ASSESSING THE SCOPE FOR GREEN ROADS
DANGARA-GULESTAN A358 ROAD

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30 March 2024
Draft for comments

1. Introduction

This is an assessment of the opportunities to turn the Dangara-Gulestan Road into a Green Road, identifying opportunities both in the investments in and around the road and in the modalities of implementation.

Roads are vital for the economic and social development of countries. They link people, markets, and services, and facilitate movement and access. However, roads also have significant environmental and social externalities that need to be addressed. For instance:

- **Climate change**: Road transport is a major source (18%) of global energy related CO_2 emissions and has been leading the increase in carbon emissions in recent decades[1]. Across world regions, growth in transport sector emissions is highest in Asia, driven largely by growing demand in road passenger and freight transport.[2]

- **Water resources**: Road development can alter the natural hydrology of landscapes, causing springs to dry up in mountain areas, waterlogging to increase in coastal areas, and floods to be amplified as roads disrupt the natural drainage. Roads are also estimated to increase erosion in catchments by 12-40%, which affects soil fertility and water quality[3].

- **Biodiversity**: Road development can fragment and degrades habitats of wildlife, plants, and insects. Roads are among the top three causes of animal mortality in many countries, and also facilitate the spread of invasive species and diseases.

- **Quality of life**: Road development has various impacts on the well-being of people. For example, dust and vehicle emissions associated with road development and use can have major impact on air quality. The Asian Transport Outliik estimates that 76% of the global fine dust (PM2.5) deaths come from Asia and the Pacific. Roads also contributes to urban heat islands, which raise temperatures in cities and affect human health and comfort.

- **Material consumption**: Road development consumes a large amount of construction materials, which account for 30-40% of all the materials used in construction projects.

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[1] Liu, N., Wang, Y., Bai, Q., Liu, Y., Wang, P. S., Xue, S., ... & Li, Q. (2022). Road life-cycle carbon dioxide emissions and emission reduction technologies: A review. *Journal of Traffic and Transportation Engineering (English Edition)*. https://www.sciencedirect.com/science/article/pii/S2095756422000587#bib54

[2] M. Crippa et al. (2020), Fossil CO2 Emissions of All World Countries, JRC Science for Policy Report, Publications Office of the European Union, Luxembourg.

[3] Frank van Steenbergen, Fatima Arroyo-Arroyo, Kulwinder Rao, Taye Alemayehu Hulluka, Kifle Woldearegay and Anastasia Deligianni (2021), Green Roads for Water: Guidelines for Road Infrastructure in Support of Water Management and Climate Resilience

The demand for these materials has grown much faster in Asia than in the rest of the world. In the last decade, Asia's demand increased by 64%, while the global increase was only 17%[4]. This creates challenges for the sustainability of natural resources and the management of waste and pollution.

The huge impacts of road development require a new approach to how roads are planned, constructed, and managed. Roads should not only serve transportation needs, but also support other objectives such as enabling climate and disaster resilience, improving quality of life, promoting sustainable land and water use, reducing disaster risk, strengthening ecosystems, minimizing pollution, sourcing materials responsibly, and enhancing inclusive economies. For this reason, the Toolbox on Green Roads was developed. This was used and tested in assessing the opportunities for Green Roads for the proposed Dangara-Guleston section of the A358.

In this report the main outcomes of this assessment are presented. The next section (section 2) describes the background of road development and climate challenges in Tajikistan. Section 3 gives an overview of the main improvements that can be considered, zooming in on the different elements. Section 4 addresses the main overall capacity and policy changes that may be supported in addition to the development of the new four highway section of the A358, making the proposed project an ADB Type B project, whereby institutional measures are added to the main investments.

2. Background

Due to its size, mountainous terrain, and existing infrastructure, roads provide the backbone of the transportation system in Tajikistan. Internal transportation needs are currently mainly served by a 26,759 km long road network, consisting of:

1. Public (State) roads under responsibility of the Ministry of Transport and Communications. The Public road network is made up of 13,968 km of roads, which are further divided into:
- approximately 5,300 km of Republican roads. Republican roads are the main arteries of the network, and include 17 international roads.
- approximately 8,700 km of Local roads, or feeder roads. They consist of 1,261 roads of variable length that link settlements in rural areas to main roads. .

2. Departmental, or non-public roads. They consist of approximately 12,791 km of "industrial, technological and access roads to various sites and farmland. They do not depend on the Ministry of Transport, but on "several ministries and departments, committees and executive bodies of state power, of cities and regions" that are responsible for their construction and maintenance.

The priorities of the Government of Tajikistan's have been to repair the road network that had fallen in disrepair and to create international road corridors, to connect Tajikistan with neighboring countries and integrate it in larger regions.

[4] Source: Global demand for asphalt to reach 121mn tonnes | Aggregates Business (aggbusiness.com)

The proposed Dangara-Guleston highway is also developed with international connections in mind. It is part of a series of road investments that will facilitate regional economic trade.

The Dangara-Guliston Project Road section is 49 km long and forms an important road section of regional significance in the southern region of Tajikistan. The Project Road is part of the Bokhtar-Okamzor-Dangara-Guliston connection, which is an important trunk road of international significance in Tajikistan. It provides important transport links, supply of agricultural products and industrial raw materials. The road is running partly through hilly terrain and the road alignment consist of small curves and steep gradients. The Dangara-Guliston road traverses three districts / (Dangara, Farkhor and A. Hamadoni Districts) by connecting the Jamoats of Korez, Ismat Sharif and Guliston to the cities of Dangara and Guliston.

The existing road falls into technical category III. The project road consists of one carriageway with two traffic lanes width of 3.50 m, in each lane. Traffic volumes indicates that the existing road category is not adequate for the anticipated future traffic volumes and improvement/upgrading of the road category to category I was therefore designed.

The Dangara-Guliston Project Road provides important transport links, supply of agricultural.
products and industrial raw materials. It forms part of a significant transport connection through the People's Republic of China, Afghanistan and further south to Pakistan. The project road section runs through arid landscape with steppe like vegetation. The relief is characterized by smooth low-lying mountains.

Central Asia is strongly affected by climate related hazards, and so is also the Dangara-Guleston road ll be strongly affected by the impacts of climate change: higher average and extreme temperatures (1.5-2 °C for 2050; +6 °C by 2100), changes in precipitation patterns, extreme meteorological events, are expected to lead to water scarcity, droughts, decreased agricultural yields, increased slope instability, and more deleterious impacts

The Dangara-Guleston is in general vulnerable to climate risks and unavoidable:

Climatic change	Impact
Warming above the global mean in central Asia	Increase in average plain region temperatures of 0.5 to 0.8 C and mountain region temperatures of 0.3 to 0.5 C in 60-year period Increase in ice melt and snow melt triggering floods and mudslides. Melting of permafrost increasing landslides Shift from dry snow to wet snow
The number of days over 40°C has increased	More evaporation, higher water demand, more aridity
Increase in evapotranspiration	Estimated increased evaporation by 5-14 percent and vapor transpiration by 10-20 percent.

Reduction in snow and ice field and declining glaciers	Lower amount of water in streams, springs and seasonal streams drier earlier, droughts
Increasing frequency and intensity of extreme events particularly, intense rainfall; decrease in number of rainy days	Heavy rains, high waters caused by mudflow, high air temperature accompanied by droughts, strong winds and dust storms, frost and extreme cold temperature; larger risk of landslides
The winters are becoming warmer (temperature is expected to increase by 2 degrees), and the duration of frost-free days has increased	Spread of pests

In these circumstances, a climate resilient road network is fundamental. Moreover, **roads are also very important for post-disaster recovery and reconstruction**. Besides being a major investment, the road will have a major contribution on the quality of life, the sourcing of material, the land and water management and the local economy.

To optimize these impacts an assessment was done.

Therefore, in a region strongly exposed to climate risks and affected by climate change, having a performing and resilient road network is essential.

Another impact, which is less or only partially accounted for in the literature, is **the impact of roads on the environment**. For instance, roads can facilitate erosion due to road cutting, increase and concentrate the runoff, and lead to dust formation from road pavement abrasion. The opening of roads in hilly terrain also opens up fresh mountain slopes and increase the air-surface exposure, drying out the soil and vegetation (Van Steenbergen and Yakami 2018: 13). The road surface can be a source of sediments too. In places, it was found that road can increase erosion by 12 to 40% compared to the original situation (Van Steenbergen and Yakami 2018: 15) Part of these impacts are addressed in standard Environmental Impact Assessments (EIA), but part of the impact of roads on the hydrology (surface and groundwater flows) are often more difficult to predict and therefore seldom properly planned and accounted for. In fact, due to poor hydrology related considerations in road construction, roads can increase climate risks, trigger erosion and siltation, or block ground water flows leading to local droughts and floods, possibly risking damage to the foundations of the road itself. Road construction can equally offer potential for positive impacts on certain environmental factors, particularly the hydrology, by increasing water recharge and availability, when accompanied by the right measures. Roads that integrate these aspects into their design can be called “multifunctional green roads”..

3. Assessment results

An assessment was done of to assess the most feasible and high impact opportunities to transform into the Dangata-Guleston Road into a Green Road, that apart from improving the positive impact and effectiveness of the road section itself, can serve as a model for other roads in Tajikistan.

For this the draft Green Roads Toolkit was used, that is under development in the Asian Development Bank. This toolkit identifies improvement along nine dimensions –

decarbonization, climate resilience, water and land management, controlling pollution, improving quality of life, managing biodiversity, supporting disaster risk management, safe sourcing and supporting inclusive growth. Within each dimensions main directions are described in the Toolkit, supported by tested practices. All in all, 150 practices have been described with new ones being added.

The assessment of the Green Roads practices for the Dangara-Gulestan was done on the basis:

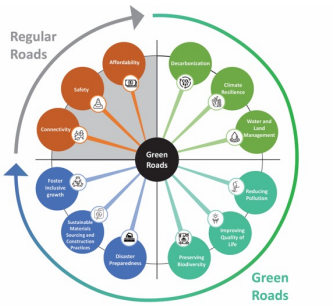
- Field visits and community discussions on 24-25 March 2024
- Review of dash cam footage from 12 February 2020
- Discussion with experts involved in the design and climate elements of the upgraded road.
- Study of design documents.

On this basis a number of potential opportunities were identified. In the diagram these are presented in the outer circle. A number of green roads practices that were already present in the existing design: these are given in the middle circle.

The proposed practice concern both physical measures and improved work practices. In general, the additional investments are not major, but require consideration and attention.

Below the different practices are discussed. The different practices are discussed in detail in this remained of this chapter. The most promising and important practices are given in bold.

1.1	**Reuse of existing road material**	Decarbonization
1.2	LED lighting	
1.3	**Roadside tree planting**	
2.1	**Bio-engineering sections in critical sections**	Climate resilience
2.2	**Rethinking road drainage in critical sections**	
3.1	**Mudflow control from the top**	Water management
3.2	Explore water reuse options	
4.1	Safe decommissioning of petrol stations	Controlling pollution
4.2	Rethink de-icing strategies	
4.3	Use of bio-accumulator plants in roadside vegetation	
5.1	Blossom road in roadside tree planting	Quality of life
5.2	Roadside tree planting	
6.1	Additional underpasses	Biodiversity
8.1	Use of ORIS to manage sourcing of material	Safe sourcing
9.1	**Local sourcing plan to optimize engagement of local capabilities**	Inclusive growth

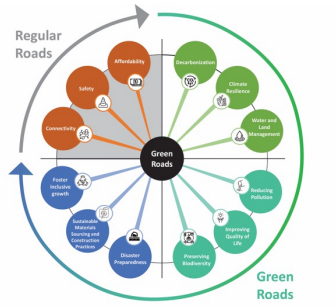
Intervention 1.1 Reuse of existing road material	Green Roads Theme  Theme 1: Decarbozation Theme 8: Safe sourcing
Location on Dangara-Gulestan Road	
Description: The current roads consist of coarse soil gravel base material and asphalt. It will not be used as the substrata for the new road, the material but should be reused in the new road design. Recycled or repurposed materials are being used both because they typically require less energy to reuse the materials, thus reducing CO2 emissions, and because of a lack of suitable construction materials in many regions. The problem is worldwide and can apply to roadway materials for low volume to high standard roads. With more roads to be built, repurposing and recycling of existing roadway materials is one way to meet the future demand for construction materials. However, for recycling, either machinery or plants that can do the recycling have to be available. One of the most common forms of recycling roadway materials is with asphalt paved roads that are ground up, producing a recycled asphalt product (RAP) that is then mixed with new asphalt oil to form a new asphalt concrete. It is understood that the reuse of asphalt for lower grade applications (like road patching or application on local roads) is already applied in Tajikistan. The safe handling aspects of this should be checked.	
Actions and implications: Assessment and calculation of material in current road Make separation and reuse plan. Include timing and reuse in the tender documents	
Visual documentation	

Repair on current road

Intervention 1.2 Using LED lightning along roads	Green Roads Theme  Theme 1: Decarbonization Theme 11: Safety Theme 12: Affordability
Location on Dangara-Gulestan Road	At several locations
Description: Pedestrian light and traffic light transport are locating on PC 53+75,69 and PC 215+91,16 in the Dangara to Gulestan section of A358. In specifically, there are nine traffic light transport Type I, ten pedestrian traffic light Type I and eight column traffic light transport. The energy consumption of such traffic lights can be reduced by using LED lightning and other alternatives. It is proposed to assess the energy demands of the project and adopt strategies to minimize power usage while maintaining lighting and safety standards. These strategies might include LED lighting, but also upgrading to energy-efficient luminous paint, beacons, and traffic signal equipment, and integrating renewable energy sources to generate and utilize renewable energy, such as solar panels.	
Actions and implications: Calculate the energy consumption for each traffic light and choose LED lighting that provides comparable light intensity. Assess the potential for constructing renewable energy infrastructure along roadways or integrating it into traffic lights. Evaluate the potential for implementing luminous road markings, beacons, and traffic signage.	
Visual documentation	

References:

- USDOT Federal Highways Authority INVEST, Project Development Criterion PD -17 Energy Efficiency
- Arizona DOT - LED Life-cycle Costing Analysis and Life-cycle Assessment

Intervention 1.3 Promoting road-side vegetation	Green Roads Theme  Theme 1: Decarbonization Theme 3: Land and water management Theme 4: Quality of life Theme 5: Pollution control Theme 6: Biodiversity Theme 9: Inclusive growth
Location on Dangara-Gulestan Road	Over main length

Description:

At present there is sporadic tree planting along the road. There seems have not been a systematic effort. Only small sections are planted with trees whilst large sections are devoid of trees.

In the construction of the four-lane road most trees along the road will be removed and replanted. These concerns … trees. In addition, double this number of new trees will be planted – totaling …

Whilst this is commendable, it does not add up to substantial roadside vegetation. A more dense and extensive vegetation could serve many purposes, particularly if well planned:

- Decarbonization by the carbon sequestration of the trees
- Land and water management by the retention and infiltration of water run-off and the biological drainage potentially provided in the road sections that suffer from drainage congestion.
- Quality of life by generally enhancing the experience of the landscape, augmented with special sections of blossom trees, that may give the A358 in this section an iconic image.
- Quality of life, dust may be captured by planting double row tree lines, to influence dust movement.
- Pollution abatement by including hyper accumulator species, including specific undergrowth species (cruciferous families (including various types of cabbage, Indian (Sarepta) mustard, and yarutka), Asteraceae (such as dandelion, sunflower, and yarrow. Bioremediation maybe done by Jerusalem artichoke**.**
- Biodiversity of flora and fauna – promoting local species and encouraging biodiversity that can be beneficial for local agriculture as well by increasing presence of pollinators.
- Inclusive growth, by providing valuable output (fruits, fodder, timber).
- Traffic safety – observing distance from the road and no placement of tree in inner bends.

This would connect with the ambitious plans of the Forestry Department to plant trees along most of Tajikistan's roads according to the proposed programmed: *"Offsetting Greenhouse Gas Emissions By Landscaping Roads".*

This would be a major boost on many agenda. In general, the species of trees that do well in the area is limited as can be seen from the relatively barren landscape – the dry and hot summer period a prime explanation. The main tree species are *prunus, Salix, ulmus* and several coniferous trees. Other species may do well (*Populus*) but are not introduced. The work on the Dangara – Gulestan Road could act as harbinger and testing ground for such a large program. The combination of different functions would translate in a tree planting plan (multiple rows, undergrowth species, alternation of species).

Actions and implications:

Develop tree planting plan with selection of species (trees and undergrowth), seedling sourcing, planting system (may consider special planting boxes), ownership, community engagement, maintenance system, business and replacement system.

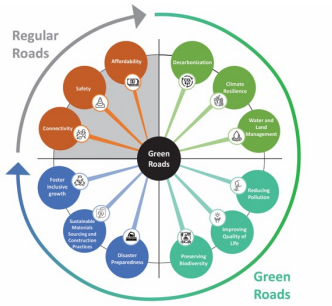
Connect and co-create with Forestry Department with respect their Roadside Tree Planting Initiative and help develop a larger strategy.

Visual documentation

Current sporadic single line roadside tree planting along section of the A358

Dense roadside tree planting (visualization[5])

[5] This is just a visualization – in reality there would be no trees in the center of the road and at the side of the road there would be more distance so as to observe traffic safety.

Intervention 2.1 Bioengineering on vulnerable riverbanks and road slopes	Green Roads Theme  Theme 2: Climate resilience
Location on Dangara-Gulestan Road	Around bridge and in last section near Gulestan and in newly constructed section

Description:

A number of sections of the road are prone to high erosion. The soils are deep eoline deposits or less structured sediment deposit, subject to extensive erosion. The sections that are particularly vulnerable are:

- Riverbanks near bridge at KM 6
- New short cut section to be constructed from KM38.
- Last section near Guleston.

At present only hard measures are proposed to deal with slope instability, but this is not enough given the high erodible slopes. Vegetative measures, in particular bioengineering would be a very important measure to be introduced on these vulnerable slopes. In bioengineering a combination of measures is used to stabilize slopes: slope treatment and segmentation, planted grass lines, shrub and tree planting, live check dams, live wattle fences, netting, hydro-seeding and turfing.

It appears that experience with bioengineering in Tajikistan is limited and not applied to all different geographies and road climate zones. This is an enormous omission. The planning and introduction of bioengineering on the A358 could contribute to the mainstreaming of an important practice, relatively unknown the Department of Forestry or the Ministry of Transport. It may also involve a better understanding of the grass and shrubs that grow well in these challenging conditions, taking into account local climate and soils and building widespread capacity to apply bioengineering methods.

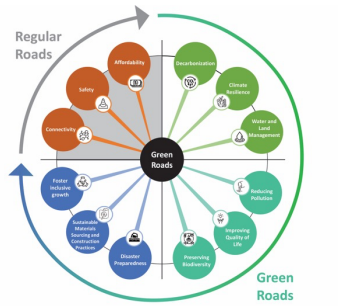
Actions and implications:

It is proposed to make in a collaborative mode a bio-engineering plan covering the highly exposed riverbanks immediately upstream and downstream of the bridge, the unstable slopes at the end of the road and the possible affected road slopes in the new road section.

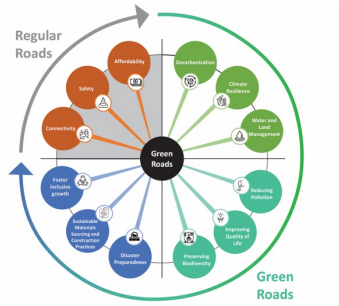
A specialist may be engaged to make an assessment not only of the measures in these sections but also for the entire country.

Visual documentation	
 Riverbank erosion around bridge	 River banking erosion in danger of threatening the road
 Weak side slopes along last road section	 Pioneer plants on untreated slope – potential for use in bioengineering

References:
https://roadsforwater.org/wp-content/uploads/2019/12/Roadside-Bio-Engineering-Site-Handbook-2076-01-12-1.pdf

Intervention 2.2 Rethink road drainage in critical sections	Green Roads Theme 
Location on Dangara-Gulestan Road	Up to kilometer 6
Description: The first section of the Dangara-Gulestan Road suffers from drainage congestion. There is limited opportunity to remove the drainage water from the hillslopes in the v-shaped landscape (with the road in the middle) and safely dispose it. The uncontrolled outlet of the land drain in very soft terrain (eoline deposits) at the moment is a major cause of erosion of the banks of the river near the bridge – with the erosion even treating the integrity of the land. To remedy the challenge with the drainage three interventions should be considered: - Provide a controlled outlet (chute) from the drain to the river. - Consider more culverts in this upper section, so as to have more distributed drainage (rather than only upsizing the culverts in the face of climate change) - Consider biological drainage to reduce the drainage coefficient and ensure dry substrata of the road – this can be done by densely planting tree species that can act as a biological pump. Willow (Salix) and poplar may be suitable.	
Actions and implications: - Make assessment of drainage system in this area, in particular current inlets and outlets - Revisit the culvert locations in this section and investigate scope and desirability for adding culverts. - Design adequate outlet/ chute for the drainage system	
Visual documentation	

 Drainage congestion in upper section of proposed road	 Massive bank erosion caused by uncontrolled outlet of land drain
References: http://www.cawater-info.net/bk/4-2-1-9-2-4_e.htm https://qcat.wocat.net/ru/wocat/technologies/view/permalink/4815/	

Intervention 3.1 Upstream control of mudflows	Green Roads Theme  Theme 3: Land and water management
Location on Dangara-Gulestan Road	Km 14-18, near village of Bulyoni Poyo

Description:

Some areas of the Dangara- Guleston road are occasionally subject to overtopping with run-off, called mudflows. These are not the devastating mudflows of the mountainous terrain of Tajikistan, but recurrent events where during heavy rain sections of the road are covered with water for a number of hours. These inundations cause traffic disruption and bring considerable sediment loads with them.

The problem was investigated and in the main section subject to the occasional mudflows the development of four main gullies in the village areas was the prime cause for the silt-ridden inundations. These gullies also threaten the village areas, present a risk to children and livestock and may affect houses.

The problem can however be easily solved by closing water entrance into the gullies with simple gabion water dispersal structures and by plugging the existing gullies with vegetative measures.

Doing so is important as the current solution of a receptor drain running parallel to the road in this section would fill with sediments, presenting a maintenance liability. Moreover, the plugging of the gullies would restore valuable village land.

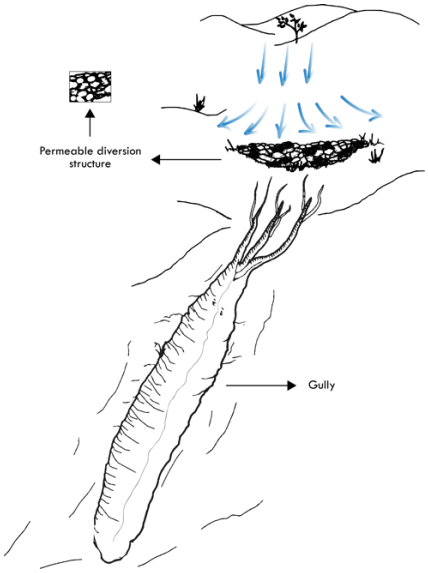
Actions and implications:

Measure and map the gullies.
Design and cost diversion structure
Decide on gully plugging program (material and distance between plugs)

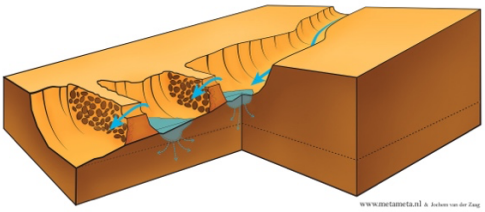
Visual documentation	

Mudflow – water overtopping the road

One of four gullies developed in . – to be closed.



Proposed diversion structure at head of the gully (sketch)



Gully plugging – complementary intervention.

Gully plugging with vegetative screens.

Stone check dams to plug the gully

Intervention 3.2 Investigate water reuse options.	Green Roads Theme  Theme 3: Water and land management
Location on Dangara-Gulestan Road	

Description:

The area is marked by relatively wet winters and springs, but dry and hot summers. Agricultural production is much determined by the access to water in this part of the year. It would make sense to retain water from the winter/spring to the summer period. The road can be instrumental in this because the run-off of the entire landscape is routed through the cross drainage of the road and hence in this way the road can be used to 'harvest water'. Road water harvesting can take the shape of feeding water to reservoirs or local shallow aquifers or to increase soil moisture.

During the field investigation there was no immediate obvious opportunity. This would need more investigation and hydrological information. Such water collection measures can always be added later at the end of the cross-drainage system.

Intervention 4.1 Safe decommissioning and removal of petrol stations.	Green Roads Theme  Theme 5: Controlling pollution. Theme 1: Decarbonization
Location on Dangara-Gulestan Road	At several locations

Description:

There are several petrol stations along the A358 in the Dangara to Gulestan section. Some of these petrol stations are no longer used – and may in fact have been abandoned for a long time. Other petrol stations are still in use.

With the widening of the road the petrol stations may have to be relocated or in case of the abandoned petrol station be decommissioned all together. The Land Resettlement Action Plan list four petrol stations, two of which will be closed, one which will be modified and one which will be shifted. The already abandoned petrol stations (3 in number) are not listed it seems.

Due to the presence of buried oil tanks and the likelihood that these have been leaking, shifting, or decommissioning needs to be done with care. This would involve the safe removal and disposal of contaminated earth and/or phytoremediation. Phytoremediation may the most practical option on the light petrochemical compounds.

The petrol stations that are newly opened should be set up as exemplary facilities compliant with all safety standards and environmental requirements. They will also have electric charging capability of electric cars.

Actions and implications:

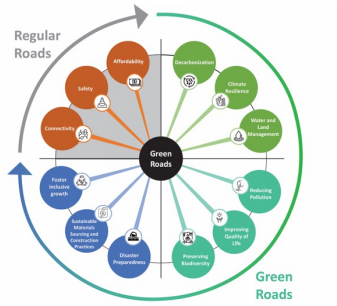
- Map and assess ownership status of abandoned petrol stations.
- Soil samples to assess degree of contamination of all petrol stations.
- Safe removal and treatment plan

Visual documentation

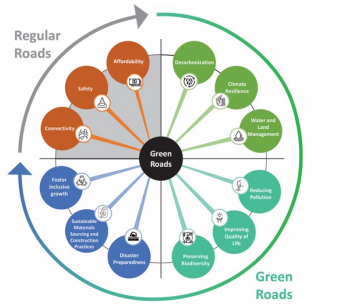
Abandoned petrol station.

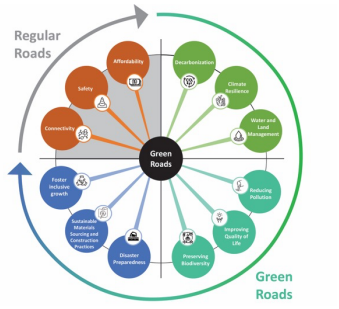
References:

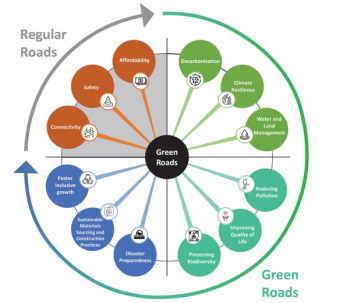
- Using Phytotechnology to Redesign Abandoned Gas Stations: Using Phytotechnology to Redesign Abandoned Gas Stations (umass.edu)
- Redesigning Abandoned Gas Stations Through Phytotechnologies | SpringerLink
- Petroleum Brownfields | US EPA
- Example: Habitat for Humanity Sees a Former Gas Station in Swanton, Vermont as a Perfect Fit for Residential Reuse (October 2008) (njit.edu)

Intervention 4.2 Rethink de-icing strategy	Green Roads Theme  Theme 4: Controlling pollution
Location on Dangara-Gulestan Road	Entire length
Description: The construction of the different new sections of the A358 as well as other highways is an opportune occasion to rethink the road de-icing strategy for the upgraded Dangara-Gulestan Roads, but also for the main road network in Tajikistan in general. Road salts, such as sodium chloride, calcium chloride, magnesium chloride, or potassium chloride, enter the environment through runoff and splashing from roadways. Consequently, the excessive release of road salts has detrimental effects on freshwater ecosystems, soil, vegetation, and wildlife. To mitigate these negative impacts, it's crucial to apply the appropriate number of salts in the correct location and timing. Moreover, the use of alternative traction agents, like sand and grit, should be avoided to prevent introducing additional pollution into runoff. It is possible to mix the salt with other brines.	
Actions and implications: Bring together main stakeholder in de-icing. Assess current methods and bottlenecks. Improve strategy: - De-icing material - Better planning	
Visual documentation	

Rethinking de-icing strategies

Intervention 4.3 Includes in 1.3 Use of bio-accumulator plants in roadside vegetation	Green Roads Theme  Theme 4: Pollution control
Location on Dangara-Gulestan Road	
Description: Roadsides are contaminated with hydrocarbons, oils, grease, heavy metals that come from wear and tear of cars plying on the roads. As a result, the immediate environment of the road is generally seriously polluted. Many of these contaminants can be removed by bio-accumulator plants that absorb and break down these contaminants. The inclusion of bio-accumulator plants in roadside vegetation (as in intervention 1.3) will reduce these effects of this pollution.	

Intervention 5.1 Blossom roads Intervention 5.2 Roadside tree planting Includes in 1.3 Blossom roads	Green Roads Theme  Theme 4: Pollution control
Location on Dangara-Gulestan Road	
Description: Roadside vegetation will in general have a marked contributions to the quality of life. People living close to vegetated roads are known to live longer. Roadside vegetation if properly planned will improve air quality and will control dust movement, as also discussed under 1.3. Roadside vegetation can also become iconic by including long sections with blossom trees, especially wild prunus or almond (that are indigenous to the area), creating a visual spectacle, that will be attracting visitors. This can be combined with the women and child development centers. This intervention Is proposed to be consider as part of 1.3.	

Intervention 6.1 Additional livestock passages Fodder trees	Green Roads Theme  Theme 6: Biodiversity Theme 9: Inclusive growth
Location on Dangara-Gulestan Road	

Description:

The road does not traverse biodiversity hotspots, though there may be some wildlife crossings. A fence is foreseen to prevent local livestock from straying onto the four-lane road and causing a traffic safety issue. The same fence will also keep wild animals out and guide them to the underpasses.

Keeping sheep, goats and cattle is an important economic activity in the area. In the winter and spring, the road verges are intensely used for grazing. They constitute a major 'commons' close to the villages where the shepherds reside. In the process livestock frequently crosses the road in search for fresh forage. In the summer the flocks migrate to the open land in the adjacent hills. It is then common for professional shepherd to take care of the flocks of several livestock owners in this season.

With the construction of the four-lane road, it will no longer be possible for livestock to cross the highway and part of the current grazing area will be used for the new road alignment. As mentioned, a fence is foreseen for long stretches of the new road to prevent livestock crossing the road and to ensure road safety. Two livestock crossing are foreseen in the current design, both in the second reach of the road.

This may not be enough. It is recommended to add two more crossings in the first section of the road by enlarging some of the culverts that are foreseen. Depending on the presence of small mammals and amphibians some rock material could be placed in the under passages to encourage safe passage. Also, in the roadside tree planting fodder trees could be included to supplement the forage of the livestock.

Actions and implications:

- Discussion with pastoralists to assess the priorities for livestock passages – possibly in combination with existing culvers (to be enlarged)
- Discussion with pastoralists/ unions to familiarize with implication of roads on grazing routes.
- Check presence of special biodiversity

Visual documentation	
 Keeping sheep and livestock is an important occupation	 The road verge is an important ‘commonly’ used by sheep and cattle in the winter and spring season  Underpass with rubble to facilitate passing of small species

Intervention: 8.1 Utilizing ORIS for the work planning	Green Roads Theme  Theme 1: Decarbonization Theme 8: Sustainable Materials Sourcing and Construction Practices
Location on Dangara-Gulestan Road	The whole road section

Description:

Moderate to low risks of landslides, floods, extreme heat, and extreme cold climates were observed across the entire road section where climate risk assessment took place. These climates adversely affect road performance and consequently increase maintenance costs.

Road designs and techniques in response to future climate changes are necessary to be considered. Besides, the use of virgin materials and material sources outside a country consumes high energy and incurs initial costs due to natural material extraction and long transportation distances.

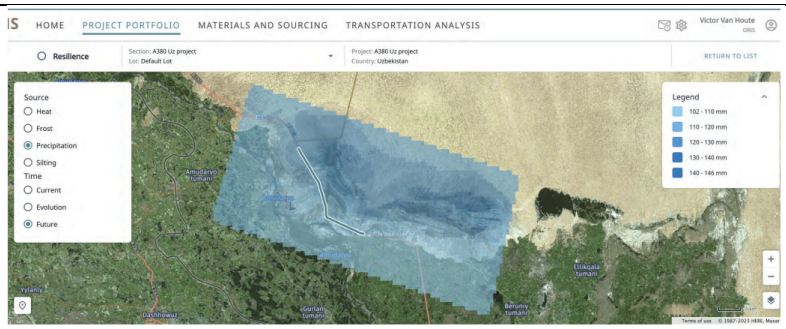
ORIS is a digital pavement design and material management platform capable of analyzing the risks of climate change over the next 40 years, based on different emission scenarios. It has been successfully used in Uzbekistan in ADB-supported road investments.

ORIS can provide pavement design analysis by comparing the base case with alternative designs. This may result in lowering initial costs, reducing the consumption of natural materials, prioritizing local resources, and increasing the usage of recycled materials. In the case of the Dangara-Gulestan road this may be too late, but ORIS can be used to plan the use of local materials. With the help of ORIS, project managers have sufficient evidence to select the best route, integrating considerations of climate change, energy reduction, and recycled material utilization

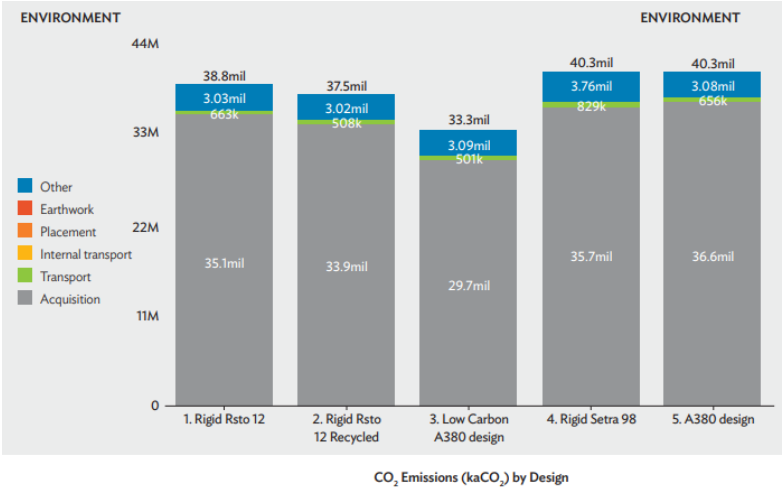
Actions and implications:

Data collection on geography, construction materials, pavement solutions, climate and local materials and design regulations

Visual documentation



Runoff risk modeling projecting precipitation levels from least (pale blue) to highest (dark blue) within a highway



Estimated carbon emission of a road life cycle for each design

References:

- Building Greener, Resilient Transport Infrastructure: Innovating with Artificial Intelligence and Digital Twins in Road Design in Uzbekistan

Intervention 9.1 Mainstream local sourcing in works implementation so as to boost the local economy.	Green Roads Theme  Theme 9: Inclusive growth
Location on Dangara-Gulestan Road	Throughout

Description:

Though reportedly the economic situation has improved in the main settlements along the Dangara-Gulestan road, poverty levels are still low. The median income is TJC 1700 and 29% of households earn less than TJC 1550 a month.

Another indicator is that a large proportion of young men work in Russia, affecting family life: 42% of the household are having one family member working in Russia.

The upgrading of the road may not bring much economic development to the villages immediately adjacent to the road, may be rather the opposite. The new four lane road may make local connections more difficult; the fencing and the roads may make it more difficult to cross and reach one's land or opposite villages.

There is a need to invigorate the local economy with the opportunities that the road construction project brings by giving preference to local labor and local contractors in the construction of the project. The estimated amount is USD 120 M. If a part of this can be spent locally and be injected in the local economy, the road project could be a major driver for local economic development.

This can be done by asking prospective bidders to include a local sourcing plan (LSP) – for the procurement of material as well as the engagement of local contractors and workers. Special provisions may be added to include local capacity building in the LSP. The LSP may be included in the scoring of the different offers.

Actions and implications:

- Develop a standard LSP to include as a provision in the tender document, taking into account inclusion of special groups too.

- Agree on scoring and weightage for the LSP in the tender procedure.

- Make the LSP enforceable, based on reporting and securities.

4. Additional measures (Type B activities)

With the ADB moving the climate resilience agenda throughout Asia, projects in general will be active on two fronts:

- Direct investment
- Additional institutional or capacity measures that may have ramifications for the entire countries.

In the table below some suggestions are made for Type B activities that may be added to the road investment:

Introducing bioengineering and roadside tree-planting	Current knowledge and capacity in Tajikistan are limited – a program of developing and introducing right methods, combined with capacity building could be considered
Network analysis to look at planning and upgrading of entire network	Making a systematic assessment of entire network and identify easy entry methods to introduce climate resilient practice
Preparing Guideline and Instruction on Green Roads	The broader concept of Green Roads is new, but there is much interest in developing Green Economy. The introduction of a Guidelines combined with specific binding instructions could be considered
De-icing practice	De-icing is much needed in Tajikistan; the project may be used to review and update current practice