Appropriate Costing Options of Climate Change Adaptation in Infrastructure Development: Experimental Studies for Road and related Infrastructure Projects in Cambodia (CAMI)

Project Implementor: Master of Science in Climate Change Program, Graduate School of Science, Royal University of Phnom Penh (MCC/RUPP)

Project Partners: Asian Institute of Technology, Thailand; University of Freiburg, Germany (Foreign); Ministry of Public Work and Transport (MPWT), Ministry of Rural Development (MRD) (Local)

Project Locations: Kampong Thom and Pursat (Tonle Sap Lake), Kratie and Prey Veng (Mekong River), and Kampot (coastal zone)

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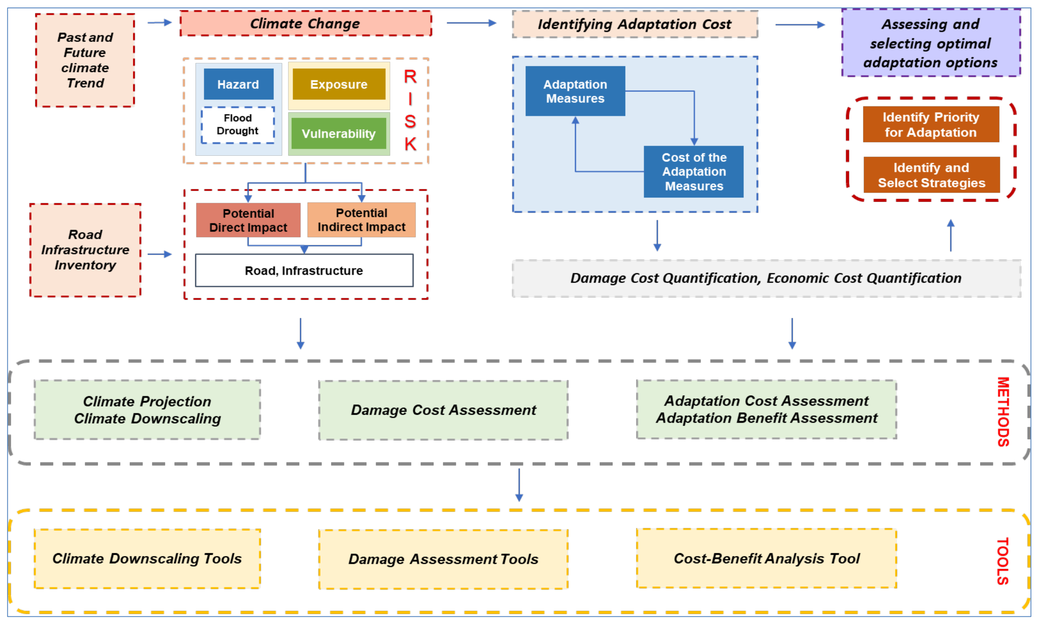
Background and objectives

The IPCC's sixth assessment report released in 2021 claimed that humans have been the main cause of climate change, causing many climatic extremes in all part of the globe. Based on the future projection of the climate modelling SLR will reach 30-40 cm by the end of the 21st century, in a globe (IPCC, 2013; Hijioka et al., 2014). Due to the climate change impacts, Cambodia encounters damage of road infrastructures every year, especially caused by heavy flood from the Mekong River and flash flood from Cardamom mountains. With projection of climate change in 2050, it shows that most parts of Cambodia will experience (i) increased wet-season rainfall, (ii) decreased dry-season rainfall, and (iii) increased average daily maximum temperatures. A vulnerability assessment sponsored by the National Committee for Sustainable Development (NCSD) and supported by the International Institute for Environment and Development (IIED), found that 17.2% of communes were found to be "highly" vulnerable and 31.5% to be "quite" vulnerable to multiple climate change hazards, namely floods, storms and droughts. Therefore, the appropriate costing for climate adaptation of roads and related infrastructure projects needs to be comprehensively studied so that damages and losses caused by flood and other climate hazards can be properly incorporated from the economic and climate change standpoints.

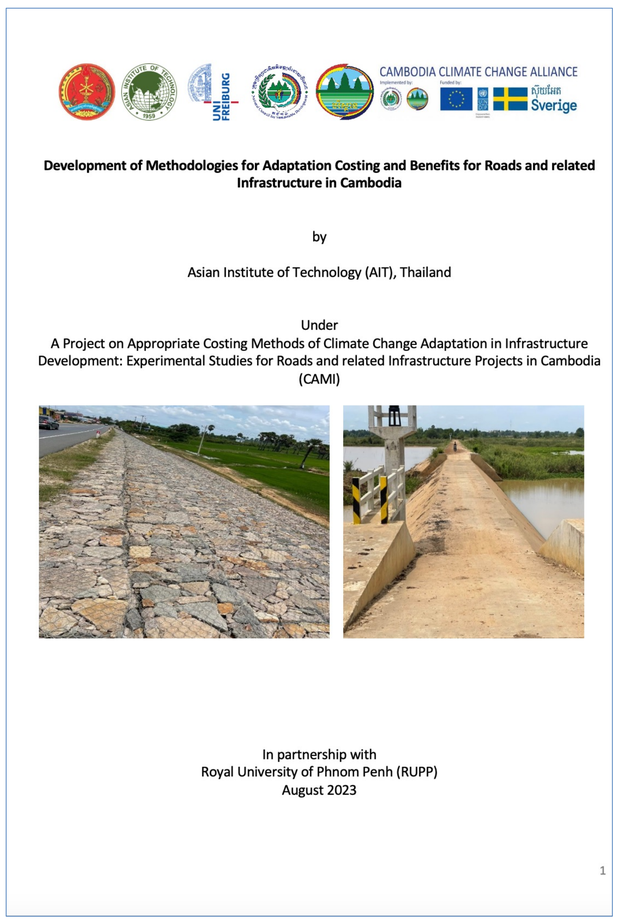
The main objective of this assignment is **to improve the efficiency and effectiveness of climate public expenditure under MRD and MPWT and to support the mobilization of corresponding resources through the strengthening of these ministries capacities and skills** to:

1) Ensure that the climate change dimension is recognized explicitly in MRD and MPWT budget submissions to the Ministry of Economy and Finance, and supported by cost-benefit analysis (and other evidence as required).
2) Provide evidence to prioritize climate change budgets and projects and align them with national and sectoral climate policy objectives.
3) Provide guidance and recommendations to the Climate Change Focal Points and concerned departments in the ministries on integrated planning and budgeting related to climate change, as well as monitoring and evaluation of the impacts of expenditures related to climate change.



Results

The framework for assessing cost and benefits from adapting to climate change on roads and related infrastructures uses an amalgamation of primary, secondary, and ancillary data from multiple sources. The hierarchical process is designed to prioritize all significant events such as floods, flash floods, and sea level rise. This methodology incorporates both qualitative and quantitative approaches to address the issue of climate change and its impact on road infrastructure, filling a gap in the current literature that primarily relies on qualitative methods.



Brush mattress measure proves to be the best adaptation measure because it outperforms the Baseline Scenario in nearly all performance measures, including NPV, and the benefit-cost ratio. The analysis provides a compelling argument for new construction of road PR382D in Prey Veng and NR 43 in Kampot to consider the effects of climate change early in the project, starting from the detailed design phase, to ensure that the new road can withstand various weather conditions and remain climate-resilient.

PREY VENG PROJECT, PR382D, 1.2 Km

	Baseline scenario				Climate scenario SSP245				Climate scenario SSP585			
	Without Adaptation Measure (Normal Construction DBST Road)	With Adaptation Measure: Application of Brush Mattress	With Adaptation Measure: Application of Vegetated Riprap	With Adaptation Measure: Application of Vegetaed Revetment	Without Adaptation Measure (Normal Construction DBST Road)	With Adaptation Measure: Application of Brush Mattress	With Adaptation Measure: Application of Vegetated Riprap	With Adaptation Measure: Application of Vegetaed Revetment	Without Adaptation Measure (Normal Construction DBST Road)	With Adaptation Measure: Application of Brush Mattress	With Adaptation Measure: Application of Vegetated Riprap	With Adaptation Measure: Application of Vegetaed Revetment
IRR	77%	78%	61%	0%	77%	78%	61%	0%	77%	78%	61%	0%
BCR	6.43	6.47	5.03	0.18	6.43	6.47	5.03	0.18	6.43	6.47	5.03	0.18
NPV	$ 419,753	$ 555,634	$ 526,340.06	$ (2,825,437.43)	$ 419,753.30	$ 555,634	$ 526,340.06	$ (2,825,437.43)	$ 419,753.30	$ 555,634	$ 526,340	$ (2,825,437)
Total Cost	$ 466,810	$ 494,001	$ 526,810.44	$ 4,374,683.38	$ 466,810.44	$ 494,001	$ 526,810.44	$ 4,374,683.38	$ 466,810.44	$ 494,001	$ 526,810	$ 4,374,683
Investment Cost	$ 90,634	$ 117,825	$ 150,634	$ 3,890,507.38	$ 90,634.44	$ 117,825	$ 150,634.44	$ 3,890,507.38	$ 90,634.44	$ 117,825	$ 150,634	$ 3,890,507
Operation and Maintenance	$ 184,176	$ 184,176	$ 184,176	$ 292,176.00	$ 184,176.00	$ 184,176	$ 184,176.00	$ 292,176.00	$ 184,176.00	$ 184,176	$ 184,176	$ 292,176
Replacement	$ 192,000	$ 192,000	$ 192,000	$ 192,000.00	$ 192,000.00	$ 192,000	$ 192,000.00	$ 192,000.00	$ 192,000.00	$ 192,000	$ 192,000	$ 192,000
Total Benefit	$ 3,716,638	$ 4,796,638	$ 4,796,638	$ 4,796,637.50	$ 3,716,637.50	$ 4,796,638	$ 4,796,637.50	$ 4,796,637.50	$ 3,716,637.50	$ 4,796,638	$ 4,796,638	$ 4,796,638
Vehicle Operatin Cost (VOC)	$ 1,984,613	$ 1,984,613	$ 1,984,613	$ 1,984,612.50	$ 1,984,612.50	$ 1,984,613	$ 1,984,612.50	$ 1,984,612.50	$ 1,984,612.50	$ 1,984,613	$ 1,984,613	$ 1,984,613
Travel Time Saving	$ 1,732,025	$ 1,732,025	$ 1,732,025	$ 1,732,025.00	$ 1,732,025.00	$ 1,732,025	$ 1,732,025.00	$ 1,732,025.00	$ 1,732,025.00	$ 1,732,025	$ 1,732,025	$ 1,732,025
Damage Savings	$ -	$ 1,080,000	$ 1,080,000	$ 1,080,000.00	$ -	$ 1,080,000	$ 1,080,000.00	$ 1,080,000.00	$ -	$ 1,080,000	$ 1,080,000	$ 1,080,000
Loss Savings	$ -	$ -	$ -	$ -	$ -	$ -	-	-	$ -	$ -	$ -	$ -

(KAMPOT PROJECT, NR43, 77 Km)

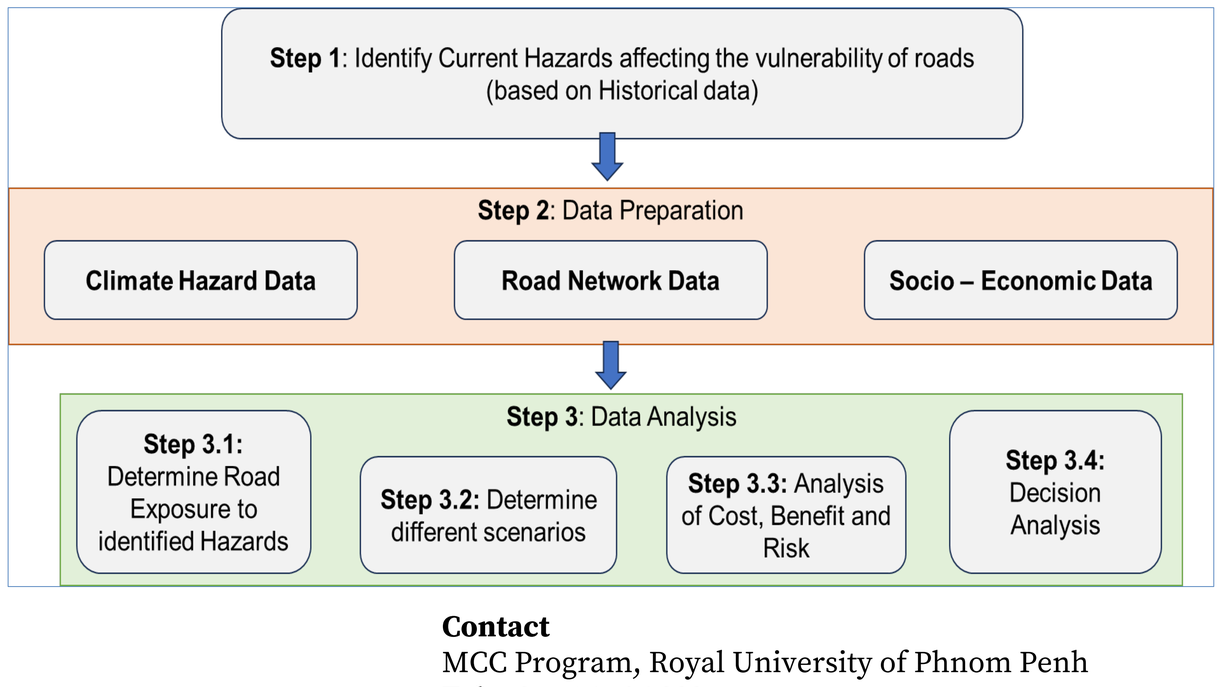
	Baseline scenario				Climate scenario SSP245				Climate scenario SSP585			
	Without Adaptation Measure (Normal Construction DBST Road)	With Adaptation Measure: Application of Brush Mattress	With Adaptation Measure: Application of Vegetated Riprap	With Adaptation Measure: Application of Vegetated Revetment	Without Adaptation Measure (Normal Construction DBST Road)	With Adaptation Measure: Application of Brush Mattress	With Adaptation Measure: Application of Vegetated Riprap	With Adaptation Measure: Application of Vegetaed Revetment	Without Adaptation Measure (Normal Construction DBST Road)	With Adaptation Measure: Application of Brush Mattress	With Adaptation Measure: Application of Vegetated Riprap	With Adaptation Measure: Application of Vegetaed Revetment
IRR	77%	74%	57%	0%	77%	81%	63%	1%	77%	88%	69%	1%
BCR	6.43	6.12	4.76	0.17	6.43	6.72	5.23	0.19	6.43	7.32	5.70	0.21
NPV	$ 419,753	$ 519,654	$ 490,360	$ (2,861,417)	$ 419,753	$ 581,215	$ 551,921	$ (2,799,856.61)	$ 419,753.30	$ 643,499	$ 614,205	$ (2,737,573)
Total Cost	$ 466,810	$ 494,001	$ 526,810	$ 4,374,683	$ 466,810.44	$ 494,001	$ 526,810	$ 4,374,683.38	$ 466,810.44	$ 494,001	$ 526,810	$ 4,374,683
Investment Cost	$ 90,634	$ 117,825	$ 117,825	$ 3,890,507	$ 90,634	$ 117,825	$ 150,634	$ 3,890,507.38	$ 90,634.44	$ 117,825	$ 150,634	$ 3,890,507
Operation and Maintenance	$ 184,176	$ 184,176	$ 184,176	$ 292,176	$ 184,176	$ 184,176	$ 184,176	$ 292,176.00	$ 184,176.00	$ 184,176	$ 184,176	$ 292,176
Replacement	$ 192,000	$ 192,000	$ 192,000	$ 192,000	$ 192,000	$ 192,000	$ 192,000	$ 192,000.00	$ 192,000.00	$ 192,000	$ 5,463,470	$ 192,000
Total Benefit	$ 3,716,638	$ 4,554,013	$ 4,554,013	$ 4,554,013	$ 3,716,638	$ 4,969,138	$ 4,969,138	$ 4,969,137.50	$ 3,716,637.50	$ 5,463,470	$ 2,024,305	$ 5,463,470
Vehicle Operatin Cost (VOC)	$ 1,984,613	$ 1,984,613	$ 1,984,613	$ 1,984,613	$ 1,984,613	$ 1,984,613	$ 1,984,613	$ 1,984,612.50	$ 1,984,612.50	$ 1,984,612.50	$ 2,024,305	$ 2,024,305
Travel Time Saving	$ 1,732,025	$ 1,732,025	$ 1,732,025	$ 1,732,025	$ 1,732,025	$ 1,732,025	$ 1,732,025	$ 1,732,025.00	$ 1,732,025.00	$ 1,766,666	$ 1,766,666	$ 1,766,666
Damage Savings	$ -	$ 837,375	$ 837,375	$ 837,375	$ -	$ 1,252,500	$ 1,252,500	$ 1,252,500.00	$ -	$ 1,672,500	$ 1,672,500	$ 1,672,500
Loss Savings	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Summary table of CBA for different scenarios for Prey Veng and Kampot Provinces

Approaches and technology used

The methodological framework consists of three main steps with step 1 being the identification of current hazards that are affecting the vulnerability of roads. This can be done through analyzing the historical data. The second step would be to prepare data for further analysis. Past and future climate data is gathered and cleaned to determine the exposure of the roads to hazards. In addition, data for road network, such as type of road, length of road, and the socio-economic data such as population demographic, education level, working population for the area of interest are also necessary for further analysis. The last step of the methodological framework is the data analysis part which can be divided into four sub-parts.

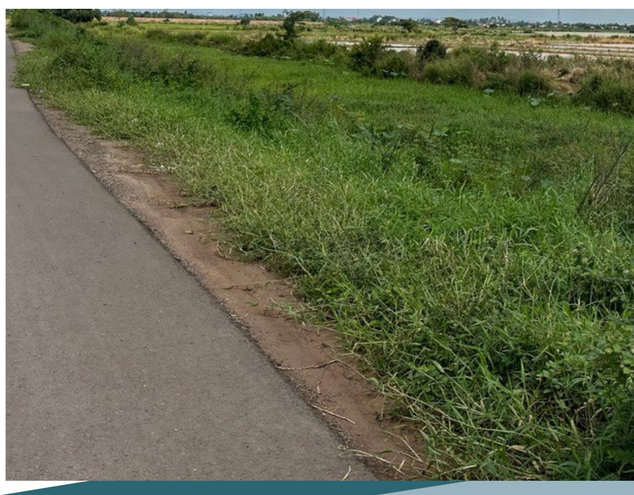
The decision analysis will be conducted using the several parameters such as NPV, IRR and BCR. By analyzing these factors, the decision to whether the adaptation measures could be implemented or not would be determined.



Scale up plan

The next steps forward in addressing the issue of road damage caused by hazards in Cambodia could include implementing the most effective, efficient, and feasible policy options identified in the report.

1. This could involve updating existing policies and creating new ones to promote the resilience of road infrastructure at the provincial level, as well as developing training and learning techniques to improve the knowledge and skills of government officers concerning assessing cost and benefits caused by climate change.
2. **Further research can focus on involvement of local stakeholder in assessing what kind of benefits that prefer and the physical implementation of the road and infrastructures in Cambodia.**
3. **Monitoring and evaluation should be done for further understanding and improvement of the road and infrastructures.**
4. Regularly assess the actual costs and benefits against the predicted outcomes to identify any discrepancies and learn from past experiences. This iterative process improves future cost and benefit analyses.



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