TASHKENT INSTITUTE OF IRRIGATION AND AGRICULTURAL MECHANIZATION ENGINEERS

DIGITAL TECHNOLOGIES CLUSTER FOR SUSTAINABLE NATURAL RESOURCES MANAGEMENT

EXPERIENCE ON CLIMATE RELATED RESEARCH IN UZBEKISTAN

Alim Pulatov

Head of EcoGIS center, Professor, PhD
National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" (NRU "TIIAME"),

Tashkent - 18th May 2023

CONTENT

INTRODUCTION

- Currently, the world is only on track to meet **22%** of **12** the environment-related SDGs and for **68%** of the environment-related SDGs there is not sufficient data at the global level to assess progress.

- Nowadays it is difficult to overestimate the role of increasing volume of the digital data (Remote Sensing and others), Artificial Intelligence and Machine Learning for the sustainable management of natural resources.
  - Data volume generated **per day** by **1738 satellites** and **15.4 billion of sensors** is **5700 scenes**.
  - Landsat archive for **32 years** consist over **5 million scenes.**
  - Internet of Things creates **400 zettabytes** (10^{21} bytes) of data **per year.**

- In 2019 UN Environmental Assembly offered a big boost policy for big data and frontier technologies and establishing World Environment Situation Room.

April 30th 2021 UzbekCosmos Agency and TIIAME signed Agreement on Cooperation In the area education, research and application space technologies

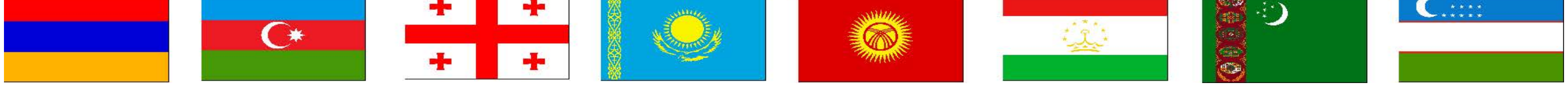
In agreement specially mentioned that UzbekCosmos Agency and TIIAME on organization joint education faculty on aerospace study natural resources on base of TIIAME Cluster on "Digital Technology for sustainable natural resources"

Erasmsus Mundus EMA2 - CASIA projects
Erasmsus Mundus EMA2 – TIMUR project

TEMPUS DESPES project 2002 – 2005
TEMPUS EWASIA project 2003 -2007
TEMPUS TEAM project 2004-2008
CASIA I December 2010 – November 2014 - 101 mobility
CASIA II September 2011 – January 2016 – 109 mobility
CASIA III July 2012 – July 2016 - 134 mobility
TIMUR July 2013 - July 2017 - 145 mobility

EcoGIS Center

CASCADE



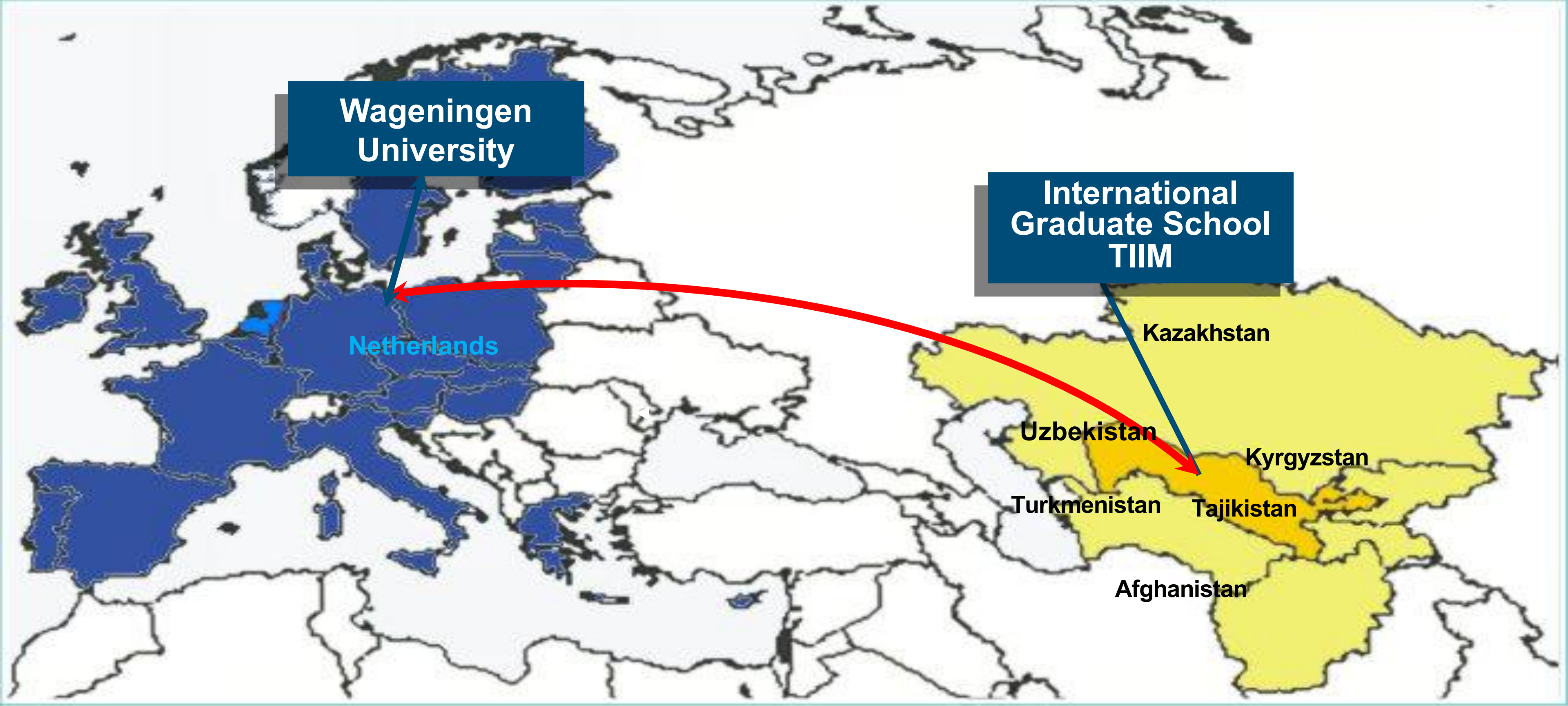
The Caucasus and Central Asia

CASCADE

CASCADE country universities - 20 + 4 (incoming) 181,536 9,986

1.	Azerbaijan	State Agricultural University	5524	445	
2.	Armenia	National Agrarian University	4603	637	
3.	Georgia	Agricultural University of Georgia	5000	599	
4.	Kazakhstan	Kazakh National Agrarian University	5985	750	QS WUR 551-560
5.	Kazakhstan	Kazakh grotechnical university named by Seifullina	13077	814	QS WUR 1000-1200
6.	Kazakhstan	West Kazakhstan Agrarian technical university named after Jangir Khan	9000	500	QS EECA 351-400
7.	Kazakhstan	Kostanay Engineering Economic university named after Dulatova	8500	326	
8.	Kazakhstan	Kostanay Regional University named after Boytursinova	2931	200	
9.	Kazakhstan	Kyzylorda University named after Korkyt Ata	6235	Nd	
10.	Kazakhstan	Taraz Regional University named after Dulati	17863	932	QS EECA 351-400
11.	Kyrgyzstan	Kyrgyz National Agrarian University named after K.I.Skryabin	7000	262	
12.	Tajikistan	Tajik State Agrarian University named after Shirinsho Shotemur	8000	500	
13.	Tajikistan	Tajik State University of Law, Business and Policy	9000	129	
14.	Turkmenistan	Turkmen Agrarian University named after S.A.Niyazov	NA	NA	
15.	Uzbekistan	National University of Uzbekistan named after Mirzo Ulugbek	22261	955	QS EECA 351-400
16.	Uzbekistan	Samarkand State university	13001	800	QS EECA 351-400
17.	Uzbekistan	Karakalpak State University named after Berdakh	21000	813	
18.	Uzbekistan	Karshi Engineering Economic Institute	12136	571	
19.	Uzbekistan	Namangan Engineering Construction Institute	5560	400	
20.	Uzbekistan	NUR Tashkent Institute of Irrigation and Agricultural Mechanization Engineers	4860	353	QS EECA 251-300

Joint Master DD programme in Tashkent



Recent results on joint master programs between Wageningen University and TIIAME

From 49 MS students studied in English 20 MS DD students successfully graduated WUR and TIIAME and received 2 diplomas

Anna Bronzes

Nargiz Mirtalipova

Konstantin Ivushkin

Mamanbek Reimov

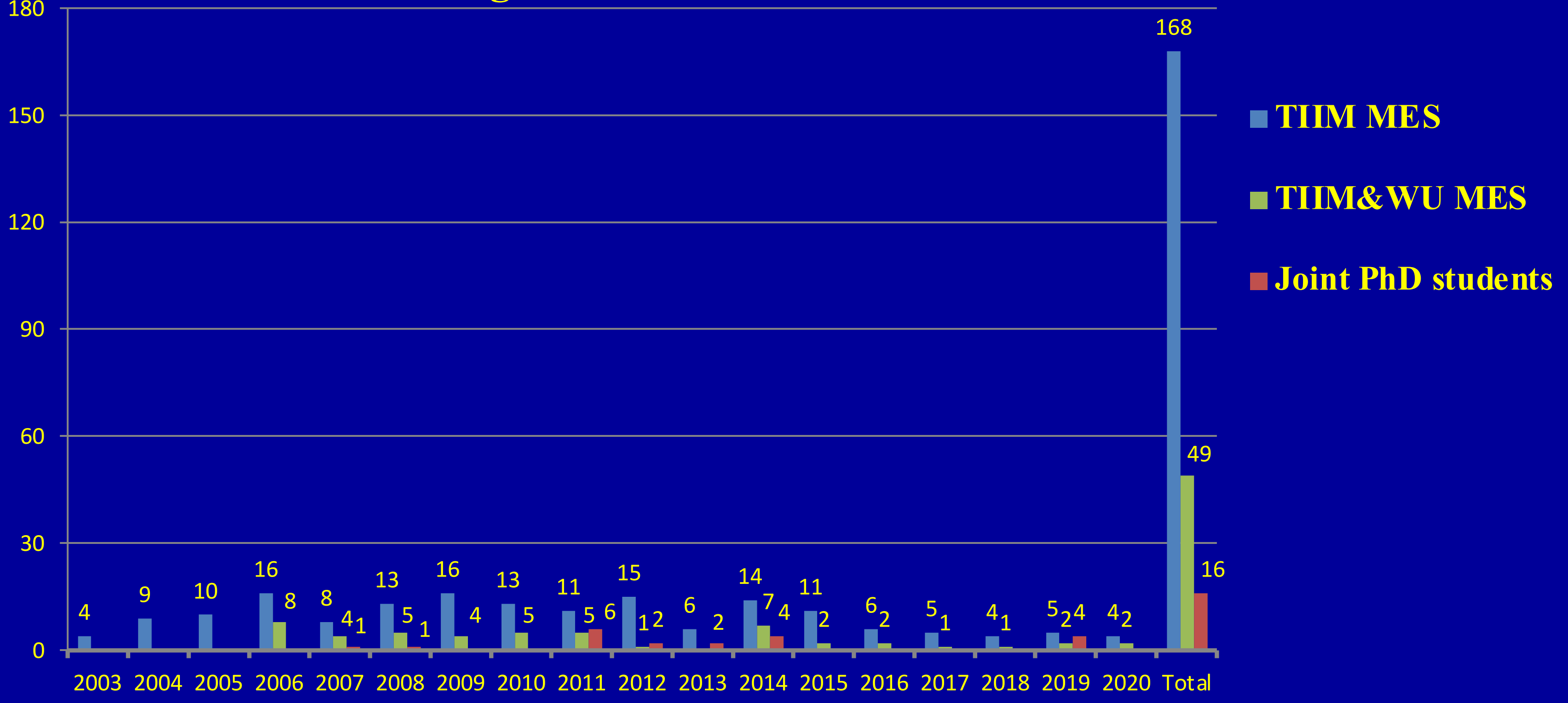
Djakhangir Atakhanov

Adil Yakubov

CASCADE

CASCADE EcoGIS center trained more than 2000 students on GIS & RS basics and other advanced courses for undergraduate, graduate level and field specialists on Environmental Science and International Water and Land Resources Management programs from 2004

Joint and double degree MS and PhD students



Collaboration between the Wageningen University, North West Agriculture and Forestry University (China), University of Michigan (USA) and the Agricultural University in Nitra (Slovakia), Nanjing Agricultural University in the field of the double master's degree programmes

Wageningen University and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers signed MOU and MS DD Agreements in 2004, 2007, 2016.

North West Agriculture and Forestry University and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (former TIIM) signed MOU in Tashkent on July, 22 2016.

Cooperation Agreement with Agricultural University in Nitra (Slovakia) and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers in the field of double degree master's programme was signed on August 28, 2017

Memorandum of Understanding with Michigan State University (U S) in the field of the double degree master's programme was signed on October 31, 2017

Memorandum of Understanding with TIIAME NUR, CASCADE, Michigan State University (U S) in the field of the double degree master's programme was signed on July 26, 2019

CASCADE

CASCADE International School on Joint Education in Central Asia

The CASCADE consortium includes the total of 19 agricultural and life sciences oriented universities from Central Asia and the South Caucasus, including Azerbaijan, Armenia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

On the eve of the 10th anniversary of consortium, the CASCADE International School on Economics and Management has been established this year.

The purpose of establishing the CASCADE International School on Economics and Management is to further improve the quality of education and its internationalization, expand cooperation with foreign qualifications, attract foreign professors and students, promote the status and ranking of institutions in the region.

In the above courses, students will gain modern knowledge and skills related to the regional economy and its sustainability, as well as the opportunity to get acquainted with their peers abroad, make friends with them, exchange views and discuss different approaches to economics and governance.

On September 7, 2020, the course “Digital Economics” based on a program developed by Tashkent Institute of Irrigation and Agricultural Mechanization Engineers in collaboration with German scientists was firstly launched at CASCADE International School on Economics and Management.

Every week of authum semester students are taught during 14 weekly by the leading professors of CASCADE member universities on topics in economics and management. Weekly classes consist of 2 credits. 400 students who successfully completed the courses received the certificate of CASCADE International School on Economics and Management and transcripts

[illegible]

[illegible] - 2020

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Сентябрь				Октябрь				Ноябрь				Декабрь					Январь		Лекции	Практика	Самостоятельная работа	Итого	Кредиты
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			недели		7-12	14-19	21-26	28-3	5-10	12-17	19-24	26-31	2-7	9-14	16-21	23-28	30-5	7-12	14-19	21-26	28-2	4-9	11-16					
1	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
2	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
3	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
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6	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
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9	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
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11	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
12	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2
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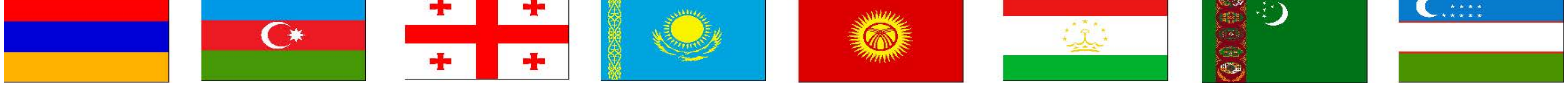
15	[illegible]	[illegible]	400	18						A						A						A	C	12	12	36	60	2

CASCADE



2020 CASCADE International School on Economics and Management

Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)
Digital Economy, 7-12 September, 2020

Sherzod Murodov,
Associate Professor,

Khabibullo Pirmatov
Coordinator CASCADE at TIIAME

West Kazakhstan Agrarian Technical University named after Zhangir Khan (WKAU) Circular Economy
21-26 September, 2020

Elvira Rustenova,
Responsible staff for the course

Irina Bogdashkina
Coordinator CASCADE at WKAU

Samarkand State University (SSU)
Ecological Economics
28 September- 3 October, 2020

Bahodir Safarov,
Responsible staff for the course

Muxtor Nasirov
Vice Rector for International Cooperation

Taraz Regional University named after M.Kh. Dulati (TarRU)
Innovative Economy,
5-10 October 2020

Marina Kenzhebaeva,
Responsible staff for the course

Umarova Galiya,
Coordinator CASCADE at TarRU

MASTER DEGREE ON ENVIRONMETAL SCIENCE SPECIALIZATION-GEOINFORMATION SYSTEMS INCLUDES FOLLOWING SPECIAL COURSES:

Developed courses:

- Geoinformation Systems
  Practical modules based on:
  - ArcGIS/ArcGIS PRO
  - QGIS
  - Super MAP
- Remote Sensing
  Practical modules based on Erdas Imagine
- Spatial Data Infrastructure
- Advance GIS
- GIS tools

Developing courses:

- Advance Remote Sensing
- Integration GIS & Remote Sensing
- R
- Python
- Machine Learning
- Deep Learning
- Artificial Intelligence

MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION OF THE REPUBLIC OF UZBEKISTAN

TASHKENT INSTITUTE OF IRRIGATION AND AGRICULTURAL MECHANIZATION ENGINEERS

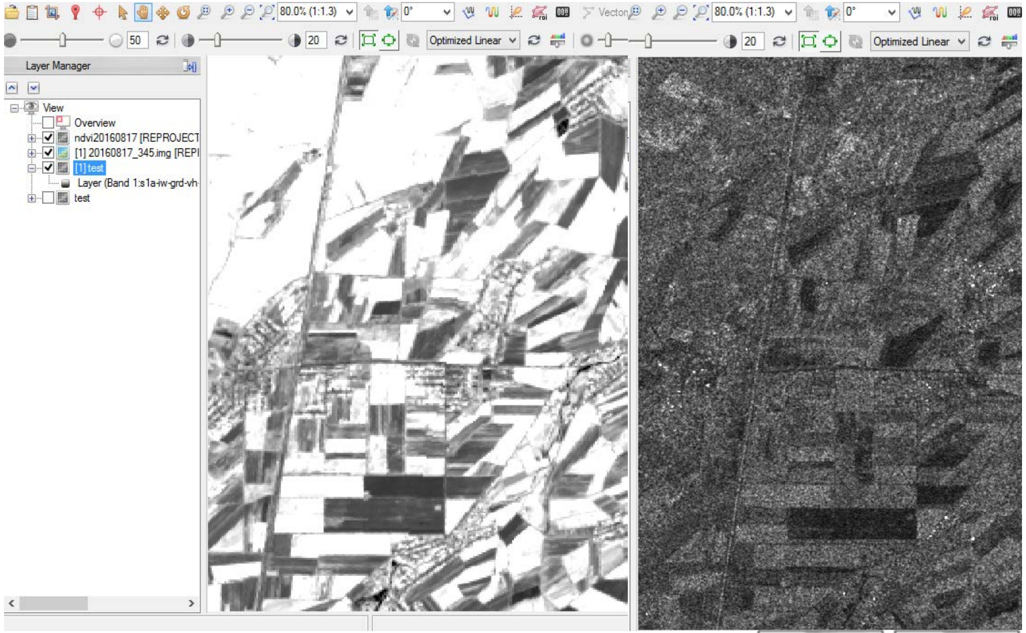
DIGITAL TECHNOLOGIES CLUSTER FOR SUSTAINABLE NATURAL RESOURCES MANAGEMENT

CLASSIFICATION IMPROVEMENT OF CROP FIELDS

MAIN PARAMETERS OF SATELLITE USED IN RESEARCH

Characteristics	Optical sensors				Radar sensor
	Landsat TM5	Landsat 7ETM+	Landsat 8 OLI	Sentinel 2	Sentinel 1A
Launch date	March 1984	April 1999	February 2013	June 2015	April 2014
Product	USA	USA	USA	Europe	Europe
Swath width	185 km	185 km	185 km	290 km	250 km
Orbit	705 km	705 km	705 km	786 km	786 km
Temporal resolution	16 days	16 days	16 days	2-5 days	2-6 days
Spatial resolution	30/120m (VIS/TIR)	15/30/60 m (PAN/VIS/TIR)	15/30/100 m (PAN/VIS/TIR)	10/20/60 m	5x20 m
Spectral resolutions	7	8	11	13	4

Comparison of optical and radar data



Radar NDVI = (VV-VH)/(VV+VH)

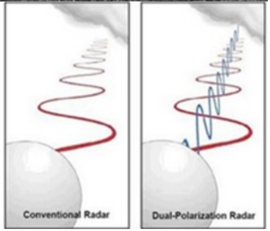
Advantage

- Independent from weather conditions
- Independent from light
- Sensitive to biophysical (moisture, biomass) and structure geometrical parameters of soil plant characteristics

Disadvantages:

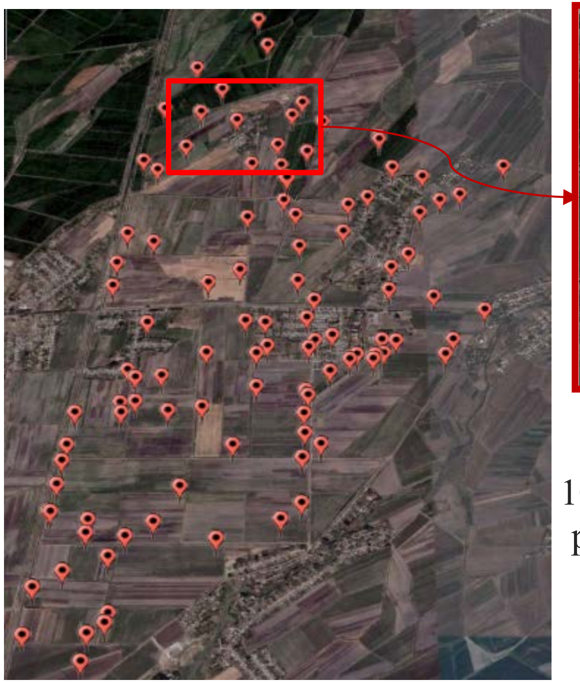
- Difficulties in processing
- Difficulties in thematic interpretation
- Noise of data
- Relief influence to quality
- Negative influence of surface roughness

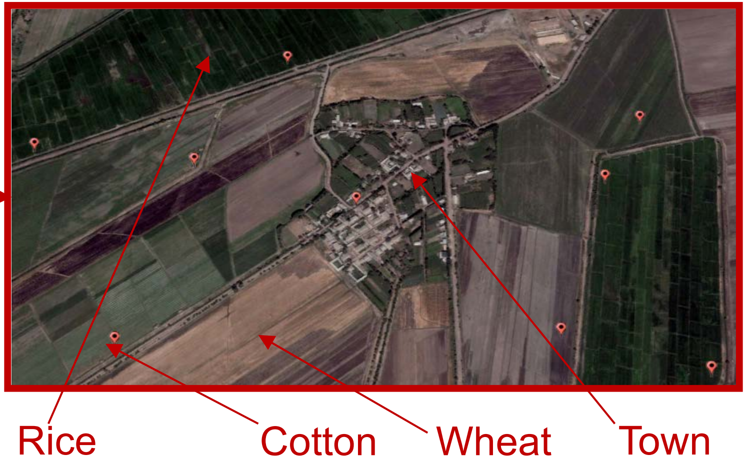
Optical NDVI = (NIR–Red)/(NIR+Red)



NDVI maps for Landsat TM (left) и Sentinel 1 (right)

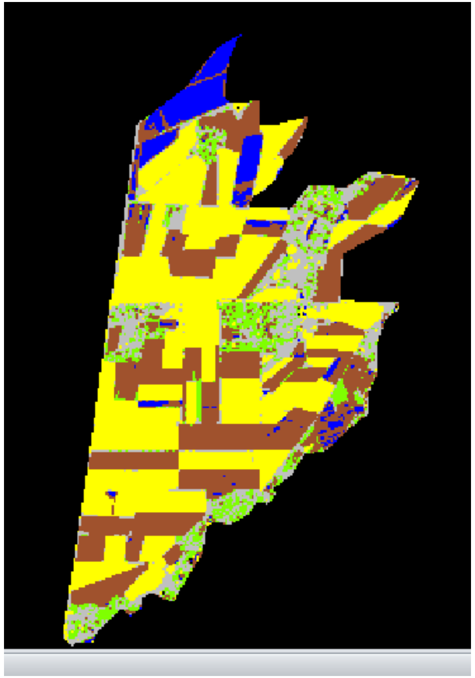
CLASSIFICATION ACCURACY ASSESSMENT





105 ground control points data were collected and processed for classification accuracy assessment

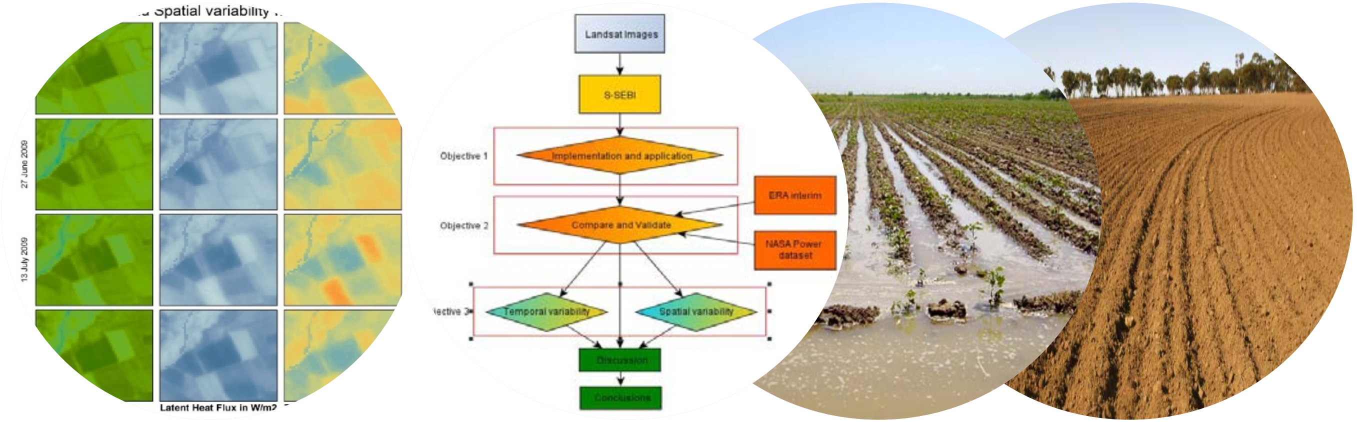
Application of conventional algorithms for processing multispectral information do not provide a high level of accuracy (less than 80%);



1. **Combined classification methods of spectral correlation and the time series of the NDVI vegetation index, increasing accuracy in 89%**
2. **Combining images with higher spatial resolution allowed to increase the quality of interpretation of classes and accuracy up to 93%**

Mapping of evapotranspiration of agricultural land in Tashkent Province by using GIS and Remote Sensing and SSEBI model

Adil Yakubov, Arnold Bregt, Ryan Teuling, Alim Pulatov



S-SEBI is relatively accurate and representative for Tashkent province (r=0.78).

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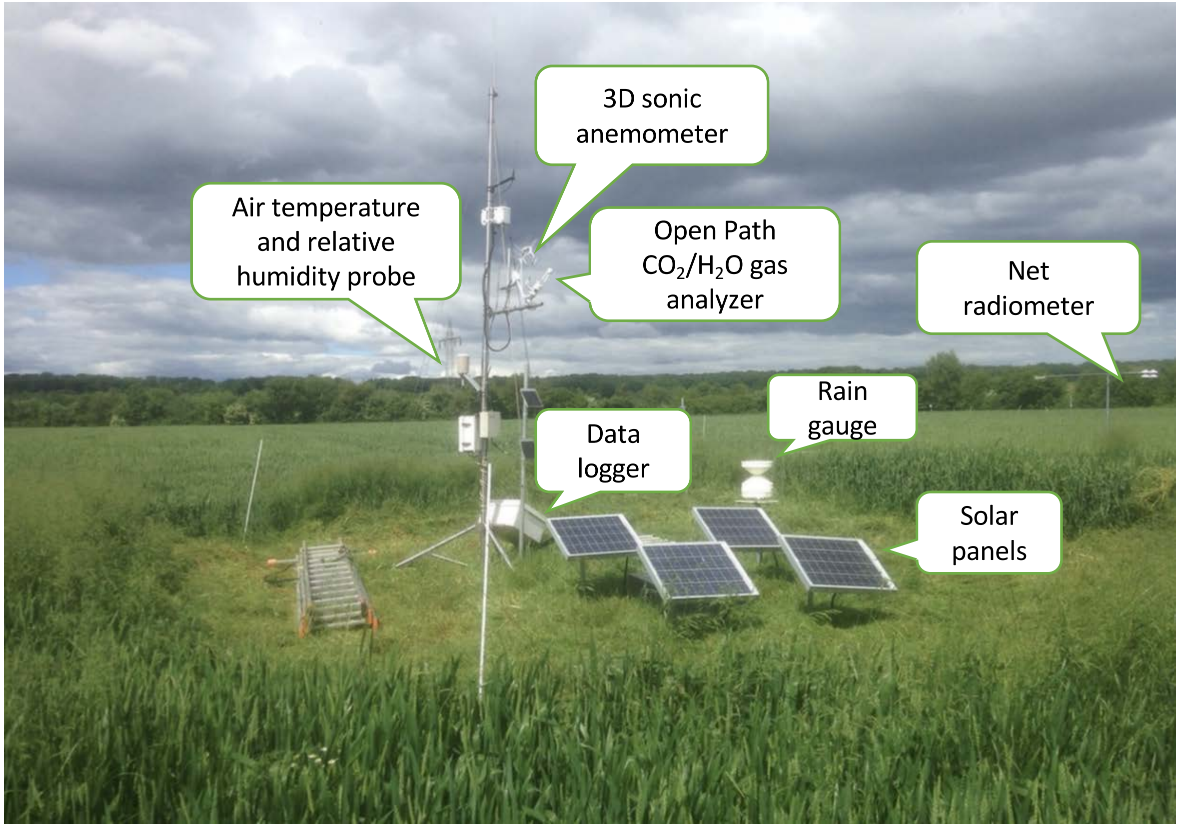
Eddy Covariance (EC) method



Source: http://launchtrailermetstation.blogspot.com/2010/08/soil-heat-flux-plate-installation-pics.html

LANDSLIDES SUSCEPTIBILITY ASSESSMENT

According recent studies between 1998 - 2017, **7255** natural and anthropogenic **disasters** including flood, earthquake, **landslides** have been registered in the world, **526 000 cases of death** of people and **3.47 billion USD of economic losses** related to the disasters caused by weather, climate and water, in totality considered as hydro meteorological disasters*

* Global Climate Risk Index 2019, Germanwatch e.V., December 2018

Introduction | **Land Management** | Water Management | Forest Management | Conclusion

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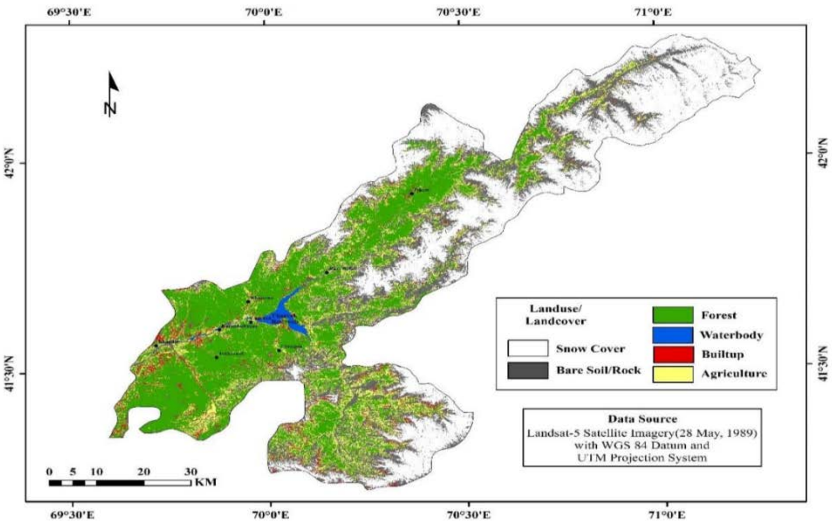
journal homepage: www.elsevier.com/locate/scitotenv

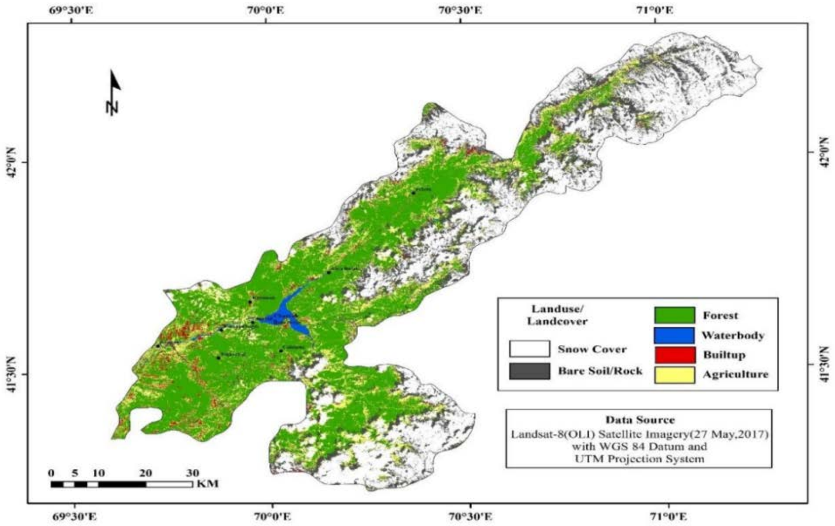
Comparative analysis of statistical methods for landslide susceptibility mapping in the Bostanlik District, Uzbekistan

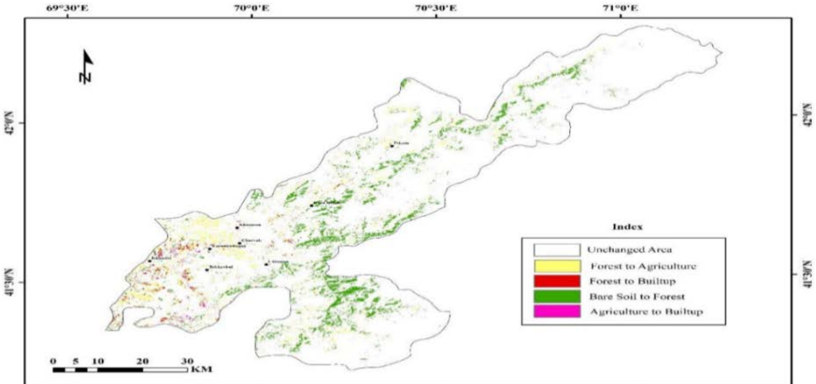
Check for updates

Mukhiddin Juliev [a,*], Martin Mergili [b,c], Ismail Mondal [d], Bakhtiar Nurtaev [e], Alim Pulatov [f], Johannes Hübl [a]

[a] University of Natural Resources and Life Sciences (BOKU), Institute of Mountain Risk Engineering, Vienna, Austria
[b] University of Natural Resources and Life Sciences (BOKU), Institute of Applied Geology, Vienna, Austria
[c] University of Vienna, Department of Geography and Regional Research, Vienna, Austria
[d] Department of Marine Science, University of Calcutta, India
[e] Institute of Geology and Geophysics, State Committee on Geology and Mineral Resources of Uzbekistan, Tashkent, Uzbekistan
[f] EcoGIS Center, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Uzbekistan



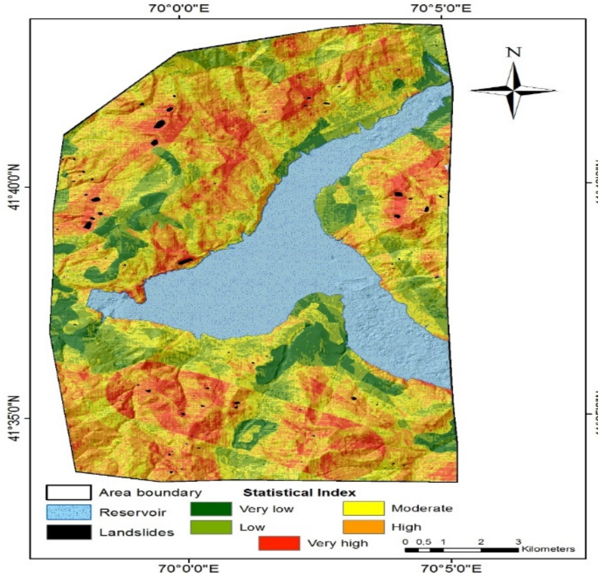




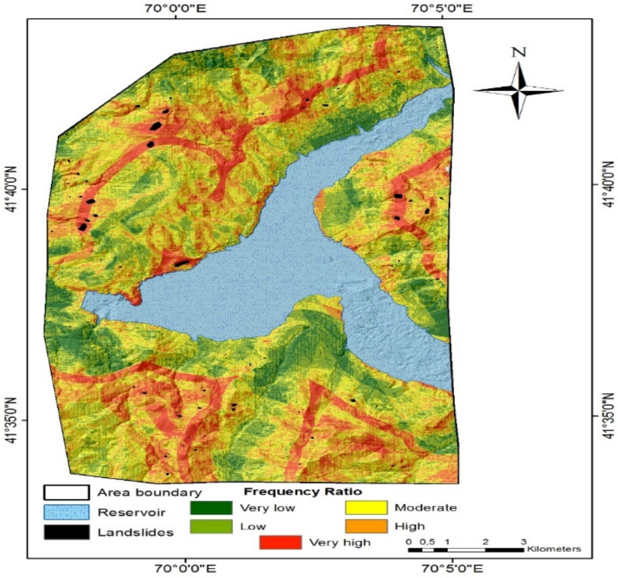
Landuse/Landcover	1989		2017	
	Area(km2)	Area (%)	Area(km2)	Area (%)
Forest	1519.6	30.5	1804.1	36.2
Snow Cover	1511.3	30.3	1504.9	30.2
Water body	36.2	0.7	38.9	0.8
Agriculture	655.0	13.1	656.9	13.2
Bare Soil	1118.6	22.5	863.3	17.3
Built-up	86.4	1.7	113.9	2.3
Total Area	4982	100	4982	100

Landslide susceptibility analysis in Uzbekistan

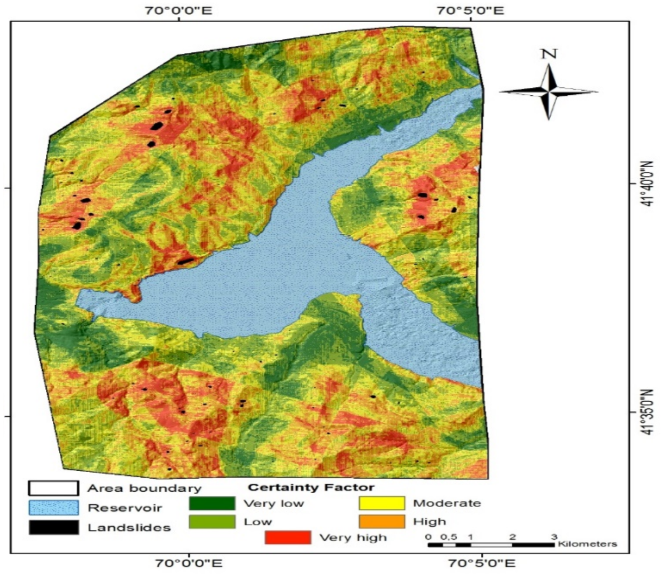
showed that the accuracies were 82.1% Statistical Index (SI), 74.3% - frequency ratio (FR) and 74% - certainty factor (CF) methods.



Landslide susceptibility map derived using the statistical index (SI) method.



Landslide susceptibility map derived using the frequency ratio (FR) method.



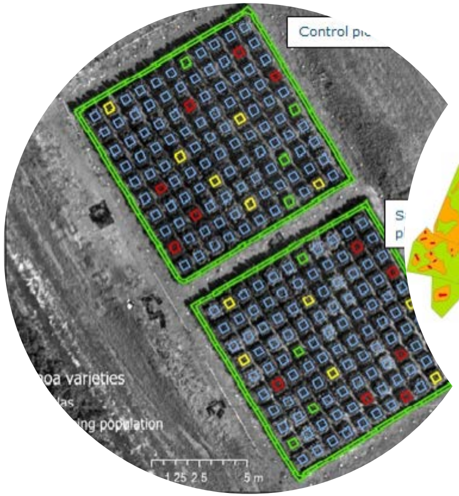
Landslide susceptibility map derived using the certainty factor (CF) method.

1/3 of all agricultural lands are becoming saline

SOIL SALINITY ASSESSEMENT IN DIFFERENT SCALES

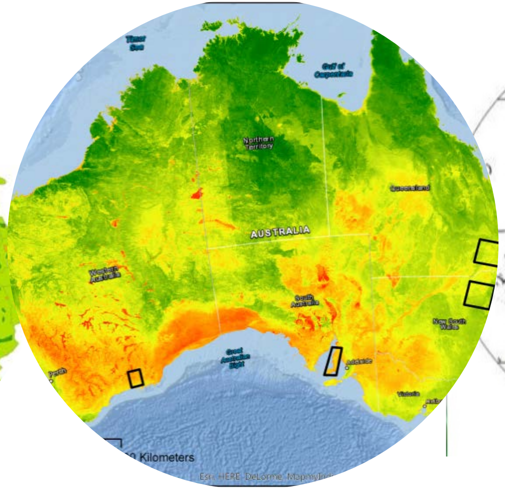
100+ countries affected by the problem

Local

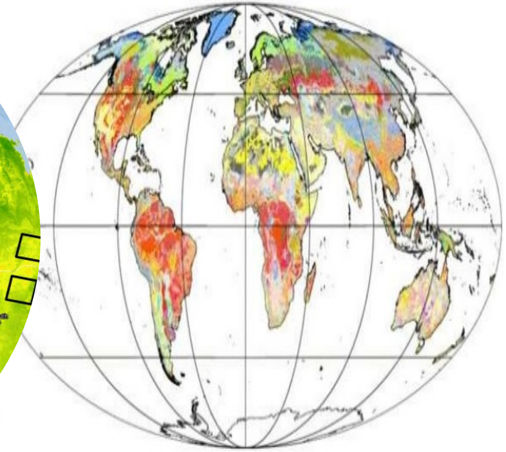


Country

Regional



Global



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UAV based soil salinity assessment of cropland

Konstantin Ivushkin[a,*], Harm Bartholomeus[a], Arnold K. Bregt[a], Alim Pulatov[b], Marston H.D. Franceschini[a], Henk Kramer[c], Eibertus N. van Loo[d], Viviana Jaramillo Roman[d], Richard Finkers[d]

[a] Laboratory of Geo-Information Science and Remote Sensing, Wageningen University & Research, Droevendaalsesteeg 3, 6708 PB Wageningen, the Netherlands
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[c] Wageningen Environmental Research, Wageningen University & Research, Droevendaalsesteeg 3, 6708 PB Wageningen, the Netherlands
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Quinoa
LiDAR
Hyperspectral
Thermography

ABSTRACT

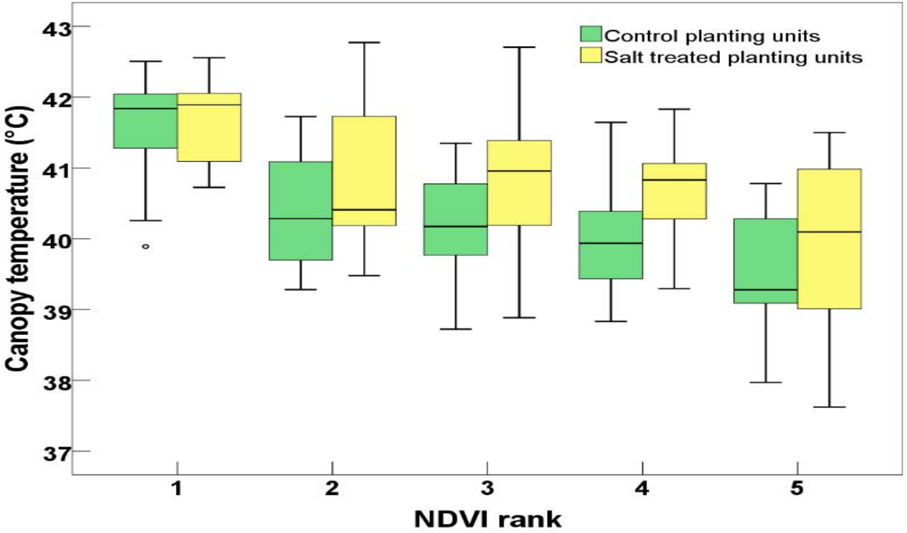
Increased soil salinity is a significant agricultural problem that decreases yields for common agricultural crops. Its dynamics require cost and labour effective measurement techniques and widely acknowledged methods are not present yet. We investigated the potential of Unmanned Aerial Vehicle (UAV) remote sensing to measure salt stress in quinoa plants. Three different UAV sensors were used: a WIRIS thermal camera, a Rikola hyperspectral camera and a Riegl VUX-SYS Light Detection and Ranging (LiDAR) scanner. Several vegetation indices, canopy temperature and LiDAR measured plant height were derived from the remote sensing data and their relation with ground measured parameters like salt treatment, stomatal conductance and actual plant height is analysed. The results show that widely used multispectral vegetation indices are not efficient in discriminating between salt affected and control quinoa plants. The hyperspectral Physiological Reflectance Index (PRI) performed best and showed a clear distinction between salt affected and treated plants. This distinction is also visible for LiDAR measured plant height, where salt treated plants were on average 10 cm shorter than control plants. Canopy temperature was significantly affected, though detection of this required an additional step in analysis – Normalised Difference Vegetation Index (NDVI) clustering. This step assured temperature comparison for equally vegetated pixels. Data combination of all three sensors in a Multiple Linear Regression model increased the prediction power and for the whole dataset R^2 reached 0.46, with some subgroups reaching an R^2 of 0.64. We conclude that UAV borne remote sensing is useful for measuring salt stress in plants and a combination of multiple measurement techniques is advised to increase the accuracy.

Satellite and aerial images used

- MODIS and Landsat thermal imagery
- MODIS and Landsat vegetation indices products to mask non-vegetated pixels
- Workswell WIRIS thermal camera
- Rikola hyperspectral camera

Results in local level with UAV (the Netherlands)

- Analysis done based on NDVI classification
- Ensures the same amount of plant material per pixel
- In all cases except one canopy temperature of saline plants is



Temperature boxplot for different NDVI clusters.

Planting experiment spatial layout. The planting units are marked by the coloured squares on an aerial photo background.

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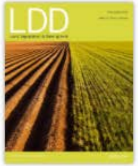
100years 1918 — 2018

Introduction | **Land Management** | Water Management | Forest Management | Conclusion

LDD Land Degradation & Development



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Research Article | Open Access

Satellite Thermography for Soil Salinity Assessment of Cropped Areas in Uzbekistan

Konstantin Ivushkin, Harm Bartholomeus, Arnold K. Bregt, Alim Pulatov

First published: 12 November 2016 | https://doi.org/10.1002/ldr.2670 | Citations: 20

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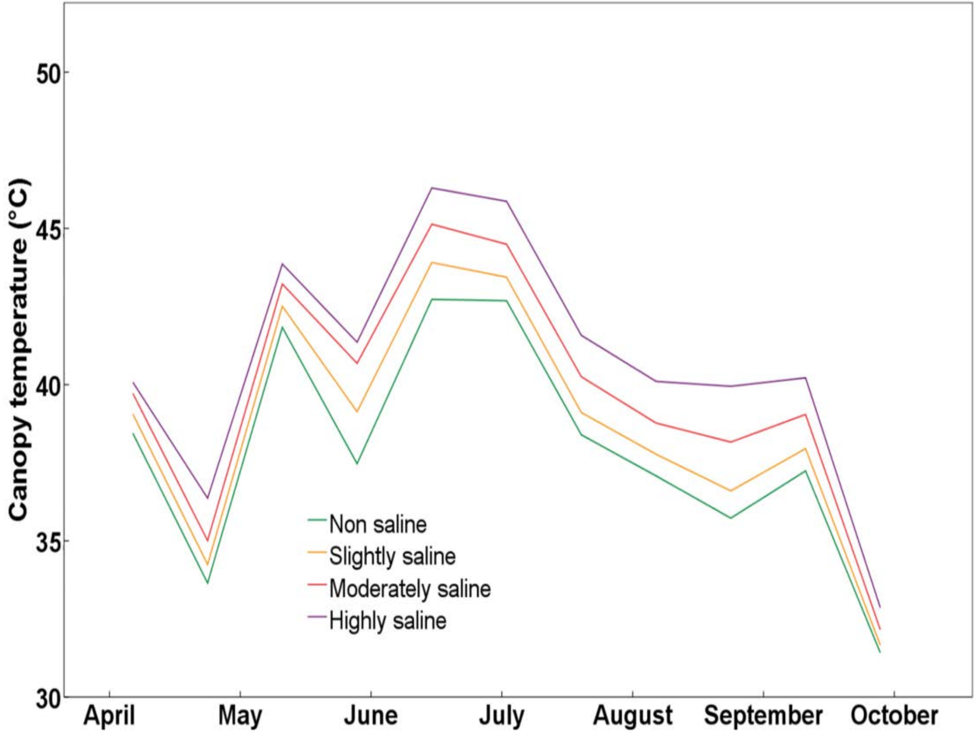
Abstract

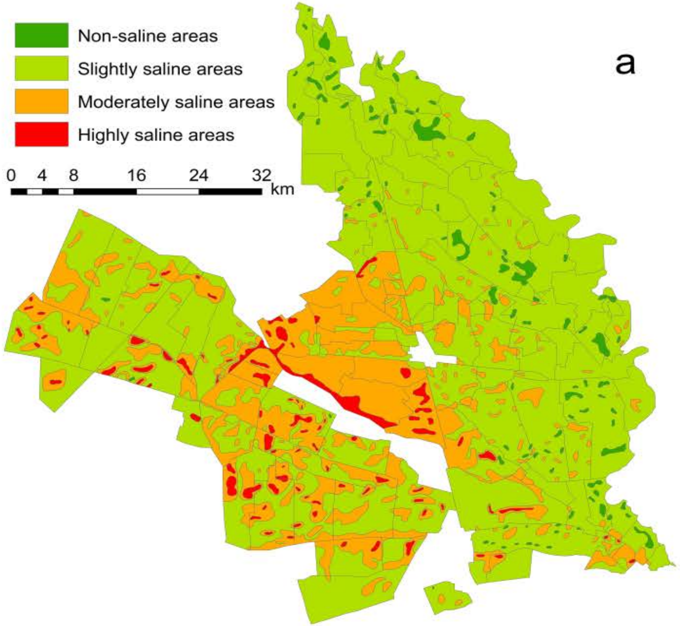
A change of canopy temperature can indicate stress in vegetation. Use of canopy temperature to assess salt stress in specific plant species has been well studied in laboratory and greenhouse experiments, but its potential for use in landscape-level studies using remote sensing techniques has not yet been explored. Our study investigated the application of satellite thermography to assess soil salinity of cropped areas at the landscape level. The study region was Syrdarya Province, a salt-affected, irrigated semi-arid province of Uzbekistan planted mainly to cotton and wheat. We used moderate-resolution imaging spectroradiometer satellite images as an indicator for canopy temperature and the provincial soil salinity map as a ground truth dataset. Using analysis of variance, we examined relations among the soil salinity map and canopy temperature, normalized difference vegetation index, enhanced vegetation index, and digital elevation model. The results showed significant correlations between soil salinity and canopy temperature, but the strength of the relation varied over the year. The strongest relation was observed for cotton in September. The calculated *F* values were higher for canopy temperature than for the other indicators investigated. Our results suggest that satellite thermography is a valuable landscape-level approach for detecting soil salinity in areas under agricultural crops. © 2016 The Authors. Land Degradation & Development Published by John Wiley & Sons Ltd.

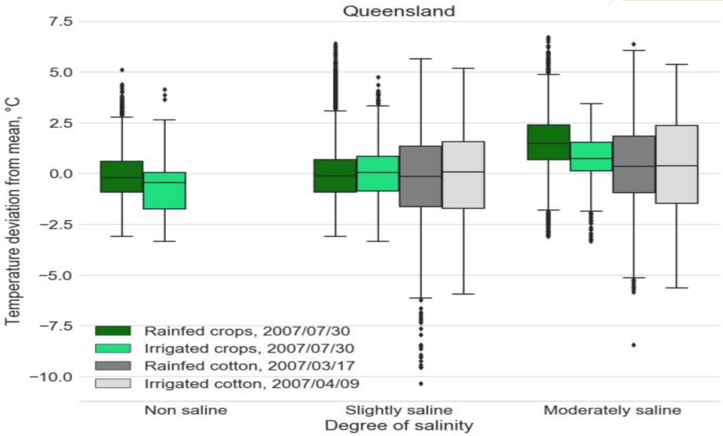
Details

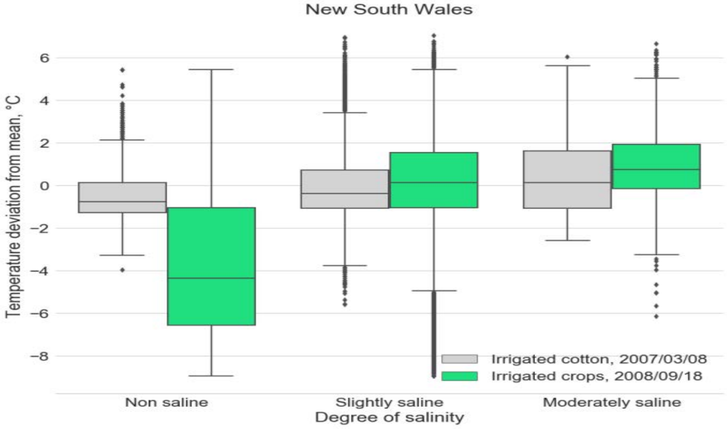
WAGENINGEN UNIVERSITY & RESEARCH

Temperature differences along the growing season (Uzbekistan)

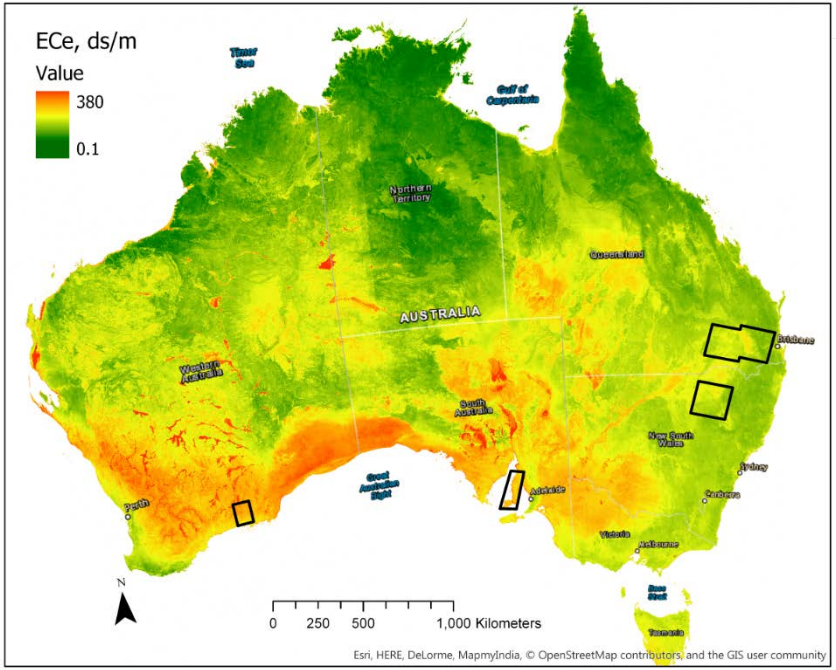








Results in regional scale (Australia)



- The trend is present on all study areas and for all crops
- But the magnitude is different – cotton show less differences as a more tolerant crops

Remote Sensing of Environment 231 (2019) 111260

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journal homepage: www.elsevier.com/locate/rse

ELSEVIER

Global mapping of soil salinity change

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Soil salinisation
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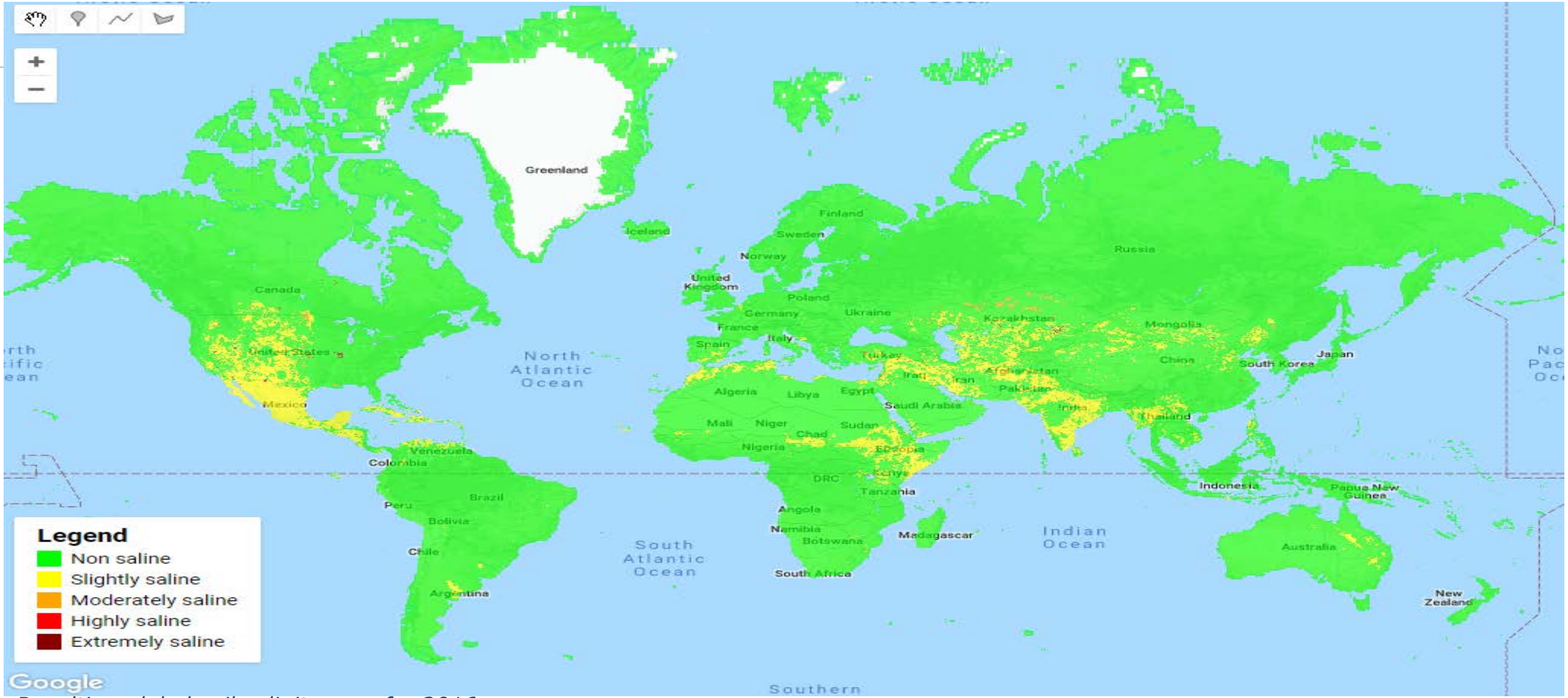
Landsat
SoilGrids

ABSTRACT

Soil salinity increase is a serious and global threat to agricultural production. The only database that currently provides soil salinity data with global coverage is the Harmonized World Soil Database, but it has several limitations when it comes to soil salinity assessment. Therefore, a new assessment is required. We hypothesized that combining soil properties maps with thermal infrared imagery and a large set of field observations within a machine learning framework will yield a global soil salinity map. The thermal infrared imagery acts as a dynamic variable and allows us to characterize the soil salinity change. For this purpose we used Google Earth Engine computational environment. The random forest classifier was trained using 7 soil properties maps, thermal infrared imagery and the ECe point data from the WoSIS database. In total, six maps were produced for 1986, 2000, 2002, 2005, 2009, 2016. The validation accuracy of the resulting maps was in the range of 67–70%. The total area of salt affected lands by our assessment is around 1 billion hectares, with a clear increasing trend. Comparison with 3 studies investigating local trends of soil salinity change showed that our assessment was in correspondence with 2 of these studies. The global map of soil salinity change between 1986 and 2016 was produced to characterize the spatial distribution of the change. We conclude that combining soil properties maps and thermal infrared imagery allows mapping of soil salinity development in space and time on a global scale.

Global soil salinity map with Google Engine and Machine Learning tools

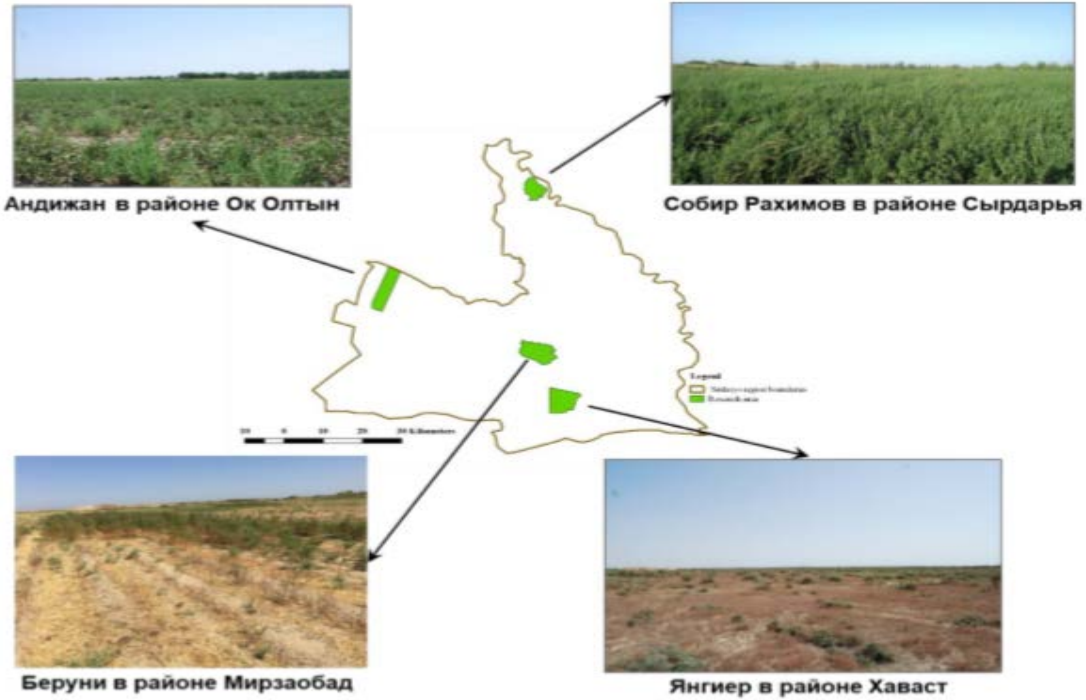
World soil salinity areas increased on 17% from 915.5 Mha (1988) to 1,069.3 Mha (2016)



Resulting global soil salinity map for 2016

Study area analysis

Syrdarya region having different levels of soil quality



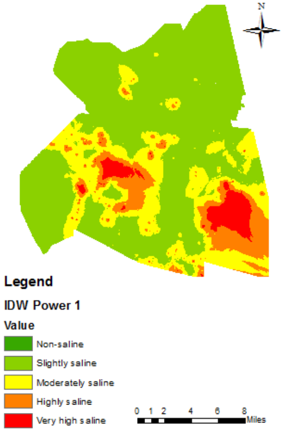
Data analysis – Bonitet data

Сирдарё вилояти суғориладиган қишлоқ хўжалик ерлари тупроқларининг сифатини баҳолаш маълумотлари

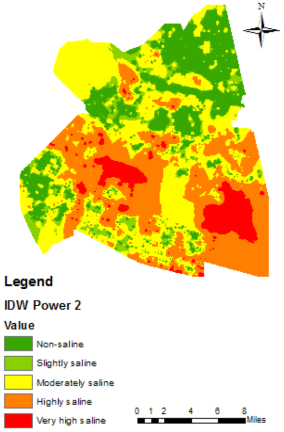
суғориладиган жами қ/х ерлари, майдони гектар ҳисобида

№	Туманлар	Тадкикот олиб борилган йил	Кадастр гурухлари										Бахоланган жами ер майдони, га	Ўртачабонитет балли (2014 йил)
			Ёмон ерлар		Ўртачадан паст ерлар		Ўртача ерлар		Яхши ерлар		Энг яхши ерлар			
			Кадастр класслари											
			I класс	II класс	III класс	IV класс	V класс	VI класс	VII класс	VIII класс	IX класс	X класс		
			Бонитет баллари											
			0-10	11-20,	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100		
1.	Ок олтин	2014				1096,3	13763,1	11727,4	16310,6	57,7			42955,1	56
2.	Сардоба	2014				6712,5	16252	6827,6	6110,2				35902,3	49
3.	Хавос	2014			82,2	6667,6	24526,8	4297,8	2749,7	0			38324,1	47
4.	Мирзаобод	2014			321,9	9900,5	18105,3	5872,9	1338,8				35539,4	45
5.	Сирдарё	2014				102,3	3753,2	11232,9	9218,1	5216,3	8,8		29531,6	61
6.	Гулистон	2014				438,2	7832,7	9037,0	5082,0	501,4			22891,3	54
7.	Сайхунобод	2014				101,2	8248,6	11155,2	9680,1				29185,1	56
8.	Боёвут	2014			85,1	1518,7	12904,7	9677,2	8113,9	766,4			33066,0	54,5
	Жами	га			**489,2**	**26537**	**105386,4**	**69828**	**58603,4**	**6541,8**	**8,8**		**267394,9**	**52,5**
		%			**0,183**	**9,924**	**39,412**	**26,114**	**21,916**	**2,446**	**0,003**			

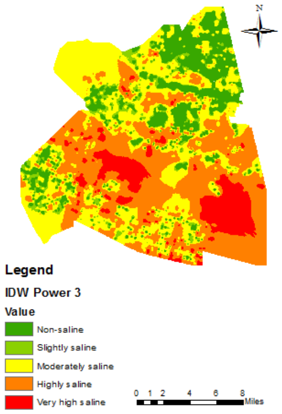
Geostatistical analysis



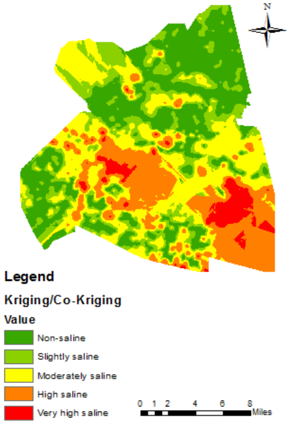
Mapping IDW (power 1)



Mapping IDW (power 2)



Mapping by IDW (power 3)



Mapping by Kriging/Co-kriging

atmosphere
MDPI

Article

Evaluation of the Perspective of ERA-Interim and ERA5 Reanalyses for Calculation of Drought Indicators for Uzbekistan

Natella Rakhmatova [1,*], Mikhail Arushanov [1], Lyudmila Shardakova [1], Bakhriddin Nishonov [2], Raisa Taryannikova [2], Valeriya Rakhmatova [2] and Dmitry A. Belikov [3,*]

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Abstract: The arid and semiarid regions of Uzbekistan are sensitive and vulnerable to climate change. However, the sparse and very unevenly distributed meteorological stations within the region provide limited data for studying the region's climate variation. The aim of this work was to evaluate the performance of the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis (ERA)-Interim and ERA5 products for the fields of near-surface temperature, humidity, and precipitation over Uzbekistan from 1981 to 2018 using observations from 74 meteorological stations. Major results suggested that the reanalysis datasets match well with most of the observed climate records, especially in the plain areas. While ERA5, with a high spatial resolution of 0.1°, is able more accurately reproduce mountain ranges and valleys. Compared to ERA-Interim, the climatological biases in temperature, humidity, and total precipitation from ERA5 are clearly reduced, and the representation of inter-annual variability is improved over most regions of Uzbekistan. Both reanalyses show a high level of agreement with observations on the standardized precipitation evaporation index (SPEI) with a correlation coefficient of 0.7–0.8.Although both of these ECMWF products can be successfully implemented for the calculation of atmospheric drought indicators for Uzbekistan and adjacent regions of Central Asia, the newer and advanced ERA5 is preferred.

check for updates

Citation: Rakhmatova, N.; Arushanov, M.; Shardakova, L.; Nishonov, B.; Taryannikova, R.; Rakhmatova, V.; Belikov, D.A. Evaluation of the Perspective of ERA-Interim and ERA5 Reanalyses for Calculation of Drought Indicators for Uzbekistan. *Atmosphere* **2021**, *12*, 527. https://doi.org/10.3390/atmos12050527

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ELSEVIER

Assessment of mudflow risk in Uzbekistan using CMIP5 models

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ARTICLE INFO

Keywords:
CMIP5
Circulation weather types
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Landslides
Mudflows
Precipitation threshold
Global warming impact
Uzbekistan

ABSTRACT

Precipitation induced mudflows are a major and longstanding threat in Uzbekistan, impacting on many properties and livelihoods. In this paper, the role of large-scale atmospheric circulation in producing the conditions necessary to initiate mudflows in piedmont areas of Uzbekistan have been evaluated based on historical and scenario (Representative Concentration Pathways; RCP8.5) experiments along from 10 Coupled Model Intercomparison Project Phase 5 (CMIP5) models. Applying the well-established circulation weather type (CWT) technique, and CMIP5 models reveal that mudflow generating large-scale circulation flows will increase by up to 5% to the end of the century. Considering the historical simulations over 1979–2005 and following the projections of RCP8.5 emission scenario for the target period of 2071–2100, precipitation climatology has been evaluated using bias correction techniques. By this way, the synthetic rainfall series were linked to a central proxy – a mudflow generating weather types, such as cyclonic (C), westerly (W) and south-westerly (SW) in order to diagnose potential changes in mudflow occurrences given the changed CWT characteristics by running the statistical-empirical algorithm of antecedent daily rainfall model (ADRM) and statistical logistic regression (LRM). Results for the important weather types (C, W and SW) confirm that mudflow activity will increase in the selected region as precipitation values associated with the CWT C and W flows in CMIP5 projections are expected to increase in the warm season for the target period of 2071–2100.

The research focuses on piedmont areas of Uzbekistan as it has remained poorly understood due to limited climate research, particularly, in mountain areas. This is important in the face of climate change, which is likely to increase pressure upon high mountain areas that may need to investigate more frequent mudflow occurrences.

climate

MDPI

Article

Analysis of Temperature Change in Uzbekistan the Regional Atmospheric Circulation of Middl during 1961–2016

Bakhtiyar M. Kholmatjanov [1,2], Yuriy V. Petrov [2], Temur Khujanazarov [3,*], Nigora N. Sulaymonova [1], Farrukh I. Abdikulov [2] and Kenji Tanaka [3]

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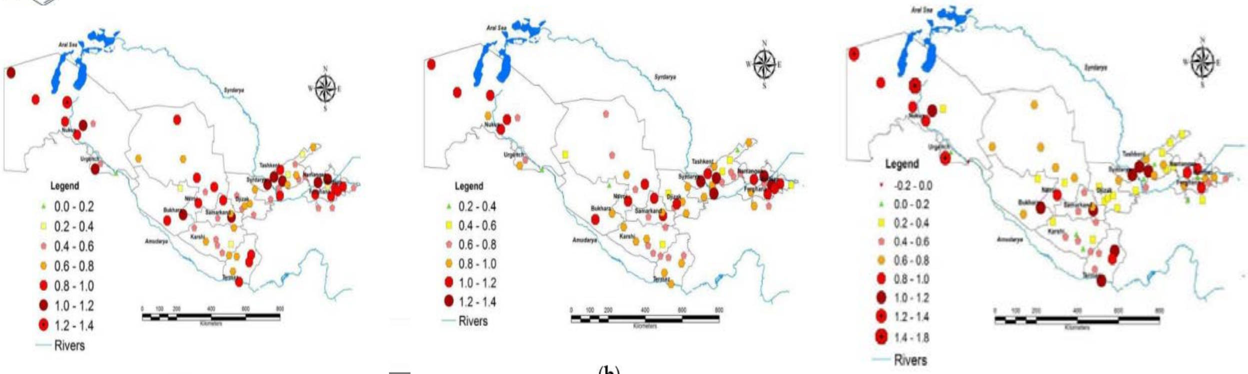
Received: 6 August 2020; Accepted: 17 September 2020; Published: 18 September 2020

Abstract: Climate change and shrinking of the Aral Sea have significantly affected temperature variations. Observed interannual changes in Uzbekistan's air temperatur to the duration of synoptic weather types (SWT) in Middle Asia were analyzed. No Mann–Kendall statistical test and climate trends coefficients were used to identify trend charac observed temperature from 1961–2016 to the baseline period of 1961–1990. The results showed temperature trends average to 1 °C in warm and cold half years over Uzbekistan. The decadal temperature trend ranged from 0.25 °C/decade in the northwest to 0.52 °C/dec center, especially pronounced in the oasis and Aral Sea zones. There were also significant c the structure of regional SWT. The main difference in the structure of SWT in Middle Asi to the baseline period was expressed in a decrease of cold mass invasion duration fron 76.1 days and an increase in low-gradient baric field duration from 65.8 to 134.6 days. Th of anthropogenic warming, which began in Uzbekistan in the 1960s of the twentieth ce accelerated from the mid-1970s with a higher mean annual air temperature than the baselin climate normals (1961–1990) and is associated with changes in the regional SWT over Mid



(a) (b) (c)

Assessment of Soil Salinity Changes under the Climate Change in the Khorezm Region, Uzbekistan

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* Correspondence: javlon@email.com; Tel.: +998-90-985-9338
† These authors contributed equally.

check for updates

Citation: Khamidov, M.; Ishchanov, J.; Hamidov, A.; Donmez, C.; Djumaboev, K. Assessment of Soil Salinity Changes under the Climate Change in the Khorezm Region, Uzbekistan. *Int. J. Environ. Res. Public Health* **2022**, *19*, 8794. https://doi.org/10.3390/ijerph19148794

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Abstract: Soil salinity negatively affects plant growth and leads to soil degradation. Saline lands result in low agricultural productivity, affecting the well-being of farmers and the economic situation in the region. The prediction of soil salinization dynamics plays a crucial role in sustainable development of agricultural regions, in preserving the ecosystems, and in improving irrigation management practices. Accurate information through monitoring and evaluating the changes in soil salinity is essential for the development of strategies for agriculture productivity and efficient soil management. As part of an ex-ante analysis, we presented a comprehensive statistical framework for predicting soil salinity dynamics using the Homogeneity test and linear regression model. The framework was operationalized in the context of the Khorezm region of Uzbekistan, which suffers from high levels of soil salinity. The soil salinity trends and levels were projected under the impact of climate change from 2021 to 2050 and 2051 to 2100. The results show that the slightly saline soils would generally decrease (from 55.4% in 2050 to 52.4% by 2100 based on the homogeneity test; from 55.9% in 2050 to 54.5% by 2100 according to the linear regression model), but moderately saline soils would increase (from 31.2% in 2050 to 32.5% by 2100 based on the homogeneity test; from 31.2% in 2050 to 32.4% by 2100 according to the linear regression model). Moreover, highly saline soils would increase (from 13.4% in 2050 to 15.1% by 2100 based on the homogeneity test; from 12.9% in 2050 to 13.1% by 2100 according to the linear regression model). The results of this study provide an understanding that soil salinity depends on climate change and help the government to better plan future management strategies for the region.

Figure 1. Average long-term air temperature variations in Uzbekistan for the 1991–2016 period compared to the baseline 1961–1990 period (in ◦C).

a) Annual mean temperature
b) Cold half-year mean temperature
c) Warm half-year mean temperature

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Original Research Article

Evaluation of perennial reference evapotranspiration (ET_o) over a typical dryland using satellite images: a case study from Uzbekistan

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evapotranspiration
agricultural land
Hargreaves-Samani
NDVI
SAVI
climate change
Karakalpakstan

ABSTRACT

Evapotranspiration (ET) is one of the most significant compartments in the energy and water balance between the atmosphere and the Earth's surface. Global climate change has an impact on the water cycle and can result in an increase in ET from the land surface; nevertheless, an increase in ET can destabilize the macro- and micro-climate at the local and continental levels. In line with this, the purpose of this article is to learn more about the factors that contribute to the high and current reference ET (ET_o) rate of Karakalpakstan (Uzbekistan). MODIS Terra images was used to analyze long-term land cover change. The Google Earth Engine code editor, Erdas Imagine 2020, and ArcMap 10.8 were used to map land cover change and the leaf area index (LAI). Though the Normalized Difference Vegetation Index and the Soil-Adjusted Vegetation Index were used because of their past performance as affirmative measurement techniques for vegetation monitoring. The Hargreaves-Samani equation was utilized to ET_o in this study. Increased crop density in agriculture and the conversion of barren soil to grasslands to rehabilitate the seashore ecosystem of the Aral Sea influenced LAI significantly, according to multifactorial analyses of perennial air temperature, land cover change, solar irradiance, and ET_o in a typical dryland of Uzbekistan. However, the extension of LAI in the agricultural area of Karakalpakstan substantially accelerated the ET_o rate, which was a key contributor of an increase in crop water demand. We can see that measured solar radiation and ET_o were consistent across time by looking at the nearly same quantities for both. As a result, we assume that global climatic changes have no effect in the uncertainty of solar radiation and ET rate.

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Modifying Hargreaves-Samani Equation for Estimating Reference Evapotranspiration in Dryland Regions of Amudarya River Basin

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https://doi.org/10.4236/as.2018.910094

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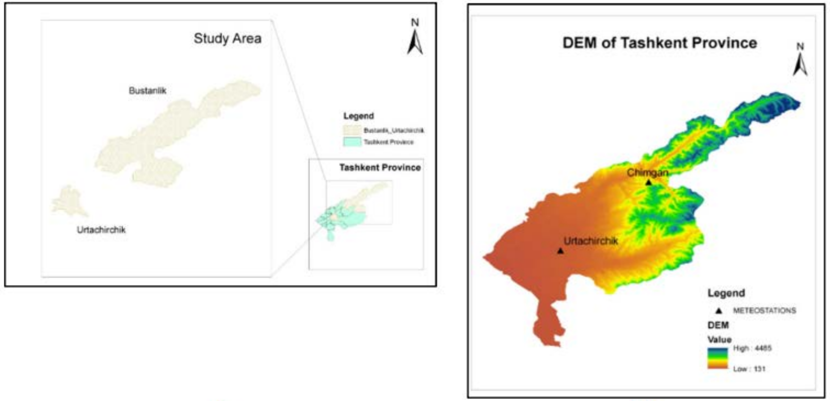
Published: October 31, 2018

Abstract

Reference evapotranspiration (ETo) is a key factor in determining the amount of water needed for crops, which is crucial to correct irrigation planning. FAO Penman-Monteith (EToPM) is among the most popular method to estimate ETo. Apparently sometimes it is difficult to compute ETo using Penman-Monteith due to challenges on data availability. FAO Penman-Monteith method requires many parameters (solar radiation, air temperature, wind speed and humidity), while Hargreaves-Samani method calculates ETo based on air temperature. Because Central Asia is a data limited region with weather stations unable to provide all required parameters for the PM method, this study aimed to estimate ETo using the Hargreaves and Samani (HS) method in Karshi Steppe, in Kashkadarya province, in southern Uzbekistan, based on data from 2011 to 2017. Reference evapotranspiration calculated by non-modified HS method is underestimated during the summer months. The reason for this underestimation might be higher air temperature and wind speed during these months. Therefore, the HS method in its original form cannot be used in our study area to estimate ETo. Modification of the EToHS, through application of a bias correction factor, had better performance and allowed improving the accuracy of the ETo calculation for this region. The calculated ETo values can inform decision making and management practices regarding water allocation, irrigation scheduling and crop selection in dry land regions of Amudarya river basin and the greater Central Asia area.



a) b)

Fig. 1. Maps of the study area (left) Location of Bustanlik and Urtachirchik districts and (right) Digital elevation model and meteorological station.

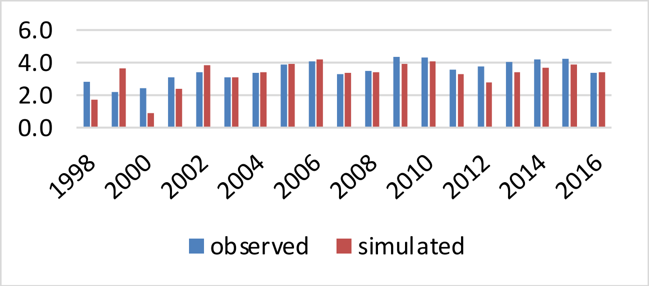
Table 1. Produced climate variables.

$T_{mean\ annual}$	$T_{mean\ sep\_may}$	$T_{min\ summer}$	$T_{max\ spring}$	Pcp_{winter}
$T_{mean\ autumn}$	$T_{min\ annual}$	$T_{min\ sep\_may}$	$T_{max\ summer}$	Pcp_{spring}
$T_{mean\ winter}$	$T_{min\ autumn}$	$T_{max\ annual}$	$T_{max\ sep\_may}$	Pcp_{summer}
$T_{mean\ spring}$	$T_{min\ winter}$	$T_{max\ autumn}$	Pcp_{annual}	Pcp_{sep_may}
$T_{mean\ summer}$	$T_{min\ spring}$	$T_{max\ winter}$	Pcp_{autumn}	

where, T-Air temperature, Pcp-Precipitation, min – minimum, max - maximum

Table 6. Multiple regression relationship between climate variables and yield.

Province	Regression Function	Adjusted R2	Significance
Bustanlik	Y = 52.81*Tmin sep_may-3.63*Tmax sep_may	0.85	<0.0001
Urtachirchik	Y= 74.54+20.63*Tmean spring-16.28*Tmax spring	0.63	<0.0001



Statistical evaluation of accuracy of simulation	
MAE, c/ha	9
RMSE, c/ha	0,7
Observed, c/ha	66,9
Simulated, c/ha	62,21

AQUACROP

Environmental Challenges 7 (2022) 100502

Contents lists available at ScienceDirect

Environmental Challenges

journal homepage: www.elsevier.com/locate/envc

ELSEVIER

An Empirical Assessment of the Interactive Impacts of Irrigation and Climate on Farm Productivity in Samarkand region, Uzbekistan

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[d] Director of IAMO, Head of the Department of Agricultural Markets, Marketing and World Agricultural Trade, Leibniz Institute for Agricultural Development in Transition Economies (IAMO), Theodor-Lieser-Str. 2, 06120, Halle (Saale), Germany

A R T I C L E I N F O

Keywords:
Agriculture
climate change
irrigation
panel data
Stochastic Frontier Approach (SFA)

A B S T R A C T

Analyzing climate change's consequences is more complex for irrigated agriculture compared to rainfed. There are still limited researches that has considered the interactive effects of irrigation and climate variables regardless the fact that a broad range of climate studies was already involved in international literature. In this view, this study aimed at exploring the cross effects of irrigation with climate on farm output using *ex post* assessment technique in Uzbekistan, where agriculture contributes for a large portion of the national GDP and irrigation water is becoming scarce. We applied a Stochastic Frontier Approach (SFA) with panel data from the central-eastern part of Uzbekistan for the period of 2013-2018, which includes a sample of 2,135 wheat and 1,141 cotton growers. The analysis revealed that climate factors have diverse influence by crop types across the region. Increased warming would be harmful for wheat farmers: a one-degree Celsius rise in average temperature between March and June could lead to up to 60% losses of total yields on wheat-growing farms, although precipitation has a positive significant effect. In contrast, increased temperatures are beneficial for cotton-growing farmers but excessive rainfall during the months of May-September could lead to 3% losses of total yields on cotton-growing farms. It's expected that both wheat and cotton growing farmers will suffer from temperature increases and excessive precipitation on their farms in the near future. More importantly, the interaction effects of irrigation and climate variables show that the cross effects of applied irrigation and mean temperature have highly significant positive impacts on the total yields of both wheat and cotton growing farmers in the study region. Thus, productivity in the region could be improved when enough water is available and more efficient irrigation techniques are used, otherwise declines in productivity could be witnessed.

Climate Risk Management 13 (2016) 19–30

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

ELSEVIER

Income and irrigation water use efficiency under climate change: An application of spatial stochastic crop and water allocation model to Western Uzbekistan

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[b] *Institute for Food and Resource Economics, University of Bonn, Germany*
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A R T I C L E I N F O

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Keywords:
Central Asia
Integrated modeling
Climate change
Risk management
Irrigation efficiency

A B S T R A C T

A decline in water availability due to rising temperatures and growing water demand presents significant and unique challenges to agricultural producers in Uzbekistan. This study investigates the impact of climate change on farm revenues and water use efficiencies in Western Uzbekistan. A spatially explicit stochastic optimization model is used to analyze crop and water allocation decisions under conditions of uncertainty for irrigation water availability in the area for the first time.

Results show farmers' income could fall by as much as 25% with a 3.2 °C temperature increase and a 15% decline in irrigation. Farmers located in the tail end of the irrigation system could lose an even greater share of their revenues. A more conservative increase in temperature could increase farmer income by as much as 46% with a 2.2° temperature increase and only 8% decline in irrigation water since some crops benefit from extended vegetation periods. Under both pessimistic and optimistic scenarios, environmental challenges due to shallow groundwater tables may improve associated with enhanced water use efficiency.

Heliyon 7 (2021) e07028

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Heliyon

journal homepage: www.cell.com/heliyon

Research article

Downscaling model in agriculture in Western Uzbekistan climatic trends and growth potential along field crops physiological tolerance to low and high temperatures

Julian Schlubach*

A R T I C L E I N F O

Keywords:
Meteorological data
Trend in temperatures
Climate change
West Uzbekistan
Amu Darya
Aral Sea Basin
Crops physiological tolerance to high temperatures
Field crops
Hot days
Tropical nights

A B S T R A C T

The Global climate change is becoming an increasing challenge for agriculture. Beyond the increased local occurrence of extreme events high temperatures are becoming an increasingly present limiting factor in crop production. The agriculture in the West of Uzbekistan with very limited rainfalls is highly dependent on irrigation schemes using the Amu Darya water flow. With low Winter (freezing nights with minimum air temperatures of less than 0 °C) and high Summer temperatures (hot days and nights with temperatures above 35 °C during daylight, and minimum air temperatures of more than 20 °C during night time – tropical nights) the local continental arid climate temperatures are a main limiting factor faced by the local agriculture. The arid climate, with a crop production dependant on irrigation, allows putting the focus on temperatures influence on field crops, while rainfalls have barely any influence.

In temperate countries the focus has mainly been on low temperatures as a main limiting factor. Freeze is indeed influencing the sowing period and putting crops at early development stages at risk.

Even though, the West of Uzbekistan is facing low temperatures over the Winter period which is also challenging the local agriculture, high temperatures are becoming an increasing threat over the Summer period.

The present study is analysing day and night temperature trends over the period 1987–1990 and 2013–2017. The observed trends are further compared with data from the Intergovernmental Panel on Climate Change (IPCC) model available on the World Bank open portal. Regression lines have been calculated illustrating the trends over the period. The inter-annual temperature variations are important with a relative standard deviation which ranges between 16 and 50%. The trend is considered as not significant when the relative standard deviation exceeds the variation over the overall time-period.

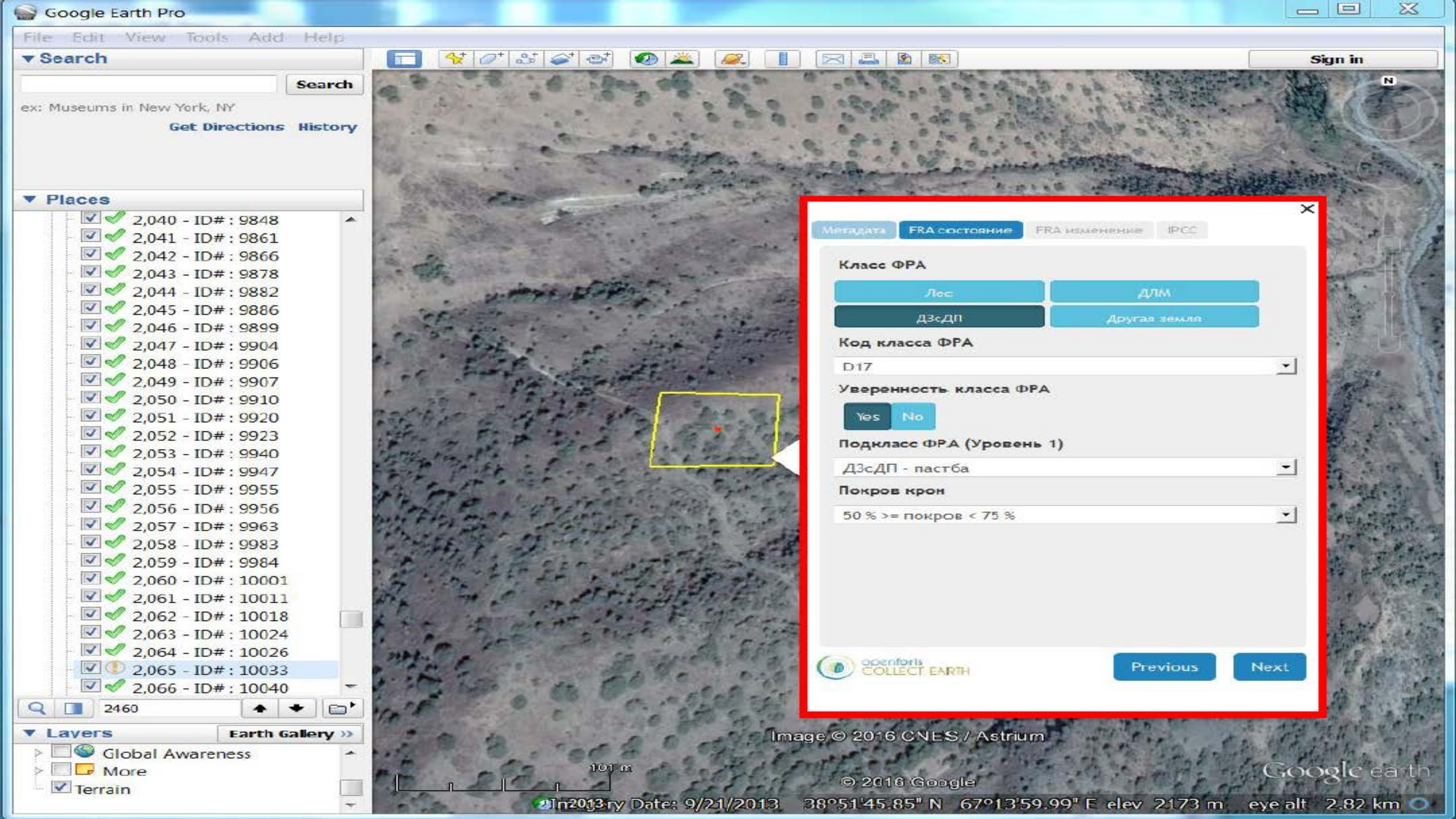
The Day degrees are used to provide an insight into the climatic impact on crop growth along plants physiological tolerance. The day degree methodology has been especially adjusted in the present publication in order to take into account the tolerance of the studied crops to high temperatures.

While the hot period is progressively expending into the Spring period, Winters are not becoming much milder limiting the benefit for Winter crops. While the hot days and tropical night event will become predominant over the Summer period the yields in cotton and rice are expected to drop drastically over the second half of the XXIst century. The expected reduction of water inflow of the Amu Darya over the century will further strongly put into question the crop production model in the West of Uzbekistan.

The present publication aims at describing the ongoing trends, expectable changes in agricultural production and timelines. It is also illustrating how hot temperatures analysis could be integrated in downscaling models in agriculture in other regions of Uzbekistan and of the world.

Forest and Collect Earth Survey

- **Quick assessment of of land-use** - no matter the size of study area
- **Collect Earth** is a software tool developed under FAO's initiative (OpenForis)
- It's **Free and Open Source** – no directs financial cost to use it
- Interpretation of **sample plots** using **High Resolution Imagery** (Google Earth and Bing Map)
- **Assessment of changes possible** using recent HR and full archive of Landsat and Modis (using Googles Earth Engine)



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Search
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Get Directions History
Places
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2,042 - ID# : 9866
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Terrain
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Лес
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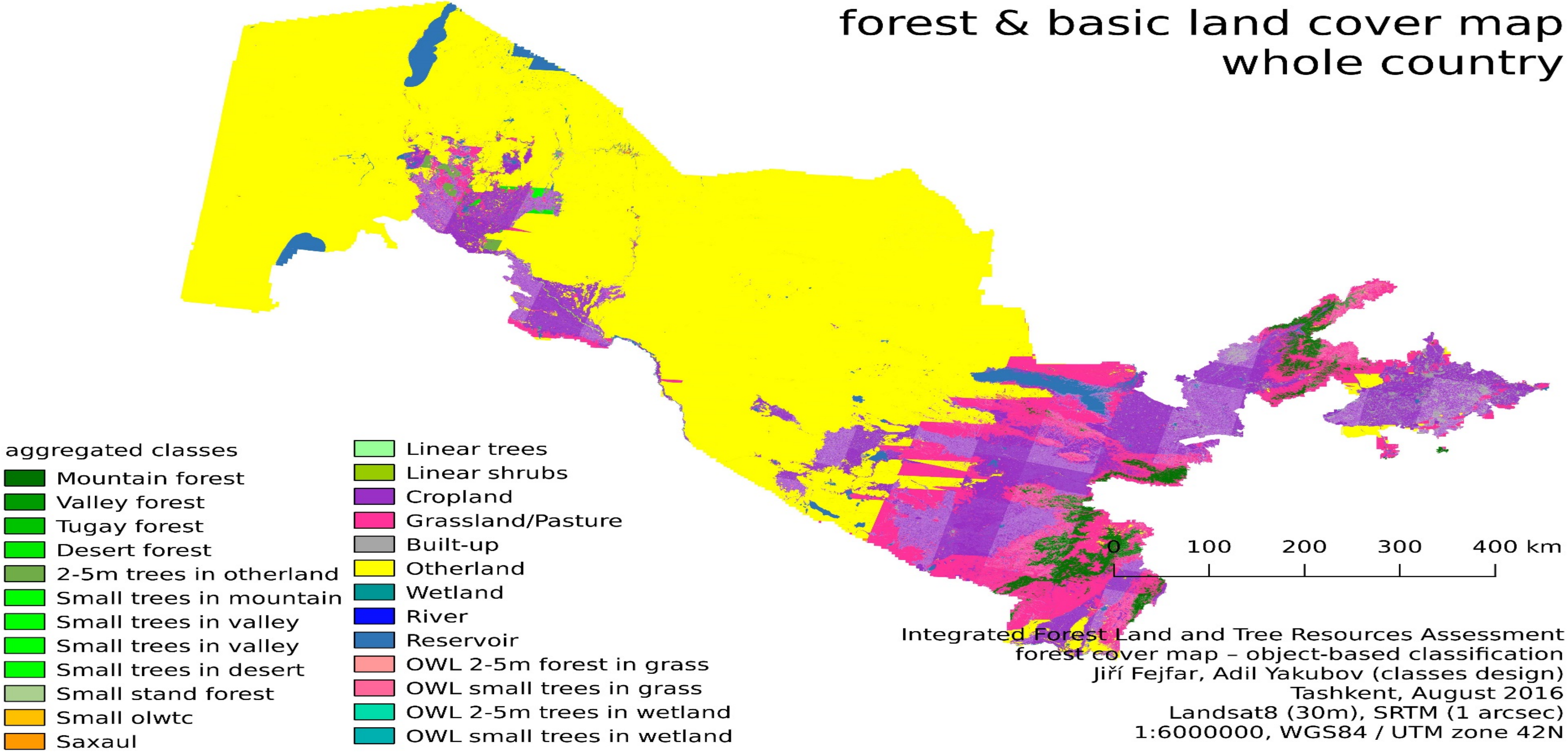
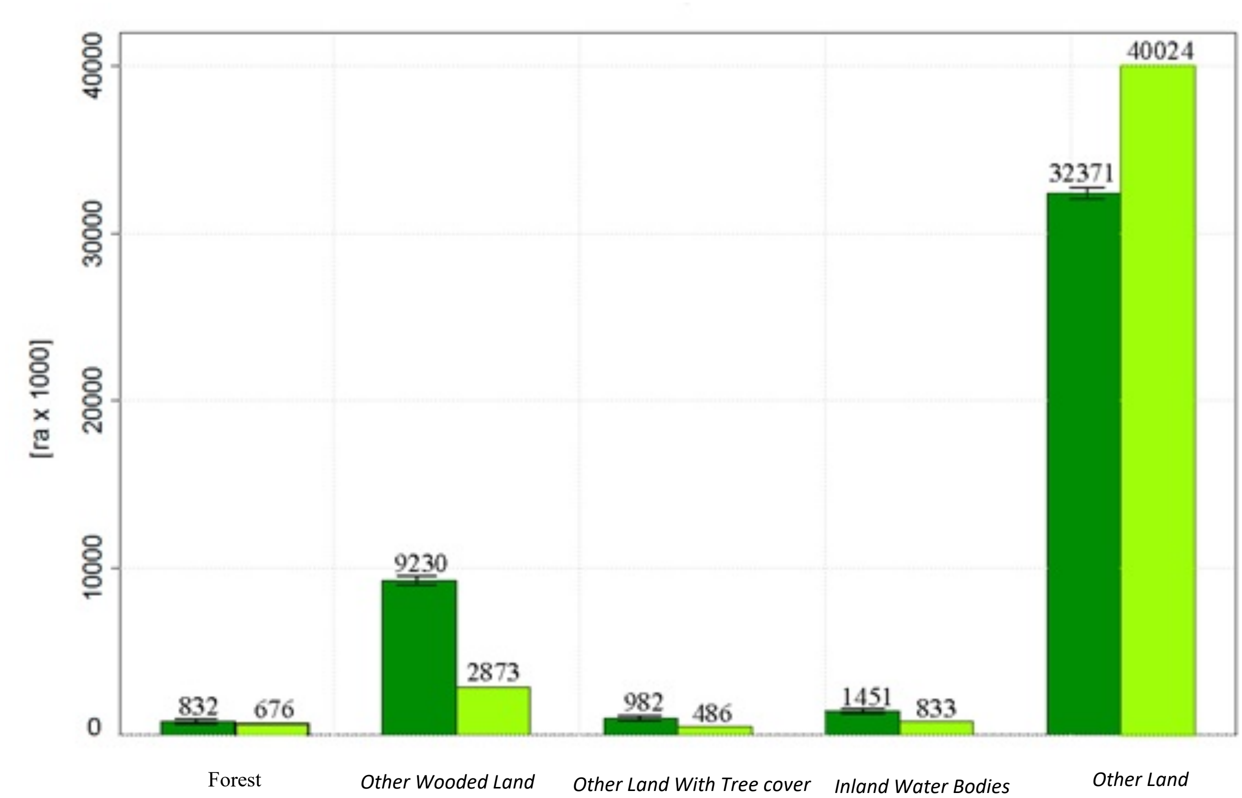
ДЗсДП
Другая земля
Код класса ФРА
D17
Уверенность класса ФРА
Yes
No
Подкласс ФРА (Уровень 1)
ДЗсДП - пастба
Покров крон
50 % >= покров < 75 %
openforis COLLECT EARTH
Previous
Next
Image © 2016 CNES / Astrium
© 2016 Google
Google earth
Imagery Date: 9/21/2013 38°51'45.85" N 67°13'59.99" E elev 2173 m eye alt 2.82 km

forest & basic land cover map whole country



Integrated Forest Land and Tree Resources Assessment
forest cover map – object-based classification
Jiří Fejfar, Adil Yakubov (classes design)
Tashkent, August 2016
Landsat8 (30m), SRTM (1 arcsec)
1:6000000, WGS84 / UTM zone 42N

Total forest areas counted by Collect Earth (**dark green**) and national assessment (**light green**) colour



Total land area for 2015

CASCADE

Water Resources in CA

CASCADE

North West Agriculture and Forestry University and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers signed Construction Agreement on SciTech Park on Water Saving Agriculture 30-11-2019

Supplementary Agreement on China-Uzbekistan Sci-tech Park on Water Saving Agriculture

Party A: Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Uzbekistan

Party B: Northwest A&F University, China

In order to accelerate the construction of China-Uzbekistan Sci-tech Park on Water Saving Agriculture, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (Party A) and Northwest A&F University (Party B) have communicated and agreed to carry out the following work:

1. Party A and Party B agree on the schematic diagram planning of the park.
2. Party A shall start the excavation of the water reservoir as soon as possible, with the reservoir volume of 300m^3. Party A shall notify Party B 20 days before the completion of the construction of the reservoir. Party B shall arrange for the dispatch of equipment and materials after receiving the notification from Party A, and at the same time, Part B send construction personnel to the park to carry out the construction of the water-saving irrigation projects.
3. Party A shall provide temporary housing for the construction workers of Party B (school training base near the park), and provide convenient conditions for Party B construction workers to dine.
4. Party A shall arrange a local technician to assist Party B to complete the construction and installation.
5. From the date of signing this agreement, Party B will quickly organize personnel concerned to complete the detailed construction design of the park, complete the procurement of system pipes and auxiliary connectors, etc., and to promote the production of water-saving irrigation equipment (with the equipment and materials list attached). The estimated investment amount at this stage is about 2 million yuan.
6. The final interpretation of this agreement shall be vested in both parties. Anything not covered herein shall be settled by both parties through negotiation.

This agreement is made in duplicate (Chinese and English versions), with each party holding one copy.

Northwest A&F University	Tashkent Institute of Irrigation and Agricultural Mechanization Engineers
Zhu Delan	U. Umurzakov
Date:	Date:

CASCADE

TIIAME

Crop production system transformation

Crop production is the pillar industry of Central Asian countries agriculture and has a good production base, but due to factors such as climate change and the degree of informatization, there is a lot of room for improvement in production efficiency.

Due to the impact of climate and environmental changes, water shortages Central Asian countries need to monitor factors related to agricultural production, such as weather, water availability, soil salinity, crop development, pesticides, chemical fertilizers and others, need to build advanced agricultural intelligence monitoring systems. During the growth process, effective measures are taken to ensure the yield and quality of crops in response to possible problems.

One of the example in this direction is the creation of new SciTech Park at TIIAME Research Farm in Uzbekistan jointly with North West Agriculture and Forestry University in China. This SciTech Park is focusing on soil and water conservation technologies on irrigated areas of CA countries by implementation of Precision Agriculture principles.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Легенда
High
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Moderate
Low to Moderate
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Station Province Altitude AverageMi... HighestTemp
Manzhouli Inner Mong... 661.7 -37 30
Hailar Inner Mong... 610 -40 30
Xiao Ergou Inner Mong... 286 -42 30
Nenjiang Heilongjiang5 242.2 -40 30
Mohe Heilongjiang1 296 -47 29
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Conclusions

- Landslide susceptibility analysis in Uzbekistan showed that the accuracies were 82.1% Statistical Index (SI), 74.3% - frequency ratio (FR) and 74% - certainty factor (CF) methods.
- Satellite and UAV thermography data is significantly related with soil salinity
- Data acquired on different scales (UAV and satellite) tells the same story
- The correlation is present for different crops, including salt tolerant, and different agricultural practices
- Salt tolerant crops requires additional steps in analysis
- The timing for this method is important - moment of maximum vegetation development after the dry season is the best time for monitoring
- World soil salinity areas increased on 17% from 915.5 Mha (1988) to 1,069.3 Mha (2016)

Thank you for your attention