Chapter I/13: WATER MONITORING IN CENTRAL ASIA – THE CENTRAL ASIAN WATER PROJECT (CAWA)

Глава I/13: Центрально-Азиатский водный мониторинг проект „Вода в Центральной Азии (ЦАВа)“

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ABSTRACT. Water in Central Asia is an important natural resource as it plays a key role for living, agricultural production and economic development. Due to the non-uniformly distribution over the entire region, the availability and direct access to freshwater often result in disputes between the different Central Asian countries. Therefore, a reliable trans-boundary water resource management is strongly recommended. Within the CAWa project, a network of automatic monitoring stations has been installed especially in remote areas and in higher altitudes providing continuously meteorological and hydrological parameters. In addition to the ground-based monitoring network, water levels of selected lakes and reservoirs are provided by the satellite-based radar altimetry. All data are stored in an open-access data base to support sustainable decisions in water management and to contribute to a scientific cooperation between the involved transnational agencies.

Резюме. Вода в Центральной Азии – важный природный ресурс, играющий ключевую роль в жизни людей, аграрном производстве и экономическом развитии. Из-за неравномерного распределения по региону, наличие и прямой доступ к пресной воде не редко вызывает споры между различными центрально-азиатскими странами. Таким образом, крайне желательно иметь надежное управление трансграничными водными ресурсами. В рамках проекта CAWa в большинстве случаев в отдаленных и высокогорных районах была установлена сеть станций автоматического мониторинга, обеспечивающая непрерывный мониторинг метеорологических и гидрологических параметров. Дополнительно к наземной сети наблюдений с помощью спутниковой радиолокационной альтиметрии предоставляются данные уровня воды в отдельных озерах и водохранилищах. Все результаты хранятся в базе данных с открытым доступом, что упрощает их использование для поддержки устойчивых решений в области управления водными ресурсами и содействия научному сотрудничеству между вовлеченными транснациональными агентствами.

KEYWORDS: CAWa, water monitoring, hydrometeorological network, ROMPS, SDSS, radar altimetry, lake and reservoir water volumes

Ключевые слова: ЦАВа, мониторинг воды, гидрометеорологическая сеть, ROMPS, SDSD, радарная альтиметрия, объем воды в озерах и водохранилищах

INTRODUCTION

In the arid and semi-arid region of Central Asia, water is an important natural resource. It is not only a fresh water supply for the growing population but also a necessary prerequisite for the economic development and agricultural production. The two main rivers in Central Asia, the Amu Darya and the Syr Darya, originate in the high mountains of the Tien Shan and Pamir and are formed from the melt of seasonal snow pack, glacier ice and precipitation. This important role of the flow formation zone for water management in Central Asia calls for a continuous monitoring which provides data needed for operational seasonal runoff forecasts as well as the assessment of changes in the headwater catchments and their water resources [2].

In the past years, an extensive transnational network of Remotely Operated Multi-Parameter Stations (ROMPS, Figure 1) has been installed in Central Asia in the frame of the CAWa project (http://www.cawa-project.net) that continuously captures meteorological and hydrological observations [1]. 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.

THE CENTRAL ASIAN HYDROLOGICAL MONITORING NETWORK

In the past, hydrometeorological monitoring in Central Asia was often made by manually operated posts. Data collection and transmission thus was based on human interactions. After the collapse of the Soviet Union, it became increasingly difficult for the new independent Republics (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) to continue this monitoring.

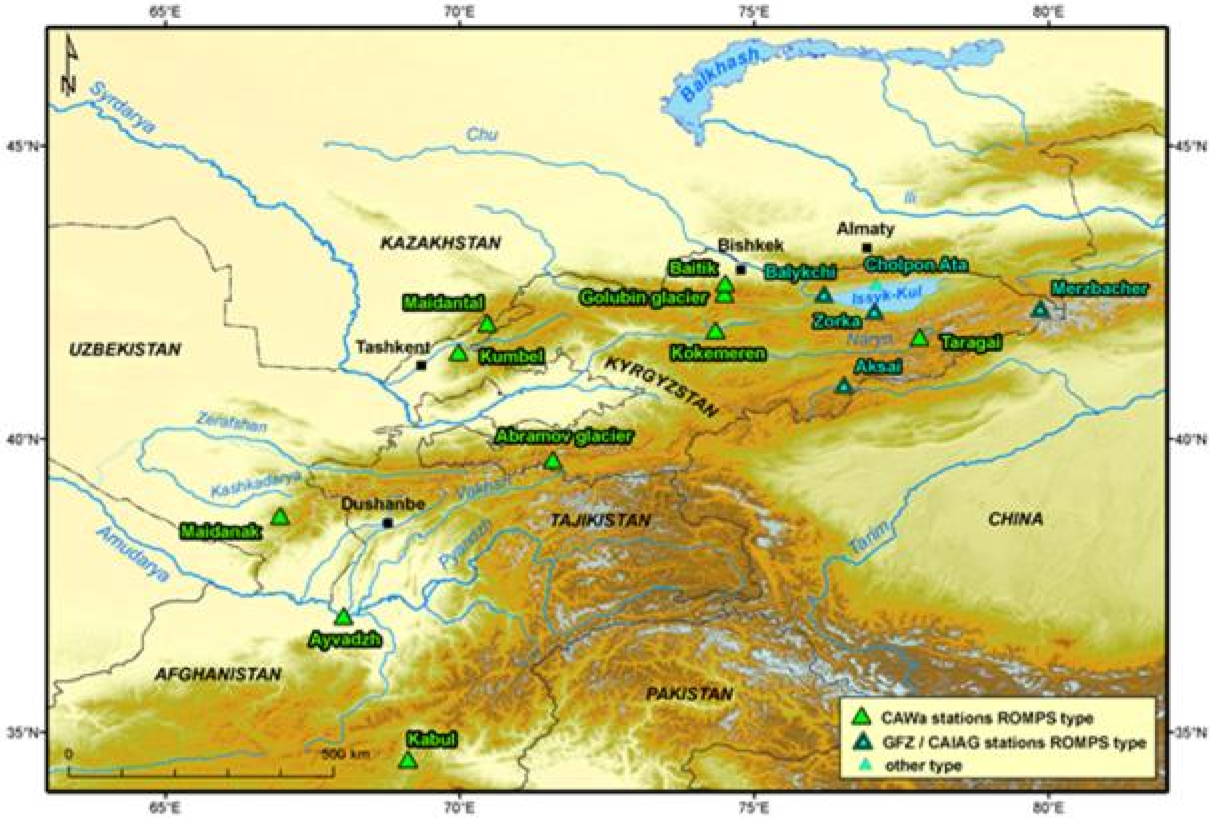

Figure 1 - The ROMPS monitoring network in Central Asia (10/2017). © GFZ, Katy Unger-Shayesteh

The resulting network declined significantly, primarily affecting stations in the flow formation zone at altitudes above 2,000 m a.s.l. (e.g., [6]). Hence, there is a great need to sustain and partly improve the hydrometeorological monitoring in Central Asian's headwater catchments. In the 1990ies and 2000s, several internationally funded projects already addressed this issue and have succeeded to install a number of automatic monitoring stations. Beside these developments, there remain a number of challenges [1]:

1. Stations are needed to consolidate the monitoring network especially at higher altitudes. The stations need to be capable of reliable un-manned operation under the prevailing extreme environmental conditions in remote areas, to have low maintenance requirements and, additionally, to incur very low operational costs.
2. Near-real time data transmission to data users is needed.
3. The data management infrastructure should be capable of facilitating data sharing among all countries.

These challenges of establishing and operating a regional monitoring network of ROMPS with a special focus on the flow formation zone are addressed in the frame of the CAWa project, the "Global Change Observatory Central Asia (GCO-CA)" of the German Research Centre for Geosciences (GFZ) and the long-term strategy of the Central-Asian Institute for Applied Geosciences (CAIAG). These programmes 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, Earth-

System hazard monitoring as well as the establishment of water-related early-warning systems. To serve these applications, ROMPS stations combine a multitude of sensors at one station with shared power supply and communication infrastructure [1].

RIVER AND LAKE MONITORING IN CENTRAL ASIA

Public information about the storage volume of reservoirs and lakes is not always available in a timely and independent way. In Central Asia, a few organizations are dealing with the collection and dissemination of water related data but sometimes require front-up registration and/or a subscription scheme. An open and emerging technology for inland water monitoring is the satellite-based radar altimetry [3]. Starting in 1985 and continuously operated since the early 1990ies, different radar altimetry missions provide measurements of water surface heights with 10 and 35 day repeat intervals. Advances in signal processing technologies, such as the so-called retracking, allow the extraction of water levels of smaller inland-water bodies along the satellite pass. The accuracy of the derived water levels (water heights) is slightly worse compared to the traditional open ocean application. Inland water hydrology requires the water levels measured by radar altimetry to be converted into volumes or volume changes using the hypsometry or a volumetric curve. In absence of in-situ topographic data, remote sensing technologies can provide the complementary information about the water extent of individual water bodies. A recent study for Central Asia for the Toktogul, Kairakum, Shardara water chain [4] (Figure 2) demonstrated that the water level of reservoirs can be determined with an accuracy of better than ±30 cm.
Also the estimation of water heights of rivers (stage monitoring) is of increasing interest. The use of radar altimetry for river monitoring, however, is currently limited by the footprint size (>Æ2 km) of the radar beam to large, well-situated rivers, but the potential of this technology has been demonstrated [5]. Recently, the development of Synthetic Aperture (SAR) altimetry on ESA's CryoSat-2 mission opens exciting perspectives for inland water monitoring. The SAR (or Doppler delay) altimetry allows sensing smaller portions of the radar footprint and thus to observe water levels of smaller water bodies such as rivers. The planned Surface Water and Ocean Topography mission (SWOT) (launch expected in 2021) with its wide-swath altimetry will provide 2-dimensional maps of any water body larger than 250 x 250 m every 21 days. These new technologies will enable hydrologists to closely monitor water volumes in most lakes, reservoirs and rivers globally.

THE SENSOR DATA STORAGE SYSTEM (SDSS)

One of the main aims of the CAWa project is the immediate and unrestricted dissemination of all acquired hydro-meteorological parameters to a broad range of users, like national hydrometeorological services, state agencies, academia, or the general public. To allow an easy access and a long-term storage, the Central-Asian Institute for Applied Geosciences (CAIAG) has developed 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 stations including ROMPS stations operated by GFZ and CAIAG in the frame of the Global Change Observatory in Central Asia. The data is seamlessly integrated into the database of the SDSS immediately after their transmission from the stations. In addition, water levels and volume data derived from radar altimetry are automatically processed for lakes and reservoirs in Central Asia and continuously added to the SDSS.
A graphical user interface available in English, Russian, and German languages offers the possibility to retrieve data interactively using a web browser. The user can select the stations and parameters of interest, display the full or tailored data time series, print charts and download the data as XML file to be opened by major data analysis tools for further analysis.
Currently, the SDSS is further developed by adding meta data for stations and sensors and by implementing quality control mechanism for incoming data.

CONCLUSIONS

1. GFZ and CAIAG, in cooperation with national hydrometeorological agencies, research institutes, and universities, are offering unrestricted access to the hydrometeorological data of ROMPS and other stations.
2. Remote sensing technologies, such as radar altimetry, allow assisting the water monitoring in urban as well as remote areas without the help of a local monitoring infrastructure.

3. With the development of the Sensor Data Storage System (http://sdss.caiag.kg) an easy-to-use interface for different types of users exist. SDSS is providing a platform for the display and download of hydro-meteorological data sets.

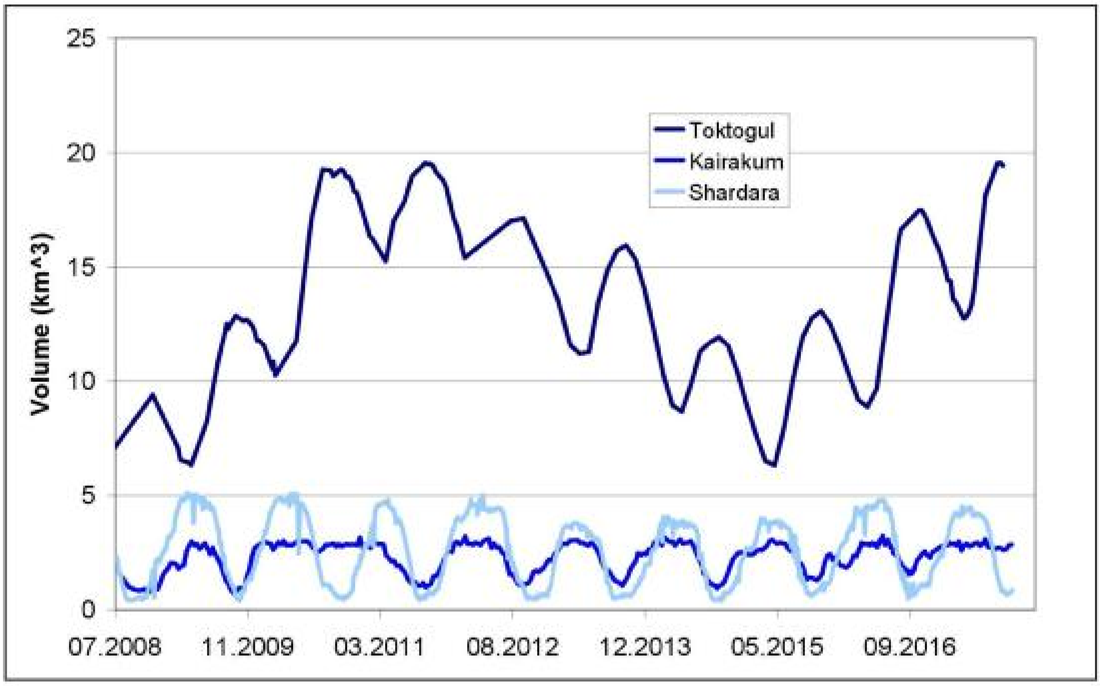

Figure 2 - Time series of volume variations in the Toktogul, Kairakum and Shardara reservoirs inferred from satellite radar altimetry (data is available at http://sdss.caiag.kg).

Figure 3 - Web Interface for the Sensor Data Storage System (http://sdss.caiag.kg).

REFERENCES

[1] Schöne, T., C. Zech, K. Unger-Shayesteh, V. Rudenko, H. Thoss, H.-U. Wetzel, A. Gafurov, J. Illigner, A. Zubovich. 2013. A new permanent multi-parameter monitoring network in Central Asian high mountains – from measurements to data bases. Geosci. Instrum. Method. Data Syst., 2, 97-111, 2013, www.geosci-instrum-method-data-syst.net/2/97/2013/, doi:10.5194/gi-2-97-2013

[2]Unger-Shayesteh, K., Conrad, C., Schöne, T., Moldobekov, B. 2015. Обоснованное принятие решений по управлению земельными и водными ресурсами в Центральной Азии: Как могут содействовать технологии наблюдения за поверхностью Земли, (Аналитические записки «Германской водной инициа-тивы для Центральной Азии» ; 1), Потсдам: GFZ Германский Центр Исследований Земли, 6 p., doi: http://doi.org/10.2312/5.4.2015.001r
[3]Birkett, C.M. 1994. Radar altimetry: a new concept in monitoring lake level changes. In EOS Trans., AGU 75, 24. pp. 273–275.
[4]Schöne, T., E. Dusik, J. Illigner, I. Klein. 2017. Water in Central Asia - Reservoir Level Monitoring with Radar Altimetry, International Association of Geodesy Symposia Series, doi:10.1007/1345_2017_265, http://link.springer.com/chapter/10.1007/1345_2017_265, 2017
[5]Koblinsky, C.J. et al., 1993. Measurements of river level variations with satellite altimetry. *Water Resources Research*, 29(6), pp.1839–1848.
[6]World Bank . 2009. Improving weather, climate and hydrological services delivery in Central Asia (Kyrgyz Republic, Republic of Tajikistan, and Turkmenistan). Report prepared in the frame of the technical assistance project "An action plan for improving weather and climate service delivery in high-risk, low-income countries in Central Asia", World Bank Russia Country Office, Moscow.

Глава I/14: РАЗВИТИЕ СИСТЕМНОГО ПОДХОДА К ИЗУЧЕНИЮ, ОЦЕНКЕ, УПРАВЛЕНИЮ И КОНСТРУИРОВАНИЮ АГРОЭКОСИСТЕМ И АГРОЛАНДШАФТОВ
Chapter I/14:Development of an System Approach to Studying, Evaluation, Management and Creation of Agroecosystems and Agrolandscapes

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РЕЗЮМЕ. Разработаны методологические основы (модель и принципы) агроландшафтно-экологического изучения, оценки и управления сельскохозяйственными землями, агроэкосистемами и агроландшафтами. Они опираются на концепцию сохранения и воспроизводства используемых в сельскохозяйственном производстве земельных и других природных ресурсов, плодородия почв, продуктивного долголетия агроэкосистем и агроландшафтов ВНИИ кормов имени В.Р. Вильямса, концепции экологического каркаса агроландшафтов и эколого-хозяйственного баланса МГУ имени М. В. Ломоносова и Института географии РАН. Методологические основы агроландшафтно-экологического изучения и анализа сельскохозяйственных земель рассматривают их как агрогеоэкосистему и оценивают во взаимосвязи и взаимозависимости с агроландшафтами. Они протестированы на основных агроландшафтах России и могут применяться для оценки и управления сельскохозяйственными землями, агроэкосистемами и агроландшафтами Евразии.

Abstract. Methodological bases (model and principles) of agrarian and ecological landscape research, evaluation and management of agricultural lands, agroecosystems and agrolandscapes have been developed. They are based on the concept of conservation and reproduction of land and other natural resources used in agricultural production, soil fertility, productive longevity of agroecosystems and agricultural landscapes, evolved by the All-Russian Williams Fodder Research Institute. They are also based on the concept of the ecological framework of agrolandscapes and the ecological and economic balance developed by the Lomonosov Moscow State University and the Institute of Geography of the Russian Academy of Sciences. The methodological basis of agro-landscape-ecological research and analysis of agricultural lands considers them as an agrogeoecosystem and evaluates its interrelation and interdependence with agrolandscapes. They are tested in the main agricultural landscapes of Russia and can be used to assess and manage agricultural lands, agroecosystems and agrolandscapes of Eurasia.