RC-East, Eastern Afghanistan, GA-ADT, Logar Province, Pul- e'Alam District, DAIL-Pul-e'Alam Watershed Restoration/Agricultural Water Resource Improvement Project (Including Hillside Treatments)

Henry F. Shovic, PhD

Jan 13, 2012

Completed under CERP contract 20111011143900 for GA-ADT, RC-East

The purpose of this analysis is to identify potential watershed restoration treatments in and adjacent to an existing restoration project. The project consists of hillside ditch treatments with planted and irrigated trees. It is close to an agriculture school and appears to benefit a major canal by reducing flooding and erosion, as well as being a training and experimental facility for the school . The client requested I locate and design erosion and infiltration control projects within the existing project area to supplement existing trreatments. Only relatively basic treatments are proposed, which affect water delivery in the watershed, benefit local agricultural uses, and utilize minimal construction. They involve local labor, minimal engineering design, and low-tech maintenance. The maps noted below and this document are designed to be input for a government estimate and contract preparation.

Methods include use of QuickBird satellite imagery (copyright Digital Globe, Inc.) at 1 m resolution; digital terrain data at 10 and 5 m resolution; and available geologic data, standard operating procedures for treatments, and soils/infrastructure data. The entire area was canvassed at scales of 1:400 to 1:3000. ARCMAP and ARCGLOBE were used for planar and perspective analysis. Images were rendered in color infrared (CIR) for vegetation and soil analysis, but are displayed in gray or brown scale for ease of use in maps. Groundwater relationships are based on general knowledge of hydrology of Afghanistan and review of geologic and physiographic spatial data; as well as client-provided ground data. Where imagery was cloud covered, GOOGLE MAPS imagery was georeferenced to fill in gaps.

Project Area

The study area (577 ha) consists of moderately-steep headslopes in intrusive rocks grading into eroded sandstone/shale/limestone hills to a large riverine floodplain. Soils have high erodibility and are gullied in places. Precipitation is low (100 – 200 cm) and average temperatures are moderately high. Land use is primarily heavy grazing and urban development. There is a major canal (at least 10 km long (4.3 km in the Study Area) and 5-7 m wide) passing through the lower part of the Study Area. This canal has numerous apparent breaches and seeps that impinge on urban developed areas.

There are some Karez systems and an apparent ditch-oriented water collection system in the area. An extensive hillside ditch treatment has been installed before 2007 (the date of our imagery), with the apparent purposes of reducing erosion and flooding effects on the major canal and to accommodate tree plantings (Figure 1). This is about 30.8 ha in size and emphasizes the lower part of the watershed (Figure 2.). The benefits of this watershed treatment can be enhanced by using infiltration (check) dams in ephemeral and intermittent drainages having only small active channels. These are specified below.

Figure 1. Hillside Ditches near Pul-e' Alam (image by U. S. Army)

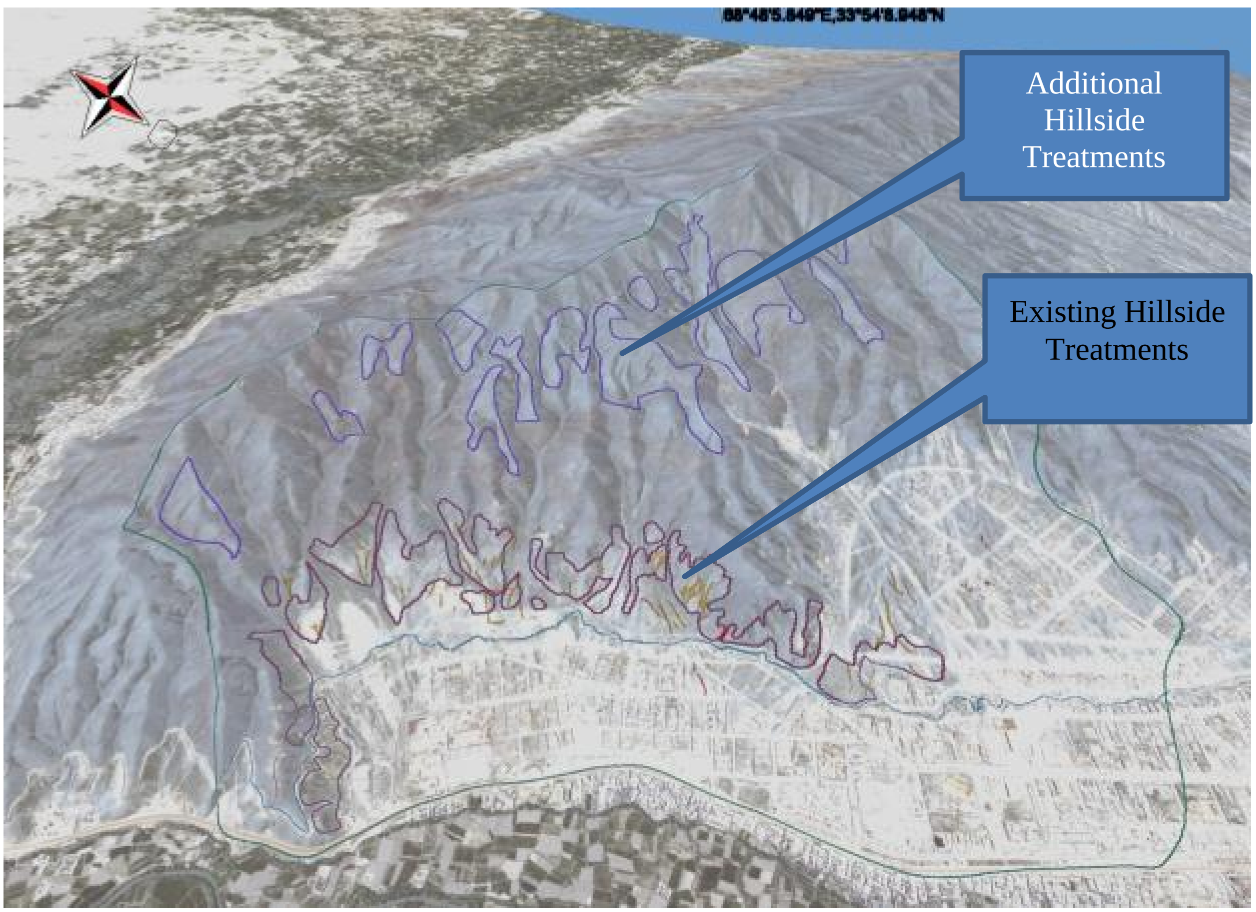

Figure 2. Existing Treatments (red) in the Study Area (green) with Additional Recommended Treatments in purple.

Treatment Descriptions

See the Standard Operating Procedures (SOP's) for standard contract specifications for these treatments. See the map *Figure 2. RC-East, Eastern Afghanistan, GA-ADT, Logar Province, Pul-e' Alam District, DAIL/Pul-e' Alam Watershed Restoration Project (With Additional Hillside Treatments)* for details of treatments and locations.

Hillside ditches and rock bunds (hillside ditches made of stones) are generally used for reducing runoff (Example in Figure 3). They are placed on hillsides to intercept runoff and provide opportunities for increased infiltration.

Figure 3. Example Hillside ditches (image by AWATT)

Criteria for Mapping Hillside Infiltration Areas for Treatments (Generic Example in Figure 9 after end of text)

- Contribute hydrologically to active irrigation systems or to flood control.
- Slopes greater than 10%, and less than 40%. Slopes less than 10% were judged to have adequate infiltration, and those over 40% are outside design specifications.
- Not directly above or in the immediate vicinity of reservoirs, roads, or dwellings, to prevent potential sedimentation if failure occurs.
- Not in badlands, on bare rock slopes, or in active intensive agricultural areas (including hayfields and croplands)
- Not in narrow, low-sight distance valleys.
- Not in heavy brush fields or bedrock slopes (hand labor is impractical there)
- Only specified in moderate to high precipitation areas
- Specify rock bunds in areas that appear stone-covered with soil underneath, but not bare rock; specify hillside ditches in areas appearing to have deep soil.

Infiltration check dams (Figure 4) are normally used for gully restoration and there are gullies in this project area. However, there are also many ephemeral or small intermittent drainageways that could benefit from check dams to increase infiltration by slowing water flow (Figure 5). These are not specified in large intermittent or perennial stream channels, because of potential hydrologic disturbance of the channel and washout potential. They are also restricted from areas where drainageways are used for irrigation or directly above habitation. They are placed only where drainageway slopes are less than 20% to avoid blowouts and associated erosion.

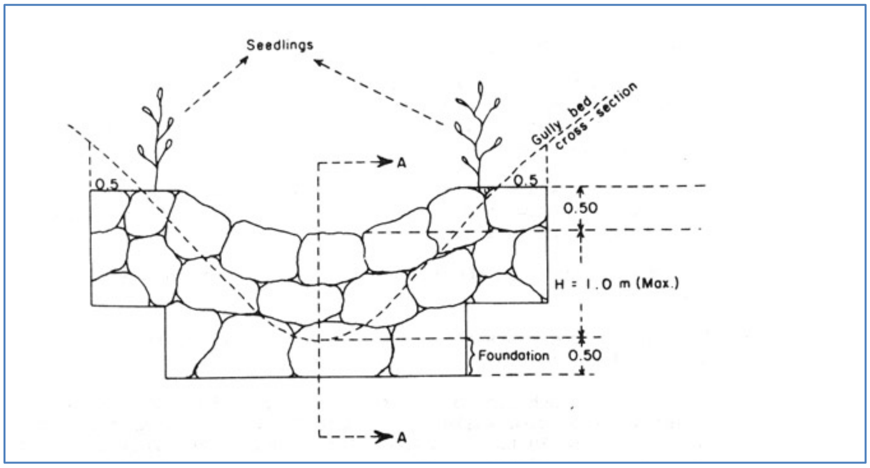

Figure 4. Schematic of a check dam (image by FAO)

Figure 5. Example of an Afghanistan Check Dam (image by U. S. Army)

Hillside Infiltration Recommendations

See Figure 2 for location of existing treatments in the watershed. Though there are many treatments already specified, they are primarily low in the watershed. Additional treatments higher in the study area will provide additional reduction in peak flows and erosion (See Figure 2 for general location of proposed treatments). See the map referenced above for more detail.

Hillside ditch and bund treatments are estimated by the following. Ditch and bund length is based on an average shape ratio of 5:1 for a master shape, and a spacing for the average slope for that polygon based on Standard Operating Procedures. Total hillside ditch length is 67,485 m (Table 1).

Total area for ditch and bund is 56.6 ha. The area in existing treatments (30 ha) plus this area is 86.6 ha or15% of the watershed, enough to be a probable significant effect on water delivery. These estimates may need to be adjusted during contract administration in the field. The identifiers (ID) in Table 1 are used on the map.

Because this method generally underestimates ditch length contract estimators should add an additional 10%.

Note that hillside ditches and rock bunds are prone to damage by heavy grazing, especially where ditches promote vegetative growth by trapping water. A grazing management system should be considered.

Though trees are planted in lower terraces, they are not recommended in this higher elevation area. Irrigation is probably not feasible due to the distance from settlements and poor road system, and the environment is not conducive to forested vegetation.

Table 1. Proposed Hillside Treatment Areas

ID	Area (m2)	Avg. Slope (%)	Treatment Type	Linear Ditch (m)	Slope spacing (m)
1	88,985	33.6	Hillside Ditches	10,544	8.4
2	44,373	30.2	Hillside Ditches	5,310	8.4
3	13,296	34.9	Hillside Ditches	1,569	8.5
4	85,929	28.9	Hillside Ditches	10,320	8.3
5	110,378	31.3	Hillside Ditches	13,168	8.4
6	43,699	31.2	Hillside Ditches	5,215	8.4
7	32,466	36.0	Hillside Ditches	3,819	8.5
8	26,989	30.7	Hillside Ditches	3,225	8.4
9	37,983	32.9	Hillside Ditches	4,510	8.4

10	16,590	28.2	Hillside Ditches	1,996	8.3
11	29,569	29.6	Hillside Ditches	3,544	8.3
12	13,653	33.7	Hillside Ditches	1,617	8.4
13	22,306	33.0	Hillside Ditches	2,648	8.4
	566,216		Total Ditch Length (m)	67,485	

Hillside Ditch Tree Planting

Existing hillside terrace treatments were also mapped (Figure 2). One purpose is to provide planting sites for trees. Existing terrace length was measured and terraces counted for three representative treatment polygons, then extrapolated to the entire treatment area. Since average slope is not similar between polygons (Table 2), slope area (not planar area) was used to calculate total terrace length/m^2 and estimated trees/polygon. Terraces average 10 m in length for an average of 0.098 m terrace /m^2 area. This combined with the recommended tree spacing (measured at 0.4 trees/m from Figure 1) should provide an estimate of number of trees needed to complete the area's plantings. ID's are on the detailed map referenced above.

Table 2. Existing Hillside Treatment Areas

ID	Slope Area (m^2)	Avg. Slope (%)	Terrace Length (m)	Total Trees for Polygon (at 0.4 trees/m spacing)
1	18,010	24.6	1,715	686
2	20,744	31.7	1,959	784
3	14,509	19.9	1,392	557
4	2,867	30.3	271	108
5	26,029	23.9	2,481	993
6	46,180	20.1	4,454	1,782
7	32,575	20.8	3,113	1,245
8	3,821	10.4	373	149
9	1,012	13.9	98	39
10	36,197	21.3	3,472	1,389
11	11,466	13.1	1,115	446
12	31,720	23.0	3,030	1,212
13	23,633	29.8	2,224	890

14	29,652	10.5	2,893	1,157
15	3,268	27.1	310	124
17	5,037	11.7	490	196
Totals*	306,720		29,390	11,757
* Note: These totals should be reduced by the polygons that have already been planted.				

I recommend adding at least 20% for breakage, loss, and mortality during transport.

Because this environment is relatively dry, tree plantings must be irrigated for the first few years to establish root systems keeping the root zone moist at all times during the growing season (probably five years). Otherwise most will die.

Infiltration (Check) Dam Recommendations

Check dams are an effective treatment to moderate water flow, reduce erosion, and increase infiltration in drainageways with slopes of less than 20%. Check dams were specified where slopes were appropriate in ephemeral or intermittent drainages. Larger drainages with established flood channels were not treated. With 1,497 m of candidate drainageways, estimated at 3 m in average linear width and a 1 m high dam (based on imagery), and an average slope of 12.3%, spacing is 12 m, according to specifications. *Therefore, 125 check dams are estimated, with a total dam length of 4,491 m.* These dams are not designed to be water-tight, or to stop gully formation. They are merely for reduction of flow to promote infiltration. Therefore spacing is not critical. Some are placed in active gullies, but little improvement will occur in these without grazing impact reduction. See the detail map for locations of candidate drainageways. Check dams are not placed in upper watershed areas. This is because of steep slopes.

I recommend a 10% increase in check dam length for field-located gullies and ephemeral drainageways in this area.

Canal Improvement Recommendations

Only one canal was mapped here, and is a major feeder for many agricultural uses. It appears that it could benefit by seepage reduction, grade control, silt removal, and breach repair (Figure 6). De-silting, vegetation removal, debris cleaning, and rebuilding weak sections look like good activities that would benefit the irrigated agricultural areas farther downvalley.

Figure 6. Canal Cleaning (Image by USAID)

Karez systems are traditional irrigation systems using a series of pits accessing subsurface channels (Figure 7 and Figure 8). There are three totaling 350 m in the Study Area. These could probably benefit from cleaning. See the detail map for locations.

Figure 7. Aerial view of Karez (Image from Registan.net)

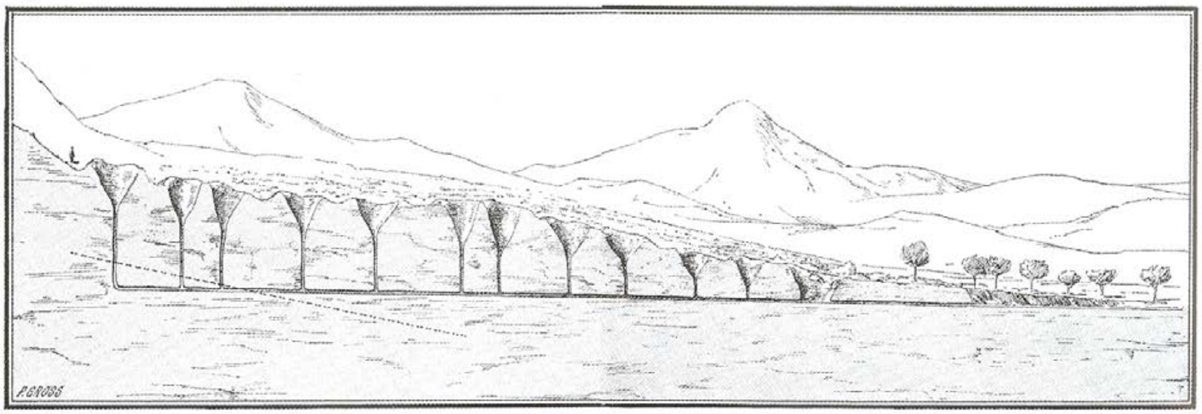

Figure 8. Typical Karez in Afghanistan (image by UNFAO)

End of text.

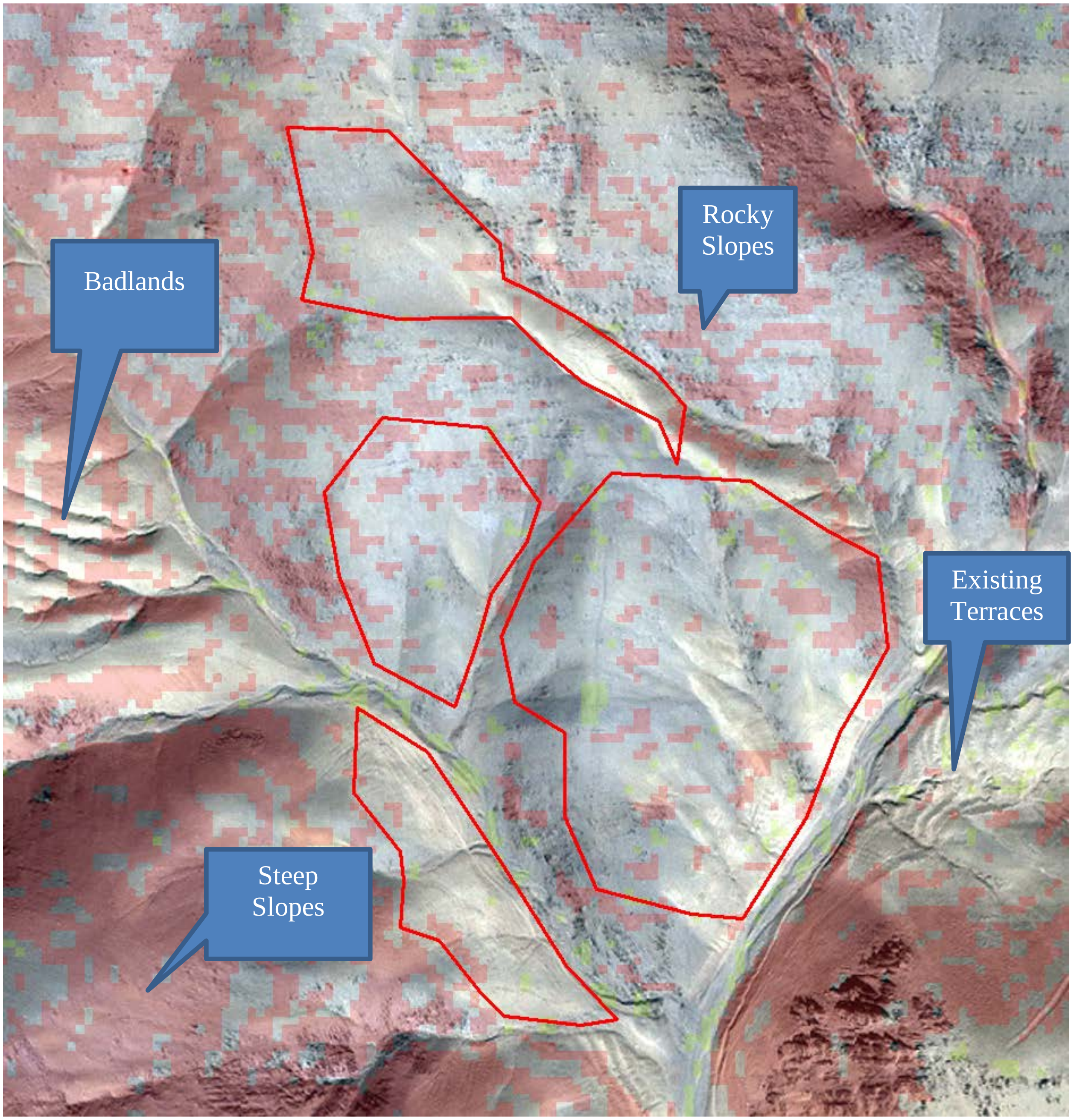

Figure 9. Example Hillside Treatment Delineation Criteria. Red polygons are proposed hillside treatments