exploiting it	Renewable Energy Mapping/ Resource Assessment	2016-2019	MCCEE / MMRI, MMS ,EPA ,ENEA	Adaptation	Energy (Renewable Energy)	Completed
Implementation of an integrated meteorological and climate information and decision support system Maldives - Create an integrated system of meteorological and climate information, due to the use of a single database that can make use of the observation tools currently available to the Maldives Meteorological Service, (MMS), guaranteeing the quality of the data and their easy use	Integrated meteorological and climate information system	2018-2020	MCCEE / MMS	Adaptation	Cross-cutting (Monitoring and Early Warning Systems)	Completed
Maldives Clean Environment Project - The development objective of Clean Environment Project for Maldives is to improve solid waste management in selected zones	Waste Management	2017-2024	MCCEE / MCCEE	Cross-cutting	Waste (Waste management)	Ongoing
Integrated, Sustainable and Low Emissions Transport in the Maldives (ISLET) - To mitigate greenhouse gas (GHG) emissions, promote energy security, and improve air quality through integrated, sustainable low-emissions transport systems in the Maldives	Transport Electrification	2021-2025	MCCEE / MCCEE	Mitigation	Transport (Transport Electrification)	Ongoing

Program / Project	Type of technology	Time frame	Recipient / Implementor	Type of support	Sector	Status
Greater Male' Environmental Improvement and Waste Management Project - Establish a sustainable solid waste management system in the Greater Male' capital region and its inhabited outer islands	Waste Management	2018-2026	MCCEE / MCCEE	Cross-cutting	Waste (Waste management)	Ongoing
ESMAP Renewable Energy Resource Mapping Project - Identifying and assessing the potential for renewable energy sources, particularly solar and wind, across the Maldives which can then be incorporated into national planning and policy decisions	Renewable Energy Mapping	2014-2019	MCCEE / World Bank	Mitigation	Energy (Renewable Energy)	Completed
Strengthening Low Carbon Energy Island Strategies (LCEI) - Mainstream energy efficiency measures into policies, guidelines, standards and building practices in the Maldives and to achieve a substantial reduction of GHG emissions as a result of improved buildings and building management practices and to leverage substantial investment in activities leading to increased energy efficiency	Energy Efficiency	2015-2022	MCCEE / MCCEE	Mitigation	Energy (Efficiency and Optimisation)	Completed
Japan's Non-Project Grant Aid for Provision of Japanese Disaster Reduction Equipment (FY2014) for the Republic of Maldives - Through the grant aid NDMC procured disaster management equipment that would enhance and increase the disaster response capacity of the Maldives. This equipment would be used to establish disaster response	Disaster Management Equipment	2015-2018	NDMA / NDMA	Adaptation	Disaster Risk Reduction ()	Completed

Program / Project	Type of technology	Time frame	Recipient / Implementor	Type of support	Sector	Status
Establishment of a skimming well gallery system for agricultural use in HDh.Nolhivaranfaru of Maldives - Design and installation of an infiltration gallery system for groundwater extraction to ensure sustainable use of limited water resources with minimum impact on the aquifers in HDh.Nolhivaranfaru Island	Infiltration gallery system	2021-2022	MCCEE / MCCEE	Adaptation	Agriculture (Groundwater management)	Completed

5.6 Capacity-Building Support Needed

The Maldives strengthens its human capacity through education, training, and public awareness initiatives. Significant investments have been made in education, focusing on developing human resources equipped to address climate and environmental challenges. Institutions such as the Maldives National University offer programs in environmental science, climate change, and sustainable development. In addition to this, there are skills development programs implemented by private sector organisations which contribute to the development of essential skills. Additionally, training programs for government officials, council members, and others, are conducted to enhance expertise in areas such as climate adaptation and disaster management. However, significant needs in terms of capacity building have still been identified.

The Ministry of Higher Education, Labour and Skills Development prepared the Government Training Needs Requirements 2021–2023, in addition to the comprehensive efforts undertaken by the project "Maldives: Enhancing Employability and Resilience of Youth (MEERY)" which aimed to empower youth with skill sets and entrepreneurship training. These efforts cover the various training needs that are in demand for developing the Maldives and includes an in-depth analysis of training necessities. While there are no quantifications on the support needed to address capacity gaps, several training needs analyses identified that environment, sustainability, and climate change are cross-cutting areas for various sectors that have seen an increased demand for skills development. Additionally, capacity needs were identified to fill gaps regarding niche environment protection technologies, especially in agricultural and fisheries sectors. The needs of the agricultural sector explicitly reference the climate change and agriculture nexus and identify needs to build capacity in climate-resilient agricultural practices for food security.

5.7 Capacity-Building Support Received

For the purpose of this report, support received for capacity building has been assessed based on available records from the Ministry of Climate Change, Environment and Energy. However, this does not reflect the full and actual capacity building support received, as some activities that have been implemented by private sector entities may not have been recorded.

Table 23 summarises the support received in terms of capacity building. Approximately 40% of the activities are for mitigation and 38% for adaptation, while 19% is for cross cutting. The majority of activities reported are from energy, waste and disaster reduction sectors.

Table 23 : Capacity building support received under Article 11 of the Paris Agreement

Programme/project description	Time frame	Recipient / Implementor	Type of support	Sector	Status
Preparing Outer Islands for Sustainable Energy Development (POISED) POISED Project is installing energy management and control systems; energy storage; and improvements in distribution networks, in order to significantly reduce the need for diesel to generate electricity.	2015-2025	MCCEE / MCCEE	Mitigation	Energy (Electricity Generation)	Ongoing
Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) - ASPIRE was designed to scale-up solar PV in Maldives, through private sector investments. There is a overall target to install 17.5MW of Solar PV	2014-2025	MCCEE / MCCEE	Mitigation	Energy (Electricity Generation)	Ongoing
Accelerating Renewable Energy Investments and Sustainable Energy (ARISE) - ARISE Project was designed and implemented as a follow up project to ASPIRE to supplement the private investment scale-up, through increasing the grid RE absorption capacity of large islands of Maldives. Thus a combination of Solar PV investments from private sector, and public sector investments in Grid Modernisation and Battery Energy Storage Systems (BESS) was the major scope of the project.	2021-2026	MCCEE / MCCEE	Mitigation	Energy (Electricity Generation)	Ongoing
Greater Male' Waste-to-energy Project - Installation of 13MW waste to energy plant at Thilafushi as a solution for regional waste management	2018-2025	MCCEE / MCCEE	Mitigation	Water and sanitation (Waste to Energy)	Ongoing
Converting waste to energy in Addu City - Installation of 1.5MW waste to energy plant at Addu as a solution for regional waste management	2018-2025	MCCEE / MCCEE	Mitigation	Energy, Waste (Waste to Energy)	Ongoing

Programme/project description	Time frame	Recipient / Implementor	Type of support	Sector	Status
Small scale waste to energy project at Vandhoo - Installation of 0.5MW waste to energy plant at Vandhoo as a solution for regional waste management	2015-2023	MCCEE / MCCEE	Mitigation	Waste (Waste to Energy)	Completed
Climate Change Adaptation Project (CCAP) - Implementing integrated, multi-sectoral climate adaptation interventions including wetland conservation, coral reef monitoring, solid waste management and capacity building in Addu City and Fuvahmulah. Climate Change mainstreaming in island development planning was supported via national scale capacity building programmes	2015-2018	MCCEE / MCCEE	Adaptation	Forestry, Fisheries and Marine, Waste (Wetland conservation, Waste management, Coral reef monitoring)	Completed
Support of Vulnerable communities in Maldives to Manage Climate Change-induced Water shortages Deliver safe and secure freshwater to 105,000 people in the islands of Maldives in the face of climate change risks, through scaling up an integrated water supply system to provide safe water to vulnerable households, Introduction of decentralised and cost-effective dry season water supply systems and groundwater quality improved to secure freshwater reserves for long term resilience	2017-2023	MCCEE, Atoll Councils, Island Councils / NDMA, MCCEE, Maldives Polytechnic	Adaptation	Water and sanitation (Water security and resilience)	Completed
Scaling up the National Capacity for Disaster Risk Reduction and Management in the Maldives Enhance disaster response and strengthen early warning systems	2016-2018	NDMA / NDMA	Adaptation	Disaster Risk Reduction (Monitoring and Early Warning Systems, Capacity development)	Completed

Programme/project description	Time frame	Recipient / Implementor	Type of support	Sector	Status
Establishment of the Regional Emergency Response Centre in Faafu Nilandhoo Establish a Regional Emergency Response Centre which compliments efforts of NDMC to strengthen the capacity of island communities to prepare for and respond to emergencies.	2017-2018	NDMA / NDMA, MNDF-FRS	Adaptation	Disaster Risk Reduction (Capacity development)	Completed
Enhancing National Development through Environmentally Resilient Islands (ENDhERI) This project aims to assist the government of the Maldives in its implementation of new environmental policies and transition towards national adoption of Green Growth atoll development that will sustain marine National Capital and strengthen the resilience and recovery of reef ecosystems	2020-2025	MCCEE / MCCEE	Adaptation	Forestry, Fisheries and Marine, Waste, Protected area management. ()	Ongoing
Building Climate Resilient Safer Islands in the Maldives (BCRSI) Shift to a new paradigm of coastal conservation and protection to maintain its natural resilience through establishment of the Integrated Coastal Zone Management (ICZM) , implementation of coastal conservation/ protection measures against coastal disasters, development of disaster warning and information dissemination and development of basic data collection and sharing system related to climate change	2022-2030	MCCEE / MCCEE	Adaptation	Disaster Risk Reduction,Coastal Protection (Monitoring and Early Warning Systems,Integrated Coastal Zone Management)	Planned

Programme/project description	Time frame	Recipient / Implementor	Type of support	Sector	Status
USAID Climate Adaptation Project (USAID CAP) Build the capacity of the private sector, civil society, and government to respond and adapt to climate change in ways that contribute to sustained, inclusive, market-based growth. Focusing on the tourism, fisheries and agriculture sectors, the activity helps identify and scale up innovative solutions to climate-related challenges, strengthen governance to address climate-related risks, and improve access to high-quality information for decision-making to reduce vulnerability to climate change	2021-2026	/ Tetra Tech	Cross-cutting		Ongoing
Development of a Wave forecasting system for the Maldivian Archipelago (WAVE4M) Creation of a wave motion forecasting system in the Maldives archipelago, which will be provision of the Maldives Meteorological Service, (MMS), in Male'	2018-2023	MCCEE / MMS, ENEA	Adaptation	Disaster Risk Reduction (Monitoring and Early Warning Systems)	Completed
Enhancing weather and climate monitoring and data management capacity of MMS for reducing vulnerabilities of climate change Strengthen the weather monitoring, early warning and disaster prevention network	2021-2022	MCCEE / MMS	Adaptation	Disaster Risk Reduction (Monitoring and Early Warning Systems)	Completed

Programme/project description	Time frame	Recipient / Implementor	Type of support	Sector	Status
Implementation of an integrated meteorological and climate information and decision support system Maldives Create an integrated system of meteorological and climate information, due to the use of a single database that can make use of the observation tools currently available to the Maldives Meteorological Service, (MMS), guaranteeing the quality of the data and their easy use	2018-2020	MCCEE	Adaptation	Cross-cutting (Monitoring and Early Warning Systems)	Completed
Maldives Clean Environment Project The development objective of Clean Environment Project for Maldives is to improve solid waste management in selected zones	2017-2024	MCCEE	Cross-cutting	Waste (Waste management)	Ongoing
Integrated, Sustainable and Low Emissions Transport in the Maldives (ISLET) To mitigate greenhouse gas (GHG) emissions, promote energy security, and improve air quality through integrated, sustainable low-emissions transport systems in the Maldives	2021-2025	MCCEE	Mitigation	Transport (Transport Electrification)	Ongoing
Greater Male' Environmental Improvement and Waste Management Project Establish a sustainable solid waste management system in the Greater Male' capital region and its inhabited outer islands	2018-2026	MCCEE	Cross-cutting	Waste (Waste management)	Ongoing

Programme/project description	Time frame	Recipient / Implementor	Type of support	Sector	Status
Strengthening Low Carbon Energy Island Strategies (LCEI) Mainstream energy efficiency measures into policies, guidelines, standards and building practices in the Maldives and to achieve a substantial reduction of GHG emissions as a result of improved buildings and building management practices and to leverage substantial investment in activities leading to increased energy efficiency	2015-2022	MCCEE	Mitigation	Energy (Efficiency and Optimisation)	Completed
Support Programme for Climate Change 2017-2018 – AOSIS Training project for 4 young negotiators from AOSIS member countries which aims to build capacity, both at an individual and political level, in the context of negotiations on international processes, with particular attention to issues such as: oceans, climate change, sustainable development and implementation, in the Small Developing Islands	2018-2018	Alliance of Small Island States	Cross-cutting	Policy (Climate)	Completed
Establishment of a skimming well gallery system for agricultural use in HDh.Nolhivaranfaru of Maldives Design and installation of an infiltration gallery system for groundwater extraction to ensure sustainable use of limited water resources with minimum impact on the aquifers in HDh.Nolhivaranfaru Island	2021-2022	MCCEE	Adaptation	Agriculture (Groundwater management)	Completed

5.8 Support Needed and Received for the Implementation of Article 13 of PA and Transparency Related Activities

The Maldives has received various types of support towards implementing the requirements of the Enhanced Transparency Framework (ETF). Table 24 summarises support received for transparency-related activities, including for transparency-related capacity building.

Table 24: Support received for the implementation of Article 13 of the Paris Agreement and transparency-related activities, including for transparency-related capacity-building

Title of activity, programme, project or other	Time frame	Recipient	Channel	Amount (USD)	Status
Preparation of the Third National Communication under the UN Framework Convention on Climate Change (TNC) To provide Support to the Maldives in development of the countries 3rd national Communications to the UNFCCC	2018-2026	MCCEE	Multilateral	500,000.00	Ongoing
Maldives Technology Need Assessment (TNA) Support Maldives in the development of the countries Technology Needs Assessment	2020-2024	MCCEE	Multilateral	125,000.00	Ongoing
Preparation of the First Biennial Transparency Report under the UN Framework Convention on Climate Change (BTR1) To provide Support to the Maldives in the development of the country's First Biennial Transparency Report to the UNFCCC	2022-2025	MCCEE	Multilateral	570,000.00	Ongoing
NDA Strengthening and Country Programming support for Maldives through UNEP To strengthen the NDA capacity to engage with GCF, and to facilitate engagement of stakeholders in an inclusive process in defining the country programme	2017-2020	MCCEE	Multilateral	259,740.00	Completed
Capacity Strengthening for Improved Transparency of Climate Change Mitigation and Adaptation Actions in the Maldives (CBIT) To strengthen institutional capacity for tracking mitigation and adaptation actions and establish a climate finance tracking system in Maldives	2022-2025	MCCEE	Multilateral	1,457,500.00	Ongoing
Initiative for Climate Action Transparency in the Maldives (ICAT) To develop and implement appropriate data collection, data management procedures and further legal instruments needed for the robust establishment of an MRV system in the waste sector	2019-2024	MCCEE	Multilateral	125,000.00	Ongoing

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CHAPTER 6: BIBILOGRAPHY

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07

ANNEXES

CHAPTER 7: ANNEXES

7.1 Relation of sectoral activity data with IPCC sectors

The following list outlines how activity data from the sectors are related to the IPCC inventory sectors, categories and sub-categories.

Energy Sector

a. Energy industries (1.A.1.)
   i. Public electricity generation
      1. STELCO, FENAKA
b. Manufacturing industries & construction (1.A.2.)
   i. Mining (excluding fuels) and quarrying (1.A.2.g.iii.)
      1. MTCC – fuel use for dredging
c. Transport
   i. Cars (1.A.3.b.i.)
   ii. Light duty trucks (1.A.3.b.ii.)
   iii. Heavy duty trucks and buses (1.A.3.b.iii.)
   iv. Motorcycles (1.A.3.b.iv.)
   v. Domestic Navigation (1.A.3.d.)
      1. Public marine transport (passenger & cargo)
      2. Resorts
      3. Safaris
d. Other Sectors
   i. Commercial/institutional (1.A.4.a.)
      1. Stationary combustion (1.A.4.a.i.)
         a. Electricity generation (MACL, Resorts, MWSC)
         b. LPG usage commercial (Maldive Gas, Villa Hakatha)
      2. Off-road vehicles and other machinery (1.A.4.a.ii.)
         a. MACL, MPL, STO, MTCC (construction, ports, airport operations)
   ii. Residential (1.A.4.b.)
      1. Stationary combustion (1.A.4.b.i.)
         a. LPG use Residential (Maldive Gas, Villa Hakatha)
   iii. Agriculture/forestry/fishing (1.A.4.c.)
      a. Stationary (1.A.4.c.i.)
         i. Electricity generation (MIFCO, Horizon)

b. Fishing (1.A.4.c.iii.)

i. Fuel and LPG use by fishing vessels

Waste

a. Incineration and open burning of waste (5.C.)

i. Open burning of waste (5.C.2.)

1. Biogenic (5.C.2.a.)

a. Municipal solid waste (5.C.2.a.i.)

2. Non-biogenic (5.C.2.b.)

a. Municipal solid waste (5.C.2.b.i.)

b. Wastewater treatment and discharge (5.D.)

i. Domestic wastewater (5.D.1.)

Memo Items

a. International bunkers (1.D.1.)

i. Aviation (1.D.1.a.)

1. Fuel use international aviation

ii. Navigation (1.D.1.b.)

1. Fuel use international maritime bunkering

7.2 Projection Methodology

7.2.1 Baseline

Baselines are defined as scenarios that describe future GHG emissions in the absence of defined mitigation efforts and policies (UNFCCC, 2017). For the purpose of this BTR, the baseline would be developed updating the baseline assessment done for the updated NDC reflecting the underlying national context. This baseline would be considered as the scenario without measures as described in the MPG, i.e. it excludes all policies and measures implemented, adopted and planned after the year chosen as the starting points for the projection. The justification for this is that includes detailed methodology in its annexes along with the results, which was referred to in the updated NDC. The Long-range Energy Alternatives Planning system (LEAP) was used to re-assess the baseline.

Table 25: Data Structure for LEAP model and the data sources for sectors

	Data Sources
Key Assumptions	Energy Balance 2010 – 2012, Maldives Population Projection 2014-2054, NBS Yearbooks
Demography	Macro-Economic update June 2024, HIES 2019
Economics	
Demand	Energy Balance 2010-2012
Commercial and Public services	
Transport	Energy Balance 2010-2012, NBS yearbooks, Transport database
Road Transport	GHG emission Sea Transport Activities in Tourist Resorts, Energy Balance 2010-2012, Transport database
Sea Transport	Energy Balance 2010-2012, STO, MACL
Aviation	Energy Balance 2010-2012
Industry	Energy Balance 2010-2012, Tourism Yearbooks, Macro Economic update June 2024
Resorts	
Residential	Energy Balance 2010-2012
Greater Male'	Energy Balance 2010-2012
Atolls	Energy Balance 2010-2012
Fishing	Energy Balance 2010-2012, Energy Yearbooks
Transformation	
Resources	
Non-Energy Use	SNC, Waste Department
Waste	Energy Balance 2010 – 2012, Maldives Population Projection 2014-2054, NBS Yearbooks

7.2.1.1 General Assumption and Proxies

7.2.1.1.1 Base year

The chosen base year for the baseline projection is 2010. This year is chosen because detailed sectoral data is processed and available in the form of energy balance study 2010-2012 (referred to as (MEA, 2014)). MEA (2014) also provides indicators for individual sectors that is invaluable for projection. That information can also be cross reference to other reports made independently, like the Maldives Carbon Audit, Energy Supply and Demand Study and Low Carbon Development Study (for Maldives) which covers information from 2009, and Second National Coomunications, and the Biennial Update Report of Maldives which covers information from 2011. This allows critical analysis of the data and indices available for 2010 from MEA (2014). That year also predates many of the mitigation actions and large scale deployment of renewable in both public and private sector, making it an ideal control year to project a scenario without mitigation measures.

7.2.1.1.2 Socio-economic Drivers

At a macro-level, there is a close relationship between total GHG emission and Gross Domestic Production (at constant price[6]) in Maldives. Similarly, as the population increases, it is observed that emissions increase. Thus, the two main macro socioeconomic indicators for emission projections are GDP and population. Actual GDP published by MBS is used for GDP projections for years till 2022, and beyond 2022, GDP projections issued by the Ministry of Finance in the Macroeconomic Update June 2024 is used. This is an update considering in the NDC, GDP projection done by IMF for the Debt Sustainability Assessment was utilised. For population growth projections, the MBS from 2014-2054 was the primary source of information used. A detailed description of how these indicators are utilised for projection in the subsectors are described in the respective subheadings below.

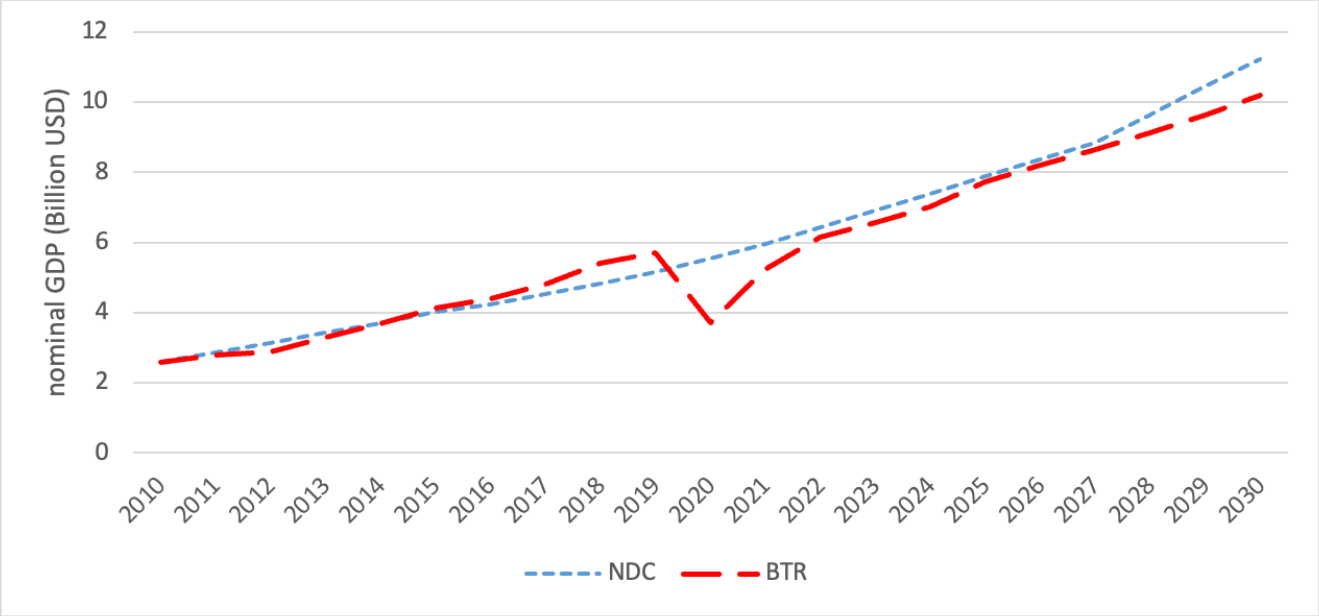


Figure 45: Comparison of GDP projection used in NDC (IMF, 2017) and new GDP projection from Ministry of Finance

7.2.1.1.3 Emission Factor

Only Tier 1 default emission factors for carbon dioxide (CO2), methane (CH4) and Nitrous Oxide (N2O) gases (IPCC, 2006) are used for the projection. Table 26 summarises the emission factors used

6 GDP at constant price also known as real GDP is an inflation-adjusted measure that reflects the value of all goods and services produced by an economy in a given year (expressed in base-year prices) and is more reflective of year-to-year growth of GDP

Table 26: Summary of Emission Factors

Emission Source		Emission Factor			
CO2		CH4	N2O		Reference
Stationary Combustion	Diesel	74100 kg/TJ	3 kg/TJ	0.6 kg/TJ	Volume 2, Chapter 2, Table 2.2
	LPG	63100 kg/TJ	1 kg/TJ	0.1 kg/TJ	Volume 2, Chapter 2, Table 2.2
Mobile Combustion	Diesel	74100 kg/TJ	3.9 kg/TJ	3.9 kg/TJ	Volume 2, Chapter 3, Table 3.2.1/3.2.2
	Gasoline	69300 kg/TJ	33 kg/TJ	3.2 kg/TJ	Volume 2, Chapter 3, Table 3.2.1/3.2.2
	Aviation Gasoline	70000 kg/TJ	0.5 kg/TJ	2 kg/TJ	Volume 2, Chapter 3, Table 3.6.4 and 3.6.5
Municiple Solid Waste – Open Burning		45.12 kg / tonne of Waste	6.5 kg / tonne of Waste	N/A	Derived from IPCC defaults (as used in SNC GHG)
Waste Water -Untreated		N/A	0.06 kg/kg BOD	N/A	Derived from IPCC defaults (volume 4 chapter 6)
Waste Water – Septic Tank		N/A	0.3 kg/ kg BOD	N/A	Derived from IPCC defaults (volume 4 chapter 6)

7.2.1.2 Energy Sector

7.2.1.2.1 Demand

7.2.1.2.1.1 Commercial and Public Services

Commercial and public services include retail, service industries operating in inhabited islands (excluding resorts), public infrastructure and services including government offices schools and hospitals that consume grid electricity. The base year data is drawn from the MEA (2014).

Table 27: Energy use for commercial and Public sector in 2010 (Data from Energy Balance 2010-2012)

	Greater Male' Region	Atoll	Total (TJ)
Commercial	394.37	60.42	454.79
Public and Government	115.85	168.07	283.92
			738.71

Power consumption in the commercial and public services sector is one that is closely linked with economic development. Thus, for future projections, the sector is expected to grow in tandem with GDP growth projection. The segregated information in the energy balance was aggregated to a single value for the purpose of this baseline projection as GDP data are not segregated geographically, and the attribution of growth for individual parts of this sector to GDP is difficult to ascertain. Figure 46 shows the energy consumption projection for this sector. The dip in energy

consumption seen in 2020 is directly related to the negative GDP growth of that year due to the COVID19 pandemic.

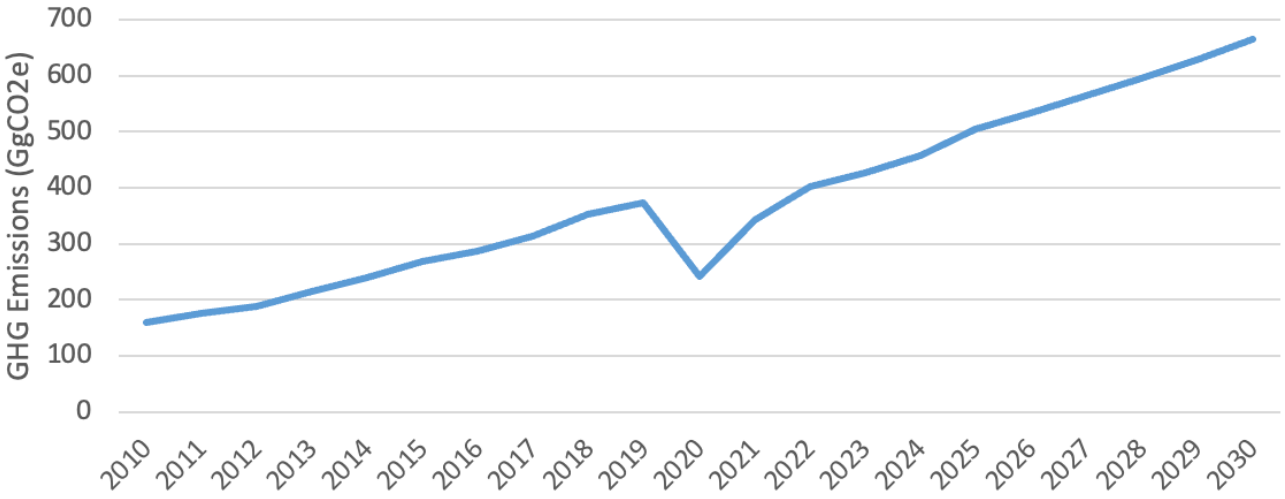


Figure 46: Projection for GHG emissions for commercial and Public Services sector

7.2.1.2.1.2 Transport

The transport sector is categorised into three subsectors: land, marine and aviation.

7.2.1.2.1.2.1 Land Transport

Land transport has been segregated geographically into Greater Male' region and other atolls. Vehicles used for land transport are broadly categorised into motorcycles, passenger cars, light commercial vehicles, heavy commercial vehicles and buses with each further subcategorised by fuel type. This categorisation is important as key indicators like fuel economy and travel patterns differ between the vehicle types. The table below shows the key indicators used. Fuel consumption indicators for vehicles were revised for this assessment because there was a discrepancy in values used in BUR (ME, 2019a) and values used in the MEA (2014). To resolve this issue, a sample inventory of registered vehicle from the Transport Authority (currently Ministry of Transport and Civil Aviation) was used to assess the overall status of the fleet. Following are findings of that assessment:

1. Honda (73 percent) and Yamaha (20 percent) makes up the majority of motorcycles in Maldives with 83 percent having engines between 100 cc and 125 cc. This category and these brands of motorcycles seem to have a fuel economy averaging at around 15 kmpl in high density settings.

2. For cars, Mazda, Toyota, Nissan and Honda models make up more than 75 percent of the fleet. Popular models of cars in Maldives include the Mazda Demio, Nissan March, Nissan Note, Toyota Vitz, Toyota Prius, Honda Fit, Suzuki Swift and Suzuki Alto. With the exception of Toyota Prius, all these other models prior to 2010 have a fuel economy of 9-11 kmpl in high-density urban settings. Given the driving

conditions and the regulatory preference for used vehicles, it is assumed that the fuel economy of cars in 2010 would be at around 9 kmpl or 0.11 l/km.

3. The light commercial vehicles (LCV) are made up of jeeps and pickups. Popular Japanese brands like Toyota, Suzuki and Nissan makes up nearly 2/3 of this fleet. About 55 percent of the sampled registered vehicles used petrol while the remainder used diesel. These types of vehicles are slightly heavier than passenger cars, and on comparing the available information of make and model, a typical LCV has an average fuel economy ranging from 7 kmpl to 9 kmpl for petrol while their diesel counterparts have a fuel economy ranging from 8 kmpl to 10 kmpl in high-density urban settings. Thus, taking in to account the local context, it is assumed that the fuel economy for LCVs is 7 kmpl for petrol and 8 kmpl for diesel.

4. Heavy duty vehicles (HDV) include lorries, trucks, and other heavy-duty vehicles including offroad vehicles like excavators and tractors etc. Approximately 5 percent of the sampled HDVs used petrol while the remainder used diesel. As there are more varieties of vehicles in this category, an approximated value is used, based on different vehicle surveys done globally in the relevant category of vehicles. The approximated value is 4.5 kmpl for petrol and 3.3 kmpl for diesel HDVs.

5. Urban buses include van and passenger buses. Of the sample population, nearly 75 percent used petrol while the remaining used Diesel. As most petrol vehicles in this category are passenger vans, the fuel economy is approximated from the available aggregated fuel economy information, estimated to be around 6.1 kmpl. The diesel vehicles consist of larger buses used on transit routes with an approximated fuel economy of 2.4 kmpl based on a similar class of vehicles.

Table 28: Indicators and Assumption used for land transport

Vehicle Types	Fuel types	Distance travelled (km)	Fuel economy (l/km)
Urban Buses	2% Gasoline	14600	0.164
	98% Diesel		0.42
Motorcycles	Gasoline	5475	0.07
Heavy Duty Vehicles	3% Gasoline	14600	0.22
	97% Diesel		0.3
Light Commercial Vehicles	42% Gasoline	7300	0.142
	58% Diesel		0.125
Passenger Cars	Gasoline	9125	0.11

For the projection purposes, and to account for the influence of population growth on vehicle numbers, the vehicle count has been normalised relative to the population. Figure 47 shows the growth of vehicles numbers normalised by population, and segregated between the Greater Male' region and Atolls.

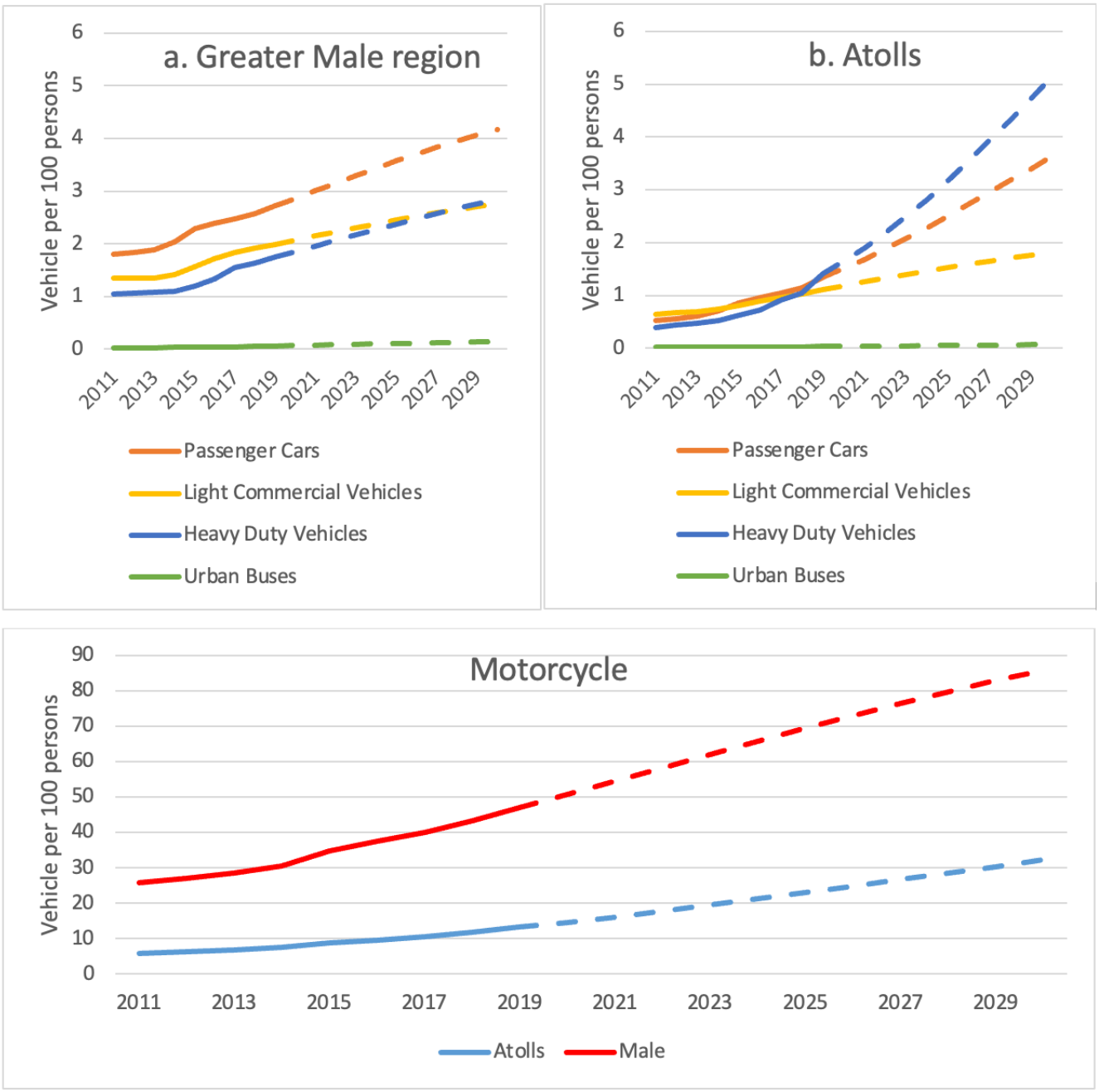
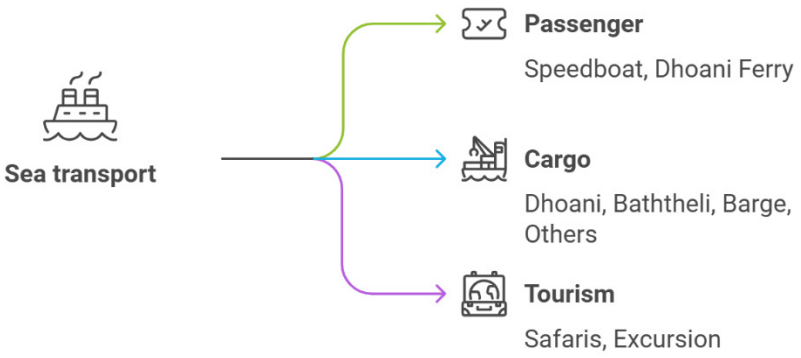


Figure 47:Historical growth (solid line) and forecast (dashed line) of Vehicles per 100 person segregated by Atoll and greater Male Region

7.2.1.2.1.2.2 Sea Transport

For the projection model initiation, sea transport has been segregated into 3 categories as shown inthe diagram below:



The energy use of tourism-related sea transport is calculated as the product of energy intensity per bed night multiplied by total bed nights. Energy intensity per bed night is derived from data available from MEE 2017 (Table 29). For future projections, we assume that energy intensity for tourism related activities will remain constant.

Table 29: Indicator and assumption used for tourism sector transport

		Energy Consumption/ bed night		
	bed-nights	diesel (litres)	LPG (kg)	Petrol (litres)
Safari	156753	15.87	0.20	1.06
Excursions and Water Sports (resorts)	5986340	3.04	N/A	2.85

For excursions and water sports, bed night refers to resort and safari bed nights used. Bed nights prior to 2022 are taken from the tourism yearbook, while post-2022 bed nights are derived from the projections provided in the Macroeconomic update from the Ministry of Finance. For safari bed nights, information prior to 2022 was taken from tourism yearbooks. For future projections, as safari tourism exhibits fluctuations in bed nights without showing any growth over the past decade, the same pattern is replicated beyond 2022 up to 2030.

The passenger transport sector is split into diesel fuel consuming *dhoani* and petrol consuming speedboats. Table 30 presents the base year assumptions made on hours of operation of each vessel, and the energy intensity of operation per hour for each vessel type. Data on vessel registration was available from the Ministry of Transport and the National Bureau of Statistics. For the projections post-2022, it is assumed that the number of *dhoani* in operation will increase with population, while the number of speedboats would increase at the historical growth rate of 8.8 percent per year, while the operation hours for speedboats would increase with GDP. The reason for this increase is mainly due to the booming guesthouse industry prompting greater transport activity using speedboats. All cargo vessels are equipped with diesel-based engines. Table 30 lists the assumptions made for each vessel type for the base year. For projection,

it is assumed that the number of cargo vessels in operation will increase with GDP. Except for speedboats, passenger and cargo transportation, it is assumed that the energy intensity or operating hours per vessel will remain constant.

Table 30: Indicators and assumptions used for passenger and cargo marine transport

	Type of vessel	Registered Vessels	% of Active Vessels	Active vessels	Fuel consumption (l/hr)	Annual Hours of operation
Passenger	Dhoni	1320	0.6	792	39	625
	Speed boats	394	0.7	275.8	65	1200[7]
Cargo	Dhoni	172	0.5	86	39	500
	Bahtheli	147	0.5	73.5	27	375
	Barge	123	0.5	61.5	57	375
	Other	39	0.5	19.5	32	375

7.2.1.2.1.2.3 Aviation Transport

For aviation, only domestic aviation is considered. A historic time series for aviation was built using data collected for the GHG inventory. For the projection, it is assumed that the sector will grow along with GDP. The comparison between actual and model projections can be seen in Figure 51 regarding aviation fuel.

7.2.1.2.1.3 Industrial Sector

In the industrial sector, the only sectors of note are the fish processing and freezing plants. The final energy consumption data is sourced from the information provided by MIFCO and Horizon for the GHG inventory. The base year data was used to calculate energy intensity per GDP dollar and is projected against GDP growth. It is assumed that energy intensity would remain constant. Based on these assumptions, Figure 48 illustrates the projection for the industrial sector and then contrasted with actual energy usage data collected from 2011 to 2022. It shows decent agreement between the projection and actual energy usage up until 2019. The impact of COVID19 on the GDP is reflected in the model; however in actuality there was little to no impact on the energy usage in these industries.

7 This is the figure for 2023, which increased from 210 in 2010.

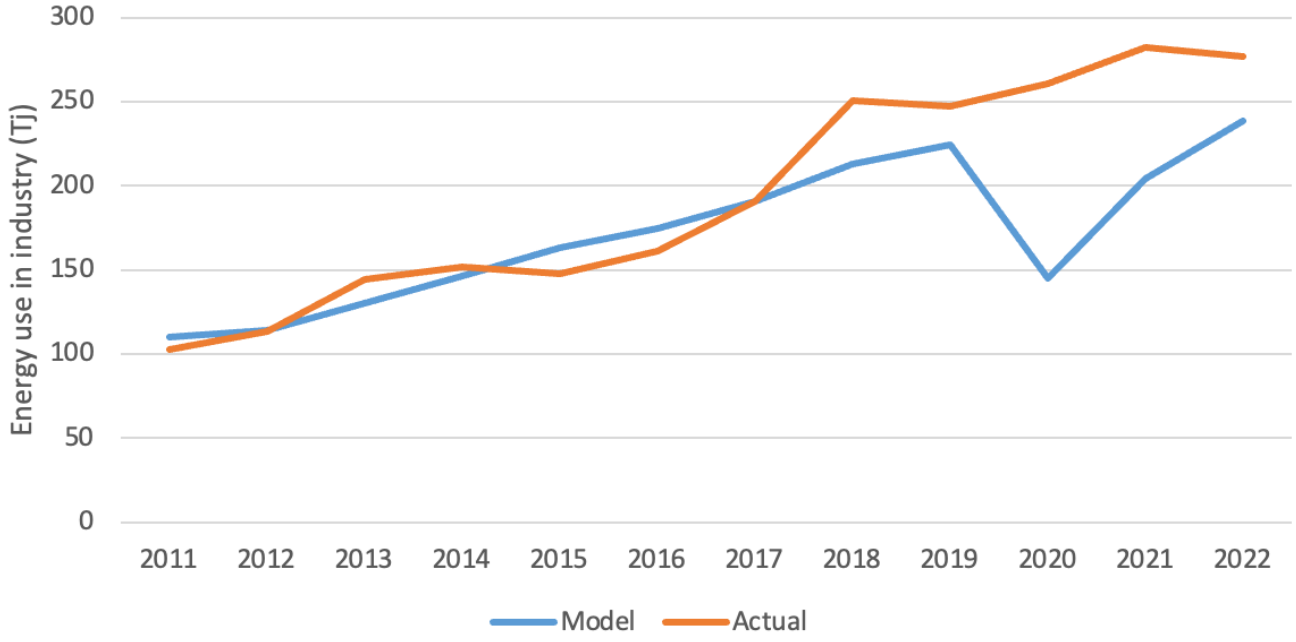


Figure 48: Comparison of energy usage in industry from model vs actual

7.2.1.2.1.4 Resorts

The resort sector was treated separately from other industrial and commercial sectors due to its large share of energy use. For the projection, energy use in resorts were categorised by end use and associated fuel consumption. The end use energy consumption is normalised by the number of bed-nights (Table 31). Bed nights prior to 2022 is taken from the tourism yearbook and post-2022 bed nights is derived from the projection provided in the Macroeconomic Update (Ministry of Finance, 2024). It is assumed that there would be no growth in energy use per bed night in the resort sector. The impact of COVID19 on resort energy use has been overestimated for 2020. This can be attributed to the fact that some resorts were operating as quarantine facilities, and therefore operating at normal levels of energy use during the 3 month full lockdown, while many other resorts had to quarantine staff in the resorts, operating at a baseline level of energy use without recording any bed night during the full lockdown period.

Table 31: Indicators and assumptions used for energy use at resort (transport excluded)

End use	Fuel share	Energy intensity (kWh/bed-night)	Notes
Cooking	LPG – 67% Electricity – 33%	11.9	
Lighting	Electricity	8.7	
Appliances	Electricity	11.3	
Cooling	Electricity	35	
Other	Electricity	19.3	include energy used centralised, like hot water generation and laundry
Desalination	Electricity	8.7	

7.2.1.2.1.5 Residential

The residential sector was segregated geographically for the Greater Male' region and other atolls, and further segregated based on end use. Energy use per capita for each category was available from the 2010-2012 energy balance data (MEA, 2014). Table 32 presents the indicators used for 2010. Although desalination is treated as an industrial activity in (MEA, 2014), it has been considered under residential and segregated geographically for ease of projection. In the Greater Male' region, 100% of the population have access to desalinated water at base year, while in other atolls, only 9.1% had access in 2010, and those that did, used desalinated water sparingly. Based on the underlying information for the Maldives Energy Balance (MEA, 2014) and information provided in SNC (MEE, 2016) it is assumed that 4.6 kWh is needed for producing 1 tonne of desalinated water (using RO technology), and the daily per capita water consumption in Greater Male' and other atolls is approximately 81 litres and 30 litres respectively.

Table 32: Indicators and assumption used for residential sector energy use

	Greater Male'		Other Atolls	
End use	Fuel share	Energy intensity (kWh/capita)	Fuel share	Energy intensity (kWh/capita)
Cooking	LPG – 82% Electricity – 18%	299	LPG – 99% Electricity – 1%	349
Lighting	Electricity	167	Electricity	142
Appliances	Electricity	507	Electricity	162
Cooling	Electricity	321	Electricity	128
Other	Electricity	4	Electricity	7
Desalination	Electricity	137.24	Electricity	51.1

For the projection, growth rates were assumed for per capita energy use (see Table 33 and Table 34). For each of the subcategories, a different growth rate was assumed, based on the

current saturation and possibility for future expansion of each of the subcategories. The same principles were applied for differentiated growth in other atolls and in the Male' region. Initial growth rates are based on the per capita energy growth between the 2003-2005 energy balance report (MEEW, 2006) and the 2010-2012 energy balance report (MEA, 2014). In addition to this growth, desalination in other atolls would increase due to new water and sanitation projects conducted in the islands. It is reflected in the projection that 100% of the population have access to desalinated water from 2023 onwards.

Table 33: Assumed growth rate for baseline for Male' region residential energy use

Male' - End use	2010	2020	2030	2040
Cooking	1.9%	1%	1%	1%
Lighting	2%	1%	1%	1%
Appliances	5%	3%	2%	1%
Cooling	5%	3%	2%	1%
Other	0%	0%	0%	0%
Desalination	5%	3%	2%	1%

Table 34: Assumed growth rate for baseline for Atolls (excluding Male' Region) residential energy use

Atolls - End use	2010	2020	2030	2040
Cooking	2.5%	2%	1%	0.5%
Lighting	4%	3%	2%	1%
Appliances	15%	7%	3%	2%
Cooling	15%	7%	3%	2%
Other	0%	0%	0%	0%
Desalination	13%	7%	4%	2%

7.2.1.2.1.6 Fishing Trips

The sector is sub-divided into Male' and Atolls. Energy use is divided into fuel types, measured in litre/trip for liquid fuels and kg/trip for LPG. The assumptions are given in Table 35, which is directly taken from the 2010-2012 energy balance (MEA, 2014). As per official Government statistics, there is a downward decline in the number of trips, even though the fisheries sector GDP (current price) has grown 12.1% over the past decade (MBS, 2021b). This increase in GDP can be attributed to the increase of the unit price of fisheries products globally. Taking this into account, it is assumed that the indicators would not have any growth for the duration of the projection.

Table 35: Assumptions and Indicators used for Fisheries

	Base year
Number of fishing trips	152,193
Greater Male' Region	16,517
Other Atolls	135,676
Assumed diesel used for transport per trip (litres/trip)	204.00
Assumed LPG used for cooking per trip (kg/trip)	4.00
Assumed Kerosene used for cooking per trip (litres/trip)	2.00

7.2.1.2.2 Transformation

7.2.1.2.2.1 Electricity Generation

The only energy transformation considered in this model is electricity generation. In the LEAP model, it is set up such that based on the demand requirement from various sectors, energy is produced from conventional sources in proportion of the available capacity with the exception of Solar PV. For Solar PV, it is assumed to be operating at full capacity irrespective of its share. The available capacity and the respective efficiency of electricity generation was borrowed from the energy balance 2012 (MEA, 2014). The assumptions and figures used are summarised in Table 31.

Table 36: Assumed Efficiency and Capacity of electricity generation from various sources

Source	Conversion efficiency	Capacity at base year
Diesel – Male'	35%	61,621
Diesel – Other Atolls	33%	36,148
Diesel – Resort	34%	120,936
Diesel – Fisheries	28%	6,233
Diesel – Other	34%	5,244
Solar PV – Male'	100%	0.23
Solar PV – Atolls	100%	9.3
Solar PV – Resorts	100%	50.3
WTE – Male'	33%	0
WTE – Atolls	33%	0

For the baseline scenario, it is assumed that there would be no change to the energy mix over time, and would continue to grow proportionally with the demand. The conversion efficiency used here is the overall process efficiency, which includes the losses from distribution networks. This approach was taken due to the lack of data available outside Male' to separate out inefficiencies in generation and the losses in the grid. Therefore, it was assumed that the distribution and transmission is at 100% for the LEAP model.

7.2.1.2.3 Resources

It is assumed that all fuel required to meet demands would be imported. As it was assumed in the transformation section above, the Maldives neither produces or refines any fossil fuel, and only refined products are imported and used to meet the energy requirements of the country

7.2.1.3 Non-Energy Sectors

The only non-energy sector considered in this projection is the waste sector. For the projection, the waste sector was segregated to the Male' area, other atolls and resorts. Based on the information provided by Waste Management and Pollution Control Department of MCCEE and the waste diagnostic study done under ICAT (MECCT and ICAT, 2021) the following were assumed:

1. Annual waste generation rate in Male', atolls and resorts are 1.022 tonnes per capita, 0.365 tonnes per capita and 7.2 kg per bed night respectively.
2. ~10% of Municipal Solid waste (MSW) generated is non-combustible (glass, metal, and other materials)
3. ~55% of MSW generated is organic: CO2 emissions from this share is not accounted.
4. ~10% of MSW consist of plastics, out of which 5% is recycled.
5. The remainder is composed of other types of combustible wastes (paper, cardboard etc) whose CO2 emissions are accounted.

It is important to highlight that the above does not reflect waste generation related to the COVID 19 pandemic. The large increase in medical and PPE waste observed during this period has not been quantified for the Maldivian context. Additionally, as the pandemic is a once in a century incident and not expected to recur during the projection period, the waste generated as not included in this assessment.

In addition to MSW, methane emissions from wastewater discharge are also estimated and projected. The following assumption are made:

1. All wastewater is released untreated via pump
2. Wastewater generation is calculated on a per capita basis with 14.6 kg BOD per person annually.
3. No methane recovery is done at any stage of the sanitation systems.

7.2.2 Model Testing

The fidelity of the model was tested by comparing the model results with actual estimates. For thorough testing, the energy use from each fuel type from the model was compared with the apparent use of fuel from the reference approach estimates. Observations from the model testing showed reasonable agreements between the model and the actual estimates. As seen in Figure 49, the model projection is in general agreement with the emission estimates.

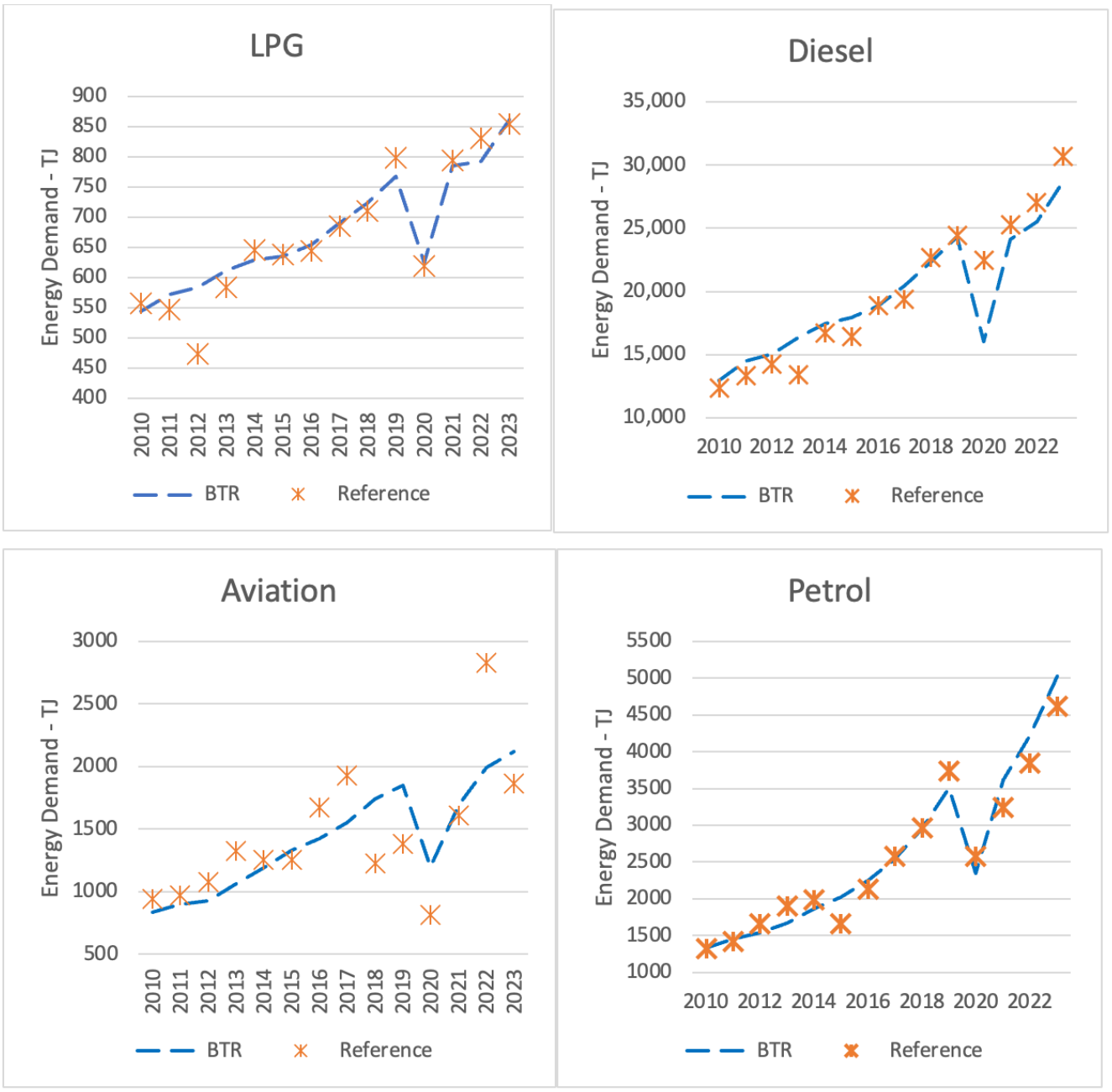


Figure 49: Comparison of energy demand/use between model (dashed blue line) and apparent use from reference approach estimates (orange asterix) of fuels from 2010-2023

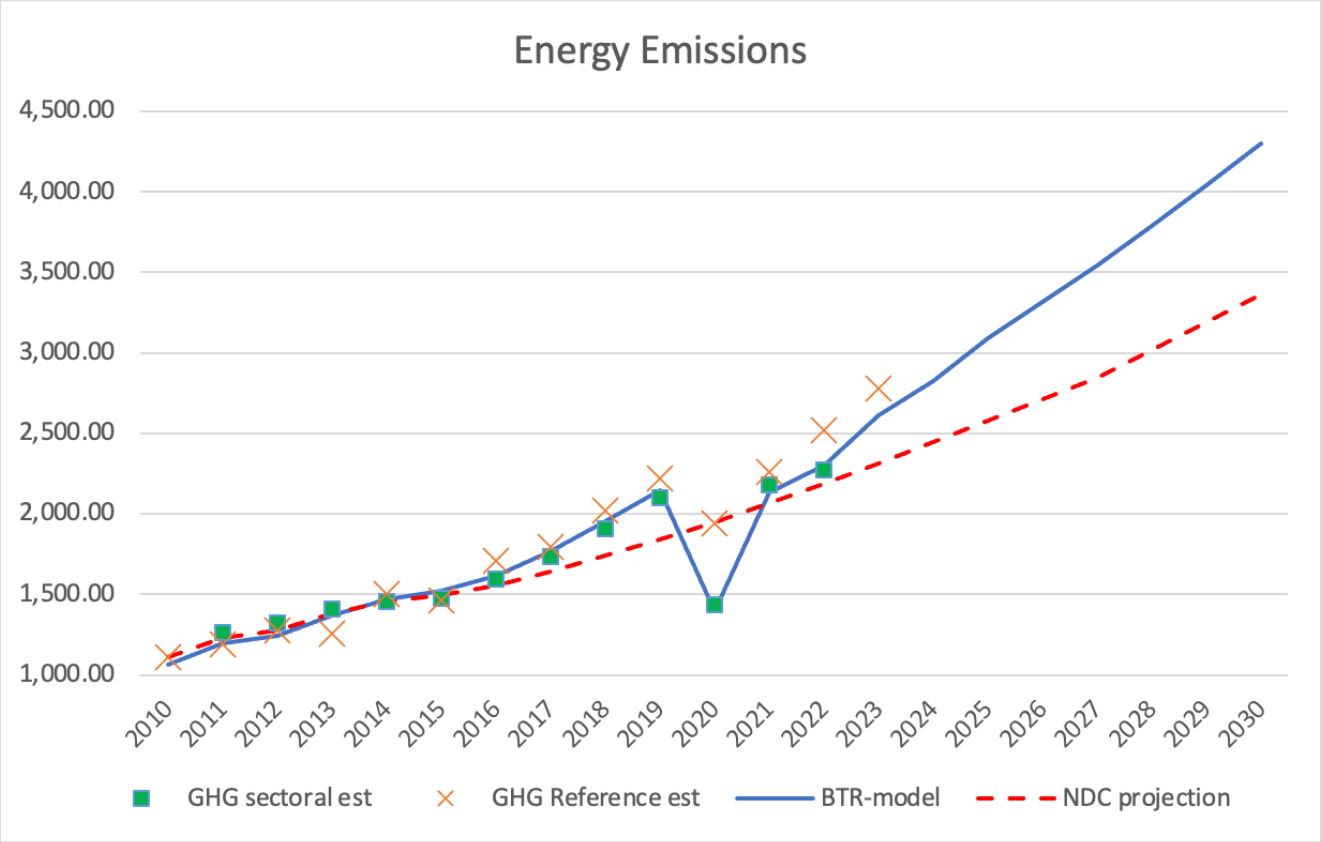


Figure 50: Comparison of emissions from energy estimated through reference approach (orange X), sectoral approach (green square), BTR projections (blue solid line) and NDC projection (dashed red line)

Figure 50 illustrates the comparison between actual emissions estimates, model projections for the BTR, and the projections made for the NDC. One key feature is that the NDC projection started to deviate from 2015 onwards, and it is clear that assumptions and indicators used in that model have changed significantly. Thus the 2030 projected GHG estimate from the NDC may not be accurate in the current national context and economic growth. The revised projection made for the BTR shows an agreement with the actual estimates of both sectoral and reference approaches. Thus, the updated projection is more in-line with the current national context and economic development. This projection would be used to as the Scenario Without Measures.

7.2.3 Mitigation Scenarios

The mitigation scenarios will be built on the identified mitigation actions and their potential impact on socio-economic development. The identification of mitigation actions will be based on the same criteria listed in the BUR which is listed below.

- Projects and programmes that includes components that lead to an emission reduction
- Projects and actions which have quantifiable indicators (e.g. power generation or power consumption) which can be utilised to compute emission reduction
- Projects that are concrete in terms of its objectives, timelines and scale.

- Projects and programmes that are either completed, ongoing or planned since 2010 to the present day.

The mitigation actions identified using the above criteria can be broadly classified into Solar PV projects, energy efficiency projects and waste to energy projects. Interventions in the transport sector has not been considered as none of the identified interventions meet the above requirement. Some of these interventions includes potential introduction of vehicle/vessel emission standards and the introduction of efficient vessels by private transportation operators.

7.2.3.1 Solar PV Projects

For solar PV projects, information was collected from the energy department and verified using the historical documentation available for public projects. For private projects, the information was only partly verified by the service provider for private installations.

The PV installations is segregated among Male', other atolls and resorts. For each of the subcategories, the PV installations were sorted chronologically starting from 2010. All installations prior to 2022 are included in the baseline. As the information of PV installations are given in kWp, that value needed to be converted to tonne of oil equivalent (toe) per year as given in the model. The following formula was used for the conversion:

Energy Capacity (toe/year) = PV installations (kWp) x Hours of Irradiation / 11630

In the above equation, the hours of irradiation were assumed as 1570 hours per year (WB, 2018). The assumption made in the projection is that any project completed in a given year in practice is assumed to be fully operational in the subsequent year, i.e. installations done in 2010 is entered in 2011. All projects completed from 2010 to 2022 have been included and projected to understand the impacts of these projects on the 2030 target.

For individual PV projects, the mitigation impact is calculated by multiplying the energy production from the PV projects with a grid emission factor. The energy produced is calculated as per the above equation, without the conversion to toe (division by 11630). GEF value is assumed to be 0.72 kqCO_2eq/kWh.

7.2.3.2 Energy Efficiency Mitigation Action

For energy efficiency measures, two nationwide mitigations were identified. That is FAHI-ALI programme and Standard Labelling Programme (SLP). The methodology applied for energy efficiency measurement is identifying avoided energy or fuel from increased energy efficiency.

The FAHI-ALI programme is focused on replacing existing light fixtures to LED lights. The programme involves distribution of 737,750 LED lights (270,250 tube lights and 467,500 bulbs) received as assistance from China, India and Germany. As per the 2011 survey, energy consumption for lighting segregated into technology is provided in Figure 51. Based on this

baseline, for the purpose of assessing the mitigation impact, it is assumed that 95% of all lights have been converted to equivalent LED lights by 2030. The avoided emissions for this particular activity are calculated as the difference between baseline emissions and emissions of the scenario with this transformation. Some of the underlying key assumptions used for assessing the impact of LED lights,

- Approximately 16% and 10% of electricity use is for lighting residential and commercial sectors respectively
- Energy saving from switching to LED from CFL, LFL and incandescent is approximately 20%, 50% and 80% respectively.

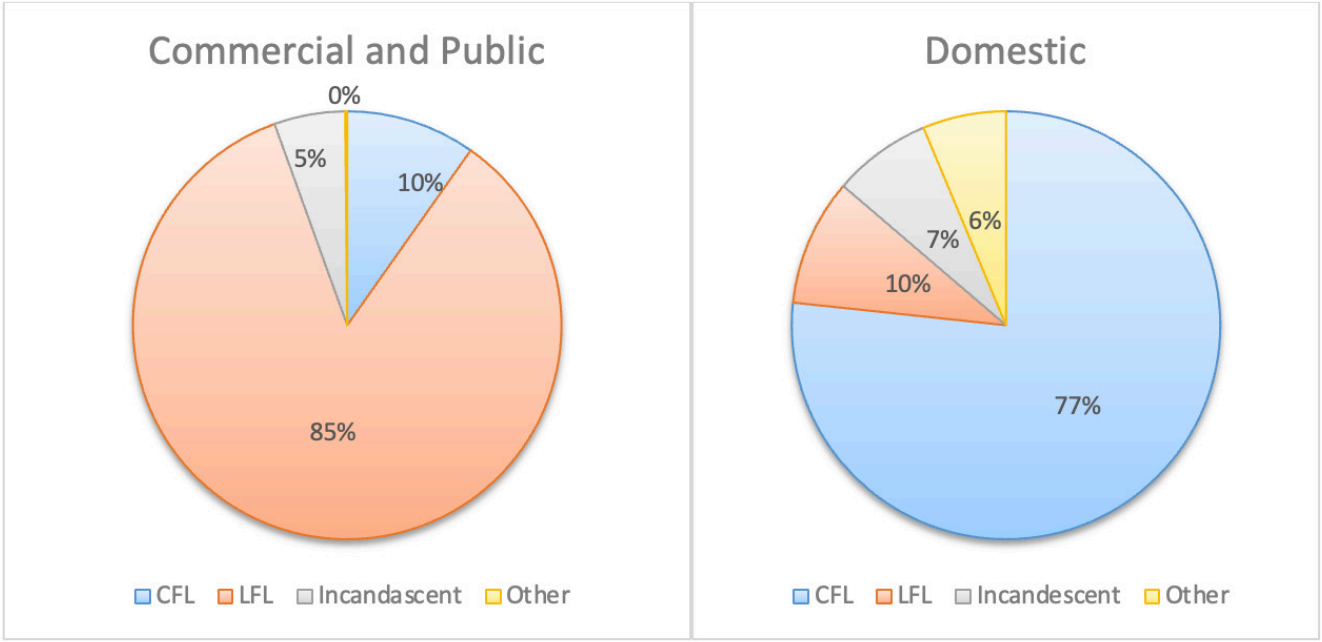


Figure 51: Energy consumption by type of lighting for Commercial and Public lighting (right) and Domestic lighting (left) (Ministry of Environment, 2019)

As indicated in the energy breakdowns in Table 31 and Table 32, cooling and appliances are the two key energy consumers in residential households and resorts. The two appliances covered under SLP accounts for approximately 40% of the energy consumption of appliances given in Table 30 and Table 31. Similarly, 78%, 86% and 80% of the energy consumed for cooling is for air conditioners in atolls, Greater Male' region and resorts respectively. As for the commercial and public sector, roughly 30 percent of the electricity is consumed by air conditioning.

To project the impact of the programme, evolution of energy efficiency ratings up to 2030 is assumed as same as the impact assessment and enforcement report (ME, 2019b). Table 37 shows the change in the energy efficiency level of all three appliances with the improvement of overall efficiency of the appliances in use in 2030.

Table 37: Assumption of distribution of sales of Air Conditioner, Refrigerators and Washing Machine projected to 2030 with resulting efficiency improvement

	Baseyear (2022)	2030
Air Conditioner		
Level 1	35%	0%
Level 2	30%	10%
Level 3	20%	20%
Level 4	10%	30%
Level 5	5%	40%
Efficiency Improvement		**24%**
Refrigerator		
Level 2	50%	5%
Level 3	35%	10%
Level 4	10%	35%
Level 5	5%	50%
Efficiency Improvement		**33%**
Washing Machine		
Level 1	35%	0%
Level 2	30%	10%
Level 3	20%	20%
Level 4	10%	30%
Level 5	5%	40%
Efficiency Improvement		**28%**

Based on above assumptions, avoided energy consumption from implementing the SLP was derived compared to the baseline scenario. Multiplying that with the GEF was used to calculate emissions reduction. Note that in this calculation, impacts of the water usage standard for washing machine was not included due to lack of baseline.

7.2.3.3 Waste to Energy

Waste to Energy Projects are also considered as a key mitigation measures that are related to the waste sector.

In assessing the impact of these projects, any emission related to the waste burnt in these waste energy facilities were moved from the non-energy sector to the energy sector (under transformation). It is assumed that these waste to energy facilities are able to operate at full capacity (80% of rated power). The third and final assumption is made using IPCC tier 1 default factor emission of energy production from waste for emission estimates from Waste to Energy.

7.3 Common Reporting Tables (CRT) and Common Reporting Formats

The Common Reporting Tables and Common Reporting Formats of the GHG inventories, NDC tracking, and support needed and received are available from: https://unfccc.int/first-biennial-transparency-reports

7.4 Participants in the Consultation Workshops

7.4.1 Participants of the BTR Inception Workshop, Male', 20th February 2024

#	Name	Designation	Office
1	Adam Ameen Ali	Research Engineer	Male' Water and Sewerage Company (MWSC)
2	Ahmed Jinan	Assistant Architect	Ministry of Construction and Infrastructure
3	Ahmed Nadeem	Chief Customs Officer	Maldives Customs Services (MCS)
4	Ahmed Raoof	Assistant Statistical Officer / Energy Department	Ministry of Climate Change, Environment and Energy
5	Ahmed Waheed	Director / Climate Change Department	Ministry of Climate Change, Environment and Energy
6	Ahna Abdulla Shujau	National Planning and SDGs Coordination Division	Ministry of Housing, Land and Urban Development
7	Aishath Afaa	Environment Specialist	Ministry of Fisheries and Ocean Resources
8	Aishath Aniya	Statistical Officer	Maldives Bureau of Statistics (MBS)
9	Aishath Maanoo Moosa	Fiscal Analyst	Ministry of Finance
10	Ali Shareef	Special Envoy for Climate Change	The President's Office
11	Aminath Shaufa	Public Health Cordinator	Health Protection Agency (HPA)
12	Aminath Shazly	Senior Lecturer	Maldives National University (MNU)
13	Fathimath Ansam Waheed	Programme Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy
14	Fathimath Maishan	Programme Analyst - CBIT Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
15	Fathimath Nashwa	Assistant Director / Climate Change Department	Ministry of Climate Change, Environment and Energy
16	Fathimath Nazeera	Spatial Planning and Development Division	Ministry of Housing, Land and Urban Development

#	Name	Designation	Office
17	Fathimath Raufa Moosa	Project Technical Coordinator - BTR Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
18	Fathimath Zaina Shareef	Programme Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy,
19	Gasith Mohamed	NDC Partnership in country facilitator	Ministry of Climate Change, Environment and Energy
20	Hamdhoon Mohamed	National Expert - Climate Change	Up Close Solutions Pvt Ltd.
21	Hamid Ibrahim Fulhu	Project Coordinator	Ministry of Agriculture and Animal Welfare
22	Hamid Yoosuf	Executive Director	Ministry of Cities, Local Government and Public Works
23	Hamiyya Latheef	Deputy Director General	Ministry of Transport and Civil Aviation
24	Hawwa Dhaiba	Assistant Finance Officer - NAP Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
25	Ibrahim Shiyam	Minister of state for transport	Ministry of Transport and Civil Aviation
26	Mariyam Shauzeena	Consultant	Ministry of Finance
27	Mohamed Inaz	Project Manager - CBIT Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
28	Mohamed Javeed	Manager, HSSE	Maldives Airports Company Limited (MACL)
29	Mohamed Najih Waleed	Senior Environment Officer	Maldives Civil Aviation Authority
30	Mohamed Sharif Ahmed	Project Coordinator	National Centre for Information Technology (NCIT)
31	Mr. Marcellus Buyela	Programme Assistant,GEF Climate Mitigation Unit / UNEP	UN Environment Programme
32	Naaifa Hassan	Assistant Director	Utility Regulatory Authority (URA)
33	Rifsheena Mohamed	Project Finance and Administrative Assistant - BTR Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
34	Sofoora Kawsar Usman	Enabling Environment Coordinator	Live and Learn
35	Ulfath Ibrahim	Assistant Director	The President's Office
36	Yashfeen Waheed	Senior Credit Analyst	SME Development Finance Corporation (SDFC)
37	Zammath Khaleel	GHG Inventory and Climate Change Mitigation Expert	Development Advisory Services Pvt Ltd (DAS Pvt Ltd)

7.4.2 Participants of Climate Change Adaptation Stakeholder Consultation Workshop conducted for the BTR project – HDh. Hanimaadhoo, 12th August 2024

#	Name	Designation	Organisation
1	Abdulla Nadheem	President	Hdh. Nolhivaranfaru Council
2	Abdulla Naeem	Meteorological Technician	Maldives Meterological Service
3	Abdulla Zamir	President, Council	Hdh. Vaikaradhoo Council
4	Ahmed Afraasim	Assistant Agriculture Officer	Hanimaadhoo Agriculture Center
5	Ahmed Jameel	Consultant	Water Solutions
6	Ahmed Rasheed	Director Meteorology	Maldives Meterological Service
7	Ahmed Sameeru	Meteorological Technician	Maldives Meterological Service
8	Ahmed Waheed	Director - Climate Change Department	Ministry of Climate Change, Environment and Energy
9	Aishath Rasheeda	Meteorologist	Maldives Meterological Service
10	Athifa Ali	Council Member	Hdh. Kulhudhuffushi Council
11	Faruhaadhu Moosa	Technical Assitant	The Maldives Climate Observatory at Hanimaadhoo (MCOH)
12	Fathimath Mamdhoodha	Council Member	Hdh. Nellaidhoo Council
13	Fathimath Zaina Shareef	Programe Officer	Ministry of Climate Change, Environment and Energy
14	Firasha Ibrahim	Committee Member	Hdh. Kulhudhuffushi - Women's Development Committee (WDC)
15	Gasith Mohamed	NDC Partnership in country facilitator	Ministry of Climate Change, Environment and Energy
16	Hawwa Dhaiba	Administrative and Finance Officer - NAP	Ministry of Climate Change, Environment and Energy
17	Ibrahim Humaid	Seismologist	Maldives Meterological Service
18	Ibrahim Husain Fulhu		Hanimaadhoo Youth Association
19	Ibrahim Mohamed	Manager -Kulhudhuffushi City Office	Maldives Red Crescent

#	Name	Designation	Organisation
20	Leela Mohamed	President	Hdh. Nellaidhoo - Women's Development Committee (WDC)
21	Leisa Perch	Consultant	United Nations Environment Programme (UNEP)
22	Mohamed Azan Abdulla	Environment Analyst -Climate Change Department	Ministry of Climate Change, Environment and Energy
23	Mohamed Musthafa	Council Member	Hdh. Nolhivaran Council
24	Mohamed Qasim	Agriculture Officer	Hanimaadhoo Agriculture Center
25	Mohamed Shaiman Adam	Chairperson, National Youth Council	Maldives Red Crescent
26	Mohmed Mahid	Met Technician	Maldives Meterological Service
27	Moosa Zameer Hassan	Climate Change Adaptation Consultant	Water Solutions
28	Mr. Abdhul Latheef Moosa	Agriculture Officer	Hanimaadhoo Agriculture Center
29	Mr. Aboobakuru Mohamed	Agriculture Officer	Hanimaadhoo Agriculture Center
30	Naziya Hassan	Council Member	Hdh. Hanimaadhoo Council
31	Raheema Gasim	Meteorological Technician	Maldives Meterological Service
32	Raufa Mohamed	Assistant Council Executive	Kulhudhuffushi City Council
33	Rifsheena Mohamed	Project Finance and Administrative Assistant - BTR Project	Ministry of Climate Change, Environment and Energy
34	Saafiyath Mohamed	Council Member	Hdh. Finey Council
35	Thibyan Ibrahim	Assistant Director	Ministry of Climate Change, Environment and Energy
36	Zuhudha Mohamed	Committee Member	Hdh. Finey - Women's Development (WDC)

7.4.3 Participants of Climate Change Adaptation Stakeholder Consultation Workshop conducted for the BTR project - S.Gan, 15th August 2024

#	Name	Designation	Organisation
1	Afrah Hussain	Inspector of Police (Head of Hithadhoo Police)	Maldives Police Service
2	Ahmed Jameel	Consultant	Water Solutions
3	Ahmed Muslim	Meteorologist	Maldives Meterological Service - Gan Office
4	Ahmed Nazeer	Assistant Meteorologist	Maldives Meterological Service - Gan Office
5	Ahmed Rashed	Director	Maldives Meterological Service - Hulhule Office
6	Ahmed Waheed	Director - Climate Change Department	Ministry of Climate Change, Environment and Energy
7	Aishath Nazahath	Asst.Council Officer	Addu City Council
8	Ali Ashfaq	MET instrument Technician	Maldives Meterological Service - Gan Office
9	Ali Shaahid	MET Technician	Maldives Meterological Service - Gan Office
10	Ali Shareef	Deputy Director General	Maldives Meterological Service - Hulhule Office
11	Aminath Afau	Assistant Director	Addu City Council
12	Aniyath Mohamed	Vice Chairperson	Maldives Red Crescent - Hithadhoo Unit
13	Asiya Abdulla	MET Technician	Maldives Meterological Service - Gan Office
14	Athifa Hassan	Inspector of Police (Head of Gan Police)	Maldives Police Service
15	Athifa Hassan	MET Technician	Maldives Meterological Service - Gan Office
16	Fathimath Shukury	General Secretary	Fuvahmulah youth and sports development association(FYSDA)
17	Fathimath Zaina Shareef	Programe Officer	Ministry of Climate Change, Environment and Energy
18	Hawwa Dhaiba	Administrative and Finance Officer - NAP Project	Ministry of Climate Change, Environment and Energy
19	Hussain Nadheemudheen	MET Technician	Maldives Meterological Service - Gan Office
20	Ismail Rafeeq	Mayor	Fuvahmulah City Council

#	Name	Designation	Organisation
21	Khadeeja Fasahath Fuad	Environment and Social Safeguard Officer	Water Solutions , Addu City
22	Leisa Perch	Consultant	United Nations Environment Programme (UNEP)
23	Mariyam Dhiyana	WDC President	Fuvahmulah -Women's Development Committee (WDC)
24	Mariyam Naseera	WDC Member	Addu City -Women's Development Committee (WDC)
25	Mariyam Saeeda	MET Technician	Maldives Meterological Service - Gan Office
26	Mariyam Solih	Assistant Council Officer	Fuvahmulah City Council
27	Mariyam Zaheena Ahmed	WDC Member	Fuvahmulah -Women's Development Committee (WDC)
28	Mohamed Azan Abdulla	Environment Analyst -Climate Change Department	Ministry of Climate Change, Environment and Energy
29	Mohamed Nazmee	MET Technician	Maldives Meterological Service - Gan Office
30	Mohamed Yameen Maumoon	Co-Founder	Project Thimaaveshi - NGO
31	Mohmed Shahudh	Meteorologist	Maldives Meterological Service - Hulhule Office
32	Moosa Zameer	Climate Change Adaptation Consultant	Water Solutions
33	Rifsheena Mohamed	Project Finance and Administrative Assistant - BTR Project	Ministry of Climate Change, Environment and Energy
34	Salmana Moosa	WDC Member	Addu City -Women's Development Committee (WDC)
35	Shafna Ahmed Didi	Manager, ACO Unit	Maldives Red Crescent - Hithadhoo Unit
36	Shehenaz Rasheed	Executive Board Member	Addu Branch - Addu Women's Association (AWA)
37	Simadh Shafeeq	Vice Chairperson	Nalafehi Meedhoo - NGO
38	Suna Nasrulla Hameed	Co-founder	Veshisaafu - NGO
39	Thibyan Ibrahim	Assistant Director	Ministry of Climate Change, Environment and Energy
40	Zulaikha Shaheema Ibrahim	Planning Officer	Maldives Meterological Service - Hulhule Office

7.4.4 BTR Validation Workshop, 29th October 2024

#	Name	Designation	Organisation
1	Adam Ameen Ali	Research Engineer	Male' Water and Sewerage Company
2	Ahmed Jameel	Managing Director	Water Solutions
3	Ahmed Masoon	Program Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy
4	Ahmed Niyaz		Maldives Space Research Organisation - MSRO
5	Ahmed Raidh	Senior Coastal Analyst / Environment Department	Ministry of Climate Change, Environment and Energy
6	Ahmed Rasheed	Director Meteorology, Public Weather Service	Maldives Meteorological Service
7	Ahmed Riffath	General Manager	Fuel Supplies Maldives
8	Ahmed Rizhan		State Electric Company Limited
9	Ahmed Shabin	Meteorologist	Maldives Meteorological Service
10	Ahmed Waheed	Director / Climate Change Department	Ministry of Climate Change, Environment and Energy
11	Ahmeem Farish	Deputy Director General, Public Health	Health Protection Agency
12	Aisha Niyaz	Chief Sustainability Officer	Noonu Naturally - NGO
13	Aishath Huma	Environmental and Social Safeguards Specialist Infrastructure Department	Ministry of Construction and Infrastructure
14	Aishath Reesha Suhail	Program Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy
15	Ali Shareef	Special Envoy for Climate Change	The President's Office
16	Aslam Shakir	Independent Expert	
17	Fathimath Nashwa	Assistant Director / Climate Change Department	Ministry of Climate Change, Environment and Energy
18	Fathimath Raufa Moosa	Project Technical Coordinator-BTR Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
19	Fathimath Zaina Shareef	Program Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy
20	Gasith Mohamed	NDC Partnership in country facilitator	Ministry of Climate Change, Environment and Energy

#	Name	Designation	Organisation
21	Haleemath Nahula	Assistant Director / Water and Sanitation	Ministry of Climate Change, Environment and Energy
22	Hawwa Dhaaiba	Administrative and Finance Officer - Advancing National Adaptation Plan (NAP) Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
23	Hawwa Raufath Nizar	Fisheries Officer	Ministrry of Fisheries and Ocean Resources
24	Hudha Haleem	Statistical Officer	Maldives Bureau of Statistics
25	Ilyas Faruhad	Senior Political Director	Ministry of Youth, Empowerment, Information and Arts
26	Izman Suhail	Climate Adaptation Analyst- The Commonwealth	Ministry of Climate Change, Environment and Energy
27	Juruath Abdulla Nafiz	Program Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy
28	Mamdhooh Ali	Coastal Management specialist	Ministry of Construction and Infrastructure
29	Mariyam Ajila	Project Officer	Ministry of Agriculture and Animal Welfare
30	Mariyam Shadheena	Deputy Statistician	Maldives Bureau of Statistics
31	Mohamed Abdul Gadir	Manager	Maldives Airports Company Limited
32	Mohamed Azan Abdulla	Environment Analyst - Climate Change Department	Ministry of Climate Change, Environment and Energy
33	Mohamed Imad	Director General / National Planning Department	Ministry of Housing, Land and Urban Development
34	Mohamed Inaz	Technical Coordinator - CBIT Maldives / Climate Change Department	Ministry of Climate Change, Environment and Energy
35	Mohamed Najih Waleed	Senior Environment Officer	Maldives Civil Aviation Authority
36	Mohamed Naufal	NDC Partnership in country facilitator	Ministry of Climate Change, Environment and Energy
37	Mohamed Shumais	National Expert - Climate Change	Geo Tech Maldives
38	Moosa Zameer	Climate Change Adaptation Consultant	Water Solutions
39	Naahy Mohamed Rasheed	Assistant Director	The President's Office

#	Name	Designation	Organisation
40	Raaniya Husnu Al Suood	Program Officer / Climate Change Department	Ministry of Climate Change, Environment and Energy
41	Rifsheena Mohamed	Project Finance and Administrative Assistant - BTR Project / Climate Change Department	Ministry of Climate Change, Environment and Energy
42	Shahuma Abdul Razzaq	Assistant Director	Ministry of Transport and Civil Aviation
43	Suma Mohamed	Senior Program Officer / Waste Department	Ministry of Climate Change, Environment and Energy
44	Thibyan Ibrahim	Assistant Director / Climate Change Department	Ministry of Climate Change, Environment and Energy
45	Umaira Ahmed	Senior Environment Analyst / Environmental and Conservation	Ministry of Climate Change, Environment and Energy
46	Umar Fikry	Deputy Chief Executive	National Disaster Management Authority
47	Zammath Khaleel	GHG Inventory and Climate Change Mitigation Expert	Development Advisory Services Pvt Ltd (DAS Pvt Ltd)

Ministry of Climate Change, Environment and Energy

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