Appendix E

Paktika Province, Afghanistan Water Resource Study
Watershed Condition and Management Project:
Measurement and extent of deforestation
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February 14, 2008

Objectives of the Water Resource Study

The objective of this study is to evaluate potential water resource projects in the Paktika Province of Afghanistan that will benefit the people of that region. This SOW was prepared at the request of the US Army Corps of Engineers' Transatlantic Programs Center and Afghanistan Engineer District in support of the Provincial Reconstruction Team (PRT) Commander, Paktika Province. The study report will assist the PRT Commander in identifying potential water resource projects which may include; hydropower potential, flood control, erosion control, irrigation dams, canals and drains. The report will also provide guidance on how to address groundwater, sanitary and other water resource problems the people of Paktika are experiencing.

Objectives of the Watershed Condition and Restoration part of this study:

Identify on a project planning level (scale of approximately 1:250,000), candidate watersheds for long term erosion/sediment production reduction, based on the following criteria

- Contributing sediment/flooding/gullying to either planned or existing irrigation works or fields in the Barmal Valley.
- Have active or recent erosion problems related to human-caused deforestation/or overgrazing as identified by imagery modeling for deforestation/devegetation and erosion modeling for erosion/sediment potential
- Have characteristics of "sensitive" watersheds: Steep slopes, landforms, unstable rock types, bare soils, climatic factors, hydrologic sensitivity
- Identify two demonstration project areas (at approximately 1:24,000) for long term erosion/sediment production reduction using the following criteria:
- Within candidate high risk watersheds as defined above
- Security is either present or practical to achieve
- Access is practical using local labor and technical expertise (ACC, Dept. of Forestry, etc.)
- Cultural capacity is present (local villages, ACC, access)
- Consistent with recommended engineering projects
- Values are present (adequate soils, slopes for agriculture) and are at risk from identified watershed conditions

See Figure 1 for extent and location of the Deforestation part of the Water Resources project.

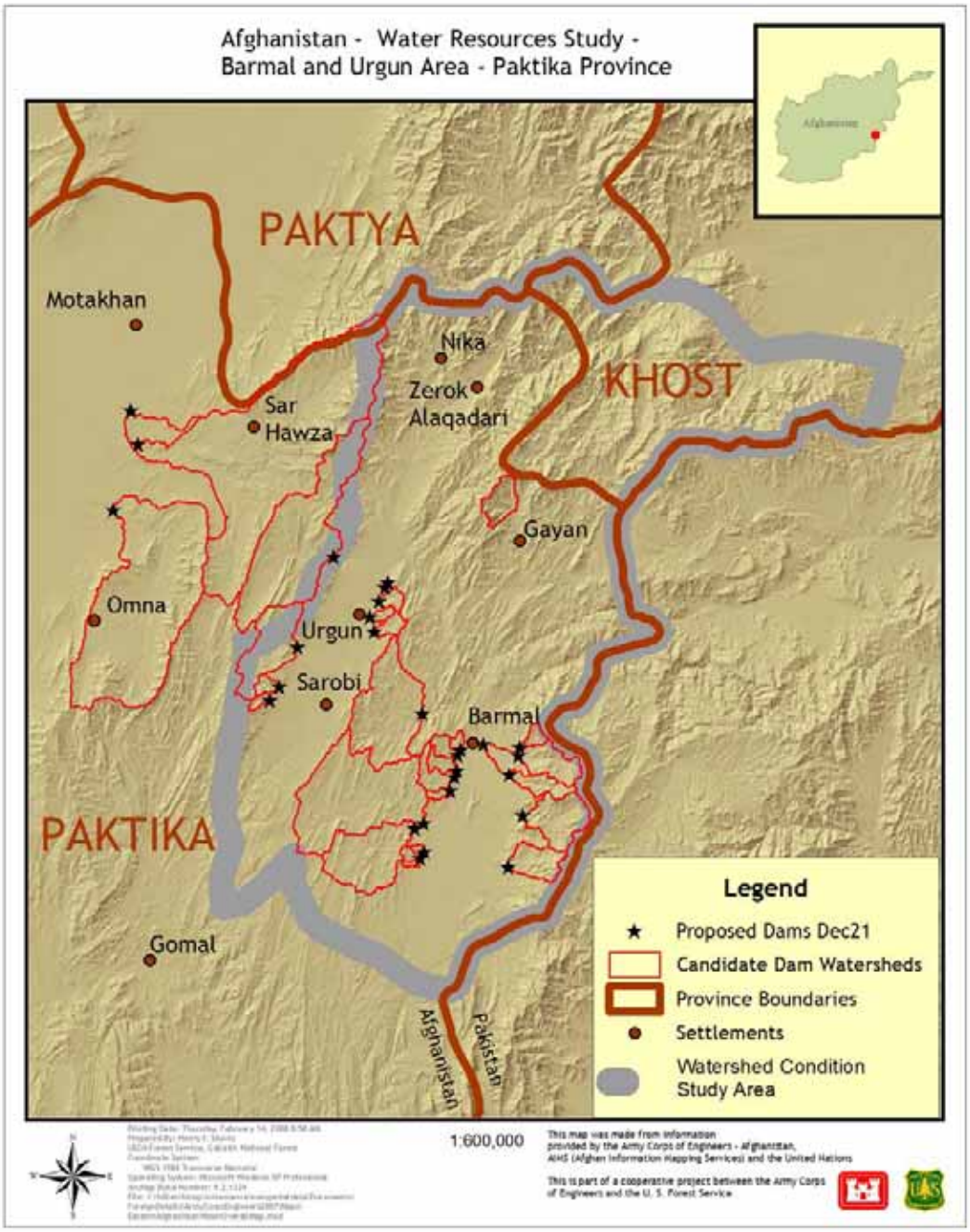

Figure 1. Study area

Objectives of this Appendix:

Describe results of the deforestation analysis of candidate watersheds.

Methods

LANDSAT imagery at two dates, a U. S. Forest Service deforestation model, and high-resolution QUICKBIRD imagery were used to determine extent and timing of deforestation in forested areas for the candidate watersheds.

The pre- and post- images are shown below for the study area (CIR band combination). They were ortho-rectified to local QUICKBIRD imagery and a 30 m digital elevation model. Generally, similar dates are recommended, to keep phenol-temporal differences to a minimum. The pre-image (LANDSAT 5) was August of 1998 (Figure 2B), and the post-image (LANDSAT 7) (Figure 2A) was September of 2007. The disparity in dates increases potential noise in the system. A nine-year spread of data was judged to give an adequate temporal framework for recent deforestation. Clouds were masked, and scan line errors in LANDSAT 7 imagery were corrected. The model used is called a BARC (Burned Area Reflectance Classification) and is based on the differences between post and pre image reflectance of a combination of bands. It was developed and tested at the U. S. Forest Service Remote Sensing and Applications Center in Salt Lake City, Utah. Higher levels of vegetation change produce a higher reflectance, and are categorized for this study in four classes (Figure 3).

High resolution (.8 m) CIR QUICKBIRD imagery was used for ground-truth. Ground indicators of recent harvest, insect/disease kill, or wildfire were used to determine the likely causes of deforestation as measured by the BARC model.

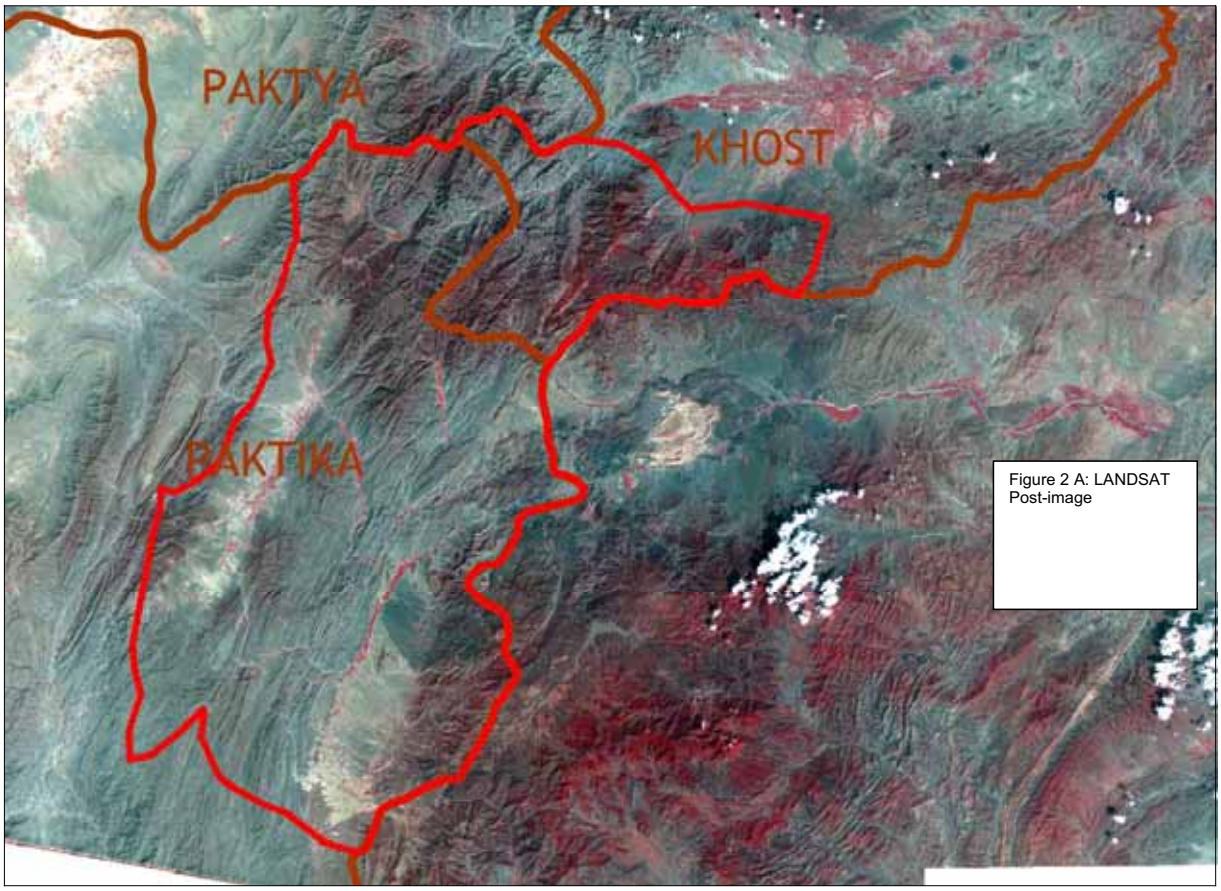

Figure 2 A: LANDSAT Post-image

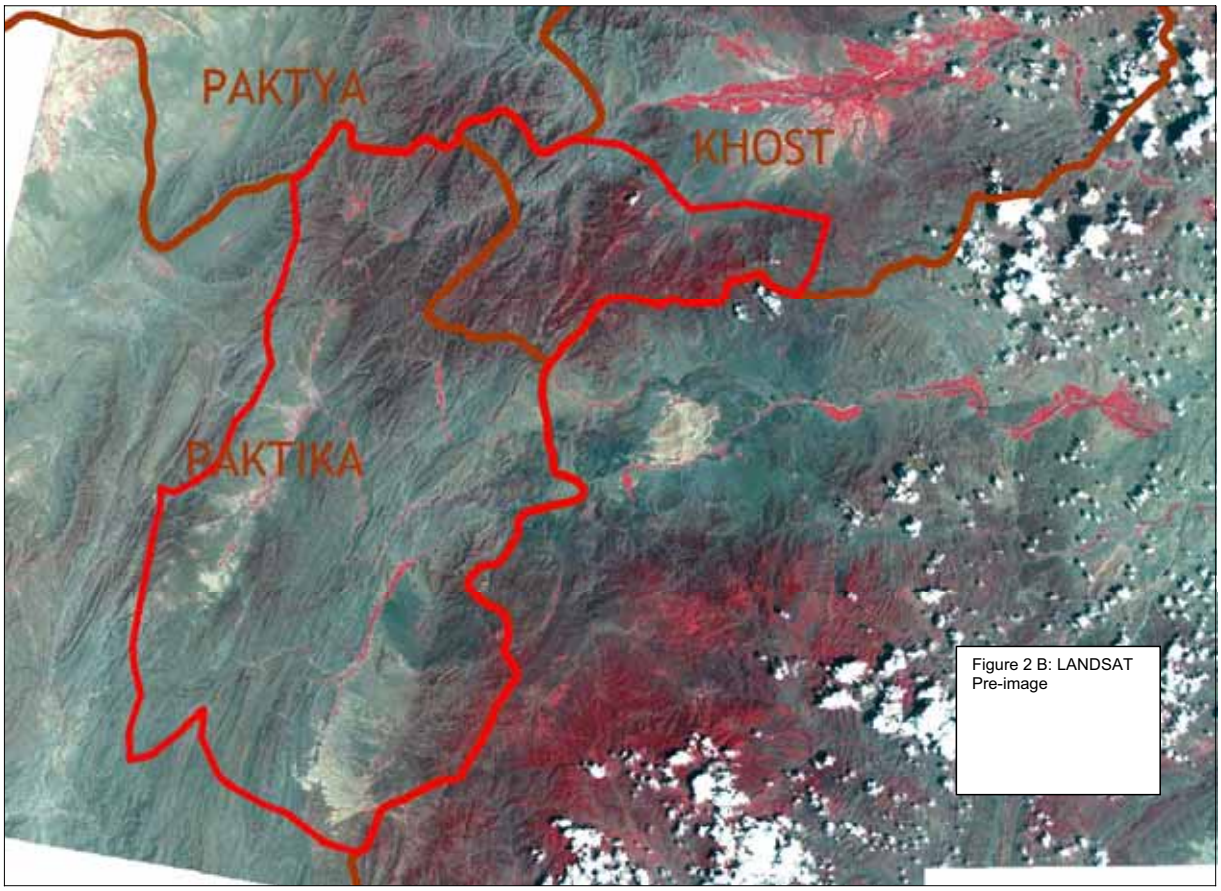

Figure 2 B: LANDSAT Pre-image

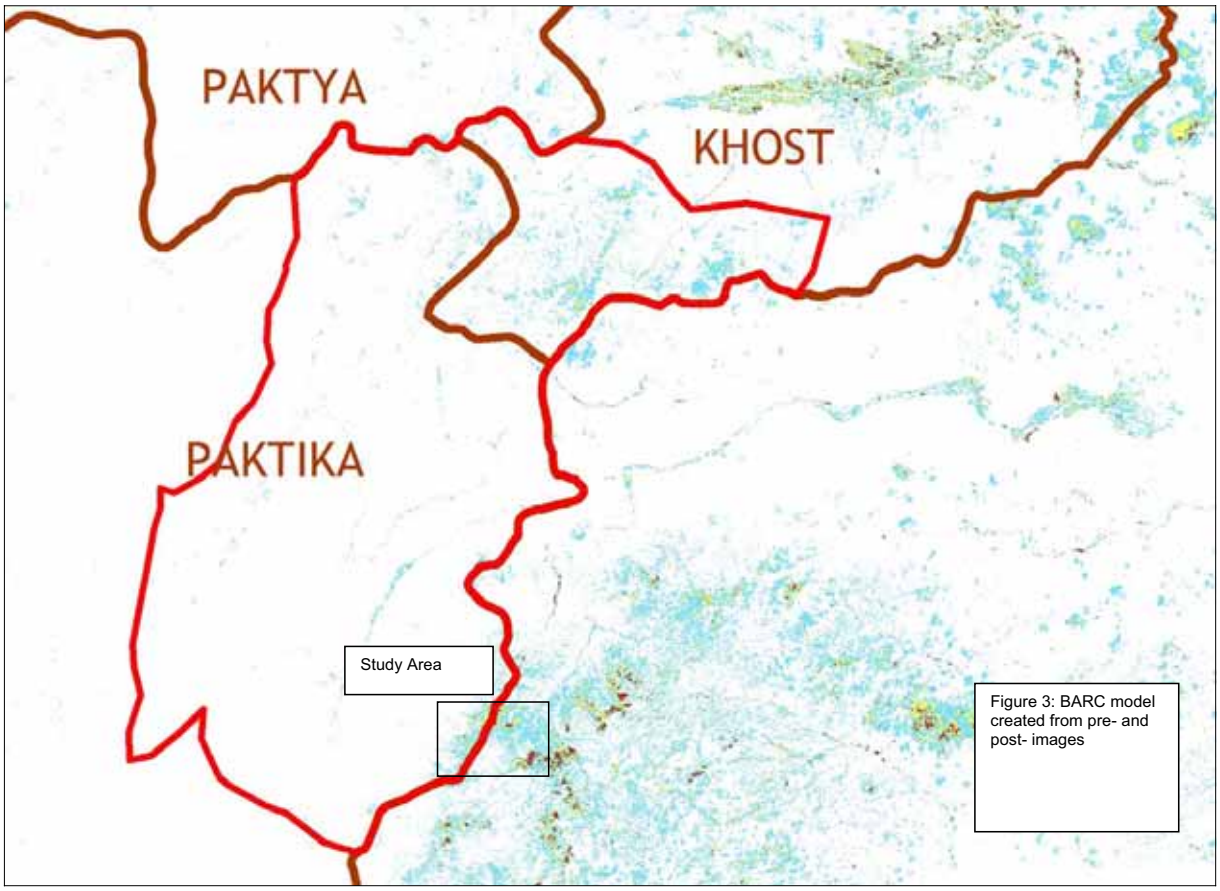

Figure 3: BARC model created from pre- and post- images

Results

The BARC model predicts change in vegetation over time. Because of differences in dates, and since the model is only calibrated for forest vegetation some areas were eliminated from further consideration. Examination of the BARC classes showed only the highest two classes indicated recent harvest. Older harvested areas may be indicated by lower classes, having had some vegetative recovery since harvest.

A detailed examination was made of areas including Barmal study watersheds (Figure 4). Quickbird imagery was compared to the areas that appeared to have recent changes in vegetation in eastern Afghanistan and in nearby Pakistan. The highest two classes (red and yellow) correlated very well with signatures of recent logging activity in both countries (Figure 5). It appears there was large scale, relatively recent (sometime in the last nine years) logging activity. From the relative intensity of road use, logged areas extended into Afghanistan with the harvested timber moving towards Pakistan. Though a two-track extends part-way down drainage from the Afghan harvested areas, it is much more likely logs were moved through Pakistan on well established routes (Figure 6). Logging activity was inferred from spectral signatures and patterns consistent with ground-based logging systems (Figure 7). Other areas were examined but are not included here, since these areas were the only ones in the current study. Border is approximate, and based on watershed modeling.

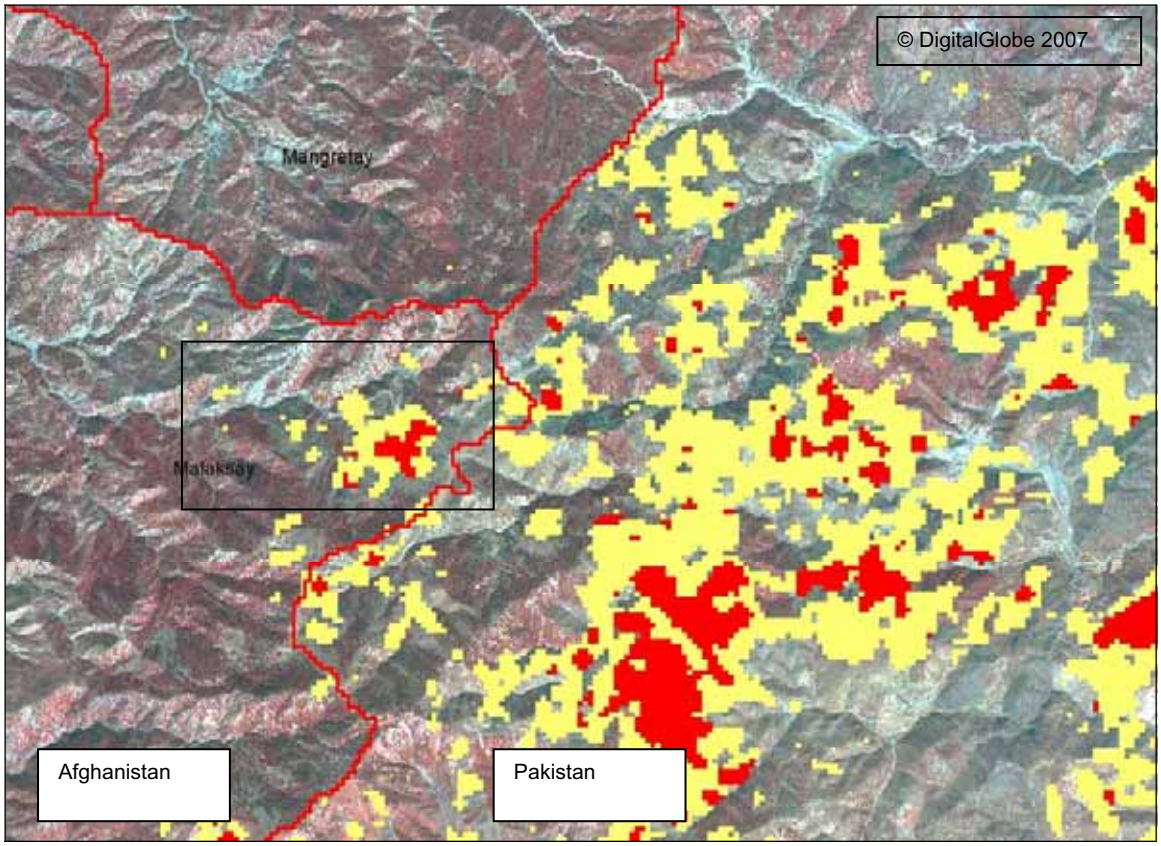

Figure 4. Study Area at head of Malaksay Dam Candidate Watershed

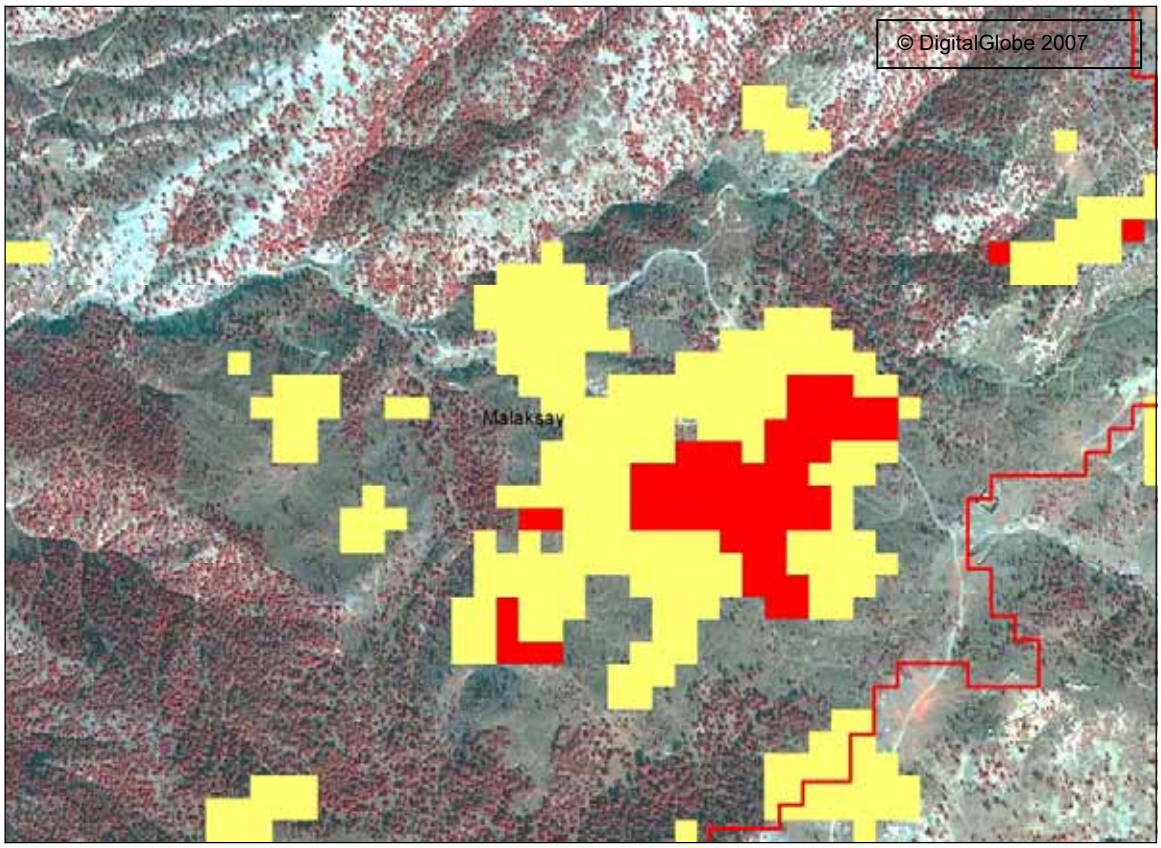

Figure 5. Relationship between BARC and logging area for closeup of study area

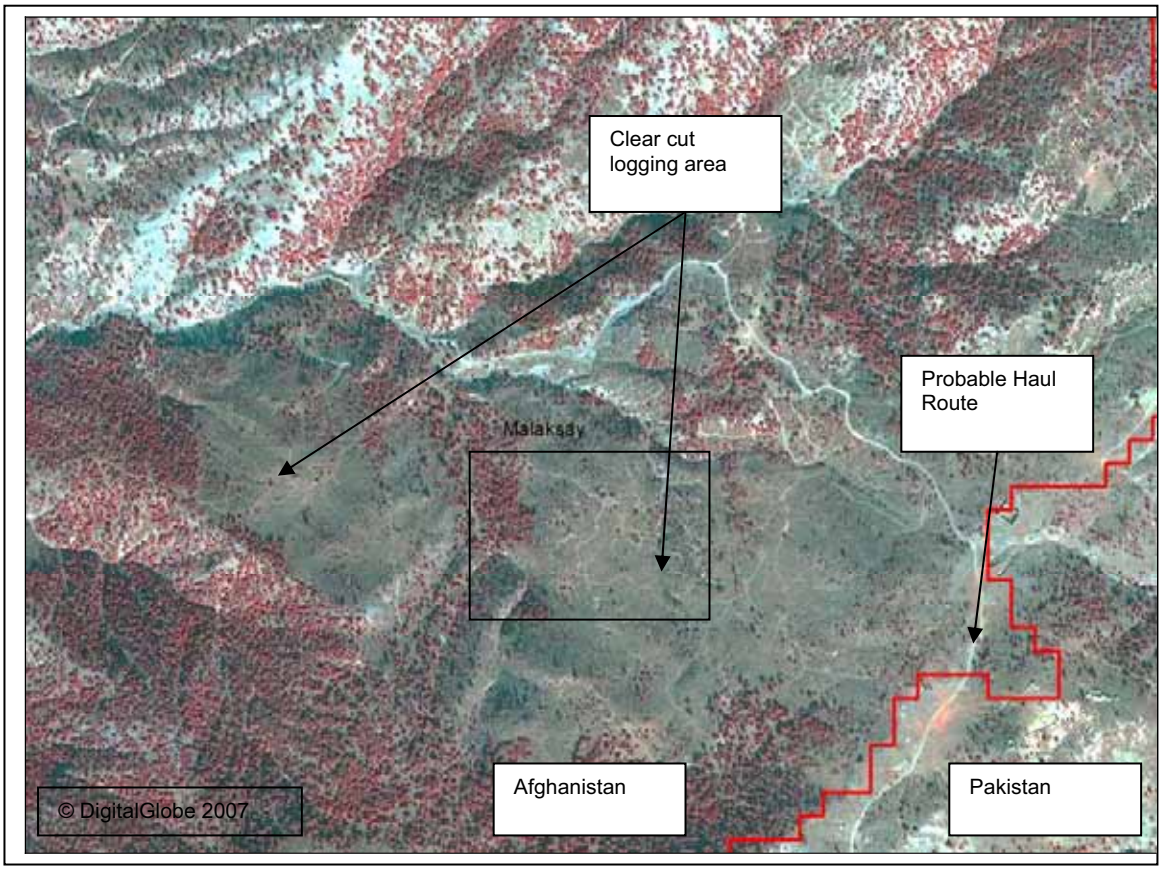

Figure 6. Probable haul routes

Figure 7. Signatures of past logging activity

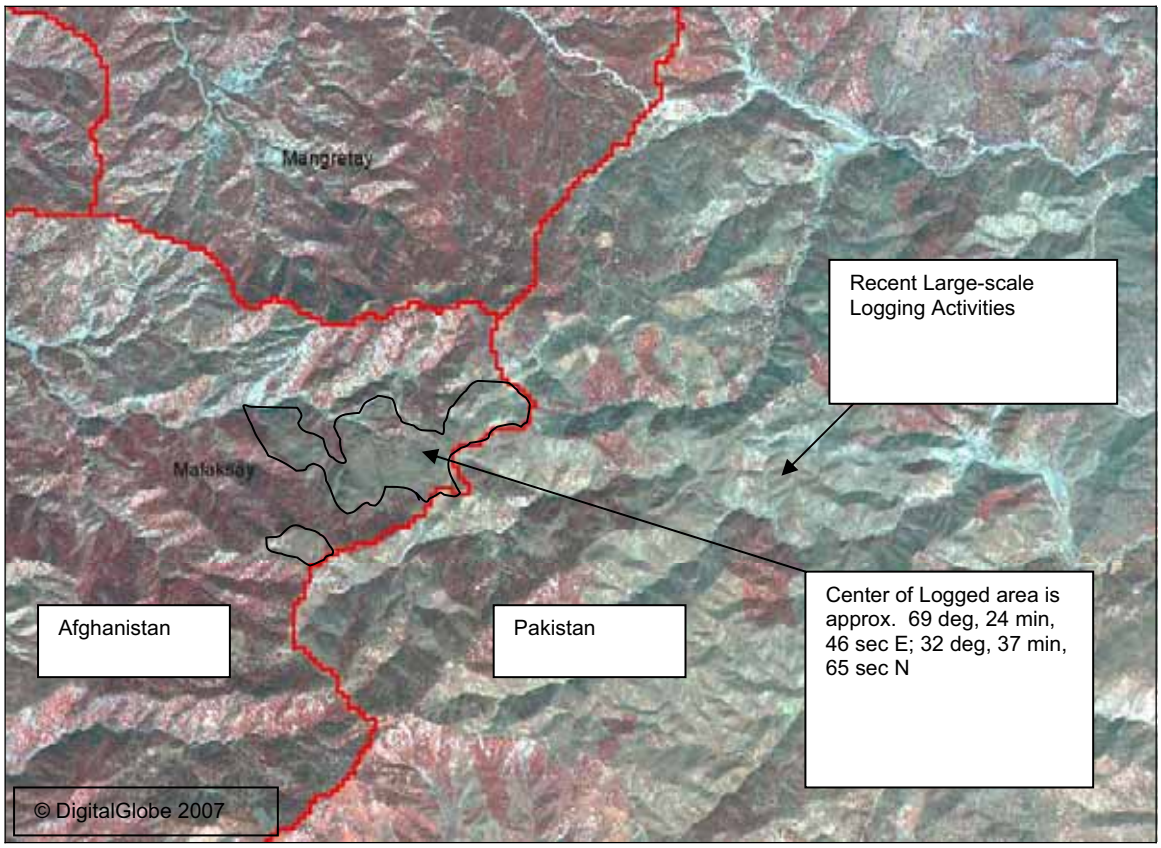

Figure 8. Deforestation polygons at head of Malaksay watershed (does not include Pakistan's harvest areas)

Conclusions

Though only a small part of Malaksay watershed has been deforested (Figure 8), it occurs at the head of the watershed on very steep slopes, with probable high snow pack and rapid hydrologic response on melt (Figure 9). Therefore it is a cause for concern for water-quality/quantity dependent downstream uses.

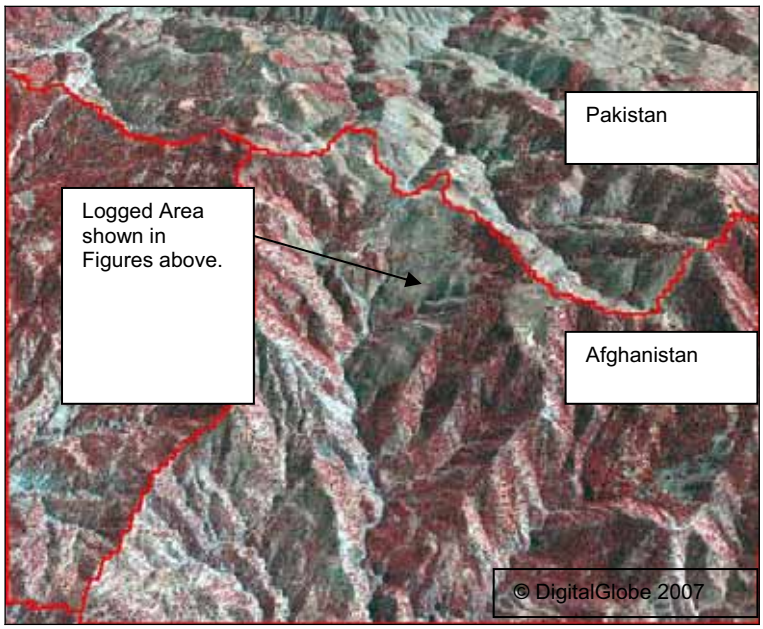

Figure 9. 3D view of head of Malaksay watershed showing deforested steep slopes

Wildfire and disease do not appear to be a large factor in deforestation in this area, though older wildfire-affected areas appear in other watersheds.