



RESILIENT ROADS AND RESILIENT WATER ROAD ENVIRONMENTS WITH SPECIAL ATTENTION TO BADAKHSHAN



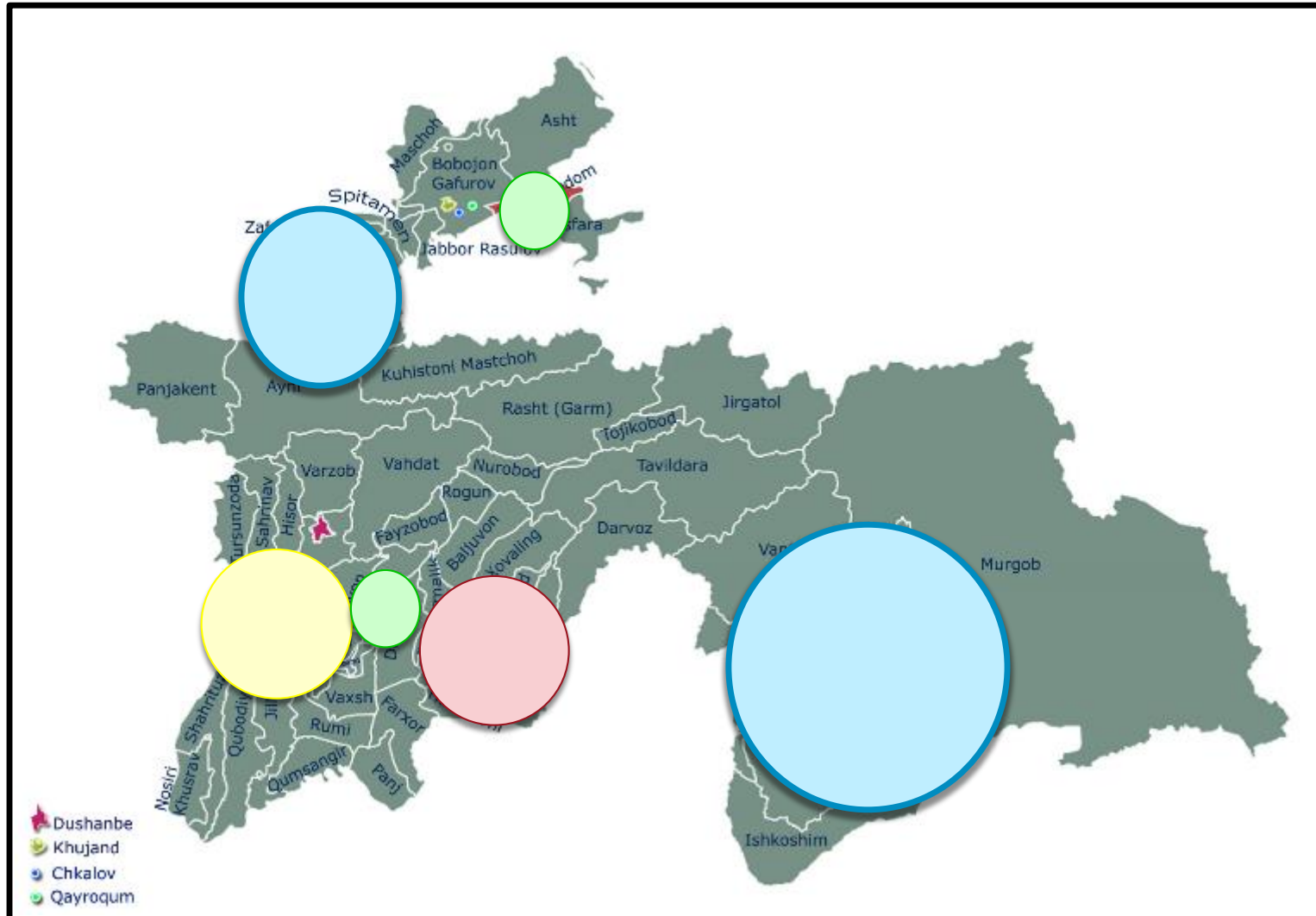
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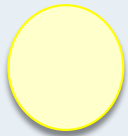


Main opportunities





Mountain environment: road/ river protection and catchment improvement



Low rainfall hills: erosion and scour control, very modest water harvesting



Medium rainfall hills: erosion control and water harvesting



Large irrigation systems: improved drainage

Mountain environment: road/ river protection and catchment improvement



| Typical districts | Darvorz, Ishkoshim, Roshqala,, Vanj, Rushon, Shugnon |
|------------------------------|---|
| Road challenges | Exposure to floods due to higher river flood peaks; and inundations by temporary lakes; landslides/ mudflows and rockfall, |
| Water environment challenges | Increased risk of landslides and mudflow; high pressure on limited land; changing climate and less sedurewater availability |
| Resilient roads | Road design aligned with predicted hydrological situation Roads at safe elevation and distance from rivers; Tunnels and galleries in sensitive areas Bank protection but also 'room for the river' Reinforced irish bridges at stream crossings; Bio-engineering in limited places |

Mountain environment: road/ river protection and catchment improvement



| Typical districts | Darvorz, Ishkoshim, Roshqala,, Vanj, Rushon, Shugnon |
|-----------------------------------|---|
| Resilient road water environments | Land use planning and controlled pastures Possible water/ snow retention measures:: Protected springs Artificial glaciers Land development with melt water Controlled grazing Irrigation canals/ diversion canals |

Challenges



Bank erosion

Damaged bridges



Landslides and temporary lakes



Washed out roads





Resilient roads:

- To be based on (minimum) 20 years forward hydrological analysis of peak floods, river water levels and run-off
- Adequate provision for height of road, provision of tunnels and galleries, embankments, river width (within economic boundaries)
- Special protection measures such as irish bridges at crossings and overflow measures
- Complemented by catchment improvement measures

Resilient roads



Galleries

Protection walls



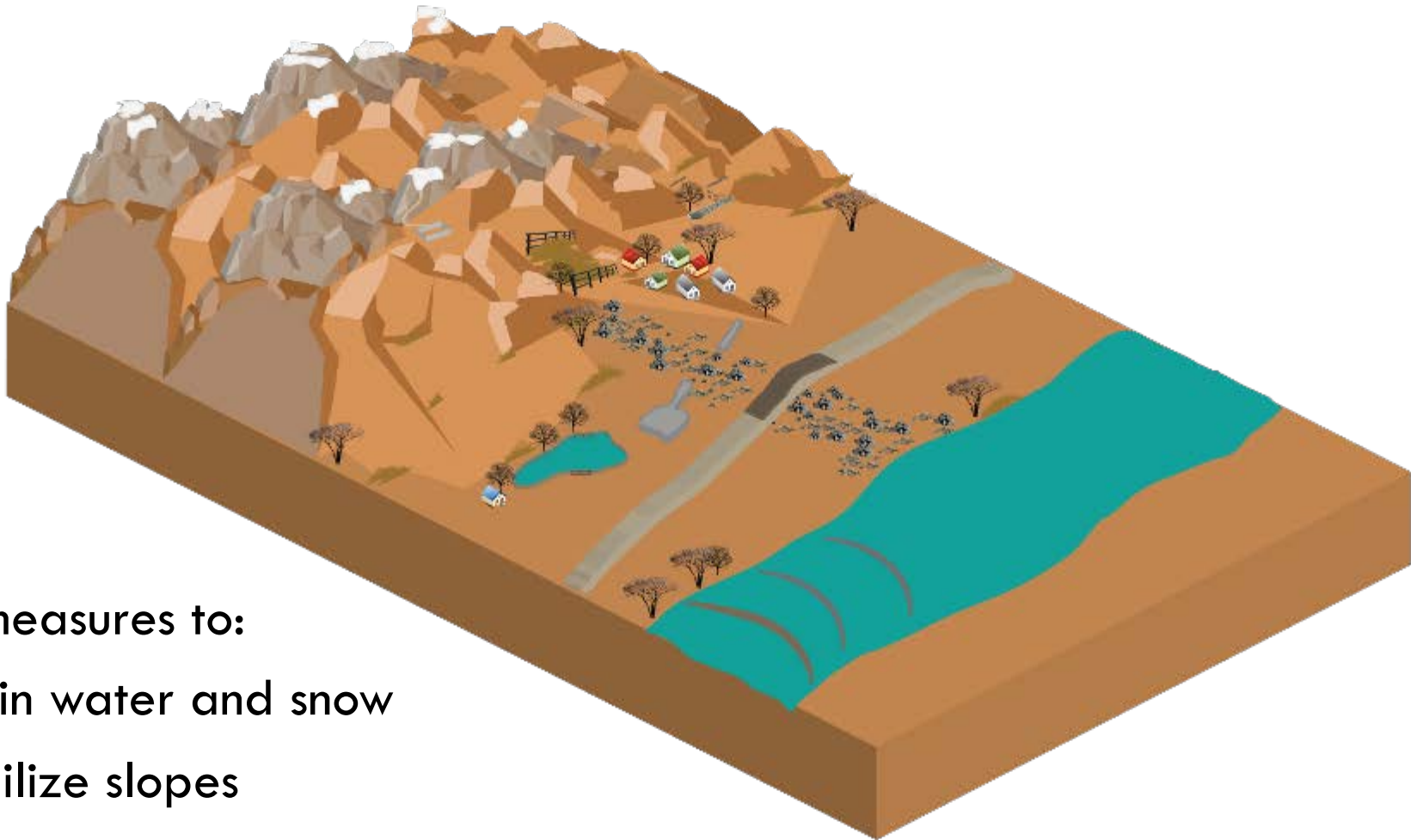
Irish bridge



Higher roads



Resilient Water Road Environment



Using measures to:

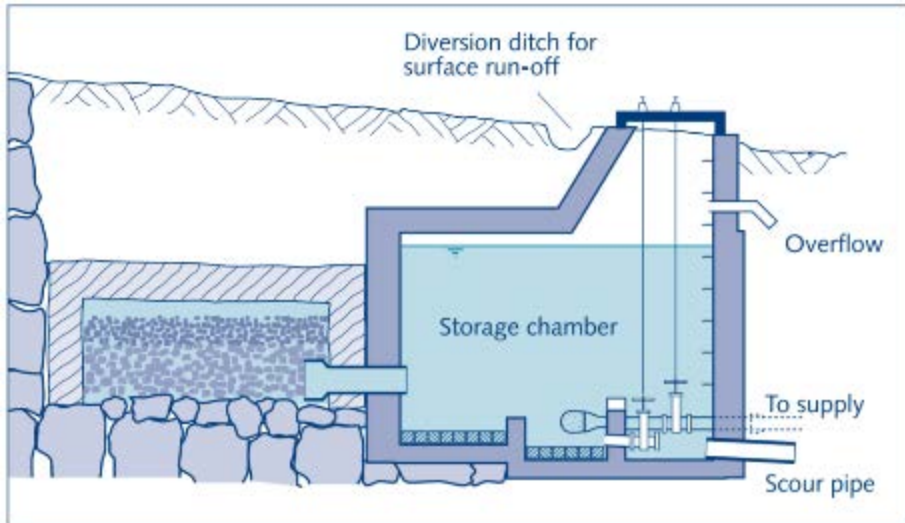
- Retain water and snow

- Stabilize slopes

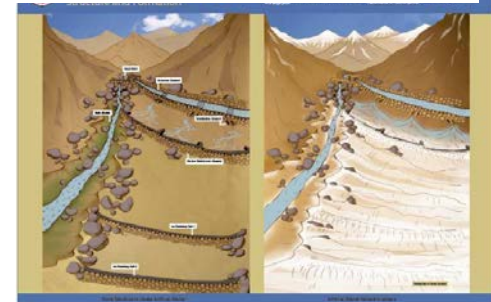
- Develop new land



Protected and managed spring



These glaciers are constructed in a shade to prevent them from melting quickly.



Artificial glacier

Bio-engineering



Managed grazing



`Warping: new land development



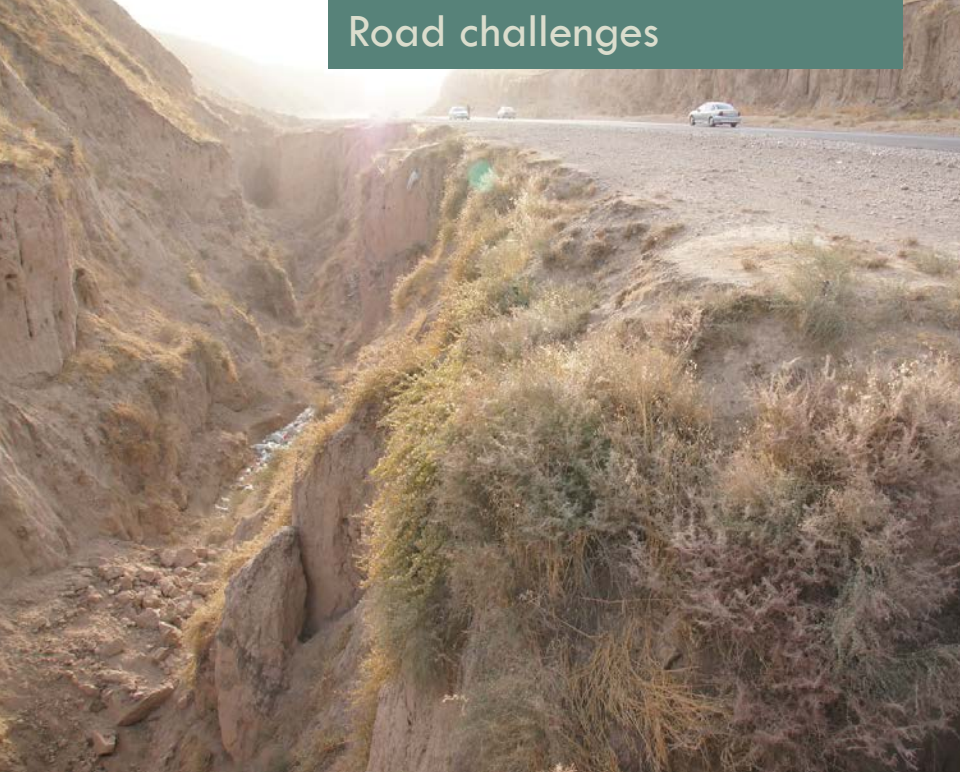
Regreening

Medium rainfall hills: erosion control and water harvesting



| Typical districts | Shuronod, Muminobod |
|-----------------------------------|---|
| Road challenges | Uncontrolled road drainage causing damage to roads |
| Water environment challenges | `Erosion related to deforestation, uncontrolled grazing |
| Resilient roads | Adequate drainage system; downstream protection of drainage disposal |
| Resilient road water environments | Water harvesting from road drainage: <ul style="list-style-type: none">• storage ponds, converted borrow pits or water spreading Regreening using road water Slope protection through bio-engineering or vertiver hedges |

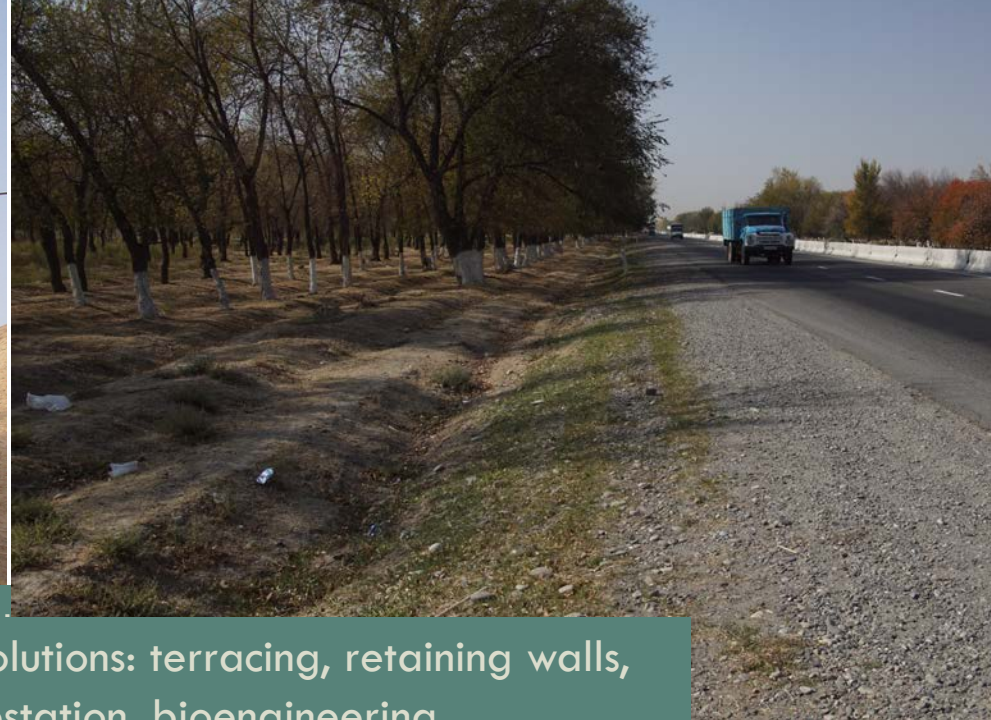
Road challenges



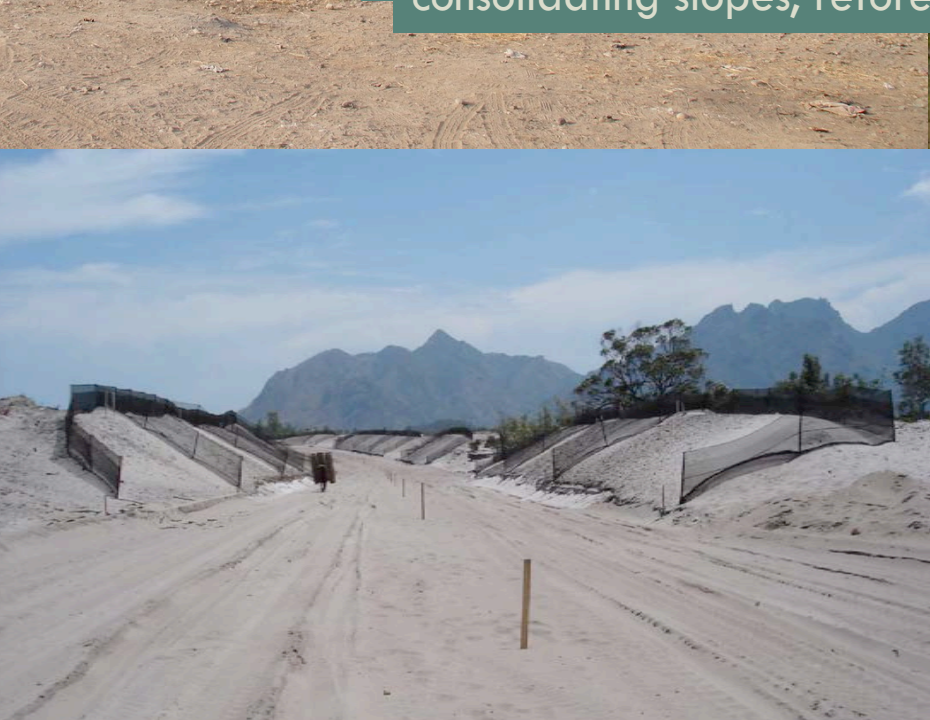
Road enviroment challenges



Roads and road construction impacts:
Rock cutting leave the soil barren
Culverts and drainage channels concentrate the rain runoff in one place



⌘ Road water environment solutions: terracing, retaining walls, consolidating slopes, reforestation, bioengineering...

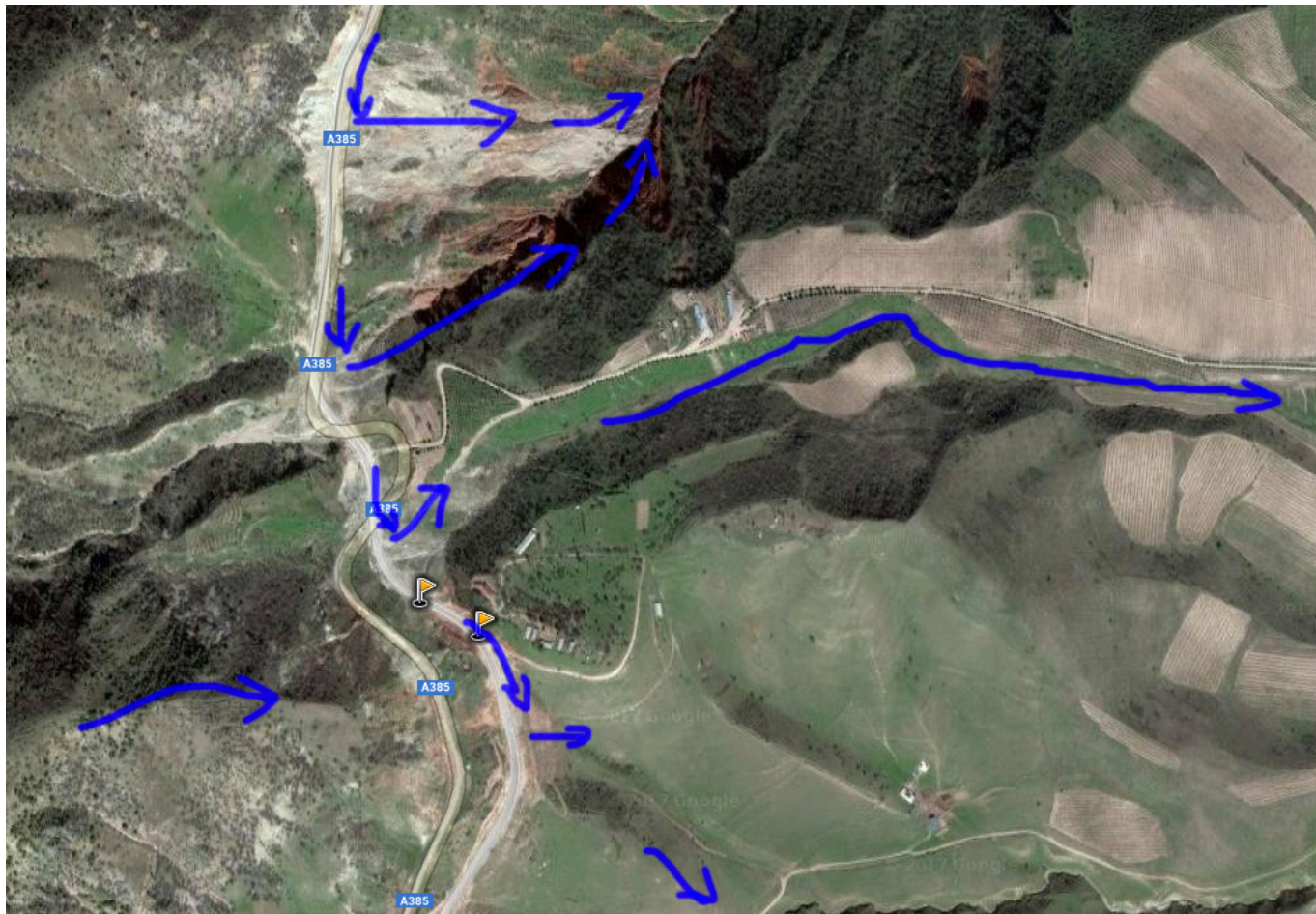




Paying attention to what happens with road drainage water



Redirecting road drainage

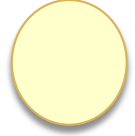












Low rainfall hills: erosion and scour control, very modest water harvesting

| Typical districts | |
|-----------------------------------|--|
| Road challenges | Hissor, Kulob, Rudaki, Khuroson |
| Water environment challenges | Modest erosion, scour, dust |
| Resilient roads | Adequate drainage and scour control |
| Resilient road water environments | Road side tree planting Modest opportunities for water harvesting – combined with low water consumption crops In some areas flood water spreading |

Large irrigation systems: improved drainage



| Typical districts | Vakhs, Vose, Konibod, Isfara, Dankhara |
|-----------------------------------|--|
| Road challenges | Road bodies effected by high moisture |
| Water environment challenges | Inadequate drainage causes water logging and salinity lesding to low agricultural productivity and human/ livestock diseases |
| Resilient roads | Adequate drainage in the road bodies Regulat repair where effective drainage is not possible |
| Resilient road water environments | Restored drainage, where feasible, preferably closed drainage systems |



Challenge: impeded drainage

Need to improve
drainage including
road drainage



Thanks for your attention

