CAWa

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Proceedings Paper

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International Symposium on Water and Land Resources in Central Asia

The symposium is organized in the framework of the Central Asia Water (CAWa) project, as part of the German Initiative for Central Asia ("Berlin Process") and is funded by the German Federal Foreign Office (grant no. AA7090002).

Venue:

Best Western Plus Atakent Park Hotel
Timiryazev St 42 Almaty, Kazakhstan
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Organizers:

German Research Center for Geosciences, Potsdam, Germany
German Federal Foreign Office
German-Kazakh University, Almaty, Kazakhstan
University of Würzburg, Germany

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Objectives

Central Asia, comprising the arid to semi-arid regions of Kazakhstan, Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan and Afghanistan, faces enormous challenges with regard to the scarcity and the pronounced inter-annual variability of water resources. Environmental hazards such as meteorological and hydrological droughts or occasional flash floods and landslides represent a major risk for the vulnerable economies of the post-soviet nations. Regional climate change, population growth and the inappropriate use of water and land resources further exacerbate the pressure on water and land resources.

The conference intends to shed light on water-related and environmental challenges in Central Asia by bringing together the international scientific community with regional stakeholders and specialists from various disciplines and backgrounds. The interdisciplinary conference will cover a broad range of topics and will analyse and discuss the tender subject from both, natural scientific and socio-economical perspectives.

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Program

October 8th	
18:00	*Registration of Participants*
October 9th	
08:00	*Registration of Participants*
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09:30	**Welcome Speech** *Lars Gerlitz (GFZ German Research Centre for Geosciences, Potsdam, Germany)*
09:40	**Welcome Speech AA** *Jörn Rosenberg (The Consulate General of the Federal Republic of Germany, Almaty, Kazakhstan)*
09:50	**Welcome Speech GFZ** *Sergiy Vorogushyn (GFZ German Research Centre for Geosciences, Potsdam, Germany)*
10:00	**Welcome Speech GKU** *Olga Moskovchenko (Kazakh-German University, Almaty, Kazakhstan)*
10:10	**CAWa Overview** *Abror Gafurov (GFZ German Research Centre for Geosciences, Potsdam, Germany)*
10:30	***Coffee Break***
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11:30	**Linking of long-term precipitation variability over Central Asia with Atlantic multidecadal oscillation** *Ekaterina Fedotova (Global energy Problems Laboratory, Moscow Power engineering Institute, Moscow, Russia)*
11:50	**Variability of the cold season climate in Central Asia - Drivers and Predictability** *Lars Gerlitz (GFZ German Research Centre for Geosciences, Potsdam, Germany)*

12:10	**Large-scale climate change meets Pamiri villages. Looking at climatic change in Central Asia through different spatial and methodological lenses** *Isabell Haag (University of Bayreuth, Research Group of Climatology, Bayreuth, Germany)*
12:30	**Application of SWAT for climate change projection of Khulm river basin, Afghanistan** *Shoaib Saboory (National Statistics and Informatioin Authority (NSIA), Afghanistan)*
12:50	***Lunch Break***
Session 2: Modelling and Monitoring the Cryosphere	
14:10	**Introduction** *Session Chairs: Martin Hölzle, Tomas Saks (University of Fribourg, Fribourg, Switzerland)*
14:20	**The value of remote sensing based regional snowline information in explaining glacier mass balance in Central Asia** *Abror Gafurov (GFZ German Research Centre for Geosciences, Potsdam, Germany)*
14:40	**Calculation and visualization of the space-time distribution of the norm and gradients of snow density in the Amu Darya basin** *Davron Eshmuratov (Hydrometeorological scientific research institute under UzHydromet, Uzbekistan)*
15:00	**Numerical estimation of snow avalanches contribution into accumulation on Tian Shan glaciers** *Anton Lazarev (Lomonosov Moscow State University, Moscow, Russia)*
15:20	**Quantifying the contributions of runoff components to streamflow using hydrological modeling and tracer measurements in a glacierized basin, Central Asia** *Sergiy Vorogushyn (GFZ German Research Centre for Geosciences, Potsdam, Germany)*
15:40	**Characteristics and evolution of ice-debris landforms in the Tien Shan** *Tobias Bolch (University of Zurich, Zurich, Switzerland)*
16:00	***Poster Session and Coffee Break***
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Session 3: Hydrology: Observations, Processes, Forecasting	
09:00	**Introduction** *Session Chair: Abror Gafurov (GFZ German Research Centre for Geosciences, Potsdam, Germany)*

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Samuel Dixon (Loughborough University, Department of Geography, Leicestershire, UK)

09:30 **Statistical forecast of seasonal discharge in Central Asia using observational records: development of a generic linear modelling tool for operational water resource management**
Heiko Apel (GFZ German Research Centre for Geosciences, Potsdam, Germany)

09:50 **Satellite monitoring of the water reservoirs of Vakhsh cascade**
Ildar Mukhamedjanov (Lomonosov Moscow State University, Moscow, Russia)

10:10 **Effects of dryland plantation forests on evapotranspiration, soil water dynamics, seepage and discharge**
Kai Schwärzel (United Nations University, Dresden, Germany)

10:30 **Water in Central Asia - lake and reservoir level monitoring with Radar Altimetry**
Cornelia Zech (GFZ German Research Centre for Geosciences, Potsdam, Germany)

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11:30 **Indicator-based assessment of the complex state of water use in the Aral Sea Basin**
Maik Netzband (University of Würzburg, Green Spin, Würzburg, Germany)

11:50 **Integrated remote sensing approach to detect soil salinity in the irrigated lands of Uzbekistan**
Tolmasbek Boltaev (Humboldt Universität zu Berlin (HU), Berlin, Germany)

12:10 **Comparative analysis of wheat crop's yield response to optimal and conventional irrigation practices in lower Kabul river basin, Afghanistan**
Atiqurrahman Jalil (Wageningen University and Research Center (WUR),Wageningen, the Netherlands)

12:30 **Remote sensing-based vegetation indices for monitoring vegetation change dynamics in the arid and semi-arid regions of Central Asia**
Dildora Aralova (Dresden Technology University, Dresden, Germany)

12:50 **Operational management of field water use using RS-measurements**
Galina Stulina (Scientific-Information Center of the Interstate Coordination Water Commission of the Central Asia (SIC ICWC), Tashkent, Uzbekistan)

13:10 Lunch

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Session Chair: Michael Hagenlocher (United Nations University, Germany)

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Venera Junisbekova (Institute of Ionosphere, Almaty, Kazakhstan)

15:00 **Methodical aspects of using aerospace data for monitoring hazardous natural phenomena**
Maira Razakova (National center of space researches and technologies (JCS), Almaty, Kazakhstan)

15:20 **Identification of drought intensity-frequency curves of Syrdarya river basin in Central Asia**
Asset Yegizbayeva, Nurlan Bekmukhamedov (National center of space researches and technologies (JCS), Almaty, Kazakhstan)

15:40 **Remote sensing for risk assessment of crop productivity in Central Asia based on drought and crop phenology change**
Nurgul Aitekeyeva (Institute of Remote Sensing and Digital Earth, Almaty, Kazakhstan)

16:00 **The potential and uptake of Remote Sensing for developing Agricultural Index Insurance in Central Asia**
Sarvarbek Eltazarov (Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany)

16:20 Poster Session and Coffee Break

17:30 **Water and Land Management in Central Asia – Present Situation and Future Perspectives**
Viktor A. Dukhovniy (Keynote Speaker 2)

18:30 End of Day 2

October 11th

Session 6: Agricultural Transition and Natural Resource Management

09:00 **Introduction**
Session Chairs: Nodir Djanibekov (Leibniz Institute of Agricultural Development in Transition, Halle, Germany), Stefanos Xenarios (Nazarbayev University, Astana, Kazakhstan)

09:10 **Assessing water use, energy use, and carbon emissions in lift irrigated areas: a case study from Karshi Steppe in Uzbekistan**
Kakhramon Djumaboev (International Water Management Institute-Central Asia Office, Tashkent, Uzbekistan)

09:30 **The effect of irrigation service delivery and training in agronomy on crop choice in Tajikistan**
Marie-Charlotte Buisson (International Water Management Institute, CGIAR, New-Delhi, India)

09:50	**Attitudes towards cooperation among farmers in water use in Samarkand province** *Abdusame Tadjiev (Samarkand Veterinary Medicine Institute, Samarkand, Uzbekistan)*
10:10	**Water policies, international development and hydro social relations in Central Asia** *Andrea Zinzani (University of Bologna & Global Development Institute, Bologna, Italy; University of Manchester, Manchester, UK)*
10:30	**Virtual water trade flows in the agricultural sector of the Central Asian region: case of the Kyrgyz Republic** *Gulnara Nurieva (American University of Central Asia, Bishkek, Kyrgyzstan)*
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Session 7: Practical Implementation of Scientific Results and Capacity Building	
11:20	**Introduction** *Session Chairs: Sarah Schönbrodt-Stitt (University of Würzburg, Würzburg, Germany), Barbara Janusz-Pawletta (Kazakh-German University, Almaty, Kazakhstan)*
11:30	**Cybercartography for pasture management: storytelling through participatory mapping to incorporate traditional knowledge in Naryn Province, Kyrgyzstan** *Jason Wong (Carleton University, Department of Geography and Environmental Studies, Ottawa, Canada)*
11:50	**Integrating climate information into local development planning – a case from the high mountainous regions in Kyrgyzstan and Tajikistan** *Elena Barth (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany)*
12:10	**Improved, innovative and decentralized Knowledge Management - the Open-Source K-Link** *Stéphane Henriod (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany)*
12:30	**Remote sensing and GIS for regional land and water management in Central Asia: Lessons learnt and a call for viable cooperation** *Christopher Conrad (University of Würzburg, Würzburg, Germany)*
12:50	**Water sciences and transboundary water governance in Central Asia** *Jenniver Sehring (IHE Delft Institute for Water Education, Delft, the Netherlands)*
13:10	***Lunch Break***
14:30	***Panel Discussion***
16:30	**Farewell and Closure** *Abror Gafurov, Lars Gerlitz (GFZ German Research Centre for Geosciences, Potsdam, Germany)*
17:00	***Coffee and End of Day 3***

Keynote Speakers:

Prof. Dr. Wilfried Haeberli

Keynote Topic: "Vanishing high-mountain ice – hydrological challenges at global to local scales"

Prof. Dr. Haeberli is a renowned glaciologist who was appointed as a professor at the Department of Geography, University Zurich in 1995. During his long-lasting scientific career he has been engaged with environmental glaciology and geomorphodynamics of high-mountain areas as well as with cryopsphere-hydrosphere interactions. His research is especially related to climate-related glacier and permafrost monitoring, slope movements and natural hazards.

He has been heavily involved in the World Glacier Monitoring Service for many years and also served a lead author of the IPCC report (working Grop II).

Prof. Dr. Haeberli is author or co-author of more than 150 international publications about high mountain regions, including Central Asia.

Prof. Dr. Viktor A. Dukhovniy

Keynote Topic: "Water and Land Management in Central Asia – Present Situation and Future Perspectives"

Prof. Dr. Viktor A. Dukhovniy is the Director of the Scientific Information Center of the Interstate Commission on Water Coordination in Central Asia (SIC ICWC) in Tashkent (Uzbekistan). He is a noted expert and active water specialist in Central Asia with a long experience and outstanding expertise from his memberships and leads in Central Asian water partnerships (e.g., Interstate Coordination of Water Commission, International Fund for Aral Sea Saving, Global Water Partnership of Central Asia and Caucasus, International Commission on Irrigation and Drainage in the World Water Council, and International Water Resources Association). He published more than 350 articles and 22 monographs and supervised 18 PhD students on the water management, advance irrigated agriculture, and perspective planning of water development. He worked in Central Asia, but also as consultant in India, Nicaragua, Syria, Yemen and other states.

Side Event

Meeting of the participants in the framework of the project "Student research competition on sustainable management of natural resources in Central Asia and Afghanistan project"

Organizers of the event, sponsors: The Central Asian Regional Environment Centre (CAREC): Smart Waters project (USAID) and Climate Adaptation and Mitigation Program for Aral Sea Basin project (the World Bank); Kazakh-German University.

Brief information about the Side-event: The Side-event is conducted in the framework of the project “Student research competition on sustainable management of natural resources in Central Asia and Afghanistan”. The purpose of the event is to bring together participants from Central Asia and Afghanistan, and their international supervisors to present participants’ research results, to share their research experience and exchange ideas.

The student research competition aims to build capacities of the young generation of specialists in the water, agricultural and environmental protection sectors in the Central Asian countries and Afghanistan. The competition supports graduate students from universities within and outside Central Asia and Afghanistan, who demonstrated good research abilities, in communicating outcomes of their research work in the form of a scientific article to be published in peer reviewed journals and other means of dissemination.
The project consists of monthly webinars conducted by international supervisors, who will also provide individual scientific supervision for participants throughout the whole period of the project.

Language of the Side-event: English, Russian. A simultaneous translation will be provided.

Name of the contact person: Marina Kovaleva, project coordinator, email address: cajwr@dku.kz

Session Overview

Title	Session Chair
Session 1: Climate Variability and Change	***Lars Gerlitz*** *(GFZ German Research Centre for Geosciences, Potsdam, Germany)*
Session 2: Modelling and Monitoring the Cryosphere	***Martin Hölzle, Tomas Saks*** *(University of Fribourg, Fribourg, Switzerland)*
Session 3: Hydrology: Observations, Processes, Forecasting	***Abror Gafurov*** *(GFZ German Research Centre for Geosciences, Potsdam, Germany)*
Session 4: Using Water and Land Resources: Challenges and Suitable Solutions	***Christopher Conrad, Maik Netzband*** *(University of Würzburg, Würzburg, Germany)*
Session 5: Natural Hazards and Risk	***Michael Hagenlocher*** *(United Nations University, Germany)*
Session 6: Agricultural Transition and Natural Resource Management	***Nodir Djanibekov*** *(Leibniz Institute of Agricultural Development in Transition, Halle, Germany);* ***Stefanos Xenarios*** *(Nazarbayev University, Astana, Kazakhstan)*
Session 7: Practical Implementation of Scientific Results and Capacity Building	***Sarah Schönbrodt-Stitt*** *(University of Würzburg, Würzburg, Germany);* ***Barbara Janusz-Pawletta*** *(Kazakh-German University, Almaty, Kazakhstan)*

Session 1: Climate Variability and Change

(Chair: Lars Gerlitz, German Research Center for Geosciences)

Central Asia is characterized by a highly continental climate and a pronounced inter-annual variability of temperature and precipitation. The increasing frequency of drought events during recent decades had far-reaching consequences for the vulnerable agrarian economies of the Central Asian states. Further, Central Asia is listed as one of the climate change hot spots with warming rates by far exceeding the global average.

The envisaged session aims at an improved understanding of the Central Asian climate, its variability and change at various spatial and temporal scales. We particularly invite contributions on climate observations and paleo-climatic reconstructions as well as modelling studies and regional climate change scenarios. The session will also provide a framework to discuss scientific progress in the field of seasonal and sub-seasonal forecasting and its application for early warning.

Oral Presentations:

Author	Presentation Title	Author's Affiliation
Cornelia Zech	Hydrometeorological observations and sensor data storage in Central Asia	GFZ German Research Centre for Geosciences, Potsdam, Germany
Ekaterina Fedotova	Linking of long-term precipitation variability over Central Asia with Atlantic multidecadal oscillation	Moscow Power engineering Institute, Global energy Problems Laboratory, Moscow, Russia
Lars Gerlitz	Variability of the cold season climate in Central Asia - Drivers and Predictability	GFZ German Research Centre for Geosciences, Potsdam, Germany
Isabell Haag	Large-scale climate change meets Pamiri villages. Looking at climatic change in Central Asia through different spatial and methodological lenses	University of Bayreuth, Research Group of Climatology, Bayreuth, Germany
Shoaib Saboory	Application of SWAT for climate change projection of Khulm river basin, Afghanistan	National Statistics and Informatioin Authority (NSIA), Afghanistan

Hydrometeorological Observations and Sensor Data Storage in Central Asia

(Oral Presentation)

Cornelia Zech, Tilo Schöne, Alexander Zubovich, Julia Illigner, Nico Stolarczuk, Azamat Sharshebaev, Bolot Moldobeykov, Jörn Lauterjung

(GFZ German Research Centre for Geosciences, Potsdam, Germany)

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The observation and derivation of terrestrial parameters are essential for a sustainable water resource management. Especially in Central Asia, where water is non-uniformly distributed over the entire region, the availability of fresh water plays a key role for the living, economic development and agriculture. In the frame of the CAWA project (www.cawa-project.net), a transnational network of Remotely Operated Multi-Parameter Stations (ROMPS) has been installed in the past years. GFZ in cooperation with the CAIAG and the national Hydromet services of Uzbekistan, Tajikistan and Kyrgyzstan, Ulugh Beg Astronomical Institute, the Kabul Polytechnic University and the German Kazakh University in combination with the Institute of Geography of Kazakhstan operate a regional network of continuously operated monitoring stations that capture various meteorological, hydrological and glaciological parameters as well as a high-rate GPS.

The ROMPS combine a multitude of different sensors at one station with shared data storage, power supply and communication infrastructure. All stations are designed as stand-alone field systems to be installed in remote areas with no infrastructure (e.g. no reliable local power supply or communication network). The system is mechanically robust, equipped with an intelligent management system to guarantee a continuous operation and self survival. Of special importance is the installation in high-mountains with only a few hours of daily sunshine and the nightly temperature drops down to -40°C.

These observations offer opportunities to support a wide range of operational, societal and scientific tasks, among them weather observations and forecasts, long-term climate monitoring, river discharge monitoring, geodynamic processes, Earth-System hazard monitoring as well as the establishment of water-related early-warning systems.

The data is made freely accessible to all national Hydromet services and the international community through the Sensor Data Storage System (SDSS), which is hosted at CAIAG (http://sdss.caiag.kg). The SDSS is the main storage and dissemination system for all Level 0 meteorological and hydrological data acquired by CAWa and other ROMPS stations in Central Asia. In addition, radar altimetry data from missions such as AltiKa, Jason-2 and -3, CryoSat and Sentinel-3A is automatically processed for lake and reservoir heights in Central Asia and continuously added to SDSS.

Linking of long-term precipitation variability over Central Asia with Atlantic multidecadal oscillation

(Oral Presentation)

V.V. Klimenko, E.V. Fedotova, V.S. Luferov

(Global energy Problems Laboratory, Moscow Power engineering Institute, Moscow, Russia)

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Multidecadal natural variability of the hydrological processes may mask manifestation of the climate change for decades. This fact may be of crucial importance for the development of the mitigation strategies.

Atlantic multidecadal oscillation (AMO) is found to be one of the main drivers of the long-term variability around the globe. Interconnections between the regional climate and the Atlantic variability are significant for a number of the world regions. However, an impact of the AMO on the Central Asia climate remains not fully investigated. We were intended to fill this gap by applying modern high-performance computation approaches to the most comprehensive observation data sets.

Evidence of the remote influence of the AMO has been found for a significant part of Central Asia. The patterns of this interconnection are highly inhomogeneous across the region. The precipitation in the east of Central Asia changes in-phase with the AMO. That is perfectly consistent with the recent findings for the Eastern Siberia hydrology. In contrast, precipitation in the middle and west parts of Central Asia demonstrates moderate to strong negative correlation with the AMO index on the decadal timescale.

The first lesson of our study is that the natural variability will likely compensate an impact of the climate change on the precipitation in Central Asia during the negative AMO phases. That may lead to underestimation of the climate change impacts in the region. The second output is evidence of the asynchronous variability of the water sources across Central Asia. This feature may to be quite interesting for the development of adaptation strategies to the climate change.

This investigation is supported by President Youth scientists grant МК-1494.2017.8 for E.V. Fedotova.

Variability of the cold season climate in Central Asia - drivers and predictability

(Oral Presentation)

Lars Gerlitz[1], Eva Steirou[1], Christoph Schneider[2], Vincent Moron[3],

Sergiy Vorogushyn[1], Bruno Merz[1]

(1. GFZ German Research Centre for Geosciences, Department of Hydrology, Potsdam, Germany; 2. Humboldt University, Institute of Geography, Berlin, Germany; 3. Aix-Marseille University, Department of Geography, Marseille)

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In order to understand the atmospheric mechanisms resulting in a pronounced cold season climate variability in Central Asia, an objective weather type classification is conducted, utilizing a k-means based clustering-approach applied to 500hPa geopotential height (GPH) fields. Eight weather types (WT) are identified and analyzed with regard to characteristic pressure patterns and moisture fluxes over Eurasia and specific near surface climate conditions over Central Asia. In order to identify remote drivers of the Central Asian climate, WT frequencies are analyzed for their relationships with tropical and extratropical teleconnection modes. The results indicate an influence of northern hemispheric planetary wave tracks on westerly moisture fluxes with positive anomalies of precipitation associated with the formation of a Rossby trough over Central Asia. Particularly the propagation of the North Atlantic Oscillation, the East-Atlantic/Western-Russia and the Scandinavian patterns are shown to modulate regional climate conditions. Variations of the El Nino Southern Oscillation (ENSO) are shown to affect the frequency of particular WTs due to the formation of an anticyclonic anomaly over the Indian Ocean and an increase of tropical fluxes of moisture and heat into Central Asia during El Nino events. Further a WT-internal influence of ENSO is distinctly defined, with enhanced moisture supply during the ENSO warm phase. The analysis of climatic trends shows that 50% of observed temperature changes can be assigned to variations of the WT composition, indicating that most likely changing regional circulation characteristics account for the enhanced warming rates in Central Asia. Trends of precipitation sums are likewise shown to be associated with changing WT frequencies, although the WT-precipitation relationships include large uncertainties.

The overall results indicate, that the variability of the Central Asian winter climate is driven by contemporaneous circulation anomalies over the tropical Oceans and the Northern Hemisphere, which suggests potential for an improvement of seasonal climate predictions.

A preliminary analysis shows, that particularly ENSO, as a seasonally persistent phenomenon, and the extent of snow cover over Eurasia during autumn, as a dominant driver of the North Atlantic Oscillation in winter, serve as skillful predictors for seasonal precipitation forecasts.

Large-scale climate change meets Pamiri villages. Looking at climatic change in Central Asia through different spatial and methodological lenses

(Oral Presentation)

Isabell Haag, Cyrus Samimi

(University of Bayreuth, Research Group of Climatology, Bayreuth, Germany)

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The region of Central Asia is one of the largest semi-arid areas in the world and argued to be a hotspot of climate change. Temperature increases are above the global average, whereas precipitation stays statistically almost unchanged including high year-to-year variability. Regional characteristics can differ greatly from large-scale observations due to the complexity of the terrain and different atmospheric forces. Altered climatic patterns entail the risk of adverse consequences for the regions water supply, agricultural production and the biodiversity of the high mountain systems. Coping with altered seasonal characteristics and enhanced climate variability is particularly challenging for small-scale agropastoralists impacting their agricultural yields and animal husbandry.

Understanding climate change in Central Asia and its associated socioeconomic consequences requires both large-scale and small-scale studies across time and space. Using free-accessible climate datasets gives a good overview of large-scale trends and characteristics of temperature and precipitation change over time and through different geographical areas. As the accuracy of these analyses is strongly affected by the density of constantly operating local weather stations or the available time length of satellite products, they are mostly used for large-scale analyses with moderate temporal and spatial resolutions. Using statistical downscaling with weather stations located in the villages helps to improve the spatial resolution of these datasets to receive more accurate information on a village-scale. To validate this information and to understand its associated socioeconomic consequences, interviews and workshops focusing on farmer's and villager's perception of the climatic change are the last pieces in an interdisciplinary analysis to understand the climatic change in the Pamirs. Taking this interdisciplinary approach, will be presented how seasonal temperature and precipitation has changed during the last 60 years in Central Asia answering the question whether large-scale variations in the warming patterns and trends can be seen and if precipitation variability has increased. In addition, will be presented how villagers of the Pamir perceived climate change and whether their perception differs from large-scale trends and statistically achieved small-scale climate information. The aim of this talk is to present the value of taking an interdisciplinary approach to understand the environmental and climatic change in remote mountain areas in the Pamirs. These results are part of the Belmont Forum founded project "Ecological Calendar and Climate Adaptation in the Pamirs", where generational knowledge is revitalized and combined with scientific climatological, ethnographical, and agricultural research in order to support climate adaptation strategies and to secure food sovereignty in an area of the world, which has least contributed to anthropogenic climate change.

Application of SWAT for climate change projection of Khulm river basin, Afghanistan

(Oral Presentation)

Somura Hiroaki, Shoaib Saboory, Ezatullah Rabanizadah

(Shimane University, Shimane, Japan; Ministry of Agriculture, Irrigation and Livestock, Kabul, Afghanistan; Ministry of Energy and Water, Kabul, Afghanistan)

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Afghanistan is essentially semi-arid to the desert and most crop production is limited to pockets of irrigable land, with some rain-fed areas in the north and at high-altitudes (FAO, 2017). To consider water resources management for stabilizing crop production, SWAT was applied to Khulm watershed from 2012 to 2015. Khulm watershed is located in the northern region with about 8300km2. River discharge and climatic information were obtained from the Ministry of Energy and Water (MEW). There are three stations for river discharge and four stations for weather information. Precipitation, temperature, and humidity are observed at every station and wind speed is at a station. Solar radiation was started to measure in December 2015, and no information has existed about it before. Instead, the solar radiation data was developed using the Angstrom formula (FAO, 1998) based on the data collected by the Ministry of Agriculture, Irrigation, and Livestock (MAIL) and actual sunshine hours collected by MEW in the watershed. It was found from the obtained information that the runoff rate at the outlet of the target watershed was about 5.0 % and water resources were limited for irrigation. At this moment the reproducibility of streamflow achieved slightly lower than the satisfactory level in daily bases, because of input data quality. The sensitivity analysis of streamflow was conducted by using future predictions of precipitation and temperature from ERA-Interim information in order to understand water resources availability and crop production variation. It was found that water resources would slightly decrease in average in the watershed, but the uncertainty of future predictions is large, and it is difficult to conclude specifically. Also, it was estimated that crop yield would increase or decrease depending on the scenarios. Thus, it is concluded that both approaches to more detail simulation with SWAT and field researches are necessary to consider adaptation and mitigation ways against future water resources management.

References

1. FAO, 2017. Country Pasture/ Forage Resource Profiles – Afghanistan –, http://www.fao.org/ag/agp/agpc/doc/counprof/afgan/afgan.htm (2017.4.21)
2. FAO, 1998. In Irrigation and Drainage Paper No.56 Crop Evapotranspiration (guidelines for computing crop water requirements), Allen RG, Pereira LS, Raes D, Smith M (eds). FAO: Rome, Italy; 290, ISBN 92-5-104219-5.

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Saniya Akhmetova	Dynamics of changing air temperature and precipitation in Almaty city	Al-Farabi Kazakh National University, Almaty, Republic of Kazakhstan
Muhammad Azhar Ehsan	Interannual variability and predictability assessment of JJA surface air temperature over the Arid region of the Arabian Peninsula in North American Multimodel Ensemble	ESP/ICTP, Trieste, Italy
Sohan Wajesekara	Impact of climate change and adaption option on water resources of Afghanistan	University of Moratuwa, Moratuwa, Sri Lanka
Naurozbayeva Zhanar	Influence of climate change to the ice regime of the Caspian Sea	Russian State Hydrometeorological University, St. Petersburg, Russia
Sylvia Pinkerneil	Stable isotopes of precipitation across Kyrgyzstan	Helmholtz Centre Potsdam, GFZ German Research Centre For Geosciences, Germany

Dynamics of changing air temperature and precipitation in Almaty city

(Poster Presentation)

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To date, one of the serious problems of humanity is global climate change. Therefore, the study of multi-year deviations of temperature and precipitation is one of the current global problems. Long-term temperature fluctuations and rainfall directly affect the river stock and the hydrological model in general. In recent decades, the warming was shown as in a global scale, and throughout Kazakhstan. An increase in surface air temperature is also noticed in Almaty. Climate change influences many natural processes, including the hydrological model of rivers. Therefore, it is important to identify these changes and evaluate regarding such characteristics of climate as air temperature and precipitation. Uneven distribution of precipitation and variability of temperature in Kazakhstan depend on a large extent of latitude and physical and geographic heterogeneity of the Republic of Kazakhstan. For the past decade in the world, scientific literature widely discussed the problem of climate change for some areas and for the world. The article considers the features of the temporal distribution of main climatic characteristics (air temperature and atmospheric precipitation) in the city of Almaty for 1915-2014. Average air temperature in the winter season was observed in the 1925-1934 years and the greatest value in the 1995-2004 years. The number of precipitation depends on temperature. If the winter temperature rises, precipitation will increase. Precipitation fluctuated within 29,2 and 42,1 mm. In recent years, air temperature and precipitation significantly increased. In the springtime, there was an increase in the temperature and precipitation. The average temperature in spring was evenly distributed to the 6th decades (9,5-9,9 °C), then increased a little in the 7th decade (10,2 °C). Maximum values were 11,8 °C in 2005-2014 years, and the minimum value was 9,3 ° C in the period 1985-1994 years. In this decade was observed the low average temperature in March, April and May. Maximum of precipitation in the springtime was 104,2 mm (1955-1964 years.). Minimum values were 77,3 mm in 1925-1934 years. As a result of comparison of the average of the first decade with the averages of the following years, a significant increase in temperature is noticeable. Based on the mean values, the summer temperature increased. In the course of air temperature and atmospheric sediments were observed deviations. For the past decade rainfall sharply reduced. During the summer, the average temperature did not change significantly over a decade (21,7 - 22,8 °C), but only in the past decade, 2005-2014's maximum temperature was 23,7 °C. Average air temperature during the summer in the period 1945-1954 years was 21,7 °C. The number of precipitation was uneven. In the 1915-1924 years, minimum value was 37,3 mm, and the maximum value in the 1995-2004 years was 50,7 mm. Because of the high-temperature in the 2005-2014 years, the number of precipitation decreased. In many years were observed fluctuations. In the 1945-1954 and 1955-1965 years of the ratio between the temperature and precipitation was the opposite. During autumn, there were no significant differences in the time course of averages air temperature and precipitation. The average temperature changed from 8,7 °C (in the 4th decade) to 11,2 °C (for the past decade). Average

rainfall ranges from 36,8 mm to 50,4 mm. After 1975-1984's rainfall decreased. Assessment of the distribution of air temperature and precipitation for Almaty is a very important task. Relying on average long-term value and their analysis, we can provide a reliable weather forecast in the future. Study of multi-year oscillations temperature and precipitation now is one of the key global problems. Despite the fact that this question considered for decades, it continues to actively discuss. Designation reasons for many years of changes in temperature and precipitation have a huge scientific and practical value. As it is known, temperature and precipitation are those climate parameters, on which depends the river stock.

Interannual variability and predictability assessment of JJA surface air temperature over the Arid region of the Arabian Peninsula in North American Multimodel Ensemble

(Poster Presentation)

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Interannual variability and predictability of summer season (June-July-August: JJA) air-temperature over the Arabian Peninsula (AP) is investigated using observations and reforecast data obtained from North American Multimodel Ensemble (NMME) for the period of 1982-2017. The regional-mean air-temperature over AP shows a statistically significant warming trend. The warming over the AP is related to the equatorial Indian and Atlantic Ocean SSTs as well as local SSTs located in the Mediterranean Sea, which itself showed a significant warming trend in recent time. When the trend is removed from the data, the equatorial Indian Ocean still stand out as the major source of predictability of the air-temperature over the AP. The potential and actual predictability of the air-temperature over the AP is explored in the reforecast data obtained from NMME at different lead times. First, unanimously all models show positive temperature anomalies in recent decades (after 1998), which is matching with the observed trend. Second, the interannual variability of the air-temperature anomalies in all the predictions is synchronized, but the magnitude of the air-temperature anomalies is notably different and underestimates the observed air-temperature anomaly, habitually due to the large error in the predicted temperature climatology. The focus of this study is to find the sensitivity of the potential and actual predictability of the air-temperature over the AP to different coupled model reforecast data and to their initial conditions. In general, all pooled models reforecast show an increase in potential predictability with a decrease in lead-time, however, CFSv2, GFDL-FlorA, and GFDL-FlorB show higher JJA air-temperature potential and actual predictability as compared to COLA, GFDL-Aero, and NASA.

Impact of climate change and adaption option on water resources of Afghanistan

(Poster Presentation)

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Climate change has been drastically affected the average surface temperature on Earth and causes many problems for human well-being. The evidence of climate change can be seen in the rising sea levels, changing of the runoff patterns, melting glaciers. In the present research, the effects of climate change on water resources of Afghanistan are evaluated. The climate change drastically impacts the water resources of Afghanistan particularly, on surface water. Increased greenhouse gases emissions caused by human activities rose the surface temperature. Afghanistan's water resources, are also affected; there has been the decrease in the overall water volume in the natural resources especially in the rivers. The change in the rainfall pattern and melting glaciers lead to the reduction of the water resources capacity, which affects the groundwater and glaciers across the country. As a large proportion of the population in Afghanistan is engaged in the agricultural sector, the decrease of water availability will affect the overall well-being of the country.

To analyze and evaluate the effect of climate change on water resources in Afghanistan, the literature review and the analysis of the hydrology of the three major river basins (the comparison of the changes in rainfall, snow and the temperature) were done. The results of the research show that the surface water is more vulnerable compared to other resources, further recommendations for adaptation by comparing multi options to reduce the effect of climate change are provided.

Influence of climate change to the ice regime of the Caspian Sea
(Poster Presentation)

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The climate of the Caspian Sea coast is determined by such factors as the geographical location, characteristics of atmospheric circulation, the surface type, and the orography of the coasts. In the present research the data is provided by the hydro-meteorological stations in the Atyrau and Mangistau regions (Kazakhstan). The programs for the data recovery allowed to increase the time series and to add the missing observations. The surface of the Caspian Sea is partly covered by ice. Northern Caspian is covered by thick ice in high motion. The ice movement causes the demolition of coastal hydraulic engineering constructions and the navigation problems. Moreover, the ice drift has a negative impact on the ecological situation in the region, for instance, on biological cycles of ecosystems, particularly affects fish behavior. The present study aims to identify the changes in the ice conditions associated with climate change. The research object is the northern part of the Caspian Sea, the coastline of Kazakhstan, where in the late autumn and winter time due to the atmospheric conditions the ice coverage is formed. As this part has a continental climate, the cold period of the year is extended, and the sea surface is covered by ice without motion. In the research is used the data of air temperatures, ice parameters, and atmospheric circulation.

Stable isotopes of precipitation across Kyrgyzstan

(Poster Presentation)

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Terrestrial climate archives like lake sediments, speleothems or glaciers are valuable tools to understand paleoenvironmental developments and climate changes. Isotopic records of terrestrial archives (e.g. d18O in carbonates, dD in n-alkanes or dD and d18O of glacier ice) may reflect the d18O of precipitation and the influence of temperature, evaporation and with this the changes of moisture sources (Aizen et al. 2006, Cheng et al. 2012, Lauterbach et al. 2014, Wolff et al. 2017, Fohlmeister et al. 2017). To reconstruct the variability of paleoclimate records and the pronounced influence of the atmospheric systems (e.g. Westerlies or Asian Monsoon), the monitoring of d18O and dD values of modern precipitation are important. The Global Network of Isotope in Precipitation (GNIP) of the International Atomic Energy Agency (IAEA) monitors the isotopic composition of precipitation worldwide. Unfortunately, only few data exist in the region of Central Asia (IAEA/WMO, 2015, Cheng et al. 2012). Here we present new d18O and dD values of monthly precipitation from several stations in the western Tien Shan, Pamir and Fergana region monitored since 2015 in the frame of the Global Change observatory Central Asia (GCO-CA) initiative of the German Research Centre For Geoscience (Helmholtz Centre Potsdam, Germany). The rain water samples from 7 stations will be monthly sampled following the sampling strategy of the IAEA and using PALMEX precipitation water sampler (Gröning et al. 2012). The altitude of our monitoring stations range from 600 until 3600 m a.s.l.. Additionally, we are collecting temperature, humidity and air pressure data using HumiBaroLog logger (Driesen & Kern GmbH, Germany). The stable isotopes were analyzed using aliquots of filtered rain water for a Cavity Ring-Down Spectrometer (PICARRO, USA).The isotopic composition of precipitation in the studied region shows a very broad range with -23 to +5‰ for d18O and -180 to +13‰ for dD. Light values during the winter time and heavy values during the summer time correspond well with the monthly temperature and are rather correlated to the seasonality than with the monthly rain amount. The altitude effect is insignificant. Most of the monthly rain samples plot above the global meteoric water line of dD=8*d18O+10 according Craig (1961). The d17O-excess (d=dD – 8d18O) values are higher than the global average of 10 from September to May and may reflect Westerlies moisture sources and recycling of moisture from land surfaces (Aizen et al. 2006). During the summer time we often found low to negative d17O-excess values probably due to influence of continental vapor.

Session 2: Monitoring and modeling the cryosphere

(Chairs: Martin Hölzle & Tomas Saks, University of Fribourg)

Glaciers as well as snow cover in the high mountain regions of Tien Shan and Pamir play an important role in the regional water cycle of Central Asia. Glacier and snow melt during summer season are essential for the water supply of the Central Asian countries. However, the dynamics of the cryosphere as well as its response to climate variability and change are still not well understood. The session intends to discuss recent advances in the field and invites contributions in the context of cryospheric observations and modelling applications. Topics may include but are not limited to

- Cryosphere-atmosphere interactions, climate change impacts and implications for hydrology
- Ice dynamics, geomorphology and georisk
- Glacier mass balance measurement campaigns and insitu observations
- Remote sensing based monitoring of glaciers and snow cover
- Cryospheric modelling (including energy balance and ice dynamic models)

Oral Presentations:

Authors	Presentation Title	Author's Affiliation
Abror Gafurov	The value of remote sensing based regional snowline information in explaining glacier mass balance in Central Asia	GFZ German Research Centre for Geosciences, Potsdam, Germany
Davron Eshmuratov	Calculation and visualization of the space-time distribution of the norm and gradients of snow density in the Amu Darya basin	Hydrometeorological scientific research institute under UzHydromet, Uzbekistan
Anton Lazarev	Numerical estimation of snow avalanches contribution into accumulation on Tian Shan glaciers	Lomonosov Moscow State University, Moscow, Russia
Sergiy Vorogushyn	Quantifying the contributions of runoff components to streamflow using hydrological modeling and tracer measurements in a glacierized basin, Central Asia	GFZ German Research Centre for Geosciences, Potsdam, Germany
Tobias Bolch	Characteristics and evolution of ice-debris landforms in the Tien Shan	University of Zurich, Zurich, Switzerland

The value of remote sensing based regional snowline information in explaining glacier mass balance in Central Asia

(Oral Presentation)

Abror Gafurov[1], Martina Barandun[2], Sergiy Vorogushyn[1], Lars Grelitz[1], Tomas Saks[2], Uktam Adkhamov[1] and Martin Hölzle[2]

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The mass balance of glaciers in remote areas depends on the variability of temperature and precipitation data, which are usually not available due to extreme climate conditions at high altitudes. However, the variability of snow cover in remote areas can be obtained using remote sensing data. Such data can serve as an indicator of climate variability in these regions. Especially, temperature and precipitation footprints in remote areas can be extracted using daily snow cover data. For example, an increase of snow cover area is an indication of precipitation event below freezing temperature whereas decrease of snow cover area is an indication of air temperature increase in remote areas. These evidences can thus be useful in understanding processes related to glacier mass balance as they control the intensity of glacier melt and accumulation. Nowadays, the remote sensing snow cover data with daily temporal and moderate spatial resolution can be extracted with reliable quality, which can serve as proxy information in regions where climate related observations are not available.

In this study, we investigate the potential of daily snow cover data obtained from MODIS in explaining annual glacier mass balance in five Central Asian glaciers. For this, we apply daily cloud removed snow cover data with 500 m spatial resolution and compute regional snowline, which highly depends on temperature and precipitation variability. We analyze the variability of daily regional snowline together with the observed glacier mass balance, which were collected in the frame of CAWa and CATCOS / CICADA projects. The results indicate the correlation of snowline evolution and annual mass balance in selected glaciers in Central Asia. Especially, in the years of 2014 and 2015 when MB was highly negative, the snowline evolution during glacier melt period coincides well with observed MB. The analysis further shows potential of assessing seasonal mass balance, given that observed data is available for such study.

Calculation and visualization of the space-time distribution of the norm and gradients of snow density in the Amu Darya basin
(Oral Presentation)

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In the research, a formula has been developed for calculating the density of snow at any altitude and instant of time during the occurrence of a stable snow cover. The altitude and time gradients of snow density are estimated. The results are presented in the form of map dynamics using GIS technology.

Numerical estimation of snow avalanches contribution into accumulation on Tian Shan glaciers (Oral Presentation)

Anton Lazarev, Alla Turchaninova, Yuri Seliverstov
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Avalanches redistribute snow from the top of the ridges down to the valley bottoms, often occupied by glaciers. The evaluation of snow avalanches' contribution into Tian Shan mountain glaciers' mass balance with a lack of direct observational data on snow avalanches is highly relevant task delivering the important knowledge of one of the least studied components of the glaciers mass balance under the climate change. Snow avalanches can be a significant accumulation resource, which is not usually counted in mass-balance observations. The results of a numerical assessment of snow avalanches contribution into glacier accumulation possess a high scientific significance due to the high sensitivity of all components of glacial mass balance to climate change.

We present a new approach for the numerical estimation of snow avalanches contribution into accumulation on mountain glaciers without carrying out detailed terrestrial snow surveys based on DEM and meteorological data analysis using GIS and numerical modeling of snow avalanches. Our approach consists of the following steps: DEM analysis; avalanche release, track and run out zones assessment; meteorological data re-calculation for the avalanche release zones; indication of active avalanche release zones and snow fracture height in them during the analyzed winter period; avalanches volumes assessment; numerical simulations of avalanches in three-dimensional terrain using avalanche dynamics program RAMMS; verification – comparison of modeling results with field observations and remote sensing data; evaluation of the contribution of snow avalanches, coming from outside the glacier limits, into the seasonal accumulation on the glacier.

Our approach was tested on the Batysh Sook Glacier, Inner Tian Shan. A case study was realized for 2015/2016 balance year based on the data of regular meteorological observations from the distance nearest to the glacier meteorological station (Kumtor Tien Shan) and high-resolution DEM obtained from a drone in July 2016. To evaluate the contribution of snow avalanches, coming from outside the glacier limits, into the seasonal accumulation, we estimated release zones that were most probably active during the winter season 2015/2016 based on the regional dependences of avalanche activity on relief and climate characteristics. We performed the numerical simulation of avalanches that were most probably released during the winter period 2015/2016 using RAMMS and estimated avalanches run out distances, flow velocities and deposition heights. RAMMS simulation results (run out distances and deposition heights) were compared with field measurements (July 2016). The simulation results were sufficiently accurate. The outlines of avalanches deposits, as well as deposition heights, were relatively well reproduced by RAMMS using predicted input model parameters considering the time difference with field measurements. Thus, the snow avalanche accumulation on the Batysh Sook Glacier during the winter season 2015/2016 turned out to be 13+/-4% of the total accumulation. Our approach is going to be tested on other glaciers in other mountain regions. The proposed approach can also be applied to the assessment of the snow avalanche's contribution to the river runoff in the future that adds more practical significance to the research.

Quantifying the contributions of runoff components to streamflow using hydrological modeling and tracer measurements in a glacierized basin, Central Asia

(Oral Presentation)

Zhihua He, Sergiy Vorogushyn, Katy Unger-Shayesteh, Stephan M. Weise, Olga Kalashnikova, Natalya Ershova, Abror Gafurov, Doris Duethmann, Martina Barandun, Bruno Merz

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We developed two approaches to quantify the contributions of runoff components to streamflow in the Ala-Archa basin, Kyrgyzstan. First, we advanced the glacio-hydrological modeling approach based on the Hydrograph Partitioning Curves (HPCs). The HPCs are extracted from the observed flow hydrograph using catchment precipitation and temperature gradients. They indicate the periods when the various runoff processes, such as glacier melt or snow melt, dominate the basin hydrograph. Model parameters characterizing different runoff processes are calibrated on different HPCs in a stepwise and iterative way, without using snow and glacier observation datasets. Second, we developed an isotope-hydrological integrated modeling approach to reduce the modeling uncertainty. The fractionation and mixing processes of water stable isotopes in and from the various water sources were integrated into a glacio-hydrological model. The HPC-based method was adopted to estimate the contributions of runoff components at annual and seasonal scales. The isotope-hydrological integrated modeling approach was used to calculate the contributions of runoff components in short periods when water tracers were measured. Results show that 1) The HPC-based method performed comparably to the multiple-dataset calibration method which used glacier mass balance, satellite snow cover images and discharge, and improved the stability of calibrated parameter values across various calibration periods; 2) The isotope-hydrological integrated modeling approach quantified the contributions of runoff components comparably to a tracer-based mixing approach for summer peak flows; 3) On average, the contributions of snowmelt and glacier melt in summer are around 35% and 21%, respectively. At annual scale, the contribution of snow and glacier meltwater is around 50%, followed by the 33% contribution of groundwater and 17% contribution of rainfall. The methods proposed in our study could provide reference tools for the evaluation of the dynamics of local water resources.

Characteristics and evolution of ice-debris landforms in the Tien Shan

(Oral Presentation)

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Rock glaciers and other forms of subsurface ice in permafrost conditions (hereafter referred as ice-debris landforms, I-DLs) are abundant in Tien Shan but have received relatively little attention in comparison to glaciers, despite the fact that they are also of significance in relation to hydrology, geomorphology and hazards. One reason for the relatively few numbers of studies is that investigating I-DLs by remote sensing is difficult as they are not as easy to detect, their topographical changes are of a lower magnitude and less evident than the changes of glaciers. Hence, very high resolution imagery and digital terrain models (DTMs) are needed to study these periglacial landforms in more detail.

We used Corona KH-4B from the 1970s (resolution ~2m), 2012 GeoEye (0.5m) and 2016 Pléiades (0.5m) data to map and investigate specifically the surface elevation changes of I-DLs in the central part of Ile Alatau (northern Tien Shan/ Kazakhstan) and Ak-Shiirak (central Tien Shan/Kyrgyzstan). DTMs with a resolution of 5 m were generated and subsequently co-registered. Surface displacements were calculated by feature tracking and manually measured by identification of characteristic boulders.

Overall we identified almost 50 I-DLs covering an area of about 18 km², which is more than 40% of the glacier cover of the year 2016 of the investigated valleys in Ile Alatau. In Ak-Shiirak range I-DLs are also frequent (more than 70) but the relative area coverage is less compared to glaciers (~3.2%). On average the I-DLs showed only a slight and insignificant overall surface lowering for the period since the 1970s. Most of the investigated I-DLs in both ranges nevertheless showed distinct patterns of change: a slight surface elevation gain at their fronts indicating an advance, a significant lowering in the upper probably glacier-affected parts. Geophysical measurements show a clear relation between surface elevation changes and ice content.

The average surface velocity of I-DLs in Ile Alatau was 0.44 ± 0.30 m a-1 with rates of up to 2 m a-1. In contrast I-DLs in Ak-Shiirak did not show measurable surface displacements rates for the investigated period since the 1970s. The differences can be mainly explained by “by distinct local topographies.
Geophysical measurements indicate massive ice bodies in the upper part of the I-DLs which are probably remnants of former glacier ice. Slanting layers in the lower parts of the I-DLs coincide with the ridges and furrows structure visible at the surface of many I-DLs. These could be a sign of current and past creep or push moraines formed by glacier advances under permafrost conditions. Work is under way to investigate the characteristics and genesis of the I-DLs more in detail.

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Ajanta Goswami	Glacial lakes as a proxy to climatic pattern in Indian Himalaya	Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India
Aamna Qamar	Spatio-temporal analysis of glacier variation extent of Nanga Parbat massif from 1990-2017 using remote sensing	Institute of Space Technology, Islamabad, Pakistan
Abdurashid Tagoybekov	Glaciation of Varzob basin	Agency of Hydrometeorology, Dushanbe, Republic of Tajikistan

Glacial lakes as a proxy to climatic pattern in Indian Himalaya

(Poster Presentation)

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India is the world's 7th largest country, which is home to 17% of the world's population. The northern border of the country is sealed by mighty Himalaya which laterally extends for about 2400 km and has a thickness of about 400 km. The Indian Himalaya is home to about 10,000 glaciers, which are a source of water to all the perineal streams flowing through the mighty Indo-Gangetic plain. These glaciers also house numerous glacial lakes, which pose a serious threat to population downstream, and numerous hydropower projects commissioned on various rivers. The breaking of the Chorabari lake in Uttarakhand Himalaya on June 16, 2013, caused immense loss of life and infrastructure. This situation has jolted entire Southeast Asia and showed how glacial lake monitoring is a necessity for the society and planners.

With this motivation, the present study was conducted to map, monitor and prepare the list of hazardous lakes in Indian Himalaya. The lakes were mapped and monitored in decadal scale right from 1964 onwards using Corona data followed by Survey of India (SOI) toposheets Landsat series of satellite data and Sentinel data. The dynamics involved with the glacial lakes were studied, and hazardous lakes were identified.

The results showed a definite pattern in the growth of glacial lakes from western to eastern part of the Himalaya. It was observed that the glacial lakes of eastern Himalaya are growing faster compared to western Himalaya. To understand the dynamism of glacial lakes, the climatic pattern over the Indian Himalayan region was studied further.

There were some significant results observed from the climatic study. It was observed that due to Karakoram anomaly, western Himalayan glacial lakes are not growing significantly. However, due to rise in temperature and variable rainfall pattern, the eastern Himalayan glaciers are growing faster. The present study has great importance for the Indian region. The results may be used for planning water resources and tackle potential hazards associated with glacial lakes.

Spatio-temporal analysis of glacier variation extent of Nanga Parbat massif from 1990-2017 using remote sensing

(Poster Presentation)

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The Himalayas are the highest mountain ranges in the world and one of the largest concentrations of glaciers outside the polar region. In Pakistan, some of the famous glaciers of the Himalayas lie in Nanga Parbat massif. Several studies have been conducted to investigate their dynamics. The aim of this study is to detect and analyze changes in four small glaciers of Nanga Parbat massif over time period of 1990 to 2017 using Landsat series satellite data.

For the delineation of clean ice glaciers Normalized Difference Snow Index (NDSI) is used. The debris cover on the glacier surface has a similar reflectance to surrounding rocky or sandy areas in the visible to near-infrared wavelength region. For the identification of debris cover glaciers band ratio is used, Land Surface Temperature (LST) and the slope is also utilized to differentiate between debris cover and surrounding rocks. Accuracy assessment is carried out through comparisons of the derived glacier outlines with high-resolution satellite data and Randolph glacier inventory version 5.0. The study provides relevant new observational information on the current state of glaciers in the Himalayan region.

Glaciation of Varzob basin

(Poster Presentation)

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The Varzob river is a large right tributary of Kafirnigan, it is the right tributary of the Amu Darya - the main waterway of Central Asia. The capital of the Republic of Tajikistan-Dushanbe is situated on the Bank of Varzob. The upper part of Varzob basin, on the southern slope of the Hissar range named Varzob gorge and height of it individual peaks reaches nearly five thousand meters above sea level. The spurs of this ridge create a complex hydrographic network of tributaries of Varzob. Relief everywhere is like as in Alpine: sharp ridges and peaks, steep rocky slopes, deep gorges, snowfields, glaciers, moraines.

According to the catalog of glaciers, there are 112 glaciers with a total area of 36.1 square kilometers in the Varzob basin. And 17 glaciers measuring are less than 0.1 square km with a total area of 0.9 square km. The volume of all glaciers is about 800 million cubic meters. The greatest number of glaciers - 35 is situated in the basin of the right tributary of the Varzob river to the Siamese, 25 glaciers located in the basin of the river Mahury -right part of the Varzob and 21 glaciers are located in the headwaters of the left component of the Varzob river and Ziddi. It's necessary pointed out that average size of the glacier in the basin of Varzob be only 0.37 per sq. km., where we can watch the small Cirque and Cirque-valley glaciers. Three-quarters of all glaciers are glaciers of the Northern, North-Eastern and North-Western expositions. The average height of the firn line in the Varzob basin consists 3690 m above sea level, the average height of the lower limit of glaciers is 3590 m above sea level.

Cirque-valley glacier Jakarta has North-Eastern exposure and is located on the Northern slope of the spur of the Turkestan range. It implies Akarca river - a tributary of Mahury, which is a right-component of Varzob. The power of the river Akarca snow-ice with a maximum expenditure of 25-35 m3/s in May - June, i.e. during intense snowmelt.

Glacier Jakarta is one of the largest glaciers in the basin of the river Varzob. The length of the glacier is 1.5 km, including 1.3 km of open part, area of 0.9 sq. km Area of the region of ablation of 0.4 sq. km Height above sea level: language is 3800 m, firn lines – 3940 m, the highest point is 4160 m. the volume of glacier 0,023 cubic km the Slope of its surface ranges from 5-100 back to 25-300 in the language part.

The valley of the river in places has a trog character, in places takes the trough-shaped form. The slopes of the mountains surrounding the river, represented by granite and granodiorite rocks with fractions of Quaternary deposits in the form of talus composed of gravel and fragments of rock, and the remains of ancient moraines, brought by the glaciers are tributaries of the glacier Jakarta.

The vegetation cover of the upper reaches of the basin is represented by fractions of herbaceous vegetation. At the bottom of the pool grow shrubs and juniper, in the mouth of the pool there are deciduous trees.

The upper reaches of the Maikhura are the "pole of precipitation" of Tajikistan – here falls more than 1000 mm of precipitation per year. The height of snow cover in the area of 2500-4000 m above sea level can reach 3-4 meters by the end of winter, and in snowy years 5 – 6 meters. Here you can crumble the avalanche with a volume of up to a million cubic meters. It is due to the large amount of precipitation and avalanches in the upper reaches of the Varzob district, on the southern slope of the Hissar range there are according to the Catalog 112 small lednicko total area of 36 square kilometers and a total volume 800 million cubic meters. The melt water of the glaciers represent a significant percentage of Varzob power in the vegetation period.

For several years on the glacier Jakarta as typical of the district conducted a comprehensive glaciological work on "the Study of regularities of accumulation and spending of moisture by elevation zones in the basin of the river Varzob".

From 1973 to 1977, the glacier retreated an average of 25 meters, freeing from ice 5700 sq.m. The balance of the glacier was negative all years except 1969 and 1972.
Photo of the glacier in 1996 showed that the retreat of the glacier slows down, that for the period since 1988, his tongue retreated by only 6 meters. Photo of transverse profiles showed that the top of the glacier not subsided. So, glacier Jakarta from the stage of degradation passed into the stationary of phase.

Photo in 1997 did not take place, because the glacier was completely covered with snow. According to visual observations, it was in a stationary state.

The following survey of the glacier Jakarta was made only in July 2006 after a decade. It turned out that the glacier is covered with dense snow height of 20-50 centimeters, so, unfortunately, to conduct a total station survey of his tongue was impossible.

Instead of it have taken place the visual survey of the glacier over the entire area and made photos of the whole glacier and some of its details.

The survey revealed that the glacier is in the stage of degradation. The right side of the feeding zone as a result of melting separated from the main body of the glacier.

The analysis showed that during 20 years from 1997 to 2017 the glacier retreated by 160-190 meters, the average rate of its retreat was 10 meters per year. The surface of the glacier is somewhat settled. Thus, the glacier lost almost 35-45 percent of the total area.

Session 3: Hydrology: Observations, Processes and Forecasting

(Chair: Abror Gafurov, German Research Center for Geosciences)

A robust assessment of seasonal water availability is important in order to achieve a fair distribution of water resources, particularly with regard to conflicting interests of irrigated agriculture and energy production in Central Asia. Moreover, a profound understanding of climate change impacts on long-term water availability is important for the implementation of adaptation measures. Thus, scientific progress is required to develop proper methodologies for the assessment of seasonal water resources and for the prediction of future changes of flow regimes.

The proposed session aims at an improved understanding of hydrological processes in Central Asia and their potential modifications due to climate variability and change. The topics include, but are not necessarily limited to, observations of hydrological components and processes (e.g. tracer experiments), in-situ and remote sensing based monitoring techniques, hydrological modeling applications, and seasonal forecasting approaches. The session will include an in-depth discussion on ongoing research and will identify research gaps in the field with particular regard to the variability of hydrological processes (e.g. glacier melt, snow melt) and the role of ongoing global warming.

Oral Presentations:

Authors	Presentation Title	Author's Affiliation
Samuel Dixon	Seasonal forecasting of reservoir inflows in Central Asia using remote climate drivers	Loughborough University, Department of Geography, Leicestershire, UK
Heiko Apel	Statistical forecast of seasonal discharge in Central Asia using observational records: development of a generic linear modelling tool for operational water resource management	GFZ German Research Centre for Geosciences, Potsdam, Germany
Ildar Mukhamedjanov	Satellite monitoring of the water reservoirs of Vakhsh cascade	Lomonosov Moscow State University, Moscow, Russia
Kai Schwärzel	Effects of dryland plantation forests on evapotranspiration, soil water dynamics, seepage and discharge	United Nations University, Dresden, Germany
Julia Illigner	Water in Central Asia - lake and reservoir level monitoring with Radar Altimetry	GFZ German Research Centre for Geosciences, Potsdam, Germany

Seasonal forecasting of reservoir inflows in Central Asia using remote climate drivers

(Oral Presentation)

Samuel G. Dixon[1], Robert L. Wilby[1] and Richenda Connell[2]

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The scope for seasonal forecasting river discharge into strategically important headwater reservoirs in Kyrgyzstan and Tajikistan was investigated. Such forecasting could facilitate improved dam safety alongside increased hydropower production. Winter large-scale climate indices (El Niño Southern Oscillation, North Atlantic Oscillation and Indian Ocean Dipole) were used to the condition following summer inflows. This provided a forecast of average summer inflows following negative/neutral/positive index phases the previous winter. We find that winter El Niño was significantly positively correlated with following summer inflows to Nurek ($p<0.01$), Andijan and Toktogul ($p<0.05$) reservoirs. Differences in the distributions of average summer inflows were statistically significant depending on previous winter El Niño for Nurek ($p<0.01$) and Andijan ($p<0.05$). Over the period 1941-2016 (1993-1999 missing), the average summer inflow anomalies into Nurek reservoir were +16%/-14% following November-December El Niño/La Niña conditions. These statistical results are consistent with physical understanding. During winter El Niño conditions the southwesterly moisture flux brings above-average precipitation to Central Asia, resulting in greater snowpack accumulation and therefore increased summer snowmelt. The techniques and data required are low cost, require relatively little modelling skill or computing power and can be applied to emerging remotely sensed products – all considerations in data sparse regions. The current development of other large, headwater impoundments in CA only adds to the potential of the method presented. Such a seasonal forecasting tool can contribute to increased dam safety, economic performance and transboundary water sharing around such projects.

The results presented stem from the following publication (in review):
Dixon, S. G. and Wilby, R. L. (in review). Potential for seasonal forecasting of reservoir inflows in Central Asia.

Statistical forecast of seasonal discharge in Central Asia using observational records: development of a generic linear modelling tool for operational water resource management

(Oral Presentation)

Heiko Apel, Zharkinay Abdykerimova, Marina Agalhanova, Azamat Baimaganbetov, Nadejda Gavrilenko, Lars Gerlitz, Olga Kalashnikova, Katy Unger-Shayesteh, Sergiy Vorogushyn, Abror Gafurov

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The semi-arid regions of Central Asia crucially depend on the water resources supplied by the mountainous areas of the Tien Shan, Pamir and Altai mountains. During the summer months, the snow and glacier melt dominated river discharge originating in the mountains provides the main water resource available for agricultural production, but also for storage in reservoirs for energy generation during the winter months. Thus a reliable seasonal forecast of the water resources is crucial for the sustainable management and planning of water resources. In fact, seasonal forecasts are mandatory tasks of all national hydro-meteorological services in the region. In order to support the operational seasonal forecast procedures of hydro-meteorological services, this study aims at the development of a generic tool for deriving statistical forecast models of seasonal river discharge based solely on observational records. The generic model structure is kept as simple as possible in order to be driven by meteorological and hydrological data readily available at the hydro-meteorological services, and to be applicable for all catchments in the region. As snowmelt dominates summer runoff, the main meteorological predictors for the forecast models are monthly values of winter precipitation and temperature, satellite based snow cover data, and antecedent discharge. This basic predictor set was further extended by multi-monthly means of the individual predictors, as well as composites of the predictors. Forecast models are derived based on these predictors as linear combinations of up to 4 predictors. A user selectable number of best models is extracted automatically by the developed model fitting algorithm, which includes a test for robustness by a leave-one-out cross validation. Based on the cross validation the predictive uncertainty was quantified for every prediction model. Forecasts of the mean seasonal discharge of the period April to September are derived every month starting from January until June. The application of the model for several catchments in Central Asia - ranging from small to the largest rivers (240 km2 to 290,000 km2 catchment area) – for the period 2000-2015 provided skilful forecasts for most catchments already in January, with adjusted R2 values of the best model in the range of 0.6 – 0.8 for most of the catchments. The skill of the prediction increased every following month, i.e. with reduced lead time, with adjusted R2 values usually in the range 0.8 – 0.9 for the best and 0.7 – 0.8 on average of the set of models in April just before the prediction period. The later forecasts in May and June improve further due to the high predictive power of the discharge in the first two months of the snowmelt period. The improved skill of the set of forecast models with decreasing lead time resulted in narrow predictive uncertainty bands at the beginning of the snowmelt period. In summary, the proposed generic automatic forecast model development tool provides robust predictions for seasonal water availability in Central Asia, which will be tested against the official forecasts in the upcoming years, with the vision of operational implementation.

Satellite monitoring of the water reservoirs of Vakhsh cascade

(Oral Presentation)

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The problem of distribution and monitoring of Central Asian water resources has been actively discussed since last century. Uzbekistan's water objects are mainly fed by two large rivers Syrdarya and Amudarya. Due to geographic peculiarities the former flows from the neighboring countries. So, there is a sensible reason to get unprejudiced information in order to make the assessment of resources and water distribution forecasting more effective.

The paper describes the procedure of data acquisition in the organization of satellite monitoring of water objects of Vakhsh cascade. Systems of remote sensing of the optical range with spatial resolution from 10 to 250 meters and SAR data from SENTINEL -1A, -1B are considered. The part of Vakhsh river was divided into several fragments between hydroelectric power stations. The research has been done with the help of the web-service for satellite monitoring VEGA-Science (http://sci-vega.ru). Processing of remote sensing data in order to get the water surface area is based on the classification of pre-contoured parts of the image. VEGA-Science supports a number of classification algorithms which make it possible to set the input parameters depending on data features. The methods used in processing also include topographical correction and speckle noise reduction (for SAR). According to the results of the monitoring, the graph expressing the dynamics of water surface area for 2017 is represented and the systems being optimal in combination for remote sensing of water reservoirs in zones with complex mountain terrain were found. Final diagrams could be useful to find the seasonal correlation between the state of water resources in the south and in the north-west of Uzbekistan, and also between vegetation values and the growing season streamflow for a defined period. Currently, the efforts to find the altimetry data are being taken. This may allow to estimate the water level in water reservoirs and understand how the water surface area depends on the water level for a certain object.

The described approach could finally become a reasonably good practice and make the assessment easier and faster as it can be repeated for a required year to reestablish the gaps in measurements. Besides, the combination of data from ground stations with the results of satellite data processing can represent detailed full annual reports of water objects and improve the existing methods of monitoring.

Effects of dryland plantation forests on evapotranspiration, soil water dynamics, seepage and discharge

(Oral Presentation)

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China produces food for a fifth of the world´s population with only 7% of the world´s arable land, although 65% of China´s cultivated land is situated in the dryland region of northern and north-western China. Drylands are defined by their scarcity of water, they include arid, semi-arid and semi-humid regions; such water-limited environments occupy about 50% of the global land surface, and are often sensitive and prone to change because of limitations in water and extreme temporal variability in rainfall. The Loess Plateau in north-western China, an area of the size of France, is one such region. It is the cradle of the Chinese civilization because the soils formed on loess - a wind-blown deposit - are very fertile and easy to cultivate. Loess soils are extremely prone to erosion by water and wind as the centuries of improper management have shown. It resulted in degenerated ecosystems and thus in poor local economy. For this reason, large scale afforestation programs have been implemented by the Chinese government since the 1970ies. These programs will last by 2050, and aim to alleviate poverty, control soil erosion, and improve and restore land quality as well as soil-based ecosystem services. While soil erosion and the sediment load of the Yellow River decreased due to the successfully established soil conservation measures, water discharge of Asia's third largest river significantly declined. To give an example, the average discharge of the Yellow River during 2000 to 2010 was only 30% that of the 1950s to 1960s. The projected increase in more frequent and more intense droughts and floods, and the increasing demand for water of a society that is more prosperous will further exacerbate water supply security in dryland China, and thus threaten food security and increasing social vulnerability and instability. It is generally accepted that the forest cover increase has largely contributed to the decline in water resources in northern China because forests evaporate more water than grassland or cropland. Moreover, the established forests are often not managed. Research has shown that unmanaged, dense forest stands in water-limited areas escalate water shortage. Forest evapotranspiration is composed of several components, such as the canopy and litter interception, understory and overstory transpiration, and soil evaporation. This means that management induced changes in forest structure will result in a different relative contribution of these components to total evapotranspiration. As a consequence, such changes in evapotranspiration will also lead to a complex change in water yield. Thus, a better understanding of how the forest structure controls partitioning of evaporative fluxes into its individual components will be the key for the development of a more water-saving forest management in water-limited environments as Northern China. For these reasons, measurements were established at adjacent sites with contrasting vegetation cover, namely black locust afforestation vs. grassland but with similar soil texture, soil type, and topography. Weighable lysimeters were used to measure grassland and understory evapotranspiration, the sap flow method was used to estimate tree transpiration and rainfall measurements below and above the canopy enabled us to determine rainfall interception. In

this paper, we (i) describe diurnal and seasonal patterns of the evaporative fluxes of the black locust afforestation and grassland, (ii) balance the water fluxes of the two contrasting vegetation covers on a seasonal basis, and (iii) discuss the contribution of forest plantations to the observed decline in water resources in Northern China using hydrological modelling ranging from the plot to the catchment scale.

Water in Central Asia - lake and reservoir level monitoring with Radar Altimetry

(Oral Presentation)

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In the arid to semi-arid region of Central Asia, water resources are vital for the growing population and are used intensively, in particular for hydroelectric power generation and irrigation. Due to joint use of water e.g., from the transboundary Amu Darya and Syr Darya River (and their tributaries), the economies of the five former Soviet Republics in Central Asia – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan – are closely interconnected and their economic development strongly depends on the availability of water. In the past decades, the chronic overuse of existing reserves and the impact of global climate change led to increasing water scarcity in the region.

In addition, lack of information on (regional) water availability poses a challenge for sustainable water resources planning and management. To assist hydrometeorological forecasts and political decision processes, independent and freely available information on water parameters, e.g. lake and reservoir levels, are in high demand.

Over the past years, radar altimetry became a tool for monitoring inland water bodies. New missions and recent reprocessing of data, acquired during previous missions, allow a construction of time series of lake and reservoir levels back to 1993. Such data allow studies of natural changes in the water availability as well as the examination of changes in reservoir fillings.

In the frame of the Caw project (www.cawa-project.net) radar altimetry data from missions such as AltiKa, Jason-2 and -3, CryoSat and Sentinel-3A is automatically processed for lake and reservoir heights in Central Asia. The data is made freely accessible to all national Hydromet services and to the international community through the Sensor Data Storage System (SDSS) which is hosted at CAIAG (http://sdss.caiag.kg). The SDSS is the main storage and dissemination system for meteorological and hydrological data acquired by CAWa in Central Asia.

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Mohammad Assem Mayar	River mapping using high resolution topographic information for flood modeling in Afghanistan	Kabul Polytechnic University, Kabul, Afghanistan
Rashid Davlyatov	Water resources of Tajikistan. Riddle - glacier Fedchenko	Agency of Hydrometeorology, Dushanbe, Republic of Tajikistan
M. Daud Hamidi	Integrated surface and groundwater modeling in data scarce region, as an example: Kabul city region	Kazakh-German University, USDA Forest Service, Almaty, Kazakhstan
Olga Kalashnikova	Application of remote sensing snow cover data from MODIS for seasonal flow forecast in the Syrdarya River Basin.	Central-Asian Institute for Applied Geosciences (CAIAG), Bishkek, Kyrgyz Republic
Fazliddin Hikmatov	Assessment runoff formation in Chirchik basin by water stable isotope analyses	National University of Uzbekistan, Tashkent, Uzbekistan
Vadim Yapiyev	Stable water isotopes in endorheic watersheds of Burabay National Nature Park (Northern Kazakhstan, Central Asia): isotope hydrology application for water balance of lakes	Nazarbayev University, Department of Civil and Environmental Engineering, School of Engineering, Astana, Kazakhstan
Cornelia Zech	Hydrometeorological Observations and Sensor Data Storage in Central Asia	GFZ German Research Centre for Geosciences, Potsdam, Germany
Natalya Ivkina	Research of wave processes in the Caspian Sea based on surface wind fields and the wave spectral model of SWAN	Hydrometeorological Research Department of the RSE "Kazhydromet", Almaty, Kazakhstan
Murataly Duishonakunov	The changing character of the hydrological regime of the Naryn River and related problems for water supply	Kyrgyz National University, Bishkek, Kyrgyz Republic
Jingheng Huang	Hydrological response of the upper Syr Darya basin to climate change and human activities during 1961-2016	Chinese Academy of Sciences, Institute of Tibetan Plateau Research, Beijing, China

Aliya Nurbatsina	Quantification of water abstraction in the transboundary Ile Basin (China/Kazakhstan) and changes in future runoff with a physically-based hydrological model	Regional Centre for Hydrology, Almaty, Kazakhstan
Ali Torabi Haghighi	Index based methods for river flow regime change assessment at different time scales	Water Resources and Environmental Engineering Research Group, University of Oulu, Finland

River mapping using high resolution topographic information for flood modeling in Afghanistan

(Poster Presentation)

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Digital modeling and simulation techniques are the cheapest solutions for natural disasters' risk management, e.g. flood events. Modeling flood using hydrologic and hydraulic models provide valuable information for flood disasters' prediction and risk mitigation. The accuracy of these models depends on the precision and resolution of the input data. An important input parameter for flood models is the river network. Unfortunately, an accurate and reliable digital river network does not exist for Afghanistan's river basins. The Afghanistan Information Management Services (AIMS) manually digitized major rivers in 1997 from the United States Defense Mapping Agency (USDMA; 1967-1988) using 1:100,000 scale topography maps. The river features produced are not accurate and are only for local planning and management purposes. Recently, UN-HABITAT in cooperation with Afghan government manually digitized a higher resolution river network only for major cities. This network does not cover the whole basin and lacks elevation information. Moreover, the modelers in Afghanistan have to individually delineate river network for their study areas using lower resolution topographic information, which is a very time-consuming process, propagates error and creates inconsistency. To address these problems, it is planned to develop a single source, accurate and higher resolution river network that can be shared with the public through a reliable online platform. The input data contains 5-meter resolution digital elevation model (DEM), Sentinel and GeoEye satellites online images in Arc-GIS interface. The methodology is based on Arc-Hydro extension of Arc-GIS software. The procedure contains delineation of the river network using Arc-Hydro algorithm, editing rivers using Sentinel and GeoEye's high-resolution satellite images, correction of DEM according to developed network and finally re-delineation of whole river network based on modified DEM. Subsequently, the river profiles are produced. As a result, the river's plan and profile calibration show good agreement.

The results provide a unique, more accurate and highest available resolution river network for Afghanistan. The features also have accurate profiles based on corrected 5-meter DEM. The river layers would be shared with the public through Afghanistan spatial data center (ASDC) advanced geoportal. Currently, the study area focuses on the Kabul River basin; later the network will be extended nationwide. The advantage of this study is that it will reduce computational time, improve the accuracy and resolution of modeling in future. Finally, the generated network could also be used for dam site selection studies and other water-related purposes as well.

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Water resources of Tajikistan. «The pearl of Tajikistan is the glacier Fedchenko! »

(Poster Presentation)

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From historical documents, we know that during the Pleistocene the Muksu glacier reached a length of 172 km and it came very close to the Kyzylsu river. The width of the glacier near the frontal part reached 4 km, in the middle of its current - 5 km, and in the upper part of the snowy valley it reached 6 km. Today the length of this glacier now named Fedchenko exceeds just over 77 km and practically reaches the Muksu River. It was noted that during the periods of its activity in the late 30s of the last century, the Fedchenko glacier often blocked the riverbed of the Muksu River. It was noted that during the periods of its activity in the late 30s of the last century, the Fedchenko glacier often blocked the riverbed of the Muksu River. In my previous article, I tried to talk about the new activation of the glaciers of the present century in the Fedchenko glacier basin. On the example of a large glacier Bivachny, which has been in the active regression stage for the last 8 years to the present day. And also numerous small nameless glaciers show their activity and connection with the main plateau of the glacier. But the general estimate for the Fedchenko glacier is of course with a minus estimate. Annual total precipitation and snow cover does not make up for its general melting. He has changed a lot and his pure ice is not now such. The causes of the glacier glaciation degradation are the ongoing global warming and the increase in glacier pollution, which increases the intensity of melting. The reason for the contamination of the glacier recently called circulation in the atmosphere. The aerosols contained in it, as a rule, fall mainly with precipitation, but often settle in a dry state. The ongoing synoptic processes only intensify this process of pollution. The frequency of atmospheric phenomena on the Fedchenko glacier is almost insignificantly dependent on the passage of air masses around it and the formation of a cyclone with subsequent precipitation is all due to the local microclimate. I will give an example from the records of the diary of my first wintering in 1984: « December … morning and afternoon wind of 6-10 m / s, temperature minus ten degrees, dry snow does not stop for 13 consecutive days. In the evening, at 20.00 local time, the wind increased to 20-25m/s. His impulses reached 38-45 m / s, knocking hard on the metal case of the station. At the station, a 30-meter antenna strip broke off and to restore it we leave in a bundle of threesome. We were wrapped in one nylon halo and kept on a leash. Perform simultaneous movements at the beginning of the right foot, and then left sticking with one hand the body of the station, and the second ahead of the going - it was like a dance of "white swans." Raised three legs - three valenoks hung in the air and did not want to obey. A strong wind with snow was blowing into my face and I had to open my eyes slightly in order to find pieces of ragged antenna cloth under the light of the beam from the flashlight. For half an hour the three of us stood in an open area blown with a terrible wind and held a ragged antenna bed while the radiotelegraph operator on duty rattled the weather telegram with Morse signs. Going to the station was even more difficult, because you had to do the same movements, but only in reverse. We held fast to the wind to knock us out into the night abyss. Already sitting at the station and warming their noses, vigorously discussed what had

happened. Meanwhile, a device for measuring wind speed recorded a maximum burst of 48 m/s. It was morning, a little cloudiness and finally the snow, which lasted fourteen days without a break, ended. All the winterers went to repair the damage …».

In 2015, during the "3rd International Pamir Geophysical Expedition" on the Fedchenko glacier, German scientists from the Bavarian Glaciology Center dealt with atmospheric aerosols and contamination of snow and ice cover. Having completed the work on diagnostics of the transverse and longitudinal profiles in the upper glacier with the help of passive radar, they started to work on the sampling of snow and ice. In the beginning, samples of snow were taken to the depth of annual precipitation, and then an ice sample was taken. All samples of snow were packed in special plastic containers, on which the depth marking was placed. Getting a sample of ice was a little more complicated. Here we had to use a special screw drill for ice. In total, for the analysis of the snow cover samples of a 3 m snow cover were taken and a two-meter ice sample was drilled.

Integrated surface and groundwater modeling in data scarce region, as an example:

Kabul city region

(Poster Presentation)

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The Kabul City Catchment lies in a semi-arid region of the Kabul River Basin (KRB). Water supply is threatened by population growth and climate has been changing since the last century, which further amplifies the water demand. Currently, Kabul City Region (KCR) is one of the most water-stressed cities in the world with the lack of accessible, safe drinking water. Models describing water supply and demand including water yield, groundwater, water quality, ecology, and economy are being developed and used in increasing number and variety to support water management decisions in many regions of the world. However, in the KCR, there is a lack of reliable and validated integrated surface and groundwater model in order to assess the real-time water balance, its components and their pathways. Model simulation can be a valuable tool for assessing surface and groundwater management options for different “what if” water balance and supply scenarios to improve the sustainability of water resources in the KCR. Therefore, proper modeling is required for the KCR basin for the development of a sustainable water plan with the integrated surface and groundwater management. Hydrological models like SWAT (Soil and Water Assessment Tool) for surface water simulation, Modified Tank Model to simulate groundwater level fluctuations, and WEAP, Conceptual model of groundwater by BGR in 2005 and USAID in 2009 were developed for the KRB. In order to develop a physically distributed and reliable model capable of assessing the climate change factors, this paper intends to compare the earlier published results from the above models and present updated results by developing an integrated surface and groundwater model using DHI MIKESHE for KCR, which is currently under calibration and validation stage and by potentially addressing deficiencies in earlier models.

Application of remote sensing snow cover data from MODIS for seasonal flow forecast in the Syrdarya River Basin

(Poster Presentation)

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The area of the Syrdarya river basin, the second largest river in Central Asia, occupies about 782,600 km². The Syrdarya River is formed by the conjunction of two rivers, the Naryn River (basin area 59900 km^2) and the Karadarya River (basin area 30100 km^2). After its conjunction several tributaries conjunct with Syrdarya River delivering water from mountains around the Fergana Valley. The Syrdarya is a transboundary river with its water resources used by four Central Asian republics: Kyrgyzstan, Uzbekistan, Kazakhstan, and Tajikistan. Water resources of Sirdarya river are mainly formed due to snowmelt and glacier melts and used for hydropower generation in Kyrgyzstan. Besides the use of river water for hydropower generation in the upstream countries during winter months, it is also a source for agricultural production in the downstream countries, which is not possible without irrigation due to high aridity in the summer months. The flow of rivers in the Fergana Valley and from Naryn and Karadarya Rivers varies greatly from year to year, and its systematic and rational use is possible only if there is adequate information about the current and expected water availability.

In this study, we analyzed remote sensing based snow cover data from MODIS in the Naryn, Karadarya, Shahimardan and Isfaram-Sai basins for the last 15-year period 2000-2015. Linear regression analysis was conducted to investigate the dependence of river runoff during the vegetation period (April-September and May-September) from the degree of snow-covered area obtained from MODIS images processed using the MODSNOW-Tool. This information was then used to compile methods for seasonal flow prediction in the summer months for individual river basins using a multiple linear regression method. Snow cover area and antecedent discharge were used as predictors to set up linear models. For some river basins with significant glacier melt contribution, the average air temperature in May was also used as the third predictor to forecast water availability during May-September. The temperature for this month is compiled by the Hydrometeorological Service in the first decade of April and is available for usage in forecast models.

The methods proposed for seasonal runoff forecast during summer months have a correlation coefficient (R) of 0.50-0.92, and the accuracy of the forecasts for the period from 2000 to 2015 is 77-100% when compared against observed discharge. A method of seasonal flow forecast for the Naryn basin has been implemented at the Kyrgyzhydromet since 2013 and is used by the operational units to forecast the discharge during summer months. Starting from 2018 an implementation of forecast methods proposed by the authors for the Karadarya, Shakhimardan and Isfayram-Sai rivers is planned at the Kyrgzyhydromet as well.

Assessment runoff formation in Chirchik basin by water stable isotope analyses

(Poster Presentation)

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Discharge of the rivers in Central Asia is basically formed in high-mountain systems. The glaciers and snowmelt play important role in runoff forming in river basins. Glacier shrinking and reduced snowpack melting have been observed in the region since 1950 under climate change (Aizen et al., 1996, 1997; Chub, 2007) which impact on the transient increases of river discharge. In addition to glacier shrinkage, climate change impacts on alteration of precipitation regime, increasing extreme weather and aggravating water supply in the region. Consequence it impacts on social, economic and ecological systems in the region. Under that circumstance, investigation of water forming components as glacier, snow, groundwater, and precipitation in the river basin is important in order to better understand water resources formation and predict water availability in the future.

Stable isotopes of water (deuterium -δ¬2H and oxygen-18 - δ¬18O) have been successfully used as a hydrological tracer to estimate the contribution of different water sources in stream flow, including glacier, snowmelt water, precipitation and groundwater (Mook and De Vries, 2000). The existing traditional method on estimation runoff formation – hydrograph separation is highly uncertain, especially with potential effects of climate variability as shrinking glacier and changing seasonal distribution of precipitation, etc. Stable isotopes can be useful to reduce the uncertainty. Additionally, although The Global Network for Isotopes in Precipitation which was established by International Atomic Energy Agency collaborating with World Meteoric Organization conducts long-term observations of isotope signatures of precipitation over the large part of the world, very few observations in Central Asian mountain areas has been provided (Meier et al., 2013). In order to characterize stable isotopes precipitation and understand its interaction with different runoff components in Chirchik river basin, stable isotope investigation in a chosen catchment will be carried out. The main aim of the research is to evaluate hydrological processes in chosen catchment by investigation water stable isotopes.

The main objectives are:

- Characterize temporal, spatial and seasonal variation of isotope composition of a glacier-snow fed stream in Chirchik river basin;

- Distinguish the contribution of stream formation components into glacier melt, snowmelt, precipitation and groundwater applying stable isotopes of water -δ2H and δ18O;

- Modeling runoff formation in the chosen catchment and evaluate model outputs.

Stable water isotopes in endorheic watersheds of Burabay National Nature Park (Northern Kazakhstan, Central Asia): isotope hydrology application for water balance of lakes

(Poster Presentation)

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The quantification of hydrological processes in the water balance of lakes is a difficult task, especially in lake systems with heterogeneous geology and complex climate controls. In most areas, including cold semi-arid regions, there are two critical processes important in Lake Hydrology: 1) open water evaporation, and 2) lateral interaction of shallow groundwater with lakes. An important factor influencing the latter processes is the fact that a significant portion of snow meltwater will percolate through the soil in spring, contributing to groundwater. Lakes can be either recipients (discharged to the lake) or donors (recharge from the lake) of water from local groundwater systems or both. In arid and semi-arid environments open water evaporation is a dominant process in the water balance of lakes. The quantification of lake evaporation is usually performed by using models such as the well-known Penman equation with available weather station data with verified pan evaporation or micrometeorological measurements. The stable water isotopes (SWI) of oxygen and hydrogen have been widely utilized as tracers in water balance studies of lakes to identify both the evaporative "signature" and lake-groundwater interaction. There are various studies on SWI application for lake water balances with the data available mostly for North and South America, Europe, Australia, South-East Asia and Africa. Overall SWI data in surface waters, groundwaters and precipitation from Central Asia, particularly its northern part, are very limited or absent.

In the present work, we analyze a small dataset of stable water isotope measurements from samples collected during one hydrological year (December 2015 to November 2016) in the watersheds of Burabay National Nature Park in the cold semi-arid part of Northern Kazakhstan. The samples represent groundwater from four monitoring groundwater boreholes, four terminal lakes, two local streams and precipitation. This SWI dataset covers an area in Northern Central Asia for which no records are currently available on SWI in precipitation and groundwaters. We used a simple tool based on a modified Craig-Gordon model to estimate the simplified mass balance of an inland water body as a evaporation/inflow (E/I) ratio based on initial and final isotopic composition of the water in a lake or reservoir, precipitation and some basic weather data (relative humidity and air temperature). The isotopic composition of precipitation confirms the gridded observations based on interpolated data as well as empirical models (based on the effect of temperature on isotopic fractionation). We also report the slope of the Local Evaporation Line (LEL) for this region (ranging from 5~6), which is close to the range reported for other mid-latitude regions. The isotopic composition and LEL slope indicate that mostly probably BNNP lakes have (E/I) regime more similar to the closed lakes in the southern part of Siberia than to steppe lakes located in more arid parts of Central Asia.

Hydrometeorological Observations and Sensor Data Storage in Central Asia

(Poster Presentation)

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The observation and derivation of terrestrial parameters are essential for a sustainable water resource management. Especially in Central Asia, where water is non-uniformly distributed over the entire region, the availability of fresh water plays a key role for the living, economic development and agriculture. In the frame of the CAWA project (www.cawa-project.net), a transnational network of Remotely Operated Multi-Parameter Stations (ROMPS) has been installed in the past years. GFZ in cooperation with the CAIAG and the national Hydromet services of Uzbekistan, Tajikistan and Kyrgyzstan, Ulugh Beg Astronomical Institute, the Kabul Polytechnic University and the German Kazakh University in combination with the Institute of Geography of Kazakhstan operate a regional network of continuously operated monitoring stations that capture various meteorological, hydrological and glaciological parameters as well as a high-rate GPS.

The ROMPS combine a multitude of different sensors at one station with shared data storage, power supply and communication infrastructure. All stations are designed as stand-alone field systems to be installed in remote areas with no infrastructure (e.g. no reliable local power supply or communication network). The system is mechanically robust, equipped with an intelligent management system to guarantee a continuous operation and self survival. Of special importance is the installation in high-mountains with only a few hours of daily sunshine and the nightly temperature drops down to -40°C.

These observations offer opportunities to support a wide range of operational, societal and scientific tasks, among them weather observations and forecasts, long-term climate monitoring, river discharge monitoring, geodynamic processes, Earth-System hazard monitoring as well as the establishment of water-related early-warning systems.

The data is made freely accessible to all national Hydromet services and the international community through the Sensor Data Storage System (SDSS), which is hosted at CAIAG (http://sdss.caiag.kg). The SDSS is the main storage and dissemination system for all Level 0 meteorological and hydrological data acquired by CAWa and other ROMPS stations in Central Asia. In addition, radar altimetry data from missions such as AltiKa, Jason-2 and -3, CryoSat and Sentinel-3A is automatically processed for lake and reservoir heights in Central Asia and continuously added to SDSS.

Research of wave processes in the Caspian Sea based on surface wind fields and the wave spectral model of SWAN

(Poster Presentation)

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Research of wind waves on the seas and oceans are important since data on wave regime needed for navigation purposes, the companies producing oil and construction in the coastal zone. Qualitative and timely data, help to prevent environmental and man-made disasters and to conduct environmental management.

Simulation of waves on the Caspian Sea was carried out using the SWAN model version 41.01. SWAN is a third generation wave model for obtaining wave parameters, both in coastal zones and in open water. It is based on the law of conservation of wave action and the balance of wave energy, takes into account the process of wave refraction, as well as the generation of waves by wind, dissipation of wave energy and nonlinear resonance interaction.

As input parameters, the data of surface wind fields with a grid spacing of 0.25 × 0.25 ° and the stationary wind conditions were used. Also one of the input parameters is the bathymetric model of the Caspian Sea, which was built in the program ArcMap 10.1.

As a result of the calculations, the basic characteristics of the wave for various parts of the sea were obtained. Based on the analysis of the data obtained, the risk zones of the Kazakhstan sector of the Caspian Sea are identified.

The changing character of the hydrological regime of the Naryn River and related problems for water supply

(Poster Presentation)

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The Kyrgyz Republic in Central Asia is a water-rich, mountainous country. The country's elevations range from 400 to 7439 m a.s.l., including most parts of the Pamir-Alay and the western half of the Tien-Shan Mountains. Due to intense snow melt and glacier runoff, Kyrgyz Republic delivers a capital part of runoff formation for the rivers in Central Asia. For example, the Syr-Darya River is formed through the rivers Naryn and Kara-Darya which drain a majority of the Kyrgyz Republic. The mean annual runoff of the Syr-Darya is about 37 km³/year, of which 26.9 km³/year (=73 %) come from the Kyrgyz territory. Thus, downstream of Kyrgyz Republic, when the Syr-Darya flows through Uzbekistan, Tajikistan and Kazakhstan, it receives only minor inflows and shows high losses due to arid climate conditions and high human water use, mainly through intense irrigation. This underlines the importance of the Kyrgyz headwaters for water supply downstream. There are however a number of problems: Since natural climate variability is high in the region, the supply of water through snow and glacier melt varies greatly from year to year. Hence, the annual runoff of the Syr-Darya ranges between 21 and 54 km³/year, which leads to high uncertainties in reservoir management and water supply. Climate change is responsible for continuous and increasing negative glacier mass balances. This has led to an increase of discharge in the tributaries of the Syr-Darya, but will lead to drastic discharge reductions in the near future. Since population numbers in Central Asia are projected to continue to increase (from approx. 75 million today to approx. 100 million by 2050), the general situation of water supply in the region will probably aggravate. Furthermore, since Kyrgyz Republic operates a large number of reservoirs to generate hydropower (the Toktogul reservoir is the largest of them, with a storage capacity 19.5 km³), the reliability of electricity production and release of water for downstream use is on the decline. The changing character of the hydrological regime of the Syr-Darya and its tributaries, together with the related problems described above, require a combination of measures to deal with future water scarcity. In an exemplary study, our research is focusing on the Naryn River. The aims of the work are twofold: First, to deliver adequate information about the hydrological characteristics and the runoff regime of the Naryn under conditions of climate variability and change in order to better assess the current and future water availability. Second, to systematically develop a concept for the rational use of water, with special regard to an optimized operation of the Toktogul hydropower plant and other reservoirs located along the Naryn. The overarching aim of our study will be to deliver a case study on how to deal with water scarcity in Central Asian catchments by taking into account the specific hydro-climatic situation, by balancing the requirements from different water users with an implementation of water saving options, and by the consideration of environmental protection. Our presentation will further explain our research plan and present the first steps of the project.

Hydrological response of the upper Syr Darya basin to climate change and human activities during 1961-2016

(Poster Presentation)

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The upper Syr Darya basin (USD) is the second largest water supply source of the Aral Sea. The total runoff at the outlet of USD exhibited a steady decline during 1961-1985, then showed a significant increase afterward. However, the Area Sea has undergone a rapid desiccation since the 1960s. There are more than 5 large dams in the USD and middle and downstream of which have also experienced severe irrigations. There are more than 40% of total runoff coming from snowmelt and glacier runoff in the USD. Current studies have either only focused on the impacts of climate change or human activities on river runoff of the USD. Few efforts have been made to obtain the relative contributions of climate change and human activities on the detected hydrological alterations in this basin. The current study tends to make a quantitative analysis of the impacts of climate change and human activities on river runoff of the USD by using the extended VIC land surface hydrological model. The scarcity of reliable meteorological datasets after 1990 poses a challenge on long-term climate trends analysis and modeling studies. In this study, the performance of 6 precipitation datasets from gridded gauge data, remote sensing, and reanalysis estimates (APHRODITE, CHIPRS, PERSIANN, TRMM, GLDAS, GPM) were evaluated and compared with each other. A new dataset of precipitation and temperature was reconstructed based on the evaluations and was used to drive the VIC land surface hydrological model at each subbasin. The contribution of climate and human activities on runoff in the USD was quantified through combining the simulated natural runoff and observed runoff at basin outlets. Quantifying the impacts of climate changes and human activities on runoff can provide a better understanding on the hydrological process in the USD under warming climates, and would offer informative knowledge to policymakers in this region with high level of geo-political complexity.

Quantification of water abstraction in the transboundary Ile Basin (China/Kazakhstan) and changes in future runoff with a physically-based hydrological model

(Poster Presentation)

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Understanding runoff changes in the transboundary Ile River basin, Central Asia, is of key importance for preservation of the unique ecosystem of the Balkhash Lake and for sustaining economic activities in Chinese and Kazakh parts of the catchment. Since late 1980s, rapid population growth and expanding irrigated agriculture in the upstream Chinese part of the Ile basin led to increasing water consumption, which is, however, poorly quantified. This change occurred at the background of ongoing climatic changes affecting natural river runoff and presumably causing discharge increase due to increasing glacier melt. This study quantifies the natural river discharge in the Ile basin since 1960s till today by means of a calibrated hydrological model and contrast it with river flow altered by human activities. In the period from 1987 to 2014 the average water consumption at the territory of the P.R. China was estimated to 3 km3 per year on average or 20 % from average annual runoff. Furthermore, we quantified the runoff components at the outlet gauge of the Ile catchment (164 km) for the past period (1971-1986). Based on the precipitation data from meteorological stations runoff components are as follows: 44 % - of underground runoff, runoff from snow melting - 7 %, runoff from liquid precipitation - 32 %, runoff from glacier component – 17 %. Based on the precipitation data from global climate data APHRODITE: underground runoff – 35 %, snowmelt runoff – 24 %, runoff from precipitated water – 17 %, glacier melt runoff – 24 %. Based on the precipitation data from global climate data WATCH: underground runoff is 44 %, snowmelt runoff – 3 %, runoff from precipitated water – 44 %, glacier melt runoff – 9 %. Finally, we have analyzed the changes in total runoff and runoff components based on the CMIP5 climate change scenarios, taking into account dynamic changes of the cryosphere. Annual and seasonal changes in total runoff and the runoff components are discussed against the background of growing water demand for irrigated agriculture in the upstream parts of the Ile basin.

Index based methods for river flow regime change assessment at different time scales

(Poster Presentation)

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Rivers supply a range of goods and services, including hydropower generation, potable water, recreation, fisheries, transport and domestic, industrial and irrigation water. River waters support aquatic ecosystems and biological communities, species distribution and adaptive capacity. The river flow regime is vital for floodplains and wetlands and habitats are easily affected by changes in flow and turbidity. The natural river regime is the result of many interactions between geomorphology, geometry, hydrogeology and climate. The dimensions of aquatic ecosystem components and the numbers of inhabitants in these are related to magnitude of flow and flow rate characteristics such as timing, duration, and frequency. The rate of change in a natural flow regime plays an important role in aquatic ecosystem components. The flow regime could be altered in different time scale from annually to hourly. The main purpose for this presentation is to demonstrate our experiences regarding to assess flow regime in different time scale. In term of assess annual and intra-annual flow regime, we will demonstrate our methodology to assess flow regime based on combination change in magnitude, timing and variability of flow. To show the performance of this method we will present the results of intra-annlual flow alteration in Volga at Volgograd dam (Russian federation), Nile at Aswan dam (Egypt), Yellow River at Lijin (China), Volta at Akosombo dam (Ghana), Niger at Jebba (Nigeria), Tigris at Mosul dam (Iraq), Colorado at Glen Canyon dam (USA), Kor at Bande-Amir (Iran) and Kasegawa at Kase dam (Japan). To assess the daily flow regime alteration, the Indicators of Hydrological Alteration (IHA), quantify 33 parametres of flow regime and recognize as the most efficient method for this matter. The result of daily flow alteration by using IHA methods for Kemijoki and Torniojoki will be shown. The sub daily regulation is happened due to releasing water to meet energy marketing in with day and called hydropeaking and mostly seen below the Run-off the river hydropower. Here we present our method to scale the impact of hourly regulation in Kemijoki river.

Session 4: Using water and land resources: Challenges and sustainable solutions

(Chairs: Christopher Conrad & Maik Netzband, University of Wuerzburg)

The overarching target of this session is to address and discuss research regarding the use of water and land resources in the context of the sustainable development goals (SDGs) in Central Asia. The dynamics of land and vegetation cover as well as recent changes in the land use systems, e.g. land abandonment, shall be demonstrated. Contributions dealing with the exploration of alternative options for land and water use (diversification of crops, lake water potentials) are very much welcome. We also invite contributions with regard to:

- Mapping and explaining patterns of land degradation, e.g. soil erosion, salinization of soils and groundwater
- Measuring land productivity and its change over time (irrigated and rainfed cropland, pastures) and scientific options for decision support
- Monitoring of evapotranspiration and assessment of water demand at different scales
- Indicator systems in ecosystem analysis, ecosystem service assessments for spatial planning in the land and water sector
- Demographic development, settlement growth and changes in urban and peri-urban ecosystems
- Competing demands of water and land resources

Oral Presentations:

Author	Presentation Title	Author's Affiliation
Maik Netzband	Indicator-based assessment of the complex state of water use in the Aral Sea Basin	University of Würzburg, Green Spin, Germany
Tolmasbek Boltaev	Integrated remote sensing approach to detect soil salinity in the irrigated lands of Uzbekistan	Humboldt Universität zu Berlin (HU), Berlin, Germany
Atiqurrahman Jalil	Comparative analysis of wheat crop's yield response to optimal and conventional irrigation practices in lower Kabul river basin, Afghanistan	Wageningen University and Research Center (WUR), the Netherlands
Dildora Aralova	Remote sensing-based vegetation indices for monitoring vegetation change dynamics in the arid and semi-arid regions of Central Asia	Dresden Technology University, Dresden, Germany
Galina Stulina	Operational management of field water use using RS-measurements	Scientific-Information Center of the Interstate Coordination Water Commission of the Central Asia (SIC ICWC)

Indicator-based assessment of the complex state of water use in the Aral Sea Basin

(Oral Presentation)

Maik Netzband[1], Viktor Dukhovny[2], Shavkat Kenjabaev[2], Lucia Morper-Busch[1], Sherzod Muminov[2], Sarah Schönbrodt-Stitt[1], Gunther Schorcht[3], Georgy Solodky[2], Anatoly Sorokin[2], Denis Sorokin[2], Galina Stulina[2], Christopher Conrad[1,4]

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Water scarcity in the semi-arid to arid Aral Sea Basin (ASB) in Central Asia together with the effects of population growth and climate change is supposed to imply future conflicts in all water-use sectors and to foster food insecurity in the long-term. An efficient irrigation agriculture and innovative technologies supporting the informed decision-making are expected to distinctly contribute to sustainable regional development, thus to support adaption to climate change and mitigation of agricultural production.

The objective of this study is to present a system of practical numerical values, hence indicators, which is capable of ideally representing the complex state of the regional water use efficiency and cropland productivity in the ASB. Additionally, the system of effective indicators is intended to build-up the contextual core element for observing and monitoring a range of irrigation related questions in the ASB.

Open-source, optical satellite remote sensing (RS) MODIS imagery, climate data, and available statistical data form the basis for the set of indicators. The spatial focus lies on the irrigated cropland area of a size of approximately 8.4 million ha, shared by the countries of Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan, Kazakhstan, and Afghanistan.

The developed indicator system currently consists of 19 indicators, which are grouped into categories referring to land use (e.g., net irrigated area and crop specific acreage), to cropland productivity (e.g., crop specific yield), and to the water use efficiency (e.g., irrigation efficiency, actual evapotranspiration as well as water availability). Derived indicators are provided annually and multi-annually. Thus, they allow to spot at the performance of the irrigated cropland (e.g., identification of marginal lands with low production / crop yields, the localization of areas with lowest or highest land use intensity, and for assessments of the water use efficiency) over time. For multi-annual indicators, temporal aggregations (e.g., fallow land frequency) of observations from all years in the entire monitoring period (2000 until current year) is considered. Furthermore, indicator values are provided at different spatial aggregation levels in the ASB such as administrative boundaries (i.e., provinces,

and districts) – and where available - hydrographic planning zones (such as basin irrigation systems authorities, water user associations, and channel command areas).

With the designed system of indicators, scientific results largely based on RS data and methods are provided to a broad user-community in Central Asia for practical purposes. For instance, they are foreseen to contribute to current databases at the regional scale. Moreover, they can be implemented into national and transboundary modeling frameworks on the future perspective of land and water use resources for refining principles in the water management. Derived indicators can be accessed and enhanced with own statistical values by any interested party consulting the online and openly accessible interactive map tool WUEMoCA (Water Use Efficiency Monitor in Central Asia; http://wuemoca.net).

Integrated remote sensing approach to detect soil salinity in the irrigated lands of Uzbekistan (Oral Presentation)

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Soil salinity plays a negative impact on soil fertility by decreasing crop productivity even though nutrients are available. Irrigated lands of Uzbekistan with its arid climate are vulnerable to soil salinity. The salinity can be decreased by soil leaching in winter times. The more salinity level in soils, the more water is required for soil leaching. Therefore, monitoring of the status of the salinity level in the agricultural lands is important. However, an accurate traditional method of soil salinity assessment requires big financial and labor costs and is time-consuming. The fast analysis based on remote sensing is therefore recommended for monitoring saline lands during the vegetation period. In this research, we used MODIS11A1 and Landsat 8 multi-spectral images to analyze the relationship between land surface temperature and soil salinity level. In total 100 soil points has been preselected in Syrdarya region of Uzbekistan for five soil salinity levels (20 per salinity level). The electrical conductivity (EC) of the 100 soil points has been measured as the indicator of salinity level. Additionally, soil samples of preselected sites within the soil profile of 1 meter were analyzed in a laboratory for chloride content. Afterward, the field EC measurements have been scaled up based on the laboratory analysis (chloride content). In the end, the ECs scaled up at regional scape and remote sensing-based land surface temperatures were correlated. The results showed that there was a high relationship between land surface temperature and soil salinity in the vegetation period. Especially, during July to September, the difference between five soil salinity levels can be easily detected. Based on the correlation results a scaling factor specific to the Syrdarya region have been derived. In the future, other researchers can use this scaling factor to correlate their soil EC measurements for the Syrdarya region. The results of this research can serve in other irrigated lands with similar climatic conditions as well.

Comparative analysis of wheat crop's yield response to optimal and conventional irrigation practices in lower Kabul river basin, Afghanistan

(Oral Presentation)

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Afghanistan is located in the arid to semi-arid climatic zone, where efficient irrigated agriculture is the only hope to meet the locally growing food demand in the region. The growing water scarcity problems in the region have not only limited the availability of water for existing agriculture but have also restricted the expansion of irrigated land. Around 90 percent of irrigated land across the country is being managed conventionally, which is associated with unsustainable practices resulting in inefficiencies in the system. Therefore, the purpose of this study is to assess the irrigation performance through application efficiency, water use efficiency and water productivity for wheat under the conventional irrigation system and to diagnose the potential for improvement in the irrigation system in the region. The current study was carried out in the Attawor irrigation scheme located in the lower reaches of the Kabul River Basin (KRB). The scheme has a command area of 260 ha, around 23% of which remained uncultivated due to insufficient use of available water for irrigation. The fieldwork for this study is split into three distinct categories: (i) the conventional irrigation system was monitored from Nov-2016 to May-2017, by measuring field-inflow to the research plots. (ii) Interviews were held with 30 farmers for knowing the reality of plot-level observations to that of scheme level, and (iii) Aqua-Crop model was used to simulate the possible irrigation optimization options for the scheme level operation. For conventional irrigation, the average application efficiency was 46%, water productivity was 2 kg m-3, and the water use efficiency was in the range of 0.58-0.66 kgm-3GI. While looking at the farm application and water use efficiencies, there is great potential for expansion of irrigated area with the existing water, provided some farm level interventions through technological incentives to the farmers as well as infrastructure development is made. The available water in Attawor irrigation scheme has a potential to irrigate about 474 ha of land at field capacity level and unstressed crop conditions. The results show that there is no need to go for deficit irrigation schedules in the area, as the improvement in the application efficiency can lead to almost double the irrigated area. The findings of this study will be helpful for the on-farm policy development and raising crop-water productivity and eventually attain the "more crop per drop' slogan to meet the local food demand.

Remote sensing-based vegetation indices for monitoring vegetation change dynamics in the arid and semi-arid regions of Central Asia

(Oral Presentation)

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An understanding of the complex environmental systems at a regional-scale is still a challenging problem in the Central Asian zones (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan), that cover 399.4 million hectares (Mha), about two-thirds of drylands. This study focuses on one specific region for each country of Central Asia and, generally, it was estimated 529K km2 area within aim to better understand changing trends in ecosystem productivity, especially in arid and humid regions and analyze irreversible landscape changes due to human/environmental impacts with utilization satellite images. The annual and seasonal variations of NDVI derived from AVHRR-GIMMS 3g data for the period 1982-2015 and differences of spectral profiles enacted to indicate weaknesses and strengths of vegetation patterns for selected zones. Within application Mann-Kendall (MK) monotonic trends analysis are estimated statistically significant trends (p-value, and MK-tau) in each selected zone. This study introduces approaches to enable and combine regional and local regions with datasets for monitoring large-scale rangeland habitats and gives an estimated amount of the data to better interpret biodiversity loss levels.

Operational management of field water use using RS-measurements

(Oral Presentation)

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Using satellite images opens up new possibilities for field monitoring. Yield programming completed earlier (1) allowed estimating contributions of each factor to growing crops. Initial soil fertility and climate conditions determine the potential productivity of fields. However, as demonstrated, different crop yields are achieved under the same base conditions. This is explained by quality of performance of agronomic operations. The proposed approach of yield modeling selects controllable agronomic factors and allows estimating crop losses by the end of growing season. Many matters of crop management are possible to be solved as early as during growing, while using RS measurements of crops.

Available water supply for crops is a very important topic. As a result of work, a tool was developed to get timely information on each field during the growing season, based on satellite images MODIS with the resolution of 250x250 m and the database in WUEMOCA (2). The available water supply is derived from the ratio ETa/ETc (observed RS-based evapotranspiration/estimated evapotranspiration).

The proposed method was validated in the fields of WUA “Oktepa Zilol” in Kushtepa district, Fergana province in Uzbekistan. In situ observations included monitoring of agronomic operations, including actual field water delivery in order to find the ratio between estimated and actual values.

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2.Remote Sensing and GIS for Supporting the Agricultural Use of Land and Water Resources in the Aral Sea BasinConference: Water Resources of Central Asia and their Use - Materials to the International Scientific-Practical Conference devoted to the summing-up of the "Water for Life" decade declared by the United NationsAt: Almaty, Kazakhstan, September 22-24, 2016Volume: Volume 3, pages 111-121

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Meerzhan Akynbekkyzy	Analysis of spatial pattern of urban system in Central Asia using DMSP-OLS Nighttime Light Data	Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences (CAS), Gansu, China
Tooryalay Ayoubi	Current situation, water availably assessment and sustainable ecosystem design of Kol-e-Hashmat Khan Wetland in Kabul City/Afghanistan	Reasearch Organization for Development (ROD), Kabul, Afghanistan
Marat Karatayev	Impact of future energy policy on water resources in Kazakhstan	Energy Technologies Research Institute, University of Nottingham, Nottingham, NG7 2TU, United Kingdom
Fazliddin Hikmatov	Water resources of the Aral Sea basin, problems of their protection and rational use	National University of Uzbekistan, Tashkent, Uzbekistan
Imtiyaz Ahmad Malik	Water & 'Kazakhstan 2050 Strategy'- An Emerging Conundrum	Centre of Central Asian Studies, University of Kashmir, Srinagar, India
Maik Netzband	Sampling strategy and validation concept for improved land use classification in the Aral Sea Basin, Central Asia	University of Würzburg, Green Spin, Würzburg, Germany
Zabihullah Paiman	Evaluation of wastewater collection and disposal in Kabul City and its environmental impacts	Kabul Polytechnic University, Kabul, Afghanistan
Ruzmatova Zarina	Application of Laser leveling technology under mountainous condition	Institute of Water problems, Hydropower and Ecology Academy of Sciences, Dushanbe, Republic of Tajikistan
Obaid ullah Safi	Water pollution in Afghanistan	Kabul University, Kabul, Afghanistan

Natalya Ivkina	Assessment of possible changes of water balance characteristics of the Caspian Sea as anthropogenic factors and climate change result	RSE Kazhydromet, National Center of Space Researches and Technologies, Almaty, Kazakhstan
Ruben Remelgado	Sampling strategy and validation concept for improved land use classification in the Aral Sea Basin, Central Asia	University of Würzburg, Würzburg, German
Azimi Ahmad Samir	Evaluation of the germination ability of Afghan and Hungarian wheat varieties under different level of H2O and concentration of NaCl	Szent Istvan University, Godollo, Hungary
Laylo Saidmakhmudova	Hydrochemical regime and water quality of water reservoirs of Uzbekistan	Hydrometeorological Research Institute, Tashkent, Uzbekistan
Matluba Abdieva	Mineralization and heavy metals content in Zarafshan river (near Ravatkhodja dam)	Hydrometeorological Research Institute, Tashkent, Uzbekistan

Analysis of Spatial Pattern of Urban System in Central Asia Using DMSP-OLS Nighttime Light Data

(Poster Presentation)

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Population growth, which is gradually leading to the increased water and other resources demand, is happening along with the rising urbanization rate in Central Asia. The cities (including towns), population centers are the cores of the economy in Central Asia (CA). Therefore, it is necessary to monitor the urbanization of the area so that the new growing points of urban development and the valid coupling mechanism between human and nature will be explored to promote regional socio-economic sustainable development.

Using the DMSP-OLS stable nighttime lights (NTL) data for period 1992-2014, in this study is analysed the urbanized spatial patterns and characteristics, trends of the main city system in CA in the view of the whole regionalized economic zone and typical cities and settlements (towns).

The results showed that, in general, the NTL intensities in the city system of CA had obvious geographical differentiation characteristics with the maximum brightness of NTLs over the Fergana Valley and Southern Uzbekistan. There were noticeable increases in the NTL digital number (DN) values and NTL covering areas in 2003 and 2013 comparatively with 1992, which indicates a decent urbanization development during this period. There was an apparent consistency in a certain local area but a large heterogeneity among different areas.

This study would provide the scientific support for the related researches and decision making of urbanization and urban economic development in Central Asia to promote the socio-economic comprehensive.

Current situation, water availably assessment and sustainable ecosystem design of Kol-e-Hashmat Khan Wetland in Kabul City/Afghanistan
(Poster Presentation)

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Groundwater is the main source of potable water, and water supply services are inadequate compared to the number of households in Kabul city. By rapid urbanization, population growth, and climate change impacts; destroyed environmental ecosystems, groundwater level is lowered, as dried many wells in recent years since 1998.

The purpose of this paper is to evaluate the current situation of Kol-e-Hashmat Khan (KHK) wetland and the critical challenges that this wetland has faced. To perform comprehensive research, (1) an actual survey from the Kol-e-Hashmat Khan was carried out, (2) land-use changes around the Kol-e-Hashmat Khan was evaluated using satellite imagery between 2009 through 2016, (3) Similar case studies of wetlands have been studied, and actionable recommendations have been provided for implementation. Since urbanization is increasing and water resources (Surface water and groundwater) are decreasing based on demands and more exploitation of groundwater, Kabul city is demolishing the Eco-environments in around, therefore reviving the Kol-e-Hashmat khan ecosystem will have positive impact on environment and be a good source of water resources for groundwater recharging, decreases surface runoff, response to the impact of climate change, and improving air quality. The SWAT (Soil and Water Assessment Tool) Hydrologic model used to delineate the watershed, create stream network, and estimate the surface runoff and the water potential at pol-e-Mahmood khan in Kabul River. The Model developed from 1/1/2006 to 12/31/2013 for 8 years. The required spatial and temporal data collected and processed in GIS (Geographic Information System) which includes Digital Elevation Model (DEM), Soil data, Land cover data and daily weather data (Precipitation, Max and Min Temperature, Solar Radiation, Relative Humidity and wind speed). After Running the SWAT, the model calibrated and validated by using the observed discharge 2007- 2013 at two stations, namely Tangi Saidan and Tangi Gharu stations. The Maximum and minimum Elevations are 4,521m and 1,750m from main sea level respectively. The result showed that the average runoff estimated 91.1 Million Cubic Meter per Year in Tangi Saidan. The coefficient of determination (R2) was 0.56 at Tangi Saidan. The average runoff in Tangi Gharu was 519.58 Million Cubic meter per Year. The correlation between observed and simulated discharge was 0.51 in the Tangi Gharu outlet station. The average runoff at Pol-e-Mahmood Khan simulated is 170.4 Million Cubic Meters per Year. The minimum runoff was Zero from JUN to OCT but there is stable wastewater flow. The result shows a good potential of river flow at pol-e- Mahmood khan that can be diverted into KHK wetland for a sustainable ecosystem.

Impact of future energy policy on water resources in Kazakhstan

(Poster Presentation)

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As part of its strategic economic and social plan, Kazakhstan has a target of increasing the share of renewables and alternative energy sources in power generation to 50% by 2050. This greatly contrasts with the current situation, where around 90% of electricity is produced from fossil fuels. To achieve the target, the introduction of between 600-2000 MW of nuclear power is expected by 2030. This would impact water resources, already under stress due to significant losses, heavy reliance on irrigation for agriculture, unevenly distributed surface water, variations in transboundary inflows, amongst others. This study presents an integrated analysis of the water-energy systems in Kazakhstan, to investigate the water resource availability to support such energy system transition.

Water resources of the Aral Sea basin, problems of their protection and rational use

(Poster Presentation)

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In the present study various definitions of water resources proposed by different scientists and specialists are considered. It is noted that the category "water resources" refers not only to nature, as its essence and content changes in accordance with the socio-historical and economic stages of the development of society. The purpose and objectives of the report are specified. Definitions of local (local), regional and global water resources are given. National, interstate (transboundary) and universal human resources are singled out. Given the location of water resources on the earth's crust, they are divided into interconnected surface and subterranean components.

A quantitative assessment of the water resources of rivers, lakes, glaciers and snow cover of the Aral Sea basin has been carried out. It is noted that, despite the limited water resources of the Aral Sea basin, insufficient attention has been paid to their protection and conservation. The consequences of this are an increase in the level of groundwater, secondary salinization of lands, an increase in the volume of return water from irrigated fields, and, as a result, the formation of a number of large lakes from irrigation-collector systems.

The basic directions of protection and rational use of water resources of the region are indicated. In general, new scientific achievements, scientifically based recommendations and proposals in the field of protection and rational use of water resources in the Aral Sea basin are the guarantees of stability in the region and its sustainable development.

Water & 'Kazakhstan 2050 Strategy'- An Emerging Conundrum

(Poster Presentation)

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Kazakhstan is a progressing both economically and socially and is emerging as a leader in the Central Asian Region. However, to reach its aspirations under the Kazakhstan 2050 Strategy, it may be missing one vital resource – water. President Nursultan Nazarbayev while outlining the Kazakhstan 2050 Strategy identified water shortages as a key global challenge, with a special salience for landlocked Kazakhstan. By 2050, Kazakhstan hopes to have solved once and for all the problem of water supply. Globally, this is a familiar problem. Today, one billion people lack access to safe drinking water. By 2025, two-thirds of the world's population will face water stress, and the situation will deteriorate by 2050. Even worse, less than one percent of the world's water is usable. Therefore, studying Kazakhstan's water resources has important theory value and significance to maintain the man-water harmony and water resources sustainable development of the Central Asian area. The paper briefly introduces the physical geography and water resources condition, gives an assessment to surface and groundwater quantity, and also the total amount of water resources. Based on the overview of the economic society and development after its independence, the paper reviews the process of water resources engineering and irrigation system, especially gives an analysis of Kazakhstan's water resources development and utilization (including the total amount of water consumption, agricultural water and supply-need condition) and development circumstance after 1991 in detail, and gives an in depth understanding of the relation between 'Water' and 'Kazakhstan 2050 Strategy'.

Key Words: Strategy 2050, Water Resources, Sustainable Development, Regional Interdependence

Sampling strategy and validation concept for improved land use classification in the Aral Sea Basin, Central Asia

(Poster Presentation)

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Water scarcity in the semi-arid to arid Aral Sea Basin in Central Asia together with the effects of population growth and climate change is supposed to imply future conflicts in all water-use sectors and to foster food insecurity in the long-term, particularly against the background of persistent dependency from agricultural production.

Understanding the spatial and temporal distribution of crops is essential offering and understanding of local water requirements and helping build more efficient water management and distribution plans. Remote sensing data and methods can play an important role here and substantially improves planning in water and land management and support informed decision making from local-to-regional level.

One goal of the CAWa project was to elaborate an online platform, which makes these data products and derived geoinformation accessible to planners in local and regional authorities, to decision makers in ministries for agriculture and water, as well as to scientific experts. In its current and last phase, one of the projects main tasks is to validate the ground truth data from field sampling campaigns needed for machine learning algorithm-based calibration and validation.

Field campaigns have been conducted in irrigated cropland areas in Fergana and Korezm and Central (Uzbekistan), will be conducted in Southern Kazakhstan by the regional partners at the Scientific-Information of the Interstate Coordination Water Commission of Central Asia (SIC-ICWC, Uzbekistan), at the German-Kazakh University (GKU, Kazakhstan). This data is valuable and provides precise information that can be used to train a classifier and validate its results. However, this data often comes with certain inconsistencies. When digitizing the collected information on errors such as the misspelling of classes and the overlapping of samples can occur influence future processing steps and result in time-consuming re-runs. To aid in the identification of errors, a series of tools for checking samples and labels is developed and presented in this contribution.

The crop classification algorithm built in the scope of the CAWa project distinguishes crop types based on their unique phenological behaviour. To know how distinctive the growth cycle of a particular crop ground-truth data is quite informative. Since single pixels can be misleading due to e.g. uneven growth patterns within a field, it is useful to summarize the overlapping pixels into a single time-series. However, when dealing with field polygons, not all the collected pixels are useful. Along the borders of a sampled field we might note - as depicted in the image below - that some

pixels are only partially covered and might be shared with fields that contain different crops with distinct growth cycles.

Consequently, this study describes an approach to define pure samples based on idealized MODIS NDVI profiles. The derivation of training samples is conducted by comparison of class-specific pure samples with pixel-based NDVI profiles using also measures of dissimilarity between time series. Those developed functions for sampling and classification are developed in an automatic process chain can be applied to all years and test sites.

Evaluation of wastewater collection and disposal in Kabul City and its environmental impacts

(Poster Presentation)

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Nowadays many water resources are polluted by anthropogenic sources including household, agricultural wastes, and industrial processes. Public concerns over the environmental impact of wastewater pollution have increased [1], and become a critical issue in many cities in the world, especially in Kabul city. There is no centralized sewerage system in Kabul City. Sewer lines and wastewater treatment plants are operated only in some small scales and specific areas like the new township. Only the Macrorayon system has a sewerage system with partially treatment plants.

Most residents use pit latrines or septic tanks for black and grey water and discharge it to the streets side channels or city drains. Due to economic concerns of emptying septic tanks, their usages are difficult for most residents. According to the interview survey by the German Development Bank (KfW) water study, traditional toilets (pit latrines) are used by 86% of the city residents [2].

Sewage of pit latrines is vacuumed up periodically by private contractors and disposed at a solid waste landfill site or in agriculture land as fertilizer. The sludge of septic tanks are also vacuumed up periodically and disposed at the solid waste landfill site. Such conditions are not adequate, as an overflow of sewage on streets is often observed which is threatening the quality of groundwater, surface water and air which causes risks for public health. The private contractors vacuum the sewage and/or sludge up for fees. They bring such sewage and sludge to the solid waste landfill sites for disposal. Most contractors, however, sell the sludge to farmers and/or dispose it into city drains.

This study reviews the present condition of sewerage in Kabul city and its effect to the environment especially effects on groundwater of Kabul City which forms the only source of drinking water for the Kabul city with more than 5 million populations. Most parts of these sources are already contaminated, and the presence of E. coli has been proven in most water wells. The research focuses on potential environmental impacts of wastewater in the city by using the checklist method of EIA and suggested suitable alternatives.

Key words: Kabul city, wastewater, groundwater, EIA

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Application of Laser leveling technology under mountainous condition

(Poster Presentation)

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Field trials and assessment of methods of water conservation, that is, laser lands alignment in the new agricultural systems of Central Asia is an important task. The main research issue was laser ground leveling effective water in the new context of land use and ownership in small private plots. The land leveling has resulted in smoother soil surface, reduction in time and water required to irrigate the field, more uniform distribution of water in the field, more uniform moisture environment for crops, more uniform germination and growth of crops, reduction in seed weight, fertilizer, chemicals and fuel used in cultivation, and improved field rafficability (for subsequent operations). Limitations of laser leveling include the high cost of the equipment/laser instrument, the need for a skilled operator to set/adjust laser settings and operate the tractor, and restriction to regularly shaped fields. Farmers, as entrepreneurs, are unwilling to adopt new technologies unless they clearly see quick and tangible results in terms of farm profitability. Theoretically, a farmer would opt for new technology if assurance of earning a net profit were shown.
Research question: Is laser land leveling an effective water saving tool in the new context of land use and ownership on smaller private plots?

Outcomes:
Benefits of land leveling by laser leveling:

- water consumption is reduced by 20-25%;
- water use efficiency increases by 30-40%;
- prevented from entering the excess of salt in soil irrigated with water;
- saves time, labor and energy for irrigation;
- ensured uniform germination of crops throughout the area of the field;
- crops provide nutrients and moisture evenly;
- number of weeds is reduced by 10-15%;
- achieved by obtaining an additional yield of 5-7 centners from each 1 ha in agriculture;
- most importantly, if the right to cultivate the land, in the next 3-5 years field surface will be smooth.

It is shown that at the present time due to the irrigation of large areas up to the foothills of the Aral Sea basin and local climate change elements of basin water resources have also changed. Derivations proposed a method of estimating the dynamic and static water resources by separating the Central Asian region to the area of formation and dispersal area of river flow. Clarify the concept of dynamic and static water reserves and balance equations are proposed for the calculation of dynamic water formation zone separately for each individual pool of a mountain river. The efficiency of the balance sheet method assessment precipitation basins highlands.

Water pollution in Afghanistan

(Poster Presentation)

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Water pollution is the contamination of water bodies, usually as a result of human activities. Water pollution is one of many types of pollution which results from contaminants being introduced into the natural environment. Water is a basic necessity of life; it must be safe and clean. Afghanistan gets its water from ravers and undergrounds supply, which is reliant on rainfall and snow.

Less than 35% of Afghan citizens have access to clean, safe drinking water, which can cause stunted growth in children Iron deficiency, anemia, dehydration, fever and kidney disease. E coli is a bacteria which can be found in water of Afghanistan. According to a survey conducted by the United Nations children's fund, 102 of every 1000 children born in Afghanistan will die before they reach the age of five. The medical and solids wastes are mixed and then buried in the capital, some are also thrown on the ground. Experts warn that over time the waste will seep into the underground water table poisoning the water. Also, more than three decades war could have a negative effect on the water.

1.5-liter clean water usually cost (0.27USD); such a high amount of money is difficult for people to pay for clean water. In same time Afghanistan is suffering from a shortage of water. Population increases and predictable temperature rises due to climate change. Thousands of wells already have been sunk in Kabul city capital of Afghanistan. Due to lack of canalization and proper waste management, underground water in Afghanistan is a serious threat. To improve the present situation, Afghanistan is constructing water dams to save its water and to generate electricity. One of the newly Dam (Salama dam) was constructed by Indian Govt, it costs 300 million USD and have currently produced 42 megawatts of power plus provided irrigation for 75000 hectares of farmland.

To conclude, it is much better to take care of rivers, not to let people to through everything into rivers and start working on the water canalization, which can help us in savage of water and to conduct regular leek hunts in canalization. The severity of water quality problems is exacerbated by climate change both during scarcity and extreme events. Climate change will aggravate regional and global water scarcity by as much as 15 to 40 percent, which means that sewage dominated waterways and unplanned reuse will increase. Moreover, waterborne disease outbreaks tied to large precipitation events will continue to plague communities. This phenomenon has been found both in developing and developed regions of the world.

Assessment of possible changes of water balance characteristics of the Caspian Sea as anthropogenic factors and climate change result

(Poster Presentation)

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When carrying out a research the method of the scientific and statistical analysis based on identification of interrelation by fluctuations of background level of the Caspian Sea and its seasonal fluctuations with climatic factors between characteristics of water balance with meteorological and climatic factors has been used, statistical processing of hydrological characteristics, detection of heterogeneity of a row in the form of differential and integrated curves was carried out.

Also, methods of a statistical and dynamic daunskeyling (regionalization) have been used. The analysis of the output data of global and regional models was carried out. On the basis of the ensemble of global climatic models preliminary "rough" estimates of changes in the future of key parameters of the atmosphere - the ground temperature and rainfall were carried out. The spatial and temporary variability of fields of temperature and rainfall was studied.

Change of level of the Caspian Sea was calculated on the basis of the equation of water balance, on regional models evaporation, the temperature of a surface of the water, relative humidity, speed and the direction of wind paid off. On models the drain of the rivers flowing into the sea was also estimated. In particular, the method of hydrological modeling of sea level based the Community Land Model in which basis the concept of ecological climatology is put has been used.

The analysis of the received results shows that the level of the Caspian Sea has a steady tendency to decrease. Especially accurately it to be shown in the second third of 21 centuries. According to the scenario RCP4.5 the level of the Caspian Sea can fall to a mark minus 32 m. According to more pessimistic scenario, RCP8.5 level can fall below a mark minus 35 m. Thus by the end of century sea level can go down on 4 and 7 m according to scenarios of climate. Such lowering of the level will lead to considerable reduction of the area of the Caspian Sea and practically disappearance of his northern shallow part.

Sampling strategy and validation concept for improved land use classification in the Aral Sea Basin, Central Asia

(Poster Presentation)

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Water scarcity in the semi-arid to arid Aral Sea Basin (ASB) in Central Asia together with the effects of population growth and climate change is supposed to imply future conflicts in all water-use sectors and to raise food insecurity in the long-term, particularly against the background of persistent dependency from agricultural production. One goal of the CAWa project was to elaborate an online platform, which provides a set of indicators on land and water management in the ASB to planners in local and regional authorities, to decision makers in ministries for agriculture and water, as well as to scientific experts. This tool aims at merging remote sensing based with secondary hydrological information (water distribution). It was designed to offer an improved understanding of local water requirements and to support in efficient water management and distribution planning.

One underlying requirement is the presence of accurate maps that show the spatial and temporal distribution of crops in the irrigation systems. Therefore, field campaigns have been conducted in irrigated cropland areas in Fergana Valley, Khorezm, and central Uzbekistan. Others have been initiated in the Karsh Steppe (Uzbekistan) and Southern Kazakhstan by the regional partners at the Scientific-Information of the Interstate Coordination Water Commission of Central Asia (SIC-ICWC, Uzbekistan) and at the German-Kazakh University (GKU, Kazakhstan), respectively. This valuable data provides precise information that can be used to train a classifier and validate its results for improved irrigated cropland classification.

However, ground truth data often comes with certain inconsistencies. For instance, field sampling is limited to accessible areas, which in turn may be the reason for missing important crops. Also, when digitizing collected information, errors such as the misspelling of classes and the overlapping of samples can occur and subsequently influence future processing steps resulting in time-consuming re-runs. To avoid errors prior to data collection and to aid in the identification of errors, a standardized mapping procedure and a series of R-based tools for checking samples and labels was developed and is presented in this contribution.

In addition, the sampling scheme should be adjusted to data, which is used for classification afterwards. For instance, the crop classification algorithm built in the scope of the CAWa project distinguishes crop types based on their unique phenological behaviour. To know how distinctive the growth cycle of a particular crop, ground-truth data is quite informative. Since single pixels can be

misleading due to e.g. uneven growth patterns within a field, it is useful to summarize the overlapping pixels into a single time-series. However, when dealing with field polygons, not all the collected pixels are useful. Along the borders of a sampled field we might note that few pixels are only partially covered and might be shared with fields that contain different crops with distinct growth cycles.

Consequently, this contribution also describes an approach to define pure and mixed samples based on idealized MODIS NDVI profiles. The derivation of training samples is conducted by comparing class-specific pure samples with pixel-based NDVI profiles using also measures of dissimilarity between time-series. Those developed functions for sampling and classification are developed in an automatic process chain and can be applied to all years and test sites in the ASB.

Evaluation of the germination ability of Afghan and Hungarian wheat varieties under different level of H2O and concentration of NaCl

(Poster Presentation)

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Agriculture has a significant role in the economy of Afghanistan and Hungary; especially wheat is the most important cereal crop in both countries with a high economic value. However, the utility, market and alimentation value of this crop is highly affected by agro-environmental conditions, drought and salinity within that crop year.

The most important objectives in this study were to find the best and most plausible varieties regarding the performance of the germination traits of various wheat varieties under different levels of water and different concentration of NaCl. The aim of our research was to make a comparison between Afghan and Hungarian wheat (Triticum aestivum L) varieties concerning their viability under various conditions in relation with salinity and investigated how the salt stress and levels of water affect both Afghan and Hungarian wheat varieties germination. In the research reliable data have been obtained concerning the varieties examined giving a chance for making comparisons. However, further investigations are needed to clear necessary parameters to enable farmers to choose the most appropriate varieties for their crop site in favour of obtaining higher yields and better quality.

The research study was conducted under laboratory conditions by testing the germination of wheat varieties in both countries on different levels of water (0, 2, 4, 6, 8 ml) and different concentration of NaCl (0.5, 1, 1.5, 2, 2.5 %) using totally randomized design with three replications in the experiment in the Laboratory of Crop Production Institute, Szent Istvan University, Godollo, Hungary. In this study, three identical genotypes of Afghan wheat varieties (Chonte #1, Moqawim-09 and Darulaman-07) and Hungarian wheat varieties (MV-Apród, MV-Karizma, MV-Kolompos) are used, which have a good yielding ability and good resistance against diseases. A set of three randomly selected seeds of each variety were placed in Petri dishes having 13.5 cm diameter (25 seeds in each Petri dish) on one layer of Whatman filter paper and kept in the optimal temperature of laboratory condition. The germination was recorded after 8 days.

Consequently, it shows that all Afghan and Hungarian wheat varieties have good germination in 8ml level of water with 100% wheat seeds germination but based on salt concentration examination, the Afghan wheat varieties have good performance in salt tolerance compare to Hungarian wheat varieties.

The results obtained suggest, that for the purpose of salt tolerance the Afghan varieties should be used while based on the water level both the Afghan and Hungarian varieties should be used at 8ml level of water for successful germination.

Hydrochemical regime and water quality of water reservoirs of Uzbekistan

(Poster Presentation)

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The Republic of Uzbekistan is located in the arid zone, where water reservoirs are important for various sectors of economy. Development of the irrigation and intensification of agriculture, has led to increase surface water contamination and also to increase anthropogenic impact to water and coastal ecosystems [1]. Research and assessment of an ecological condition of water ecosystems of the reservoirs economy is especially actual issue due to importance of them for economy of country. Data on change of chemical composition of water under the influence of natural and anthropogenic factors are necessary for rational use of water resources of reservoirs.

In this report are given the results of studying of the modern hydrochemical regime and water quality of water reservoirs of Uzbekistan such as Tuyamuyun, Southern Surkhan, Chimkurgan, Charvak, Andijan and Tuyabuguz reservoirs. Water quality monitoring data of the Center of Hydrometeorological Service (Uzhydromet) for 1990-2016 (mineralization, organic substances (COD - chemical oxygen demand) and nitrates) have been used for the characteristic of the chemical composition of water [2]. Water pollution index (WPI) for these reservoirs were calculated. Calculation made by using data for following parameters: dissolved oxygen (DO), biochemical oxygen demand (BOD) and four substances having the highest observed value concerning their maximum allowable concentration (MAC).

Analysis of long-term data shows that monthly mean values of water mineralization of Uzbekistan reservoirs changes over a wide range (from 133.7 mg/dm3 to 1174.1 mg/dm3). For 1990-2016 mean values of mineralization exceeded (1000 mg/dm3) only in Chimkurgan and Tuyamuyun reservoirs where the mineralization changed in the range from 572.3 mg/dm3 to 1074,2 mg/dm3 (Chimkurgan) and from 488.4 to 1174.1 mg/dm3 (Tuyamuyun) in water samples. The highest mineralization was observed in reservoirs, as well as in the rivers, in water scarcity years (1994, 2000, 2006, 2013).

For the observed period (1990-2016) content of nitrates in water of reservoirs changed in the range from 0.18 mg/dm3 to 4.69 mg/dm3, and COD - from 1.5 mg O/dm3 to 42.05 mg O/dm3. In these reservoirs excess of MAC of nitrates (9,1 mg/dm3) wasn't revealed. Excess of MAC of COD (15 mg O/dm3) was revealed in some water samples in all six reservoirs.

During 1990-2016 water quality of reservoirs by WPI fluctuated from III class (moderately polluted water) to the II class (pure waters). WPI values changed in Tuyamuyun reservoir in the range 0.35-1.74, in Southern Surkhan reservoir - 0.51-1.30, in Chimkurgan reservoir - 0.52-1.79, in Charvak reservoir - 0.31-1.55, in Andijan reservoir - 0.59-1.41, in Tuyabuguz reservoir - 0.56-1.30.

Analysis of modern dynamics of the hydrochemical regime of the studied reservoirs of Uzbekistan has shown that the hydrochemical regime of waters of these reservoirs is formed under the influence of physical-geographical and anthropogenic factors. Natural factors are predominant information of the chemical composition of water of reservoirs in pre-mountain areas, and anthropogenic factors is predominant in formation of the chemical composition of water of reservoirs in plain areas. Decreasing of WPI has observed for all reservoirs for period 1990-2016. High impact on increasing of mineralization and pollutants concentration in Tuyamuyun and Southern Surkhan water reservoirs is influenced both by dumping highly mineralized drainage water into rivers and collectors and regulation of water flow due to irrigational regime.

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Zeravshan River water mineralization near Ravodkhodja dam

(Poster Presentation)

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Zeravshan River is one of the main rivers of Uzbekistan along with the Syrdarya and Amudarya rivers. The main tributaries of the Zeravshan River begin from glaciers and snow patchs in the territory of Tajikistan. Water quality of the Zeravshan River on an entrance to the territory of Uzbekistan has been controlled on Ravotkhodja observation point (formerly – Pervomay observation point).

Ravotkhodja water quality observation point is located in the middle part of the Zeravshan River in the territory of the Samarkand province of the Republic of Uzbekistan. Hydrological observations on Ravotkhodja point were made in 1939-1941, 1948-1950, and have been carried out since 1984 regularly. Hydrochemical observations on the Ravotkhodja point were began in 1984. The observation point is located 0.4 km below the Ravotkhodja dam. Water samples are taken monthly for hydrochemical monitoring.
Zeravshan River water mineralization on the Ravotkhodja point for 1990-2017 have been studied by using surface water quality monitoring data of Uzhydromet.

The mineralization of water is influenced by both natural and anthropogenic factors. The natural mineralization depends on geology of the region of origin of waters. Anthropogenic influence is caused by dumping of waste water from various sectors of economy.

During 1990-2017 average annual water mineralization in point of below the Ravotkhodja dam changed within 252.7-318.8 mg/dm^3. The analysis of water quality shows that the water mineralization on the Ravotkhodja point doesn't exceed limit values – maximum allowable concentration (MAC=1000 mg/dm^3). However, according to Alekin's classification, Zeravshan River water at the Ravotkhodja point fall into group of water with medium mineralization.

On water quality of the Zeravshan River, including a mineralization, affect hydrochemical regime of the river. High values of mineralization is observed during low water period of the year (October-April), low values of mineralization – during high water period (May-September).

Studying of water quality at Ravotkhodja observation point shows that the hydrocarbonate ions and calcium ions prevailed during a high water period, sulfates, chlorides and sodium ions prevailed in low water period. During 1990-2017 in the Zeravshan River water the average long-term content of hydrocarbonates (HCO_3^-) changed in the range 155.25-112.91 mg/dm3, calcium (Ca^{2+}) – 47.35-34.41 mg/dm^3, sulfates (SO_4^{2-}) – 93.08-42.4 mg/dm^3, chlorides (Cl^-) – 9.55-3.68 mg/dm^3, sodium (Na^+) – 14.19-6.89 mg/dm^3, magnesium (Mg^{2+}) – 21.61-10.4 mg/dm^3, potassium (K^+) – 0.98-1.42 mg/dm^3.

Investigation results show that there are no water pollution sources before the Ravotkhodja observation point in the territory of Uzbekistan. Observed contamination of water of the Zeravshan

River on this point is caused by influence of effluent disposal of settlements and industrial enterprises in the territory of Tajikistan. The quality of water on the Ravotkhodja point belongs to the second group – the moderate polluted waters. The analysis of quality of water shows that the water mineralization on the Ravotkhodja point doesn't exceed MAC. High values of mineralization is observed during low water period of the year (October-April), low values of mineralization – during high water period (May-September). Hydrocarbonate ions and calcium ions prevail during high water period, sulfates, chlorides and sodium ions prevail during the low water period.

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Session 5: Natural hazards and risk

(Chair: Michael Hagenlocher, United Nations University)

Central Asia is highly exposed and vulnerable to a range of natural hazards. These include earthquakes and their secondary effects (e.g. landslides and glacier lake outburst floods) as well as meteorologically triggered events, such as riverine and pluvial floods, mudflows or droughts. Both, exposure and vulnerability are expected to further increase as a result of environmental (incl. climatic) and societal change, leading to an increase in disaster risk. In order to address environmental hazards and associated risks in Central Asia, governments and the international community have undertaken an increasing number of initiatives. However, many of these efforts are constrained by a lack of data and a limited understanding of underlying processes.

This session invites researchers and practitioners to discuss the current state and scientific progress as well as persistent challenges in the field of risk assessment, disaster risk reduction, risk transfer and adaptation in Central Asia. Contributions regarding (1) the drivers and dynamics of disaster risk associated with different hazards (e.g. floods, landslides, slope failures, earthquakes and droughts) at different spatial and temporal scales, as well as (2) on innovative solutions for disaster risk reduction, risk transfer (e.g. through risk insurance) and adaptation are welcome.

Oral Presentations:

Author	Presentation Title	Author's Affiliation
Venera Junisbekova	SAR Interferometry and Object-Based Image analysis for landslide mapping in south-eastern Kazakhstan	Institute of Ionosphere, Almaty, Kazakhstan
Maira Razakova	Methodical aspects of using aerospace data for monitoring hazardous natural phenomena	National center of space researches and technologies (JCS), Almaty, Kazakhstan
Nurlan Bekmukhamedov	Identification of drought intensity-frequency curves of Syrdarya river basin in Central Asia	National center of space researches and technologies (JCS), Almaty, Kazakhstan
Nurgul Aitekeyeva	Remote sensing for risk assessment of crop productivity in Central Asia based on drought and crop phenology change	Institute of Remote Sensing and Digital Earth, Almaty, Kazakhstan
Sarvarbek Eltazarov	The potential and uptake of Remote Sensing for developing Agricultural Index Insurance in Central Asia	Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany

SAR Interferometry and Object-Based Image analysis for landslide mapping in south-eastern Kazakhstan

(**Oral Presentation**)

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The wide range of remote sensing data from different optical and synthetic aperture radar (SAR) sensors and the increasing temporal and spatial resolution offer new possibilities to derive valuable landslide information. This study investigated the use of the SAR Interferometry and Object-Based Image Analysis (OBIA) in the field of landslide mapping using Sentinel-1 and Sentinel-2 data.

The region near the small village of Saty in south-eastern Kazakhstan was selected as study area. There were several reasons for selecting this study area, which has so far received only a little attention for remote sensing based landslide studies. The most important reason is that in April 2018 a massive landslide occurred near the village, which is located approximately 120 km east of Almaty, the largest city in Kazakhstan. This landslide-prone area was also selected because of an interesting fact that the landslide occurred in the epicentral area of one of the strongest earthquakes in this region, the Chilik earthquake of 11 July 1989 with a magnitude of 8.3. It can be assumed that numerous, unrecognized landslides happened in this area in the past and that also future landsliding is likely. On the one hand, the conventional Differential Interferometric SAR (DInSAR) technique was applied to study the slow-moving landslide mass. Sentinel-1 images were deployed to identify landslide movement, whereby the analysis was also done for areas nearby the recent landslides to detect other slow-moving areas. On the other hand, OBIA was used to identify the landslide area based on pre- and post-event Sentinel-2 images, in particular considering the spectral change between segmentation-derived image objects. Finally, the results from both analyses were compared and jointly interpreted to exploit the potentials of SAR and optical remote sensing data. This study illustrates that SAR interferometry and OBIA techniques can provide valuable quantitative measurements of landslides. The combined interpretation of optical and SAR data offers remarkable possibilities for improved landslide mapping compared to conventional, cost- and time-intensive techniques.

Methodical aspects of using aerospace data for monitoring hazardous natural phenomena

(Oral Presentation)

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One of the dangerous natural disasters in the foothills of Kazakhstan is the landslides. Detection of landslides from aerial and satellite images with the developed spatial analysis system is helpful for hazard investigation and mitigation. The object of the study was the events of 2018 when a mudflow occurred in the Aksai couloir (Kazakhstan, Almaty). In this research, in addition to the use of time series of satellite imagery, the analysis of aerial survey and satellite radar data is carried out. A new approach has been developed to combine the spectral and geomorphological parameters of the terrain using remote sensing data. Areas of accumulation of mud deposits are identified, irregularities in the structure of mudflow are classified, a microrelief of the surface of the mudflow channel is constructed.

Keywords: landslides, aerial and satellite images, UAV, change detection

Identification of drought intensity-frequency curves of Syrdarya river basin in Central Asia

(Oral Presentation)

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Drought risk assessment by characterizing the Intensity-Frequency of Drought (DIF) is one of the important and popularized approaches for drought disaster assessment and management. Drought indices are extensively used for climate extreme analysis e.g. increasing temperature and irregularity in precipitation regimes on a regional scale. This study provides a comprehensive analysis of drought intensity, frequency and severity in Syrdarya River Basin of Central Asia by using meteorological and environmental variables derived from remotely sensed information. DIF curves were identified based on precipitation deficit and evapotranspiration rates by using Reconnaissance Drought Index (RDI). Climatic variables for the study period of 1985-2015 were derived from Climate Research Unit, University of East Anglia (CRU) TS3.1 database. The occurrence of historical droughts, frequency and duration, was defined as a number of drought events appearing from April to September of each year, and drought severity was calculated as the sum of the integral period from severe to extreme range defined with RDI varied between -1.5 and -3, respectively. Several drought events, recognized as moderate, severe and extreme in past 30 years period, were revealed over the study basin in the present study. A significant increasing trend at high elevations in contrast to obvious decreasing trends at low elevations of river basin for DIF curves was found in the dynamic variations of drought events over the Syrdarya River Basin, which implied the different patterns of climatic impacts on drought occurrence in the mountainous region. Overall, DIF curves derived for Syrdarya River Basin can provide valuable information for future agricultural planning, water resource management and drought risk mapping and prediction over the region.

Remote sensing for risk assessment of crop productivity in Central Asia based on drought and crop phenology change

(Oral Presentation)

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Crops are the main commodity supplying food security based on locally available natural resources and management. Central Asia is known as an arid region with a shortage of water where drought is an unavoidable phenomenon occurring periodically and challenging the regional food security. Crop yield and climate relationship investigation for purposes of identifying risks is an important aspect in agriculture studies and remote sensing has become an important tool for monitoring of crop growth utilizing the spatial, spectral and temporal resolution of the sensors. The aim of the research is a spatiotemporal risk assessment of crop productivity by calculating drought risk and crop phenology change through space and time (2000-2015) using Enhanced Vegetation Index (MOD13Q1) and Land Surface Temperature (MOD11C2) information from MODIS (Moderate Imaging Spectroradiometer) sensor for the Central Asian region. Vegetation Health Index has been calculated to estimate spatiotemporal drought variation. Important stages extracted from Enhanced Vegetation Index as onset, offset, maturity time and length of the season. Rainfed crops revealed as more vulnerable to environmental challenges due to the northern region experienced more drought occurrence and shifts in main phenophase stages.

The potential and uptake of Remote Sensing for developing Agricultural Index Insurance in Central Asia

(Oral Presentation)

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During the last decade Remote Sensing techniques have been implemented in various studies in agriculture, environment, land and water management as well as other earth-related fields of science. A series of findings has proven efficiency and reliability of remotely sensed data in developing agricultural index-based insurance in developing countries. As weather index-based insurance can support to secure the income of farmers who are particularly vulnerable to climate variability, it can also improve and stabilize the livelihood of rural population and reduce food insecurity. Nevertheless, it faces operational and technical challenges to reach long-term sustainability and trust of farmers. Especially data availability, accessibility, quantity and quality are the main challenges in the developing world. This publication is designed to evaluate the feasibility of remote sensing for development of weather index-based insurance in Central Asian countries. Particularly, the focus is on rainfall estimation from satellite products as these are freely available on a daily basis, provide long time series data and wide spatial coverage. In this study we selected three rainfed agricultural lands in Jizzakh Province (Uzbekistan), North Kazakhstan (Kazakhstan) and Chuy province (Kyrgyzstan) to conduct a statistical comparison between satellite-based rainfall products and metrological survey stations. Initial results show a high correlation and an index of agreement between the data obtained from state metrological stations and satellite-based rainfall products (*CHIRPS, **GSMaP) on a ten-days as well as monthly sum basis during the vegetation period of winter-wheat. As a consequence, it gives a chance to develop a weather index insurance using satellite-based rainfall products for the selected study areas. Moreover, this method is less time-consuming than conventional approaches, allows for compact data storage, and has a possibility for long term monitoring. These advantages assist for an efficiently functioning insurance process in the regions. This study is being implemented within the framework of the project “KlimALEZ – Increasing climate resilience via agricultural insurance – Innovation transfer for sustainable rural development in Central Asia” at the Leibniz Institute of Agricultural Development in Transition Economies (IAMO). The project’s overarching goal is to strengthen the resilience of Central Asia’s agricultural sector by innovative insurance markets against climatic risks, in particular drought.

*CHIRPS - Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a 30+ year quasi-global rainfall dataset. CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring. **GSMaP - Global Satellite Mapping of Precipitation (GSMaP) provides a global hourly rain rate with a 0.1 x 0.1 degree resolution. GSMaP is a product of the Global Precipitation Measurement (GPM) mission, which provides global precipitation observations at three hour intervals. Values are estimated using multi-band passive microwave and infrared radiometers from the GPM Core Observatory satellite and with the assistance of a constellation of other satellites.

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Oleg Arkhipkin	Monitoring of flood dynamic on the basis of joint analysis of radar and optical remote sensing data	National Center of Space Research and Technology, Almaty, Kazakhstan
Serikzhan Atanov	Natural Disaster Scoring System. Prediction of flood damage using Machine Learning technology	German Kazakh University, Almaty, Kazakhstan
Abdulhalim Zaryab	Triggering factor evaluation of Argo Landslide using Limit Equilibrium Slope Stability Analysis	Kabul Polytechnic University, Kabul, Afghanistan

Monitoring of flood dynamic on the basis of joint analysis of radar and optical remote sensing data

(**Poster Presentation**)

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Our organization has been engaged in the development and implementation of flood space monitoring technologies in the practical activities of Kazakhstan emergency authorities at various levels since 2001. Our system of space monitoring of high water and flood has a three-level structure, respectively Remote sensing data of low, medium, high and ultra-high resolution. Functionally, the system of space monitoring of high water and flood can be divided into several blocks. The most important of these is the block of operative space monitoring. Data transfer block is used to create on the results of monitoring output data and transmit them to users. If necessary the survey and analytical blocks and also the modelling block can be used additionally. The main task of the survey block is to summarize the results of monitoring in a particular territory for a certain period of time (week, decade, month, season, etc.).

The system of space monitoring of high water and flood is a constantly developing system. Development is carried out by introducing new tasks, methods, technologies, new Remote sensing satellite systems and etc into the system. In recent years, much attention has been paid to the development of methods of the joint use of optical and radar data in flood space monitoring. A joint analysis of optical and radar data of different resolutions, on the one hand, makes it possible to better identify the flood zones and determine their structure, and on the other, it is better to track the dynamics of the passage of flood waters and floods. The need for such a complex analysis is due to several reasons, including different spatial resolution, the different time period of re-survey, noise during the survey (cloudiness, haze, noise interference, etc.). Radar data play an important role in flood monitoring. This is due to the features of the radar survey: independence from weather conditions and time of day, regularity, good spatial resolution, the possibility of using polarimetric properties (including phase information). The use of radar data also provides additional information, including the allocation of wet soils, flooded vegetation and infrastructure.

The joint use of radar and optical data also makes it possible to determine the initial period of snow melt and to qualitatively assess the potential threat of floods. For these purposes, such properties of the radar survey as transparency of dry snow and change of reflected signal during snowmelt are used. To detection wet snow by radar data, a special technique has been developed that takes into account the specific features of the radar survey of the snow cover. Such an estimate is not carried out directly by the radar image. It is carried out by comparison the current value of the backscattering coefficient with the base image, which is the average value of the backscatter factor in each pixel for all pictures with a dry snow cover.

Comparison of the current value of the backscattering coefficient in the snow melting period with

the base one can be carried out in several ways. In one of them, the difference (D) of the current and the base value is calculated in each pixel. In another way ratio (R) of this two values is analyzed. Methods are also being developed for the use of several polarizations at once to obtain snow cover characteristics. Another important component of the technology is optical space images of different resolution, which allows to track the actual situation with the descent of the snow cover and the passage of flood waters. First of all, they are used to determine the boundaries of the snow cover, since outside its boundaries the parameters D or R behave differently than within the boundaries. GDAS (The Global Data Assimilation System) data are also used to estimate snow cover boundaries. To assess the potential threat of floods the spatial distribution of the R or D value is compared with the spatial data of the GDAS on the water equivalent of the snow cover.

Natural Disaster Scoring System. Prediction of flood damage using Machine Learning technology

(Poster Presentation)

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The aim of the study is to develop a platform for classifying threats based on historical flood data that includes damage and damage parameters using machine learning techniques. The problem is to understand the risk of disasters in measuring a potential threat, to systematize risk assessment before the onset of disasters, mitigate the consequences and improve the effectiveness of response measures.

As methods in the study, a comparative analysis of Self-Organizing Maps and the K-means method are used to cluster large amounts of data and create a platform. The study also uses statistical methods for processing flood damage data and calculating the statistical parameters to disaster risk understanding. The study includes a review of legal mechanisms, statistical analysis of flood damage in Central Asia, as well as international experience in flood management, as a description, justification and modern solutions of the flood management.

The result of the work is an online platform was created for scoring flood damage in Vietnam using Machine Learning technique on a five-point scale, based on damage data from 1989 to 2015.

Triggering factor evaluation of Argo Landslide using Limit Equilibrium Slope Stability Analysis

(Poster Presentation)

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The main purpose of this study is to evaluate the triggering factor of Argo landslide, which happened on May 2, 2014, in Abe Barek village, Argo district, Badakhshan province, Afghanistan; it buried a village and led to the death of many hundreds of people. According to geological studies in the landslide area and soil testing, the loess deposits which are marked as silty loess are classified as silt and silty clay (ML and CL-ML) in unified soil classification system. The tests were conducted on dry and saturated samples. For the slope stability analysis of the landslide the Limit Equilibrium Method and the Slide Software were used. There are many factors that can trigger a landslide and in the Argo case, there was an intense rainfall event the day before the incident. In accordance with geometrical information of the landslide area, soil's dry and saturated characteristics, the slope condition before and after soil saturation, the simulation was conducted and the minimum safety factor for both conditions was calculated. The results show that the saturation of the slope body can reduce the safety factor from a stable condition (>1) to an unstable condition (<1). It is concluded that the dry stable slope became unstable as a result of the additional weight of the slope body and reduction in shear strength parameters of soil after soil saturation.

Session 6: Agricultural transition and natural resource management

(Chairs: Nodir Djanibekov, Leibniz Institute of Agricultural Development in Transition Economies & Stefanos Xenarios, Nazarbayev University)

The recent emphasis on agricultural development in Central Asia has underlined the importance of commercialization and innovation adoption. Increasing frequencies of droughts, thus of water scarcity, are posing particular challenges for the sectoral development and require proper adaptation measures at local, national and transboundary scales. At the same time, sustainability concerns call for friendlier interactions between productivity enhancements and natural resource management. The cross-country diversity of agriculture and resource pathways offers the fertile ground for comparative theoretical and empirical studies to better inform academia and policymakers.

We invite contributions covering a wide range of topics, including agricultural economics, rural development, international development, natural resource management, agricultural sciences and related disciplines to share and discuss their findings to better understand the complex issues, challenges and opportunities for the Central Asian agricultural development. Interdisciplinary and cross-country comparative contributions are particularly welcome.

Oral Presentations:

Author	Presentation Title	Author's Affiliation
Kakhramon Djumaboev	Assessing water use, energy use, and carbon emissions in lift irrigated areas: a case study from Karshi Steppe in Uzbekistan	International Water Management Institute (IWMI)-Central Asia Office, Tashkent, Uzbekistan
Marie-Charlotte Buisson	The effect of irrigation service delivery and training in agronomy on crop choice in Tajikistan	International Water Management Institute, CGIAR, New-Delhi, India
Abdusame Tadjiev	Attitudes towards cooperation among farmers in water use in Samarkand province	Samarkand Veterinary Medicine Institute, Samarkand, Uzbekistan
Andrea Zinzani	Water policies, international development and hydro social relations in Central Asia	University of Bologna & Global Development Institute, Bologna, Italy; University of Manchester, Manchester, UK
Gulnara Nurieva	Virtual water trade flows in the agricultural sector of the Central Asian region: case of the Kyrgyz Republic	American University of Central Asia, Bishkek, Kyrgyzstan

Assessing water use, energy use, and carbon emissions in lift irrigated areas: a case study from Karshi Steppe in Uzbekistan

(**Oral Presentation**)

Kakhramon Djumaboev[1], Tulkun Yuldashev[1], Bunyod Holmatov[2], Zafar Gafurov[1]

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Advantages of a nexus approach in addressing complex environmental challenges are increasingly becoming clear. In Central Asia, however, the nexus between water-food-energy has not received adequate attention, as the very few studies that were conducted fell short of quantifying nexus tradeoffs and benefits at a practical, small scale. This paper applies a quantitative accounting method to assess water and energy use intensity in irrigated areas of Karshi Steppe of Central Asia that are supplied by pumping water uphill (lift-irrigated) from the underlying river. The results indicated that the potential water and energy savings, as well as the greenhouse gas (GHG) emission reductions, could be achieved by applying optimal planning deficit irrigation schedule simulated using Cropwat-8. Some 575 million cubic meters of water and 259 GWh of electricity can be saved while the CO2 equivalent emissions can be reduced by almost 122 ktons. Achieving these savings requires a mix of technical and policy components. This study describes an example of proper irrigation planning as a tool for water/energy savings and consequent reduction of CO2 emissions.

Key words: Water use; pump irrigation; energy use; irrigation scheduling; carbon emissions; Kashkadarya; Uzbekistan

The effect of irrigation service delivery and training in agronomy on crop choice in Tajikistan

(Oral Presentation)

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The aim of this study is to analyze the effect of irrigation delivery services and agricultural extension services on crop choice in southern Tajikistan. This analysis is motivated by the government's recent efforts to address the country's severe malnutrition problem by supporting changes in irrigation service delivery and agronomy to increase diversity in agricultural production and consumption, in an environment where the cultivation of cotton had, until recently, been mandatory. Water management in Tajikistan has largely been transferred to the community through the creation of water users' associations (WUAs) between 2011 and 2013. While all WUAs received training to improve irrigation delivery services, some also received training in cropping alternatives and improving cultivation practices through agricultural extension services. Through specific empirical analysis conducted on a primary panel dataset of 1,855 farms in southern Tajikistan, we identify the extent to which improvements in irrigation services and agronomy training through extension services affect decisions pertaining to cultivated areas of cotton and wheat (the traditional crops) and the cultivated area and number of (newer) high-value crops. We also examine the effect of water delivery and agricultural extension services on crop diversity and cropping intensity (how often land is used in a calendar year). We find that improvements in irrigation delivery services affect cultivated areas of cotton and wheat. Cultivation of high value crops is significantly influenced by agricultural extension services. While cropping intensity depends on water delivery services, crop diversity depends on extension services. From a policy perspective, these results highlight the importance of agricultural programs for stimulating agricultural value added in landscapes historically characterized by limited crop choice and a collapse of the agricultural sector.

Attitudes towards cooperation among farmers in water use in Samarkand province

(Oral Presentation)

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Farm cooperation in water use can be one of the main useful actions to overcome new challenges brought by climate change driven water supply variability and scarcity. Followed by the farm restructuring, the government of Uzbekistan took efforts to decentralize the agricultural water supply and improve the role of water user associations (WUA) in water management. Yet, the outcome of this reform has been disappointing. As many scholars and observers reported, the water management in Uzbekistan failed to organize around WUA and farmers' cooperation in water use.

The attributes desired towards the new water management system were (1) farmer involvement; (2) farmer participation; (3) separation of functions; (4) water charges could be practicable solutions on water management problems.

However, there are some challenges in water management among individuals which can explain failing cooperation: (1) top down water management - decisions on water allocation plans not discussed with water users, water turns are not followed, and water is unequally distributed; (2) lack of information flow on current water situation to water users; (3) farmers' psychological resistance to cooperation, and lack of knowledge on organization of cooperation with peers; (4) the governmental coordination of agricultural production and water use. Water is primarily targeted for irrigation of cotton fields; (5) absence of land ownership and the unpredictable process of farm restructuring; (6) farmers do not have any economic interest to save water. There is no price for irrigation water in Uzbekistan, only water service fees to WUAs. In addition, frequencies of water scarcity, proximity to markets, group size, and farm size and governance structure also affect the collective action of water users.

Therefore, the main goal of this study is to determine and to evaluate the factors that impact on farm cooperation in water use and to identify options for promoting such cooperation. The main research question is "Which factors may improve farmers' attitudes towards cooperation in water use in Samarkand province?"

Our study is based on farm survey data collected within the AGRICHANGE project. In total 450 individual farms were surveyed from 3 districts of the Samarkand province, Uzbekistan. 406 of them have irrigated the land area. We use probit model to estimate cooperation in water use. Our results showed that (1) informal agreements on water use with farmers are associated with formal education; informal agreements with neighbour farms; interests own well-being of people; working together; discussion and decide together of village members; farms profitability in 3 years from now; difficulty to obtain satisfactory irrigation in 3 years from now. (2) WUA/Rayvodxoz

agreement based on own rights for water use is associated with cotton producer farms; the limits of water deciding by WUAs; working together; encouraging of government to cooperation between farmers. (3) Even scarce years using water to be enough for others is associated with farms age; formal education; interests own well-being of people; encouraging of government to cooperation between farmers; discussion and decide together of village members; level of agricultural 3 years from now.

This study provides empirical evidence on farm cooperation in water use. Our selected variables showed that there are eight variables that not statistically significant to any one of three dependent variables. Our study showed that Paiarik district significantly effects on informal agreements in water use. By our results, we may conclude that farms with less education may more interest in cooperation. Thinking only own well-being will lead to weak cooperation. Holding a discussion and deciding together of the village members is important to improve cooperation on water use.

Water policies, international development and hydro social relations in Central Asia (Oral Presentation)

Andrea Zinzani

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The present research aims to provide an overview of the contemporary context of water politics, the role of international development actors and hydro socio-political relations in Central Asia at diverse scales. The research adopts the perspective of the Political Ecology of Water and Development, aimed at the understanding of the social and power dimensions of water management and the impact of international development policies at regional, local and community levels.

Water resources have always played a key role in Central Asia due to its semi-arid territories and the importance of irrigated agriculture. Since the collapse of the Soviet Union, five independent Central Asian states (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan) have undertaken heterogeneous national water reform processes and signed interstate treaties for the management of transboundary rivers. However, by the end of the 1990s several international development organisations, such as the World Bank, the Asian Development Bank, USAID among others, have started to promote in the region the implementation of global water policies inspired by the Integrated Water Resource Management (IWRM) and the UNECE Water Convention. Since the 2000s diverse development projects have been designed in collaboration with national authorities.

Therefore, the research, through the adoption of a multi-scalar ethnographic approach, on the first hand focuses on the implementation of IWRM initiatives in Uzbekistan by specifically analysing the Middle Zeravshan Valley at the local community level. While on the second hand analyses the design of the Chu-Talas Commission, shared by Kazakhstan and Kyrgyzstan, attempted at strengthening interstate water cooperation, and the impact of its formalisation at the community level in borderlands of the Talas river basin. Qualitative ethnographic research was conducted from 2011 to 2015 in Uzbekistan, Kazakhstan and Kyrgyzstan through semi-structured interviews to province and district water authorities, national and international experts, water users and farmers. In parallel, field surveys and waterscapes observations were carried out in the Zeravshan and Talas valleys.

Despite the efforts and the success story underpinned by international development organisations with regard to Central Asian water politics, over the last decade their projects mainly contributed to the strengthening of state hydraulic bureaucracies, their power and rule. The empowerment and the participation of community level water users remain quite limited, and their concerns rarely considered by national authorities and international organisations. Moreover, international projects have led still weak socio-ecologic benefits in terms of water access, sharing and allocation, increasingly threatened by climate and environmental changes. Therefore, in order to strengthen efforts to mitigate climate and environmental changes, it would be strategically important to increase the role of water and agricultural communities, their knowledge and practices.

Virtual water trade flows in the agricultural sector of the Central Asian region: case of the Kyrgyz Republic

(Oral Presentation)

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Central Asia, one of the regions, where water resources are unevenly distributed in space and time, faces a complex set of water-related challenges, including water scarcity, desertification, and reduction in water availability. Development of the Central Asian countries under such conditions is resulting in political tensions and worsening environmental and socio-economic conditions. Agriculture and its significant international trade flows, play one of the leading roles in the regional economies. The sector makes use of more than ninety per cent of all water withdrawn in the region. Yet, countries do not actually trade in virtual water. Nevertheless, a virtual water trade analysis contributes to revealing aspects related to production and trade of agricultural goods, and informing decision-makers in water management and trade policies. This study investigates virtual water flows in the agricultural sector of the Central Asian countries, with emphasis on the Kyrgyz Republic, from 2007 to 2017. Results of the study point to key issues that needed to be addressed by those who are involved in the water food-energy nexus.

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Gulnara Anapiiaeva	Biogas production development in rural areas of Kyrgyzstan	Institute of Waste Management and Circular Economy, Faculty of Environmental Sciences, Department of Hydrosciences, Pirna, Germany
Shovkat Khodjaev	Implementation of Smartstick technology in rural asreas of Uzbekistan	International Water Management Institute (IWMI)-Central Asia Office, Tashkent, Uzbekistan
Makhliyo Murzaeva	Providing of agricultural sustainability under the climate change in Uzbekistan	Tashkent Institute of Irrigation and Agricultural Mechanisation Engineers, Tashkent, Uzbekistan
Sholpan Smagulova	Features of agricultural management in Kazakhstan	University of Narxoz, Almaty, Republic of Kazakhstan
Abdikaiym Zhiyenbek	Using mathematical optimization in sustainable agricultural and water resources management	ETH Zurich, Institute of Environmental Engineering, Zurich, Switzerland
Zikirov Sovetbek	State owned seed producer cooperatives: Working toward available, affordable and appropriate local seed	Dortmund Technische Universitat, Dortmund, Germany
Nicole Pfefferle	Biodiversity and ecosystem services in agrarian landscapes	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Germany

Biogas production development in rural areas of Kyrgyzstan

(**Poster Presentation**)

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Introduction: Kyrgyzstan produces about 90% percent of its electricity from hydropower, and there have been only a few actions taken towards the diversification of renewable energy sources in spite of the risk in the context of climate change and rarefaction of glaciers on the Tian Shan and Pamir mountain chains. Nowadays, diversification of energy sources is a key for the future development of the rural Kyrgyzstan, where agriculture, cattle-breeding and poultry farming are developing. A real opportunity to address energy problems of the rural population, including a significant reduction in the load on the country's environment by preventing methane emissions to the atmosphere, is the application of biogas production technologies in Kyrgyzstan. This research project nails down in detail political, economic, social and environmental aspects of biogas production integration perspectives in Kyrgyzstan. Moreover, this research considers natural fertilizer as one of the important co-benefits of biogas production in agriculture of rural areas of Kyrgyzstan.

Results/Conclusions: Biogas production using livestock and poultry manure directly influences the climate mitigation and the energy consumption by easing the load on hydroelectricity generation, various fossil fuels and fostering rural development. One of the significant contributions of application of biogas production in rural areas of Kyrgyzstan is followed by detailed research on the integration of biogas production in rural areas of Kyrgyzstan in order to alleviate dependency on hydropower generation and fossil fuels, since it represents a sustainable and decentralized way to produce energy for rural households.

Key words: natural resource management, biogas, energy policy, agriculture, rural Kyrgyzstan

Implementation of Smartstick technology in rural asreas of Uzbekistan

(Poster Presentation)

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Vulnerability: Today, there is a tendency of decreasing of the total quantity of hydro stations for water measure in Central Asia. The main reason is lack of financial resources for proper maintenance of hydro posts and mechanical deterioration of equipment. At the same time construction of new hydropost stations is not efficient due to high construction cost. Under the condition, water measurement becomes a more sensitive issue not just in Uzbekistan, but in whole Central Asia.

Water accounting process needs modernization of central canals at on inter-farm levels in Uzbekistan. Current water accounting data exchange services between different institutions are based on out-of-date technology and infrastructure. For example, there is still no data on water flow on inter - farms canals in Lutfulla Bakhramov WCA Andijan province. Only limited numbers of WCAs in Uzbekistan has a water monitoring system using old technology. The situation became a point of misunderstanding between WCAs and ISA. The same situation in WCA itself, where farmers would like to know the exact amount of water they receive from mirabs, who are responsible for water distribution. Mirabs in their turn, have not reliable data on water supply amount due to lack of measurement equipment and tools. As the consequence inaccuracy in water payment process, and is difficult to switch from area to volumetric service fee payment approach.

The objective of the research: implementation of Smartstick technology
Definition: Smartstick BAT and NFC collect and deliver data measured by local Mirabs (Gauge Readers) to centralized system software installed on a PC in the office of Water Consumers Associations.

Smartstick BAT - is portable equipment for water level measuring, applicable in small canals/trays. After immersion, Smartstick BAT determines water level and displays it in real time. The equipment is fully automatic, requires low maintenance and has a long-life battery. By simply measuring of water level and then applying graphic curves, it determines a flow rate of the canal. Mirabs after measuring the water level, send SMS via phone (all phone types are supported) to the database (platform). In a few minutes the sender receives a message which includes the flow rate of the measured canal.

Expected outcomes:
The web application allows members of WCA to perform the following steps:
- Maintain a list of members of WCA;
- To make a registry journaling of treaties systems and automatic drafting contracts;
- Management accounting for farmers;
- Maintain a list of issuing coupons to conduct irrigation and making information on watering;
- Water accounting at hydro stations using ultrasonic level gauge W-60-L and Smartrail BAT and NFC.

Providing of agricultural sustainability under the climate change in Uzbekistan

(Poster Presentation)

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Climate change is profoundly impacting the conditions in which agricultural activities are conducted. In every region of the world, plants, animals, and ecosystems are adapted to the prevailing climatic conditions.
Central Asia (CA) covers an area of 400 million hectares, however, only 20% of that is suitable for farming while the rest is deserts and mountainous areas. Nevertheless, agricultural production forms the backbone of CA economies. Land degradation as an effect of these improper policies is still a major problem in all Central Asian countries where land salinization affected about 12% of the total irrigated area in Kyrgyzstan, 50–60% in Uzbekistan and even more than 90% in Turkmenistan. Reduction of the cropping areas in the irrigated lands has been observed during the last decades, which often occurs due to land degradation. Uncertainties during the transition phase combined with land degradation caused high rates of poverty in most of the regions in CA. Climate change adds additional dimensions to the problems in the CA region and increases the vulnerability of rural producers.

Rising air temperatures impact on climate aridity, which is expected to increase, especially in the lowlands. Higher surface temperatures result in increased evaporation and reduced soil moisture content, especially during the dry summer months, thereby amplifying the risk of droughts. With climate change, population growth and plans for steadily increasing agricultural output, water will become a fundamental issue for the region. Less water will be available in the period of highest demand for irrigation in the future.

The observed effects of past climate trends on crop production are evident in several regions of the world, with negative impacts more common than positive ones, including several periods of price spikes following climate extremes in key producing regions. There is evidence that climate change has already negatively affected wheat and maize yields in many regions and also at a global level.

In order to find mitigating and adaptive measures of the impact of climate change on agricultural producers in Uzbekistan, current research was carried out with support of professor of Lund University Bakhtiyor Pulatov in 2016-2018.

In this study, a correlation was made between climate indicators (precipitation and temperature change over the past 30 years), crop yields (wheat, potatoes over the past 20 years) and NDVI of the respective crops by multiple regression analysis. Meteorological data are collected and biased,

adjusted from Uzhydromet (Hydrometeorological Service of the Republic of Uzbekistan) and climate model (CMIP5).

First, the created regression model helps to determine the crop and harvesting dates of crops based on future scenarios of temperature and precipitation changes. Sowing crops earlier is one of the strategies to avoid periods of heat stress, but in the early sowing of wheat can cause an increased risk of frost at the flowering stage. Alleged climate changes are likely to favor the dispersal of seeds and provide an environment suitable for new species of weeds in the state, while perhaps insects and pathogens are harboring. Breeding for wheat with earlier maturation or tolerance to elevated temperatures can be a suitable strategy for adapting to climate change. There is a need to improve the accuracy of seasonal forecasts and increase knowledge of the reaction of varieties to certain climatic conditions.

Secondly, using this regression model, yields can be seasonal forecasted. It is assumed that the use of crop models and historical weather data in combination with genotypic data will lead to increased knowledge in a prediction of crops.

Finally, research results help as a guide for the government, planning the structure of crop areas under crops.

Features of agricultural management in Kazakhstan

(Poster Presentation)

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At present, the agricultural sector is a system-forming base of the economy and ensures the country's food security. However, serious shortcomings in the technological and material development of farmers and agricultural enterprises do not allow significant growth in production, as well as a positive formation of processing and storage of products. The aim of the study is to show the role of the AIC based on the establishment of agricultural cooperatives, as well as to determine the benefits of their activities to increase the output of food products in the manufacturing sector of Kazakhstan. The methodology of work is based on the use of the index method, statistical, tabular, analytical and system approaches. The application of this methodology allowed us to justify the expediency of using the policy of agricultural cooperation based on the introduction of foreign experience. The scientific and practical significance of the work is dictated by the analysis of the contribution of agriculture to the formation of GDP, the level of labor productivity, investment and production capacity of the food sector. The value of the research is concentrated on the study of practical activities of agricultural cooperatives, which, based on economies of scale, pooling investment and financial resources of households and farms, can purchase new equipment and produce high-quality food products that are in demand both inside and outside the country. The conclusions of the work are aimed at revealing the problems and presenting recommendations for improving the management of cooperative associations in the processing complex of the agro-industrial complex.

Using mathematical optimization in sustainable agricultural and water resources management

(Poster Presentation)

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Central Asian countries are the developing countries with half of its population being relatively poor, living in rural areas, and generating income from agriculture [1]. The intensive and unsustainable agriculture and water resources management have resulted in soil degradation, water scarcity and a decline in yield.

Significant research and government programs have been conducted, however, agriculture and environmental research is still in a crisis [2]. There is a significant gap and the need for a comprehensive and cutting-edge crop, impact assessment modelling and analysis [3,4]. Furthermore, the implementation of research solutions is severely limited in the region due to the low participation of farmers and local authorities during the "solution design". Studies state that the participatory and integrated approach [5] is a practical and optimal method for solving such complex situations [6,7,8].

To address the research gaps mentioned above, the goals of this work:
• analyze the current state of agriculture and water resources and identify potential environmental improvements in management, practices and productivity
• support the implementation of optimal solutions and maximize the management efficiency with the proposed "participatory and integrated sustainability approach (PISA)"

The current "top-down" decision making system follows "decision-announce-defense" and is mostly inefficient. In contrast, the proposed new approach (PISA) involves all the stakeholders' and decision makers' interests and needs, integrates parts and parties using transparent co-design, and results in "best-compromised sustainable alternatives" and "social learning".
The approach's framework consists of several steps and phases:

• in-situ literature, models, experimental and input data collection. Coupling in-situ data with global soil (SoilGrids, Worldgrids) and climate datasets (NOAA, Era5, NASA Power). Continuous collaboration with the partners in the formulation and modelling of stakeholders' and decision makers' interests and constraints
• modelling crops (based on WOFOST, LINTUL), irrigation (based on CropWat and AquaCrop), soil (nutrient balance models), greenhouses and optimization (multi-objective) of the integrated agriculture and water resources systems. Coupling iterative participatory procedure with the environmental life cycle assessment method (Brightway2, Ecoinvent) to produce Pareto optimal, best-compromised, sustainable alternatives in strategic and structural solutions
• micro (understanding the system) and macro scale analysis (management and regulation) to evaluate the alternatives

• providing the Pareto optimal, best-compromised, sustainable alternatives to the partners for dissemination

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State owned seed producer cooperatives: Working toward available, affordable and appropriate local seed

(Poster Presentation)

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On May 31, 1997, the government of Kyrgyzstan issued a degree to establish government-owned 'seed producer cooperatives (SPC)' across the country. The role of these SPCs was to supply quality seeds to rural farmers on a sustainable long-term goal through intervention/support of the government financial and technical assistance, which so far is not adequately assessed, nor documented.

The study provides a brief overview and chronology in the seed sector development in Kyrgyzstan since 2000. Using the case study methodology, this paper documents and analyzes the seed producing role of eight SPCs in Karasu rayon of Osh oblast working to improve seed availability and access to it in the country. It documents the overall performance of the government-run SPCs. It draws on scientific literature, government reports and documents, various project data, and websites. In addition, it points out that the newly elected president encouraged government policies to engage in developing projects aimed to support government-run SPCs for which the results, findings and recommendation could be utilized.

Key words: Government owned Seed Producer Cooperatives, Seed System, Food Security, Seed Distribution

There are 8 government owned SPCs in Karasu district in Osh oblast and the author has been working on a managerial and decision-making level at one of these SPCs since 2016; obtains government data of SPCs and well aware of the current situations and information about these government-run SPCs.

Biodiversity and ecosystem services in agrarian landscapes

(Poster Presentation)

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Central Asia's wealth of biodiversity and its broad range of habitats results in a unique species composition and a multitude of endemic plants and animal species. In Tajikistan, protected areas cover 22% of the total land areas. Despite the fact, that most protected areas lack management plans and have been negatively affected by the civil war, they enable for the conservation biodiversity. Tajikistan has signed the Convention on Biological Diversity (CBD) and committed to the Cartagena Protocol as well as to the Nagoya Protocol. Together with the Aichi Targets 2020 and the Agenda 2030 for Sustainable Development, these global commitments strengthen Tajikistan in their efforts to conserve their biological wealth. Biodiversity is, however, more than species conservation, together with other ecosystem services it is the basis for all agricultural outputs.

For the agricultural sector, biodiversity provides a multitude of ecosystem services, vital for environmental sustainability and human well-being that are increasingly under threat due to overuse, mismanagement and climate change. The natural capital of agricultural landscapes is a source of food, fibre, firewood, fodder and provides additional ecosystems services such as nutrient cycling, soil fertility, water conservation and pollination. The richness of genetic diversity in the agricultural landscapes guarantees better adaptation to changing conditions such as severe droughts, the variability of precipitation and other weather extremes. Adaptation to climate change is gaining urgency globally and in this regard, the conservation of biodiversity and ecosystems services and sustainable use of land resources play a key role in addressing the challenges and alleviating threats posed by climate change.

In Tajikistan, agriculture is a priority sector for livelihood security and economic development. In 2015 the agricultural sector accounted for 23% of GDP and provided for 25% of national employment. Despite its efforts in biodiversity conservation in protected areas, the importance of biodiversity for agriculture has not yet been fully recognized. Strengthening the capacities of land users, technical experts and decision makers on the importance of biodiversity for the agricultural sector is the objective of the currently running global project on biodiversity and ecosystem services in agrarian landscapes implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and commissioned by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The project is implemented in Tajikistan, India, and Kenya in close cooperation with the political partners. The project evaluated existing biodiversity-enhancing land-use practices in agriculture and implement them pilot wise in two districts of Tajikistan. Technical, organizational and socio-cultural experiences gathered during implementation are currently collated, analyzed and disseminated at national,

regional and international level. At national level biodiversity is mainstreamed with the aim to improve the sectoral plans and the capacities of the institutions operating in the agricultural sector.

The poster that will be presented, outlines biodiversity-enhancing land use practices and provides an overview of the national and regional policies and strategies in relation to biodiversity and ecosystem services in the agricultural sector. Further, the poster presents the project's contribution to the Aichi Targets and the Agenda 2030 for Sustainable Development.

Session 7: Practical implementation of scientific results and capacity building: Towards sustainable development in Central Asia

(Chairs: Sarah Schönbrodt-Stitt, University of Wuerzburg & Barbara Janusz-Pawletta, German Kazakh University)

The session focusses on the development and implementation of sustainable water management techniques from different perspectives (e.g. data driven, informed decision making, capacity building and development cooperation). We are inviting in particular contributions with regard to open source tools for environmental monitoring, regional data, databases, access to data and knowledge management. Constraints and potentials of global open source data sets, space-borne and air-borne remote sensing and geographical information systems under data scarcity are considered as further important topics for this session.

Furthermore, we are looking for contributions highlighting lessons learnt in regional capacity building and innovations in educational programs on water management at various academic levels. Perspectives from practice on transboundary and regional water management in Central Asia are welcome, as well as studies on the use of scientific results in regional projects, development cooperation and for policy recommendations. Examples for potential future pathways will round off the session.

Oral Presentations:

Author	Presentation Title	Author's Affiliation
Jason Wong	Cybercartography for pasture management: storytelling through participatory mapping to incorporate traditional knowledge in Naryn Province, Kyrgyzstan	Carleton University, Department of Geography and Environmental Studies, Ottawa, Canada
Elena Barth	Integrating climate information into local development planning – a case from the high mountainous regions in Kyrgyzstan and Tajikistan	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany
Stéphane Henriod	Improved, innovative and decentralized Knowledge Management - the Open-Source K-Link	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany
Christopher Conrad	Remote sensing and GIS for regional land and water management in Central Asia: Lessons learnt and a call for viable cooperation	University of Würzburg, Würzburg, Germany
Jenniver Sehring	Water sciences and transboundary water governance in Central Asia	IHE Delft Institute for Water Education, Delft, the Netherlands

Cybercartography for pasture management: storytelling through participatory mapping to incorporate traditional knowledge in Naryn Province, Kyrgyzstan

(**Oral Presentation**)

Jason Wong

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Kyrgyzstan's pasture management policies have been challenged by the limited capacity of its nascent, village-level committees and pasture user groups. The collapse of supporting Soviet-era institutions that collected up-to-date information means policies have little connection with actual practice on the ground. As a result, rural Kyrgyz livelihoods have stagnated in Naryn province.

A cybercartographic approach with user-generated data is implemented to visualize traditional practices on an online atlas. Participants identify pasture management, ecological monitoring, and medicinal plants as key categories of practices to be mapped. Both the produced atlas and the process of making the atlas are examined for their impact on pasture stakeholders' roles in pasture management.

Spatial and interview results show spatially different representations of pastures by various groups and a dialogue-building effect of visualizing practices on an atlas. Demonstrating spatial and thematic linkages between groups offers new partnerships and deeper possible engagement of pasture users in managing pastures. These results are discussed in the context of informing a future pasture governance tool.

Integrating climate information into local development planning – a case from the high mountainous regions in Kyrgyzstan and Tajikistan
(Oral Presentation)

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Central Asian high mountainous regions urgently need to adapt to climate change, with its multiple observed and projected impacts on ecosystems, and the livelihoods of millions of people who depend on these ecosystems at stake. Ecosystem-based Adaptation (EbA) is a promising approach to tackle this adaptation challenge, with the crucial aspect of integrating climate information in any planning process to avoid maladaptation. However, in spite of the proliferation of methodologies and research on the subject, stakeholders from different levels still face difficulties in designing sound adaptation strategies that are tailored to their specific situations, taking into account observed and projected climate change.

This presentation will share the method (further called EbA method) for the design and implementation of an ecosystem-based climate change adaptation strategy, including complementary ecosystem-friendly measures. The EbA method has been developed in the framework of a GIZ led regional project in the Central Asian high mountainous regions together with local communities. A strong focus of this part of the session will be on how tailored climate information is integrated into the planning process.

The developed EbA method is broadly based on the Conservation Measures Partnership Open Standards for the Practice of Conservation, the leading adaptive management framework in the field of biodiversity conservation and sustainable ecosystem management. The purpose of the EbA method is to support local communities to develop integrated local climate change adaptation strategies with a particular focus on EbA. This includes clear, user-friendly, step-by-step guidance. The presentation will follow these steps, in particular highlighting the step on climate information integration and the respective experiences made with the local communities.

Communities trying to adapt to climate change need to look at future as well as observed climate change related hazards and impacts. In this context, several aspects need to be considered: (1) With the help of seasonal calendars, climate projections can be tailored to the local reality. (2) Uncertainty inherent in climate models needs to be considered and can be tackled with scenario planning. (3) Work with a full range of model outputs for certain climate parameters for identified seasons, but not with annual averages. Only by following these aspects for planning, communities can reduce their vulnerability and avoid maladaptation.

Improved, innovative and decentralized Knowledge Management - the Open-Source K-Link

(Oral Presentation)

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Data, Information and Knowledge are the base for informed and efficient decision-making. However, they usually are scattered: across institutions and projects, between various knowledge platforms and tools, between poorly connected networks of local, regional and international experts. They also very often have an expiry date: as soon as a project and its financing are over, websites are turned off, laptops and servers are cleaned and handed over and all the stored data and information disappear. The resulting weak accessibility of information and knowledge becomes a strong barrier for Sustainable Development: it leads to duplication of efforts and causes the same mistakes to be repeated over and over. Based on those premises, the K-Link initiative was born in Central Asia in 2013, in an attempt to develop an open-source tool allowing the integration of already existing knowledge platforms (websites, online libraries, document management systems, etc.) in the field of sustainable land use. Instead of re-inventing the wheel, the K-Link connects the existing and facilitates the sharing and retrieval of relevant information. 5 years later, the K-Link has evolved into a fully working technology, ready to be deployed to other thematic fields and to other regions. Thanks to it being published under a free and open-source license (https://github.com/k-box), it has already been taken up and upscaled by various projects and institutions, most of which have supported technical improvements (the most notable ones being the support for videos and for GIS data).

It now consists of two intertwined tools:

* K-Link itself - A Free and Open Source Data Publishing Tool (DPT) that allows to connect knowledge platforms (websites, Document Management Systems, etc.) into a decentralized knowledge network. Each platform can publish documents to the network, thus making them available to all members.
* K-Box - A web-based Free and Open Source Data Management Tool (DMT) natively connected to a K-Link network. It offers a very flexible approach for managing documents and for disseminating them through a K-Link network.

During this session we will
1) shortly present the long and sometimes chaotic road that has led to the emergence of a technology developed specifically with Central Asia in mind
2) discuss the lessons learnt from this process, that are relevant for any ambitious IT and knowledge projects in the region
3) demonstrate the current state of the K-Link technology
4) look at the future and introduce the upcoming developments of K-Link, in Central Asia and beyond

Short introduction to K-Link and K-Box: https://eba.klink.asia/klink/1082330445/preview

Remote sensing and GIS for regional land and water management in Central Asia: Lessons learnt and a call for viable cooperation
(Oral Presentation)

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Innovative tools such as remote sensing (RS) and Geographical Information Systems (GIS) support in implementing environmental assessment workflows for decision-making. They are essential for data collection and integration, hence for developing indicators in the context of the UN's Sustainable Development Goals such as SDG 2 "Zero Hunger" (e.g., food security and sustainable agriculture) and SDG 6 "Clean Water and Sanitation" (e.g., availability and sustainable management of water). All are of paramount importance for Central Asia, where agriculture is the economic backbone in many regions.

Geotechnology is a great chance, yet a challenge for Central Asia. This is mainly due to the high demand for spatial information while the supply with reliable data remains difficult. For instance, consistent information on crop yields or water use efficiency is relevant for a sustainable land and water resource use in the Aral Sea Basin (ASB). The knowledge about innovative geotechnology, however, did not emerge in the region. Thus, the regional knowledge gap has been persisting in both, research and practice.

How can RS and GIS enter practice in Central Asia? Present contribution aims at answering this crucial question using the example of the regional web-based tool "Water Use Efficiency Monitoring for Central Asia". WUEMoCA is an automated tool for computing RS-based indicators for supporting water management in large-scale irrigation systems in the ASB. It is the result of an intense cooperation between German and Central Asian partners, in particular, the University in Würzburg in Germany and the Scientific Information Center of the Interstate Commission on Water Coordination (SIC-ICWC) in Uzbekistan.
The presentation will look beyond the technical details. It will shed light on important aspects of the cooperative tool development, different expectations to RS applications, and sustainability, i.e. long-term acceptance as well as maintenance and use of the tool. Selected major bottlenecks and potential solutions in cooperative development will be highlighted.

For instance, Central Asian partners have certain expectations of including own indicators, which, however, were not reviewed for a long time. Opposite, geoinformation scientists bring in their research background, but need to get familiar with local and regional workflows of decision-making

and characteristic in cooperative relationships. Moreover, cooperation requires familiarization with inter- and transdisciplinary project work.
It is recommended to the start the process of implementation with one potential user. This certain user such as the SIC-ICWC in the development of WUEMoCA is supposed to act as an interface between science and practice. Based on its expertise and the collaboration, the first user(s) will be enabled to take over future ownership and to promote the tool. Other aspects in cooperation may consider the tool design, the tool implementation, sensitivity of secondary data, and expectations of accuracy and standardization.

To run WUEMoCA in the long-term is of great interest, but might be hampered by numerous reasons, one of which definitely is a mixture of the knowledge gap in geoinformation science and the slow academic development. Thus, the tool including its entire development code will be provided free of charge towards any interested university or research institute in the region. A training program in GIS and RS is also intended.

In the future, similar tools will become possible but require a strengthening of the academia and cooperation by researchers, donors, practitioners, and politics. This should include the selection of the most talented young researchers and the strengthening of integrating them into science and practice, particularly those who gained knowledge and experiences abroad (i.e., multiplier). Finally, cooperation among the institutes and authorities will be improved, thus will become more efficient and future-oriented.

Water sciences and transboundary water governance in Central Asia

(Oral Presentation)

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The recent focus in the discourse on transboundary water management on 'water diplomacy' acknowledges the inherently political nature of water governance and that any effort to achieve water cooperation needs to take into account political dynamics. While diplomats and social scientists might be well equipped for understanding such dynamics, they also need basic knowledge on water, as well as critical awareness on water science methods. Natural and social sciences are necessary not only to provide technical solutions or understand political obstacles independent from each other, but they need to be combined in assessing the political feasibility of proposed technical solutions and to identify the technical requirements for political arrangements to work.

In transboundary and regional water governance processes, science is often perceived to bring in neutral and unbiased information to address complex and wicked water problems. Science-policy dialogue and evidence-based decision-making are seen as recipes to find "best" solutions. In these processes, knowledge brokers like think tanks and international organisations can serve as a bridge and translate complex scientific results into policy language. However, there are some caveats to these assumptions.

In practice, neither science nor knowledge are neutral, but socially constructed and often shaped by the same power relations that shape the political situation they address. Considerable research has shown that the use of knowledge in policy-making tends to be selective and instrumental. Therefore, it is important to analyse discourses, production and utilization of knowledge in order to understand why certain research results are acknowledged and others aren't, and to develop adequate strategies to promote sensible use of scientific knowledge.

This study will analyse the role of data and scientific knowledge in regional water cooperation in Central Asia, and address the question what contribution science does and can make in regional multi-track water diplomacy processes.

Poster Presentations:

Author	Presentation Title	Author's Affiliation
Almas Kitapbayev	From glaciers to the Aral Sea	German Kazakh University, Almaty, Kazakhstan
Alla Sabbatovskaya	Water Journal for children (environmental education for kids and children up to 14)	Central Asian Youth Forum on Water in Turkmenistan, Youth Council on Environmental issues in Turkmenistan, Turkmenistan
The Central Asian Regional Environment Centre (CAREC)	Student research competition on sustainable management of natural resources in Central Asia and Afghanistan	The Central Asian Regional Environment Centre (CAREC): Smart Waters project (USAID) and Climate Adaptation and Mitigation Program for Aral Sea Basin project (the World Bank); German Kazakh University, Almaty, Kazakhstan
Central Asian Journal of Water Research (CAJWR)	e-Journal: Central Asian Journal of Water Research	German Kazakh University, Almaty, Kazakhstan
Akhmedova Tamara	Decision support tool for monitoring Kashkadarya river bason, southern part of Uzbekistan	Hydrometeorological Scientific research institute, Tashkent, Uzbekistan

From glaciers to the Aral Sea

(**Poster Presentation**)

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The countries of Central Asia are gradually introducing the principles of Integrated Water Resources Management (IWRM) in their practice of public administration by shifting water management systems from administrative to hydrographical boundaries, developing strategies of implementing IWRM at all levels, establishing basin councils, etc. Currently, the countries are actively working on the promotion of IWRM principles both at the national and regional levels. In this context, it is important not only to involve all the Aral Sea basin states to the dialogue and joint decision-making on shared rivers, but also to consider various aspects of water use and different stakeholders in the long-term planning.

During the last decade a significant decrease in the interest of young people towards engaging in science and research was noticed mainly due to overall poor perspectives, including low salaries in the engineering and scientific sector, laborious work and limited perspective of recognition. However, due to the transboundary character of Central Asian rivers and the interdisciplinary and interdependent character of water-related issues of Central Asia, common understanding of the joint water systems is essential in promoting knowledge-based water management in the region. Thus, measures to increase the attraction of science and research for youth need to be developed. The activities under this project should contribute to raise awareness and increase the attraction of science and research on water-related issues in Central Asia.

Youth expedition “From glaciers to the Aral Sea” is organised by German-Kazakh University with support The Regional Environmental Center for Central Asia (CAREC) via USAID with Smart Waters program, World Bank’s CAMP4ASB project, Swiss Agency for Development and cooperation (SDC), Executive Committee of International Fund for saving Aral Sea. The expedition is dedicated to the 25th anniversary of International Fund for saving Aral Sea.

The aim of the project is to raise awareness towards the importance of science and research for transboundary water management, to increase the scientific and research capacity of young water specialists of Central Asia and raise awareness about the transboundary nature of water and its interconnectedness. This shall be achieved through the organisation of a joint scientific expedition, starting from the origins of the big CA rivers all the way to the Aral Sea, there by exploring and exposing challenges related to water management across countries, and getting an insight into the current state of the Aral Sea basin.

Outputs

● 10 students and early career specialists from Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, and

Afghanistan have selected to participate in the scientific expedition under the supervision of 5 international supervisors

● Expedition works in 6 scientific directions:
- The impact of climate change on the water resources of Central Asia
- Water and ecosystems
- Water and Agriculture
- Water and energy
- Socio-economic aspects of water resources management
- Transboundary cooperation (legislative aspects)

● Multiple outreach material is available including the main documentary film and short promotional percussive film about the expedition. For this purpose 5 early career journalists from Kazakhstan and Uzbekistan.

● Participants participate at multiple outreach events and tell/evidence their story

Expedition route

The route developed according to the main theme “From glaciers to the Aral Sea” and crosses four countries: Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. The overall length distance covered is 4500 km.

Starting in Almaty on August 1 with a visit to Tuyik su glacier and ending on the Aral Sea August 21 Expedition covers basins Syrdarya and Amudara rivers. The chosen route allows for multiple interactions with projects and institutions supported by SDC, IFAS and CAREC and dealing with water issues in the region.

Water Journal for children (environmental education for kids and children up to 14)

(Poster Presentation)

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Water magazine for kids and children
(+4 - 14)
"Journey across the land of the blue elixir"
or
«One day without water»

This magazine is intended for children up to high-grade adolescence with a focus on a group of preschool and primary school children.

The main purpose/goal of the release of this journal is not to teach, namely, to show and tell the child by the available language about the value of water and its usage by unusual methods, so that the child learns about water, its significance and value, rather than sees, collides, drinks and uses water every day, not knowing its full importance. The child himself must feel "water stories" and exercises on himself so that later he can invent new ones for himself and his family. Thus, the content of the magazine will carry not moralizing, but a game with a child with different stories, pictures, and examples. Thus, the child can develop later automatic thinking about the rational use of water, its correct application and an interesting approach to secondary and tertiary water use. The child himself will think out and decide how to deal with excess or vice versa water shortage. This thinking will be formed gradually.

It is supposed that the magazine will be distributed in two languages, and later on three (English, Russian and Turkmen).

The magazine was based on children's thoughts, a children's approach to thinking about water usage, one of the questionnaires was compiled by children both of older age and younger. There was work with the group of the children during 4 months. A detailed survey was done by the kids and children but mostly by the children being 10-14 years old. Children were given the choice to compose "water" tales, give examples of the rational use of water, develop some excerpts from the plot of the magazine, and vote for the names of the heroes of the magazine. For example, the name of the Water Princess "Drop" was proposed by one of the girls, who is 13 years old and her name is Polina Mametniyazova. She was the most active among the survey participants.

The main heroine was decided to make a Water Princess or Princess of Water, which was called

"Kapelka" or "Drop (English version), (other names were proposed as well, such as Aqua, Ariel, Runlet, Spring, Well, Source, Water Bewitched, etc.).

This magazine is not designed for an older children's group, because it is more realistic to change the thinking about the usage of water in childhood than in the older age, thus there will not be a need to retrain children when they grow up or already become adults.

To the magazine is given a more fabulous character, so that it would be interesting for the kid and child to read. In no case this journal should be obtrusively instructively in nature. A child should perceive it at ones ease.

The journal can be distributed through the international organizations such as UNESCO, CAYFWATER, the World Bank, CAREC, Aarhus Centers, CAAWWA, UNDP, USAID and other organizations conducting regional and international projects; at conferences, symposiums and specialized seminars on water education, in kindergartens and schools (with official permission to distribute and conduct lectures through akimats/hakims (local state administration of the city) or ministries of culture and education); as gifts at various competitions, events, festivals, promotions, Olimpiads.

The magazine will differ from the other magazines, it will contain less text, but more pictures, photos, animations and small stories. This is especially good for those kids who do not like or can’t yet read.

The journal will be small, but a springboard for the preparation of methodologies (methodological instructions) for children in the preparation of training in the rational use of water resources. The journal can be partly used to develop programs in kindergartens and schools among the disciplines, other subjects on the environmental education.

Student research competition on sustainable management of natural resources in Central Asia and Afghanistan

(Poster Presentation)

The Central Asian Regional Environment Centre (CAREC): Smart Waters project (USAID) and Climate Adaptation and Mitigation Program for Aral Sea Basin project (the World Bank); Kazakh-German University

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The student research competition aims to build capacities of the young generation of specialists in the water, agricultural and environmental protection sectors in the Central Asian countries and Afghanistan. The competition is sponsored by the Smart Waters (USAID) and Climate Adaptation and Mitigation Program for Aral Sea Basin (WB) projects.

The competition supports graduate students from universities within and outside Central Asia and Afghanistan, who demonstrated good research abilities, in communicating outcomes of their research work in the form of a scientific article to be published in peer reviewed journals and other means of dissemination. The competition winners are provided with financial support to carry out their research in the amount of up to US$ 1,500. Winners' research work is focused on one of the following topics:

- Water management and reforms: IWRM, international and national laws, policy development;
- Water management approaches for transboundary basins;
- Technologies and practices for sustainable water and land management on community and farm level;
- Water supply for rural areas: provision with drinking water, etc.;
- Economics of natural resources management, valuation of ecosystem services, economic efficiency of water use;
- Climate modeling and climate risk assessment;
- Assessment of climate vulnerability of households and sectors;
- Adaptation to climate change in agriculture and water sector;
- Low-carbon development, promotion of renewable energy and energy efficiency;
- Water, food and energy nexus;
- Gender and gender policy in the management of natural resources.

Central Asian Journal of Water Research (CAJWR)
(Poster Presentation)
e-Journal
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Central Asian Journal of Water Research (CAJWR), is a peer-reviewed, open access, bi-lingual (English-Russian) e-Journal devoted to all aspects of water management in Central Asia and Afghanistan (ISSN 2522-9060). It was established in 2015 and since then it has shown a continues growth thanks to various contributors from the region and beyond, who have chosen CAJWR as a venue for their research work.

In 2017 CAJWR was indexed in Google Scholar, Russian Science Index System, and received its DOI prefix by CrossRef.

All accepted manuscripts are published free of charge together with their translation into English or Russian, respectively.

CAJWR is a forum for innovative review, reflection and discussion informed by recent and ongoing regional (Central Asia) and international water-related research. CAJWR bridges regional and international scientific communities, policy makers, developers and civil society with a view to sharing information and debate with the widest possible audience.

Decision support tool for monitoring Kashkadarya river bason, southern part of Uzbekistan

(Poster Presentation)

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Talking about water generally gives a view of food security, climate change and energy efficiency. The scarcity of water leads to better understanding of the role of water regarding the environment and its effect to nature. As water is an indispensable part of agriculture, there is always need for positive developments of sustainable water management system in agricultural fields. Without good information and knowledge, irrigation can affect negatively any of the activities in agricultural areas in the region. Hence there is a need for the development of good information systems for decision maker and support monitoring of water-related activities to ensure sustainable water resource management in any of the agricultural areas. Therefore, this study aims to develop water resource monitoring database, which will help to monitor changes over time and their influence on the water management. Local available and satellite data, as well as climate and meteo data, will be used to develop a decision making support tool. It is important to develop the system, because this region is one of the areas that is experiencing water scarcity issues with limited data availability. Moreover, it is very important to carry out researches to assure a sustainable water management system in the area since the economy of the region is highly dependent on agricultural fields. Through research activity, a science-based decision support tool will be developed; it could be used in further different applications and analysis for better water resource management.

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german cooperation DEUTSCHE ZUSAMMENARBEIT Издатель: giz	Deutsche Gesellschaft für Internationale Zusammenarbeit	UNI FR UNIVERSITÉ DE FRIBOURG UNIVERSITÄT FREIBURG	University of Fribourg
carec	CAREC - The Regional Environmental Centre for Central Asia	DLR	Deutsches Zentrum für Luft- und Raumfahrt
CAIAG	Central Asian Institue of Applied Geosciences	UZHYMET	Uzhydromet - Centre of Hydrometeorological Service at Ministry of Emergency Situations of the Republic of Uzbekistan
LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN	Ludwig-Maximilian Universität München	КАЗГИДРОМЕТ	Kazhydromet - RSE "Kazhydromet", Ministry of Energy of the Republic of Kazakhstan
Julius-Maximilians- UNIVERSITÄT WÜRZBURG	University of Würzburg		Tadjikhydromet - National Hydrometeorological Service of Tadjikistan
	SIC-ICWC - Scientific-Information Center of the Interstate Coordination Water Commission of the Central Asia (SIC ICWC)	КЫРГЫЗГИДРОМЕТ	Kyrgyzhydromet - The Agency on Hydrometeo-rology under the Ministry of Emergency Situation of the Kyrgyz Republik
ZEU ZENTRUM FÜR INTERNATIONALE ENTWICKLUNGS- UND UMWELTFORSCHUNG	Zentrum für internationale Entwicklungs- und Umweltforschung	CATCOS	Capacity Building and Twinning for Climate Observing Systems
KRASS Khorezm Rural Advisory Support Service	Khorezm Rural Advisory Support Service	GREENSPIN	green spin GmbH