CLIMATE CHANGE ASSESSMENT

I. BASIC PROJECT INFORMATION

Project Title:	Republic of the Union of Myanmar: Second Greater Mekong Subregion Highway Modernization Project
Project Cost ($ million)**:**	526.34
Location:	Myanmar: Bago region and Mon state in south of Myanmar
Sector:	Road Transport (Non-urban)
Theme:	Inclusive economic growth
Brief Description:	The project involves the construction of a new arterial highway, shorter by 32 kilometer (km) than the current National Highway-8, which will halve travel time from Bago to Kyaikto. National Highway-8 is partially submerged by flooding which prevents traffic between Phayargyi and Kyaikto for part of the year. The new arterial highway will be about 64 km long and will include a 2.3 km bridge over the Sittaung river (but funded under JICA and not ADB). This new link will connect to the existing national road network; i.e., four at-grade interchanges will provide connections to the local rural road network. The highway is being developed as a toll road. The Bago to Kyaikto highway will be a toll expressway. Access will be controlled with an interchange at the start on the Yangon to Mandalay Road just south of Bago. The highway will begin nine kilometers south of Bago on the Yangon to Mandalay Road (National Highway-1) in the Village of Gwayt Tan Shey. There will be an interchange that will allow traffic to enter the Bago to Kyaikto Road on a flyover structure or to continue on National Highway-1. The Yangon to Bago Railway tracks must be crossed then the Bago River. Both crossings will require bridges. The highway will a four-lane dual carriageway with a design speed of 120 km/hr. The road surface will be asphalt, with concrete used at the toll stations. The highway for the most part crosses low lying land, used for intensive agriculture and which is prone to flooding. In order to protect the asset, the road will be constructed on embankment at an elevation up to 10 m above existing grade. The major structures along the whole alignment include a railway bridge, river bridges (15), road bridges (27), box culverts (203) and underpasses (101).[1]

II. SUMMARY OF CLIMATE CHANGE FINANCE

Project Financing		Climate Finance	
Source	**Amount** ($ million)	**Adaptation** ($ million)	**Mitigation** ($ million)
Asian Development Bank			
Ordinary capital resources (concessional loan)	483.80	10.70	0.00
Counterpart Financing			
Government (resettlement, interest during implementation)	42.54	0.00	0.00
Total	**526.34**	**10.70**	0.00

Source: Asian Development Bank.

[1] Environmental Impact Assessment (available from the list of Linked Documents in Appendix 2).

III. SUMMARY OF CLIMATE RISK SCREENING AND ASSESSMENT

A. Sensitivity of Project Component(s) to Climate or Weather Conditions and the Sea Level

Myanmar ranked second out of 183 countries most affected by extreme weather events between 1995 and 2014 in the Global Climate Risk Index. This ranking was mainly due to the damage and loss of life caused by Cyclone Nargis in 2008.[2] The project component that may be sensitive to climate is Output 1, i.e. the whole road infrastructure and its sub-components. Output 2 (enhancement of capacity of MOC for developing, financing, implementing and managing arterial highway projects, as well as for managing road safety) is climate neutral.

B. Climate Risk Screening: Downscaled Climate Projections for Yangon Delta Region

Temperature and precipitation projections are based on the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) dataset released in 2015 (NASA, 2015). It comprises downscaled climate scenarios derived from the General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5) for two greenhouse gas emissions scenarios RCP 4.5 and RCP 8.5. These simulations were developed in IPCC AR5. The spatial resolution of the dataset is 0.25 degrees or approximately 25 km x 25 km. For Myanmar the two time-windows represent 30-year averages of 2011-2040 and 2041-2070. All change factors are relative to the averaged 1980-2005 base period. The low estimate is the 25th percentile under RCP4.5 and the high estimate is the 75th percentile for RCP8.5.

Temperature increase. The estimates for mean temperature's projected change (in °C) compared to baseline 1980-2005 average are as follows. For the period 2011 to 2040, the annual mean temperature increase ranges from a low of 0.6°C to a high of 1.0°C; during hot seasons from March to May, the low is 0.7°C and the high is 1.1°C; during wet seasons from June to October, it is from 0.6°C to 1.0°C; and for the cool season from November to February, it will range from 0.6°C to 1.1°C. For the period 2041 to 2070, the annual mean temperatures range from 1.2°C to 2.4°C; during hot seasons from March to May, the low is 1.2°C and the high is 2.7°C; during wet seasons from June to October, it is from 1.1°C to 2.2°C; and for the cool season from November to February, it will range from 1.2°C to 2.7°C.[3]

Rainfall increase. Mean projected precipitation changes (in %) compared to baseline 1980-2005 average are as follows. For the period 2011 to 2040, the annual mean precipitation increase ranges from a low of 0.0% to a high of 12.0%; during hot seasons from February to May, the low is -12% and the high is 19%; during wet seasons from June to October, it is from 1% to 11%; and for the cool season from November to January, it will range from -29% to 14%. For the period 2041 to 2070, the annual mean precipitation ranges from a low of 5% to a high of 24%; during hot seasons from February to May, the low is -4% and the high is 17%; during wet seasons from June to October, it is from 5% to 26%; and for the cool season from November to January, it will range from -5% to 15%.[4]

Sea Level Rise. Myanmar's 1,930 kms coastline will experience rising seas and increasingly frequent and extreme hazards, with the low-lying Delta region likely to be most affected. Sea level rise alone will cause larger areas to be inundated during storm surges and coastal floods, even if the intensity of cyclones and coastal storms remain the same. The projections for Myanmar indicate a rise of 20-41cm by the 2050s and 37-83cm by the 2080s, with the highest projected sea level rise for this period almost 1.2 meters (foonote 2). Increased Sea level rise may cause inland flooding due to the backpressure effect on riverine discharges.

Extreme Events. Two extreme events in Myanmar are tropical cyclones and monsoons. The summer monsoon accounts for between 75-90% of Myanmar's total annual rainfall and may lead to "an increase in the risk of flooding resulting from a late onset and early withdrawal of monsoon events; The other is strong tropical cyclones like Nargis of 2008. Overall, it is expected that climate change and variability will lead to an "increase in the occurrence and intensity of extreme weather events, including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures and drought."

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[2] Environmental Impact Assessment (available from List of Linked Document in Appendix 2).
[3] Source data: NASA NEX-GDDP (2015)
[4] Ibid

Climate Risk Classification: Medium	
C. Climate Risk Screening Tool and/or Procedure Used Preliminary risk screening was conducted in accordance with the Asian Development Bank's climate change risk management framework, and the project is rated as "medium risk" for climate change impacts.	

IV. CLIMATE ADAPTATION PLANS WITHIN THE PROJECT

The adaptation measures integrated in the project design center on enhanced drainage capacity and elevated embankment heights. The design of all structures likely to be affected by hydro-meteorological parameters (precipitation extremes, peak river flows, flood levels), most importantly embankment height, river crossings and drainage structures will apply projected hydro-meteorological parameters rather than historic ones. The new road will be above the 20-year flood height thus allowing traffic to proceed throughout the raining season. All river crossings and major drainage structure will be designed using 1-in-100-year flood design assumptions. The climate proofing measures included in the project design are presented in the table below. The Sittaung Bridge, financed through a loan from JICA, is not included in this computation to avoid double-counting for climate adaptation finance.

Climate Change Adaptation Activity	Target Climate Risk	Estimated Adaptation Costs ($ million)	Adaptation Finance Justification[5]
Preliminaries - Will increase by per-cent	Intense precipitation and tropical storms that bring intense precipitations may lead to flash flooding, riverine flooding, riverbank erosion, siltation/sedimentation, and landslides.	0.21	The identified adaptation (engineering) measures are in response to the analysis that a rainfall increase of 15% is assumed to occur and that these measures should be applied to all extreme rainfall figures used in the hydrologic assessment.
Embankment - Increase road height by 0.40 m		2.38	
Box Culverts 1.5m x 1.5m - Increase size and number		0.18	
Box Culverts 2.0m x 2.0m - Increase size and number		0.27	
Box Culverts 3.0m x 3.0m - Increase size and number		0.61	
Box Culverts 6.0m x 4.5m - Increase size and number		1.11	
River Bridges - Increase clearance		3.12	
Pipe Culverts 0.9m complete with HW - Increase size and number		0.10	
Pipe Culverts 1.2m complete with HW - Increase size and number		0.19	
Grouted Riprap, Class A - Increase amount		0.09	
Grouted Riprap Ditch Lining - Increase amount		0.25	
River Training & Protection, Gabions - Increase amount		0.06	
Interchange Embankment - Increase road height by 0.40 m		0.38	
Contingencies and Taxes[6]		1.78	
Total		**10.72**	

[5] Preliminary assumptions to be confirmed at the Detailed Engineering Design stage.

[6] Contingencies (physical and price), taxes, and duties are estimated at $1.78 million, which is about 17% of the total cost. Considering the cost items associated with climate change, all items are not expected to have full amounts of physical and price contingencies, which are usually 14% and 10% the base cost respectively for the overall project cost estimates, due to each item's intrinsic nature. Taxes and duties do vary from item to item. A careful estimation of all these items have been conducted and therefore the $1.78 million has been reached.

V. CLIMATE MITIGATION PLANS WITHIN THE PROJECT

Mitigation Activity	Estimated GHG Emissions Reduction (tCO_2/year)	Value of CO2 emission savings per year ($ million)	Mitigation Finance Justification
Reduced vehicle fuel consumption due to reduced travel distance from Bago to Kyaikto (31.8km), improved speeds and traffic flow.	59.1 (2025) 202.5 (2035) 366.9 (2045)	1.70 (2025) 5.81 (2035) 10.53 (2045)	The emission reduction benefits are not accounted for as mitigation finance, but are listed here as project benefit. See GHG emission reduction computation and justification below.

The total greenhouse gas emissions from the project and the GHG reduction as compared to the no-project alternative was conducted in the framework of the economic analysis, using HDM4.[7] The assessment was based on the following assumption:

- The Bago-Kyaikto expressway will be 64km long, and travel speed will average 85km/h (vehicle-type dependent). Average speed is not anticipated to decrease in the period 2025-2045.
- Without the Project the traffic from Bago to Kyaikto must travel on the existing NH-8 route (E02 BBP-West – E08 NH-1 BBP-PG -> E11 NH-8 PG-SR -> E12 NH-8 Sittaung Bridge 2 -> E15 NH-8 North of Kyaikto). This route is 95.8km long, i.e. 31.8km longer than the proposed expressway. Average speed on the existing route are projected to be 46km/h in 2025, and is expected to decrease to 40km/h and 30km/h in 2035 and 2045 as a result to increased traffic loads are related congestion.
- CO2 emissions per vehicle-km are vehicle- and speed-specific, ranging from 110 mg CO2/km (car at 80km/h) to 1,000 mg CO2/km (truck articulated at 30km/h). See Table below.[8]
- The value of CO_2 is assumed to be $28.70 per ton of CO_2.[9]

Table: Average CO2 emission per vehicle type and vehicle speed

KPH	Car	Bus	Truck 2-Axle	Truck 3-Axle	Truck 4-Axle	Truck Articulated
10	381	621	454	740	1,116	1,491
20	251	436	337	580	860	1,141
30	197	354	283	502	739	976
40	166	306	251	454	663	873
50	145	273	228	419	610	801
60	130	249	211	393	570	747
70	119	231	198	372	538	703
80	110	216	187	355	512	668
90	119	231	198	372	538	703
100	130	249	211	393	570	747

Source: footnote 9.

[7] HDM4 VOC Module (Road User Costs Knowledge System (RUCKS) HDM-4 RUC Model Version 2.00, February 18, 2010).
[8] Ministry of Land, Infrastructure and Transport of Korea. 2017.Evaluation Guidelines for Transport Infrastructure Investments. Seoul.
[9] Source: Carbon Tracker Report, Author: M. Lewis, August 2019.