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Imprint

Conference documents for the International Scientific Symposium “Water in Central Asia” held in Tashkent (Uzbekistan), 24-26 November 2010

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

Scientific Information Center of the Interstate Commission on Water coordination SIC ICWC, Tashkent (Uzbekistan)

Editors: B. Merz, V. Dukhovny, K. Unger-Shayesteh

Cover picture: Toktogul reservoir, summer 2008, © CAIAG 2008

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Introduction

Central Asia faces big water-related challenges, among them water scarcity, degrading water quality and inefficient water use.

The impact of climate change on the region's water resources, although studied by a number of Central Asian and international researchers at various scales, is not yet known in detail. The results obtained from different scientific approaches like trend analyses, climate models and hydrological models have to be compared and validated to give an overall picture of the region's future water budget. Various scenarios have to be considered.

But it is not the future of Central Asian water resources alone which is subject to research. In present days, water managers are coping with significant data gaps hampering water management decisions. Not all processes influencing the water balance are yet quantified – such as the interaction of ground and surface water. Today, space-based information on land cover and water-related parameters offer great opportunities to bridge those gaps. Their incorporation into integrated water management models is expected to significantly improve water management.

The International Scientific Symposium "Water in Central Asia" is organized jointly by GFZ German Research Centre for Geosciences and the Scientific Information Center of the Interstate Commission on Water coordination SIC ICWC. It is funded by the Federal Foreign Office of the Federal Republic of Germany in the frame of the CAWa project which itself is part of the German Water Initiative for Central Asia (so-called "Berlin Process").

The symposium will focus on applied research against the background of Central Asian water management intending to bridge the gap between scientists and water managers.

In particular, the symposium aims to

- present and discuss the preliminary results of the CAWa project,
- review current research achievements in Central Asia,
- discuss new scientific methods to approach Central Asian water issues,
- debate regional research priorities,
- promote regional cooperation among scientific institutions from Central Asia and the EU and
- provide a platform for the strengthening of international networking through sharing and mutual learning.

We wish the symposium success and its participants inspired and fruitful scientific discussions!

Tashkent, November 2010

Prof. Bruno Merz
GFZ German Research Centre for Geosciences

Prof. Victor Dukhovny
Scientific Information Center of the Interstate Commission on Water Coordination (SIC ICWC)

Session 1 – Water availability in Central Asia: Past, present, future

Global change will affect the amount, temporal distribution and quality of naturally available water resources in Central Asia - with consequences for water management. This session will focus on the assessment of the dynamics of change using climate and hydrological models, trend analyses and scenario development.

Session chairs: Dr. Sergiy Vorogushyn, Dr. Natalya Agaltseva

Regional Atmospheric Modeling for Hydrological Analyses

Harald Kunstmann

Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research IMK-IFU
Kreuzeckbahnstrasse 19, 82467 Garmisch-Partenkirchen, Email: harald.kunstmann@kit.edu

Global warming is accompanied by changes in the spatial and temporal distribution of precipitation and the terrestrial water cycle. The assessment of related changing long term water availability, particularly flood and drought risks, is one of the central challenges of hydrological and climate research. It can only be accomplished by joint and coupled use of atmospheric and terrestrial hydrological modelling systems.

Global climate and atmospheric models have too coarse resolution to allow for catchment-size and regional conclusions on water resources and fluxes. Dynamical and statistical regionalisation approaches bridge the gap between global climate projections and their regional shape. The capabilities and limitations of high resolution dynamical downscaling by regional atmospheric models will be discussed. Special focus is set on the ability of regional atmospheric models to reproduce observed precipitation and temperature characteristics in different climate regions.

Finally, first results on the investigation of the sensitivity of small-scale land surface properties and lateral water flows on atmospheric processes and precipitation feedbacks are presented for an orographic complex region in the Alps.

Methodical approach to the assessment of climate change impact on water resources in Uzbekistan

Natalya Agaltseva

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Climate projections for Central Asia using the Regional Climate Model REMO

Markus Müller, Heiko Paeth

University of Würzburg, Dept. of Geography, Germany

The presentation will show in examples the efforts to analyse the past and future climatic conditions in the CAWa region by means of a Regional Climate Model.

In a two step approach runs of the Global Climate Model ECHAM 5 under the A1B scenario were used as a forcing to drive regionalized simulations for Central Asia. ECHAM 5 was found not to be an outlier within the CMIP ensemble of Global Climate Model runs for the area of Central Asia.

For the physical downscaling the Regional Climate Model REMO 2009 were used. In a first run the spatial resolution was scaled to 0.5°, covering the area from 5°N to 65°N and 30°E to 110°E and enfolding the time period from 1950 to 2100. This run has been used for validations against observations and reanalysed observation data sets as ERA. For some of the climatic parameters provided by the model the need of a bias correction was found and correction factors have been derived. The reasons for the bias are complex, they are partly due to insufficient knowledge i.e. of soil properties in the area, partly due to model internals (i.e. standard REMO does not take irrigation areas into account).

In a next step the resolution was dragged down to about 1/6° resolution (nesting into the REMO 0.5° run), covering the area of 25°N to 45°N and 55°E to 83°E, enfolding the years from 1961 to 2100. The demand for computing time is dominated by the number grid points. So with the background of limited computing resources the investigated area has to be smaller compared to lower resolutions.

This high resolution run has provided new details of the distribution of climatic parameters in Central Asia, notably for basic variables of the hydrological cycle.

The presentation will show available products from gridded data sets to derived information by statistical postprocessing. This includes means, extremes and time series for gridpoints as well as grid point independent products. For instance for regions with sufficient historical rainfall records, station like daily series for precipitation can be computed. Here, model output is adjusted for every desired point within that region by a weather generator to the characteristics of observed precipitation.

Simulating future water balance using a process based hydrological model and output of a regional climate model

Doris Duethmann[1], Abror Gafurov[1], Andreas Guentner[1], Markus Mueller[2], Heiko Paeth[2], Sergiy Vorogushyn[1], Janek Zimmer[1]

[1] *GFZ German Research Centre for Geosciences, Section Hydrology, Telegrafenberg, 14473 Potsdam*

[2] *Julius-Maximilians University Würzburg, Institute for Geography, Am Hubland, 97074 Würzburg*

Central Asia highly depends on water for irrigation and hydropower generation. It has an observed warming rate above the global average, and in the future, climate change may be an important factor affecting water availability. In this study potential impacts of climate change on future water availability will be assessed by using a process based hydrological model in combination with output of a regional climate model (RCM). Here we will present results for the Karadarya basin in Kyrgyzstan.

The hydrological model WASA has been adapted and set up for this region. This included the interpolation of meteorological input data, and regional parameterisations for vegetation and soil data. The spatial interpolation of precipitation data is important to correctly represent runoff generation, but in a region with sparse data and complex terrain this is not a trivial task. Here we compare two approaches; the spatial distribution of rainfall is inferred from multi-linear regression on the one hand, and by ERA-40 data which have been downscaled by the RCM WRF to a resolution of c. 12 km on the other hand. The advantage of using the ERA-40 driven RCM output is that the wind field is known to the RCM and thus windward/leeward effects should be represented in a more suitable way, RCM output is however often biased. The hydrological model is then automatically calibrated to discharge data using the DDS algorithm.

Particularly in mountainous regions like in Kyrgyzstan and Tajikistan direct output from global climate models is not suitable for impact studies on water availability. Within the CAWa project output of the global climate model ECHAM5 is dynamically downscaled to a resolution of 1/6° using the RCM REMO. We will show first results of using the hydrological model with climate input for a future scenario.

Modeling the water management processes in the Syrdarya and Amudarya river basins: experiences and prospects

Anatoly Sorokin

SIC ICWC, Uzbekistan

The report presents the results of the research by SIC ICWC in the sphere of development and adaptation of the integrated water management models for Syrdarya and Amudarya basins for the short-term (1-2 years) and the long-term (20-25 years). The theoretical basis and architecture of the set of models was elaborated in the case of the Chirchik-Akhangaran-Keles basin (RIVERTWIN Project), the regional database is used as the source of data for the models (CAREWIB Project – www.cawater-info.net).

Adaptation of the developed approaches and methods for the Syrdarya and Amudarya river basins implies a number of specific research and development in individual directions (river network, flow regulation by cascade of HEPS', basin's environmental demand, and economic assessment of effects from water and energy management, etc.).

The basin integrated model should enable, based on own user project, different strategies of water and energy resources management in the basin as a whole and for specific areas (planning zones) within the Central Asian states, taking into account probable national socio-economic development scenarios, climate change scenarios, environmental limits and needs (aquatic ecosystems, the Aral Sea), and cropping pattern scenarios, etc. Thus, the software package should include: the model of water allocation and flow regulation by reservoir hydrosystems and HEPS (water and energy balances, etc.); the planning zone model (calculation of agricultural production, water supply for irrigated land, water balance of irrigated area); socio-economic model (calculation of economic indicators), the database; and, the Interface.

Receipt of water in the rivers of Northern slope of Jetisu Alatau because of glacier degradation

Vsevolod Golubtsov, Anastassiya Lineitseva

Regional Centre of Hydrology, Almaty, Kazakhstan

The estimation of water receipt in the rivers of northern slope of Jetisu Alatau, caused by thawing of long-term stocks of mountain glaciers is considered, for example of basin of the Karatal River.

The Karatal River is located on a northwest slope of Jetisu Alatau.

For an estimation of runoff of the Karatal River and its inflows were used differential integrated curves.

The analysis of differential integrated curves for the period 1932…2009 has shown, that a runoff of the researched rivers of the beginnings to be increased, from middle 80th years of 20 century, in connection with natural and anthropogenic climate changes, and glaciers' degradation.

Average runoff of the rivers for the period 1987 … 2009 was much above, than for the previous period 1932 … 1986.

The glaciers' degradation in the Karatal and Koksu rivers basins was observed, at least, since 1956. However, up to middle 80th years of the last century there wasn't receipt of water from the glaciers' degradation in these rivers.

The increase of the runoff for the second period (1987…2009) in comparison with the first period (1932…1986) was much more for the rivers, which basins are characterized by the greater area of glaciation. This substantial growth of runoff, we suppose, basically has occurred because of receipt of additional amount of water in result of glaciers' degradation in basins of the rivers

Comparison of the runoff data of the Shizin River, which basin is characterized insignificant glaciation (11,6 km2), and the Karatal River, which basin is characterized by significant quantity of glaciers (76,7 km2), are shown, that increasing of a runoff for the period 1987 … 2009 on the Karatal River was 10,0 m3/c (i.e. on 40 % more, than for the period 1932 …1986), and on the Shizin River - 2,4 m3/c (on 21,4 %). Comparison of a runoff of the Koksu River and Shizin River also was made. For the period 1987…2009 the runoff of the Koksu River has increased on 11,6 m3/c (on 35,3 %).

The receipt of water in the Karatal River because of glaciers' degradation became appreciable only, since middle 80th years of the last century. Consequently of glaciers' degradation for the period 1956 … 2009 this receipt of water in the rivers was 3,98 km3 for the Karatal River, and for the Koksu River - 3,66 km3. With respect to amount of glacial's runoff it is 67,8 % for the Karatal River, and for the Koksu River - 45,1 %. With respect to annual runoff of these rivers is 7,83 % for the Karatal River and 5,61 % for the Koksu River.

The results of the analysis specify an opportunity to use for an estimation of runoff changing in process of glaciers' degradation also for other mountain's rivers basins.

Structure of water resources of Central Asia and prospect of their use at any scripts of climatic and anthropogenous changes

Alexander Mandychev

Central Asian institute of applied researches of the Earth, Kyrgyzstan

The structure of system of water resources of Central Asia is submitted by such basic elements as glaciers, river, lake and reservoir, basins of underground waters. These elements is characters for all Central Asia with variations of prevalence first in the mountain countries and last in flat.

Irrespective of a direction of development of climatic conditions in Central Asia, both in the party siccation, and in the party of humidifying, and as tendencies of requirements of economic activity, it is obvious, that optimal by variant in the field of such element of system of water resources, as the river drain, is maximal controlled flow by means build of reservoirs. Accommodation of reservoirs is optimum within the area of mountain regions, where it is possible to ensure maximal volume at the minimal areas and accordingly minimal ecological losses and losses of ground resources. In this case in the high-water period there is a mitigation of negative influences of floods, and in low-flow period is possible use of the saved water stocks in interests of all Central Asia region.

In conditions of any direction of climatic changes, irrespective of a nature and character is necessary complex use of all elements of water resources. It means, that is necessary to be ready to flexible strategy of use of those or other elements of water resources depending on real conditions and requirements. So, in conditions long total of siccation, last boundary are underground waters. In this case on their use should be focused of most priority consumers, and secondary should essentially correct sources and scales of water use.

The stocks of underground waters as well as a river drain give in to regulation already approve in practice by technology artificial recovery of underground waters. As is possible regulation of process of melting of glaciers, for the present tested in experimental variants, by decrease of albedo of ice or covering by heat-insulated screen.

The obvious moment at any scripts of change of water resources is the development optimum rational water use in all branches of activity on the basis of new technologies.

Concerning the long-term forecasts of the tendencies of modern climatic changes in Central Asia it is necessary to emphasize incorrectness of linear extrapolations, in particular, increases of temperature of surface air. It is precisely known to the professional scientific experts, that in system of geosphere always there were cyclic nonlinear changes of all climatic parameters. It means, that the global tendency of increase of temperature will inevitably be replaced by the tendency of downturn, at the expense of realization of set of compensatory mechanisms of geosphere, much more energetically powerful, than declared as the reason global warming influence of greenhouse gases.

Mankind and its Central Asia part should be ready in technological aspect to any variants of climatic changes by means of optimum adapting to them, than actually it and is engaged during all history of existence. And while it with it not bad manage, About what testifies of fact of our existence.

Zarafshan River water quality assessment: retrospective and present

Dr. Malika Ikramova, Dr. Ifoda Akhmedkhodjaeva, Feruz Yusupov

Central Asian Scientific Research Institute of Irrigation, Tashkent, Uzbekistan

Zarafshan River has been the one of the cleanest tributaries to the Amu Darya. Coming from the mountainous area in Tajikistan the River connected the famous cities of Samarkand, Navoi and Bukhara. Today, Zarafshan does not reach the Amu Darya anymore because of the artificial abstractions supporting irrigated agriculture.

Zarafshan Basin is of high importance for the water-based economy in Uzbekistan. In the river basin lives about 6 million inhabitants, or approximately 11% populations of Uzbekistan. The population is steadily growing. Socio-ecologic problems of the region are concerned with the intensive river water use as being the exclusive water resource in this region. Beside intensive agriculture, several industrial sites form the anthropogenic pressure. According to the Uzbek Nature Protection Committee National Report 2004 the risk of the ecological status at the Zarafshan river basin is stated as crucial.

Within the project “Impact of transition processes on environmental risk assessment and risk management strategies in a Central Asian transboundary basin (Zarafshan)” funded by Volkswagen Stiftung the issues indicated above were investigated and worked out recommendations to mitigate the situation.

The work to be presented conducts to water quality by the specific focus on how irrigation and industrial waste water is affecting the pollution status. Quality standards were studied existing at soviet period and compared to the present Uzbek regulations for drinking, irrigation and industrial water. Reviewed and assessed water quality change dynamics based on data for the last 20 years (soviet and current periods). Existing surface and ground water quality stations and database sources, water quality national standards and its comparison to ex-soviet and international norms, the methods for testing and available equipment and other relevant aspects were studied.

Pollutants expansion, as well as point and non-point sources of pollution in Samarkand and Bukhara regions was investigated and Zarafshan water quality for the 1995, 2000 and 2007-2010 years ware analyzed.

Types of water exchange in hydrogeological structure on Fergana valley

A. A. Mavlonov, J. H. Djumanov, Y. T. Chertkov

The paper presents different types of water exchange in hydrageological structure of aquifers on Fergana valley. Stands out the following types of aquifers underground water..

1. Aquifers of hilly under on-board of Fergana valley, hydraulically insulated;

2. Hydraulically interconnected aquifers of alluvial fan and underground water aquifers of Central part of Fergana valley;

Stands out of following types of water exchange on hydrodynamical of sign, by condition on simultaneity of ground water intake (linear, area of polygon and others) and discharges (the total evaporation, water outcrop, recharge of flow and others):

A. Regional an isochronous (on ground water intake and outflow- drainage underground water) -a type of water exchange perennial typical of aquifers underground water on-board parts Fergana valley and alluvial fan with rate (duration) of water exchange equal 3-5 years.

As monitoring of studies equalized regimen of underground water is installed on alluvial fan retardation water flow (simultaneity) water outcrop of flow from time of ground water intake for 2-3 months. At stationary mode ground water intake (infiltration) the pressure of underground water to occur on action two power: 1) issue hydrostatically of the pressures (the level and piezoconductivity) under the law Pascal and; b) migration of underground water under the law Darsi and so value flow underground water on alluvial fan correlated on synchronous graphics, different consumptions of rivers, but with their integral crooked (Geync V.A., 1969).

B. Local synchronous (seasonal) type of water exchange of zones: retardation water flow and forms 3-7 months typical of irrigated lands under deep-water lie under water table (alluvial fan of aquifers on Central part of Fergana valley).

Chosen types and rates of water exchanges can be used under integrated management resource underground and surface water.

Integrating environmental flows into water management to sustain wetlands ecosystem services - Learning from EU NeWater research in the lower Amudarya River Basin

Umid Abdullaev[1] Vladislav Talskikh[2], Gulchekhra Khasankhanova[1] , Raisa Taryannikova[2], Ilya Joldasova[3] and Maja Schlüter[4]

[1]*UZGIP Institute, MAWR, Tashkent, Uzbekistan.*

[2]*Research Hydrometeorological Institute, Uzhydromet, Tashkent, Uzbekistan*

[3]*Karakalpak Branch of Uzbek Academy of Sciences, Institute for Bioecology, Nukus, Uzbekistan*

[4]*Helmholtz Centre for Environmental Research Leipzig, Permoserstrasse 15, 04218 Leipzig, Germany*

The desiccation of the Aral Sea and Amudarya delta led to the most significant damage of aquatic and terrestrial ecosystems and is considered to be the largest human-made disaster in Uzbekistan. The last decades have been characterized by global climate change and an increase in the number of extreme weather and climatic phenomena, causing serious damage to people, the economy, and habitats.

The wetland ecosystems of the delta of the Amudarya river have for centuries supported the local population with a multitude of ecosystem services. The water management measures to store water in high water years in depressions in the delta region have created a system of old and new lakes which support commercially valuable fish and muskrat populations, other game species, as well as reed production. The main tradeoff in water use in the delta is between water use for irrigation and fish enterprises in deltaic lakes. There is no interaction between the irrigation sector and the fisheries and wetland conservation sectors, which would facilitate coordination and balancing of spatio-temporal water needs. The extreme drought event in 2000/2001 which was a strong disturbance to all wetland components has further caused degradation of the ecosystems up to the destruction of ecosystem functions on the whole.

This contribution wants to raise awareness about the potential to improve the provision of wetland ecosystem services in the lower Amudarya River by integrating their flow requirements into water allocation schemes. We develop and analyze several future water management/water use scenarios and assess their implications for the provision of environmental flows under the climatic uncertainties, and the potential and benefits of the proposed options, as well as challenges and needed steps in their realization. The findings indicate that the technical interventions of redistribution and efficiency increase need to be accompanied by institutional changes and a move towards multi-purpose water use system that recognizes the needs and benefits of other water users besides agriculture. The paper highlights the need for mobilization of resources and change in perception on social and economic benefits of environmental flows, and use of local knowledge of farmers, fishers and local communities for monitoring and development of mitigation measures.

Session 2 – Water management in agriculture: Processes, modeling and implementation

Water managers in Central Asia are facing large challenges, such as optimal water allocation, increased irrigation efficiencies, selection of appropriate crops, soil salinisation. Yet, not all processes influencing these tasks are fully understood and quantified. This session will cover processes affecting agricultural performance such as interactions between surface and groundwater, as well as monitoring methods, integrated models for water managers and approaches to increase water productivity.

Session chairs: Prof. Victor Dukhovny, Prof. Hans-Georg Frede

Present problems of irrigated agriculture in Aral Sea basin and future decisions

Prof. Victor Dukhovny

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Two-part tariff - Irrigation Pricing Alternative for Water User Associations in Central Asia

Oyture Anarbekov[1], Kakhramon Jumaboev[1], Dennis Wichelns[2]

[1]IWMI-Central Asia

[2]IWMI HQ-Sri-Lanka

Water pricing and recovery of the costs of irrigation operation, and maintenance have been continuous issues for many decades. The low charges for irrigation water are questioned, as well as, the small percentage of farmers who actually pay the charges. In some water management organizations, fee collection rates are near zero, even when water charges are well below the cost of project operation and maintenance (O&M) (Ahmand 2002; Easter 1993; Govt. of People's Republic of Bangladesh 2000; Svendsen et al. 1997). This creates serious problems both for irrigation agencies and, in the long run, for farmers. If the fees collected do not cover the costs of an irrigation or water management organization, its sustainability, without continued government subsidies, may be at risk.

This paper will focus on historically the objectives of the fee structures and introduction of irrigation service fee pricing. What are the key prerequisites to achieve the primary goals of irrigation service pricing and how to design an effective pricing mechanism based on local conditions and develop a strategy for obtaining high rates of collection.

The structure of the paper is as follows. A brief overview of the Irrigation Service Pricing Alternatives practiced worldwide. Then discuss what is the main irrigation service pricing method practiced in WUAs of Ferghana Valley, Central Asia today. Discuss the advantages and disadvantages of the current irrigation service pricing practiced in WUAs of Ferghana Valley. Afterwards, the discussion will revolve around the introduction of the two-part irrigation service fee pricing in WUAs of the Ferghana Valley. There will be provided examples of introduction two-part tariff from WUAs of IWRM-FV & WPI projects[1]. Separate session will address what are the benefits & limitations of introduction two-part tariff ISF pricing in WUA level. Finally, the discussion will be concluded with recommendations of its extensions.

[1] IWRM-FV & WPI projects are implemented by the Consortium of IWMI and SIC, ICWC in three countries Uzbekistan, Tajikistan and Kyrgyzstan with the funding from the Swiss Agency for Development and Cooperation (SDC).

Role of virtual water concept in the arid areas of Central Asian countries: The case of cotton and wheat production in the Khorezm region

Inna Rudenko[1], Utkur Djanibekov[2], John Lamers[1]

[1]*ZEF/UNESCO Landscape restructuring project in Khorezm, Uzbekistan*

[2]*Centre for Development Research, University of Bonn, Germany*

Irrigated agriculture produces 40% of world's food on 17% of world's croplands. The well-being of many countries in arid and semi-arid areas depends on irrigated agriculture. For example, in Central Asian Uzbekistan, food self-sufficiency, employment and income of the majority of the rural population is generated in irrigated agriculture. Large amounts of water are diverted from the rivers each year for agricultural production. At the same time, agriculture contributes only 20% of GDP, and varies depending to administrative regions within the country. In addition, unsustainable water use by farmers and ill-performance of irrigation and drainage systems has affected croplands' productivity. The increasing scarcity of water may also lead to increased political and social tensions and transboundary conflicts over water may become evident. Hence, to deal with the regional water challenges in the future, it is critical now to create awareness of the population on water problems and to find the more efficient ways of using water.

The research undertakes a combination of value chain and virtual water analyses of the main crops in Uzbekistan – cotton and winter wheat – by the case study of Khorezm region. The study provides a solid basis for better informed decision-making to reach land, water and ecosystem sustainability, compared to the individual results of these approaches. Based on the findings, it would be recommendable to intensify local cotton processing for higher revenues. However, virtual water analysis indicates that unless the 'grey' (waste) water originating from deep cotton processing by the textile industry can be handled, it is advisable to go for light processing of fiber to yarn.

Results of the study pointed at two options for actions, such as (i) reduction of agricultural water use by upgrading irrigation and drainage networks and introducing field level innovations; and / or (ii) promote the shift of water use from the high water consuming agricultural sector to a less water consuming industrial sector. Increasing water use efficiency, processing products with higher value added and raising water users' awareness on water shortage will support Uzbekistan to contribute to the Millennium Development Goals of eradicating poverty and hunger and achieving food and water security.

Methods to determine optimal water use for cotton growth

Yvonne Dernedde, Gulom Umirzakov, Prof. Hans-Georg Frede

Center for international Development and Environmental Research (ZEU) Giessen Germany
CAWa Project Central Asian Water WP3

The water foot print of Uzbekistan is approximately five times as high as the global foot print. This is not only due to the high water demand of the cotton plant which is grown as one of the major crops in the country. It is mainly due to inefficient irrigation practices: the irrigation infrastructure is old and irrigation management plans are inefficient.

In this work we focus on investigating the Water Use Efficiency (WUE) in cotton production under actual irrigation management. The objectives of our work are to quantify unproductive losses of irrigation water during the vegetation period, to determine the optimal water use for cotton growth and to develop efficient irrigation scheduling for the future.

We use information on soil moisture, groundwater level, meteorological data, irrigation amounts and harvest data which have been monitored for the vegetation period 2010 to quantify the individual components of the water cycle.

This data will be used within the CROPWAT model to estimate actual WUE and actual evapotranspiration losses. With CROPWAT, the recommended water amount and irrigation schedule is calculated and will be compared to the current management and scheduling. In addition, the loss of evaporation from the ground water storage have been calculated by analyzing the isotope fractionation of soil water samples in several soil profiles in the observation area.

We detected a huge ground water level rise caused by the current irrigation practice. The interpretation of this observation is indicating that the plant is obtaining water primarily from the ground water storage than from the soil water storage. In addition, the results indicate that a great amount of irrigation water evaporates from the ground water storage during the vegetation season, due to a high ground water level.

Effective management of soil salinity – based on advanced monitoring and modeling tools

Akmal Akramkhanov, Bernhard Tischbein, Usman Khalid Awan

Center for Development Research (ZEF), University of Bonn, Germany

The effectiveness of the current soil salinity management practices mainly focusing on pre-season leaching according to static norms is limited, despite the high water input the lowering of soil salinity is rather small and often only influence the upper layers. This is illustrated by electromagnetic induction measurements of spatial distribution of soil salinity in the study area. To optimize the current situation, we suggest an approach which integrates interventions referring to the leaching and the accumulation of salts during the vegetation period in a coordinated way. Recommendations to improve the current practices are based on introduction of advanced monitoring tools by utilizing modern technologies such as non-destructive electromagnetic induction technique coupled with GPS and data logger, and the modeling approaches (i.e., HYDRUS). The above described monitoring and modelling tools provide information to react by timely and site-specific measures on temporally and spatially variable soil salinization. With respect to implementation of advanced leaching strategies, infrastructure for discharge dosage at field level is a prerequisite. As the establishing of sophisticated measures (flumes; weirs) is not achievable at short notice, the introduction of siphons or using the hydraulic characteristics of pipes currently in use at field level can be suitable option to estimate discharges. As a typical win-win-situation, the discharge dosage infrastructure supports optimization of the irrigation water application process in the vegetation period and volumetric water pricing as an incentive towards irrigation and leaching water saving.

Monitoring of ecological consequences of irrigation development in Central Asia

Dr. Galina Stulina

SIC ICWC, Tashkent, Uzbekistan

Big scale development of irrigated lands in Central Asia that achieved 8.3 million ha promoted huge growth of agricultural production in all states of region, increase of employment in rural area, but same time lead to significant worsening of environmental situation that got reflection in some directions:

- growth of ground water level and following permanent deviation under impact of regime, type and intensivity of irrigation same as from probability of drainage;
- increase of degree salinity of lands;
- change in mineralization of ground and rivers waters;
- shrinking of Aral Sea:
- desertification of former bed of Aral Sea and delta of rivers Amudarya and Syrdarya.

Project CAWA concentrated attention on the monitoring interrelation between irrigation and drainage on example Ferghana valley and Priaralie, where beside of practical observations of dynamic ground water depending from irrigation regime was gathered and analyzed data base for changing level and mineralization of ground water from 1985 up to 2008 years.

Second direction of investigation covered area of Priaralie and dry bottom of Aral Sea, where complex hydro geological, hydrological, soil and environment monitoring was organized by common forces of German and local specialists.

Presentation described results of finding and program for organizing permanent monitoring by combination of land survey on the typical points and remote sensing for recognizing processes of stabilizing zone of ecological disaster.

Hydrochemical and stable isotope composition of various compartments in the Amudarya river delta and the dynamics of surface / groundwater interaction

Georg Schettler[1], Hedi Oberhänsli, Galina Stulina, Stephan Weise

1 Helmholtz Centre Potsdam- GFZ, German Research Centre for Geosciences, Section 5.2 Climate Dynamics and Landscape Evolution, Telegrafenberg, 14473 Potsdam, Germany

2 The Scientific Information Centre of the Interstate Commission for Water Coordination – SICICWC, Karasu-4/11,Tashkent, 100187, Uzbekistan

3 Helmholtz Centre for Environmental Research - UFZ, Theodor-Lieser-Str. 4, 06120 Halle, Germany

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Development of the Demand management for increasing of water productivity in agriculture

Mohsen Barahimi, Inom Normatov

Institute of Water problems,Hydropower and Ecology, Academy of Sciences Republic of Tajikistan

Iran is a water scarce country with limited rainfall in many places and irrigation is widely used to support the agricultural activities in the country. Present irrigation techniques are characterized by rather low water productivity due to losses in the system and inefficient water allocation schemes. The National Water Document (NWD) has been adopted as a directive on how to manage irrigation systems and is supposed to improve the situation. Technical issues in NWD relate to insufficient attention for local conditions related to soils, crops, average weather data and spatial differentiated canal efficiencies. As a result of this it appears that the demand for irrigation requirement according to the NWD differs substantially from the real demand and that appropriate delivery in time and space does not take place. Still the law requires that the NWD should be implemented. The main objective of this work is to improve the water productivity and allocation efficiency of the irrigation systems in Iran. It will do this by updating the NWD and the operationalization of this document by providing the responsible agencies with approaches and tools for planning (on a yearly basis) and operational management (on a weekly basis). Analyzes the water resource management in the agricultural sector in Qazvin Province with specific attention to crop water requirements, water availability (supply), balance between surface water and groundwater, actual and desirable delivery structures, irrigation efficiency. Furthermore, an analysis will be made of the situation of the agricultural water users and interactions with other stakeholders in the process. Use will be made of modern GIS and RS techniques.To gain a better understanding of the functioning of the irrigation system by trying to identify and quantify the issues related to the individual water balance components of the irrigation system. This forms the base for the work related to planning and operations. The groundwater level changes in the system can be converted to water volumes through the aquifer's specific yield values making it possible to assess the long-term trend in the groundwater system. The water balance in the irrigated system can in principle be calculated by comparing the input by precipitation, groundwater and irrigation deliveries against the system's output, i.e. the actual evaporation, which will be determined by remote sensing techniques. It is proposed to study the period from 2000 - 2008 because MODIS (medium resolution) and ASTER images are available from 2000 onwards. In addition use will be made of AVHRR and LANDSAT imagery.

Technical aspects of water resources management in the IWRM-Fergana Valley Project

Mikhail Horst

Leader of the SIC ICWC team on technical issues of the project “IWRM-FERGANA”, Uzbekistan

Optimization of decisions in the irrigation sphere is, in a general sense, a complex technical and economical problem including both agricultural and economic assessment and determination of a rational maximum crop yield under specific conditions of agricultural production and a number of other factors and background indicators. When solving it, it is required to search for reasonable compromises that could significantly meet the versatile requirements of parties in the irrigated agriculture. Thus, the farmer is concerned with gaining maximum net profit from the agricultural production, while the government is concerned with more efficient and productive use of water resources along with possible meeting the requirements of not only the irrigated agriculture but also of the environment.

Under current conditions of irrigated agriculture in Central Asia, when large state farms have been transformed to a great number of smaller farms, the irrigation network manageability level has substantially lowered. Low-water periods of recent years often worsen due to man-made water deficits caused by poor water use discipline, mismatch between crop demands for irrigation and irrigation network operation modes, that is due to proper management deficiency. In this context, the Itegrated Water Resources Management in the Fergana Valley Project implemented under under the aegis of Swiss Agency for Development and Cooperation is of practical importance for the countries involved in it: Kyrgyzstan, Tajikistan, and Uzbekistan. One of the main goals of this project is development and strengthening of interaction between different levels of the water hierarchy: Canal Management Organizations, Water Users/Consumers Associations (WUA/WCA), and farmers-water users.

The technical aspects of the Project are tested on four pilot main canals, i.e. on their command areas of 116 ths. ha (70 WUAs/WCAs), and include the activity aimed at the development of tractical recommendations and appropriate tools for the implementation in the following areas:

- Water demand and water use & water distribution planning;
- Water demand management and water saving;
- Management Information Systems;
- Monitoring and assessment;
- Measuers to ensure the economically sustainably operation of IWRM.

Experience of institutional building in IWRM-Fergana Project

N. N. Mirzaev

SIC ICWC, Tashkent, Uzbekistan

Since 2001, Swiss Agency for Development and Cooperation (SDC) has been supporting water sector reform in Central Asia. Financial support of the Integrated Water Resources Management in Fergana Valley Project (IWRM-Fergana) is the most significant contribution of SDC in the region and, according to independent international experts, it has become a brand.

The word “integrated” (from Latin integrum - wholeness) is a key concept in IWRM and reflects the holistic, integrated system of water resources management. In addition, the term “integration” (from Latin integratio - the union, process of mutual approaching and establishing interrelations) should be understood as a process of creating new institutional structures.

The main objective of the project is to improve water management efficiency in Fergana Valley through institutional reforms based on the IWRM principles. It may be said that, in principle, for almost 10 years, the IWRM-Fergana Project has been dealing mainly with the problems of integration in water management. The integration process is a very common phenomenon in any society at any time and in this sense, the project’s work is not original. Another thing is how to integrate. The history of reforms in agriculture shows different examples of reorganization in the form of integration, “reintegration” and disintegration:

The special feature of integration in the IWRM-Fergana Project is that, according to the IWRM logic, all new structures designed to improve water governance and management (water supply management) were developed on the basis of hydrographic principle, while the structure designed to improve water use governance (water demand management), i.e., Water and Land Commission (WLC) is established based on a territorial principle. Stages of the development of new institutional structures and levels of integration within the project are as follows:

- Water Users Association (WUA) – integration of water users (farms and other water users).
- Canal Management (CM) – integration of water suppliers (water managers) along the main canal (system) (MC).
- Union of Canal Water Users (UCWU) – integration of MC water users’ organizations to coordinate and protect interests of WUAs and others.
- CWC - integration of MC stakeholders to improve water delivery:
- Board of Canal Water Committee (CWC) - integration of water suppliers and mainly agricultural water users.
- CWC Council – integration of all stakeholders: water managers, water users, local authority, environmentalists, etc.
- Basin Water Committee (BWC) – integration of all stakeholders within the river basin.
- WLC – integration of all stakeholders within administrative boundaries (rayon, province) to improve water and land use efficiency.

Monitoring and assessment of the project impact shows that institutional reforms entailing improvement of water governance had a positive impact on the quality of water management (improvement of stability and equitability of water supply).

Initiating SCADA Projects in Irrigation Districts of Lower Rio Grande Valley, Texas, USA

Askarali Karimov, Eric Leigh, Dr. Guy Fipps

Texas A&M University, Texas, USA

Delivering water efficiently through distribution network systems is a priority task for irrigation districts but sometimes it is a difficult goal to achieve. SCADA shows promise of improving operational efficiency, increasing flexibility in the amount and timing of water deliveries and reducing spills and other losses in the distribution network systems.

However, implementing SCADA in a district for the first time is a difficult process. Districts often do not understand or are distrustful of the technology. They often do not know or understand how their system actually operates, thus making it difficult to design SCADA systems and to determine operational parameters and control algorithms.

Selecting equipment that is easy to integrate into the district operation is not a simple decision. Simple tasks such as selection of sensors and communication hardware become time consuming because of the need to explain advantages and disadvantages of each component. District board of directors are normally reluctant to spend money, which further complicates the process. Once SCADA is installed, district personnel have to be trained on how to use the equipment to perform daily operations.

In this paper we discuss the process of implementing SCADA projects for the first time in Hidalgo County Irrigation District No.6 that had no previous experience with such technology or control systems. The paper will cover both hardware aspects as well as human consideration, and discuss some of the many lessons learned....

Virtual water trade of Uzbekistan

Maksud Bekchanov[1] and John Lamers[2]

[1]*Center for Development Research (ZEF), Uni-Bonn, Germany*
[2]*ZEF/UNESCO (Uzbekistan) Project*

Worldwide increase in water demand due to population growth, industrial development and urbanization results in a need of increasing economic efficiency of water resources. In particular, as a consequence of ill-water management and governance in the Aral Sea Basin, in Uzbekistan, water efficiency is too low bringing frequent water shortages, especially in downstream regions. In the aftermath of independence, in spite of liberalization reforms in agricultural sector cotton production with its huge water requirement and low economic efficiency slightly decreased. To compare water use efficiency of the production in different economic sectors, this study aims to estimate virtual water content of the production and export-import in these sectors on the basis of national input-output model. The results indicate that Uzbekistan is net exporter of virtual water due to substantial contribution of cotton fiber export to total hard currency revenues. Direct virtual water use in producing in particular rice, wheat, and cotton is higher compared to all other crops and sectors. Indirect virtual water use in livestock production and cotton and food processing is high, although direct water use in these sectors are extremely low compared to cotton, wheat and rice production. The study concludes that in order for Uzbekistan to exploit all its opportunities in the future, the differential crop support must be omitted or equal importance should be given to all crops and sectors....

Increasing irrigation efficiency in dryland Uzbekistan under conditions of uncertain water supply

Ihtiyor Bobojonov[1], Jennifer Franz[2], John P.A. Lamers[3]

[1]Farm Management Group, Faculty of Agriculture and Horticulture, Humboldt-Universitaet zu Berlin, Germany. Email: ihtiyor.bobojonov@agrar.hu-berlin.de,

[2]University of St Andrews, School of Geography and Geosciences, Scotland (UK),

[3]ZEF/UNESCO Uzbekistan Project, Uzbekistan

During the study a stochastic programming model was elaborated that allows analyzing the potential impact of policy options on irrigation water use in the irrigated drylands of Central Asia which are suffering more for a physical than economic water scarcity. The model combines hydrological, biophysical and economic aspects in one framework. Uncertainty of irrigation water supply, groundwater capillary rise, agro-ecological heterogeneity of irrigated fields and the location of the farm within an irrigation system were taken into account in the model development for the case study region Khorezm, located in northwestern Uzbekistan. Following the successful calibration of the model to the base scenario, increasing the probability of water shortage, irrigation water pricing, liberalization of the agricultural markets, availability of water-wise technologies were the main scenario simulations.

The results demonstrated that a change in crop portfolio towards less water-demanding crops has the potential to increase irrigation water use efficiency (WUE) and reduce income volatility under an uncertain water supply when assuming existing agricultural policy system in Uzbekistan remains unchanged. A widespread adoption of water-wise innovations showed to be a high potential in reducing risk associated with irrigation water availability and increasing (WUE). However, innovations with the highest potential of increasing WUE tend to be capital-intensive and expenses for such innovations are higher than the marginal income obtained from technological development under the state procurement system. The impact of introducing water pricing (for diverse reasons) will be also limited under the present conditions. Given the present low income of farmers, a water pricing will bear the risk to increase the volatility of farm income. In contrast, policy scenarios that assume liberalized agricultural markets demonstrated that introducing irrigation water pricing and investment into water-wise innovations are feasible under conditions of increased choice of farmers on crop allocation and marketing channels. Increased irrigation WUE under the current state procurement system is not realistic, unless the state subsidies the purchase of water-wise technologies and increases the investment on irrigation and drainage infrastructure as observed in certain developing countries. Otherwise, shallow groundwater and secondary soil salinization will continue since expectation of private investment on irrigation sector maintains unfeasible.

It is argued that agricultural policies and socio-economic settings play a determining role in the success of innovation adoption and measures aiming at improving irrigation WUE. Therefore, polices aiming at increasing access to credits and subsidies for the purchase of water-wise innovations could support farmers during the transfer period from a command economy to agricultural-decision driven by market signals.

Keywords: irrigation efficiency, uncertainty, water saving technologies, agricultural policy

Opportunities for Improved Water Productivity On-Farm Level in the selected farms along South Ferghana Canal

Kahramon Jumaboev, Davron Eshmuratov, Oyture Anarbekov

IWMI-Central Asia

Irrigated agriculture in Central Asia can only be developed through increase of crop yields and reduction of water volumes applied per unit of agricultural production. Thus to improve agricultural production, proper agronomic measures and irrigation schedules have to be developed considering local conditions.

This paper will focus on results from 9 cotton farms along South Ferghana canal, where actual cotton irrigation water productivity have been measured and through application of Soil-Water-Air-Plant (SWAP) model for the same fields potential cotton water productivity and cotton yield have been predicted.

Simulation results indicated that actual irrigation water applied was more than crop water requirement in selected farms and there are much more contribution from groundwater except Sobir ota farm. Model results indicated that there are potential opportunities exist to increase crop yield in Abdurahimov,Kobilov, Umid, Didiyor and Sobir ota selected farms along South Ferghana Canal and finally cotton water productivity can be considerably improved if irrigation scheduling for cotton properly organized and shallow ground water table considered.in selected farms....

Income-based projections of water demand for food consumption in Central Asia: The case of Uzbekistan

Nodir Djanibekov, Klaus Frohberg, Utkur Djanibekov

Central Asia is considered among the most vulnerable areas to climate change and prone to problems issued by climate change. Climate change, all things held constant, will reduce regional water availability and thus will adversely impact rural incomes in irrigated areas. It is widely recognized that in addition to projected water supply scenarios, the water situation has to be assessed from the perspectives of water consumption requirement for food.

On example of Uzbekistan, this paper demonstrates an elegant approach that can be applied for projecting the impact of income-driven changes in food consumption pattern on water requirements in Central Asia. To reveal the influence of large income changes on food diets, the Normalized Quadratic – Quadratic Expenditure Systems (NQ–QES) was calibrated and applied. Using the NQ-QES, the national water requirements from consumer side were projected till 2025 using virtual water content of main food items consumed in Uzbekistan. The chosen approach proved to be reliable with respect to the forced theoretical conditions and convenient for parameterization without imposing a computational burden for the entire Central Asian region.

The results show that for Uzbekistan the increase in water requirements will be largely caused by the income growth than by the expected population growth. Unless proper measures are taken, due to the high income responsiveness of food diets in Uzbekistan, the economic growth can put higher pressure on already scarce water resources. The pressure of population and income growths on water requirements can be relieved by improving crop yields and livestock productivity and introducing water-wise technologies and fodder crops that are less intensive in water. Adjustment of the population diet via raising the people awareness is likely to contribute to the mitigation of the future water scarcity impacts. Ultimately, considerations towards virtual water trade can be an option to address the issue on the regional water implications of climate change.

Water market in Central Asia: Ambitions and Reality

Yusup Kamalov

The Union for Defense of the Aral Sea and Amudarya

Necessity to divide the Aral Sea basin water between 6 countries by any principle leads to idea of creation of water market in Central Asia. However this idea doesn't meet support in downstream countries yet. The market is understood as uncontrollable aspiration of stakeholders to gain money by anyway. Responsibility of subjects for the contracts, for guarantees of deliveries, for quality of services is rejected. Ecosystems aren't considered as equal right partners in economy, and the payment for environmental services is perceived as violation of human rights. Meanwhile losses from droughts, floods and irrational use of water continue to grow. Global climate change threatens with a total disappearance of the glaciers feeding the rivers.

Monetary relations between the countries in water distribution would be the tool stimulating increase of efficiency of water use, would allow to create a reliable financial system to insure against natural disasters and to restore the already destroyed ecosystems. A legal basis for the market creation is a concept of equality of all subjects of the water market. All countries have the right to own natural objects and to be provided by water of the same quality and by quantity, sufficient for existence of these objects.

Implementation of the water market should pass several stages. Definition of "the owner of water» should be the main problem. The upstream countries can apply for this role. However, considering the highest responsibility of the "owner" before participants of the market and some mistrust between the countries, it is better to entrust this right to such interstate formation as IFAS. Legitimacy and trust to IFAS is provided by Presidents' Council. At the beginning IFAS will incur responsibility for keeping alive of water ecosystems, taking for this a payment for water pollution. This payment will increase in due course till will reach the cost of water treating by the best contemporary technology. The increase schedule should be known in advance to all subjects. This stage should take at least 10 years.

The following stage — introduction of a payment for water use by industry and agriculture. It will also gradually increase, having reached the cost of cheapest technology of getting fresh water. This stage also should take not less than 10 years. The money collected should be directed to crediting of less water technologies, insurance payments in cases of natural disasters, restoration of ecosystems, especially of forests along the rivers.

Session 3 – Remote sensing and information systems for sustainable water and land management

Remote sensing offers great opportunities for natural resource managers, scientists, and policy makers. Crucial information on the land surface can be derived at different spatial scales and for repetitive time steps, e.g. on land use, land cover, snow, soil moisture changes. Such earth observation and other information can be tailored to the needs of users and visualized by information systems. This session is dedicated to remote sensing applications and information systems and their potential for supporting sustainable water and land management.

Session chairs: Dr. Gerd Rücker, Dr. Kamilya Kelgenbaeva

Potentials of remote sensing for sustainable land and water management in arid ecosystems

Dr. Christopher Conrad

University of Wuerzburg, Institute of Geography, Remote Sensing Unit
In cooperation with the German Aerospace Center (DLR)

The ongoing Global Change has considerable implications on the environmental and soicio-economic conditions in many parts of the world. Population growth, increasing temperature and changing water regimes will incrementally affect the spatial distribution, function, availability and quality of land surfaces and water storages. Objective and reliable geoinformation have shown to be highly supportive for managing limited resources in different ecosystems. Especially in Central Asia, where sustainable land and water management is essential for the rural population mostly depending on income generation in agricultural production and livestock farming, an increasing demand on such geoinformation has been formulated by many stakeholders.

The presentation focuses on variables and indicators for land and water management which can be provided by remote sensing. To get an impression of present and future options an overview of current and upcoming remote sensing systems and their general properties (lifetime, resolution, area coverage) will be given. Afterwards latest approaches for mapping land use and land cover (LULC) at different spatial scales and their suitability for political decisions and spatial planning will be presented. LULC maps provide primary geoinformation for the derivation of biophysical parameters of the land surface such as albedo, vegetation cover fractionFraction of Absorped Photosynthetically Active Radiation (FPAR), Leaf Area Index (LAI), net primary production (NPP). The derivation of these parameters will be part of the presentation as well as their utilization for monitoring rangelands and (irrigated) agricultural production systems. Selected examples will demonstrate, how both geoinformation, remotely sensed LULC maps and biophysical parameters, are increasingly used as input for hydrological modelling (catchment hydrology or water distribution in irrigation systems) or for modelling soil erosion.

Throughout the presentation, different applications, related data requirements, approaches, results and implications will be illustrated by examples from Central Asia, but also from arid ecosystems in South and West Africa. The outlook attempts to relate presented approaches to questions which currently need to be answered for adequate and sustainable land and water management in Central Asia and it will show options for future collaboration in the field of remote sensing. An important role of real capacity building in the field of remote sensing and problem oriented collaboration between projects in Central Asia will be the focus of the conclusion.

Design and Development of the CACILM Multicountry Sustainable Land Management Information System: Inception phase results

Kamilya Kelgenbaeva[1], Chris Hatten[2], CY Ji[3], Mark Kunzer[4]

[1] CACILM MSEC SLM-IS Specialist, Bishkek, Kyrgyzstan (kkelgenbaeva@cacilm.kg)

[2,3] ADB SLM-IS International Advisor, Manila, Philippines (hattencj@hotmail.co.uk, cyji888888@yahoo.com)

[4] ADB Senior Environmental Specialist, Office of the Director General, Central & West Asia Department, Asian Development Bank, Manila, Philippines (mkunzer@adb.org)

The Central Asian Countries Initiative for Land Management (CACILM) is a 10 year partnership program of Central Asian countries (CACs) and development cooperation partners dedicated to combating land degradation and improving rural livelihoods. CACILM brings together Kazakhstan, the Kyrgyz Republic, Uzbekistan, Tajikistan and Turkmenistan supported by the international donor community to work towards sustainable land management, land degradation, biodiversity, water management and adaptation to climate change.

The paper discusses the design and development of the CACILM Sustainable Land Management Information System (SLM-IS) component, and use of remote sensing and national GIS data in the Inception phase. Landuse, landcover, Water Management, Climate and detailed socio-economic data have been used to establish baseline information and evaluation indicators for assessment of changes in land management and rural livelihoods. The inputs of the Central Asian Countries and other partners are summarized here.

Keywords: CACILM, Landuse, Landcover, Land Degradation, GIS, RS

Regional land surface properties of Central Asia derived by remote sensing for an improved understanding of the interactions between climate, water and vegetation

Ursula Gessner[1], Gerd Rücker[2], Andreas Dietz[1], Christina Eisfelder[2], Malte Ahrens[2], Claudia Künzer[2]

[1]University of Wuerzburg, Institute of Geography, Remote Sensing Unit,
in cooperation with the German Aerospace Center (DLR)
[2]German Aerospace Center (DLR), German Remote Sensing Data Center (DFD)

The globally ongoing alterations of terrestrial ecosystems are a key element of Global Change. They are mainly induced by land use and climatic changes and associated alterations in land surface properties can influence e.g. water cycles, water quality, erosion and even regional climate. Objective and consistent information on the dynamics of the land surface are required for an improved understanding of these interactions between climate, water and vegetation. For a large region like Central Asia it is of special importance to base this understanding on regional and consistent baseline data in order to enable an improved and sustainable land and water management. This kind of data can be provided by remote sensing at high (30m) to medium (250m to 1km) spatial resolution.

This presentation gives an overview of different remote sensing based approaches which allow capturing the state and dynamics of land surface at regional scale. A selection of datasets on land surface characteristics and variables for Central Asia are presented such as land cover, snow cover, soil moisture and biomass.

Land cover datasets at high and medium spatial resolution are derived using the “Twinned object and pixel based automated classification chain” (TwoPac). This semi-automated approach is based on a flexible training and validation sample database which is designed for repeated use. Snow cover analysis is accomplished by processing medium resolution time series from 1985 to 2010. For these 25 years, it will be possible to identify potential regional trends in snow cover development and therefore changes in water availability. Time-series of soil moisture are derived using radar data at coarse resolution (50km) since 1992 and medium resolution (25-1km) since 2007 and 2005 respectively. By the analysis of anomalies in surface soil moisture, drought as well as good growing conditions in Central Asia can be traced. Biomass on medium resolution scale is derived based on the synergetic use of optical and radar data. For the derivation of both the variable grass biomass and the shrub biomass a combined approach is being developed. Finally, the added-value of integrating these regional datasets into the information system ELVIS is outlined.

Assessment of Vegetation Cover Fractions

Klein Doris[1], Asam Sarah[2]

[1] *University of Wuerzburg, Institute of Geography, Department of Remote Sensing, Germany.*

[2] *German Remote Sensing Data Center (DFD), German Aerospace Center (DLR),Oberpfaffenhofen, Germany*

Mountainous regions are fragile ecosystems and especially vulnerable to climate change and land use pressure. In order to monitor subtle changes and assess their implications, detailed land cover information is necessary.

For the water catchment of river Naryn, Kyrgyzstan, vegetation cover fractions are derived in order to establish continuous land cover information for the assessment of land degradation in terms of vegetation cover and density change as well as an improved input parameter for e.g. hydrological modeling.

The cover fractions are calculated using a multi-scale approach starting with field data collected in September 2009 to classify a Quickbird image (0.6m) using a hybrid approach of object oriented and maximum likelihood classification. This result is aggregated to the spatial resolution of Landsat (30m) and the fractions of woody, herbaceous and bare are calculated accordingly. These results are used as training data together with spectral features of the Landsat image as well as different indices to estimate cover fractions with a random forest. From these results again training pixels are extracted and together with MODIS NDVI (250m) time series features and a random forest spatially extrapolated to the whole river catchment. The validation of the results with the Quickbird classification shows RMSE ranging between 5 and 17, being lowest for the MODIS level and bare soil and highest for herbaceous cover at Landsat scale. The spatial distribution of vegetation cover shows that woody cover can be found mainly on northern slopes, while bare soils are predominant on southern slopes.

Using of LADA methodology for development of the national SLM-Information System in assessment and mitigation of land degradation and climate change impacts in Uzbekistan

Gulchekhra Khasankhanova[1&3], Tatyana Khamzina[1], Andrey Yakovlev[2], Rustam Ibragimov[1] and Kamilya Kelgenbaeva[4]

[1] *Design and Research UZGIP Institute, MAWR, Tashkent, Uzbekistan.*

[2] *Research Hydrometeorological Institute, Uzhydromet, Tashkent, Uzbekistan*

[3] *CACILM National Secretariat, Tashkent, Uzbekistan*

[4] *CACILM Multicountry Secretariat, Bishkek, Kyrgyz Republic*

The paper describes the first application of international FAO LADA methodology in Uzbekistan in the framework of CACILM Multicountry Partnership Framework Support Project, which assists the five Central Asian Countries in adopting an integrated approach to land use planning and management. Development of design and national SLM-Informational System using FAO LADA methodology was a main objective of the project. Landuse, landcover, socio-economic data, and recent Remote Sensing (MODIS) and GIS data with other indicators has been used to establish baseline information for monitoring and assessment of changes in land management and rural livelihoods. The assessment of land degradation, hotspot and bright sports analysis has been conducted by interpretation historical and seasonal change of NDVI using MODIS (2007-08) and LANDSAT-7 data. Based on LADA LUS guideline, the national Land Use System Map at a higher resolution in GRID format was created. National LUS Map consists of 25 classes; each of them is divided into 3-4 sub classes depending on biophysical attributes of ecosystem, land use attributes and social economic features. The new jointly prepared with FAO LUS Map of Uzbekistan (at scale 1:1mln, dated 2009) provides opportunities for the evaluation and mapping of land degradation and monitoring of SLM at country level. Results include also climate variability data and discuss drought issues and other challenges for adaptation to climate change on example of Uzbekistan. Necessity and readiness for adaptation of global WOCAT knowledge system to reduce impacts and enhance adaptation and mitigation global climate change described also here.

Established national SLM information system has improve the current weaknesses in the information base and enhance the countries' institutional capacity to assess and monitor land degradation and climate change risks, and promote data sharing between the national, multicountry and global systems. Its allows bringing together national group of experts for harmonization of the generated information to adopt integrated land use planning and emergency response, and ensure resilience against land degradation, droughts and other climatic challenges.

Evaluation and application of MODIS snow cover product in Central Asia

Abror Gafurov, David Kriegel, Elyor Alimardonov

GFZ German Research Centre for Geosciences, Potsdam, Germany

Snow plays an important role in the hydrology of Central Asia and it is an important source of water for hydropower operation or agricultural production. Spatially continuous snow cover observation is only possible through airborne or satellite information. Moderate Resolution Imaging Spectroradiometer (MODIS) sensor installed onboard Terra and Aqua satellites provides among other environmental parameters, binary snow cover information globally at 500 meter spatial and daily temporal resolution. This study evaluates the accuracy of MODIS Terra and Aqua daily snow cover observations in Central Asia using in-situ measurements of snow depth from 30 meteorological stations in the period from 2000 to 2009. The results indicate that under clear sky conditions the agreement of snow classification from MODIS Terra and Aqua snow products are 90 % and 86 %, respectively. These results satisfy the application of MODIS snow cover product for hydrological purposes. However, the utility of MODIS snow cover product is limited by cloud cover under which no information is possible to obtain. The MODSNOW algorithm is used to fill cloud gaps and to generate spatially distributed cloud free daily snow maps at basin scale. The accuracy of snow product after cloud removal is also tested using in-situ measurements of snow depth and the results indicate the overall snow classification agreement of 81 %. Additionally to the evaluation of MODIS snow cover product against in-situ measurements, the evaluation against higher resolution LANDSAT data and some snow related studies are carried out to demonstrate the usefulness of MODIS snow cover product in Central Asia. The outcomes of this study show that the near-real-time spatially distributed daily snow cover data from MODIS can be usefully applied for water resources management purposes such as hydropower operation or irrigation planning for agriculture.

Lakes surface and level variations from satellite altimetry and remote sensing: towards an international lake data centre

Crétaux Jean-François[1], Jelinski Wojtek, Vuglinski Valery[2], Generro Marie-Claude, Calmant Stéphane, Maisongrande Philippe, Bergé-Nguyen Muriel

[1] *Legos, 14 Av Edouard Belin, 31400 Toulouse, France, jean-francois.cretaux@legos.obs-mip.fr, 33 5 61 33 29 89*

[2] *State Hydrological Institute of Roshydromet 23, Second Line, SU-199053 St. Petersburg, Russia*

For more than 10 years satellite radar altimetry has been a successful technique for monitoring the variation in elevation of continental lakes, and reservoirs. Large open lakes affect climate in a regional scale through albedo and evaporation. In some regions highly ephemeral lakes provide information for extreme event like severe drought or inundation. On another hand closed basin lakes are sensitive to changes in regional water balance. In a given region covered by group of lakes, if the records of their level variations are long enough, they could reveal recurrence of trends in a very reliable and accurate manner. Lakes are supposed to have enough inertia to be considered as excellent proxy for climate change.

Moreover, during last century thousand of dams have been constructed along the big rivers worldwide, leading to the apparition of big reservoirs. This has several impacts on the basins concerned by those constructions, as well as effect on Global Sea level rise. Assessment of changes in water storage for lakes and reservoirs, through remote sensing system allowing calculating lake level and surface variation is a demand of the GCOS (Global Climate Observation System). A lake data centre (SOLS/HYDROWEB) is under development at the Legos in coordination with Hydrolare project (Headed by State Hydrological Institute of the Russian Academy of Science). It already provides the level variations of about 150 lakes and reservoirs, freely available on a web site, and surface-volume variations of about 20 big lakes are also calculated through combination of various satellite images (Modis, Asar, Landsat, Cbers) and radar altimetry (Topex / Poseidon, Jason-1 & 2, GFO, Envisat, ERS2). The final objective is to propose a data centre fully operating in 2009 based on remote sensing technique and controlled by in situ infrastructure for the Global Terrestrial Network for Lakes (GTN-L) under the supervision of WMO and GCOS.

For Central Asian, SOLS/HYDROWEB already provides monthly level variations of main natural lakes (Aral, Balkhash, Issyk-Kul...) and artificial reservoirs (Chardarya, Toktogul.). They should be included in future HYDROLARE data centre at SHI. Association and cooperation with CAWa project and database is a good opportunity to link together different science community, and to open Remote Sensing products to potential new users in Central Asia.

Role of the information technology in water quality management of Central Asian transboundary rivers

Nurmakhmad Shermatov, Makhmadrezbon Idiev

Tajik National University, Tajikistan

The main goal of the paper is the support of the acceptance system of international agreements on using water-power resource potential in the drain formation zone. The network informational system is creating to minimize technical control means costs due to maximal use of the informational resources of the departmental monitoring system integrated to the unique Earth remote probing (ERP) net. The system includes the organization – owners of the database ground monitoring, nature managers and administrative parts. Management of water-economic complex, making justified decisions for documents signing, even intergovernmental, can based on the advanced figure control system (river ranges, observation posts) and presents the data processing methods. Today there is no common understanding of economical rules of the river drain regulation and pricing setting questions. Today there is no reliable hydrologic data, forecast, mode operation waterworks facility plan and there is little operative information about its realization. The sharp problem is hydrological forecasts. After USSR collapse many hydro – and meteorological services were divided and hydroposts were liquidated. Absence of the uniform coordinative informational bank is showed in the fact, that today there is no operative information exchange between water users, water suppliers and waterworks facilities. In spite of the data incompleteness the total number of figures and objects, controlled by departmental networks of monitoring is usually redundant for PAD. It demands “Compression of the information” – receiving of integral evaluation thanks to which PAD can place priorities choosing the strategy variant. The important instrument of “curtailing of the information” and providing maintenance of presentation for PAD is geoinformational system (GIS), forming informational – compact cartographical images of the maps.Maintenance of water use management is the difficult task, demanding supply with information of accepting decision process. On its first step it is necessary to create parameters-criteria and indicators system.So the topicality of this task is in:

-sharp necessity in supplying with information of accepting decision process connecting with river drain regulation, exhaustion and pollution of water objects long-term – strategic like preparing of international agreements as well as effective;

-absence of unique database necessary for representational evaluation of the water-power resources(WPR) in the region and development situation forecast;

-to minimize the costs of technical means of control possibility by reduction of relative density of ground objects using ERP data and GIS technology.

Hydrometeorological and real-time GPS monitoring network in Central Asia

C. Zech[1], A. Zubovich[2], T. Schöne[1], H. Thoss[1],

T. Queisser[1],V. Rudenko[1], R. Häner[1]

[1]GFZ German Research Centre for Geosciences, Germany

[2]CAIAG, Bishkek, Kyrgyzstan

Central Asia with its catchment area of the Aral Lake is very sensitive to changes in the hydrological cycle. The continuous monitoring of meteorological and hydrological parameters is the main background for a sustainable water resource management. One component of the CAWa project is the installation of a modern infrastructure for acquisition and processing of hydrometeorological data. Therefore, GFZ and CAIAG are installing several GPS-equipped monitoring stations at selected places to densify the hydrometeorological observation network.

The monitoring stations combine different kind of sensors for several applications. They automatically measure parameters such as air temperature, air pressure, relative humidity, precipitation, wind speed and direction, solar radiation, river discharge, snow parameters including the snow depth as well as high-rate GPS data. All stations are designed as independent field systems for the usage in remote areas with no existing infrastructure (e.g., power supply, communication network, human interaction). The measured hydrometeorological and high-rate GPS data will be transmitted by a satellite-based real-time communication link to an Operation Processing and Archiving Facility (SOPAF) for further processing, archiving and presentation. SOPAF serves as an integration platform for historical data or data from different databases and sensor systems (e.g., seismological-, simulation- or meteorological data). The data and derived products can be provided in a user specified context for different users/institutions and applications.

Session 4 – The dynamics of the cryosphere and its role in the Central Asian water cycle

The cryosphere accumulates significant amounts of water in the Central Asian high mountains and is thus a key source of water supply. Yet, it is particularly fast responding to increasing temperatures and changed precipitation patterns. This session is dedicated to glacier and snow cover dynamics in Central Asia, monitoring methods and the quantification of the cryosphere's role in Central Asian water balances.

Session chairs: Dr. Wilfried Hagg, Prof. Gleb Glazirin

Glacier Volume Changes in the Panj and Vakhsh Basins. Application of simple parameterizations to estimate past and future glacier change in the Panj and Vakhsh river basins and its comparisons to other mountain ranges

Martin Hoelzle[1], Stephan Wagner[2]

1 Department of Geosciences, University of Fribourg, Switzerland

2 ITOS GmbH

Central Asia is well known as an area of substantial water problems accentuated by climate change and strong consumption of water resources. As in other parts of the globe, where high mountains are surrounded by arid and semi-arid zones, snow and glacier melt are major contributors for river runoff and important resources for agriculture in the lowlands. The FAO-UN has started a "Climate Impact Study on Streamflow" to estimate future discharge in the catchments of the rivers Vakhsh (39,100 km^2) and Panj (114,000 km^2), the two tributaries of Amu Darya river. According to the World Glacier Inventory (WGI) prepared in the mid 20th century, the Panj and Vakhsh catchments have glacier covers of 3,913 km^2 and 3,675 km^2, respectively. A new inventory was conducted in 2003 within the frame of the GLIMS project. We used a simple parameterization scheme assuming quasi steady state conditions to infer the ice volumes for two different time periods in the past and to extrapolate future changes. The calculated volumes for the WGI are 170-200 km^3 for the Panj catchment and 200-240 km^3 for the Vakhsh catchment, or an overall ice volume of both catchment areas of around 370 to 440 km^3. Based on the uncertainties in the calculation of the ice thickness, a general uncertainty range of ±25 to 30% has to be taken into account. Comparing these values to estimations calculated for the European Alps with 126 km3 or the Southern Alps of New Zealand with 67 km^3, shows the important ice reserves within this dry mountain area.

From the mid of the 20th century to 2003, an area (volume) decrease of 8.2% (10.5%) for the Panj and 7.5% (4.1%) for the Vakhsh catchment was determined.

Regional climate simulations project a warming of 1.8 °C up to 2.9 °C until 2050, while it remains unclear, if and in what direction precipitation will change. Assuming a temperature increase of 2 °C until 2050 and no change in precipitation, the ice reserves in the two catchments will decline at an accelerated rate, compared to the past with total volume reduction of 75.5% for the Panj basin and of 53% for the Vakhsh basin.

Estimation of current mountain glaciers of selected regions of Gissar–Alay and its changing during 45 years with use of ASTER images

Andrey Yakovlev

Hydrology Department, Uzbek scientific investigation and design survey institute (UzGIP) of Ministry of agriculture and water resources, Uzbekistan

In 1999 the TERRA orbital platform was launched. Onboard the orbital platform the Japanese sensor ASTER was installed. Characteristics of the sensor give unique possibility for monitoring glaciers from the space. In the given work the cataloguing of glaciers of some river basins of Alay, Turkestan and Zeravshan ranges of Gissar–Alay mountain system, which in turn is a part of Pamir–Alay mountain system, was fulfilled. Thematic processing of the images was implemented for the range of the images on the date of the survey – second half of August 2001–2002 years. Previous data of glaciation of this region were obtained as per 1957 and 1980 with application of materials of aerial photography (1957) and analogue satellite images (1980). According to data for 2001 the aggregate area of the glaciers of Gissar–Alay study region amounted to 514.7 km2. In 1957 and 1980 years the aggregate area of the glaciers of these basins was 624.8 and 553.6 km2, accordingly. In spite of global climate warming which occurs from the middle of 20 century and till the present time, there is a fact that for period from 1980 to 2001 years the mean annual rates of degradation of the glaciation are, approximately, in one and half times lower than for the period from 1957 to 1980 years, 0.43% per a year and 0.61% per a year, accordingly. For last 45 years the glaciers of the study river basins lost about 17.6% of the initial area and 25.4% of volume.

West Pamir glaciation change (Rushan and Shiva ridges)

Alexander Finaev

Institute of Water Issues, Hydro-power engineering and Ecology
Academy of Sciences, Dushanbe, Tajikistan

Change of mountain glaciation area has an essential role in hydrological mode of mountain rivers in conditions of climate fluctuations. However, inaccessibility of the most glacial regions and expensive researches keep down the real estimation of glacial area change. This problem can be solved by remote-sensing methods together with using meteorological network data analysis.

The analysis of climatic data from 1960 to 2009 has shown that average annual air temperature in this region has increased on 0,3°C, and annual precipitation rate has increased on 20 % in comparison with climatic norm. The river run off has decreased in beginning of the period, and in the end it has increased and got back to norm.

Landsat images for the period of 1992-2009 have been used for glaciation change study. The analysis of this images has shown that glaciation area of Rushan ridge has decreased on 15,2 % by 1998, and then it has started to increase again. By 2009 the glaciation here has increased on 4,5 % compare to its initial size. Shiva ridge, located to the west from Rush ridge, is characterized by lower heights, therefore its glaciation area is much less. In spite this glaciation area of the ridge has reduced on 13,7 % by 1998. However, by 2009 it has increased again and has exceeded its initial size on 7,3 %.

Such analysis proves substantial dynamics of the Pamir region glaciation.

Reconstruction of glacier mass balances with the hydrological model WASA

David Kriegel, Sergiy Vorogushyn, Doris Duethmann, Janek Zimmer

GFZ German Research Centre for Geosciences, Potsdam, Germany

At several sites around the world, glaciers retreat with different loss rates. While glacier area changes are a more apparent sign of glacier retreat, mass balances allow the quantification of mass losses.

According to an observed average temperature rise, the melt season starts earlier, ends later and runs with a higher intension each year, as found by many authors. Accumulation of solid precipitation, which is gained during winter months and during summer still in high altitudes, faces a stronger ablation during summer months, so that the annual net balance of the water budget of the glacier is negative.

During times of the Soviet Union, the Golubina glacier in the Ala-Archa catchment was one of the well observed key glaciers. For this catchment, there exist time series of hydro-meteorological parameters as well as discharge records for several different stations. The mass balance of the Golubina glacier was measured from 1972 until 1993. Additionally, in 2005 the mass balance was measured during one seasonal campaign. With the semi-distributed hydrological model WASA, we reconstructed the glacier mass balance and closed the gap between 1993 and 2005. The model is set up for the Ala-Archa River catchment. Due to an integrated glacier- and snowmelt routine, the snow and glacier evolution can be taken into account. On the basis of the reconstructed climatology with the WRF climate model, the annual net balances are determined. A key question is how the net balance is distributed over the whole elevation range of a glacier. So the model determines the mass balance according to altitudinal steps. The methodology which is demonstrated, allows the mass balance reconstruction for glaciers that are no longer monitored. The reconstructed glacier mass balance provides a basis for the analysis of glacier dynamics over the past decades.

A new glacier inventory for the upper Naryn basin and first results of the 2010 field campaign

Wilfried Hagg

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About formation of the glacial sediments in the nival zone during the deglaciation period (for the last forty years)

Petrov M.,[1] Tikhanovskaya A.,[1] Ni A.[1],Tomashevskaya I.[1]

1Institute of Geology and Geophysics Academy of Sciences of Uzbekistan, Glacial geology Lab.

The entry of rock sediments to the valley from the glacier tongue during glacier retreat and its subsequent transport by glacial river (on example of Southern Tian-Shan and Pamir glaciers) is considered.

The carryover of the rock sediments from the periglaciation zone is practically equal to the moraine intake from the glacier tongue. It is typical for the glaciers with the domination of moraine cover. In case if moraine cover on the glacier is poorly developed, sediments is carried out by means of subglacial, frontal and colluvial sediments erosion.

Inventorying of mountain glaciers and regionalization of their spatial distribution by materials of remote sensing

V.G. Konovalov

Institute of Geography RAS, Moscow

Vector files of glacier contours on the Asia territory were obtained in India, Nepal, China, Pakistan and Russia by means of processing of topography maps, data of air-photo survey, images from satellites LANDSAT7-ETM+, TERRA-ASTER, SPOT, IRS-LISS and other space apparatus. These data serve as basic for estimating of size of contemporary glaciations in the river basins of High Asia and computation of its hydrological regime. Tools and modules of GIS IDRISI ANDES together with known digital elevation models GTOPO30 (http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/GTOPO30) and SRTM 3 (NASA, USGS http://srtm.csi.cgiar.org/) were used to process the vector files of glacier polygons. The following set of parameters for each glacier was obtained as the result.

1. Minimal and maximal altitudes of glacier a. s. l.

2. Mean altitude of glacier or low boundary of accumulation area.

3. Area of accumulation and ablation parts and glacier as a whole.

4. Relationship of areas: a) accumulation and ablation (glacier's coefficient), and b) accumulation and glacier as a whole (AAR coefficient).

5. Distribution of area as function of altitude.

6. Standard deviation of altitude inside of glacier contour.

7. Volume of glacier as function of its area.

8. Geographical coordinates of glacier centroid.

9. Mean values of glacier aspect and slope.

For optimization the methods of glacier regime calculation 3533 homogeneous groups of glaciers were separated inside of watersheds of tributaries of river basins Amudarya, Syrdarya, Indus, Ganges, Brahmaputra and Tarim. As classification criteria were used eight ranges of aspect and 23 grades of their area. Mean and average weighted characteristics of glacier were determined for each group. Data in river basins of the High Asia for 27 698 glaciers with total area 43 981 km2 were used for illustration the capabilities of suggested method.

POSTERS

Posters to Session 1 – Water availability in Central Asia: Past, present, future

Using automated measuring sensor of conduct of the monitoring of underground water of the Republic of the Uzbekistan

Jamoljon Djumanov

SC «Institute HYDROENGEO», Uzbekistan

In the paper presents improvement of the methods execution of the monitoring of underground water with increasing of objectivity, validity, operative estimation and informatively, as well as development information and software on use instrument automated measure of level, mineralization and temperature of underground water at conduct of the State monitoring hydro regimen station of the Republic of the Uzbekistan. The given product becomes one of the wide-spread forms of the presentation of the collection, processing and analysis of the different sort hydro regimen of information.

The State monitoring of underground water is a system regularly executed with chosen by periodicity of the observations of level, temperature and chemical composition of underground water. Execution of these observations by traditional methods is connected with greater expenses of the labor and regular visit to observation posts. In relationship, with than when the execution of these observations manual labor- consuming process measure strive on hydro geological station of the Republic of the Uzbekistan changes on automated.

Comparative value of level underground water, measured by sensor and manually shows the divergences between value of level underground water, measured by sensor and manually change from 0,2 sm until 2,0 sm refer to under guaranteed accuracy 2 sm refer to water pole on diver. This allows for study level mode to recommend equipping with the observant network of the monitoring hydroseismic field by sensor-diver.

Water Resources of Central Asian Mountain Areas – relevance for the water balance of semiarid regions

Murataly Duishonakunov[(1)], Lorenz King[(2)], Ryskul Usubaliev[(3)]

[(1)]Department of Physical Geography. Bishkek, Kyrgyz Republic
[(2)]Institute of Geography. Justus Liebig University, Giessen, Germany,
[(3)]Central Asian Institute of Applied Earth Research. Bishkek, Kyrgyz Republic

The population of arid and semi-arid lowland areas in Central Asia depends largely on fluvial water originating from mountain areas. Kyrgyzstan has huge resources of ground and surface waters, and significant stocks are in the rivers, permafrost and snow and ice covered mountains. The fresh water resources of Kyrgyzstan have enormous potential to contribute to the economy of the country, for agriculture as well as production of hydro-energy, and its efficient use has become a matter of intense research. However, these water resources are also utilized by neighboring countries for increasing their agricultural output, and the use of this same resource raises serious questions, as water is a strategic, vital resource.

Mountain glaciers in semi-arid regions such as Central Asia are the principal reservoirs of water. Glaciers (more than 8000), and perennially snow fields cover about 30 % of the total land area of Kyrgyzstan. Together, the glaciers have a water equivalent of about 580 billion cubic meters – enough to cover Kyrgyzstan with 3 meters of water. In addition, water is also stored in perennial snow fields and ground ice of perennially frozen ground. This permafrost is the product of climate, snow cover and exposure/slope. Its origin and preservation is promoted by a low MAAT, and low winter temperatures with insignificant snow cover as insulation.

Chemicals and Bacterial Pollution by Water in Kyrgyzstan

Igor Hadjamberdiev, Rustam Tukhvatshin

Medical Academy of Kyrgyz Republic

We have studied threaten of coast tailings disasters, and contemporary pollutant contents in upper, ground, and drinking waters - in four rivers basin of Kyrgyz republic (KR) in 2000-2009 years. The pollutants are: a) hydrocarbons aromatic (formaldehyde, benzene, phenol) – ground and drinking waters in 3 towns,; b) uranium, strontium – ground, drinking water and in vegetables in old tailings 3 areas; c) metals (chromium 6, mercury, stibium), pesticides, in main irrigation canals of the rivers (Chuj, Naryn, Ak-Buura); d) bio-pollutants (abdominal typhus, coli bacteria, cholera, 4 helminthes) – in the same rivers; e) big disasters risk of old tailings (uranium, stibium, mercury) throw down. After studding we created maps by point a,b,c,d - by each impact by human toxicity 5 rank. And done common (complex) map by superposition methods, which show scale of water-polluted areas of KR. The map of threat tailings throw down (mostly to neighbored country - Uzbekistan) has been done separately. We have referred created ranks by analysis of base human health markers (immunity level 6 tests, genetic disorder 3 tests). Results of both studies were agree each other. First consequence of studies is detection of most vulnerable areas in KR that need immediately rescue. It has been offered/improved the water-toxicants alleviation methods: a) twice prolongation of water staying in sediment basin (in water-purified stations); b) protecting 5 tailings from rivers, and we have done project for protecting genetic of vulnerable groups (install 14 updated drinking water filters in schools, nursery, hospitals); c) there are 3 common projects for gathering obsolete pesticides and keep in contemporary warehouses, we created filter system for mercury and other metals purify; d) bio-pollutants is a results of human and animals fertilize utilization and toilets absent, we have installed composting toilets in Alpine area.

Integrated Water Resources Management in Afghanistan (IWRM):

Hasan Hamid, Mohammad Q. Seddeqy

Kabul Polytechnic University and National Hydrology Committee of Afghanistan (NHCA)

IWRM is the integrating concept for a number of water sub-sectors such as hydropower, water supply and sanitation, irrigation ,drainage and environment. An integrated water resources perspective ensures that social, economic, environmental and technical dimensions are taken into account in the management and development of water resources.

Vision: poverty reduction and unemployment, economical and social development and public welfare through effective management of water resources.

Goal: gradually decentralize the relevant activities to main river basin and sub river basin institutions to access maximum utilization of water resources for social – economical development, environmental protection and sustainable development.

Afghanistan is characterized by a continental climate, though the presence of mountains causes many local variations. The annual distribution of rainfall shows a picture of an essentially arid country, with more than 50% of the territory receiving less than 300 mm of rain.

Afghanistan Boundary Rivers sharing the water flow with the neighbour's countries after the sharing Afghanistan would be lift with 55,000 million cubic meters of surface water flow for its own use. This is a rather large amount of surface water (2500 cubic meters per head per year). The annual ground water recharge volume is about 18,000 million cubic meters. Ground water quality is varies in deferent places, while

Only about 24 % of the population has access to safe drinking water;

- In Afghanistan more than 5.6 million ha irrigation land exist, currently only about 1.8 million ha is under irrigation;
- Afghanistan has the capacity to produce more than 23 thousand mega watt hydro-powers; unfortunately today we have only access to 260 mega watt powers.

Challenges:

- Less than one-third of its water resources available for irrigation with high losses;
- Climate change is a challenge that may require effective water resources management in all river basins of country;
- Lack of hydrological data and water infrastructures to control and develop the water resources;
- Lack of integrated plans for water infrastructures at river basin in the past;
- Low institutional and human resources management capacity

Modern state of water-power and social-ecological problems of the Zeravshan river basin

Inom Normatov[(1)], Oliver Olsson[(2)], Gottfried Wilhelm Leibniz[(3)]

[(1)]Institute of Water problems,Hydropower and Ecology Academy of Sciences Republic of Tajikistan

[(2)]Division Head Water Resources Management (WARB) Institute of Water Quality and Waste Management (ISAH)

[(3)]Universität Hannover

In the Zarafshon River Basin the formation of floods is observed most often (almost 7% of the total across Tajikistan) and their average number in a year reaches 150. The population of the Zarafshon valley is affected almost annually with great economic losses. The damage connected with emergency situations causes an essential loss to economy of the given region and republic as a whole. The situation which has developed and inherent in mountain districts demands acceptance of cardinal decisions on rehabilitation of an ecological condition. Transboundary of the basic waterway of the given region - the Zeravshan river which water it is used for an irrigation of huge territories of the Republic Uzbekistan to rise about contribution of the given republic into improvement of an ecological situation of the drain formation zone of the river. The problems of the Zeravshan valley population connected with the electricity and other energy carriers leads to mass cuttings down of trees and bushes and accordingly to the biodiversity grow poor of a valley and to some extent brings the contribution to formation of emergency situations presented in the table. It is necessary to notice that the afforestation area in the Zeravshan valley in 2004 in comparison with 1980 was reduced to 13 %. It is necessary to notice that for the Republic of Tajikistan is perspective the energy potential of waterways of the Zeravshan river basin which makes – 11.8 Bln. kWt·h. In the presence of such rich energy potential suspended to the Zeravshan river Basin in Sugd area huge deficiency of the electric power is observed - 3-4 Bln. kWt·h /year which is covered by import of the electric power from the Republic of Uzbekistan.The intensive grows of the Tajikistan population , presence of the large file of the fertile but not mastered lands suspended to upstream of the Zeravshan river demands principal processing of economic use of the Zeravshan rivers scheme. The mutual combination of interests of upstream and downstream countries of the Zeravshan river is quite achievable by building of the cascade of Hydropower station (HPS) with regulation of the river drain. At presence of several HPS with reservoirs the top reservoir can work only in power mode, the bottom reservoir of the same volume can regulated a drain up to restoration of its natural regime. Especially it can provide drain regulation in interests of an irrigation. At presence not two but many quantities of HPS with reservoirs the situation even more will improve.

Assessment of snow cover in different elevation zones using GIS technology and remote sensing

Y.A. Podrezova[(1)], I.A. Pavlova [(2)]

[(1)]Central-Asian Institute for Applied Geosciences - CAIAG

[(2)]Kyrgyz-Russian Slavic University - KRSU

Water resources are special and sometimes strategic product type as water demand rapidly grows in developing countries. Water resources are required to account strictly, proper planning and management. The solution of this problem has significant meaning for Central Asia, including Kyrgyzstan. Central Asia is a zone of insufficient and irregular moisture, where water resources do not always satisfy the requirements in the usage. In these conditions the primary role belongs to the reservoirs, allowing vary runoff, and then rationally use it for irrigation, water supply and other components of the water complex.

The solution of hydrological problems, such as calculation and prediction of runoff, water resources assessment, identification of main hydrographic characteristics and other are problems which difficult for us to solve it by traditional methods based on field data. Today, the problem of data collection has aggravated due to the downsizing of the observation stations and posts, avalanche stations, lack of modern cartographic information, lower quality of observations, due to financial difficulties and low-skilled staff.

The use of GIS technology and remote sensing data can quickly and efficiently solve such problems. This is due to the fact that GIS technologies have great potential of representation, analysis and modeling of geographic objects and phenomena as compared with traditional methods. In addition, remote sensing data provide more complete information, especially spatial and temporal characteristics.

The most important for solving problems of water management is the forecast for the time of the vegetation period. For these purposes the estimation of the accumulation snow over the cold period (October to March) in the mountains is required.

This article shows the possibility of using GIS technology and remote sensing data to determine the area of snow coverage in the Kara Darya River basin of the Kyrgyz Republic.

In the project we used such programs as ArcGIS and ERDAS Imagine. Satellite imageries of five-channel radiometer AVHRR weather satellites of the series of NOAA were used as initial data. For the interpretation of satellite data on snow coverage were used 1, 2 and 4 channels (0,58-0,68; 0,725-1,0; 10,3-11,3 mm). Images were processed in the program ERDAS Imagine:

- georeference of images to the locality and elevation zones was made using a digital model of the relief of Kyrgyzstan and maps of the region under study were obtained;
- features on the images were classified into three types: clear sky, earth and snow;
- determine the total area of snow coverage.

The processed satellite images were downloaded from ERDAS as img-file in ArcGIS, which converts these files to the GRID-format. ArcGIS draw up maps of snow, calculate a height of the snow line and snow coverage area for different elevation zones.

The Kara Darya River is a left tributary Syr Darya, which flows from the Fergana Valley. The area above the basin Andijan reservoir is about 12300 km2, the height is from 0,8 to 5,0 km. The melting

of seasonal snow and glaciers has a significant share in the flow of river. Rainfall plays a significant role only in the formation of flooding.

The Kara Darya basin was divided into 8 elevation zones in 500 m. The study period was from March to September 2009. For this period the calculations of height of the snow line and snow coverage area were made for different elevation zones of the river basin.

In mid-March 2009 the total area of the basin snow coverage was 91%, and the height of the snow line was on average 1,392 m. Then the overall basin snow coverage decrease, but the height of the snow line increase. The total area of snow coverage of the basin reached minimum value (0,85%) in the mid-September. At the same time, the height of the snow line reached its highest value (4414 m). After September the area of snow coverage gradually increased.

For spring-summer period the highest percentage of snow coverage is observed at altitude of 4000 m and more (60-85%), at altitude from 1100 to 3000 m snow coverage is less than 20%.

Thus, the use of remote sensing data from satellites can be processed successfully using GIS technology, and then analyzed. The results of calculations can be applied in practice, for example, in order to forecast runoff of Mountain Rivers, warning of avalanche danger, calculating snow loads, agriculture, etc.

Integrated Water Resources Management in Central Asia, Model RegionMongolia, IWRM-MoMo.

Buren Scharaw

Fraunhofer IOSB-AST Ilmenau, Germany

Mongolia has been proposed as a model region for the development, solution and implementation of integrated water resources management (IWRM) in Central Asia within the respective BMBF-Programme. The basic concept of the programme and of this proposal is the integrated consideration of uses and protection of freshwater resources including the development of measures and their implementation using a transdisciplinary management approach.

In a first project phase (2006 – 2009) a pilot catchment (Kharaa River including the City of Darkhan) has been analysed by means of basic inventories, identification of priority problems and options for action or measures with a strong cooperation with the Mongolian partners.

Major elements include climate, hydrology, land use, drinking water supply and wastewater treatment and aquatic ecology which have been combined in an integrative and management oriented way.

Phase II will now focus on selected key problems and priority fields of action including capacity development.

The project will be organized with a matrix structure of three thematic modules and three section modules.

Thematic module 1: Hydrology and land use

Thematic module 2: Aquatic ecology and ecological quality

Thematic module 3: Integrated urban water management

Two cross-section modules have been identified as a joint effort of all partners and will be supervised by the project coordination.

Section module 1: Monitoring, data and modelling

Section module 2: Matter fluxes and mass balances

Section module 3: Capacity Development and environmental information

Calculation of sedimentation in the Toktogul Reservoir during its operation (1974-2009) and specification of its useful capacity

Anton Shabunin

Central-Asian Institute for Applied Geosciences (CAIAG)

The work has been spent for the purpose of an estimation of total amount of deposits and their distribution on water area of the Toktogul Reservoir, and also for specification of its useful capacity.

For an estimation of sedimentation volumes in the Toktogul Reservoir in this research the method bathymetric survey of its water area, and definition of absolute heights of district in the drained part has been chosen. This method, in comparison with other methods of definition reservoir's sedimentation, is the most exact at an estimation of the valid volumes of the collected firm material in a reservoir bowl.

For carrying out of calculations on the given method, the topographic maps of scale 1: 25 000 (survey of 60th years, before reservoir creation) have been used and a number of field researches by definition of absolute heights of district is spent. By results of the given works digital maps of land before creation of a reservoir and on current moment have been constructed.

Calculations of the Toktogul Reservoir's sedimentations during its operation are carried out. The volume of sedimentation is 0,52 billion m3.

Calculations of the Toktogul Reservoir's sedimentations during its operation by this method (0,52 billion m3) well agreement with a theoretical estimation of the carrying and weighed deposits (0,50 billion m3).

Level of dead volume in the Toktogul Reservoir to be on a mark of 837 m. In a zone of useful volume is located 0,38 billion m3 deposits (2,3 % from useful volume), and 0,14 billion m3 in a zone of dead volume (2,2 %).

As a result of calculations on topographic maps of survey of 1960th years, the size of full volume of the Toktogul Reservoir has been received – 20,0 billion m3 at level of 900 m. However under the literary data this size makes 19,5 billion m^3. The reason of this are demands special detailed studying.

Ancient deltas of Amudarya River, population settling moving, and ancient agriculture development

Julia G. Trofimova

National University of Uzbekistan, Tashkent

The ancient population always settled at banks of rivers and lakes. Mouths (deltas) of the rivers were especially attractive for him. People left the home-like places mainly in two cases: when the rivers dried up and when deltas were flooded by after water level increasing in lakes of sees. One of typical areas of the Earth is set of Amudarya River deltas.

Three deltas were formed by the river one after another from the end of Pleistocene and during Holocene: the most ancient was Akchadarya delta included two components. Next was Sarykamysh delta, which functioned mainly in the Middle Ages. Then arose a youngest Priaralsky delta, which was formed in XVI century AD. It was not taken into consideration. We tried to define more accurately time of the old deltas functioning using data of previous investigators.

326 ancient settlements were discovered by archeologists at the territory. The Southern delta of Akchadarya contains 17 per cent of them. The delta was populated in the early Neolith (7-8 thousands years BP). More than 60 percent of monuments are dated by bronze epoch (3-2 thousand years BP). 17 percent of settlements are dated by antiquity time and approximately 5 per cent of them by the Middle Ages. Population lives at the Northern delta since the late Neolith up to antiquity. It did not probably exist there in the Middle Ages. No monuments of the Neolith exist at Sarykamysh delta. Total number of settlements increased practically twice from antiquity to the Middle Ages. Thus, earlier Southern Akchadarya delta was supplied with water at least since the early Neolith to the Middle Ages. The drain along the Northern Akchadarya delta started some later and has stopped earlier (about 2 thousand years BP). Sarykamysh delta was supplied with water from the Bronze Age. Evidently it was supplied with water together with the Southern Akchadarya one for some time.

Ancient agriculture at the deltas developed actively too. Indicators of the process are area of irrigated agriculture, sizes and number of ancient settlements.239 Irrigated area at plains of Central Asia was estimated by S.P. Tolstov. He found that the total area of ancient irrigation in deltas of Amudarya was equal approximately to 1.8 millions of hectares. However the area was not irrigated at one time.

We used correlation of ancient channels length and the fields area where their water was supplied for approximate estimation of the areas of simultaneous irrigation. Quite good conformity of our results with data of A.S. Kes' has been found as a result.

Traces of primitive fields of Neolithic farmers have not been found. Principal changes in economic way of the antique population in the region took place before VII-VIth centuries BC. An unreliable source of water for irrigation - decaying and changing the direction river channels could not satisfy the population any more. Big and long enough channels were constructed. The irrigation network covered all area of Sarykamysh and Southern Akchadarya deltas in antique time.

Maximal development of ancient irrigational system existed from IV century BC to VIII century AD. Only about 2/3 of the area irrigated in antique times were used to XII-XIV centuries AD. The Khiva khanate was formed to XVI century after fatal consequences of the Mongolian invasion. An irrigational network of the Khorezm oasis was restored and new big channels were constructed. However total area of irrigation was less in comparison with the previous periods.

Posters to Session 2 – Water management in agriculture: Processes, modeling and implementation

LUCA and CliNCA: capacity building programs to train young scientists in Central Asia

Frauke Barthold, Ira Pawlowski, Mirza Nomman Ahmed,

Michael Schmitz, Hans-Georg Frede

Center for international Development and Environmental Research (ZEU) Giessen Germany

In Central Asia, the interaction of environmental factors and human action is of critical importance. The landscapes of Central Asia cover diverse ecosystems, ranging from deserts to humid climates, from lowlands to mountains. Land use strategies determine the quality of ecosystem services. The Millennium Ecosystem Assessment Report specifies supporting, provisioning, regulating and cultural ecosystem services which may be affected by human action. In turn, ecosystem services directly support human wellbeing in terms of health, food security and development. In case one ecosystem service is supported, the value of other functions may be reduced. A lack of control and a deficient legal framework have contributed to the degradation of natural resources, e. g. water, soils, and vegetation in Central Asia. The intertwined problems of legal, socio-economic and environmental conditions show the clear need for education and research in the field of land use management and its effects on ecosystem services and human well-being in Central Asia.

For these purposes, the LUCA (Land Use, Ecosystem Services and Human Welfare in Central Asia) project was established. It is funded by the Volkswagenstiftung and based at Justus-Liebig-University Giessen, Germany. LUCA is a post-graduate program for young scientists from Central Asia. It builds a platform for joint analysis of land use effects for a whole region, involving participants from different countries of Central Asia. The program aims to train young scientists on topics concerning the intrinsic interaction of people and their environment in vulnerable regions like Central Asia.

The availability of water has a great impact on both agriculture and economic development. Due to climate change Central Asia and its water resources have been identified to be especially vulnerable. There is a need in the development of adaption strategies to face predicted climate change effects.

CliNCA provides transnational cooperation, networking and education of (young) scientists from different disciplines in the field of water resources research. The focal point of the program relates to merge of socio-economic and environmental aspects of climate change and water resources in Central Asia. CliNCA focuses on teaching and capacity building throughout the entire chain of knowledge building from MSc to senior scientist level. It is funded by the German Academic Exchange Service (DAAD) and consists of a core team that includes ZEU (Center for int. Development and Environ. Research) Giessen, Germany, CAIAG, ICWC, DKU and Samarkand Univ.

Modeling water resources use and supply in the Aral Sea Basin

Maksud Bekchanov[(1)], John Lamers [(2)]

(1)Center for Development Research (ZEF) / Uni-Bonn

(2)ZEF/UNESCO (Uzbekistan) Project

Increased water demand due to population growth and industrial development necessitates efficient, equitable and sustainable water management in many developing countries. It is forecasted that more than 65% of the population in the world will live in areas with physical or economic water scarcity by the year 2025. This is more evident in the Aral Sea Basin where irrigated agriculture plays a pivotal role in the economy supporting substantial part of the welfare. Irrigated farming expansion due to population growth (about 3% per annum) and consequent overdependence on agriculture, from one hand, and decreasing water use efficiency due to lack of private and public investment on agricultural machinery and irrigation infrastructure, lack of economic incentives to adopt water-wise approaches, and unsustainable water management and governance, on the other hand, are root causes of water scarcity. Taking into acount the importance of user-friendly modeling approaches for analysing water use efficiency improvement opportunities and water trading market perspectives, this study reviews at first hydro-economic modeling practices and their results from the context of .the Aral Sea Basin. Then, recent developments in the hydro-economic modeling in the world and their potential use to solve the water issues in the basin will be discussed. In particular, water trade introduction opprtunities and its impact on efficient water use and water saving technology adoption will be analyzed.

Impact of irrigation on rural livelihood: Case study from WUAs in Kashkadarya region, Uzbekistan

Nuriddin Eshmatov, H. Kreutzmann

Center for Development Studies, Freie University Berlin

Today, Irrigated Agriculture accounts for 80% of water consumption and provides 40 % of the world's food. Irrigation water is important asset to alleviate rural poverty and to improve life conditions of rural livelihoods. Among the Aral Sea basin countries, Uzbekistan is the most dependent on the irrigated agriculture with its largest irrigated land, the biggest rural population (more than 16 million) and the highest population density. Moreover, the irrigation plays an important role in the economy of Uzbekistan with the 90 % of the cropland irrigated. The average water withdrawal rate is 12,000 m3/ha in Uzbekistan, while this rate is 9000-10000 m3/ha in the other climatically similar regions of the world. Consequently, more than half of the irrigated areas of Uzbekistan are faced with problems such as waterlogging and salinization. This research is aimed to study the role of irrigation water for rural livelihoods, impacts of irrigation reforms such as creation of WUAs to alleviate rural poverty in the study area. Moreover, it assesses the role of WUAs in water management and their contribution to improving rural livelihoods. The research is based in Kashkadarya Region of Uzbekistan. One of the irrigation canals and 5 WUAs are chosen for the analysis. Research data was collected through face to face household surveys (105 households were interviewed) and statistical data and reports from national and local water management organizations. The results show positive and negative consequences of newly introduced irrigation reforms to rural poverty.

Salt removal capacity of horticultural species *Tetragonia Tetragonoides* and *Portulaca Oleracea*

Ahmad Hamidov[(1)], José Beltrao [(2)], Carla Marques[(2)],
Mukhammadkhan Khamidov[(3)], Alcinda Neves[(2)]

[(1)]Faculty of Agriculture and Horticulture, Humboldt University Berlin, Germany
[(2)]Faculty of Engineering of Natural Resources (FERN), University of Algarve, Portugal
[(3)]Rector of the Bukhara Branch of Tashkent Institute of Irrigation and Melioration (BB-TIIM), Uzbekistan

Application of excessive amounts of fresh water in highly salinized soils and the heavy use of fertilizers are methods, which have been used to combat soil salinity and to increase crop salt tolerance in agricultural lands. The intense use of these conventional techniques has attracted public attention due to the environmental pollution, and the contamination of deeper soil layers and the groundwater resources. Recently, a new environmentally safe and clean technique – phytoremediation, whereby salt (ion) removing species are planted in the salt-affected soils - has been introduced to address salinity problems. Two horticultural species – *Tetragonia tetragonioides* and *Portulaca oleracea* - have been assessed under this study, and showed a high potential to remove soil salts. The field experiments were conducted in Algarve Region, South Portugal for *Tetragonia tetragonoides* and in the Khorezm Region, northwest of Uzbekistan for *Portulaca oleracea*, during the summer, the most sensitive period for salt-affected soils. Meantime, the leafes of these species can be used for human consumption and it can also be integrated into cultivation/rotation programmes to rehabilitate saline soils. According to the results, *Tetragonia tetragonoides* produced high biomass and removed salts from the deeper soil layers. Meanwhile, the results of *Portulaca oleracea* showed that this crop is relatively high tolerant to salinity as well as to droughts. It can be highlighted that this new technique to control salinity is a powerful and environmentally clean tool to maintain the sustainability of the agricultural areas; however, additional research is needed.

Keywords: horticultural crops, phytoremediation, salt removing species, soil salinity, and groundwater.

Assessment of the efficiency of the use of scarce input resources in the Agriculture of the Zeravshan Valley

Shavkat Hasanov[(1)], Mirza Nomman Ahmed[(2)]

(1)Samarkand Agricultural Institute, Agricultural Economics and Management

(2)Justus-Liebig-University of Giessen, Agricultural and Development Policy

The main issue investigated in this paper is the scarcity of resources and consequently the analysis of the differential management approaches used by farmers to adapt to this situation. To this effect this paper aims at developing a DEA-Model to investigate the farm level efficiency levels with respect to the use of the limited resources available to the farmers. This study is based on a survey that was carried out in early 2010 among private (farmer) and household (dehqon) farms mainly of the Samarkand and partly of the Navoiy and Kashkadarya region's counties, covering 102 farms and households. The main questions included the types and modes of input resources use, off-farm income sources, questions related to farm management and other social questions. The efficiency of recourse use in different organisational farm types is evaluated and an economic assessment of yields from main agricultural crops on different land and farm types is conducted. The average farm size in the area surveyed amounted to 59 ha for the 67 private farms and on average 0.4 ha for the 35 household farms. The findings indicate that input resources are not used efficiently, especially in the case of cotton growing farms. In terms of technology use, a trend towards demechanisation could be seen, which is found to be driven by high unemployment outside the agricultural sector.

Amudarya river downstream water resources management

Malika Ikramova, Alisher Khodjiev, Sergey Batishev

Central Asian Scientific Research Institute of Irrigation, Tashkent, Uzbekistan

The downstream part of the Amu Darya River is characterized by a number of world's most pressing environmental problems, such as water scarcity, toxic pollution, soil degradation, and serious impacts to human health. More than 3 million inhabitants live at this area without sufficient water supply. Without having access to good quality water, uncontrolled use of polluted surface water and ground water remains as the only local option for the people.

The paper revises our assessment of the current status of water management and gives outline recommendations for increase of water use efficiency in the region. The work has been undertaken within the FP6 INCO funded project "Interstate Water Resource Risk Management: Towards A Sustainable Future For the Aral Basi" (JAYHUN).

The JAYHUN database and GIS map has been developed including detail water units in the fife irrigation projects at the basin: Surkhandarya, Kashkadarya, Bukhara, Khorezm and Karakalpakstan. Depreciation of canals and regulators and other water structures, drainage systems have been analyzed to fix water delivery efficiency and water loss rate. As well as operation terms in different water conditions: deficit, enough and excess.

In order to analyze a risk from water deficit a water balance scheme for water abstraction, consumption and return water has been developed for the irrigation projects in the regions of Uzbekistan with different water availability.

Balance calculations were carried out to proper distribute water and to fix a water deficit/or overflow, water losses at any part of irrigation systems. The water balance scheme was tested in order to find optimal scenario of water distribution, to increase water use efficiency, to analyze and manage the irrigation systems. Recommendations to improve water supply have been developed.

Water resources for rehabilitation of fish farming at Southern Priaralye

Ilia Joldasova

Institute of Bioecology of Karakalpak Branch of Academy of Sciences of Republic Uzbekistan

Formerly, at Southern Aral Sea region, the amount of commercial fish made 20 thousand tones in a year (95% - 98% of fish over Uzbekistan). Sea fisheries integrated from sea into lake systems, but it failed to support fish industry, which dramatically went down because of water shortage. Extremely unstable climate of the region of the Southern Priaralye region recently gave a series of dry years which had an devastative affect on commercial fish, the most fish water bodies went dry and the fish stock was almost extinct. This brought to downfall of all fisheries and created a big army of unemployed fishermen.

In their framework, programs ASBP-1 and ASBP-2 put forward target measures for recovering stressed ecosystem at Southern Priaralye, by means of establishing local waterbodies in Amudarya delta zone which would rehabilitate and boost fish farming. At present in Karakalpakstan there are about 70 working fish farms, this rent over 70000 ha of natural water basins. However Karakalpakstan huge fish domain failed to meet the rehabilitative demands of district ecological system and its water management policy which is still very low; the biggest year catch of fish makes 1.4 thousand tones.

The main problems concerning to the remote parts of Amudarya basin is the unregulated and insufficient water stream and still remaining unmet water allocation system of low river at Southern Priaralye.

Besides this, the well being of Southern Priaralye and its fish resources is tightly connected with Amudarya, not only as a source of water supply but also as a transit canal for young fish from river to the lakes. That's why, besides the powerfulness of water stream the regulated system of water allocation is also of a great importance. The biggest part of commercial fish grow in the lakes but drop their spawns in running waters of Amudarya. Roe and young fish are carried down by water to the below parts. The total quantity of fish larvae moving downstream in during spawning period was over 100 billion individuals per annum.

Altogether with the offspring, the larvae of fish is also being drawn from zone of Tuyamuyun and other upper located parts of Amudarya. These are the major source of future fish resources in the lakes of Southern Priaralye.

Regarding this, the water management system of Amudarya at the Southern Priaralye, side by side with the agricultural demands must take into consideration fish farming demands as well. In part, besides of the total outlet of water for fish farming it is more expedient to fix a constant amount of water in May - June period with 1.2 cube km. This is the period of highest concentration of larvae of commercial fishes in the river.

Programme of economical, social and technical activities in water-agriculture sector of CA for rehabilitation of degraded bioecosystems.

Anvar Kadirov

Chairman of NGO “ECOLANDSCAPE”, member of Council of ECOFORUM of EcoNGO’s of Uzbekistan

The program of economic actions.

Given programs should allow to lift quantity of made raw production in 3-7 times, and a total cost of production taking into account final finished goods and trading profit at 10-20 time.

1. Development of agricultural sector of economy.

2. Manufacture of necessary techniques for realization water economic and agriculture works, and also for processing and manufacture.

3. Maintenance of fast introduction of the new program at the expense of world community attraction in business of the decision of problems of change of a climate by restoration bioecosystems in basin of Aral sea and the Aral sea.

4. Construction of an economic basis of manufacture in CA by attraction of the foreign capital on a mutually advantageous basis.

The program of technical actions.

The end result - effective working system of constructions, technologies and techniques which meets the requirements on protection natural экосистем, and to necessary requirements for technical agriculture-water-economic system.

The main priority: Full satisfaction of requirements natural экосистем, in this case Aral sea, the rivers Syr-Daryas and Amu Darya and their inflows, тугайных woods in walleyes of the rivers at level of steady bioecosystems, restoration flooded water reservoirs valleys and bowls. Appointment of this main priority is connected by that the most vulnerable, conservative and nonflexible element of working system undertakes the main priority.

Priority of the second order - technical agriculture-water system. Includes the water basins water regulating constructions, channels, methods of watering, power systems.

The program of social actions.

Expected result:

Involving in restoration and control process of bioecosystems all population, as main executor and interested participant.

Success and limitations of local cooperation on small transboundary rivers within the Ferghana Valley

Jusipbek Kazbekov, Murat Yakubov and Kai Wegerich,

International Water Management Institute, Central Asia Office,Tashkent, Uzbekistan

While riparian cooperation between the transboundary states in the Syr Darya basin is appears to be under continuous negotiation on the national level, there is cooperation on the local level. The presentation discusses project experiences of up-scaling local water users in 3 different countries (Kyrgyzstan, Tajikistan and Uzbekistan) and on the two small transboundary rivers (Shakhimardansay and Khodjabakirgansay) within the Ferghana Valley. The presentation will highlight early success but also the limitations of upscaling cooperation on the basin level.

Development of methods for irrigation monitoring in Central Asia (on the example of Fergana Valley)

Shavkat Kenjabaev

SIC- ICWC, Tashkent, Uzbekistan

Improved descriptions irrigation-groundwater interactions are required for enhanced water resource management in irrigated areas. Fergana province is characterized by complex hydro-geological conditions causing development of negative ecological and ameliorative processes with irrigation (strengthening head of underground water, rise of level and mineralization of ground water and thereafter soil salinity).

In this study the interrelation between irrigation and groundwater from point of minimization of total executed water resources were investigated in the experimental sites.

In two plots 9 piezometers: 3 and 3 along closed horizontal drainage (CHD) line and 3 within drainages are installed in each to monitor ground water table (GWT) through measurement applied irrigations and regular drainage discharge measurements in each 5 days.

GWT near to closed drainages fluctuated from 2.7 to 2.85 m from soil surface and in the middle of the field- 2.64-2.71 m. After the beginning of the rechargeable irrigation (1260 m3/ha) of winter wheat from September 18 to 23, 2009 the GWT began gradually rising. Within the field GWT fall was uniform, and by November 1, 2009, it was falling more down near to the drains and in the middle of field, it is somewhat less falling due to efficient operation of the drains. First irrigation was applied in the middle of February, 2010 with rate of 1030 m3/ha which completely used for charging of the aeration zone and not affected the GWT at all due to dry winter in 2009.

In spring, much less irrigation rate of 711 m3/ha caused GWT rise by 1.2 m almost uniformly in all inter-drains; but GWT falling rate at the margin sites that are remote from the collector were rather lower: by 20 cm right after the irrigation. Hence, one should take into account during irrigation within 1000 m3/ha, the spreading intensity is sufficient to keep uniformity of the drainage and irrigation interaction at good degree of drainage.

Water level measurements from monitoring wells showed that at a depth of 1.5-1.8 m, certain pressure head remained within 20 cm at no irrigation, but with the main canals being filled. At the irrigation, the pressure immediately increases up to 75 cm, and then gradually decreases, and without irrigation it disappears in the canals. The pressure appears again with filling systems and especially under influence of irrigation.

Water flow measurement in the drains showed under the conditions of low pressure supply, the drainage flow dynamics change slightly, but lowers up to two times after the irrigation is stopped.

Key words: ground water table, irrigation, drainage, Fergana province.

Soil protection and anti-erosion techniques for cotton irrigation in Uzbekistan

Mukhamadkhan Khamidov[(1)], Dilshod Nazaraliyev [(2)], Ahmad Hamidov[(3)]

[(1)]Rector of the Bukhara Branch of Tashkent Institute of Irrigation and Melioration (BB-TIIM), Uzbekistan

[(2)]Head of Hydrology and Hydrogeology Department, Tashkent Institute of Irrigation and Melioration (TIIM).Uzbekistan

[(3)]Faculty of Agriculture and Horticulture, Humboldt University Berlin, Germany

In the Republic of Uzbekistan, irrigation erosion is one of the most commonly occurring problems adversely affecting agricultural crops. This environmentally dangerous phenomenon is spread for over 660 thousand hectares in the country. In order to prevent the negative effects of irrigation, it has been developed an anti-erosion technique for cotton irrigation on eroded soils. A zigzag furrow irrigation technique has been found as the most productive and efficient way to prevent soil erosion and subsequently, increase the productivity. The results of this experiment have revealed that using zigzag furrow irrigation practices, the yield of cotton reached to 3.35 tons/ha, about 0.6 ton/ha more than the traditional straight furrow irrigation practices. Furthermore, this technique significantly contributed to the improvement of agro-physical properties of the soil in the experimental stations of the Uzbek Research Institute of Cotton Growing.

Keywords: Anti-erosion techniques, zigzag furrow irrigation, conventional (straight) furrow irrigation, cotton growing

Application of IWMI performance indicators to assess performance of irrigation systems in the Kashkadarya River Basin, Uzbekistan

Sanjar Khodjaev Khayrulloevich

Director of Information Analytic Serves "Water Resources" ,Tashkent Institute of Irrigation and Melioration, Uzbekistan.

The Kashkadarya River Basin covers entirely part of Kashkadarya administrative province in Uzbekistan (Shultz 1949; Irrigation of Uzbekistan 1979). The total population is about 2.3 million inhabitants of which about 78% reside in rural areas. The total agricultural area is about 667 600 ha of which 418 700 ha is irrigated. The total number of Water Users Associations is 181 and 7659 farmers are members of these WUA. The total command area under the WUA is about 503 100 ha in Kashkadarya River Basin (Ministry of Agriculture and Water resources of Uzbekistan 2010).

For the fulfilment of the thirsty ambition of self-sufficiency of the Soviets for cotton production, the arid Uzbekistan has been extensively exploited. In fact, vast tracts of deserts (Kashkadarya steppe) have been converted into irrigated agricultural lands without proper consideration to environment and technical standards (UNESCO 2000; World Bank 2003). As a result natural resource degradation (soil salinity, desertification, water quality) as well as declining crop yields have dramatically increased. Thus has potential impact for food security and livelihoods of local populations.

Since the independence (after the breakup of the former Soviet Union) the situation has changed dramatically in terms of institutional, political and technical systems in the irrigated agriculture settings of Uzbekistan (Yalcin and Mollinga 2007). Political transition could be defined as a shift from once planned centralized economy to a market-driven one which has introduced ‘new’ concepts like land tenure, water rights and different kinds of ownership.

The institutional change can be described as decentralization of the farming systems i.e., transition from the former state collective farms into the smaller forms of private farms. The institutional interventions are aimed to increase agricultural production through improving water management at inter-farm and on-farm levels (Yakubov and Manthrithilake 2009). The technical change is attributed to the deteriorated irrigation & drainage infrastructure, poor irrigation methods, overuse of fertilizers in agriculture (Noble et al., 2005; Abdullaev et al., 2006).

The biggest challenge for a sustainable irrigated agricultural production lies in the recent reforms of water management sector in Uzbekistan (UNDP 2007). The water users associations have been established for replacing the former collective farming systems for irrigation water distribution and maintenance of irrigation infrastructures at on-farm level (Abdullaev et al 2006). The intention of the national government was to shift the operation, maintenance and management of irrigation infrastructures to non government institutions (decentralization). However, these institutions have not fulfilled their promising tasks because of i) a rapid increase of number of private farms along canals; ii) the cropping structure is mosaic with different crop water requirements against the former monoculture; iii) a poor financial, trained and technical capacities of new established institutions; iv) a state ordered agricultural production quota system (for cotton and wheat).

Fermer is a private farm, successor of kolkhoz and responsible for targeted production of cotton and wheat to the government. The fermer can lease the plot in size ranging from a minimum of 10 ha to several hundred ha, with an average size of approximately 20 ha (as of 2000). These fermer farms have flexibility in the hiring of labor and access to other subsidized inputs from government (such as fertilizers, lease of machinery and access to bank credits). According to the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan (2010) as of 2009 there were about 220,000 fermer farms in Uzbekistan. Recently (2008) there has been further reforms in the

agricultural production system, i.e., an enlargement of fermer farm command area. The main objective of recent reforms is to consolidate smaller poor performing fermer farms into efficient large fermer farms. As a result, about 50% of total number of farms has been reduced to 104 000, an average agricultural land of 27 ha per fermer farm increased to 57 ha.

There is fragmented and limited information about Kashkadarya River Basin in international literature in terms of irrigated agriculture, farmers and irrigation systems. Therefore, the goal of research proposal is to comprehensively assess the irrigation system performance and identify the intervention actions for the improving.

The assessment will be carried out using performance indicators developed by IWMI to examine performance of irrigation system in Kashkadarya River Basin, Uzbekistan. The main output considered is crop production, while the major inputs are water, land and finance then in a gross sense the performance of irrigated system can be assessed (Molden et al 1998). The following indicators will be collected and calculated such as: output per cropped area ($/ha), output per unit command ($/ha), output per unit irrigation supply ($/m3), and output per unit water consumed ($/m3). Five additional indicators such as relative water supply, relative irrigation supply, water delivery capacity (%), gross return on investment (%) and financial self-sufficiency will be estimated in the research project. For agricultural production cotton and wheat will be used in the research. In addition structured surveying will be conducted for evaluating WUA performance along the selected irrigation system for identification of major problems from WUA and farmers perspectives.

Inefficient performance of irrigated agriculture systems (fermer type) in Kashkadarya River Basin, Uzbekistan causes poor agricultural water management which degrades soil and water resources quality impacting crop yields and challenges sustainable agricultural production for meeting needs of local people livelihoods.

Water for Cotton and Light:Soviet Legacy of Agricultural Policy and New Ambitions for Hydropower

Murodbek Laldjebaev

CAFDP FELLOW, UNIVERSITY OF CENTRAL ASIA, Tajikistan

The Central Asian region's abundant natural resources were inefficiently used during the Soviet period. Particularly, expansionary agricultural policies had a detrimental impact on the environment as well as human health. The desiccation of the Aral Sea was primarily the result of resource overexploitation and misguided attitudes towards the environment. Although this was done through a resource sharing mechanism among the Central Asian countries during the Soviet period, the lack of mutually agreeable method in the post-Soviet period did nothing better for the environment either. Environmental concerns are now raised not necessarily with an objective to preserve the environment; rather it is used as a political tool to pressure the conflicting interests of the states. This was vividly illustrated in the case of Roghun HPS.

The main theme of this paper is two-fold. First is to uncover the historical roots of the inefficient water use, particularly for agriculture, taking its origins in the Soviet policies to development in Central Asia since 1930s. And second is to update on the recent developments with regard to rejuvenated ambitions of harnessing hydropower potential and the opposition to it. Another related matter discussed is the failed state of the resource sharing scheme that followed the collapse of the Soviet Union. The context of the research will mainly be focused on Tajikistan but with the view of the country's relations with Uzbekistan.

The structure of the paper is as follows. A brief overview of the natural resources in Central Asia is given in the beginning. Then, agricultural policies of the former Soviet Union in Central Asia are discussed. Next, the discussion will revolve around the degradation of the Aral Sea. After that, the impacts of the agricultural policies, both negative and positive, will be detailed. The next section will describe the resource sharing mechanism that was successfully implemented during the Soviet period, but failed after the Union disintegrated. Building upon the discussion, an update on the renewed hydropower ambitions in Tajikistan will be provided in the next section. Finally, the discussion will be concluded with recommendations on future courses of action.

Integration and disintegrating of small transboundary tributaries from the larger Syr Darya basin

Kai Wegerich, Jusipbek Kazbekov, and Murat Yakubov

International Water Management Institute, Central Asia Office,Tashkent, Uzbekistan

This article focuses on the integration and seeming disintegration of small transboundary tributaries within the Syr Darya basin from the larger Syr Darya basin agreement. Linking a water control framework to scale, the paper shows how the loss of Soviet-style water control on the local level has direct impacts on different scales. In this respect, the paper reveals that riparian water sharing agreements are subject to local level water management control.

Electrochemical methods of treatment wastewater having heavy metals

A. N. Zhylsbayeva, A. B. Baeshov, R.Z. Abisheva

Shymkent , Kazakhstan

Having methods of heavy metal contained wastewater treatment are foreseen an addition of reagents. The demerits of this methods are an economical unprofitable connecting with expenses of different reagents, not conformity with modern ecological requirements, an additional pollution by ions and formation of hard solute combination of metals and difficulty of metal extraction from them.

It's important to take consideration on electrochemical methods of industrial wastewater treatment. During their realization a lot of valuable chemical elements are extracted, the technological scheme and exploitation of-industrial plants get simplified considerable, the work is automated easily, industrial squares necessary for place of treatment construction are decreased. These methods give a possibility to process wastewater without preliminary dilution, a salt contents of cleaned wastewater isn't increased and it can avoid of formation of sediments or decrease their quantity.

Having electrochemical methods have their demerits: requiring a high expenditure of electrical energy and using deficient metals, a low current efficiency, a lack of good constructive elaboration of separate part of industrial plant.

We examine an opportunity of using a lamp (scrap) electrodes, composted metallic or graphite electrodes with large developed surface, for avoid pointed out demerits. Being unreagents and ecological clean this method of treatment can be a perspective direction and using of lump electrodes can intensify process.

A number of research works on cleaning waste solution and wastewater of chemical and metallurgical production from metal ions (Pb, Cr, Fe, Ni, Cu, Zn) by electrochemical methods with lamp electrodes [2-4] is holding in our university by supervision of professor A.Baeshov. The research works direct to study mechanism of heavy and non-ferrous metals reduction processes by the polarization developed surface lump electrodes.

There are showed the electrochemical extraction of heavy metals from waste solution is possible not only by polarization permanent current and by polarization alternating current in these works. Using of industrial alternating current allows simplify of process, that is removing necessity of straighten constructor and additional service.

The results of experiment showed that extraction degree of heavy metals from waste solution and wastewater have reached above 90 %.

The electrochemical method of treatment of underground mine water of Mirgalymsai plant “Achpolymetal” was elaborated on a result of above mentioned works. The extending laboratory and industrial test of electrolyze plant of treatment of Kentau mine wastewater from heavy and non-ferrous metals were carried out.

In this case, the results of electrochemical researches with using of lump electrodes showed an opportunity of the using of electrochemical method for waste solution and wastewater treatment, for intensify of electrode processes and for solution some ecological problems of chemical and metallurgical industry We consider the using of lump electrodes is a new direction in the electrochemical branch on solution of ecological problems.

Posters to Session 3 – Remote sensing and information systems for sustainable water and land management

Assessment of phenological patterns for Central Asia using NOOA NDVI time series

Roman Bohovic[(1)], Doris Kein[(2)], Christopher Conrad[(2)]

[(1)]Department of Geography, Masaryk University in Brno, Czech Republic

[(2)]Department of Remote Sensing, Geography Institute, University of Wuerzburg, Germany

Vegetation dynamics, especially phenology is directly linked to climatic conditions. Thus the analyses of phenological parameters can be used as indicators for climate change.

For the assessment of vegetation dynamics on a regional scale remote sensing is the only method that can provide this information and at the same time with the potential for a continuous monitoring over long time spans. The most widely used indicator connected to vegetation activity is the Normalized Difference Vegetation Index (NDVI) which can be used for the calculation of different parameters of phenology.

In this study we analyse phenological parameters in their spatio-temporal context for Central Asia with a special focus on the start of spring season. The start of the spring season (SOS) is one of the most important phenology parameters that help to characterize vegetation patterns. Its benefit among the others basic parameters (end of the season, length of season, etc.) is the higher stability of the SOS when derived from satellite data. This allows more relevant spatio-temporal comparisons within study area and over time.

We used NDVI data from the Global Inventory Modeling and Mapping Studies (GIMMS) derived from imagery from the Advanced Very High Resolution Radiometer (AVHRR) instrument onboard the NOAA satellites which cover a time period of 25 years from 1982-2006 with a spatial resolution of 8 km. Different methods for extracting phenological parameters are employed and proper tuning of parameters is investigated.

The results show the spatial pattern of SOS which reflects the different climatic conditions within central Asia: e.g. spring starts 7 weeks earlier in the Southern parts of Uzbekistan compared to northern Kazakhstan. At the same time also land use patterns and the human impact could be recognized within the large irrigation areas, where the SOS is influenced mostly by land management rather than climatic conditions.

Lakes surface and level variations from satellite altimetry and remote sensing: towards an international lake data centre.

Jean-François Crétaux[(1)], Wojtek Jelinski[(1)], Valery Vuglinski[(2)], Marie-Claude Generro[(2)], Stéphane Calmant[(2)], Philippe Maisongrande[(2)], Muriel Bergé-Nguyen[(2)]

[(1)] *CNES / Legos, Toulouse, France*

[(2)] *State Hydrological Institute of Roshydromet 23, St. Petersburg, Russia*

For more than 10 years satellite radar altimetry has been a successful technique for monitoring the variation in elevation of continental lakes, and reservoirs. Large open lakes affect climate in a regional scale through albedo and evaporation. In some regions highly ephemeral lakes provide information for extreme event like severe drought or inundation. On another hand closed basin lakes are sensitive to changes in regional water balance. In a given region covered by group of lakes, if the records of their level variations are long enough, they could reveal recurrence of trends in a very reliable and accurate manner. Lakes are supposed to have enough inertia to be considered as excellent proxy for climate change.

Moreover, during last century thousand of dams have been constructed along the big rivers worldwide, leading to the apparition of big reservoirs. This has several impacts on the basins concerned by those constructions, as well as effect on Global Sea level rise. Assessment of changes in water storage for lakes and reservoirs, through remote sensing system allowing calculating lake level and surface variation is a demand of the GCOS (Global Climate Observation System). A lake data centre (SOLS/HYDROWEB) is under development at the Legos in coordination with Hydrolare project (Headed by State Hydrological Institute of the Russian Academy of Science). It already provides the level variations of about 150 lakes and reservoirs, freely available on a web site, and surface-volume variations of about 20 big lakes are also calculated through combination of various satellite images (Modis, Asar, Landsat, Cbers) and radar altimetry (Topex / Poseidon, Jason-1 & 2, GFO, Envisat, ERS2). The final objective is to propose a data centre fully operating in 2009 based on remote sensing technique and controlled by in situ infrastructure for the Global Terrestrial Network for Lakes (GTN-L) under the supervision of WMO and GCOS.

For Central Asian, SOLS/HYDROWEB already provides monthly level variations of main natural lakes (Aral, Balkhash, Issyk-Kul...) and artificial reservoirs (Chardarya, Toktogul.). They should be included in future HYDROLARE data centre at SHI. Association and cooperation with CAWa project and database is a good opportunity to link together different science community, and to open Remote Sensing products to potential new users in Central Asia.

Zarafshan River Basin water resources management improvement

Malika Ikramova, Ifoda Akhmedkhodjaeva, Nodir Ikramov

Central Asian Scientific Research Institute of Irrigation, Tashkent, Uzbekistan

Annual Zarafshan River runoff amounts to 5.3 km^3 and is generated by 96% at the territory of Tajikistan. Tajikistan utilizes 6% of water, the rest part flows to the Uzbekistan territory to irrigate the fields in Samarkand, Jizzak, Navaiy and Kashkadarya regions over 550,000 hectares. The difference between the annual runoff and 6,6 km3 annual consumption of water is covered by return waste water.

After independence, in Uzbekistan, water resources management has changed due to transferring from administrative method to a basin management system. Water resources use efficiency is directly depends on efficient allocation of water. The Zarafshan Basin irrigation systems are complex and need especial approach at planning and distribution of water resources.

Taking into account further increase of water demand due to construction of energy generation structures and irrigated areas in upper streams in Tajikistan, need for increase agricultural food production according to population growth, development recommendations for improve water resources use efficiency is very urgent.

By the Uzbekistan Ministry of Agriculture and Water Resources request an operative water allocation computer model has been developed based on a water balance scheme. It is developed water balance estimation method based on the water abstraction data from all sources and water consumption by all branches of economy. GIS database and water use monitoring system has been developed. The model installed in Basin management unit and irrigation system management units. Using developed data transmission system, they can exchange information.

Development in Cadastral Mapping in Tajikistan with the use High Resolution Satellite Data.

A. Yatimov, R. Kaczynski

Design Research Institute FAZO, Tajikistan

European Commission funded project in Tajikistan: “Support to the mapping and certification capacity of the Agency of Land Management, Geodesy and Cartography” has been started in 2007. The urgent need to establish and develop a modern cadastral system based on a parcel map with right dimensions, right shape in open geodetic coordinates system, and correctly computed areas of parcels nowadays cannot be done without the use of modern mapping technology and the new high resolution satellite data: QuickBird, WorldView, IKONOS, GeoEye. The new open geodetic coordinate system WGS84 - UTM for cadastral mapping has been established in which parcel boundaries are being mapped. Capacity building and strengthen of the Institute “Fazo” in the field of modern satellite geodesy, digital photogrammetry, advanced digital satellite image processing and digital cartography.

On the basis of generated digital orthophoto maps on Leica Photogrammetric Suite ERDAS, agricultural borders is being elaborated in FAZO Institute with the use of ArcGIS software. Accuracy of digital orthophoto maps is RMSExy<1.1m which is equivalent to two pixels. These digital orthophotomaps could be also used for mapping water resources. On the basis of elaborated technology and methodology in the framework of the European Commission financed project more then two thousands of digital orthophoto map sheets in the scale of 1:5000 with pixel size 0.5m have been produced so far by the “FAZO” Institute.

Technical data, workflows, accuracies achieved in all of the cartographic processes for elaboration of final digital cadastre maps of agricultural areas in Tajikistan will be presented.

Posters to Session 4 – The dynamics of the cryosphere and its role in the Central Asian water cycle

The dynamics of density norm for the snow cover on example of Western Tien-Shan

Boris Tsarev, Eleonora Semakova

Hydrometeorological Research Institute, Tashkent, Uzbekistan

The greatest interest for hydrological forecasting purposes is an average snow density on all snow pack as well as its changeability on the area, elevation ranges and in temporal pattern.

The regularities of snow density norm change with terrain elevation and time change are considered for the region of Chirchik and Ahangaran rivers basins as an example. The empirical nomograms for calculation of this value on the end of months from December till May were constructed for these basins. The analysis of observations data allowed describing the functional dependence of snow density norm in the form of computation formulas and to receive the estimations of vertical and temporal gradients of snow density for the period of snow accumulation and snow melting. The revealed regularities allow extrapolating the snow density norm on the end of ten-day periods. There is an opportunity to compare these values with data of ten-days snow surveys in the investigated basins.

The received analytical formulas are used for special mapping using the GIS-technologies. The maps of snow density distribution for the given territory on the end of months are presented. These types of maps allow clearly seeing the change behaviour of this characteristic in the annual aspect.