Adaptation Finance: Definition

Climate adaptation finance is the cost of activities undertaken to lower the current and expected risks to or vulnerabilities of the project, or community, economy or the environment, posed by climate change.

Adaptation Finance: Recap of Key Elements

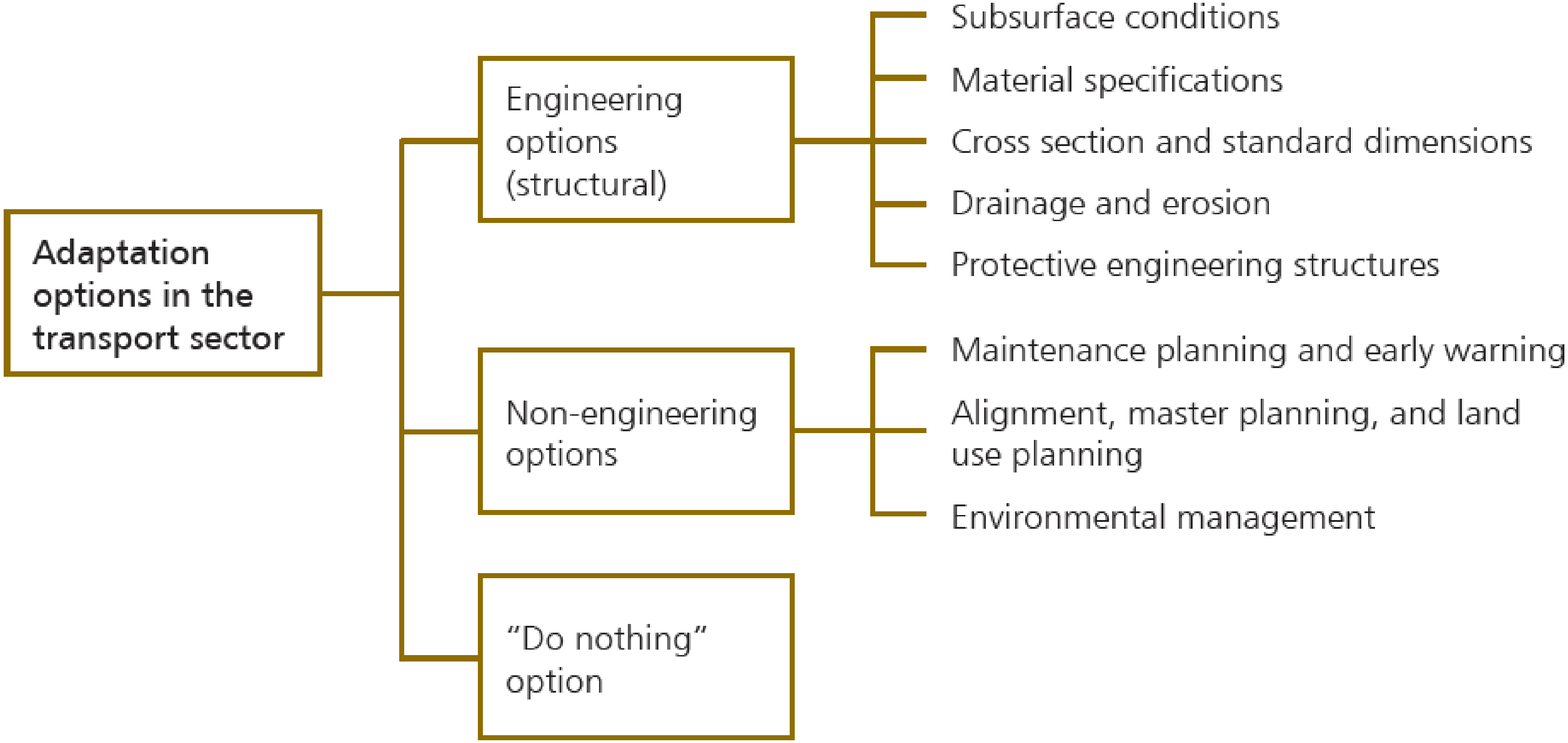
A transport sector project activity is eligible for inclusion in project adaptation finance if we can answer YES to the following questions:

1. Is the project at demonstrated risk from the impact(s) of climate change? (establishing the climate vulnerability context of the project);
2. Is there an explicit statement of intent to address climate vulnerability through project design and/or activities?
3. Is there a clear and direct link between the climate vulnerability context and specific project activities? (Are they logical responses to the climate risks identified?)

Examples of Potentially Eligible Adaptation Activities in the Transport Sector

- Modifications in project location and/or scale (e.g., changes in road alignment to avoid flooding, SLR)
- Modifications in engineering materials and designs (e.g., pavement stiffness; drainage capacity)
- Alternative technology choices
- Biophysical- and Ecosystem-based measures (e.g., bio-engineering for slope stabilization)
- Revised National, sectoral design standards and protocols (including re-estimation of design event magnitudes)
- Training and Capacity Development

Figure 1 **Nature of Adaptation Options in the Transport Sector**



Source: ADB.

Road Infrastructure Impacts, Design Parameters I/II

Climate Event	Potential Impacts	Vulnerable Infrastructure Design Parameters
Temp-erature	**Extended hot weather can cause:** • Pavement deterioration due to liquification of bitumen • Heating, thermal expansion of bridges • Bucking of joints in steel structures	**Pavement:** • use of stiff bitumen to withstand heat • control of soil moisture • maintenance planning **Bridges:** • selection of material • provision of expansion joints • corrosion protection
Rainfall	**Increased intensity of precipitation:** • Increased flood magnitude • Affect drainage, pavement & driving conditions, visibility • Affect bridge, culvert clearances, • Scouring of foundations • Trigger landslides, road blockages	**Bridges and culverts:** • Revise estimated design flood magnitude • Improve foundation and bank protection **Drains:** • Revise design discharge • Size, shape, slope of drain **Mountain roads**: • Slope protection • Subsurface, catch drains **Pavement:** • Increase road surface camber • Increase frequency of maintenance

Road Infrastructure Impacts, Design Parameters II/II

Climate Event	Potential Impacts	Vulnerable Infrastructure Design Parameters
Storm, Storm Surge	• Rainfall and wind create flooding, inundation of embankments • Disrupt traffic safety, emergency evacuation operations • Affect traffic boards, information signs	Drains and cross-drains: capacity enhancement, slope Road embankment: increase height Road signs: wind load, structural design, foundation, corrosion protection
Sea Level Rise (SLR)	• Rise in sea level (in combination with storm surge, large waves) will affect coastal roads • Potential need to re-align or abandon roads in affected areas	**Coastal roads:** • Protection walls • Additional warning signs • Re-alignment of road sections to higher areas • Edge strengthening

Source: Regmi and Hanaoka (2011) Survey on Impacts of Climate Change on Road Transport Infrastructure and Adaptation Strategies in Asia. Environ Econ Policy Studies 13: 21-41.

What are Typical Costs of Climate-Proofing Transport Sector Infrastructure?

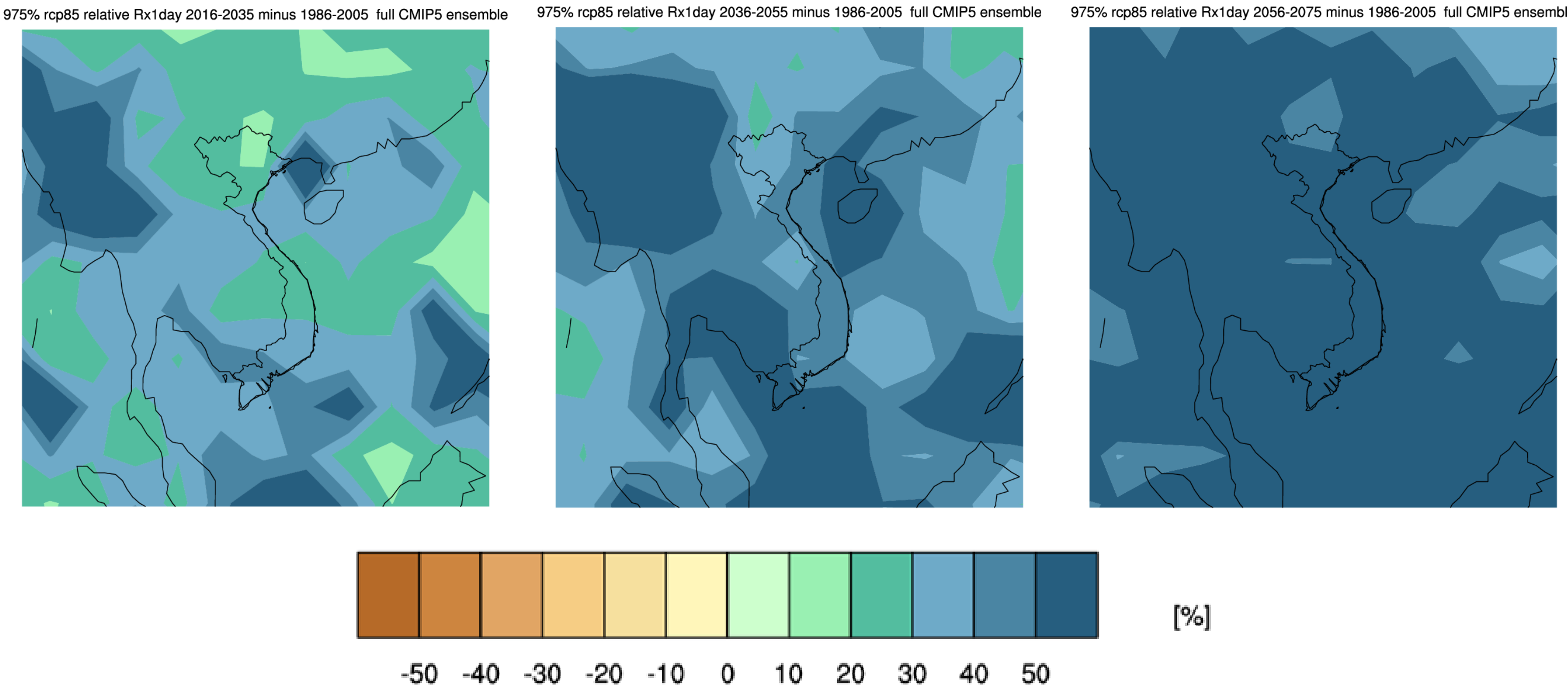
- ADB (2016) in *Meeting Asia's Infrastructure Needs*, estimates that climate change adaptation adds ***7%*** to the costs of transportation infrastructure (based on 7.8% for road transport, 0.6% for other transport (rail, airport and seaport).
- Climate adaptation as a percent of ADB's total internal finance for the period of reporting (2011 – 2017) has been around ***5%*** (4.85%), inclusive of all sectors.
- For the Transport sector, climate adaptation finance has averaged ***5.2%*** of total ADB Transport finance for the period 2015-2017.
- In the IDA16 Special Themes report (2013), World Bank staff estimated climate proofing costs of around ***6%*** of the total value of IDA investment projects per year on the basis of the findings of the EACC study (2010).
- While reasonably consistent, these are portfolio percentages and do not necessarily provide guidance on individual projects.

Case Study: VIE Basic Infrastructure for Inclusive Growth in the North Central Provinces (2017)

Bao Ninh to Hai Ninh coastal road, Quang Bing Province. The proposed structures are at risk from (1) high-intensity rainfall and insufficient flood conveyance through culverted sections; as well as (2) flooding and/or damage by storm surge-tide-wave interactions with sea level rise.

Projected Changes in Heavy Rainfall, Viet Nam

2016-2035 **2036-2055** **2056-2075**



Climate model projections of changes in maximum 1-day rainfall:

- 97.5th percentile 1-day maximum rainfall over Viet Nam
- All changes are with respect to 1986-2005
- Based on the CMIP5 ensemble under RCP8.5
- Data source: KNMI Climate Explorer

Climate Change Adjustment Factors, Maximum 1-Day Rainfall, Viet Nam

Scenario	Return Period (years)				
	2	5	10	20	25
2016-35	15	20	20	20	20
2036-55	40	30	30	30	30
2056-75	60	50	45	50	50
2076-95	80	80	75	75	70

National **adjustment factors** (%) for 1-day maximum based on CMIP5 RCP8.5:

- All changes are with respect to 1986-2005
- Based on the 97.5th percentile of the ensemble
- Rounded to the nearest 5%
- Return period estimates assume the Gumbel distribution

Fluvial Flood Climate Change Adjustment

Bao Ninh to Hai Ninh coastal road

- The ***25 year design flows*** at two culvert sections increased by around ***29%*** after applying the 25 year climate change adjustment to 1-day maximum rainfall.
- ***Flood water elevations*** increased by ***17%*** (0.12 m), which imply a need to correspondingly raise the level of the road embankment to provide adequate freeboard.
- Projected ***flow velocities*** at these two culvert locations increased by around ***10%***, indicating need to strengthen the culvert aprons and wing walls.

Adapted from: ADB (2018:17)

Calculation of Climate Adaptation Finance

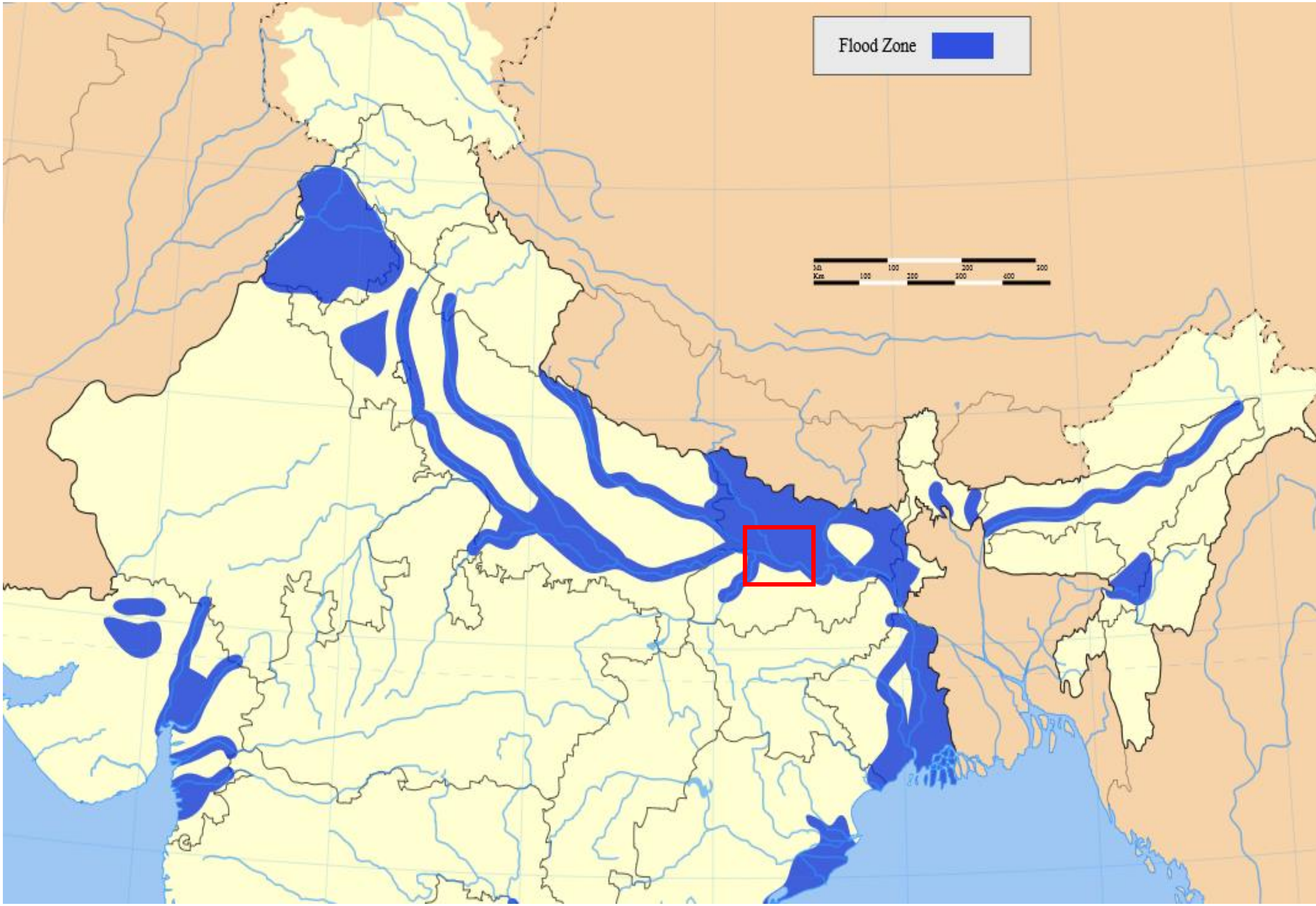
Total ADB Financing:	$149.0 million
Total financing:	$203.5 million
Assessed climate risks to the project:	Medium
Climate change adaptation finance:	$27.0 million (18%)

Basis for calculation: difference in costs between baseline (no climate change) and climate change-adjusted design requirements.

Statement of Intent (RRP): “The climate change scenarios indicate a high risk to the project outcome but subproject design will incorporate adaptations to mitigate the risk level to medium. Additional climate change costs will be quantified within the subproject detailed designs. The climate adaptation measures follow the government’s project construction and implementation procedures. Climate mitigation is estimated to cost $3 million and climate adaptation is estimated to cost $27 million, both 100% financed by ADB.”

Case Study: Bihar New Ganga Bridge (2016)

Flood-Prone Regions of India

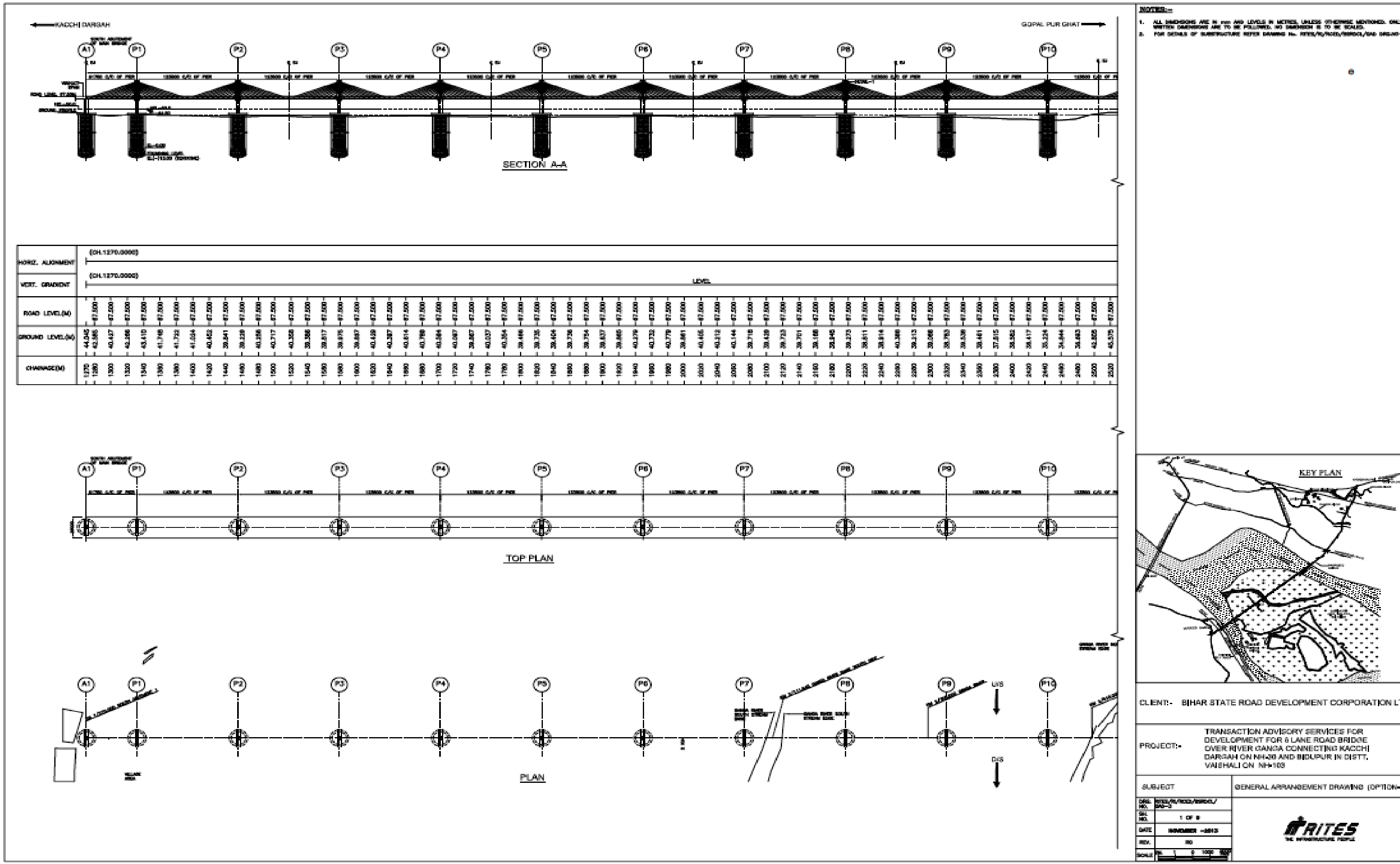


Climate Change Risk: Floods on the Ganga

- Climate models generally project increased precipitation in the Upper Gangetic Basin
- India requires 100-year flood design standard
- Design flood includes combined discharge of 2 rivers

Scenario	Discharge (Q) m^3/sec
Highest measured Ganga Q (1994)	**83,000**
100-year Ganga Q (GEV, stationary)	**89,093**
100-year Ganga Q (GEV, non-stationary)	**94,127**
100-year design standard, upstream bridge	**96,277**
Highest measured Gandak Q	**25,000**
100-year Gandak Q	**20,620**
Final design standard	**106,839**

Preferred Option 3: Elevated Spans



Calculation of Climate Adaptation Finance

Total ADB Financing:	$500.90 million
Total financing:	$715.90 million
Assessed climate risks to the project:	High
Climate change adaptation finance:	$200.00 million

Basis for calculation: difference between selected design and lower-cost but less flood-resilient design.

Statement of Intent (RRP): "… the New Ganga Bridge will span from bank to bank over the two river channels and the Raghopur Diara river island. This helps minimize effects on the river regime and is an important climate adaptation measure because the alternative option of constructing an embankment road on Roghopur Diara river island, while less costly, could be vulnerable to floods."

Case Study: Central Mekong Delta Connectivity Project (2013)

The project:

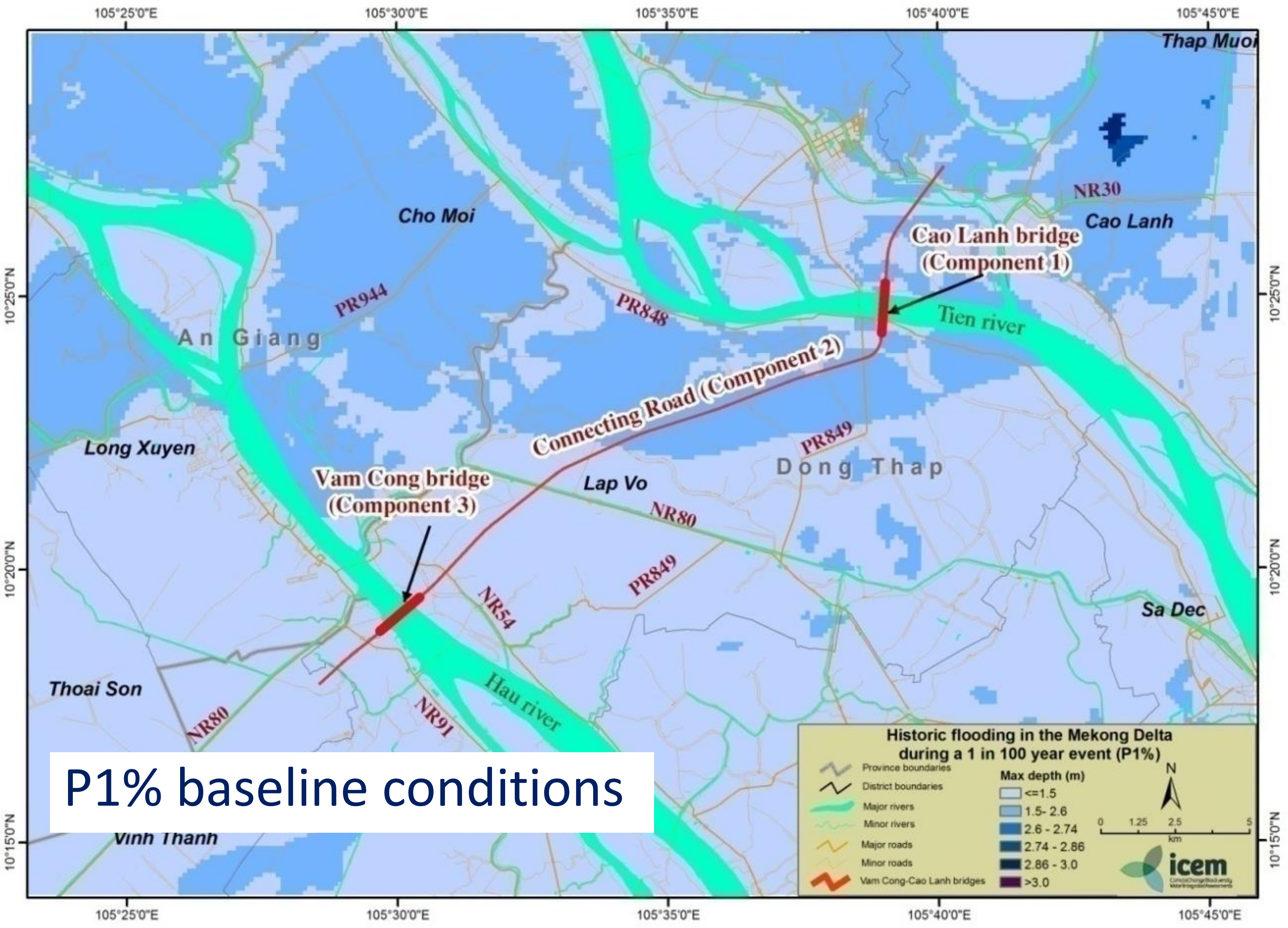
Improve connectivity in the Mekong Delta region by extending National Highway 2 from HCMC to Mekong Delta:

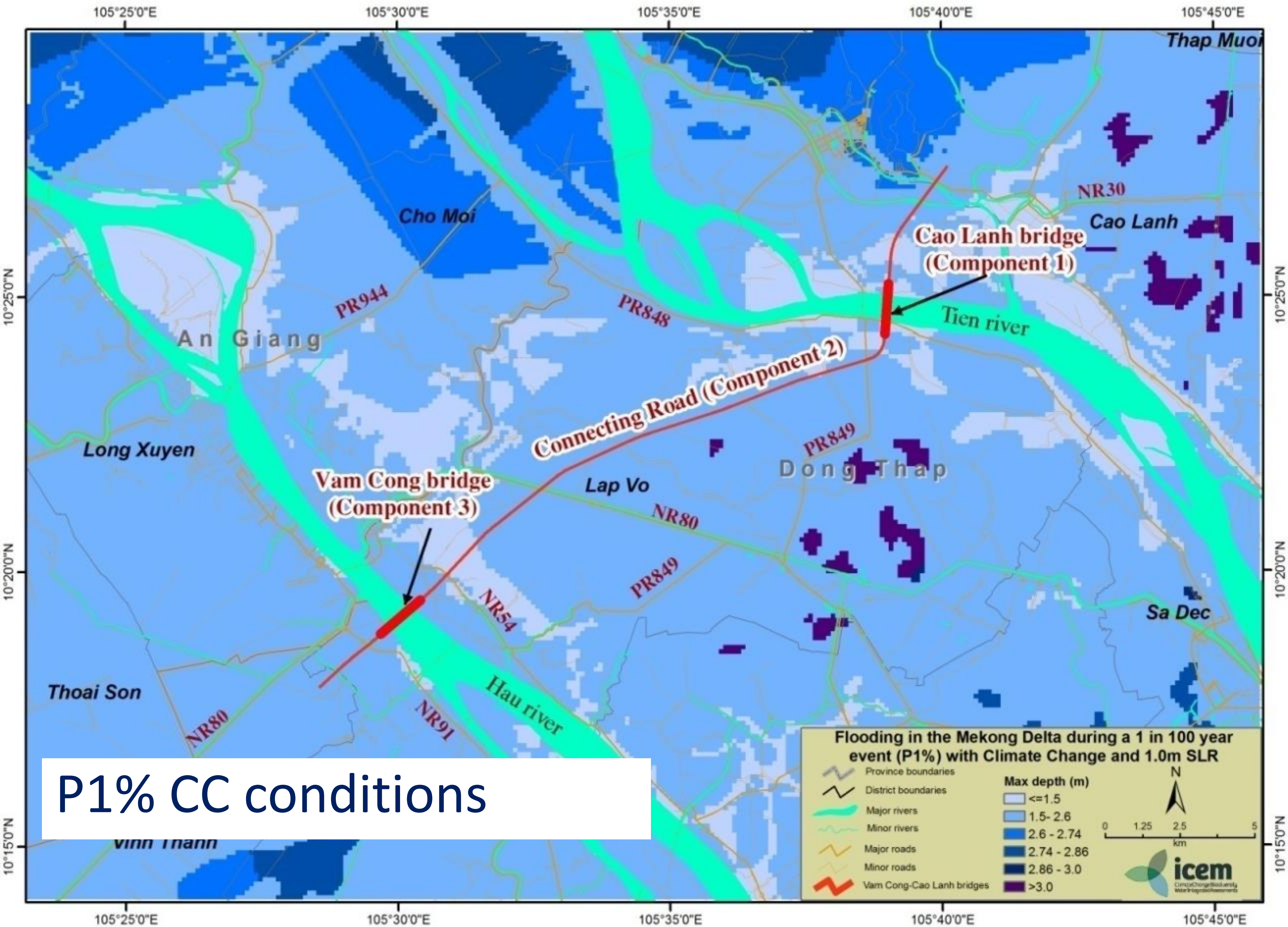
1. **Two cable stayed bridges to replace current ferry services (combined length of 5.4km);**
2. **25-km highway link between the two bridges**

Design Constraints

- **Navigational Constraint** (Mekong River Commission): must allow passage of 10,000 DWT vessels upriver to Phnom Pen port – minimum navigational clearance of 37.5 m for the P_{05} (5%) annual flood (approximately equal to the 2000 event – 2.6 masl)
- **Connector roads**: minimum elevation of road profile must allow passage during P_{01} (1%) annual flood; with 0.5 m freeboard to accommodate overflow and wave action from upstream flood plain
- **Bridge crossings**: must allow navigation clearance for the P_{05} (5%) annual flood
- **Flood conveyance**: culverts must enable conveyance of P_{01} (1%) annual flood

P1% baseline conditions

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10°15'0"N
Thap Muoi
Cho Moi
NR30
Cao Lanh
Cao Lanh bridge
(Component 1)
PR944
PR848
Tien river
An Giang
Connecting Road (Component 2)
Long Xuyen
PR849
Dong Thap
Vam Cong bridge
(Component 3)
Lap Vo
NR80
PR849
NR54
Sa Dec
Thoai Son
Hau river
NR91
NR80
Vinh Thanh
P1% CC conditions
Flooding in the Mekong Delta during a 1 in 100 year event (P1%) with Climate Change and 1.0m SLR
Province boundaries
District boundaries
Major rivers
Minor rivers
Major roads
Minor roads
Vam Cong-Cao Lanh bridges
Max depth (m)
<=1.5
1.5- 2.6
2.6 - 2.74
2.74 - 2.86
2.86 - 3.0
>3.0
N
0
1.25
2.5
5
km
icem

Calculation of Climate Adaptation Finance

The climate risk and vulnerability analysis (CRVA) evaluated 14 specific hydro-climate threats associated with climate change and 13 structural components of the project encompassing:

- **Bridge sub/superstructure,**
- **Approach & connecting roads,**
- **Embankments & road foundations**
- **Flood protection/drainage infrastructure**

The most critical impact (vulnerability) was found to be the likely changes in design flood elevations relative to road embankment design elevations.

Total project finance: $860 million.

Climate adaptation financing estimated at $4.5 million

Transport Sector Example, 2017 MDB Report

Brief Description of Project: Rehabilitation of three main sections of National road network (around 52 km) in order to improve climate resilience. Other objectives are to support ongoing reforms aimed at improving service quality and cost recovery.

Climate Vulnerability Context: The country is projected to experience temperature increases and greater precipitation variability including increased frequency of heavy precipitation events. This increases risks of flash flooding, erosion and landslides.

Statement of Purpose or Intent: “The project aims to increase the climate resilience of the road network by incorporating climate change adaptation measures into the road rehabilitation and upgrade.”

Project Activities: Activities include structural measures such as increased drainage capacities, reinforced road embankments and altered bridge designs, to avoid worsening erosion and increased frequency and severity of landslides. Non-structural measures include improved maintenance routines.

Estimation of Adaptation Finance: Total MDB finance for tranche 1 (of 3) is 10 million Euro, of which 66% (6.6 million Euro) is counted as adaptation finance. Adaptation measures include rehabilitation and strengthening of highly vulnerable road segments and supporting walls; improved drainage and reducing scour at bridges.

Transport Sector Example, 2015 MDB Report

Brief Description of Project: The project aims to enhance the connectivity of selected national and regional roads and to improve the Government's capacity for road safety and climate resilience.

Climate Vulnerability Context: Increased risks of erosion and landslides due to sudden short heavy rainfall. Assessment of vulnerability was conducted through review of available literature and country documents.

Statement of Purpose or Intent: "The project includes consideration of climate adaptation in the design of road works to ensure the construction of proper drainage systems on the roads, therefore increasing their resistance to flooding. Climate resilience is also included at various points throughout the project's results indicators."

Project Activities: One component involves civil works specifically identified as necessary to build climate resilience to erosion and landslides on selected locations of the road network. Another component involves institutional and technical assistance to evaluate additional resilience enhancing measures, and to prepare guidelines for the road agency to consider resilience in design of road works.

Estimation of Adaptation Finance: Components described above are combined to total the incremental costs of adaptation for the project at $3.07 million, or less than 1% of total project commitment. Both line item and proportional approaches are used.

Transport Sector Example, 2013 MDB Report

Brief Description of Project: The project aims to enhance connectivity across provinces through the construction of two major bridges, a road connecting the two bridges, and approach roads.

Climate Vulnerability Context: The project is located in a coastal area highly vulnerable to climate change. Projected regional changes in climate include increased intensity of precipitation, higher storm surges and sea-level rise. These changes would result in increases in both the magnitude and frequency of floods and storms, and greater seasonal variability in weather patterns in the project area. Projected impacts included: (1) erosion of road embankments and scour of road foundations; (2) water logging of road foundations leading to road subsidence; (3) reduced stability of infrastructure; and (4) increased maintenance effort.

Statement of Purpose or Intent: The findings of the climate risk and vulnerability assessment fed into the design of the infrastructure. The project's technical designs include climate change adaptation measures such as increased height for road embankments and larger clearance for bridges to reduce climate change risks on the project.

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Transport Sector Example, 2013 MDB Report

Project Activities:

- Additional embankment volume. During the first phase, a nominal increase of 0.30 m in finished road level for low-lying stretches of the road was considered adequate for the medium term; in the long term, beyond a 30-year horizon, a second phase of adaptation would be considered as part of further maintenance and road upgrades and expansion;
- Additional area of ground treatment due to increased width of embankment;
- Additional length of culverts due to increased width of embankment;
- Additional height of abutments and piers of six bridges

Estimation of Adaptation Finance: The additional cost of adaptation measures was estimated at USD 4.5 million or 0.5% of project cost.