



SIBELIUs: building satellite Earth observation capacity to assist the Kyrgyz herding community in a changing climate

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SIBELIUs in Kyrgyzstan 2 years of cooperation

- SIBELIUs in Kyrgyzstan started in October 2019
- Last day is 31 October!
- It has been a very busy 2 years
- Our technical solution was developed by the SIBELIUs project in Mongolia which started in 2018
- Worked with many people despite the Covid lockdown



eOsphere

Our Team

eOsphere



UNIVERSITY OF
LEICESTER





- IPP is a >£150 million initiative to use UK satellite technology to deliver benefits in developing countries
- Since launch in 2016, IPP has grant-funded 43 projects in 47 countries across Africa, Asia-Pacific and Latin America
- Funding for IPP has ended

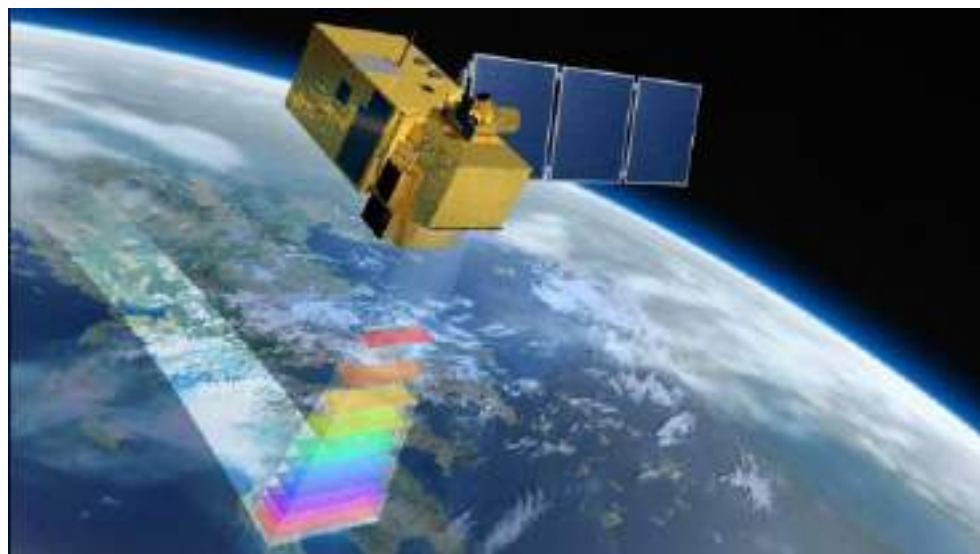


<https://www.spacefordevelopment.org/>

SIBELIUS focused on the herding community

- Large % of population dependent on livestock herding
- Deteriorating pasture and lack of basic pasture information
- Exacerbated by climate change





Pasture



Snow



Drought



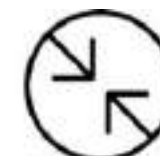
Country-wide coverage



More frequent updates for more of the year



Better accuracy

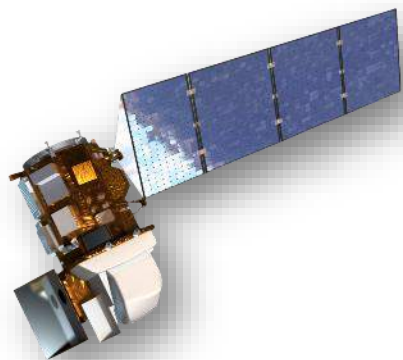


Better resolution

Satellites can monitor environmental conditions

- Efficiently
- Regularly
- Consistently

Allowing better informed decision making



Landsat 8

- 11 bands
- Visible light
- Cirrus cloud
- Infra-Red
- Thermal Infra-Red
- Every 16 days
- 15m, 30m and 100m



MODIS

- 36 bands
- Visible light
- Ocean colour
- Atmospheric temperature
- Cloud temperature
- Every 1-2 days
- 250-1km



Sentinel 2

- 12 bands
- Visible light
- Vegetation specific bands
- Infra-red
- Every 5 days
- 10m, 20m and 60m



VIIRS

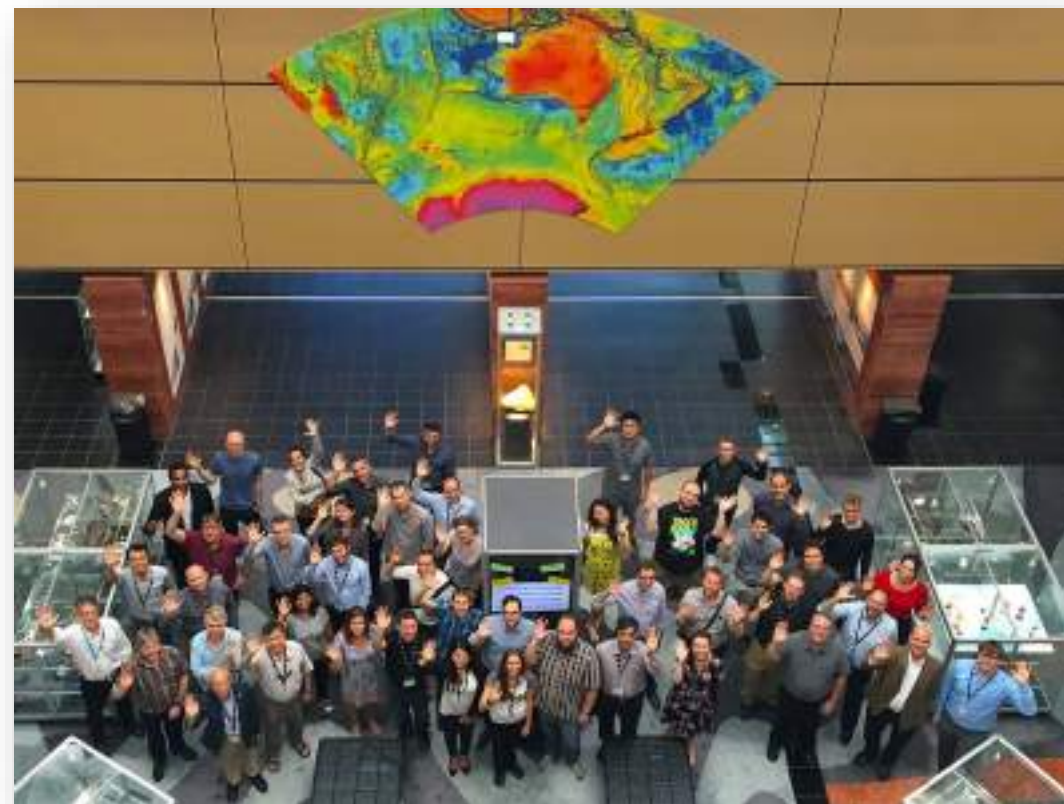
- 22 bands
- Onboard Suomi-NPP
- Snow
- Ocean colour
- Aerosols
- Cloud
- Every day



- An efficient system for storing and accessing large volumes of satellite data and derived products
- Total Size of Data Cube – **17.1 TB (Terabytes)**
- Growing at 2.3 TB per year
- Data from:
 - Sentinel-2 (going back to 2015)
 - Landsat 8 (going back to 2015)
 - MODIS (going back to 2003)
 - VIIRS (going back to 2012)
- All MODIS/VIIRS products go back to 2003.
- All high-resolution indices (NDVI, NDSI, NDWI, NDDI) go back to 2015



- The Kyrgyz Data Cube is based on the Open Data Cube (ODC) by Digital Earth Australia
- ODC is a non-profit, open source project that was motivated by the need to better manage Satellite Data
- And to foster a community to develop, sustain, and grow the breadth and depth of applications
- ODC will always be 100% open-source software, free for all to use



<https://www.opendatacube.org>
@opendatacube

The Kyrgyz Data Cube is now sited in CAIAG

- In April 2021 the KDC equipment was installed at the Central-Asian Institute for Applied Geosciences (CAIAG)
- The UK team have been working collaboratively with the CAIAG team
- An independent consultant chose CAIAG as the best site for the KDC because it has:
 - Good facilities
 - Well trained staff
 - A commitment to openness





<https://kyrgyzstan.sibelius-datacube.org/>





Data Access and Training: tailored for each user group

The SIBELIUs Visualization system



For **visualizing**
satellite imagery and
products

For everyone
but especially **Pasture Committees**
and
APIU ARIS Camp Alatoo
Pasture Department Kyrgyzhydromet
LMDP2 **Citizens**

No training
required

WMS (Web Map Service)

For **visualizing**
satellite imagery and
products

For casual users
APIU ARIS Camp Alatoo
Pasture Department Kyrgyzhydromet

Instructions
required
and some
assistance where
necessary

WCS (Web Coverage
Service)

For **analysis** with
satellite imagery and
products

For expert users
APIU ARIS Camp Alatoo
Pasture Department Kyrgyzhydromet

Python

For **developing** new
products and
maintaining the Data
Cube into the future

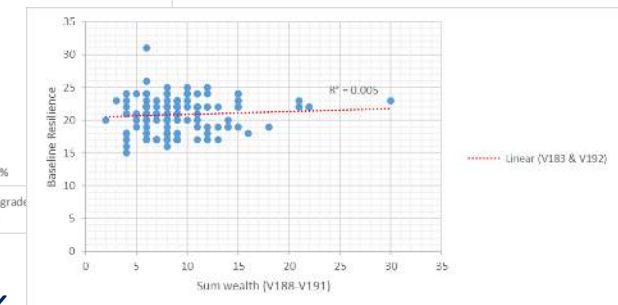
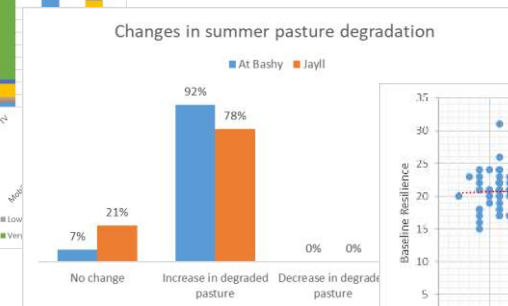
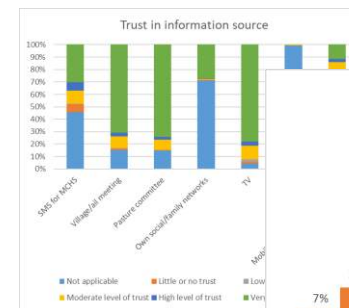
For developers ...
APIU Pasture Department
Kyrgyzhydromet

Python training
required

Requirements gathering,
measuring resilience,
engagement and training

Local engagement for Understanding Requirements and Resilience

- Several surveys in the project's two test sites
 - Ak-Bashat and Jaiyl Aiyl Okmotu in Jaiyl region, Chuy Oblast
 - Ak-Muz and Kazybek Aiyl Okmotu in At-Bashy raion, Naryn Oblast.
- Interviewed 203 households
- To understand requirements & priorities
- To understand technical infrastructure
- To measure resilience using a SIBELIUS defined metric



- Section 1: Household Socio-Economics & Pasture Use
- Section 2: Information Usage and Requirements:
- Section 3: Resilience
 - Overall Baseline and Endline Resilience figures, comprising 4 key dimensions of resilience:
 - 1. Increased Preparedness and Coping Mechanisms
 - 2. Increased Resilience of Systems and Livelihoods
 - 3. Better Access and use of Information
 - 4. Improved Decision-making and Planning
 - Focus on aspects of resilience that SIBELIUs can influence
 - Focus on changes in resilience over the project term
 - Households need improvements in 2 out of 4 dimensions to count towards our 10% goal



- For institutions mainly based in cities
- Pasture Department, APIU, ARIS, Camp Alatoo, Kyrgyzhydromet, CAIAG, Ministry of Emergency Situations, Tes centre and Kompanion Bank
- Conducted Python coding training on how to use satellite data and the Data Cube
- Approximately 47 hours of training
- Created lots of training materials and videos
- Nearly all provided virtually during the Covid pandemic



- Pasture Committee training
 - Training was provided for the members of the Pasture Committees
 - Mainly on how to use the Visualisation Website
 - In each of the 4 regions in the project's test sites
 - Virtually and in-person in July
- Training with agronomist support
 - In September further training was provided in collaboration with livestock & agriculture specialist from an agricultural consulting company "TES Centre"
 - 57 people took part in the trainings in 4 PC, including representatives of Aiyl Okmotu and pasture users

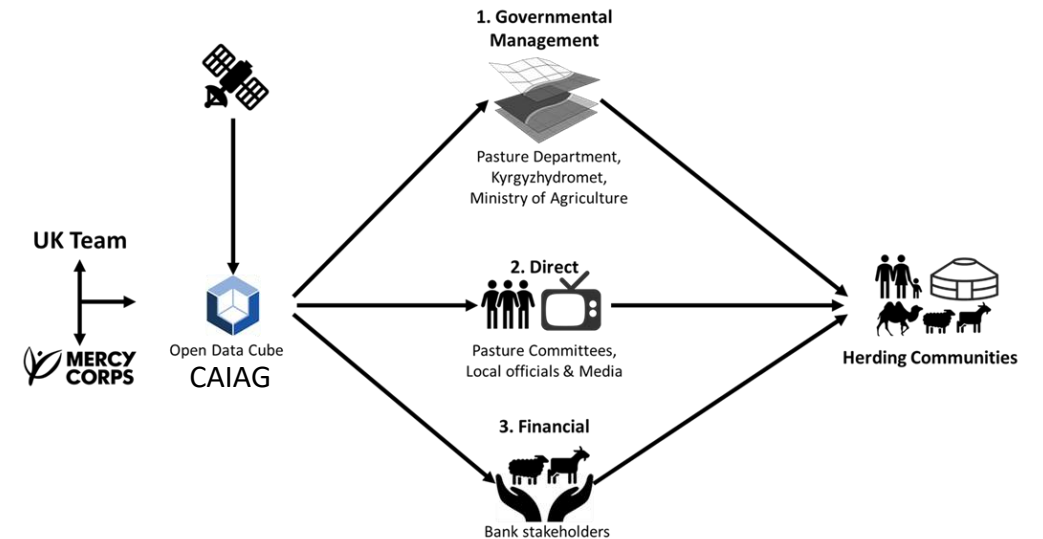


Pasture Committee training



Training with agronomist support

- The KDC is an asset for Kyrgyzstan
- Please use it!
- There are many possible applications for satellite Earth observation
- These are a few examples
 - Pasture
 - Karagana
 - Agriculture
 - Climate change
 - Snow and hydrology
 - Glacial lakes



- Our main aim was to provide information relevant for livestock herding
- Information about pasture, pasture anomaly and trend
- We believe this should be useful for state agencies
 - & for people in the countryside
 - Especially Pasture Committees





Краткое описание кыргызских пастбищ
20 августа 2021 г.



NDVI Зеленая растительность

Пастбищная аномалия

Индекс растительности
На первом изображении показано, сколько живой зеленой растительности на земле по данным спутника. Самые зеленые участки на изображении - это леса, здоровые пастбища, кустарники и кустарники. Более светлые участки обозначают регионы с небольшим количеством растительности или без нее.

Пастбищная аномалия
На втором изображении показано, как текущие условия пастбищ в Кыргызстане, измеренные со спутника, сравниваются со средними условиями пастбищ в это же время года. Средние условия были измерены за последние 11 лет.

<https://kyrgyzstan.sibelius-datacube.org/>

В целом, на изображении аномалии оранжевый и красный цвета указывают на условия пастбищ, которые хуже, чем обычно, а зеленые цвета указывают на условия лучше, чем обычно.

Анализ
Спутниковые данные показывают, что на севере страны, в Таласской, Чуйской и северо-западной Джал-Абадской областях, пастбища примерно на 5-15% хуже, чем в среднем для этого времени года, что обозначено оранжевым цветом. Аналогичная ситуация существует для региона с центром на границе между Джала-Абадской и Ошской областями.

В других местах пастбища выглядят относительно хорошо по сравнению со средними условиями.

В южной части Ошской и Нарынской областей пастбища примерно на 10% лучше, чем в среднем по сравнению с обычными. Некоторые районы на севере Нарына также демонстрируют хорошие пастбищные условия.

Кто мы есть?
Веб-сайт визуализации куба данных SIBELIUS предоставляет актуальную информацию о пастбищах, снеге и засухе в Кыргызстане.
<https://kyrgyzstan.sibelius-datacube.org/>
Для получения дополнительной информации о SIBELIUS в Кыргызстане, пожалуйста, посетите:
www.facebook.com/SIBELIUSKyrgyzstan

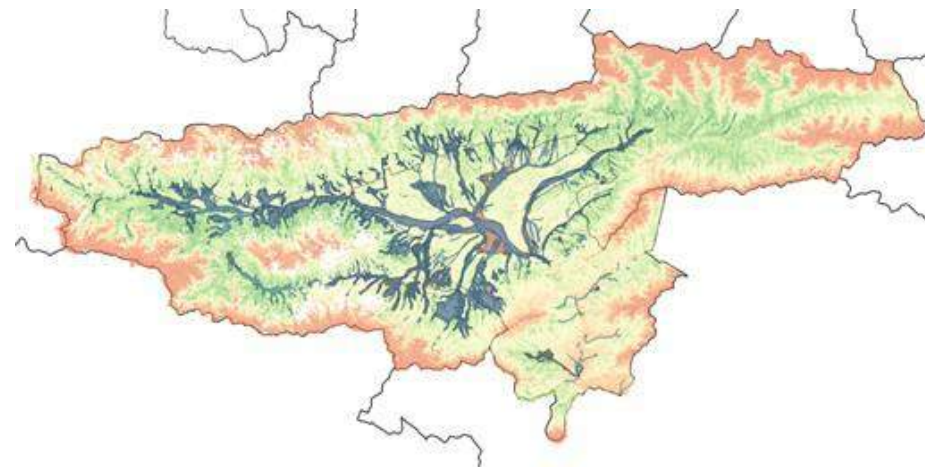




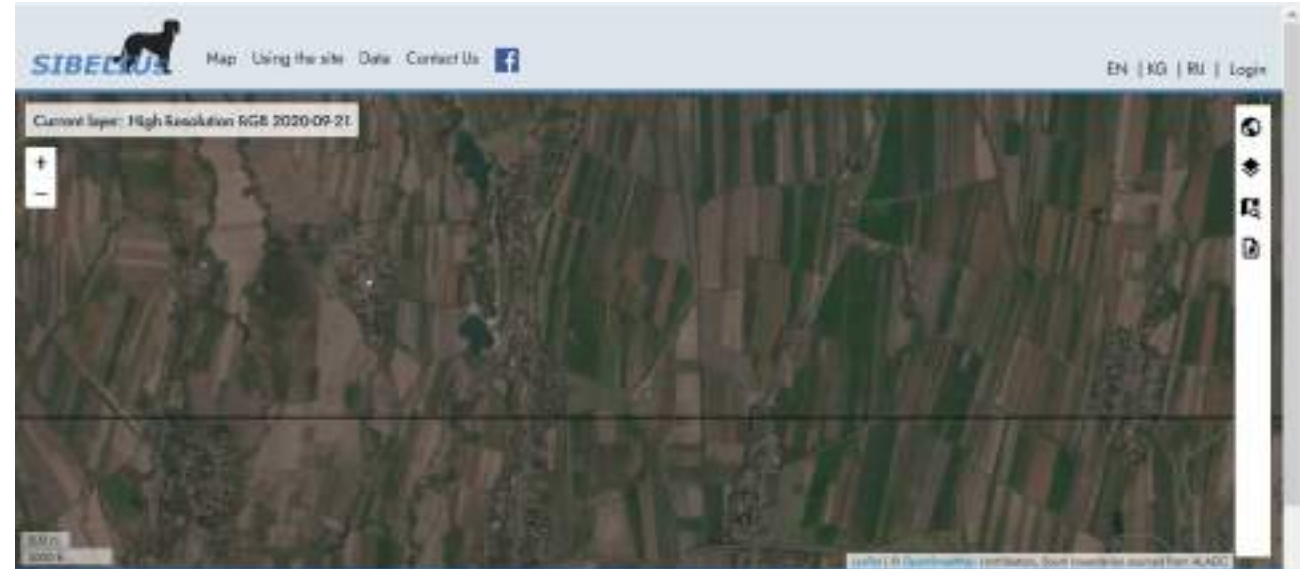


eOsphere Monitoring pasture regions and karagana

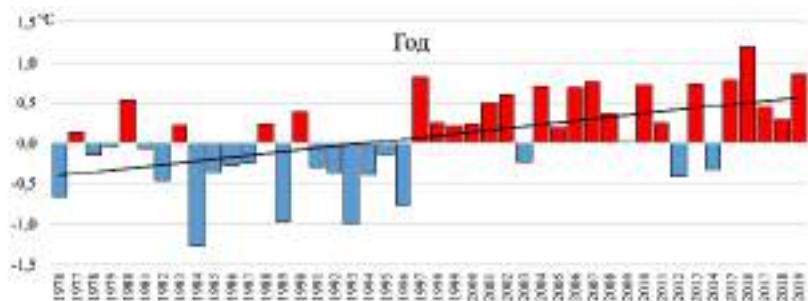
- Karagana is an inedible bush that is spreading in many parts of Kyrgyzstan, reducing the pasture available to livestock
- The Suusamyр Valley is an important pasture region in Kyrgyzstan
- We created an updated karagana map of the Suusamyр Valley, based on Sentinel-2 data acquired in 2020
- Shows where this has increased since the last map that was made, which was based on data from 2014
- Overall there was an increase from 6.3% to 7.1%
- This work was done by Megan, a summer internship physics student from Southampton University



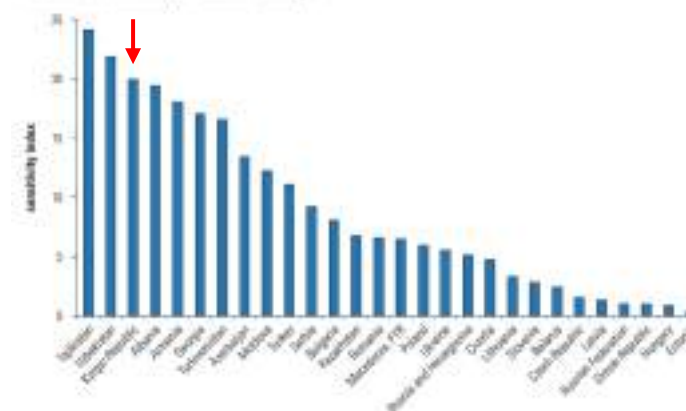
- The resolution is ideal for examining agricultural crops
- Understanding the impacts of problems on crops:
 - Droughts
 - Hail damage
 - Disease etc
- When to irrigate
- Crop yield prediction is increasingly common using satellite EO



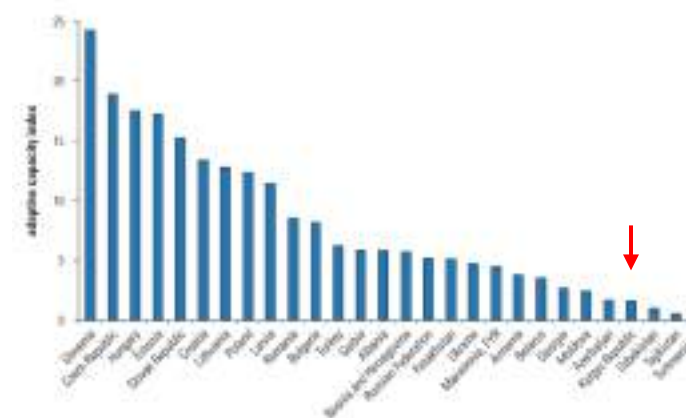
- Many projects in Kyrgyzstan are focused on climate change
- Many of these could be improved by using satellite earth observation
- The Kyrgyz Data Cube as a facility for bringing people and resources together to examine climate related issues



An Index of Sensitivity to Climate Change



An Index of Adaptive Capacity to Climate Change



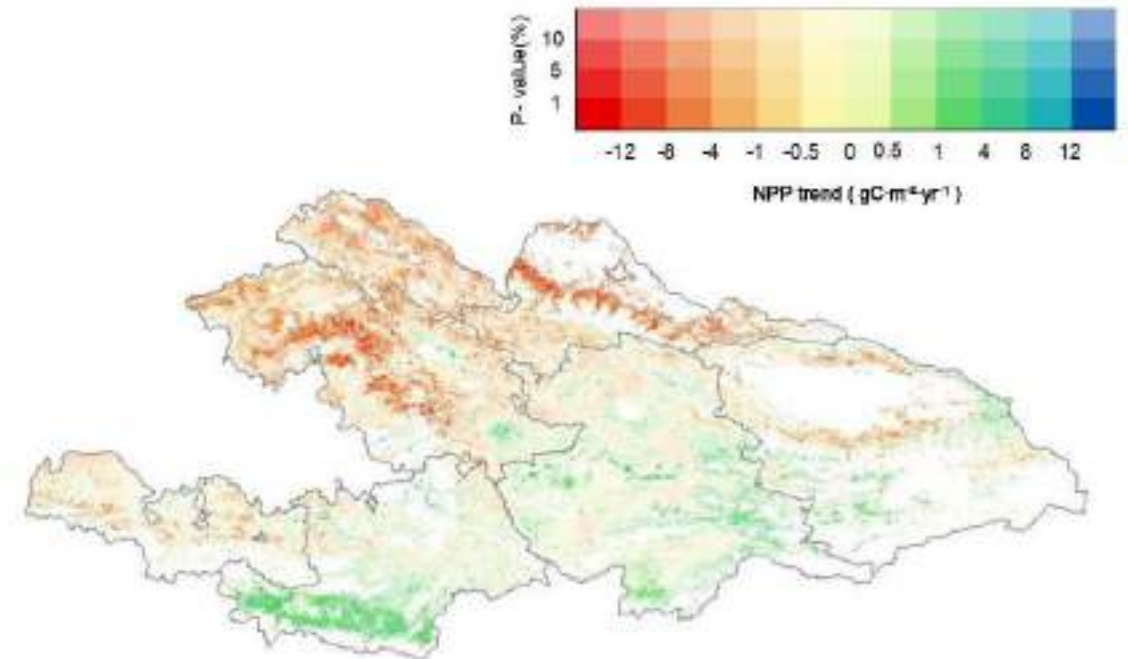
Fay, et al., 2010. Adapting to Climate Change in Eastern Europe and Central Asia. World Bank
<https://openknowledge.worldbank.org/handle/10986/2407>

Monitoring & evaluating the impact of ground-based climate change interventions

- Many climate change projects are changing things on the ground
 - Pasture
 - Forestry
 - Crop productivity
 - Artificial glaciers
- Kyrgyz Data Cube satellite EO can be used to monitor the impacts
- Before, during and after interventions
- Defining quantitative metrics allows success (or otherwise) of the intervention can be assessed

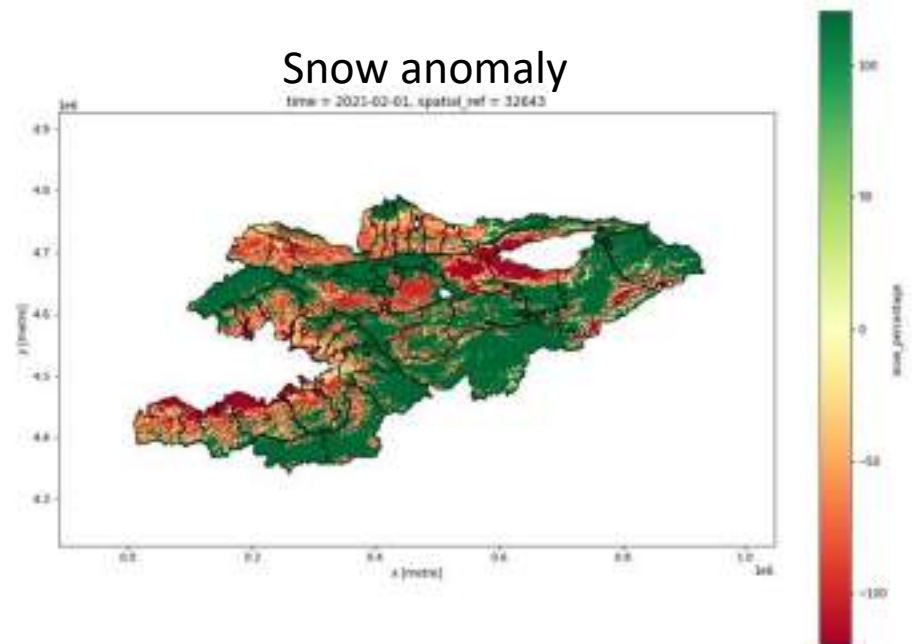
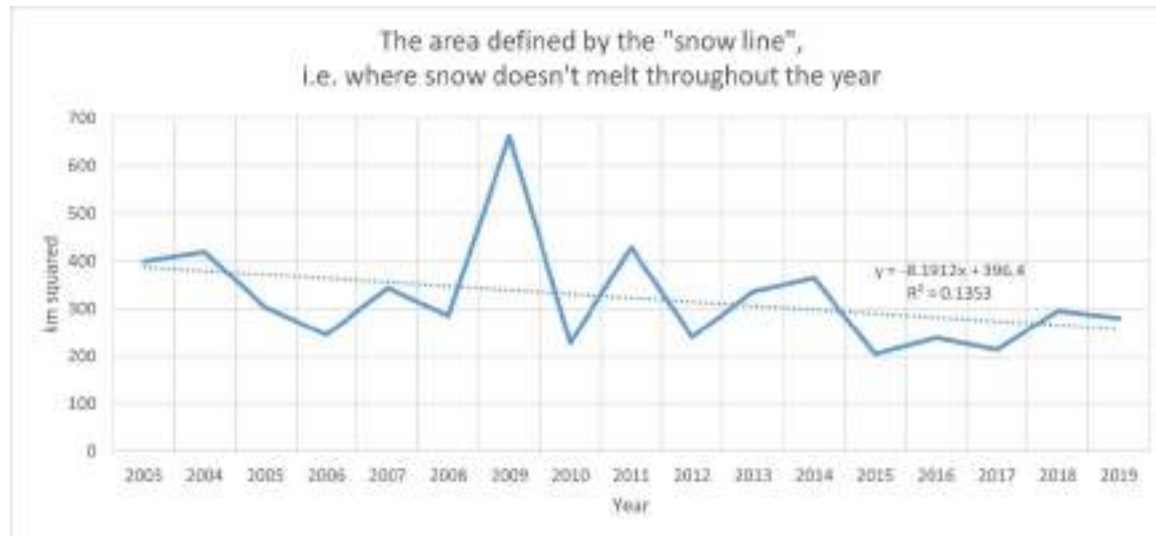


- Rangeland pasture photosynthesizes atmospheric CO₂ and leaves carbons in the soil
- Grassland/rangelands, have a great potential to function as a sponge for carbon dioxide from our atmosphere
- Microsoft recently paid \$500,000 for carbon credits from an Australian cattle rancher
- Livestock grazing can stimulate plant growth through a variety of mechanisms, resulting in increased carbon capture by the grazed ecosystem
- Net primary production (NPP) is the net photosynthetic accumulation of carbon by plants
 - Correlated with NDVI but requires a land cover map and other inputs, temperature, precipitation, soil texture, solar radiation and elevation

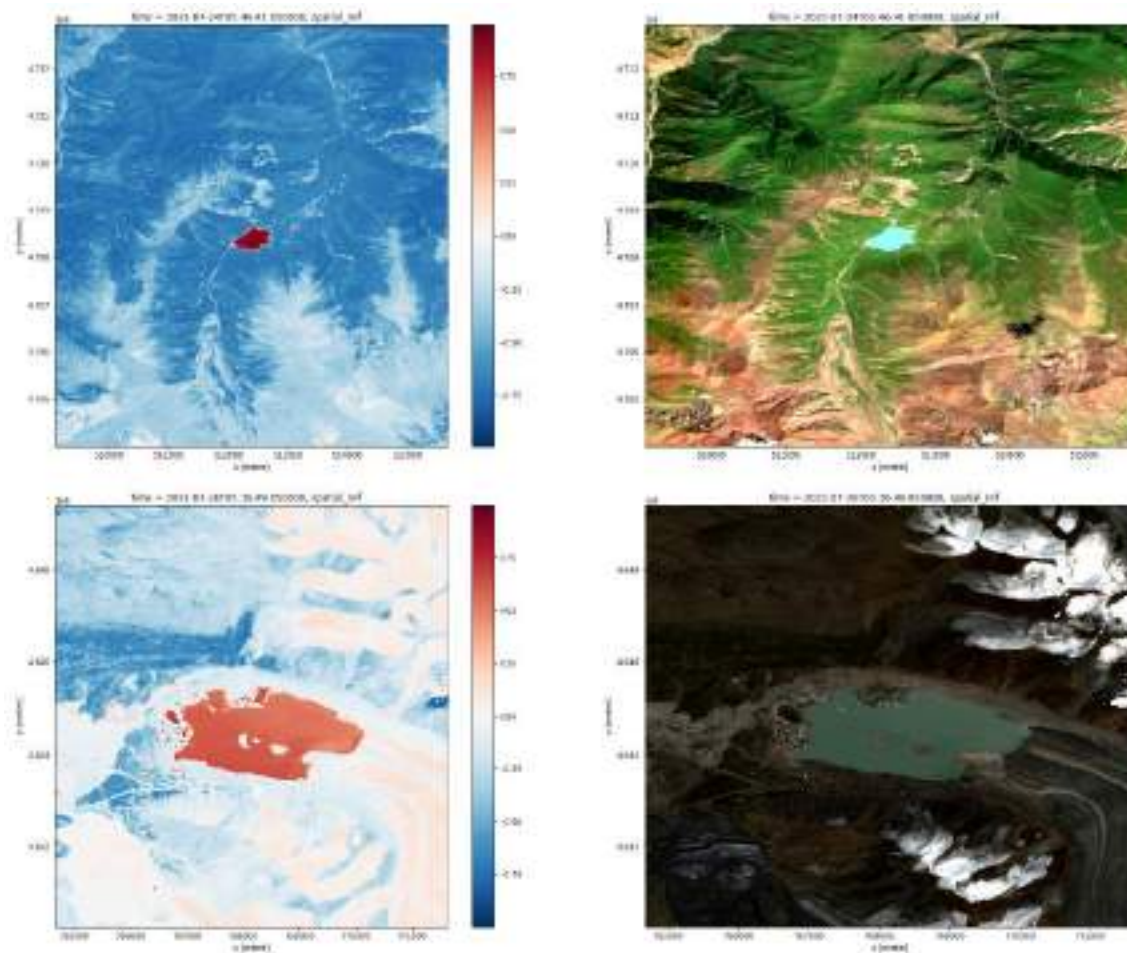


Net primary productivity (NPP)
Yanwen Wang, in Land Degradation & Development, April 2020

- Melting snow provides a large percentage of the water needed for irrigation
- Many herders are reporting that lower levels of snow are leading to water shortages
- Satellite data can tell us about snow coverage
- Our 2021 summer student Naivasha Williams, looked at snow data



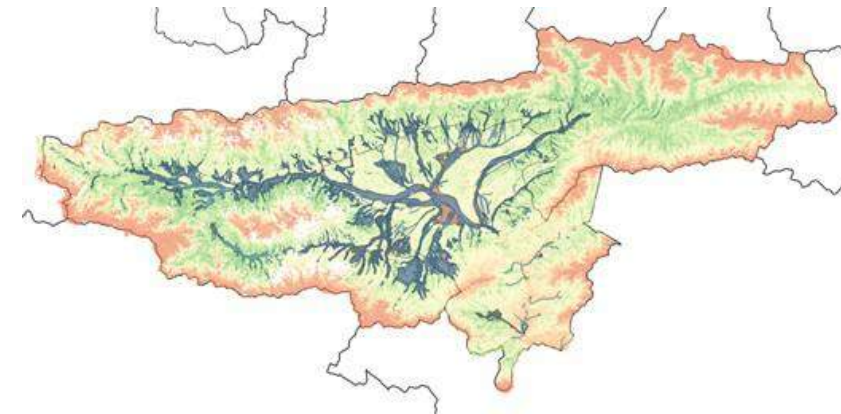
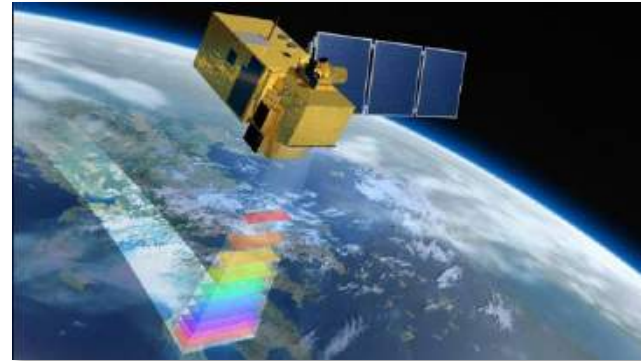
- A glacial lake are changing because of our changing climate
- Changes can lead to outbursts and floods
- Since 1952 more than 70 disastrous lake outbursts have occurred in Kyrgyzstan
- According to the Kyrgyz lake inventory, 328 lakes are at risk of outburst and 12 lakes are considered as dangerous



NDWI

Optical (RGB)

- Many thanks for your support and hospitality
- It has been a pleasure to learn about Kyrgyzstan
- We would like to continue working in Kyrgyzstan if possible
- Please think about how satellite data could help your work or research
- Please use the Kyrgyz Data Cube



Thank you

- **Contact details**

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