World Bank

Incorporating Climate Adaptation

Task 4: Performance Metrics

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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1 Introduction

The World Bank is conducting research with the objective of developing guidelines to assess, assign and price the risk of climate change in Performance-Based Contracts for roadways. Part of this work includes the development of performance metrics for the incorporation of climate risk considerations into the project design and development. This memo highlights recommendations of how climate risk could be assessed and incorporated into existing practices in a way that will allow it to be measured and tracked.

2 Climate Risk

Climate risk is difficult to identify, quantify and predict over the life expectancy of a project. In addition, standard engineering practices require the use of historic climate data to inform design decisions. The increasing frequency of extreme events has called into question this practice and has caused many infrastructure investors and owners to incorporate some aspect of future climate risk into their designs. The challenge becomes finding the balance between over-designed and under-designed solutions.

Based on industry examples and workshops with both the World Bank and the Asian Development Bank, the recommendation is to incorporate climate risk on a sliding scale, relative to the criticality of that particular roadway. For critical roadways, projected climate impacts from the high emissions scenario (e.g., RCP 8.5) would be adopted; a less critical roadway would be designed using the climate projections of a lower emissions scenario (i.e., RCP 4.5 or 6.0). In other words, for a roadway that has national significance, we would propose using the precipitation values that are project under RCP 8.5 to inform the subsequent design storms.

Determining Asset Criticality

Usage Definition

Economic
Does this road
- Connect commercial hubs?
- Serve as a route for goods?
- Provide access to employment?

Redundancy
- Is there another road/alternative route nearby?
- Will any community or resource be isolated by road loss?

Volume
- Revenues
- Average Daily Trips
- Level Of Service

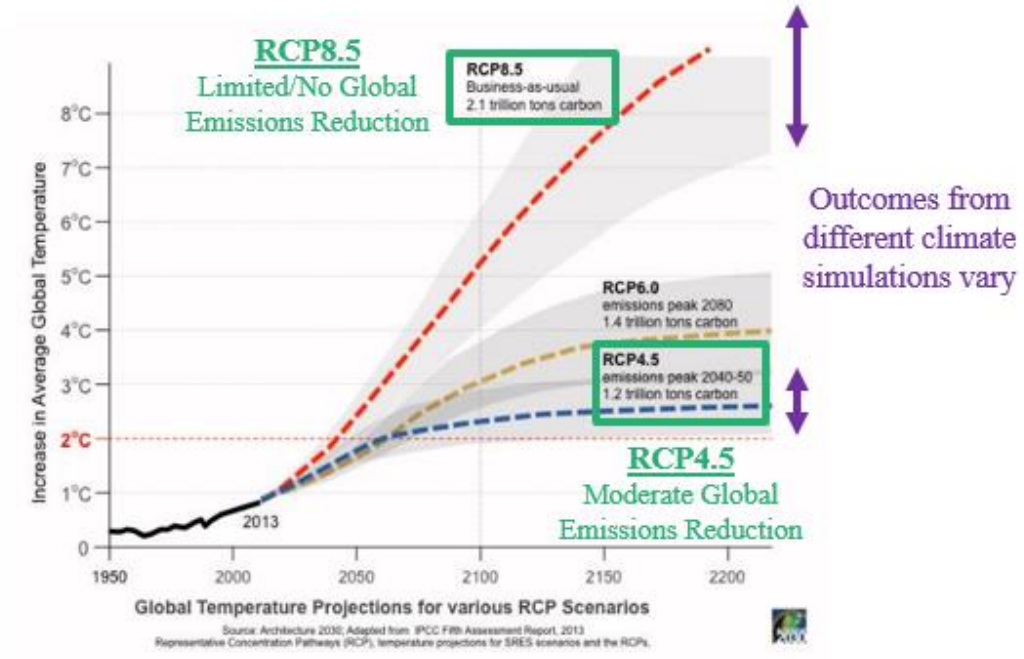
Class
- Local only
- Collector road
- Regional
- National

Social
Does this road provide direct access to
- schools?
- hospitals?
- daycares, eldercare or related facilities?
- police or fire stations?

Infrastructure
Does this road provide direct access to significant
- energy utilities (e.g., substations)?
- telecomm utilities?
- water utilities?
- wastewater utilities?

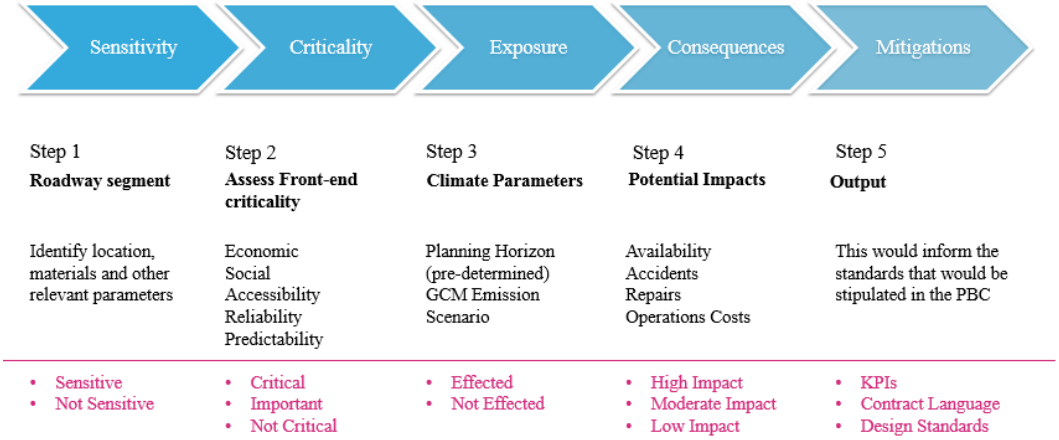
Significance
Is this roadway of regional or national significance?
Does this road provide direct access to significant
- community or cultural resources?
- parks or recreational areas?

How Different Emission Scenarios affect Design Inputs



The planning horizon for assessing climate risk (i.e., how many years to project into the future) would need to be determined at the start of the project and could be as little as 10 years, paralleling the length of the overall investment, or as long as 30-50 years to adequately account for the life expectancy of that particular asset. The graphic below summarize the key decisions for those considerations.

Identifying and Assigning Climate Risk



3 Performance Metrics for Climate Risk

All of the criteria listed below are currently used to assess roadway performance and will be directly impacted by climate change.

World Bank Roadway Climate Change Key Performance Indicators (KPIs):

- Flooding
- Erosion
- Scour
- Pavement cracking/potholes
- Asphalt wear
- Street Light deterioration
- Metal corrosion
- Landscape damage
- Paint peeling
- Paint melting
- Salt damage from snow treatment
- Snow plow damage
- Increased costs of snow removal
- Mechanical failure from increased pumping
- Increased drainage maintenances
- Electrical failures
- Camera failures
- IT failures
- Increased accidents due to storms
- Wall/tunnel damage from increased accidents

- Railing failure
- Fire damage
- Demand change due to lifestyle changes
- Embankment failure
- Debris Damage

User-based KPIs:

- Travel time increases
- Level of service decrease
- Capacity decrease
- Delay increase
- Decreased accessibility
- Sun exposure
- Heat exhaustion
- Network reliability
- Road closures
- Expenditure on transport (increases due to road quality, mode shift, delay)
- Travel mode availability

We propose no significant change to either the metrics that are currently used to assess performance of roadways or the metrics used to assess how well a particular contract is performing. The metrics to measure performance remain the same – what changes is the requirement that those metrics are expected to be met in the midst of climate risk. The contracting process would explicitly state that climate risk is be included as part of the design considerations and the World Bank would indicate the projected values for precipitation, sea level rise, temperature, wind and other considerations based on the process outlined in Section 2.

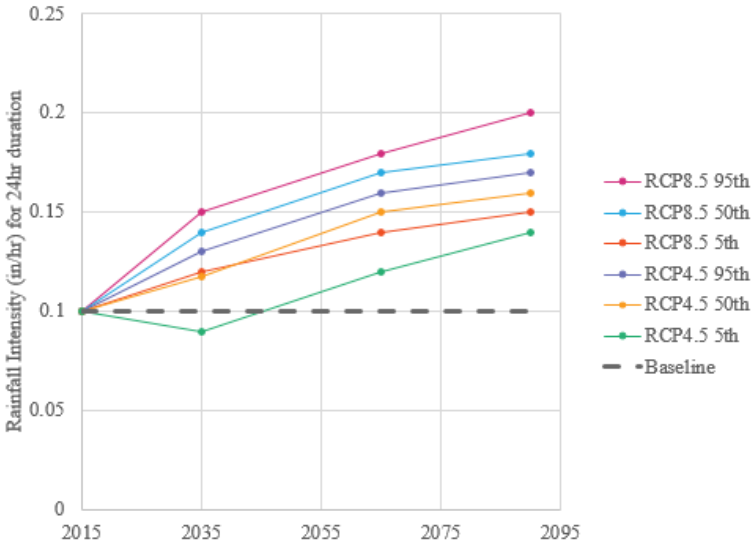
Below is an example of how climate risk would be incorporated into the existing metric of Availability Performance and how it could affect the overall performance of a project.

Climate Impact on Availability Performance

Availability Criteria
- Impassable days per year
- Reduced Service days per year
- Accidents per year
- Cracking / Potholes per square meter

Climate Impacts
- Inundated roadway – flood depth
- Inundated roadway – flood duration
- **Inundated roadway – rainfall intensity**
- Visibility impaired – rainfall intensity
- Ponding on roadway – rainfall intensity
- Ice on roadway – freezing temperatures
- Snow on roadway – winter storms

Identify Correlations with Design Specs
- Intensity vs. Runoff Rate
- Minimum temp vs. Freeze Index
- Maximum temp vs. Heat Index



By adopting this approach, there is an equitable sharing (and risk reduction) between the World Bank and the Contractor. The world Bank has the responsibility for determining the overall criticality of the roadway and assigning the appropriate climate projections for design inputs. This information is made available to the potential bidders in the initial Terms of Reference (TOR). That risk is then transferred to the contractors as another consideration that must be accounted for in the overall design and ultimate performance of the project. The one aspect that the World Bank and the Contractor may wish to negotiate on is the overall length of the planning horizon. This may be especially useful in the early years of adoption to lessen feelings of "additional burden" on behalf of the Contractors and to allow for both sides to hone and streamline the overall process.