REGIONAL RESEARCH NETWORK

» CENTRAL ASIAN WATER «

Tools for improved water resource management

CAWa

Federal Foreign Office

CAWa – TOOLS SUPPORTING WATER MANAGEMENT IN CENTRAL ASIA

Central Asia, comprising Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and Afghanistan, is characterized by a highly continental semi-arid climate.
Climate change and variability have substantial impact on water availability and thus present a major challenge for sustainable agricultural development and energy production.
The project „Central Asian Water" (CAWa) is part of the German Water Initiative for Central Asia ("Berlin Process") which was launched by the German Federal Foreign Office in 2008 at the "Water Unites" conference in Berlin. Since then, CAWa scientists in close cooperation with Central Asian partner organizations, have developed several tools, all aiming at the improvement of transboundary water management.

The tools cover a broad range of water related applications, such as hydro-meteorological observations in high mountain regions, radar altimetry based monitoring of reservoir levels, remote sensing based estimation of land use, irrigation, potential yield and snow cover and user-friendly algorithms for seasonal precipitation and runoff forecasts. It is our policy to make all data and methods freely accessible, some are already used by Central Asian partners and stakeholders and have been found to support decision making at the regional level. Interested users are welcome!

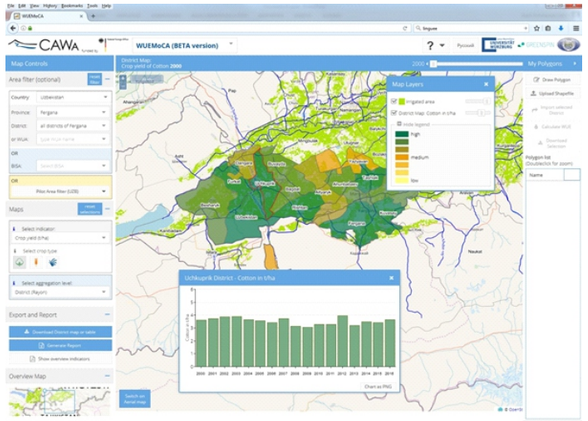
WUEMoCA - WATER USE EFFICIENCY MONITOR IN CENTRAL ASIA

Efficient irrigation agriculture is essential for regional development and adaption to climate change. It requires timely, reliable and accessible data on water use efficiency as well as land use.

The online information tool WUEMoCA constitutes a continuous and automated monitoring platform that provides free access to spatio-temporal agricultural geo-information, such as land use and crop types, yield estimations, and evapotranspiration assessments. This information is derived from open-source optical satellite remote sensing MODIS imagery and freely available global climate data.

The spatial focus of WUEMoCA is on the irrigated cropland area in the Aral Sea Basin shared by Uzbekistan, Kazakhstan, Turkmenistan, Tajikistan, Kyrgyzstan and Afghanistan.

The tool completely builds on flexible and extensible open-source software packages, such as GeoServer, Java and Python programming libraries, QGIS, GDAL geospatial data abstraction library and OGC web map services. Thus, it is open to modifications and adaptions to specific user demands. Key indicators allow for the identification of marginal lands with low productivity, the localization of areas with lowest or highest land use intensity and for assessments of water use efficiency.



Screenshot of WUEMoCA: (left side) the map control panel with the options to select any area of interest (Area filter function) and annual and multi-annual indicators on the land use, crop types and water use efficiency (Select indicator function) and to download and export queried information (Export and Report function); (center) the web mapping window for visualizing queried information in form of maps and diagrams and (right side) the interactive user polygon tool (My Polygons function).

Irrigated cropland in the Ferghana valley.
Picture provided by SIC-ICWC (Tashkent, Uzbekistan).

WUEMoCA will contribute to the current database at the scale of the Aral Sea Basin and thus to informed regional decision-making. The tool addresses national governments, regional and transboundary authorities as well as specialists in water management institutions. Potential users include also educational institutions and the scientific community.

The tool may be used in study programs on geoinformation technology and remote sensing, as well as in environmental research in Central Asia.

WUEMoCA can be freely accessed by any current standard web browser and is hosted and maintained at the SIC-ICWC: www.wuemoca.net

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

GREENSPIN

SDSS - HYDROMETEOROLOGICAL OBSERVATIONS AND SENSOR DATA STORAGE

In the past years, an extensive transnational network of Remotely Operated Multi-Parameter Stations (ROMPS) has been installed in Central Asia in the frame of the CAWa project that continuously captures meteorological and hydrological observations. In addition to the ground-based station network, a satellite-based monitoring system has been established to provide water levels of selected lakes and reservoirs in this region.

The data is made freely accessible to all national Hydromet services and to the international community through the Sensor Data Storage System (SDSS) of the CAWa project.

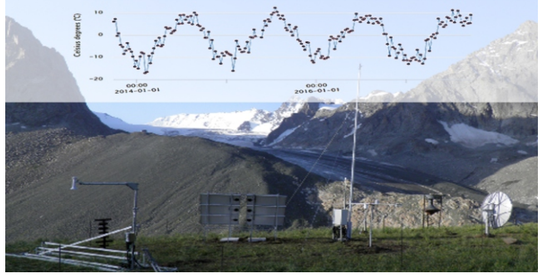
SDSS is the main storage and dissemination system for all Level 0 meteorological and hydrological data acquired by CAWa and other ROMPS stations in Central Asia.

The data are seamlessly integrated into the database of the SDSS immediately after their transmission from the stations.

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.

A graphic user interface available in English, Russian, and German languages offers the possibility to interactively retrieve hydro-meteorological data and selected water levels using a web browser. The user can choose the station and variable of interest, display the data time series, print charts and download the data as XML file to be opened by major data analysis tools for further analysis.

SDSS is hosted and maintained at CAIAG and is accessible via: http://sdss.caiag.kg



Hydro-meteorological station near Golubin Glacier (Kyrgyzstan) and the timeseries of temperature observations from 2014 to 2016 as available in SDSS.

MODSNOW – AN OPERATIONAL TOOL FOR SNOW COVER MONITORING

Nowadays, snow cover information of high temporal and moderate spatial resolution can be obtained from optical remote sensing imagery, e.g. from MODIS products. Such information is valuable for the assessment of the status quo water storage in the mountains of Central Asia.

However, processing of such data is time consuming and not straightforward.

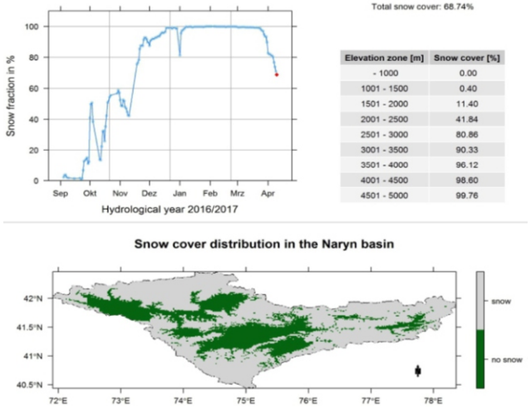
The user-friendly MODSNOW tool offers the possibility of automatically processing MODIS snow cover data for pre-defined river basins or a selected region.

The processing includes the data download, the elimination of clouds from the images, the derivation of daily snow cover maps as well as basin-wide and elevation dependent snow cover statistics.

The tool may be set up in operational mode with automated daily updates of snow cover information.

The non-operational mode may be used for deriving historical time series of snow cover information.

The resulting spatio-temporal information on snow cover can be used for seasonal water availability forecasting but also for scientific studies on climate and hydrological change.



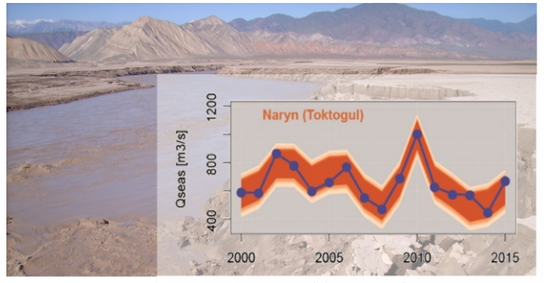
Elevation zone [m]	Snow cover [%]
- 1000	0.00
1001 - 1500	0.40
1501 - 2000	11.40
2001 - 2500	41.84
2501 - 3000	80.86
3001 - 3500	90.33
3501 - 4000	96.12
4001 - 4500	98.60
4501 - 5000	99.76

MODSNOW-Tool daily output of snow cover distribution and statistics for the Naryn basin as of April 10, 2017.

SEASONAL AND PRECIPITATION RUNOFF FORECAST

A robust seasonal forecast of summer water availability is required in order to adapt the agricultural strategy to anomalous hydro-climatic conditions. For a quantitative prediction, state-of-the-art statistical forecast models have been developed, which relate observed hydro-climatological anomalies with suitable predictor variables during preceding months. These forecast tools enable both, a deterministic forecast of water availability based on automatically selected covariates and an estimation of inherent uncertainties. For the prediction of summer runoff in various Central Asian catchments, snow cover rates (derived from the MODSNOW tool) as well as temperature and precipitation observations during winter have been found to be skillful predictors and explain up to 80% of runoff variations.

With the aim of extending the lead time of runoff forecasts, similar models have been developed for the prediction of winter precipitation amounts. Large scale atmospheric and oceanic modes, particularly the El Niño and the Arctic Oscillation, have been shown to significantly influence the Central Asian precipitation climate and various atmospheric indices have been identified as skillful predictor variables. Although uncertainties of climate predictions remain large, the modelling tool suggests that a certain degree of predictability exists already 6 months in advance. The forecast tools are based on the free and open source environment R. Forecasting trainings for Central Asian experts have been conducted during the project period and the tools have been adjusted to their operational needs.



Naryn river inlet at Toktogul Reservoir (Kyrgyzstan).
Mean runoff during summer (blue line) and forecast range (orange) derived from an ensemble of linear regression models based on winter and spring predictors variables.

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Funded by

Federal Foreign Office
Division for Environmental and Biopolitical Issues in Foreign Policy
www.diplo.de

Grant number AA7090002

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