

# Ground-based and Remote sensing studies in Mountainous Regions: Experiences of Kyrgyzstan

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## GEWEX START AUCA Workshop on Central Asia was held on 4-6 October, 2021

### An Exploration of Climate Science in Central Asia - Moving Towards Frontiers of Knowledge and Action

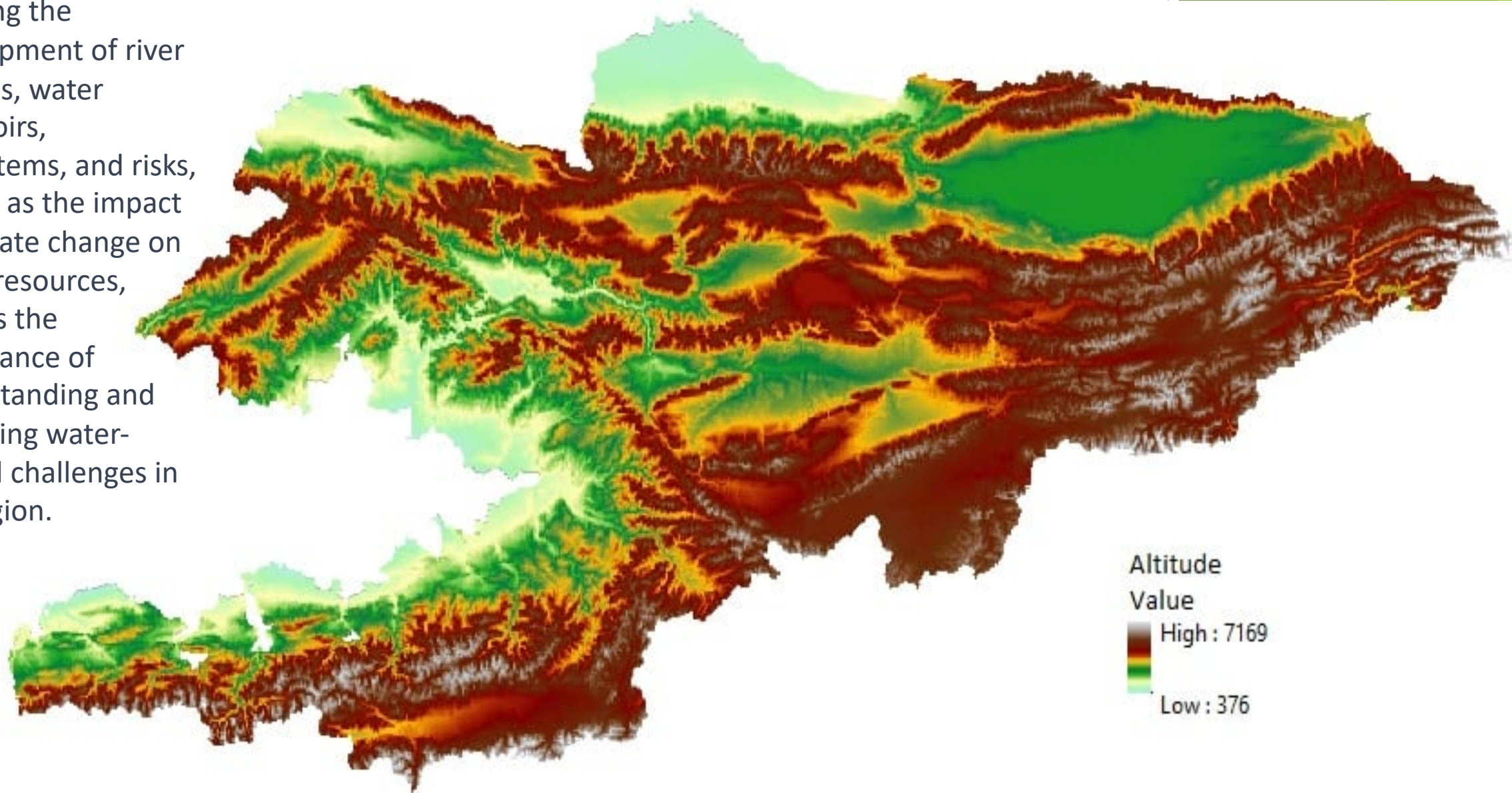
- ▶ More regional collaboration on water and climate is needed including bridging the policy science gap
- ▶ Inclusivity (culturally and across stakeholders) needs more attention
- ▶ There is a need for more complete and better-quality data (incl. observations) that goes beyond just open data (resources) sharing
- ▶ Capacity development is needed at all levels and long term, and should include strategies for adaptation and mitigation, from research to applications/implementation
- ▶ Global and regional hydrologic projects should be coordinated and linked to the relevant communities (incl. indigenous knowledge).
- ▶ Strong need to prevent brain drain and attract and retain young talent

# Group of researchers:

- ▶ Bakhtyiar Asanov - Assistant professor of AUCA, Associate researcher in water quality
- ▶ Maxim Kulikov - Associate researcher of MSRI, GIS expert
- ▶ Kanat Sultanaliev - Researcher, Agriculture experts
- ▶ Sagynbek Orunbaev - Researcher, Water resources, river basin modeling

## Mountainous Kyrgyz Republic

AUCA's focus on studying the development of river systems, water reservoirs, ecosystems, and risks, as well as the impact of climate change on water resources, reflects the importance of understanding and managing water-related challenges in the region.



SRTM1arcsec (~30m) data

(Orunbaev et al., 2021)

# CLIMATE CHANGE HAZARDS In KYRGYZSTAN

Underground flooding



Glacier degradation



Outbursting lakes



Droughty



Air Pollution



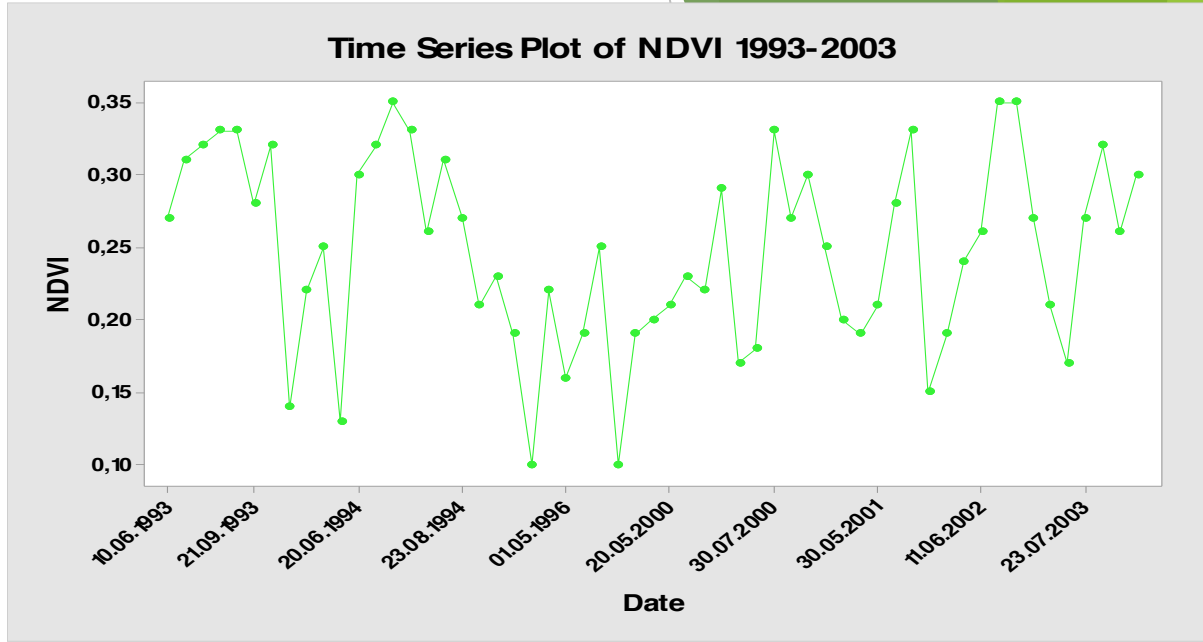
Mud flows



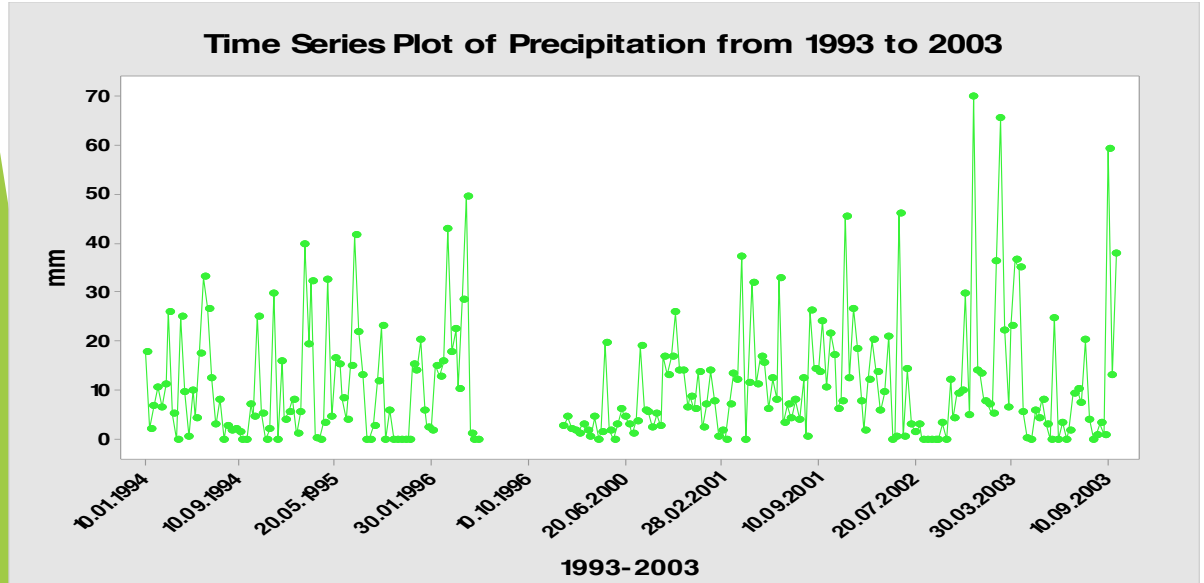
# Meteorological data sample

Управление по гидрометеорологии		ГОСУДАРСТВЕННЫЙ КОМИТЕТ СССР ПО ГИДРОМЕТЕОРОЛОГИИ														
Станция <i>Возврат</i>		ТАБЛИЦА														
Республика <i>Наран-Уул</i>		метеорологических и агрометеорологических наблюдений														
Область (край) <i>Ций</i>		Станция <i>Возврат</i>														
числа месяца	воздуха			На поверхности почвы (снега)		средняя за сутки температура почвы на глубине (на метеолошаде)					Влажность воздуха		Облачность (балл)	Осадки (мм) за:		
	сухого	влажного	снежного	макс.	мин.	5	10	15	20	40	относительная %	дефицит %		день	ночь	сутки
11	11.8	10.5	1.7	46.5	1.0	19.2	19.1	9.2	17	11.7	17.5	5				
12	12.1	10.0	2.1	44.0	0.5	18.8	19.1	3.8	11	10.5	20.1	5				
13	13.4	18.0	3.6	47.0	5.3	18.7	19.0	3.3	11	11.0	19.9	5				
14	13.8	18.0	3.4	47.8	4.3	13.0	18.8	2.6	8	12.7	18.2	6				
15	10.2	20.2	-1.6	46.0	-3.0	18.3	18.6	3.0	10	10.5	18.2	6				
16	11.2	17.6	3.3	44.0	-2.4	18.2	18.3	3.4	2.3	9.4	14.2	4.7	2.6			
17	9.7	14.5	5.4	33.4	3.7	17.6	18.2	3.6	2.1	8.6	12.3	5.7	2.6			
18	8.2	11.5	5.4	30.5	3.3	15.8	17.8	3.7	2.5	7.3	9.2	6.8	1.5			
19	4.4	16.0	-0.7	34.0	-2.2	15.6	17.1	4.8	3.5	4.8	8.4	6.5	3.9			
сумма за декаду	9.7	30.5	-2.7	22.6	-2.0	14.4	16.3	6.6	4.4	2.6	5.0	6.7	4.7	7	0.0	0.0
сумма за месяц	9.7	30.5	-2.7	47.8	-3.0	17.7	18.2	3.7	3	8.9	20.3	4	2	12	0.0	0.0
сумма за квартал																

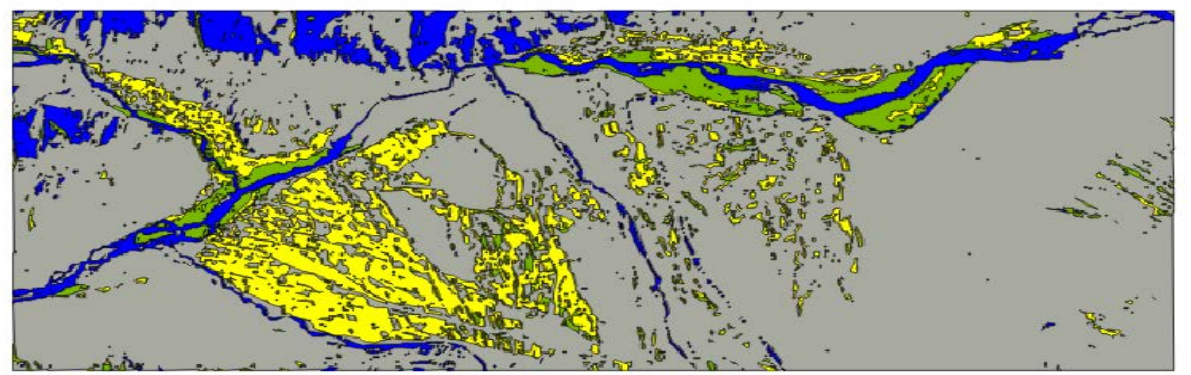
# Time series of NDVI from 1993 to 2003



# Time series of precipitation from 1993 to 2003



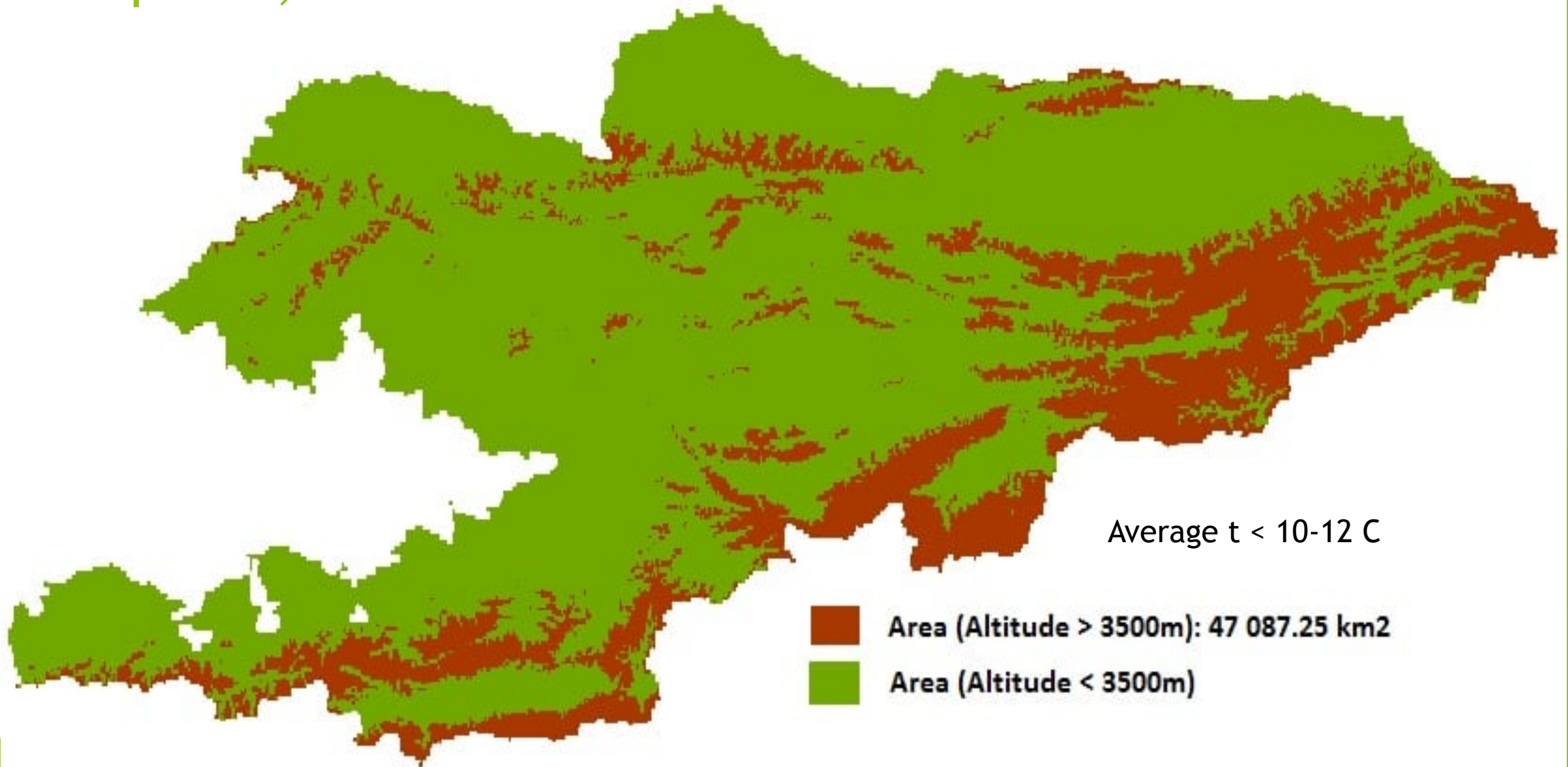
Chong-Alay Valley map. Land cover classification of Daroot Korgon administrative center



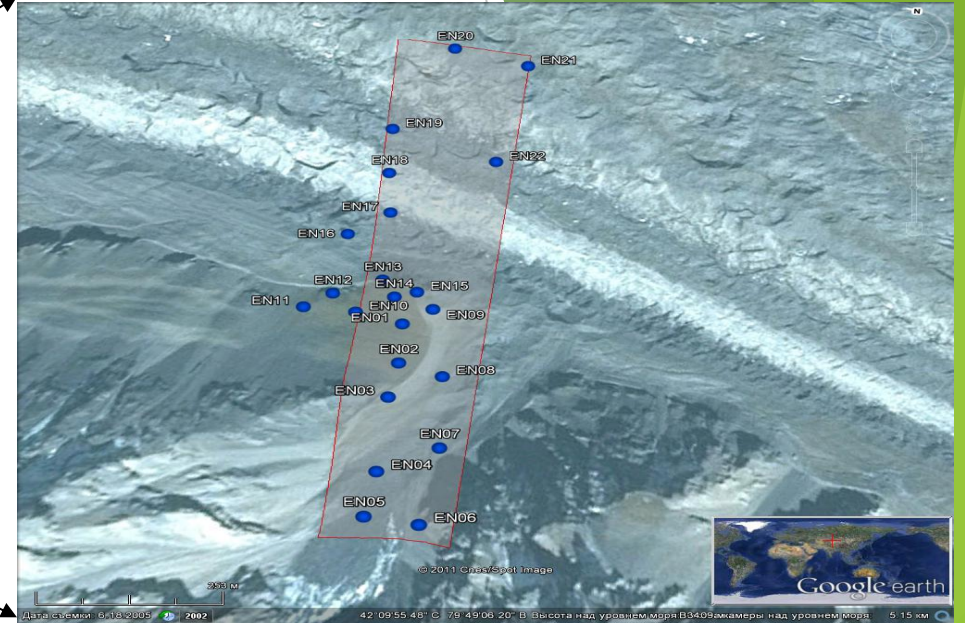
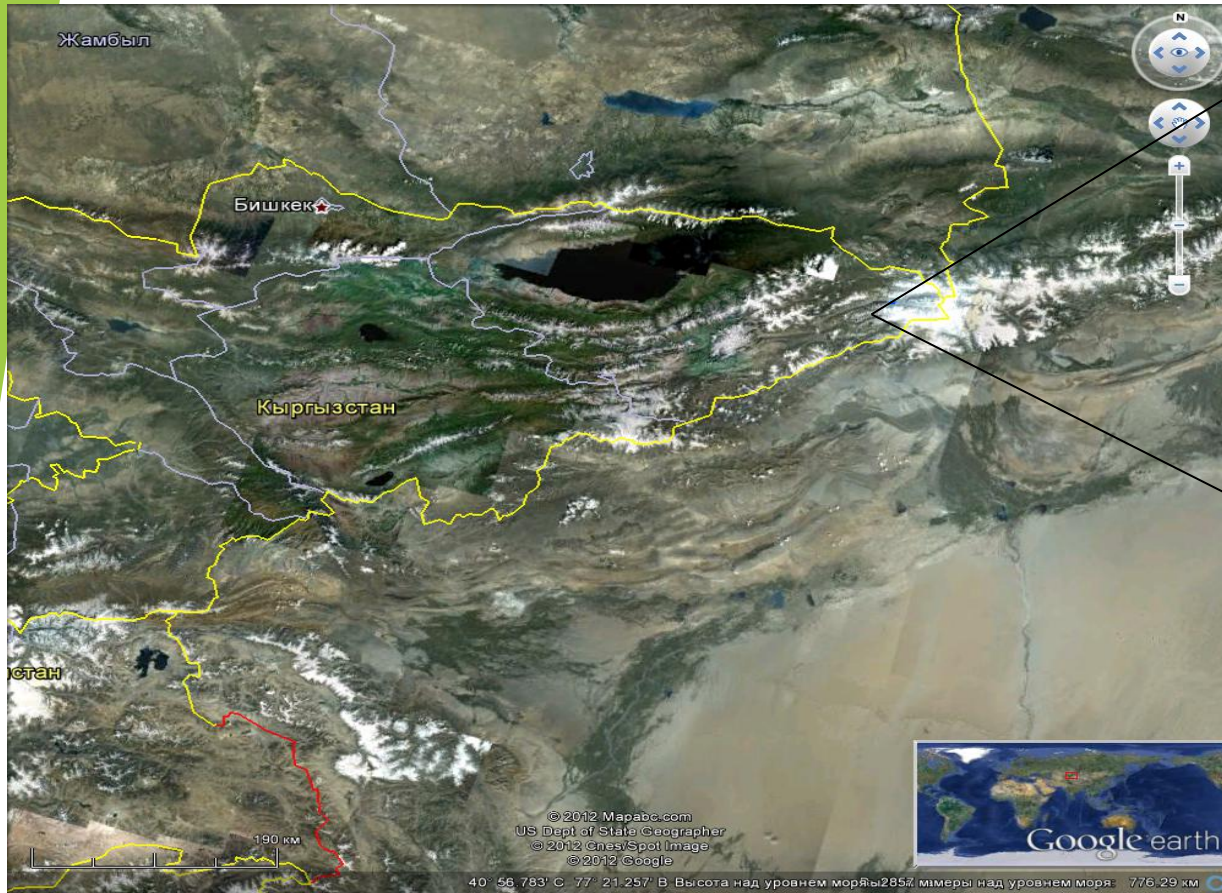
- 1 - Cropland
- 2 - Water
- 3 - Bare Soil
- 4 - Vegetation

# Land cover classification of Daroot - Korgon

The permafrost boundary can reach heights of up to 3,500 meters above sea level.

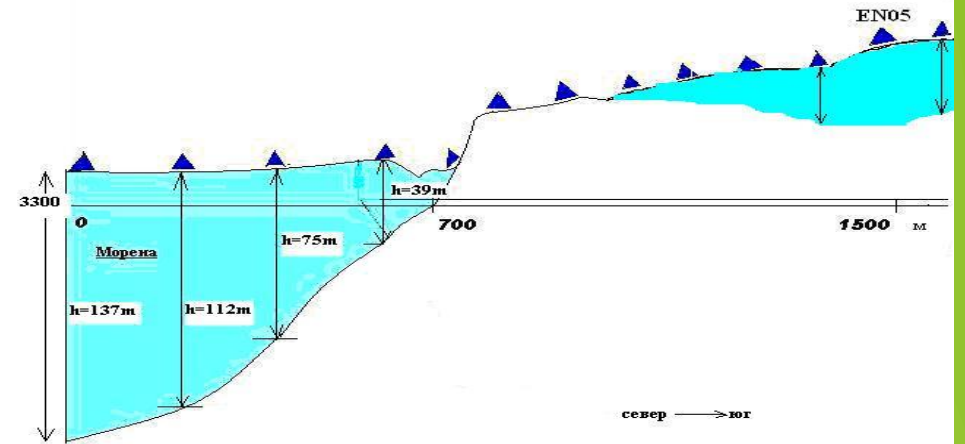


# Seismic Noise measurements in the Enylchek glacier moraine, assessment of the glacier thickness



**Измерение шумов по профилю (0-1500м) на леднике Енльчек**  
**Noise measurement through profile (1500m) on the Enylchek glacier**

(Orunbaev et al., 2013)



It is possible to have information on the glacier thickness by using the horizontal-to-vertical (H/V) spectral ratio method using seismic noise. To this regard in 2011, 46 microtremor measurements were carried out on the Enylchek glacier moraine (Central Tien-Shan) and 12 on a nearby soil/bedrock site, and the resonance frequency of each measurement site was estimated from the main peak in the spectral ratio between the horizontal and vertical component, aiming at deriving the main resonance frequencies of the moraine.



# Toward Understanding Degradation in Mountain Pastures: Current Perspectives and New Insights from the Highlands of Kyrgyzstan



Research supported in part by the NASA LCLUC program projects 80NSSC20K0411 & NNX15AP81G. Thanks!



# Mountain Pastures of Central Highlands in Kyrgyzstan

## Mountains and Mountain Pastures of Central Asia

- Mountains of Central Asia:
  - large continuous semi-arid area
  - hotspot of biodiversity & climate change
- Heterogenous vegetation belts coevolved with pastoralism
- High economic, political and social importance of pastures generated by environmental differentiation but depleted by overgrazing

- 90% territory of Kyrgyzstan is mountainous
- Most prevalent land use is pasture
- Non-grazing uses of pastures
  - Beekeeping & honey production
  - Collection of medicinal herbs
  - Hay making
  - Tourism and recreation
- 78% of the rural population is sustained through pastoralism (2018)

## Study Area

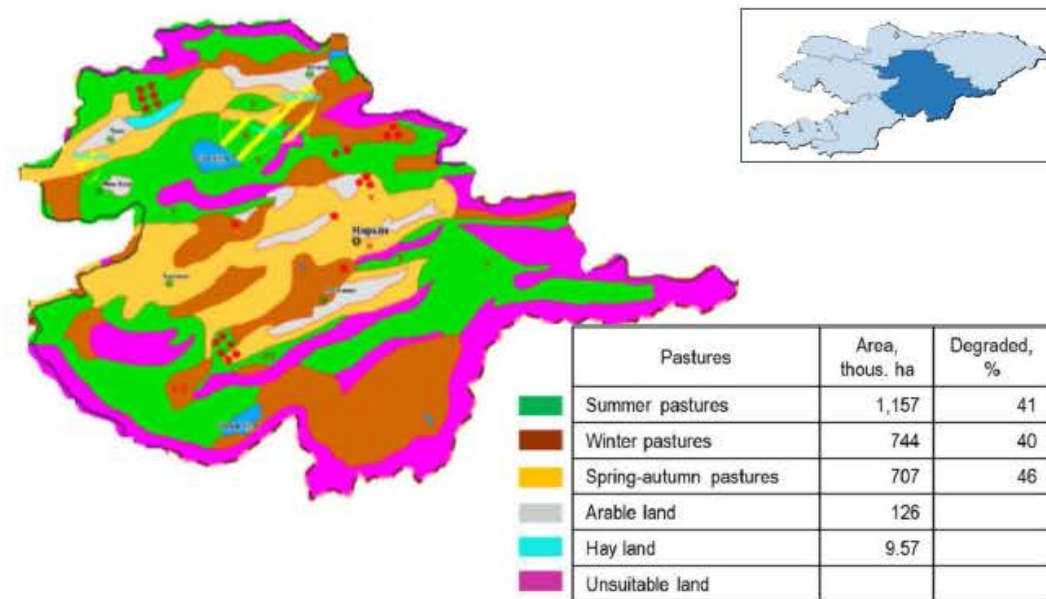
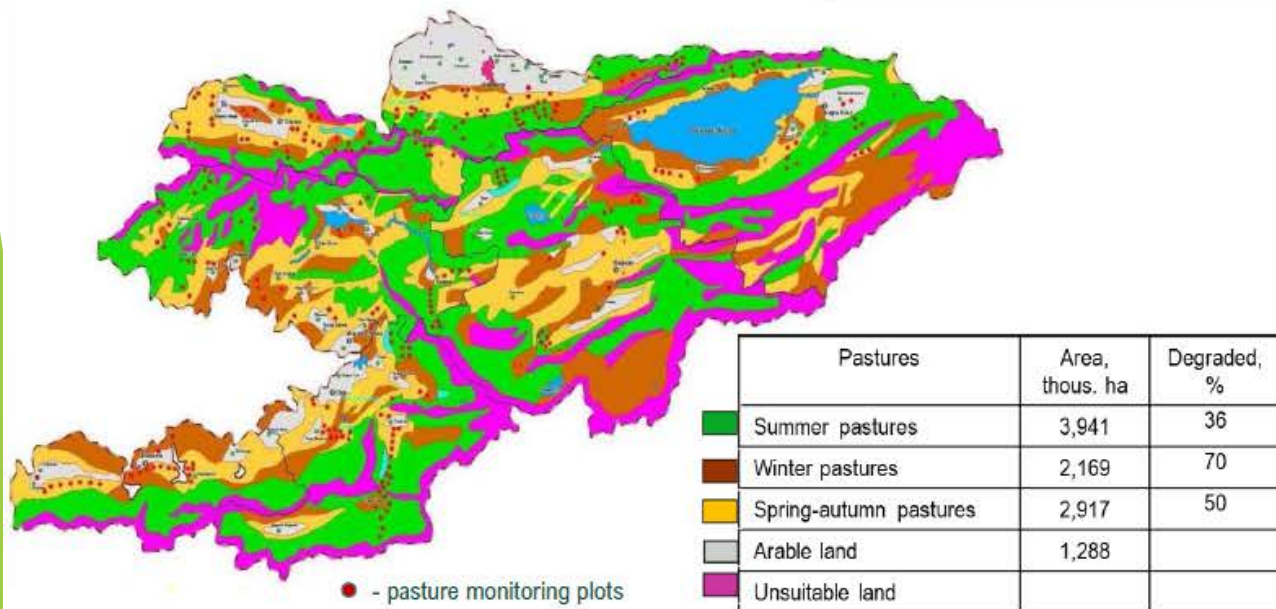
### Naryn Oblast, Inner Tien-Shan part of the Central Tien-Shan Mountains

High-elevation oblast status, located above 1500 m, mean elevation 3000 m, highest point Peak Dankov 5982 m, Kakshaal-Too range

Naryn oblasts contain 60% of its territory (~50K km<sup>2</sup>) and 92% of agricultural land (2.6M ha) – pastures, making grazing the prevailing land use due to the short growing season (156 days)

Nearly one-third of the pasture area of Kyrgyzstan (~2M ha) occurs in At-Bashy rayon

## Distribution of seasonal pastures and their condition across Kyrgyzstan



# Ground based study

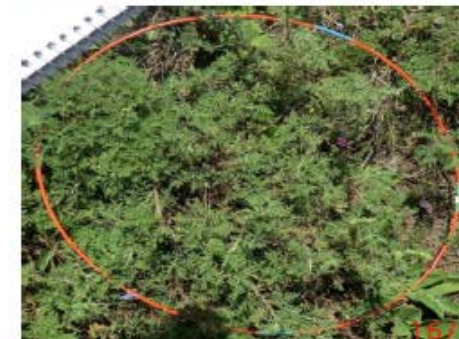
Data collection

July 2021

- 48 sites across five vegetation types (ecozones) & 23 plant communities
- Sites' locations by seasons of use:
  - 6 winter pastures
  - 20 spring-autumn or transitional pastures
  - 22 summer pastures
- Paired 100 m orthogonal transects at each site
- Line-point-intercept (every 1 m) and canopy & basal gap intercept
- Quadrat-based sampling to estimate several vegetation attributes
- A near-nadir digital photo every 2 m yielding 102 digital photographs of the 0.25m<sup>2</sup> size at each site (4807 images)

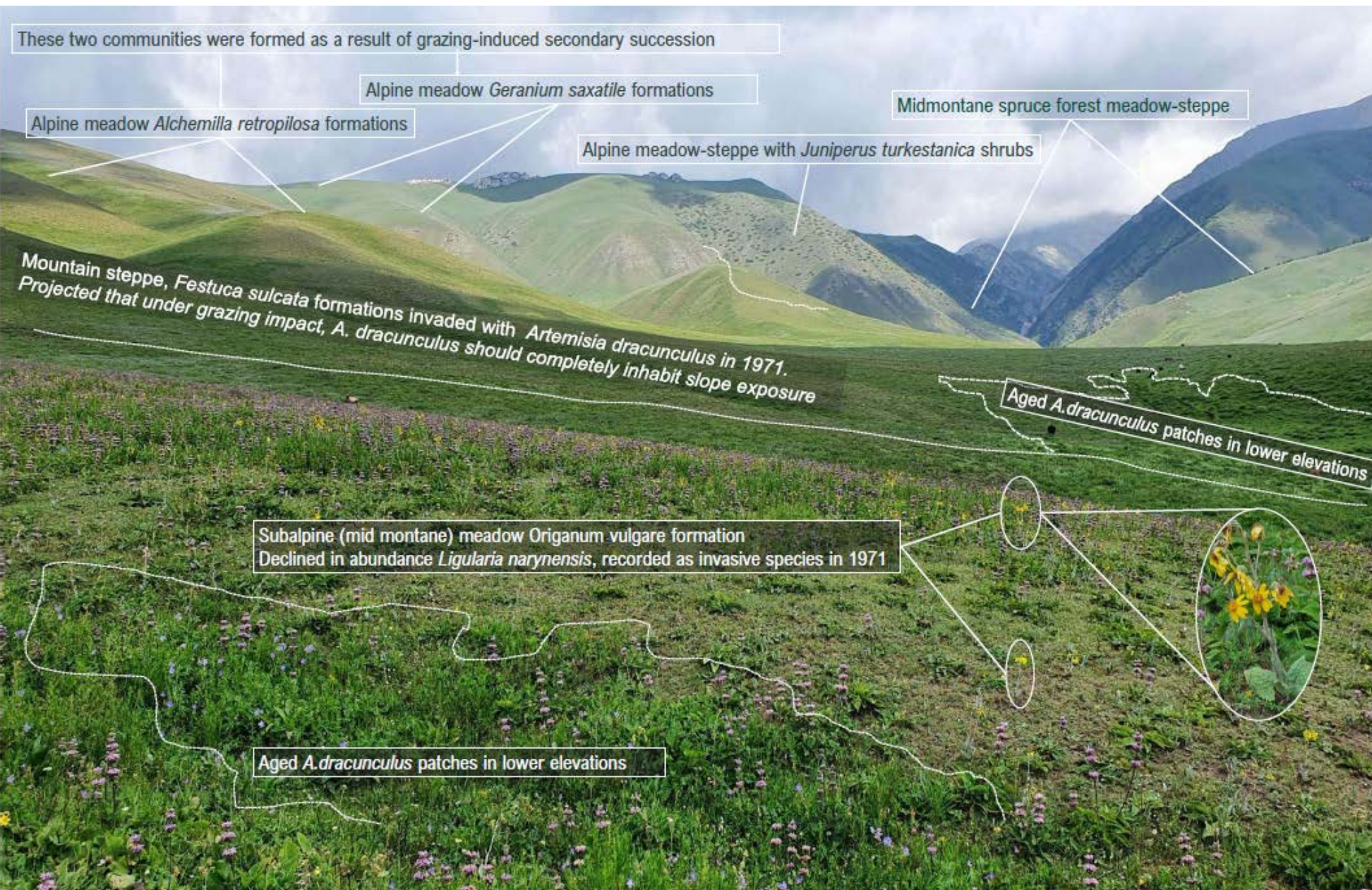


At each site, 5 quadrats with a 1m<sup>2</sup> size



Casio Exlim camera (model EX-H20G) photo's size 4320x2432 (16:9) – resolution supports high magnification to identify plant life forms and even species for prominent plants

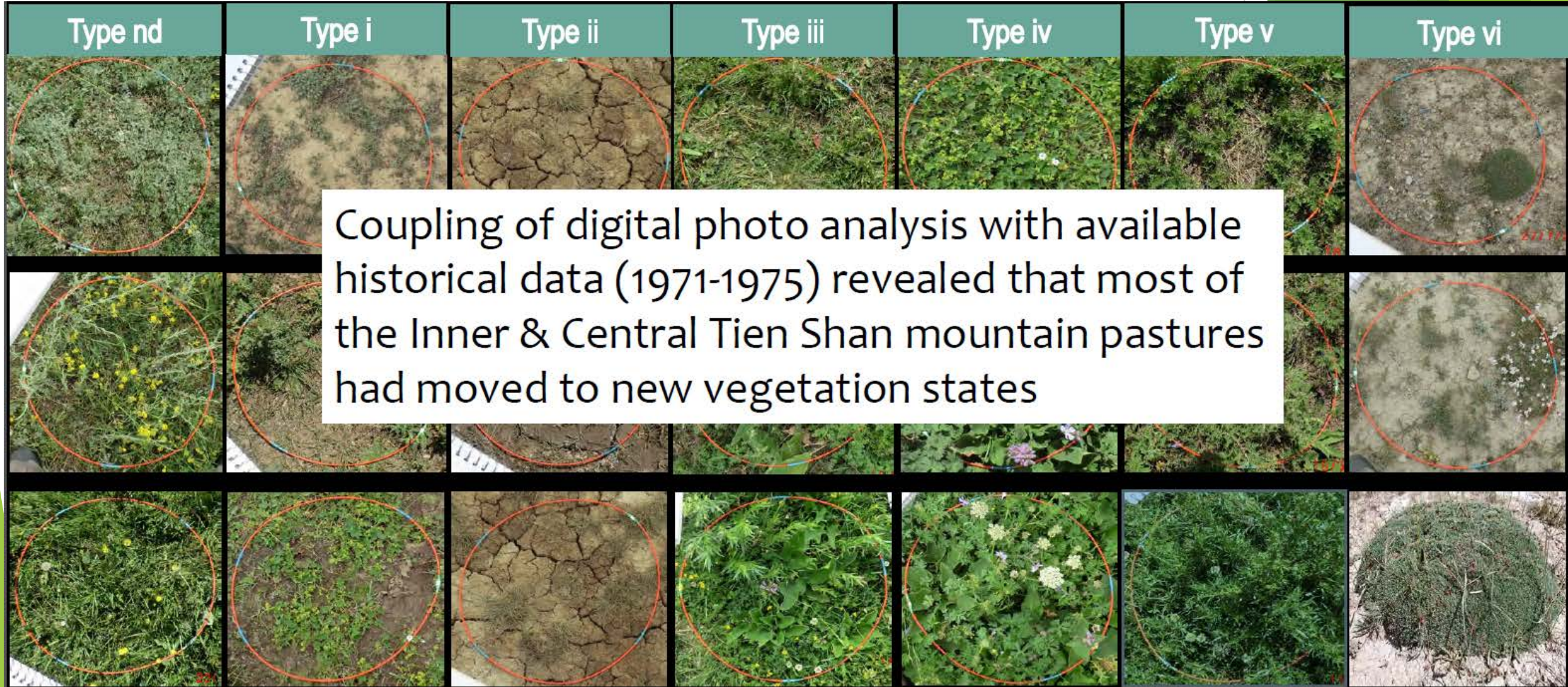
# classify degradation types and their dynamics over time



- In the current vegetation composition of pastures, species of bordering plant communities are prevalent, blending with each other

- Different indicator species allow seeing different communities, revealing the intricate details of shifts in elevational ranges and expansions over time

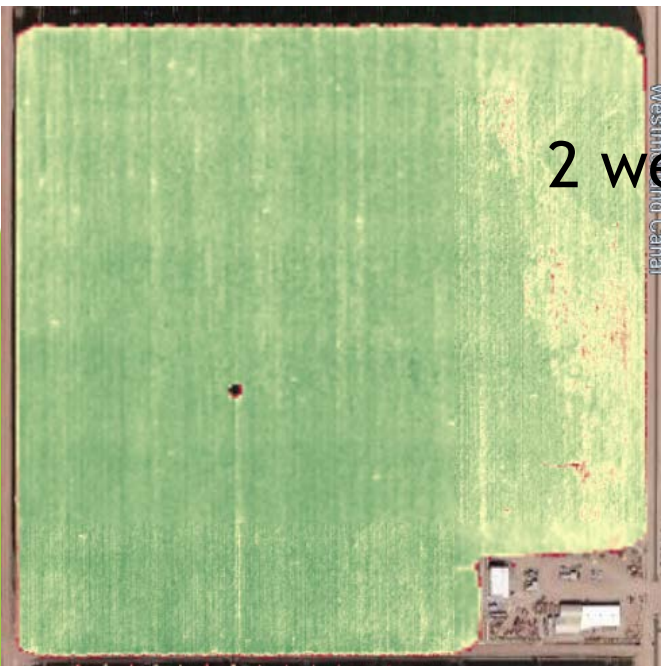
Examples of degradation types using 4K digital photography  
(orange ring covers 0.25 m<sup>2</sup>)

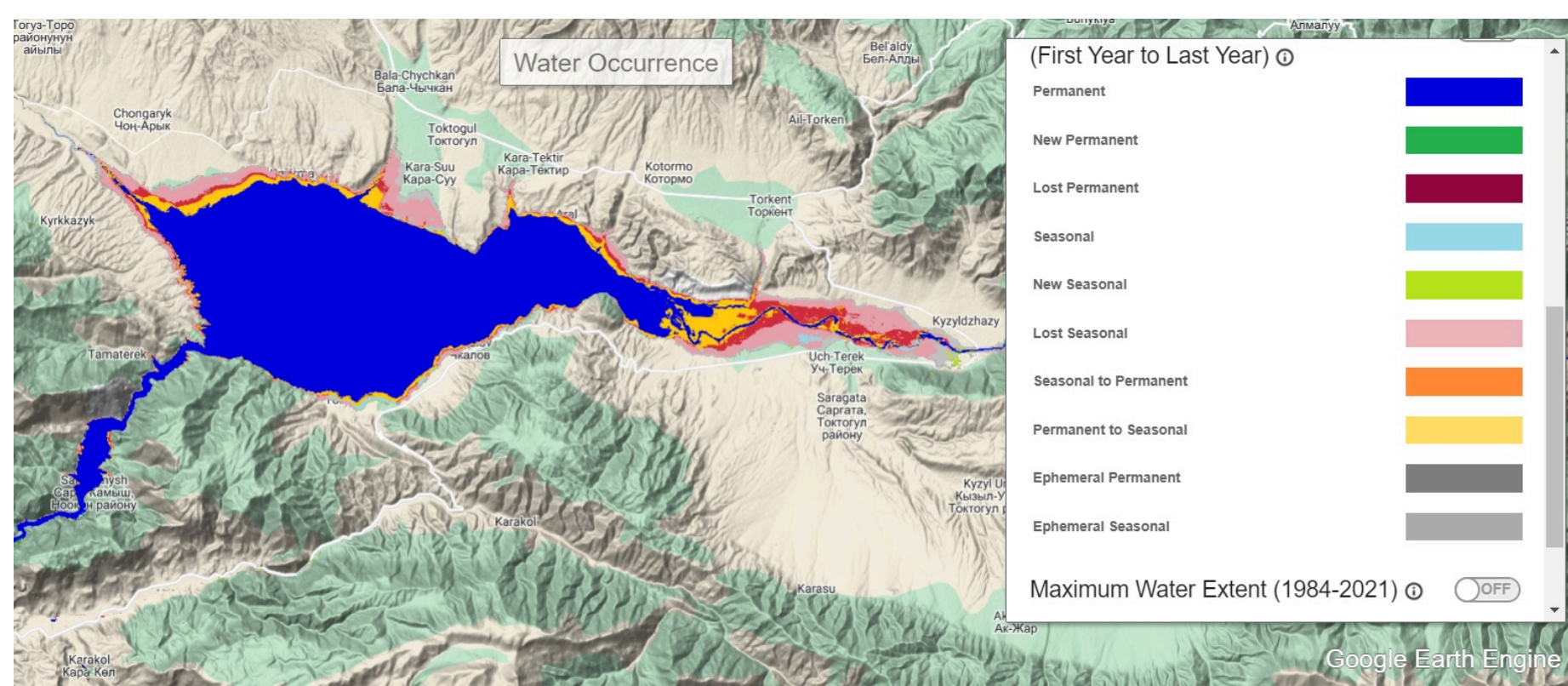


# MAPIR Survey multispectral sensors (UAS/Drone) Resolution - 5.5 cm

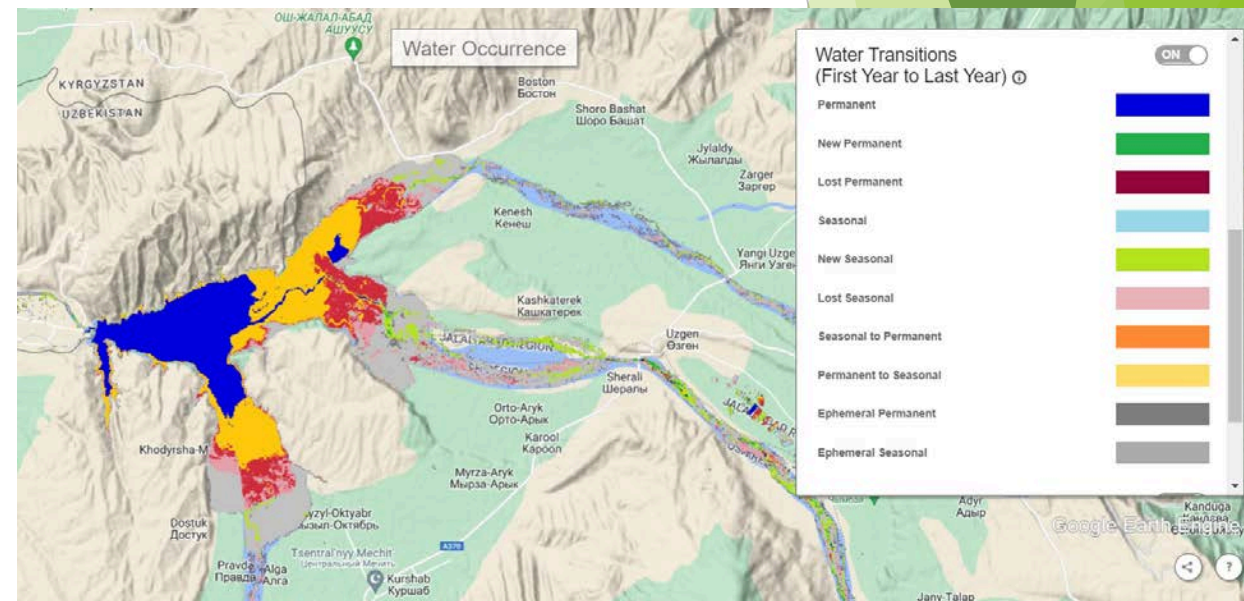


- 6 Filter Options
- Visible Light RGB
- OCN (Orange+Cyan+NIR)
- RGN (Red+Green+NIR)
- NGB (NIR+Green+Blue)
- Red-Edge (RE)
- Near Infrared (NIR)





Using GEE was calculated NDWI with borders of Toktogul and Kempir-Ravat reservoirs



## Join us at the Central Asia Regional Information Network (CARIN) workshop in Cholpon-Ata, Issyk-Kul, KYR in September 2023!

CARIN (<https://centralasiarin.net>) is a node associated with the Global Observations of Forest Cover/Global Observation of Land Dynamics (GOFC/GOLD) program (<https://gofcgold.umd.edu/>) and the NASA Land Cover Land Use Change (LCLUC) program (<https://lcluc.umd.edu/>).

CARIN will be holding an international workshop in Cholpon-Ata, Issyk-Kul, KYR from 13-16 September 2023. The workshop will feature presentations by research groups working across Central Asia, ample opportunities for professional networking, and interactive working groups focused on how geospatial technologies (i) can address regional knowledge gaps evident in the IPCC's Sixth Assessment Report (AR6) and (ii) can advance the UN Sustainable Development Goals—especially SDGs #6 (clean water & sanitation), #11 (sustainable cities & communities), #13 (climate action), #14 (life below water), #15 (life on land), and #17 (partnerships for the goals).

This CARIN workshop is sponsored by GOFC-GOLD, NASA LCLUC, American University of Central Asia, and Michigan State University. ***(We are open to other sponsors & collaborators!)***

Just prior to the workshop (**11-13 September**), **geospatial training for early career scientists** will occur at the American University of Central Asia (AUCA) campus in Bishkek.

For more information contact: Dr. Sagynbek Orunbaev ([orunbaev\\_s@auca.kg](mailto:orunbaev_s@auca.kg)) or Dr. Geoff Henebry ([henebryg@msu.edu](mailto:henebryg@msu.edu))



Thank you for your attention!  
If you have any question please email me  
[orunbaev\\_s@auca.kg](mailto:orunbaev_s@auca.kg)