

Agência Fiduciária e de Administração de Projetos
Projeto Desenvolvimento do Setor dos Transportes e Proteção Costeira

Grant No.: D 44 60 ST

Assignment Title:

Development of climate resilience of the transport network, through vulnerability assessment and climate-informed road assets management in Sao tome and Principe

Reference No.: 17/C/TCP/2019

The Government of the Democratic Republic of Sao Tome and Principe has received financing from the World Bank toward the cost of the Transport Sector Development and Coastal Protection Project, and intends to apply part of the proceeds for consulting service to Develop climate resilience of the transport network, through vulnerability assessment and climate-informed road assets management in Sao tome and Principe.

The consulting services (“the Services”) include:

- a) Vulnerability Assessment of Road Network;
- b) Climate Resilience and Adaptation Strategy for STP’s Road Network,
- c) Development of Guidelines for Vulnerability Assessment and Work Program of Priority Measures for Road Network;
- d) Recommendations for the development of a resilience Database to enhance the current RAMS used by Roads Department of STP for planning and decision-making

The consulting services is to be implemented in eight (8) months, from September 2020 to April 2021.

The detailed Terms of Reference (TOR) for the assignment can be obtained at the address or email given below.

The Project Administration and Fiduciary Agency (AFAP) now invites eligible consulting firms (“Consultants”) to indicate their interest in providing the Services. Interested Consultants should provide information demonstrating that they have the

required qualifications and relevant experience to perform the Services. The shortlisting criteria are:

- Must have at least 10 (ten) years of relevant experience in Detailed Road Engineering Design and technical specifications;
- Solid knowledge of the institutional and policy process required in the implementation of climate change adaptation measures;
- Must have at least 3 (three) contracts in road design projects in the last 6 (six) years.

Key Experts will not be evaluated at the shortlisting stage.

The attention of interested Consultants is drawn to Section III, paragraphs, 3.14, 3.16, and 3.17 of the World Bank's "Procurement Regulations for IPF Borrowers" dated July 2016 and revised in November 2017 and August 2018 ("Procurement Regulations"), setting forth the World Bank's policy on conflict of interest.

Consultants may associate with other firms to enhance their qualifications, but should indicate clearly whether the association is in the form of a joint venture and/or a sub-consultancy. In the case of a joint venture, all the partners in the joint venture shall be jointly and severally liable for the entire contract, if selected.

A Consultant will be selected in accordance with the Quality and Cost-Based Selection (QCBS) method set out in the Procurement Regulations.

Further information can be obtained at the address below during office hours: **08:30 to 12:00 and 15:00 to 17:00 hours (Sao Tome and Principe local time) Monday to Friday.**

Expressions of interest must be delivered in a written form to the address below (in person, or by mail, or by e-mail) by **August 11, 2020 until 16:00 hours (Sao Tome and Principe local time).**

Agência Fiduciária e de Administração de Projetos
Attn: Mr. Alberto F. Leal, Coordinator
Avenida Kwame N'Krumah
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**CONSULTANCY SERVICES TO DEVELOP CLIMATE RESILIENCE OF
THE TRANSPORT NETWORK, THROUGH VULNERABILITY
ASSESSMENT AND CLIMATE-INFORMED ROAD ASSETS
MANAGEMENT IN SAO TOMÉ E PRÍNCIPE.**

TERMS OF REFERENCE

BACKGROUND

Roads and bridges are key assets for Africa - they connect villages to economic centers, people to hospitals, children to schools and goods to markets facilitating trade. Climate change is expected to increase disruption time of the network, shorten their rehabilitation life-cycle, and increase repair and rehabilitation costs. For Sub-Saharan Africa, it is estimated that climate change will threaten to increase road maintenance costs by 270% in the case of inaction.

The proposed activity aims at conducting innovative climate vulnerability assessments for roads and bridges at the national level for Sao Tome e Principe (STP) to enhance the climate change resilience of the national infrastructure network. This entails a comprehensive methodology for assessing the impacts of climate change on long-lived infrastructure, and for identifying robust investment options that can improve the performance of that infrastructure over a wide range of future climate scenarios.

As a small archipelagic state, STP is particularly vulnerable to climate-related hazards such as floods, coastal/river mouth flash floods, storms and drought episodes. These events are very likely to become more frequent and more intense due to global climate change, have significant impacts on critical sectors such as agriculture, fisheries, and also transport. Most of the national infrastructure (port, airport, the oil reservoirs, hotels) is located in low lying areas along the shoreline, and therefore, directly exposed to the elevation of the sea-level, which, in addition to increased consequences of coastal flooding, exacerbates the coastal erosion. Roads are usually located between this shoreline and the higher slopes, making them exposed to coastal erosion on one side and landslides or rockfalls on the other sides. The drainage systems (natural and human) are often either under-designed

or poorly maintained, causing regular overflow and inundations. The developments in the coastal areas, often based on the plans developed during the colonial period, have not integrated those threats.

OBJECTIVES

The Development Objective of the Technical Assistance is to:

- Develop an effective strategy to reduce climate and disaster risks for STP road network and improve its maintenance, by assessing vulnerability of the country's roads to current disaster risks and future climate change impacts, improving climate resilience planning for future road investment and adapting road assessment management.

To achieve the Development Objective, this assignment will focus on the following four sub-objectives:

- Assessment of the vulnerability of road network assets and development of a prioritized work program of climate resilience measures for the same road network;
- Development of Guidelines for the Climate Change Vulnerability Assessment and Prioritized Work Program of STP's Road Network Assets;
- Development of Guidelines for Climate & Disaster Resilience Audit of road engineering designs and pilot climate & Disaster resilience audit of a road engineering design, and
- Development of the Road Assets Management System with climate change data to improve planning and decision-making processes.

SCOPE OF WORKS

Several countries have already carried out vulnerability assessments of road infrastructures and mapping of vulnerable areas or have made attempts. All of them have been applying different methodologies subject to the availability of data in respective countries. Instead of inventing a new methodology, the Consultants are encouraged to review those methodologies used in other countries and determine if any of them can be adjusted to the context and replicated prior to suggesting a new vulnerability assessment methodology for this assignment.

Task 1: Vulnerability Assessment of Road Network

Sub-task 1.1: Data Collection and Consultations on climate and disasters: The Consultant will gather all available current and historical climate, geological, hydrological and seismological information about STP, including projections of future climate under different scenarios. The Consultant will collect and collate available information about climate threats, climate impacts and climate resilience options relevant to roads and bridges. This data may include rainfall, temperature, geological

information, mudflow, landslide and seismological data. Historical data will provide clues as to how current road infrastructure assets may withstand future climate stressors; while projected climate information would be useful to estimate future climate conditions to plan for.

The Consultant will hold discussions with National Institute for Roads (INAE) and other relevant stakeholder government agencies such as those involved in environmental policy making (e.g. DG Environment), meteorology (National Institute for meteorology) or disaster risk prevention (e.g. CONPREC) to get a perspective of the different types of disaster and climate change hazards and their historical, present and future occurrence, and risk levels.

Sub – task 1.2: Socio-economic data collection and review: The Consultant will collect and review the pertinent demographic and socioeconomic data, to identify the different poles of interest of the network, either because of their social, economic, cultural or overall importance for the country. Hence the Consultant will

- Identify areas with high densities of population, including the most vulnerable people, the most likely to be impacted in case of a disaster
- Collect and review the existing data and Government development plans and identify the location of critical services and major economic activities, existing and planned (including hospital, gas reservoir, civil protection buildings, ports, major markets, schools);
- Undertake a critical assessment of the socio-economic potential of high-risk areas and rank these on a rigorous methodological analysis that the Consultant will propose.

Sub-task 1.3: Inventory of road assets The Consultant will identify relevant road infrastructure assets (including bridges and culverts) for vulnerability assessment and determine which characteristics of these assets are most critical for this vulnerability study. The inventory is expected to include assets which are susceptible to disaster risks and climate change impacts given their location, configuration and use in the transportation network.

Sub – task 1.4: Assessment of criticality of the different road assets: The Consultant will map out the existing road network and assess existing and forecasted traffic data that will help identify critical transport links for local socioeconomic development. The Consultant will identify the transport links that were disrupted in recent severe weather events or considered to be susceptible to disruption during disasters. The Consultant will also assess the impact of loss of connectivity and access to critical services and facilities on the lives and livelihood of vulnerable population and overall economic activities. In addition, the Consultant will identify critical transport links that could serve as important

means of escape, access to emergency relief or for the transport of agricultural or other economic assets. GIS-based maps should be prepared to illustrate at-risk areas as well as critical connectivity links and location of critical services and facilities.

Sub-task 1.5: Assessment of the vulnerability of road assets to climate change impacts and natural hazards based on a multi-criteria analysis: The Consultant may propose and, after validation with the client and consultation with the World Bank, use any methodology for assessment of natural hazard and disaster risks that is appropriate in the context of STP. The Consultant will prepare tools to assess the vulnerability of single road assets to current and future climate events, including methodologies for determining the adequacy of existing and future road assets to resist or adapt to climate impacts. This assessment will include the vulnerability as individual elements, but also the vulnerability as part of the system.

The Consultant is expected to prioritize the vulnerable assets using a multi –criteria analysis. The Consultant should determine a number of criteria of different ranking to assess the vulnerability and impact of climate changes and natural hazards to road assets. Exposure/Vulnerability would consider the connectivity/critically and the link with the size of population, the level of poverty, concentration of critical social services and major economic activities, among other indicators that the Consultant proposes (based on the data collected in previous sub-tasks) that are appropriate in the context of STP. The Consultant should carry out consultations with the client and other stakeholders to agree the respective ranking and weights of the indicators. It is expected that the chosen indicators will include socio – economic metrics. Based on the collected information, the Consultant should prepare GIS-based vulnerability maps and identify areas with higher hazards and exposure/vulnerability risks in STP.

Sub-task 1.6: Assessment of the vulnerability of the road network. In this sub-task, the Consultant will propose a methodology to evaluate the risk of the system as a whole, with estimation of its weaknesses.

Outputs from Task 1:

(i) Results of the vulnerability assessment of STP road network,

Task 2 Climate Resilience and Adaptation Strategy for STP's Road Network

The Consultant will prepare a Climate Resilience and Adaptation Strategy for Cabo Verde's road network based on the analysis from the risk assessment. It will (i) outline

a general climate change adaptation policy framework and objectives for the road sector; (ii) recommend a program of priority investments and other interventions at specific risk locations; and (iii) propose specific policy reforms required to provide a foundation for climate change adaptation and to address disaster and climate-related risks in the road sector. This will be achieved by the following:

Sub-task 2.1 Identify potential adaptation options that respond to the risk assessment and that are technically feasible and appropriate in the context of São Tomé and Príncipe. The analysis should include:

- a) Specific interventions at high-risk locations; and
- b) Measures that can be taken at a national level to reduce vulnerabilities and enhance the resilience of the road network, as described in the following tasks.
- c) Identification of expected outcomes as a result of the proposed potential adaptation options, on the overall vulnerability of the system
- d) Estimation of their costs, both construction and maintenance costs

Sub-task 2.2 Develop a prioritized program of investments at specific locations to improve the resilience of the road network and define the general nature of each of the proposed investments. The priority investments should be grouped into time bands, such as short-term (1-5 years), medium term (5-10 years), and long-term (10+ years), considering the urgency of the required response, the design life of the proposed investment, and a cost-benefit analysis of each investment. The Consultant should propose a methodology to deal with the uncertainty related to climate change projections.

Sub-task 2.3 Review current road planning processes, the institutional and legal framework for the roads and traffic sector (e.g. relevant legislation), national road construction standards, maintenance (routine, periodic, and emergency) methods, and related processes and assess their adequacy in the light of projected climate change and natural hazard vulnerability. The Consultant should recommend suitable reforms, such as (but not limited to):

- a) Embedding consideration of climate change and disaster risk management issues into all road planning processes;
- b) Updating road design standards;
- c) Employing new approaches to road maintenance that take into account climate change and natural hazards; and
- d) Mainstreaming climate change adaptation and disaster risk management into the road sector from infrastructure and operational perspectives.

Sub-task 2.4 Review the institutional framework as relevant to the implementation of the disaster and climate resilience strategy, and recommend specific reforms needed to:

- a) Improve management of traffic and road access during and following natural disasters; and

- b) Enhance quick response procedures to ensure that roads are repaired and restored quickly following severe weather damage.

Outputs from Task 2:

- (i) Adaptation program for STP road network
- (ii) Proposed reforms for standards and procedures to improve climate change mainstreaming in the process

Task 3. Development of Guidelines for Vulnerability Assessment and Work Program of Priority Measures for Road Network

Based on the methodology used in the vulnerability assessment, the Consultant will prepare a clear and practical methodology for updating the vulnerability assessment of road network that can be replicated in the future, without the full modelling. This Guidelines is expected to comprise step-by-step principles for identification and prioritization of climate threats/natural hazard and disaster risks and impacts which INAE can use for any of their road classes. The Guidelines should describe:

- Type and format of data needed for the climate change vulnerability assessment of road assets in STP, including proposed forms (paper and electronic). The data should be compatible with the road assets-based management system
- Recommended methods for mapping, preferably GIS-based ones, of infrastructure assets in vulnerable areas, and inventory of critical assets that are susceptible to climate change impacts;
- Recommended methods for monitoring of asset condition in conjunction with environmental conditions (e.g., temperature, precipitation, winds) to determine if climate change affects performance;
- Methodology for prioritization of risk areas and assets and identification of high risk areas and highly vulnerable assets; the prioritization methodology should be based on a multi-criteria analysis, with various criteria of different ranking to assess the vulnerability and impact of climate change hazards to road infrastructure in STP;
- Methodology for the development of a work program of priority climate resilience measures for vulnerable road assets/at risk areas.

Outputs from Task 3:

- (i) Guidelines for climate change vulnerability assessment and work program of priority climate resilience measures of the road network in STP.

Task 3: Climate Resilience Audit of Road Engineering Design

This Task will focus on the provision of guidance for INAE to ensure that climate resilience and adaptation measures are implemented at projects/contracts levels. Using the information obtained from the task above, the Consultant is expected to prepare a clear and practical Guidelines (methodology) for climate change resilience audit of road designs and existing roads. The results of Task 1 should inform the Consultant which

assets are highly disruptive and time critical¹ that they become the center of a climate resilience audit. This Guidelines Manual should comprise a step-by-step guide to check for climate change adaptation measures in the engineering designs. The Guidelines should be developed in a format that they could be applicable not only for audits of new designs but also for climate resilience monitoring and inspection of existing roads, as well as potential maintenance/retrofitting exercises. The Guidelines should also include the following:

- Guidance on design, construction, maintenance for climate resilience of vulnerable roads and structures;
- Guidance on hydrological criteria to be taken into account in the design of bridges and drainage structures;
- Guidance on engineering and bioengineering measures to counter climate and disaster impacts on pavements, surfacing, bridges, earthworks and drainage structures.

The proposed Guidelines for road engineering design audits should be discussed and validated with INAE engineers and other stakeholders and should be prepared in a format ready for an official approval by the respective government authority in STP.

Outputs from Task 3:

(i) Guidelines for climate resilience road engineering design audit in STP;

Task 4: Enhancement of Road Asset Management System with Climate Change Data

To improve its capacity to implement the adaptation strategy, INAE needs to enhance its Road Asset Management System (Database). This task, to enhance the RAMS should be largely informed by the previous Tasks: what type and format of data and for which assets should be collected, and what collection methods should be used. The Consultant will provide the recommendations on the following:

- Data type and format and for which assets: The Consultant will define the data to be collected at a project and network levels, and will define the structure of the data in a format easily convertible into a geodatabase for compatibility with INAE's current RMS hosted on an ArcGIS server.
- Data collection: The Consultant will define the data collection methods, frequencies, responsibilities, budget and the procedures for updating the database.

¹ For example, the UK Highway Agency's Climate Change Risk Assessment identified the following vulnerabilities as "being highly disruptive and time critical with high level of confidence in the appraisal: (i) First Tier: pavement skid resistance and, identifying best ways of investing resources and investment resources and investment appraisals; (ii) Second Tier: wind actions (loads) applied to superstructures, designs for increased scour for foundations, pavement material integrity, strategic geographic importance of a region, network resilience, budgeting, and staffing; and (iii) Third Tier: Pavement materials specification and construction details, design of pavement foundations, design of bearings and expansion joints, surface water drainage, attenuation and outfalls, pavement maintenance, and flooding." M. D. Meyer, A. Amekudzi, and J. P. O'Har (2010). Transportation Asset Management Systems and Climate Change: Adaptive Systems Management Approach. *Transportation Research Record: Journal of the Transportation Research Board*.

- Data analysis and results reporting: The Consultant will define the methodology to analyze the data and report results to facilitate the selection of the most suitable adaptation measures and inform RD’s multi-year and annual planning processes.

Outputs from Task 4:

(i) Recommendations for the development of a resilience Database to enhance the current RAMS used by Roads Department of STP for planning and decision-making processes.

Task 5: Knowledge Dissemination Workshop

The Consultant will organize a knowledge dissemination workshop to be attended by Roads Department and other relevant stakeholders in STP. At the workshop, the Consultant will present the results of the vulnerability assessment and work program of priority measures for road network, as well as demonstrate how to use the developed assessment methodologies for the vulnerability assessment and work program of priority measures development and the climate change engineering design audit. During the study, the Consultant will hold several workshops to present preliminary results of each task to seek feedback and recommendations of INAE and other stakeholders, prior to the finalization of its main outputs.

Output from Task 5:

Report presenting the results of the dissemination workshop.

ESTIMATED LEVEL OF EFFORT

The level of effort required from the Consultant is currently estimated at 6 months. In addition, the Consultant is expected to *submit three hard copies and three USB copies of each report in both Portuguese and either English or French.*

Deliverables	Requirement
Inception Report	The Inception Report shall be submitted within 4 weeks since the contract commencement. The Inception Report shall summarize the findings related to the existing data and the relevant literature review, presenting an understanding of the assignment and the objectives. It should present an overall approach and detailed program, work plan and completion schedule for the services. It should also discuss constraints and challenges identified by the Consultant and ways to address them in order to timely and effectively deliver the assignment

Interim Report 1	Interim Report 1 shall be submitted within 3 months since the contract commencement. The report shall present outputs from Task 1 which will include the following: (i) Results of the vulnerability assessment of STP road network, and (ii) Work Program of Priority Climate Resilience Measures for the same road network.
Interim Report 2	Interim Report 2 shall be submitted within 4 months since the contract commencement. The Report will present outputs from tasks 2 and 3 the scope of works, which will include the following: <ul style="list-style-type: none"> • Guidelines for climate change vulnerability assessment of and work program of priority climate resilience measures for the road network in STP; • Guidelines for climate resilience road engineering design audit in STP; • Recommendations for the development of a Climate Change Database to enhance the current RAMS used by Roads Department of STP for planning and decision-making processes.
Draft Final Report	The Draft Final Report shall be submitted no later than 5 months since the contract commencement, and incorporate Bank's comments as well as the feedback received from the RD and other stakeholders on the previous Interim Reports. The Report shall present the revised outputs for Tasks 1, 2, 3, and 4.
Final Report	The Final Report should address comments on the Draft Final Report and feedback from the knowledge dissemination workshop. The Final Report should be submitted within 1 week after receiving the feedback from the Dissemination workshop and World Bank's comments and no later than one week before the expiration of the contract for these services.

All the data collected, acquired or produced during this consultancy will be transferred to the Government of São Tome and Principe in a standard format, with completed metadata.

REQUIRED SKILLS/ EXPERIENCE

The assignment is expected to be executed by a firm or a team of Consultants with the following competencies:

- Detailed Road Engineering Design and technical specifications;
- Climate change hazard assessment and adaptation;
- Extensive international experience on road projects;
- Solid knowledge of the institutional and policy process required in the implementation of climate change adaptation measures;

- Excellent ability to consult with key decision makers and stakeholders in the road sector, relevant ministries, municipalities, environmental agencies, NGOs, and communities; and
- Fluency of the Portuguese language is required.

Consulting firms are encouraged to develop their own methodology as well as the staffing plan, level of effort and work approach to accomplish the TOR. This technical assistance assignment will require the firm to staff an appropriate mix of highly qualified international and local staff. An example of possible key team members may include a number of, but not necessarily limited to, the staff noted below. Where key experts proposed by firms do not have experience in small island countries, it is expected that they would be assisted by non-key experts with such experience. It is up to the firm to propose which of the staff on its team is Team Leader, among the positions: Road Engineer; Disaster Risk Assessment Specialist; Climate Change Specialist; Economist. That individual will have overall responsibility for the direction, technical excellence and successful completion of the project and must have at least 15 years of Project Management experience having leadership qualities in addition to the requisite qualifications of one of the key staff positions noted below.

Key Staff	Qualifications	Experience
1. Economist	Master's degree in Economics required, PhD preferred.	At least 10 years of experience in micro-economics. Experience with statistical modeling. At least 3 years of experience in similar studies, preferably in small island countries.
2. Road Engineer	1 st degree in civil engineering, with post-graduate qualification in roads-related discipline.	15 years or more experience in the field of road engineering, out of which a minimum 7 years of post-graduate experience in roads and drainage design in small island states. Some Climate Change Adaptation and/or Disaster Risk Management-related project experience preferred.
3. Climate Change Specialist	Master's degree in climate sciences, urban planning, or related field is required.	Minimum of 8 years of experience working on climate change; at least 3 of which should be with a developing country or emerging nation, preferably in a small island country.

4. Disaster Risk Assessment Specialist	Bachelor's degree in Civil Engineering, Urban Planning, Geology or other relevant Disaster Management subject required as well as a relevant post graduate qualification.	Minimum of 8 years of experience in the fields of natural disaster assessment, mitigation and remediation; at least 3 of which should be with a developing country or emerging nation, preferably in a small island country.
5. Engineering Hydrologist	Bachelor's degree in Hydrology, Physical Geography, Earth Science, Engineering, or Environmental Science required with a strong focus on hydrology. Preferably Master's degree.	At least 7 years relevant experience in engineering hydrology including 3 years of experience of hydrodynamic analyses and modelling, flood risk assessment with hydrologic modelling software. Some CCA and/or DRM-related project experience preferred.
6. Lawyer / Policy Specialist	JD, LLB, LLM or equivalent preferred. Alternatively, individuals with Master's degree in relevant discipline with at least eight years' experience in policy and legal reform and regulatory issues may also be considered.	At least 8 years of experience in policy and legal reform and regulatory issues on road sector.
7. GIS/Mapping Specialist	Bachelor of Science or Engineering Degree required.	Minimum of 8 years of GIS experience and experience working with various data formats such as CAD, GPS, etc. Knowledge of environmental resource management, transportation, or geography strongly preferred.
8. Environmental Specialist	At a minimum, a Bachelor's degree in science or engineering discipline (Biology, Chemistry, Geology, Civil or Chemical Engineering).	At least 8 years of experience in positions requiring proficiency with the analysis and application of environmental regulations; skills in the application of environmental and technical concepts is also required. At least 3 years'

		experience in similar studies preferable in small island countries.
9. Social Development Expert	Master's degree in a relevant field such as sociology, anthropology, urban planning, or other social sciences.	At least 8 years of relevant social development experience and proven track record in working on projects covering a broad range of resettlement and social development issues. Experience working in small island countries preferred. Having good knowledge of World Bank policies and framework for social development.

ESTIMATED SCHEDULE

It is expected that the study will be completed within eight months of commencement.

MANAGEMENT AND LOGISTICAL SUPPORT

The Consultant will report directly to INAE and AFAP

The logistics (Displacements and offices), will be the consultant responsibility.

- (i) Data and Information: The client will provide unimpeded access to relevant data and information to assist the Consultant in this project on an “as available” basis. This includes maps, execution projects/designs, list of urgent works and respective contractual pieces, and access to the road database. The documents produced by the Consultant including reports, drawings, software, data, models etc. will be the exclusive property of the Road Institute.
- (ii) Counterpart personnel: The GoSTP will provide a local liaison officer, who will liaise with local communities and vulnerable persons on matters concerning the project field work and related matters. The Road Institute will also facilitate contacts with relevant stakeholders.
- (iii) Office accommodation and logistics: The mission will take place in the Road Institute headquarters, during which the Road Institute will facilitate a room for the Consultant’s work. The Consultant shall be responsible for providing all accommodation, computing, software, and drafting equipment, etc. The Consultant will also be responsible for all land transportation arrangements during the project.
- (iv) Capacity building: The Consultant will do their best to pass on knowledge to the Road Institute engineers and other staff by training and advising in a hands-on manner.

PAYMENT SCHEDULE

The following percentage payments will be made on approval of the respective reports

Deliverables	Percentage of contract price to be paid
Inception Report	10%
Interim 1 Report	25%
Interim 2 Report	25%
Draft Final Report	20%
Final Report	20%

USEFUL PUBLICATIONS

The following are the materials which the Consultants are recommended to review or consult when starting this assignment:

- Ingerop, NOVEC, ACTERRA Environment Climat (2015). Adaptation of Roads to Climate Risk and Climate Change in Morocco. Final Report.
- E. Jenelius, Road Network Vulnerability Analysis of Area-covering Disruptions: A Grid-based Approach with Case Study. Transportation Research Part A 46.
- E. Jenelius, T. Peterson, and L.-G. Mattson (2006). Importance and Exposure in Road Network Vulnerability Analysis. Transportation Research Part A 40.
- M. D. Meyer (2006). Design Standards for U.S. Transportation Infrastructure: The Implications of Climate Change. Georgia Institute of Technology: Atlanta, Georgia.
- M. D. Meyer, A. Amekudzi, and J. P. O’Har (2010). Transportation Asset Management Systems and Climate Change: Adaptive Systems Management Approach. *Transportation Research Record: Journal of the Transportation Research Board*.
- S. Muzira, M. Humphreys, and W. Pohl. 2010. Georhazard Management in the Transport Sector. Transport Note TN-40. World Bank: Washington, DC.
- . Disaster Risk Management Working Paper Series No. 9. World Bank: Washington, DC.
- S. Sadek, R. Ramadan, and H. Nagi (2005). A GIS-based Landslide Hazard Framework for Road Repair and Maintenance. American University of Beirut.

Some Presentations

- Adapting Road Infrastructure to Climate Extremes and Change: Experience from Small Pacific Island States. September 2015.Presentation.
- Bhutan: Improving The Resilience and Affordability of Roads and Bridges. Presentation. 2015. World Bank: Washington, DC.
- Prevention is Better than Cure: Bioengineering Applications for Climate Resilient Slope Stabilization of Transport Infrastructure Assets. Presentation by A. Faiz, B.H. Shah, A. Faiz. 2015. *First International Conference on Surface Transportation System Resilience to Climate Changes and Extreme Weather Events*. Washington, DC.
- Prioritization of Transport Infrastructure Investments under the Belize Climate Resilience Investment Project. Presentation. 2016. World Bank: Washington, DC.

