United Nations Educational, Scientific and Cultural Organization

UNESCO Chair on water resources management in Central Asia, German-Kazakh University, Almaty

Monthly Scientific Digest on Water Issues in Central Asia: March 2018

Dear members of the Academic Teachers' network in Central Asia,
the current monthly issue gives a short overview of recent research trends in the field of Water Resources in Central Asia

---
Scientific articles
---

[1] Hydrologic Controls and Water Vulnerabilities in the Naryn River Basin, Kyrgyzstan: A Socio-Hydro Case Study of Water Stressors in Central Asia

Alice F. Hill, Cholpon K. Minbaeva, Alana M. Wilson, Rysbek Satylkanov

Water 2017, 9(5), 325

Link to the article: https://doi.org/10.3390/w9050325

Abstract

Water vulnerabilities in Central Asia are affected by a complex combination of climate-sensitive water sources, trans-boundary political tensions, infrastructure deficiencies and a lack of water management organization from community to federal levels. This study aims to clarify the drivers of water stress across the 440 km Naryn River basin, headwater stem to the Syr Darya and the disappearing North Aral Sea. We use a combination of human and physical geography approaches to understand the meltwater-controlled hydrology of the system (using hydrochemical mixing models) as well as the human-water experience (via community surveys). Surveys indicate that current water stress is primarily a function of water management and access issues resulting from the clunky transition from Soviet era large-scale agriculture to post-Soviet small-plot farming. Snow and ice meltwaters play a dominant role in the surface and ground water supplies to downstream communities across the study's 4220 m elevation gradient, so future increases to water stress due to changes in volume and timing of water supply is likely given frozen waters' high sensitivities to warming temperatures. The combined influence of social, political and climate-induced pressures on water supplies in the Naryn basin suggest the need for proactive planning and adaptation strategies, and warrant concern for similar melt-sourced Central Asian watersheds.

[2] Can a change in cropping patterns produce water savings and social gains: A case study from the Fergana Valley, Central Asia

Akmal Kh. Karimov, Munir A. Hanjra, Jiří Šimůnek, Botir Abdurakhmannov

Journal of Hydrology and Hydromechanics, Volume 66, Issue 2, 2018, Pages 189–201
Link to the article: https://doi.org/10.1515/johh-2017-0054

Abstract

The study examines possible water savings by replacing alfalfa with winter wheat in the Fergana Valley, located upstream of the Syrdarya River in Central Asia. Agricultural reforms since the 1990s have promoted this change in cropping patterns in the Central Asian states to enhance food security and social benefits. The water use of alfalfa, winter wheat/fallow, and winter wheat/green gram (double cropping) systems is compared for high-deficit, low-deficit, and full irrigation scenarios using hydrological modeling with the HYDRUS-1D software package. Modeling results indicate that replacing alfalfa with winter wheat in the Fergana Valley released significant water resources, mainly by reducing productive crop transpiration when abandoning alfalfa in favor of alternative cropping systems. However, the winter wheat/fallow cropping system caused high evaporation losses from fallow land after harvesting of winter wheat. Double cropping (i.e., the cultivation of green gram as a short duration summer crop after winter wheat harvesting) reduced evaporation losses, enhanced crop output and hence food security, while generating water savings that make more water available for other productive uses. Beyond water savings, this paper also discusses the economic and social gains that double cropping produces for the public within a broader developmental context.

[3] Re-establishing glacier monitoring in Kyrgyzstan and Uzbekistan, Central Asia

Martin Hoelzle, Erlan Azisov, Martina Barandun, Matthias Huss, Daniel Farinotti, Abror Gafurov, Wilfried Hagg, Ruslan Kenzhebaev, Marlene Kronenberg, Horst Machguth, Alexandr Merkushkin, Bolot Moldobekov, Maxim Petrov, Tomas Saks, Nadine Salzmann, Tilo Schöne, Yuri Tarasov, Ryskul Usubaliev, Sergiy Vorogushyn5, Andrey Yakovlev, Michael Zemp

Geoscientific Instrumentation, Methods and Data Systems, Volume 6, Issue 2, 2017, Pages 397-418
Link to the article: https://doi.org/10.5194/gi-6-397-2017

Abstract

Glacier mass loss is among the clearest indicators of atmospheric warming. The observation of these changes is one of the major objectives of the international climate monitoring strategy developed by the Global Climate Observing System (GCOS). Long-term glacier mass balance measurements are furthermore the basis for calibrating and validating models simulating future runoff of glacierised catchments. This is essential for Central Asia, which is one of the driest continental regions of the Northern Hemisphere. In the highly populated regions, water shortage due to decreased glacierisation potentially leads to pronounced political instability, drastic ecological changes and endangered food security. As a consequence of the collapse of the former Soviet Union, however, many valuable glacier monitoring sites in the Tien Shan and Pamir Mountains were abandoned. In recent years, multinational actors have re-established a set of important in situ measuring sites to continue the invaluable long-term data series. This paper introduces the applied monitoring strategy for selected glaciers in the Kyrgyz and Uzbek Tien Shan and Pamir, highlights the existing and the new measurements on these glaciers, and presents an example for how the old and new data can be combined to establish multi-decadal mass balance time series. This is crucial for understanding the impact of climate change on glaciers in this region.

[4] Analysis of the Spatio-Temporal Patterns of Dry and Wet Conditions in Central Asia

Zhijie Ta, Ruide Yu, Xi Chen, Guijin Mu, Yanfei Guo

Atmosphere 2018, 9 (1), 7
Link to the article: https://doi.org/10.3390/atmos9010007

Abstract

Drought has become an important threat to industrial and agricultural production and human activities in Central Asia. Using the Standardized Precipitation Evapotranspiration Index (SPEI), we explored the spatial and temporal patterns of dry and wet changes in Central Asia from 1930–2014. The Mann-Kendall trend test and empirical orthogonal function analysis were used to analyze the characteristics of drought in the interannual and seasonal scales. The results showed that the interannual SPEI index in Central Asia presented a distinct phased feature, in the late 1930s, 1970s and 1990s, three consecutive periods of drought occurred. Seasonal SPEI presented different characteristics, with no obvious drying trends in spring and summer. Autumn and winter showed a wet trend. While an obviously wetting tendency has been detected for the winter season, it started in the mid-1950s. Spatially, drought frequency is 42.87% over the entire region of Central Asia from 1930 to 2014. Kyrgyzstan and Tajikistan are wet relative to other countries in Central Asia, with the

frequency of drought occurring at 41.6% and 41.9%, respectively; lower than the average frequency of drought in Central Asia. The average frequency of drought in Kazakhstan is 43.1%. Droughts frequently occur in the central and southern parts of Kazakhstan, with the frequency of drought reaching 46.76%. Droughts hardly occur in eastern of Kazakhstan, as well as in the northeastern region. Turkmenistan and Uzbekistan are the two driest countries in Central Asia, especially in the desert region. The frequency of drought was 50.68% and 47.64% respectively.

[5] IWRM and the Politics of Scale: Rescaling Water Governance in Uzbekistan

Andrea Zinzani, Christine Bichsel

Water 2018, 10 (3), 281
Link to the article: https://doi.org/10.3390/w10030281

Abstract

Over the last two decades, politics of scale and rescaling processes in relation to water have been debated by several scholars, especially by geographers and political ecologists, who emphasized their socio-political nature and their interactions with the environment. By contributing to this debate, this paper analyses rescaling processes in water governance in relation to the implementation politics of Integrated Water Resources Management (IWRM) in Uzbekistan. IWRM and related initiatives were promoted worldwide, especially in the "Global South". These initiatives proposed the shift in water governance from administrative to hydrographic, or river basin, units. Empirically, the analysis focuses on the Middle Zeravshan valley in Uzbekistan, where IWRM was promoted as a part of post-Soviet water reforms. The analysis demonstrates that rescaling water governance towards IWRM and hydrographic units is inherently political. The evidence shows that the process is deeply interlinked with interests and power of Uzbek hydraulic bureaucracies at multiple scales. Firstly, the IWRM sponsored establishment of hydrographic units coincided with a recentralization of water management, supported by national hydraulic bureaucracies. Secondly, the design of the hydrographic unit and related boundaries in the Middle Zeravshan valley was driven by controversial multi-scalar power dynamics and relations between national and province levels, which emphasized the complexity and the multi-scalar nature of rescaling processes rooted in Post-Soviet political transformations.

[6] Trends and variability in streamflow and snowmelt runoff timing in the southern Tianshan Mountains

Yan-Jun Shen, Yanjun Shen, Manfred Fink, Sven Kralisch, Yaning Chen Alexander Brenning

Journal of Hydrology, Volume 557, 2018, Pages 173-181
Link to the article: https://doi.org/10.1016/j.jhydrol.2017.12.035

Abstract

Streamflow and snowmelt runoff timing of mountain rivers are susceptible to climate change. Trends and variability in streamflow and snowmelt runoff timing in four mountain basins in the southern Tianshan were analyzed in this study. Streamflow trends were detected by Mann-Kendall tests and changes in snowmelt runoff timing were analyzed based on the winter/spring snowmelt runoff center time (WSCT). Pearson's correlation coefficient was further calculated to analyze the relationships between climate variables, streamflow and WSCT. Annual streamflow increased significantly in past decades in the southern Tianshan, especially in spring and winter months. However, the relations between streamflow and temperature/precipitation depend on the different streamflow generation processes. Annual precipitation plays a vital role in controlling recharge in the Toxkon basin, while the Kaidu and Huangshuigou basins are governed by both precipitation and temperature. Seasonally, temperature has a strong effect on streamflow in autumn and winter, while summer streamflow appears more sensitive to changes in precipitation. However, temperature is the dominant factor for streamflow in the glacierized Kunmalik basin at annual and seasonal scales. An uptrend in streamflow begins in the 1990s at both annual and seasonal scales, which is generally consistent with temperature and precipitation fluctuations. Average WSCT dates in the Kaidu and Huangshuigou basins are earlier than in the Toxkon and Kunmalik basins, and shifted towards earlier dates since the mid-1980s in all the basins. It is plausible that WSCT dates are more sensitive to warmer temperature in spring period compared to precipitation, except for the Huangshuigou basin. Taken together, these findings are useful for applications in flood risk regulation, future hydropower projects and integrated water resources management.

[7] Climate impact assessment on water resources and glacierization in the Naryn, Karadarya and Zerafshan basins, Central Asia

Abror Gafurov, Doris Duethmann, David Kriegel, Katy Unger-Shayesteh, Matthias Huss, Daniel Farinotti, Sergiy Vorogushyn

Geophysical Research Abstracts, Volume 19, EGU2017-15122, 2017, EGU General Assembly 2017
Link to the article: http://adsabs.harvard.edu/abs/2017EGUGA..1915122G

Abstract

Central Asian river basins with their runoff formation zones in high mountains are currently experiencing the impact of increasing temperatures and changes in precipitation. The

headwaters thus exhibit negative glacier mass balances, decreasing glacierization, changes in snow cover characteristics and changing runoff response. These changes are likely to intensify in future, as temperatures are projected to grow further. Both hydropower industry and irrigated agriculture in the downstream areas strongly depend on the water availability, its seasonal and long-term distribution. In order to improve water management policy in the region, reliable assessments of water availability in the runoff formation zones of Central Asia are necessary. One of the approaches to assessment of water resources is the evaluation of climate scenarios using hydrological models. We present an assessment of climate impact on water resources and glacierization in the 21st century using the semi-distributed hydrological model WASA in the Naryn, Karadarya and Zerafshan basins in Central Asia. In order to constrain hydrological model parameters reliably, a multi-objective calibration approach using observed discharge, glacier mass balance and satellite snow cover data was applied. Consideration of initial glacier volume and its temporal dynamics can be essential for climate impact assessment in transient model simulations. Here, we used estimates of initial glacier thickness, calculated glacier mass balance, and the Δh-approach to simulate the glacier evolution on an annual basis. Future climate scenarios based on the CMIP5 ensemble projections reflecting cold-wet, cold-dry, warm-wet, and warm-dry conditions were used and bias corrected with an empirical quantile mapping technique. The results indicate that the impact of changing climate varies regionally. Based on the ensemble mean of the simulated glacier area evolution, the glacier area retreat is fastest in the low-lying Karadarya basin followed by the Naryn basin. The Zerafshan basin, located in the western part of Central Asia, is projected to experience least glacier retreat. The changing climate will further influence the inter-annual flow regime with peak discharge being shifted from late summer towards early summer due to increasing temperature and earlier snowmelt. Water availability in August, the month with the largest glacier melt contribution, will strongly decrease mainly due to the decrease in glacierization. The obtained results provide important information for decision makers in developing strategies for water usage.

[8] The importance of aspect for modelling the hydrological response in a glacier catchment in Central Asia

Hongkai Gao, Yongjian Ding, Qiudong Zhao, Markus Hrachowitz, Hubert H.G. Savenije

Hydrological Processes, Volume 31, Issue 16, 2017, Pages 2842–2859
Link to the article: https://doi.org/10.1002/hyp.11224

Abstract

Understanding how explicit consideration of topographic information influences hydrological model performance and upscaling in glacier dominated catchments remains underexplored. In this study, the Urumqi glacier no. 1 catchment in northwest China, with 52% of the area

covered by glaciers, was selected as study site. A conceptual glacier-hydrological model was developed and tested to systematically, simultaneously, and robustly reproduce the hydrograph, separate the discharge into contributions from glacier and nonglacier parts of the catchment, and establish estimates of the annual glacier mass balance, the annual equilibrium line altitude, and the daily catchment snow water equivalent. This was done by extending and adapting a recently proposed landscape-based semidistributed conceptual hydrological model (FLEX-Topo) to represent glacier and snowmelt processes. The adapted model, $FLEX^{G}$, allows to explicitly account for the influence of topography, that is, elevation and aspect, on the distribution of temperature and precipitation and thus on melt dynamics. It is shown that the model can not only reproduce long-term runoff observations but also variations in glacier and snow cover. Furthermore, $FLEX^{G}$ was successfully transferred and up-scaled to a larger catchment exclusively by adjusting the areal proportions of elevation and aspect without the need for further calibration. This underlines the value of topographic information to meaningfully represent the dominant hydrological processes in the region and is further exacerbated by comparing the model to a model formulation that does not account for differences in aspect ($FLEX^{G,nA}$) and which, in spite of satisfactorily reproducing the observed hydrograph, does not capture the influence of spatial variability of snow and ice, which as a consequence reduces model transferability. This highlights the importance of accounting for topography and landscape heterogeneity in conceptual hydrological models in mountainous and snow-, and glacier-dominated regions.

[9] Precipitation evolution of Central Asia during the last 5000 years

Christian Wolff, Birgit Plessen, Alexey S Dudashvilli, Sebastian FM Breitenbach, Hai Cheng, Lawrence R Edwards, Manfred R Strecker

The Holocence, Volume 27, Issue 1, 2017
Link to the article: http://journals.sagepub.com/doi/abs/10.1177/0959683616652711

Abstract

Central Asia is located at the confluence of large-scale atmospheric circulation systems. However, the number of Holocene climate records is still low in most parts of this region and insufficient to allow detailed discussion and comparisons to disentangle the complex climate history and interplays between the different climatic systems. Here, we present the first stalagmite record from arid Central Asia (south-western Kyrgyzstan) by using δ18O, δ13C, and micro x-ray fluorescence (μXRF)-sulfur data spanning the last 5000 years. The cave hosting stalagmite Uluu-2 is ideally suited to identify past shifts in seasonal variations in precipitation in this part of the world. Comparison of instrumental and paleo-isotopic studies demonstrates that the Uluu-2 speleothem isotope composition faithfully records climate changes and responds to shifts in the proportion of moisture derived from mid-latitude Westerlies during the winter/spring season. The reconstructions suggest that the area was

characterized by a dry climate from 4700 to 3900 yr BP, interrupted by a wet episode around 4200 yr BP. Further drier conditions also occurred between 4000 and 3500 yr BP. Wetter conditions were re-established at ca. 2500 yr BP, after another dry episode between 3000 and 2500 yr BP. With the exception of two short dry events (1150 and 1300 yr BP), the period after 1700 yr BP shows moderate to wet conditions. Regional comparisons suggest that the strength and position of the Westerly winds control climatic shifts in arid Central Asia, leading to complex local responses.

[10] Power and Water in Central Asia

Filippo Menga

Routledge, 2017, Social Science, 194 pages

About the book

Water is an irreplaceable and transient resource, which crosses political boundaries in the form of rivers, lakes, and groundwater aquifers. The collapse of the Soviet Union in 1991, led to the birth of fifteen countries including the five Central Asian republics, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. When the USSR ceased to exist, so did the centralised Soviet resource distribution system that managed the exchange and allocation of water, energy, and food supplies. A whole new set of international relations emerged, and the newly formed Central Asian governments had to redefine the policies related to the exchange and sharing of their natural resources.

This book analyses the role of state power in transboundary water relations. It provides an in–depth study of the evolution of interstate relations in Central Asia in the field of water from 1991-2015. Taking as a case study the planned construction of the Rogun and Kambarata dams in Tajikistan and Kyrgyzstan, the author examines various forms of overt and covert power shaping interstate relations and the way hegemonic and counter-hegemonic measures are put in place in an international river basin. He argues that the intimate correlation between the concepts of power and hegemony can offer key insights to the analysis and understanding of transboundary water relations. While the analytical focus is placed on state power, the book demonstrates that hegemonic and counter-hegemonic tactics represent the ways in which power is wielded and observed.

Offering fresh theoretical interpretations to the subjects of power and counter-hegemony in the Aral Sea basin, this book puts forward the original circle of hydro-hegemony, an analytical framework in which the various forms of power are connective in the function of hegemony. It will be of interest to scholars in the field of water and environmental politics and Central Asian Studies.

[11] Spatial differentiation in stable isotope compositions of surface waters and its environmental significance in the Issyk-Kul Lake region of Central Asia

Long Ma, Abuduwaili Jilili, Yao-ming Li

Journal of Mountain Science, Volume 15, Issue 2, 2018, Pages 254–263
Link to the article: https://doi.org/10.1007/s11629-017-4499-4

Abstract

Stable isotope values of oxygen (18O) and hydrogen (2H) of surface waters were used to study the origin and environmental significances in the Issyk-Kul basin of Kyrgyzstan in Central Asia, which is the most important intermountain basin in the modern Tien Shan orogen. This study is the first analysis of hydrochemical spatial differentiation in the stable isotopes of surface waters in this watershed. 75 samples were collected from rivers, springs, lakes, rain and snow during the rainy season in July and August of 2016. Stable isotopes of 18O and 2H were studied for all samples, and cation ratios (Sr/Ca and Mg/Ca) were also determined for lake water samples. Stable isotope values from precipitation scattered around the Local Meteoric Water Line (determined from Urumqi Station of the global network of isotopes in precipitation (GNIP)), together with values of the Deuterium excess parameter (d) from 15.3‰ to 30.5‰, with an average of 19.8‰, indicating that the moisture sources are primarily from regions with low relative humidity. The δ18O and δ2H values were significantly different between the river and lake samples, indicating that regional evaporation caused the isotopic enrichment of lake water. Geospatial autocorrelation, measured by Moran's I coefficient, indicated weak spatial autocorrelation within stable isotopes of oxygen and hydrogen in the surface waters of the studied area, which is primarily an effect of climate during the water chemistry evolution. The cation ratios Sr/Ca and Mg/Ca in lake water samples were not correlated with the concentration of total dissolved solids, but did show correlation with stable isotopic values, which is significant for paleoenvironmental reconstruction.

[12] Current and Future Challenges of Water Security in Central Asia

Stefanos Xenarios, Ronan Shenhav, Iskandar Abdullaev, Alberto Mastellari

Global Water Security, Pages 117-142
Link to the article: https://doi.org/10.1007/978-981-10-7913-9_5

Abstract

The notion of water security in Central Asia has evolved throughout the years in an attempt to control an extensive transboundary river network which divides the region between upstream (Kyrgyzstan, Tajikistan) and downstream (Uzbekistan, Kazakhstan, Turkmenistan) countries. In Soviet times, the belief in engineering and technical supremacy over nature was applied in the installation of numerous hydraulic facilities and mechanical interventions. Water for energy was provided by a series of hydropower stations upstream, while downstream, extended supply and drainage networks and large pumping stations served mainly cotton monoculture. After independence in 1991, water security in the newly established downstream states became synonymous with sufficient irrigation volume for agricultural production, while upstream, water security was interpreted as increased hydropower capacity. Still, however, the transboundary nature of water resources in Central Asia determines to a large extent the need for coordinated national policies and compromises between the Central Asian countries for the attainment of water security in the region. The current study indicates the geophysical, institutional, and historical challenges to be met for the mutual understanding of water security among these five countries. The newly introduced river basin management approach is presented as a crucial reform that may improve common initiatives in water resources management between the riparian countries. Attention is given to the increased effort to be made by interstate and regional organisations in the implementation of feasible and effective solutions for better allocation of transboundary water resources in Central Asia.