

Multi-year Expert Meeting  
on Transport, Trade Logistics and  
Trade Facilitation  
8th Session

**Climate Change Adaptation for Seaports  
in Support of the 2030 Agenda  
for Sustainable Development**

27–28 October 2020

**Cases of Maldives and Male'  
Commercial Harbor**

Aishath Shimla  
Maldives Ports Limited



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**Eighth session**

**Climate Change Adaptation for Seaports in Support of the 2030 Sustainable  
Development**

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**October 23, 2020**

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## EXECUTIVE SUMMARY

Due to the geographic spread and the physical diversity of economic nodes throughout the Maldives, a fragmented network of maritime landing points has evolved to receiving facilities for goods and passengers at the resort and to local islands. Without a well-functioning and climate-resilient port entire logistic services of Maldives may come to an end. MCH Male' Commercial Harbor, the principal maritime gateway for the Republic faces coast inundation from time to time. Some island coastal inundation is so worse that centuries-old trees fell into the sea. majority of the population believes islands coastal inundation occurring due to the local Harbour projects.

During wet season flooding in male' and islands get deteriorate, this also damages hinterland transportation vessels and infrastructure. CFF operations of MCH get distressed and land transportation movements from male' port get discontinued due to the high floods. Which brings port breakable cargo movement to termination.

For semi-labour intensive ports such as MCH ship turnaround time depends on port labours. Rising temperatures affect the health of employees and their productivity. Undocumented breaks are given to the labour which delays the operation of ships. Storm surges and tides have crushed many hinterland transportation modes which monetary values count in millions.

Climate change's core heating point is global warming and this is not an issue that one can only address and overcome. Extreme measures from the global community can ease the stress projecting to small island developing states. Also, funding, the responsibility to develop climate resilience infrastructures is not a weight Maldives can tackle alone. Developing a sector-specific climate resilience plan and regional integration can ease the burden and the new upcoming port of Maldives should design a climate resilience port to assure the future.

According to World Bank reports climate change severely and threatens the existence of the Maldives as well as diminishing existing human capabilities on these islands. with "future sea levels projected to increase in the range of 10 to 100 centimeters by the year 2100, the entire country could be submerged" Its projected Maldives could be almost completely inundated by about 2085.

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## **1. Introduction**

### ***1.1. Maldives and climate vulnerability***

Maldives the lowest county in the world. "The Maldives stands at the frontline of the climate change battle. We are one of the most vulnerable countries on Earth and therefore need to adapt to climate change" former president Mr. Mohammed Waheed Hassan.

The Maldives is formed around 26 natural ring-like atolls just across the equator. The country is made up of about 1,190 coral islands, the total territory area is 90,000 sq kilometers. 99.6 percent includes the sea and the total land area of the country is less than 300 square kilometers. The lowest point is 1 meter above sea level and an average natural ground level of only 2.4 meters and 1.5 meters above sea level, some islands have dunes which can reach 2.4 meters above sea level like the NW coast of Hithadhoo in Addu Atoll.

Unquestionably the Maldives has world-wide uniqueness. However, "the country's exposure to natural hazards and climate variability poses a threat to lives and the economy" World Bank. "Even a slight sea-level increase due to global warming poses an existential threat, as the country lies nearly at sea level. Rise in seawater temperatures by -12.8°C (9°F) killed 65% of the country's coral reefs in 1998" World Bank.

According to World Bank reports climate change severely and threatens the existence of the Maldives as well as diminishing existing human capabilities on these islands. with "future sea levels projected to increase in the range of 10 to 100 centimeters by the year 2100, the entire country could be submerged". At this point, it is a Question of the future? It is a question of existence? It is a Question of preserved history, culture and forefathers resting place?

## ***1.2. General climate of Maldives***

The Maldives experiences a monsoonal climate. The Maldives has two distinct seasons; dry season (northeast monsoon) and wet season (southwest monsoon). In these two seasons, the temperature varies hardly. Since the Maldives consists of small islands and is surrounded by seas, hot days are often tempered by cooling sea breezes. Throughout the year, the temperature remains almost the same in the Maldives. However, daily temperature ranges from around 31 °C in the daytime to 23 °C at nighttime. This range of temperature does not differ much from the north to the south of the Maldives.

## ***1.3. Population and urbanization***

“Maldives has a population of around 515,696 people dispersed across 197 islands. The country has been a development success; enjoying robust growth coupled with considerable development of the country’s infrastructure and connectivity. More than 30 percent of the population lives in the capital city Male’”. The country’s GDP per capita reached \$11,890 in 2018, compared to \$200 in 1978.

## ***1.4. Economy and livelihood depend on ports***

The mixed Maldivian economy is vulnerable to climate change for many reasons. The country depends highly on imports and Climate change affects the coastal transport infrastructure and hinterland transportation. The Maldives is consisting of numerous far-flung, often sparsely populated, atoll communities. In this setting transport, specifically, sea transport is a critical factor in ensuring access to goods and economic opportunities and is thus a key ingredient for social and economic advancement. Without a well-functioning and climate-resilient port entire logistic services of Maldives may come to an end. The principle activities of the economy are tourism and fishing. The largest industry in the Maldives tourism depend on the “sun, sea and sand” accounting for 28% of GDP and more than 60% of the Maldives' foreign exchange receipts. “sun, sea and sand” is vulnerable to rising sea levels and storm surges, coastal erosion, and coral bleaching, thus it has an extreme direct impact to economy and livelihood of Maldives.

## 2. Overview of the Ports

### 2.1. Male Commercial Harbour

Male' Commercial Harbor (MCH) consists of a main berth 101 m in length with an alongside depth of 9.5m. This is backed up by an area of approximately 1.6 ha used for the storage of



containers and break-bulk cargoes. The latter is stored in a transit shed having an area of approximately 3500 m<sup>2</sup>. Eastern side 100-meter quay is used for loading empty containers to be transferred to Hulhumale' as well as for loaded containers to be transshipped directly to

the resorts and islands. At the western edge of the terminal is a 140 m quay with alongside depth of approximately 3.5 m. This is used by traditional boats unloading break-bulk cargo, primarily foodstuffs, from Tuticorin and other Indian ports. It is also used by smaller vessels for unloading various break-bulk cargoes. On the other side of the West Lighter Basin from this quay is a quay for mooring the tugboats and barges and an open area for storing empty 40-foot containers and construction material. MCH is managed and operated by the Maldives Port Limited (MPL). Ministry of Transport commissioned MPL to operate the two new regional ports on the Ministry's behalf. A management contract for this service has been agreed upon.

Most of the imports flow through the capital island and others in its immediate vicinity, and most dry cargo arrives via Male' Commercial Harbor, the principal maritime gateway for the Republic. Exports are minimal so outbound international traffic via Male' consists mostly of empty containers. In Male' shipments are broken into smaller consignments for sale to local retailers and consumers on the outer islands. It has been estimated that approximately 40 percent of imported goods are subsequently re-shipped to consumers on the outer islands via the markets of Male', and 90 percent of this domestic interchange currently occurs at Male' North Harbor.



Due to limited market size and physical constraints on accommodating large vessels, the outer islands are served by small vessels with capacities of 50 – 250 tons.

Also, the Ministry of Transport and Communications inaugurated northern and southern regional hub during 2006.

**2.1.1. Hithadhoo Regional Port (HRP) (southern hub)**



Length of causeway: 1025 m  
 Width of causeway 7m  
 Length of quay wall 130m  
 Depth of berth: 8m  
 Container stacking area 5400 m  
 Warehouse area 1725 m

**2.1.2. Kulhudhufushi Regional Port (KRP) (Northern hub)**



Length of quay wall 171.5m  
 Depth of berth: 5 m  
 Container stacking area 6075 m  
 Warehouse area 1140 m  
 Total Reclaimed area: 14400  
 Total Dredged area: 70453 m

### **3. Climate change impact on Maldives-Effects on the port**

#### ***3.1. Coastal Inundation***

The islands of Maldives are known to get eroded and recover naturally. however, there are cases the island did not recover naturally and lost the features of an island, almost vanished from the chart. This only means that the amount of sand recuperated and deposited naturally is not even close to the amount washed away.

Dr. Ibrahim Mohamed, the Deputy Director of Environment Protection Agency (EPA). stated that the “The sand then flows through the lagoon with the current and gets deposited to another side of the island. Even though some of the sand is lost to the sea, this is recovered from the sand created by the reefs”.

According to the Tasmania report “Temporary inundation is caused by storm tides” and considered that factors such as storm surge and tides, in MCH temporary coastal inundation damaged quay wall area that needed urgent attention. This extreme occurrence did not take days it was sudden. MCH faces the issues of sinking parts of the port ground area. Heavy machinery and cargo weight adds more impact to the sinking part of the ground. The latter makes machinery movement difficult. There have been accidents due to the leveling of MCH ground. MCH allocates a budget every year for Ground leveling work. Also, it adds additional costs for vehicle maintenance as well.



The Male' city is protecting through a sea wall, which construction projects started in 1992 along with the Port Development project. The city has reclaimed the lagoon areas of utmost usage. However, from time to time under the sea wall sand gets washed away with strong waves and sinks the area near sheet piled. This is an alarm of a bigger disaster awaiting. MCH infrastructure is old and it is the model of a harbor, designed without climate change resilience consideration.

### ***3.2. Paradise vanishing as we watch - Case of R. Fainu island***

People of the island remember even 60 years ago the trees of island Fainu stood the same as 2019. It's said to be the trees were 200 years old and the island was protected from the 2004 Tsunami because of the trees at the front beach. Within one and half MONTH what could have happened to all the trees fell into the sea. A scary and discouraging experience for the people of these beautiful islands.



Sources: Mihaaru.com





Sources: Mihaaru.com

People of the island believe the reason for such a disaster could be due to the **construction of the local harbor** and design of the harbor. When the dredging started for the project, island faced the issue of uncontrollable waves and erosion and back then it was handled with stones revetment.

### ***3.3. Believe it or not, climate change is real***

Maldives island faces erosion issues. However, in the case of R. Fainu is evident that something alarming is happening and it's beyond our control. 200 years old trees fell almost 3 and a half years after the local harbor project. It could not be only the harbor project. What is happening now, is on another scale.

“There are two reasons for erosion. The effects of human activity and climate change,” said Dr. Ibrahim Mohamed, the Deputy Director of Environment Protection Agency (EPA). “What happens is that we humans, we bring changes to the dynamic or natural system of islands. For instance, the construction of harbors and other structures in the lagoon causes blockages in the flow of sand (within the lagoon),” said Dr. Ibrahim. Most of the time, harbor construction projects are conducted without not so much as a glance on the impact it can have on the environment. The end result is that sand washed away during the Northeast Monsoon not being deposited back to the original area during the Southwest Monsoon. The sand from the same area is once again washed away during the Northeast Monsoon when the process is repeated. It either gets deposited inside the harbor or is lost to the sea forever in some islands.

Kulhudufushi Regional Ports berth is too shallow due to the strong wave crushing the sand into the port area. The basin entrance and port berth area need occasional dredging once in every 5 years.

### 3.4. Sea-level Rise



“Sea-level rise is likely to worsen existing environmental stresses in the Maldives, such as periodic flooding from storm surge, and a scarcity of freshwater for drinking and other purposes. “Since the 1950s, sea level in and around the Maldives has been rising at a rate of 0.03–0.06 inches (0.8–1.6 millimeters) per year. Because of the Maldivian

topography, small changes in sea level translate into extensive land inundation” Climate hotmap.

Maldives islands experience high tide flooding every year. Male' appears to be generally about 2 meters above sea level. In 1987 and 1988 storms flooded Male' city as a result freshwater stock diminished. This experience alarmed how vulnerable the Maldives can be to even a small rise in sea levels. However, with the construction of breakwaters did not prevent flooding. Its projected Maldives could be almost completely inundated by 2085. Global sea levels are currently increasing at an average rate of 3.2mm per year, permanent-inundation levels rising by an average of 6mm annually over the last two decades (PCCSP 2013:4). Figure 1 indicates the global mean sea level as per the 4th report of IPCC Blue shade indicates 21st-century model projections relative to 1980-1999 mean.

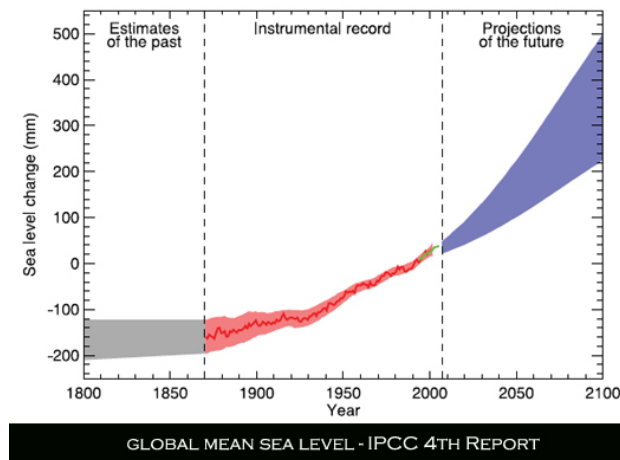


Figure 1 Global Mean Sea Level. Source: (IPCC 4TH Report, 2001)

Sea level rise causes wave agitation and swells this impact navigation and berthing of vessels. During the wet season flooding in Male' and islands gets worsen, this damages hinterland transportation vessels and infrastructure (picture-story 1) CFF operations of MCH gets distressed and land transportation movements from male' port get discontinued due to the high floods in the wet season. which makes port breakable cargo movement difficult. Strong Wave distress and crashes local boats who call port to load breakable cargoes to atolls (Refer picture-story2). Also in 2005 when Hithadhoo Regional Port operations started the very first ship which call to port crashed into the port fenders due to the strong waves. it took a few more construction and design works to make the harbor a "safe shelter".

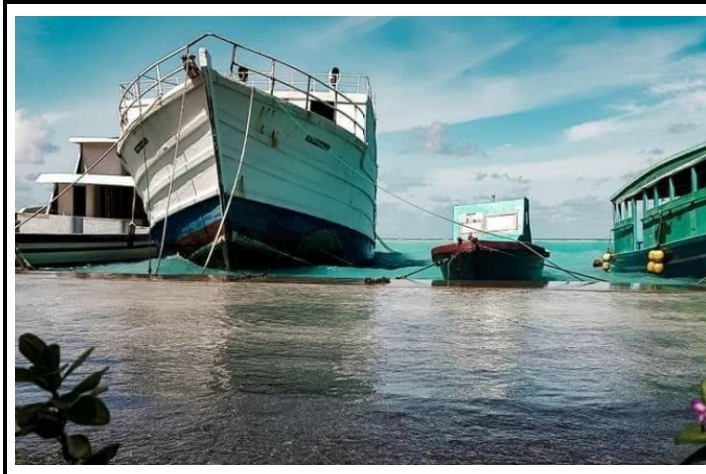


i. Picture story 2





ii. Picture story 1

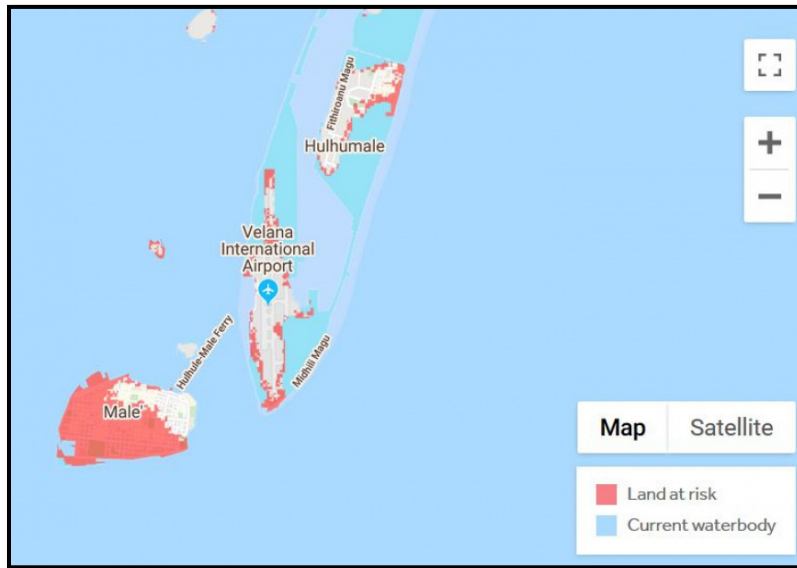


Wet season flooding.



### 3.5.High Temperature

It is a fact that the world is warming up because of the huge amount of greenhouse gases released by humans into the atmosphere. This affects the ocean tides and currents as well. A survey published by the Nature Communication Magazine's Climate Central reads that a sizeable area of the Maldives Capital Male' would be underwater by the year 2050.



Dr. Abdulla Naseer stated that there was little that the Maldives can do to combat this and that the government was already doing everything it can, including calling and advocating to prevent this to the international community. He also stated that the government was already protecting islands that needed to be protected.

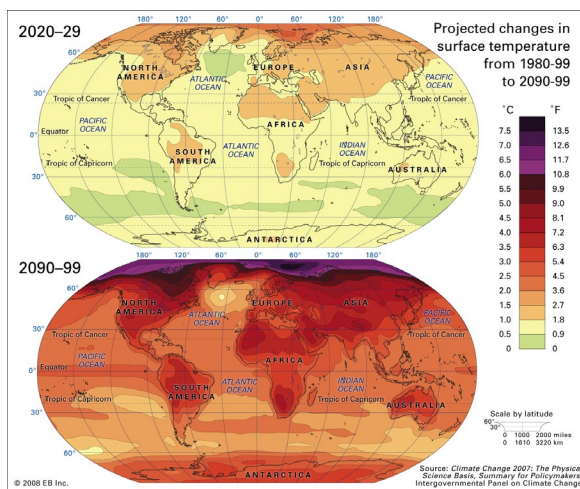


Figure 2 Projected changes in surface temperature Source: (IPCC, 2007)

Figure 2 indicates how the world temperature is projected to increase as a result of the climate change.

The World Bank indicates that depending on the level of Green House Gas (GHG) emissions into the future, the average global temperatures are expected to increase by 1 to 5 degrees by 2100. It is also projected that some regions will see a higher temperature compared to the global average.

During the dry season of Maldives high temperatures requiring more and prolonged usage of air conditioners. However, for Port workers who work in the field, it is not a possible set-up. For semi-labor intensive ports such as MCH ship turnaround time depends on port labors. Rising temperatures affect the health of employees and their productivity. Container yard supervisors and ship labor gangs find the temperature unbearable when congested containers area heats up and heat vaporized. In addition to worker's health issues the storage of cargo, handling of dangerous flammable goods, and the operation of cargo handling equipment get affected due to high temperature.

The container yard area gets extremely intense in the dry season that cargo operation head Mr. Ahmed Inaan stated that they give undocumented breaks to the staffs at noon. Although it affects the port's productivity. In MCH traditional boats unloads break-bulk cargo, primarily foodstuffs, these small vessels get delayed and the quality of foods effects due to high temperature.

It is said global warming can create new Arctic shipping routes but the question is at what cost do we need this opportunity?

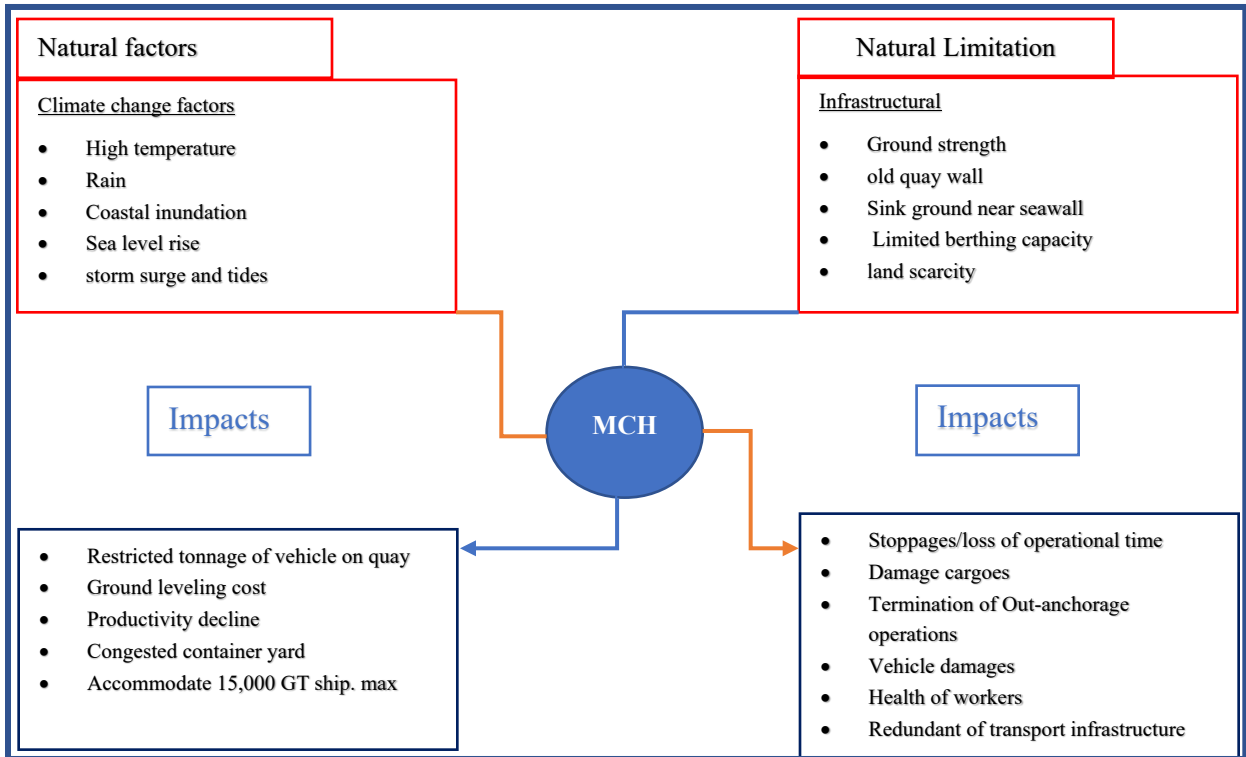
### 3.6. Heavy Rains (picture story)

Local media in the Maldives report that severe weather caused flooding in Male on 15 May 2020. Some areas recorded more than 80mm of rain in 24 hours. Every year hundreds of homes get damaged millions of worth cargoes and local ships destroyed and goes under the mercy of the rough sea.

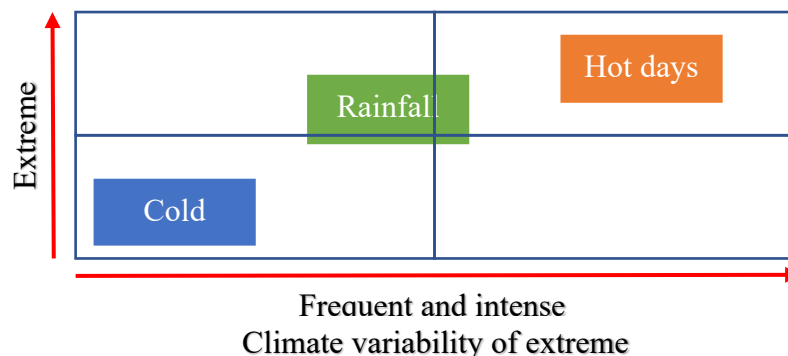


## 4. Port vulnerability to climate change

### 4.1. Critical factors and impacts



The above table indicates the critical factors that affect the business of MCH. Natural factors are closely linked to the advent of climate change. Critical factors such as limitation of nature and climate change factors are deterioration of the financial and economic opportunities of the port. Vulnerability is the degree to which a system is inclined to and unable to cope with the effects of climate change, including climate variability of extremes. MCH operations interrupted by hot days more frequently and extreme rainy days are less frequent but high intense and the damages are more in monetary value than extreme hot days.



## 5. Potential climate impacts on different sub- components of the port system

| Quay Operation   | Out-anchorage operations   | Vehicle & movements  | CFF operations  |
|--|--|--|---|
| <b>Climate change impacts</b>  |  |  |   |
| <ul style="list-style-type: none"> <li>➤ Sea level rise</li> <li>➤ Sea spray</li> <li>➤ surface temperature</li> <li>➤ storms</li> <li>➤ storm surges and tides</li> </ul> | <ul style="list-style-type: none"> <li>➤ Sea level rise</li> <li>➤ Sea spray</li> <li>➤ Sea surface temperature</li> <li>➤ Heat</li> <li>➤ Rainfall</li> <li>➤ wind</li> <li>➤ storm surges and tides</li> </ul> | <ul style="list-style-type: none"> <li>➤ Heat</li> <li>➤ Rainfall</li> <li>➤ Ground strength</li> </ul>  | <ul style="list-style-type: none"> <li>➤ Heat</li> <li>➤ Rainfall</li> </ul>  |
| <b>Climate impact: functions and workforce</b>   |  |  |   |
| <ul style="list-style-type: none"> <li>➤ Ship turnaround time</li> <li>➤ Damage fenders</li> <li>➤ Damage loose cargo</li> </ul>   | <ul style="list-style-type: none"> <li>➤ Increase the number of accidents</li> <li>➤ Loss of cargo</li> <li>➤ Decrease productivity</li> <li>➤ Termination of operation</li> </ul>                               | <ul style="list-style-type: none"> <li>➤ Cost of operation increase</li> <li>➤ Cost of repair and maintenance increase</li> <li>➤ Decrease productivity</li> <li>➤ Difficulty in handling certain cargoes</li> </ul> | <ul style="list-style-type: none"> <li>➤ Damage cargo</li> <li>➤ Decrease productivity</li> <li>➤ Interrupt LCL container clearing operation</li> </ul> |



## 6. Relevant adaptations and action

### 6.1 Mitigation Contribution (national plan)

Mitigation Contribution Maldives aims to achieve a low emission development future and ensure energy security.

|  |  |
|--|--|
| <p><b>Unconditional Reduction</b></p> <p>“In accordance with Decisions 1/CP.19 and 1/CP.20, Maldives communicates that it intends to reduce unconditionally 10% of its Greenhouse Gases (below BAU) for the year 2030”</p> | <p><b>Conditional Reduction</b></p> <p>“The 10% reduction expressed above could be increased up to 24% in a conditional manner, in the context of sustainable development, supported and enabled by availability of financial resources, technology transfer and capacity building.</p>  |
| <p><b>Time frame</b></p>   | <p><b>2021- 2030</b></p>   |
| <p>Type of Contribution</p>  | <p>Maldives is focusing its efforts, actions and undertakings in reducing its GHG emissions in the energy sector. These actions and undertakings will be based on strategies and sectoral action plans designed, amongst others, for the following areas of intervention: energy, tourism, waste, water, and building sectors.</p> |
| <p>Sectors</p>   | <ul style="list-style-type: none"> <li>➤ Energy <ul style="list-style-type: none"> <li>Electricity generation</li> <li>Energy Efficiency – domestic consumption</li> <li>Energy Efficiency – processes and product use</li> </ul> </li> <li>➤ Transportation</li> <li>➤ Waste</li> </ul>   |
| <p>Gases</p>   | <p>CO<sub>2</sub>, CH<sub>4</sub> Contribution of other GHGs like Sulphur hexafluorides (SF<sub>6</sub>) and Nitrous</p>   |

|  |  |
|--|--|
|  | oxides (N <sub>2</sub> O) are significantly low and hence not considered |
|--|--|

## 6.2 Adaptation Contribution

Maldives aims to undertake adaptation actions and opportunities and build climate resilient infrastructure to address the current and future impacts of climate change. As a minimal contributor to global GHG emissions, Maldives places a significant priority on adapting to the adverse impacts of climate change.

|                           |   |
|---------------------------|---|
| Coastal Protection        | <p>The islands of the Maldives are low lying and beach erosion is widespread causing significant loss of land and costal infrastructure. Priority is given to protect the human settlements and infrastructure of inhabited and resort islands.</p> <ul style="list-style-type: none"> <li>➤ Facilitate and continue to invest in coastal protection of inhabited islands and resorts.</li> <li>➤ Include land elevation, shore protection and reclamation as an adaptation measures to increase resilience of vulnerable islands.</li> </ul> |
| Infrastructure Resilience | <p>Considering the highly vulnerable nature of the Maldives the critical infrastructure in the country require additional protection from the potential adverse impacts of climate change. The Ibrahim Nasir International Airport, and other international and domestic airports</p>   |



|  |  |
|--|--|
|  | <p>and sea-ports are crucial infrastructure in the Maldives. Increasing resilience of island communities is a critical challenge, which needs to be addressed to meet the adverse impacts of climate change.</p> <ul style="list-style-type: none"><li>➤ The Ibrahim Nasir International Airport is planned for expansion to handle additional passenger capacity along with an additional runway. Moreover, coastal protection measure would be carried out to protect the shoreline of Hulhule (the Airport Island) as well as for other air and sea ports.</li><li>➤ Malé Commercial Port that handles more than 90 percent of the imported cargo. To increase the capacity and reduce the impacts of high winds and seas to the operation of the port, the commercial port would be relocated to a different island called Thilafushi.</li><li>➤ Increase resilience and climate proofing of all critical infrastructures across the country including utility services, health care facilities, and telecommunications.</li><li>➤ A National Building Code will be established to provide guidance to the</li></ul> |
|--|--|

|   |   |
|---|---|
|   | <p>planners, architects and engineers to integrate climate and weather related factors into the designs of buildings and facilities. The building code will help to increase resilience and climate proofing.</p> <ul style="list-style-type: none"> <li>➤ Establishment of National Development Act to facilitate integration of climate change into development planning, considering the economies of scale for public services, land use planning and population consolidation.</li> </ul>  |
| <p>Early warning and Systematic Observation</p> | <p>Climatological measurements are limited due to capacity constraints and inadequate resources. Improvement of climate data collection, management and forecasting remains a critical gap area.</p> <ul style="list-style-type: none"> <li>➤ Expand and strengthen the meteorological network and weather related early warning system to cover all the communities of the Maldives.</li> <li>➤ Improve climate forecasting using climate modeling to provide information to support decision making sectors affected by weather and climate variability.</li> <li>➤ Develop appropriate early warning systems and risk management tools.</li> </ul> |
| <p>Cross Cutting Issues</p>                     | <p><b>Finance</b></p>   |

|  |   |
|--|---|
|  | <p>Sustainable finance remains a major challenge in addressing climate. Domestic budgetary spending on addressing climate change remains an additional burden towards the achievement of sustainable development. Nevertheless public finance is being allocated to meet urgent and immediate adaptation actions. However International support is necessary to address the adverse impacts of climate change facing the islands of the Maldives.</p> <ul style="list-style-type: none"><li>➤ Creating sustainable financing mechanisms for programmes related to climate change activities.</li><li>➤ Establishment of a Maldives Climate Resilient Fund to finance climate change adaptation and mitigation programs.</li></ul> <p><b>Climate governance and capacity building</b></p> <p>Addressing the adverse impacts of climate change requires good governance and adequate capacity. Education, training and public awareness remain a key priority. Climate change research and technology transfer remains an area, which needs to be strengthened.</p> <ul style="list-style-type: none"><li>➤ Develop National Adaptation Plans to address immediate, medium and long term adaptation programmes with</li></ul> |
|--|---|

|  |   |
|--|---|
|  | <p>support from international community.</p> <ul style="list-style-type: none"> <li>➤ Develop Climate Change Act for addressing climate change.</li> <li>➤ Continue to build national capacity with support from international community.</li> <li>➤ Develop and promote appropriate technologies to address climate change impacts with support from international community.</li> <li>➤ Implement appropriate policies and strategies to address the impacts of climate change on vulnerable groups.</li> </ul> |
|--|---|

Source: unfccc.int

### ***6.3 New port project can be climate resilience infrastructure***

Three sites vicinity of Male' have been identified as possible locations for a new Commercial harbor, the islands of Hulhumale' and Thilafushi, and the submerged reef at GulhiFalhu adjacent to Thilafushi. Greater Male' area concept is to connect three islands via a bridge. MCH has already established terminals in Hulhumale to overcome the operational congestions. The three sites of Hulhumale', GhuliFalhu and Thilafushi have been assessed to determine their capacity to accommodate the concept, the cost thereof and the associated operational and environmental implications. Gulhifalhu is not an easy option to navigational and it is uninhabited land where the government tried to locate business and basic housing units but it wasn't favorable due to the smoke of garbage burning from adjacent Thilafushi, this makes the island environment poisonous.

Although all factors considered relocation project is taking place in Gulhifalhu, the port will accommodate initially 400,000TEUs throughput and planned expansion for the next 50 years. To address climate change impacts, such as sea level rising the height of land is taken to consideration when reclaiming the land.

#### 6.4 New Port: -Climate Vulnerability assessment approach

| Climate variable                      | Suggestive risks   |
|---------------------------------------|--|
| Heatwave                              | <ul style="list-style-type: none"> <li>➤ Higher deterioration of pavements and roadways</li> <li>➤ Higher energy consumption of refrigerated containers.</li> <li>➤ Heat dissipation of vehicles</li> </ul>  |
| Increased intensity of storms         | <ul style="list-style-type: none"> <li>➤ Closure of bridge and other modes of transportation (<i>Temporarily</i>)</li> <li>➤ The toppling of containers in stacking Yards due to flat land.</li> </ul>   |
| Increase the intensity of storm surge | <ul style="list-style-type: none"> <li>➤ Flooding's of berth facility</li> <li>➤ Increased wave action at waterfront structure and consequently the redundant of terminal services.</li> </ul>   |
| High-speed wind                       | <ul style="list-style-type: none"> <li>➤ With navigation difficulty factors of new location – damage to navigation and communication equipment.</li> <li>➤ Stoppages to unloading and loading vessels</li> <li>➤ Damage to buildings/ warehouses due to flat land area.</li> </ul> |
| Increased intensity of rainfall       | <ul style="list-style-type: none"> <li>➤ Damage to warehouse and buildings due to flooding</li> <li>➤ Drainage system overload</li> <li>➤ Stoppages of CFF operations</li> </ul>   |

Idea generated from (Scott et.al 2013)

## ***6.5 Measures to be taken into consideration in the adaptation of climate change***

**Developing a sector-specific plan:** MCH needs to develop a “climate resilience plan” with sector-specific to deal with climate change and National disaster management should work together when dealing with climate change adaptation in port due to their overlapping roles.

**Capacity building for environmental management:** While the Maldivian government offers free education till post-graduate level therefore, the government should fund more programs to build on the environmental management area. Whilst the responsibility of creating awareness and educating youth and women.

**“Climate resilience new port”** Upcoming new investment should be aligned to measures of “Climate resilience port”. The port’s adaptation strategy should address the issues of safety during flooding, ensuring safe access for both vessels and passengers, buildings, the urban water system, and Greater Male’ area climate.

**“Green port concept”** For a country like the Maldives which lay on the equator, Solar power is an option for decarbonizing terminals and machines.

**Regional Integration:** In a crisis, the neighbor country is most likely to provide aids on time and to call for support. South Asian countries can transfer knowledge on climate change adaptation and transfer expertise to deal with crisis and resilience projects. South Asian countries more or less have the same level of resilience. MCH unfortunately has features of very first model of port and infrastructure is old, which is not compatible to projecting climate impacts.

## **Conclusion**

Climate change has brought much intense change to small local islands of Maldives and ports of Maldives. Uncertain and changing weather patterns in the form of floods and coastal inundation have challenged hinterland transportation infrastructure and system of land transportation. Extreme measures from the global community can ease the stress projecting to small island developing states. Also, funding and the responsibility to develop climate resilience infrastructures is a burden to small island developing states, most of the time in development projects the economic benefits outweigh environmental impacts. Continuous efforts are being undertaken to increase adaptation actions and opportunities, and to undertake low emission development. However, limited financial resources, capacity and technology remain as major challenges in addressing the impacts of climate change.

The correlation between increasing temperatures and coastal inundation and other environmental issues core heating point is global warming and this is not an issue that one can only address and overcome. Arctic sea is melting and this may be an opportunity for some businesses as a new maritime route. These extreme opportunities force communities and ports to relocate especially when resilience has not been built. Island losses its habitat and its naturally developed protection, this decline economic activity of those islands and regions. Port tenants may also decide to move out of the port environment and decide to rent space somewhere else. In a worst-case scenario, they might have to move to a neighboring port, like Sri Lanka, Colombo.

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