National Rangelands Monitoring System for Afghanistan
Geospatial science supported rangelands resource inventory and monitoring

- Rangelands area and classification to facilitate broad management decisions, systematic sampling and extrapolation of sample results

- Monitoring rangelands productivity (Biomass assessment) and degradation trends across

- Capturing and analyzing spatial interactions of pastoralist and rangelands resource
Geospatial science supported rangelands monitoring system

- Delineation of the rangeland area and types
- Remote Sensing based phenology and productivity patterns
- Degradation trends based on the data from 2001-2018
Intra-annual vegetation changes in rangelands and agriculture areas

Monthly NDVI changes during - 2019
## Methods

### Dataset and Software used

<table>
<thead>
<tr>
<th>S No.</th>
<th>Data / Product</th>
<th>Data Type</th>
<th>Time Range</th>
<th>Spatial Resolution</th>
<th>Temporal Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NDVI and QA / MOD13Q1</td>
<td>Raster</td>
<td>2002 - 2019</td>
<td>250 m</td>
<td>16 Days</td>
</tr>
<tr>
<td>2</td>
<td>CHRIP rainfall data</td>
<td>Raster</td>
<td>2013-2019</td>
<td>5 Km</td>
<td>5 Days</td>
</tr>
<tr>
<td>3</td>
<td>SRTM-DEM</td>
<td>Raster</td>
<td>NA</td>
<td>30 m</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td>Bioclimatic zones of Afghanistan</td>
<td>Vector</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>5</td>
<td>Administrative Boundaries of Afghanistan</td>
<td>Vector</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

### Ground data:

1. Ground sample point (reference points)

### Software:

1. TIMESAT MODEL
2. R- MANN-KANDELL PACKAGE.
3. ARCGIS
Observing Phenology – Vegetation Dynamics Metrics (VDM)

- **SGST** = Start of Growing Season Time
- **EGST** = End of Growing Season Time
- **LGS** = Length of Growing Season
- **MSN** = Maximum Seasonal NDVI
- **SIN** = Seasonal Integrated NDVI

*SIN is function of both LGS and MSN*
Methods

Time series NDVI data cleaning and processing

Adaptive Savitzky-Golay filtering


Time series parameter setup for Savitzky-Golay filter

Smoothened NDVI images

Mann-Kendall Trend analysis

Season Integrated NDVI

Season Maximum NDVI

Season SOS

Season EOS

Season LOS

Phenological metrics from time series data

Rangeland Delination

Extraction of phenological metrics from time-series data

Phenological assessment of Rangeland

Deriving Thresholds

Products

Rangeland Classified map

Potential Rangeland maps

Productivity maps

Area Estimation

Rangeland type map

DEM

Bioclimatic zones
## Deriving vegetation phenology

<table>
<thead>
<tr>
<th>PPM</th>
<th>Metric type</th>
<th>Description</th>
<th>Ecological meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of growing season time (SGST)</td>
<td>Time when NDVI reaches a defined threshold value in spring</td>
<td>Approximates the start of the season when green forage becomes available; time of highest quality forage</td>
<td></td>
</tr>
<tr>
<td>End of growing season time (EGST)</td>
<td>Time when NDVI decreases to a defined threshold value in autumn</td>
<td>Approximates the end of the season when seasonally active vegetation becomes senescent or has been covered in snow; green forage becomes scarce</td>
<td></td>
</tr>
<tr>
<td>Length of growing season (LGS)</td>
<td>Number of days between start and end of growing season</td>
<td>Number of days when forage is available</td>
<td></td>
</tr>
<tr>
<td>Time for the mid of the season</td>
<td>Phenology</td>
<td>Time of maximum NDVI</td>
<td>computed as the mean value of the times for which, respectively, the left edge has increased to the 80 % level and the right edge has decreased to the 80 % level</td>
</tr>
<tr>
<td>Seasonal amplitude</td>
<td>Difference between the maximum value and the base level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of increase at the beginning of the season</td>
<td>Calculated as the ratio of the difference between the left 20 % and 80 % levels and the corresponding time difference</td>
<td>Calculated as the absolute value of the ratio of the difference between the right 20 % and 80 % levels and the corresponding time difference. The rate of decrease is thus given as a positive quantity</td>
<td></td>
</tr>
<tr>
<td>Rate of decrease at the end of the season</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seasonally integrated NDVI (SIN)</td>
<td>Productivity / biomass values of the season</td>
<td>Proxy for seasonal primary production of vegetation</td>
<td></td>
</tr>
<tr>
<td>Maximum seasonal NDVI (MSN)</td>
<td>Maximum NDVI value of season</td>
<td>Proxy for maximum forage biomass of the season</td>
<td></td>
</tr>
</tbody>
</table>
Methods

Phenology analysis

Vegetation classification

Bioclimatic classification

Ground Land cover samples

Agro-ecological zones

Legend
- Barrenland
- Cropland
- Forest
- Rangeland
- Sand
- Water

Elevation Value
- High: 7467
- Low: 0


Ground Land cover samples

Aggregated Land Cover
- Vineyards
- Barren Land
- Sand Cover
- Forests & Shrubs
- Rangeland
- Permanent Snow
- Built Up
- Water Bodies & Marshland
Phenological response- Large season Integral

Season Integrated NDVI

Year


LULC
- Barrenland
- Forest
- Rangeland
- Water
- Cropland
- Rainfed cropland
- Sand
Phenological response - Length of Season (LOS)

- Rangeland and rainfed crop is extremely dynamic.
- The rangeland have longer LOS as compared to rainfed cropland.
- The difference between the LOS is observed in rangeland and rainfed crop land.

Rangeland Definition:

- $1.5 < \text{Season Integrated NDVI} < 3$
- LOS $> 130$
- Last 5 Years observation
Rangeland - Afghanistan (2013-2018)

System Area (sq.km)

<table>
<thead>
<tr>
<th>System</th>
<th>Area (sq.km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRLMS (2014-18)</td>
<td>34,230,311</td>
</tr>
<tr>
<td>RLCMS (2014)</td>
<td>31,602,130</td>
</tr>
<tr>
<td>FAO (2010)</td>
<td>30,243,985</td>
</tr>
</tbody>
</table>

Yearly active rangeland area

- 2013: 21,000,000
- 2014: 21,000,000
- 2015: 18,000,000
- 2016: 22,000,000
- 2017: 22,000,000
- 2018: 25,000,000
Rangeland type map = Bioclimatic zones + Phenological Characteristics

- Alpine meadows
- Sub-alpine meadows
- Temperate Woodland
- Steppe and semi desert
- Desert (Haloxylon persicum, Calligonum spp. Aristida spp)
The rangeland area estimated (LULC) is slightly overestimated as compared to active rangeland area estimated in present framework.

The overestimation of the area (in LULC) is mainly observed in rainfed cropland and barren/sand LULC class.
Difference between rangeland area produce through RLCMS and rangeland monitoring system.

- The RLCMS use machine learning classification approach and national rangeland monitoring system use modelling based approach.
- The rangeland monitoring system used 16 days temporal interval data whereas RLCMS use seasonal composites.
- RLCMS approach use training data based on visual interpretation, which is challenging specially when collecting data from rangeland, rainfed cropland and barren land because these land cover features are quite similarly looking.
- However, rangeland monitoring system derived vegetation based primitives such as LOS, Season integrated NDVI to separate out rangeland from other confusing class.
The 5 years average active rangeland area (rangeland area) estimated by NRLMS is nearly equal to yearly area estimated by RLCMS system.
Greening/browning trend

- Monotonic upward or downward trend of the variable of interest over time.
- A monotonic upward (downward) trend means that the variable consistently increases (decreases) through time, but the trend may or may not be linear.

Legend:
- Degradation (-)
- High Browning (-)
- Moderate Browning (-)
- Less browning (-)
- Less stable (-)
- Stable
- More Stable (+)
- Greening (+)
- High Greening (+)
- Regeneration (+)

Browning 05 %
Stable 86 %
Greening 09 %
Correlation Between Rainfall and Rangeland
Conclusion and Way forward

- Rangeland is a very dynamic land which drastically changes every year in Afghanistan.
- The (potential) rangeland area of Afghanistan is 34,896,582 Ha. (potential) but the active rangeland varies every year.
- Rainfed cropland and range land is highly intermixable. LOS plays a major role in separating these two classes.
- Further scientific understanding of rangelands vegetation growth, in alpine and sub-alpine areas, relation to snow cover dynamic is needed.
- Work on Range Resource-use needs to be carried out.
Thank-you for your kind attention

Let’s protect the pulse.