PROJECT CLIMATE RISK ASSESSMENT AND MANAGEMENT: SUBPROJECT 1

I. Basic Project Information

Project Title:	National Road Development Project, Subproject 1
Project Cost ($million):	$199.81
Location:	Republic of Uzbekistan
Sector:	Transport
Theme:	Road Transport
Brief Description:	The proposed National Road Development Project will enhance regional integration and inclusive economic growth in the Republic of Uzbekistan by improving efficiency and safer movement of goods and people on an approximately 106.4-kilometre (km) section from Derbent to Denau. The Project will upgrade the existing two-lane road, which is presently highly deteriorated, for an extended service life of 20 years. Currently the road is two-lane with little in-built safety features. The project crosses through diversified topographic relief in areas with a combined summer-hot-semi arid to humid climate with Mediterranean climate-like influences according to Köppen.[1] The region is therefore expected to experience possible future worsening of the extremes and a shift in average temperature highs with increased frequency of periods of draught followed by intense precipitation. The possible main repercussions of these events on the road infrastructure would be the following: 1. Rapid saturation of the embankments and subgrade, 2. Salinization of flat areas, 3. Rapid saturation and mobilization of unconsolidated colluvium on slopes, 4. Rapid melting of ephemeral snow accumulation and progressive melting of the ice caps in mountain regions, 5. Erosion of piers' caps in bridges crossings.

II. Summary of Climate Change Finance

Project Financing		Climate Finance	
Source	**Amount** ($ million)	**Adaption** ($ million)	**Mitigation** ($ million)
Asian Development Bank			
Ordinary Capital Resources (regular loan)	168.240	7.920	0.320
Government of Uzbekistan	31.570	0.330	0.016
Total	**199.810**	**8.250**	**0.336**

Source: Asian Development Bank.

III. Summary of Climate Risk Screening and Assessment

A. Sensitivity of project component(s) to Climate/weather conditions and sea level	
Project component: • The design of bridges and culvert features • Design of concrete pavement (including embankments)	**Sensitivity to climate change:** Consider: future risk of flooding, salts induced corrosion, blockage, scouring, etc. Consider: excessive future excessive thermal stresses on pavement, future risks of loss of bearing capacity with rapid saturation after draught, salts crystallization, active loads from gravity flows
1. The Project is located in the Surkhandarya region and characterized by a variety of climate conditions which can be aggravated by climate change. The project runs through the foothills of Boysuntau ridge and the southwestern branch of Gissar range having elevation of 4,000 m above sea level with hydrological and hydrogeological cycles depending on ice-caps melting rates and depending on precipitation. 2. Controlled drainage in this area is required not only to protect the surface and groundwater and maintain existing drainage patterns, but also to avoid over-wetting the underlying soil and materials from which embankments are reconstructed, which could lead to slope instability. 3. Floods, mud & debris flows caused by the extreme precipitation events and sudden snow melt may affect the bridge foundations and exert direct pressure on embankments.	

[1] World Bank. *Climate change knowledge portal* (accessed 12 November 2021).

4. More intense floods in combination with mud-floods carrying significant amount of coarse solid load may block the drainage structures and lead to overflowing onto the pavement, and to erosion as well as to siltation of surrounding areas due to insufficient capacity of culverts and drains.

5. The incremental costs to respond to the potential impacts of climate change will be calculated during the preparation of the detail design.

B. Climate Risk Screening

Temperature (thermal effects)	• Uzbekistan may experience an increase in average temperature in the next decades estimated to be up to twice the average expected increase globally (from 2-3°C to up to 4-5°C in the hottest months). Exposure to repetitive higher-than-average highs and to lower-than-average lows will cause abnormal contraction and expansion pavements (fatigue cracks and blow-ups)
Precipitation (moisture effects and conditions for rapid saturation)	• Rapid saturation of the embankments and subgrade following prolonged draught will cause softening and loss of resilient modulus of subgrade, sub-base, and slope instability of embankments by increased pore pressures; • Rapid saturation of relatively dry surface layers of unconsolidated colluvium on slopes will potentially cause gravity induced phenomena such as mud flows and debris flows; • Mud flows and debris flows may, depending on the size and grain size, directly exert active loads on the road infrastructure (bridges, embankments, pavement) or they may cause blockage of drainage systems (culverts, etc); • Rapid melting of ephemeral snow accumulation and progressive melting of the ice caps in mountain regions may become additional loading factors to water/mud/debris related geo-hazards; • Erosion of piers' caps in bridges crossing rivers at risk of very high solid transport during extreme events.
Salinization (physical-chemical-mechanical effects)	• Salinization of flat areas caused by severe draught with capillary rise within the pavement structure may cause deleterious cracking of concrete for salts crystallization and corrosion of reinforced concrete structures because of exposure to wet/dry cycles with saline water.

Climate Risk Classification: Medium

(i) **Climate risk and adaption assessment**

A climate risk assessment and management were conducted during project preparation on the basis of the modelling prepared during the preparation of the Initial (1999), Second (2007) and Third (2016) National Communications for United Nations Framework Convention on Climate Change. Afterwards with simulation of CIMP5 the findings were verified with downscaling to the project area. The key results from these scenarios include:

(ii) In Surkhandarya region the mean temperature might increase as follows: in the spring around 0.5-2.0 °C, in summer up to 1.5-2.5° C, in autumn up to 0.5-2.0° C, in winter up to 1.5-3.5° C, for the period from 2041-2060 compared to the baseline period from 1986 to 2005. The maximal temperature may increase in the range from 1.5 to 3.0°C and the minimal temperature might increase from 1,5 to 2.0°C.

(iii) On average, within the territory of Uzbekistan, the duration of the frost-free period will increase by 8-15 days. The dates of the temperature transition will occur 5-10 earlier days in spring, and in autumn this transition will occur 5-15 days later. The effective air temperature will increase by 5-10 %[2]. Downscaled information on these parameters is not available.

(iv) The 1-day maximum precipitation is a very important indicator as the most the project area is prone to mud-flows and landslides. Usually in the region they are triggered by extreme continuous raining events due to combination of geomorphological, geological and hydrological factors. Depending on the project location it is anticipated rain precipitation to increase by 2-5 mm/day over the period from 2041 to 2060 compared to base-line period from 1986-2005. The relative increase will be of about 10%, while annual precipitation volume for Uzbekistan and the adjacent mountain territories are expected to be in excess of 100% to 120% of the historical averages.

The road project adopts two types of cross-sections: one for the 2-lane road outside of settlements, and 4- and up to 6- lane road sections within the villages, with road featuring 3.75-meter (m) traffic lanes with adjacent shoulders featuring a configuration of 0.75 m paved and 3.00 m unpaved. The road will be made with concrete and widening of the embankment will be designed in both one-sided and two-sided options. The project will include bridges as well.

The concrete pavement has also been designed by taking into account the rise of temperature and possible intensification of thermal extremes between summer and winter, as well as the risk of potential temporary submersion under water due to increased precipitation.

The adaptations conducted during the design stage are: (i) use of concrete pavement for the most of the project alignment, due to the higher resilience to climate change of this material; (ii) strengthening of embankments to protect against flooding; widening of culverts and bridges to avoid backwater; and (iii) erosion control measures.

[2] The Initial National Communication of Uzbekistan under the UNFCCC.

C. Climate Risk Screening Tools and/or procedures used
The following screening tools have been used for the screening: • KINMI Climate Change Explorer with CMIP5-Climate Model Inter-comparison Project • ADB Preliminary Climate Risk Screening Checklist. • UNEP Preview Data Platform • World Bank Group Climate Change Portal

Source: Asian Development Bank.

IV. Climate Risk Management Response within the Project

Preamble

1. The climate risk management response should include different sources of mitigation in view of the global effort initiated by the Paris 2015 agreement and continuing to-date with the progressive refining of GHG emissions models requiring a strong reduction of CO2 by 2030 with tentative carbon neutrality by 2050. In order to meet the GHG limits for a road project, however, it should be considered a summation of contributing factors that may be summarized below, and that strongly depend on the level of technology and awareness developed by the country where the mitigations are proposed.

2. First, the actions to reduce carbon footprint should be considered.

Materials and construction technology related factors

i. Use of sustainable materials to build the new infrastructure such as: use of recycled aggregates as source of construction materials, use of low clinker content[3] cementitious materials for rigid concrete pavement construction, use of warm asphalt technologies for flexible pavement construction, use of green solutions to build reinforced earth embankments and slope protection minimizing the use of high carbon footprint construction materials such as plastics, polymers, etc.
ii. Use of sustainable construction solutions such as: minimizing the dosage of binders in the asphalt concrete or concrete, reducing transport logistics for construction materials (proximity of quarries, in situ recycling of existing pavement, etc.).
iii. Use of pavement solutions with the most suitable performance in the climate of the region to minimize ordinary maintenance and extend service life.

Government policies related factors

i. Introduction of modern specifications contemplating and endorsing the design, production, placing of sustainable road construction materials.
ii. Promoting education among engineers/contractors on sustainability of construction.
iii. Maintaining the international roughness index (IRI) of pavements as low as possible (i.e., resurfacing and/or building new pavement to the highest smoothness standards) as high roughness indices promote fuel consumption.
iv. Limiting the overweight on roads.
v. Removing progressively old trucks and vehicles from traffic fleets.

3. Then, the actions to limit temperature increase locally and absorb part of the CO2 emitted by the road infrastructure in service should be considered such as:

i. Use of light colors (i.e., light grey concrete pavement as opposed to dark/black asphalt pavement) to increase reflectivity of surfaces and reduce locally forming heat-islands.

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[3] Approximately for each ton of clinker, 0.8 tons of CO2 are produced.

ii. Plan suitable plantations across the road to maximize absorption and reduce, locally, air temperature.

4. When the above list of direct or indirect mitigation strategies are contextualized to the case of Uzbekistan it is clear that not all of the above, in fact only a few of the above, are presently doable mitigations. This is because the country needs first to reach sufficient modernity in the way projects are planned, executed and maintained to meet the present-day ever more stringent targets in terms of GHG emissions and control of temperature rise. For instance, promoting the use of recycled aggregates and sustainable designs cannot be put in practice until the entire set of technical specifications and rules for construction in the country are modernized.

5. Because of the above constraints there are only some (in fact, realistically speaking, very few) mitigations/preventive measure that can be taken, presently, in this road project and they should focus on achievable targets, such as detailed below. Only by raising, at a very fast pace, the technology and awareness level in the country[4] it will be possible to maximize actions for future road projects by combining all of the above strategies for the overall result of a more tangible GHG emissions reductions plan.

Adaption activity[a]	**Target Climate Risk**	**Estimated Adaption Costs** ($ million)	**Adaption Finance Justification**
Adaptation of Design to accommodate for future flood events. The measure includes the bridges and culverts crossing irrigation channels of the Project. The proposed culvert outlet diameters will be increased from 0.5 to 1.0 m.	Extended drainage system with larger culvert sizes to reduce the risk of road over-flooding and water ponding along the roads.	0.550	Higher capacity and improved drainage systems will prevent clogging of drains from storm debris, flooding due to higher water volume, and formation of salt residues on the pavement. This preliminary estimate is based on experience in earlier projects with a proportional approach, improved by about 50% This constitutes about .05% of the total civil works contract.
Rigid pavement	The rigid pavement is selected to better resist the rise of mean and extreme temperatures	7.000[5]	The projected increase in temperature is one of the factors for the pavement upgrading from asphalt to concrete. The concrete is not susceptible to softening and rutting due to high temperatures as it is with asphalt pavement. Cement concrete surfaces reflect more heat from sun radiation and ensure lower surface temperatures in summer compared to asphalt, concrete pavements. The cost reflects the estimated difference between the cement concrete and asphalt concrete pavement. Service life of a concrete pavement is generally assumed to be of 30 years[6] as opposed to that of asphalt pavement (20 years) and concrete pavement, when recycled, may provide more aggregates for newly built concrete pavements in the future.

[4] Uzbekistan specifications and design codes are still based on outdated and, certainly, not green building oriented Russian standards.

[5] This amount represents approximate additional cost to build road with C/C pavement in comparison to A/C pavement for the entire project road.

[6] AASHTO: Mechanistic-Empirical Pavement Design Guide.

Provision of larger temperature joints	The road design considers wider expansion joints with soft wood boards at designed interval.	0.100	This type of joints allows for a higher expansion than the traditional contraction joints, cut only in the upper part of the concrete cement slabs to control shrinkage strains. Cost is estimated based on an increment of 100% of the joint filler for about 1200 joints, for an average length joints of 15.2 m (two directions). Average incremental cost per unit length of joint is assumed to be 7.0 USD/m.
Provision of additional slope protection, riprap, gabions and retaining walls.	Erosion relating to extreme rain events	0.100	The additional structure will ensure the road safety and significantly reduce maintenance cost.
Introducing of overloading control (WIM) for heavy trucks	Large changes in temperature	0.500	Since the project area is already exposed to high temperatures reaching as high as 40°C, the projected temperature increases due to climate change may cause buckling, cracking, and expansion joint spalling. This damage may allow moisture to penetrate the pavement which can cause additional damage due to the freeze-thaw cycle. This damage can be exacerbated by overloaded vehicles. The use of the WIM system will ensure truck axle loads remain within the design loading and will help prevent premature pavement failure.

[a] Adaptation activity is subject to acceptance by the Executing Agency.
Source: Asian Development Bank.

V. Climate Mitigation Plans within the Project

Mitigation Activity	**Estimated GHG Emissions Reduction** (tCO2e/year)[a]	**Estimated Mitigation Costs** ($ million)	**Mitigation Activity**
Planting of at least 1,329 of trees and shrubs	The trees will sequester on average **76** tons per year of CO2 over 10 years.[7]	0.400	The trees and shrubs will stabilize surface soils first of all while contributing to creating areas where CO2 can be reabsorbed. Mitigation under afforestation is removal of CO2 through sequestration and its potential can be estimated through study of land area covered, species of trees proposed to be planted by experts in forestry field. It involves estimating above ground and below ground biomass addition in the carbon stocks. A comprehensive study has been carried out for this project comparing two approaches. One, from U.S. Department of Energy[8] and the other one for IPPC[9]. While the first considers more variables and it has been designed for urban and sub-urban settings, the IPPC is more suitable to Uzbekistan but includes less variables. The average projected (balanced) carbon intake by this activity is reported in the column on the side.

GHG = greenhouse gas, tCO2e = tons of carbon dioxide equivalent.
Source: Asian Development Bank

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[8] Method for Calculating Carbon Sequestration by Trees in Urban and Suburban Settings, April 1998, U.S. Department of Energy.

[9] IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, 2003.