Late Holocene Environmental Change in the Aral Sea Region

Ian Boomer
University of Birmingham, UK

The Aral Sea was formerly (during the early 20th century) the fourth largest inland water body in the world. Since 1960, the volume and area of the Aral have been reduced dramatically largely due to the unregulated abstraction of water for irrigation from the two main in-flowing rivers. The impacts of these most recent changes, together with high levels of man-made pollutants have brought about significant environmental problems in the region.

The present-day Aral Sea catchment lies along the western margin of the arid Asian region. Modern climates in the arid Asian region are dominated by westerly-derived moisture sources and the Holocene variability in the strength of these sources have been reconstructed from a range of biological and geochemical proxies across the central Asian region, including the Aral Sea. These studies have shown a 3-fold climate shift through the Holocene, specifically a dry early Holocene, a wetter early to mid-Holocene period, and a moderately wet late Holocene. Superimposed upon these broad-scale changes are a number of discrete, shorter-lived events within the Aral catchment that relate to more local-scale events including significant influences from local societies as water resources become a focus for regional power struggles.

As a terminal lake (i.e. with no surface outflow) the level of the Aral Sea is largely controlled by inflow from its two main inflowing rivers the Amu Darya and the Syr Darya. Natural variability in the regional climate during the Holocene (e.g. changing meltwater supply from the Tien Shan and Pamirs) has led to marked changes in the volume and water level of the Aral Sea. Palaeoenvironmental records from cores of Aral Sea bottom sediments has allowed high-resolution studies of past climatic and hydrological changes in the Aral catchment. In particular, recent palaeoenvironmental work in the region has elucidated marked ‘sea level’ oscillations over the past 2000-3000 years as the Aral Sea responded to local climate forcing. As part of these recent investigations it has been possible to obtain a detailed insight into the environmental changes within the Aral Sea catchment and the impact on late Holocene Aral Sea levels. Furthermore, archaeological and digital terrain modelling have revealed that a previously proposed mid-Holocene highstand of the Aral Sea at 72–73m a.s.l. would not have been possible, and a revised highstand for the Holocene was set at about 54–55m a.s.l.

A summary of the most recent environmental changes together with ongoing plans for remediation of various parts of the Aral Sea system is presented.

Culture of Zhetisu in Antiquities and Middle Ages

Karl Baipakov
Institute of Archaeology, Kazakhstan

Certainly in the life of population in antiquities have been rendered the natural ambience. In scientific literature spread the term and notion “noosphere” (V.I.Vernadsky). Biosphere, changed by society, became the ambience of public development for the last 10-20 thousand years.

Zhetisu has it is own particularities of nooshere. In Zhetisu stands out “zone of life” located from north to south – from the region of Balkhash to the mountain range of Tyan-Shan. The natural ambience of Zhetisu promoted the development of cattle breeding and husbandry in different form and their interactions in different periods of society from ancient time. Bronze Age is the husbandry and development of cattle breeding from yard to open-range and nomadic. Archaeologists are studying settlements and burial grounds in steppe and mountain zone.

In the Early Iron Age in facilities and culture of Sakae and Usun tribes developed also husbandry, including using irrigation system and nomadic cattle breeding. It is indicative of excavations of settlements and burial grounds.

On the base of husbandry and cattle breeding there arose states of Sakae and Usuns.

In the Epoch of Middle Ages, in the period when ancient Turk states existed here appeared towns beginning the process of urbanizations, escalated displacement the branch of the Great Silk Road. Blossoming of the settled way of life, and urban culture apexed in the state of Karakhanid.

Town and steppe formed economical base of state. It is indicative of excavations of towns and necropoles.

In the period of Mongol invasion the base of urbanization were destroyed, shortening the base of the settled way of life and husbandry and raised cattle breeding. The settled way of life is saved. In the 16th-19th centuries there appeared hundreds of Kazakh settlements. Russian settlers got from Kazakhs the tradition of husbandry and irrigation.

Comparative Study of the Medieval Urbanization of the Talas, Chu and Ili River Basins

Renato Sala and Jean-Marc Deom
Kazakhstan Scientific Research Institute on Problems of the Cultural Heritage on Nomads, Kazakhstan

The present paper analyzes the process of Medieval urbanization of the piedmonts of Northern Tienshan (Talas, Chu and Ili river basins) in its geographical, morphological and chronological and aspects, with particular attention to the case of Semirechie. Being the scanty survey, documentation and state of conservation of non-walled settlements, only walled structures of any size have been considered. Their number is around 500 and, among them, is also included the preliminary documentation of the settlements of the Ili valley on Chinese territory.
The Medieval urbanization of the Northern Tienshan piedmonts starts at the beginning of the Iº millennium AD in the Talas delta; it sees a very dynamic development during the Early Medieval period when spreads in the Talas and Chu valleys (500-900); reaches a blossoming phase during the X-XI centuries AD when it spreads in the Semirechie region; and shows signs of deep irreversible contraction during the XII AD, i.e. before the Mongol invasion. By the ends of the XIII century AD the phenomenon is practically over, but a totally new proto-urban trend will start and fade three-four centuries later under Jungarian rule.
The location, morphology (size, shape) and life-span of urban structures are various, depending from regions and historical phases, and showing complex trends of development. The study of such a wide urban park and of its complex transformations has been started with the reading of the existing scientific literature and with the survey and fixation of most of the monumental park. It proceeded with the elaboration of a multi-entry data base that allowed statistical analyses, the elaboration of thematic tables and maps, cross-sections between different entries and comparisons between different territories.
The location features of settlements and clusters of settlements (urban systems) are classified by hydrological and hydraulic devices. The main morphological characters of monuments and systems are: size, concentration, morphology (gradually evolved or planned structures, number of walls, number of cultural layers, number and surface of clustering small towns and villages, etc). Their variety depends from the amount and stability of water resources, from the economical background (irrigation agriculture, dry agriculture, pastoralist activities, mining activities, commercial activities) and from special administrative and military functions. The chronological characters are documented by century of start and abandonment.
The complex development of all these variables is plotted on the background of political-military events recorded or reconstructed by historical sources. General hypotheses on the reasons of the start, development and end of the urban process are submitted to collective discussion.

Case Study of "Monuments of Otrar Oasis in Their Settings: Investigation of Irrigation System and Cultural Landscape" Project

Dimitry Voyakin
Institute of Archaeology, Kazakhstan

Investigation of the irrigation system – this is first of all is investigation of the dynamic of life one or another region. Main constituents of such investigation could be not only irrigation canals but river arteries, ancient stream channels, former riverbeds, which are difficultly perceptible even from the bird's eye view; neglected hundreds of years ago fields, wells, all kind of monuments and as well as legends still living in folk memory. Only comprehensive collection of the information with use of all kind of investigation methods could lead to result which will allow to get not just ephemeral theory but numerous of data supported by facts. In this case method of collection of information without creation hard assertion and summaries is most acceptable one. Therewith collected documentation gives good possibility for fixation and monitoring of condition of the monuments as well as arise threats for their existence.

Territory of Otrar oasis is over 2500 square kilometers. Within this territory over 130 sites were found out. Most of the sites are settlements and cities existence of which implies necessity of water presence. Three main water arteries Syrdariya, Arys and Bugun Rivers are the basis of life of oasis. Numerous canals as a vessels delivered life-giving water to settlements.

At the beginning of 1969 by Otrar Archeological expedition (under supervision of K.A.Akishev) and from 1971 by South Kazakhstan Complex Archeological Expedition (under supervision of K.A.Akishev and K.M.Baipakov), which still has been working with interruption in 1993-1996, basic information was collected as well as general stages of the irrigation development in Otrar oasis was defined. Investigation of the irrigation system of Otrar oasis was an aim of INTAS project in 2003-2005. Geo-ecological investigation and modeling for the purpose of checking the reconstruction of irrigation systems which were implemented earlier were carried out in the frame of the project.

V.A.Groshev who was a leader of the team for irrigation investigation of South Kazakhstan Complex Archeological Expedition had observed that main moments of socio-economic history of the cities and settlements involved into sphere of activity of irrigation system… reflected in their evolution. History of Otrar oasis – this is a history of hydrolytic society and because of this fact it is impossible to investigate ancient culture in isolation from irrigation.

One of the main aims of current project was Investigation of Otrar oasis' territory for survey and fixation of irrigation system's condition, which is integral part of ancient cultural landscape and trough such documentation solve important questions touch upon dating, development, belongings etc.

In the frames of project has been done air photo documentation of Otrar oasis, irrigation situation in oasis has been observed, sixteen irrigation systems and enclosing branches and irrigated sections have been fixed. Thirty head constructions have been fixed. More than 50 air photos of sites added already existed data base of Otrar oasis. More than 20 flying hours were spent, more than 4,5 thousand sq. km were shouted. More than 1.5 thousand control GPS points for air photos' comparison were created. More than 7 thousand air photos were done. 25 land searches were made. Satellite data were processed and correction was done with earlier collected materials.

Special program providing for generation of united data base of air photos "IG synchronizer" for comparison of air photos with GPS data with help of specialists on informational technologies.

Main role is played by relief of place in study of any irrigation system. On vast space of Otrar oasis in amount 250,000 hectares fixation, representation and following analytical analysis of place relief is a problem, which is possible to solve thanks to introduction of new methods. So, NASA (National Agency on aeronautics and research of cosmos space) materials were used for detailed height outcome of wide territory. For example, ancient channels of Shubara and Akaryk got another interpretation in frames of new data.

Analysis of the Hydraulics of the Irrigation Canals of Otrar, Kazakhstan

Derek Clarke
University of Southampton, UK

Evidence of the former canal networks used to transport water from the Syr Dara river to the irrigated areas in the Oasis of Otrar exists in the form of relic canals and water storage areas. Four distinct phases of development of the canal system were identified between 1200BP and 500BP. In this paper we describe how the canal networks were mapped and dated at different stages of development. The changes in the canal networks are related to variations in climate and economic prosperity in the region. Accumulation of salts in the soils is identified as the reason for the abandonment of some irrigated areas and the movement upstream of the main canal connection to the river. The dimensions of the canals were surveyed and modern hydraulic models were combined with a digital terrain model to calculate the water carrying capacity of the canal systems. Results indicate that the canal system was not able to deliver water to all parts of the oasis simultaneously so a coordinated system of irrigation water delivery by rotation was probably necessary. The FAO "Cropwat" irrigation tool was used to calculate how much water was needed to grow typical crops and estimates of probable crop production have been used to estimate the population of the city of Otrar.

Dendroclimatic Reconstructions from Central Asia

David Frank and Jan Esper
Swiss Federal Research Institute WSL, Switzerland

Tree-ring data represent one of the most important climate proxies over the past millennium. For the land-areas of the mid to high latitudes, trees are widespread and may provide information on temperature, precipitation, or drought variation depending upon both site ecology and the measured tree-ring parameter. Despite their importance, nearly all large-scale temperature reconstructions contain data from fewer than 10 locations at AD 1000, with a strong bias towards the high latitudes [1]. Thus any such long archives, and particularly those from the mid latitudes, are exceptionally valuable towards understanding past regional to global-scale climate variation.

This talk will begin with an introduction on the basic principles of dendroclimatology with a focus on climatic response and the removal of the biological age-trend. Recent and on-going progress towards developing millennial-length records of climatic variation from tree-ring archives in Central Asia will then be presented, with examples including tree-ring width measurements from the Tien Shan, Altai, and Karakorum mountains [e.g., 2, 3, 4], maximum latewood density measurements from the Altai [5], and carbon and oxygen measurements from the Karakorum [6, 7]. The broad characteristics of the transitions between the Medieval Warm Period, Little Ice Age, and modern warmth will be shown, but we will emphasize uncertainties in the long-term climatic evolution related to noise inherent in tree-ring data. The talk will conclude with discussion of global temperature variations, teleconnections, and research challenges [8, 9, 10].

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Tree-ring Chronology of the Last Seven Centures in Glacier Engilchek Area, Tien Shan, Kyrgyzstan Republic

Olga Maximova
Institute of Geography, Russia

Short and rare meteorological records, especially at the high elevation, limit our ability to understand, reconstruct and predict long-term climatic variations in many regions. This is also the case in Tien Shan where the longest meteorological records are up to one century long only. A number of tree-ring based climatic reconstructions were published recently in Tien Shan Mountains (Borscheva, 1983, Shiyatov, 1981, Esper et al., 2002, Solomina et al., 2006, 2007, Maximova et al., 2008), however many questions concerning the high resolution climate reconstructions in this area still remain unclear, and new tree-ring chronologies can be useful in this relation.

In this paper we present a new ring width chronology of spruce (Picea Schrenkiana Fish. et May.) at the upper tree limit in Engilchek area, Tien Shan, Eastern Kyrgyzia.

In summer 2004 we collected more than 60 samples of spruce in the vicinity of Engilchek glacier (2726-3120 m.a.s.l.) (42 09 N, 79 27 E) both cores from the living trees and dead trees cores and disks. Up till now we managed to cross-date 44 radii and combined them in the ENG chronology extending from AD 1360 to 2005. This is the longest spruce chronology in Tien Shan at the moment. The samples were collected and analyzed according to the standard methods used in dendroclimatology (Frits, 1979). The samples are cross-dated and quality controlled by using COFECHA soft ware. ARSTAN was used for the chronology building. We tried both standard chronology and RCS method of standardization in our analyses.

Prominent positive growth anomalies in the ENG chronology are recorded in 1920-1930s, 1850s, 1800s, 1680s, 1640s, 1610s, 1570s, 1480s: the negative growth anomalies occurred in 1980s, 1916-1918, 1830s, 1690s, 1620s, 1580s, 1550s, 1530s, 1500s, 1450s. Most of these anomalies correspond to these of other spruce chronologies constructed at the upper tree limit in Tien Shan Mts. (Solomina et al., 2007). The coefficient of correlation between the ENG and other chronologies is from 0.35 to 0.64. It means that all spruce chronologies at the upper tree limit reflect a similar climatic signal. We compared the ENG chronology with the meteorological data (Tien Shan meteorological station, 1930-2000) in order to identify the climatic signal controlling the spruce growth. The response function shows a significant negative correlation of ENG chronology with April temperature and no correlation with precipitation. The lack of correlation with summer temperature expected in such harsh conditions can be explained by the long distance from the site to the meteorological station. Comparing of the individual negative summer temperature anomalies with the ENG chronology we found out that the narrow rings always coincide with the cold summers (1932, 1938, 1946, 1954, 1958, 1972, 1974, 1976, 1993). The correspondence of warm summers with the positive peaks occurs less regularly (e.g. in 1973, 1978, 1990, 1994). The anomalies do not correspond to the precipitation outliers. A general similarity of the ENG chronology with the MJJA temperature reconstruction based on the spruce density chronology from inner Tien Shan (Solomina et al., 2006) indirectly confirms the summer temperature controls of spruce growth at the Engilchek site.

Reconstruction of Climate and River Discharge in the Last 1000 Years Based on Mountain Ice Core Data in the Central Asia

Nozomu Takeuchi[1], Koji Fujita[2], Akiko Sakai[2], Chiyuki Narama[3] and Vladimir Aizen[4]

1: Chiba University, 2: Nagoya University, 3: RIHN, 4: University of Idaho

Climate changes could have affected human history in the Central Asia. In particular, changes of river discharge must have been large impacts on people living in such arid regions. The past environmental conditions have been recorded in natural proxies such as glaciers, trees, and bottom of lakes. By physical and chemical analysis of these natural proxies, we can know changes of past environments. Reconstructions of climate and river discharge are important to understand human history on the Central Asia.

In 2007, ice cores were successfully drilled on Grigoriev Ice Cap located in the Tien Shan Mountains, Kyrgyztan. The elevation of the drilling site was 4600 m a.s.l. and entire core length was 87 m. Based on accumulation rate and carbon isotope dating, the ice core covers one to ten thousand years. The analysis of the ice core is expected to reveal air temperature and precipitation of the region in the time period. Another ice cores were also recovered in 2003 from the Belukha Snow Firn Plateau located in the Altai Mountain, which is further north of the Tien Shan Mountains. This core is 171 m long from surface to bottom of the glacier. Although analysis of this core is still in process, this core could help our understanding sources of water vapor of the basin in wider scale of this region. In order to reconstruct water availability in this region, we developed a model of river discharge including a process of mountain glacier variations. Results of the model calculations showed that glaciers could play a role to maintain stable river discharge during periods of less precipitation. The model results could be improved by using additional past climate data of new ice cores and tree rings.

Prehistorical and Historical Stages of Development of the Balkhash Lake

Bolat Aubekerov, Saida Nigmatova and Renato Sala
Kazakhstan Scientific Research Institute on Problems of the Cultural Heritage on Nomads, Kazakhstan

A- The prehistory of the lake Balkhash is connected with the features of development of the Balkhash depression and with the geological-geomorphological development of the mountain region and of the Balkhash-Irtysh watershed.

B - The formation of the modern lake Balkhash is connected with the last climatic rhythms. The following stages are individuated, all characterized by specific mollusks and microfauna assemblages, pollen spectra and mineralogical sedimentary structure.

1 - Post-Glacial stage:
before 11000 years BP

2 - Final Glacial stage:
10300 BP ±200 years: transgression
8300 BP ±100 years: regression

3 - Balkhash stage:
5600 BP ± 200 years: transgression
4380 BP ± 150 years: regression

4 - New-Balkhash stage:
2690 BP ±120 years: regression

5 - Historical stage: characterized by natural large fluctuations and technogenic loading

C - Palynological analyses of ground sediments of western Balkhash show a good conservation of spores and pollens and a quite homogeneous structure of vegetal associations. In the structure of pollen spectra, the prevailing pollen type is the one of the vegetation of the central deserts. However well reflected are also pollens of neritic water vegetation, of tugai floodplain trees and pollens of wooden vegetation transported by the river from the mountain region.
During this preliminary stage of research, in the spectra of ground adjournment have been individuated not less than 4-5 types of vegetation connected with changes of climate. The stage most clearly manifested is the Holocene climatic optimum.

D - Concerning the problem of formation of the lake Balkhash the most debatable question is the correlation between glacial events and stages of formation of the lake. This fact largely depends from the weakness of studies concerning the Holocene history of the mountain glaciation.
Our researches have shown that during the Holocene 3 large stages of growth of glaciers are established, the largest of which connected with the Holocene climatic optimum. However during the Holocene glaciers did not reach very large sizes and could not play a major role in the destiny of lake Balkhash.

E - The Balkhash lake and the Northern Pre-Balkhash region represent an important zone of buildup and development of human cultures. The Stone Age is represented by unique camps and workshops from ancient Paleolithic (Semizbugu, etc.) to Neolithic times; the Bronze age by mining-metallurgic industries and petroglyph sites; the Early Iron Age by Scythian funerary monuments and artifacts; the Middle Ages archaeological park witnesses the transit of formidable nomadic confederations and the development of very high skills of adaptation to the extreme conditions of arid zones.

F - Life in arid zones is always difficult and did not become easy during the present technological stage. Only the deep analysis of these landscape conditions by joined efforts of interdisciplinary and international teams will allow to elaborate a model of optimal organization of life, to predict the changing conditions of ecology and climate, to suggest lines for development of the agricultural and animal sectors and, as a whole, to provide knowledge for mastering oases in arid zones.

Reconstruction of Lake Level Change and Paleo-environment Using the Core from Balkhash Lake, Kazakhstan

Kunihiko Endo
Nihon University

On the basis of the Balkhash Lake 2007 core analysis, and lake and land surveys, the lake level and sedimentary environmental changes during the last 2000 years were investigated in and around Balkhash Lake, Kazakhstan. The Balkhash 2007 core, taken from the western Balkhash Lake, is composed of homogeneous gray silty clay with a thickness of 6 meters. Magnetic susceptibility, soil color, AMS 14C ages etc. were measured, and diatom flora was analyzed.

Sedimentary conditions in Balkhash Lake were checked by acoustic profiler survey along the survey line about 290 km long in the eastern part of the lake. According to the survey, the most part of the lake is shallower than 10 m in depth, thickness of the soft sediment is about 10 m in maximum, and several buried valleys were recognized. Existence of buried valleys and erosional terraces recognized in the profiles, suggests that the lake level probably stayed at 325 m, 330 m, and 335 m, being 5 m to 15 m lower than the present level of 340 m above sea level (Haraguchi et al., 2009).

Tentative results of the diatom analysis show changes in depth and salinity clearly. Benthic diatoms dominate at some horizons such as -280cm, -580cm, so on. At the same horizons, brackish species are dominant (Endo et al., 2009). These suggest quick lowering of the lake level and increasing of salinity occurred. Especially, just after these horizons, freshwater and planktonic species increased. This suggests quick rising of the lake level in Balkhash Lake. At the horizons of -150 cm and -500 cm, a similar but not so clear trend is obtained. Consequently, salinity changes based on diatom flora are a good indicator of frequent lake level changes in Balkhash Lake. Age model of the core is not complete at this moment, however, the comparison with the result of Aral Sea core was tried using the tentative age model. Environmental changes in Aral Sea are reconstructed very well mainly based on Dinoflagellate cyst and pollen analyses (Sorrel et al., 2006, 2007; Boomer et al., 2008). In Aral Sea, during the Medieval Warm Period (MWP) and AD 0 to 400, the lake level was lowered and lake area was highly reduced. Soon after MWP, around AD 1200 to AD 1400, the lake condition changed from brackish to freshwater by increased precipitation. After AD 1400, the lake condition changed to brackish again, corresponding to Little Ice Age. From the tentative result obtained from the Balkhash Lake core, Balkhash Lake have probably experienced a similar environmental changes to those of Aral Sea clarified by Sorrell et al.(2006 and 2007) and Boomer et al. (2008).

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Problems of Historic Studies on the Economical and Cultural Development in the Ili River Watershed and South Balkhash Lake Area in the Late Middle Ages and Modern Times

Irina Yerofeyeva
Kazakhstan Scientific Research Institute on Problems of the Cultural Heritage on Nomads, Kazakhstan

The territory of the North Semirechiye, situated south from the Balkhash Lake, represents the arid zone with extremely hostile environmental conditions for human life. This is why, starting from ancient times, those lands were used exclusively for nomadic animal husbandry. In comparison with those arid landscapes of the northern part of Semirechiye, its southern piedmont and high mountainous areas are distinguished by more favorable natural-climatic conditions suitable not only for the nomadic lifestyle, but also for settling. Due to the above zonal differences, the Semirechiye region as a whole was characterized, during a period of the last 500 years, by an unequal level of population in different local areas, by certain differences in the land use types (nomadic and semi-nomadic pastoralism, agriculture), and also by uneven physical and cultural adaptation of its territories by the local population.

Due to the nomadic lifestyle of the absolute majority of population of the Balkhash Lake area in the Middle Ages and Modern Times, and also because of the remoteness of this area from all settled/agricultural countries of Central Asia, the history of populating those territories and of their economical and cultural development till the middle of the XIX century, is reflected in the written sources in a very discrete and uneven manner. Therefore, a profound and versatile study of this problem appears to be possible only on a basis of different sources of historical knowledge, through interdisciplinary scientific synthesis of factual information they deliver. Those sources are: 1) large and small scale XVII – early XX cc. maps of the European origin; 2) the records of both Kazakh and Oyrat folklore of different periods; 3) the mid-XIX – early XX cc. military-topographical descriptions of Semirechiye; 4) the fiscal discount documents from the archives of the Russian tsarist administration of the same period; 5) the documents related to the settlement of nomads in 1930-50ies from the archives of the Soviet and Communist Party institutions; 6) the materials of archaeological field surveys and the ethnographical records carried out in the local Kazakh *auls* (villages) during the last decades; 7) the data of sociological questioning of the modern Kazakh population.

The analysis of the above complex of materials as a whole allow us not only to study the history of economical and cultural development, physical and cultural adaptation of the region in question in different periods during the 2nd millennium AD, but also to clarify the character of influence of local natural landscapes on those historic processes.

An Investigation of the Winter and Summer Campsites of Great Küre and the Nomadic Sites of Küre Warehouse of the Oirat Mongols

Borjigitai Oyunbilig
Renmin University of China, China

Küre, a group of yurts of the size of a complete monastery, refers to a place of Buddhist service suitable for Mongolian nomadic life. "The Great Küre of Oirats" was established by Oirat eminent lama Zaya Pandita Namkhai-Jamtsu; the Warehouse of Küre (*Küren sang*) was in charge of livestock and property of the Great Küre. They were active during the years between the 40s and 80s of 17th century.

This paper investigates the extent of the religious activities of the Great Küre and the nomadic sites of the Küre Warehouse, which belonged to the Great Küre, mainly based on the Mongolian source *Biography of Zaya Pandita* and the Chinese sources such as *Xiyu tuzhi* (The Geography of Western Regions), *Xiyu shuidao ji* (Records of the Water Resources in Western Regions), etc.

The range of religious activities of the Great Küre can be divided into two major areas: one was the Tarbagtai region and the area between Tarbagatai and Lake Balkhash, including present-day Tacheng, Yumin, Emin, and Tuoli counties of the Tarbagatai Prefecture of Xinjiang Uyghur Autonomous Region of China, as well as the region in the vicinity of the Emin River and Lake Ala-Köl, the Lepsi River basin, and the upper reaches of the Qaratal River in Kazakhstan; the other was the middle reaches of Irtysh River, roughly distributed over the area of Ust-Kamenogorsk and the upper part of Irtysh River basin in eastern Kazakhstan, the southern bank of Lake Zaysan, and the region of the Bu'erjin County of Altay Prefecture, Xinjing, China. The former was the manor of the Khoshud ruler Ochirtu Tsetsen Khan while the latter was under the control of his younger brother Ablai Taiji, which was a considerably vast area.

The nomadic sites of the Küre Warehouse were mainly distributed over the area extended from the southern part of the Tarbagatai Prefecture of Xinjiang, China, to the Emin River, Lake Ala-Köl, and the eastern bank of Lake Zaysan within the borders of Kazakhstan.

Land and Water Use in the Ili-Balkhash Basin from Paleolithic to Modern Times

Jean-Marc Deom, Renato Sala, Bolat Aubekerov and Saida Nigmatova
Kazakhstan Scientific Research Institute on Problems of the Cultural Heritage on Nomads, Kazakhstan

Today a major methodological development of archaeological research is represented by interdisciplinarity, namely the cooperation between archaeology and geographical and environmental sciences. This new approach, called geo-archaeology, is irreversibly changing the archaeological procedures of survey, excavation, documentation and interpretation. The present paper, adopting this point of view, analyzes the forms, factors and phases of landscape colonization in the Ili-Balkhash basin (Semirechie) from Paleolithic to modern times, on the basis of the documentation of the geographical location and chronology of monuments of material culture: settlements and towns, water devices and mines, roads, cemeteries and landscape marks like petroglyphs, henges and cairns. Some classificatory frames are suggested: ecological, topographical, and geomorphological.
The ecological frame results to be the most proficient. It is based on the consideration of the relative weight and complex interaction of 6 *"location factors"* (partly natural partly cultural: raw materials, water resources, climate, relief, strategic economical opportunities, and socio-political control) which appear to be of the highest significance not only in the case of Semirechie but more generally in arid regions. The relative importance of these factors in determining the location of monuments is changing during history, in connection with non-linear demographic, technical-economical and climatic variations. The study ends up with a model partitioning the historical development of land and water use in the Ili-Balkhash basin in 4 periods: Stone Age, Bronze and Early Iron, Middle Ages, Modern period. The other 2 location frames, topographical and geomorphological, most dependent on climatic changes, in some extreme cases will suggest the distinction of sub-periods. An esteem of demographic levels in the region for the whole time span under analysis is also provided.

The *Nukte* of Ili

Kicengge
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The word *Nukte* came from a Mongolian word “*negüdel*”. It means nomadism fields and people living there. In Chinese, *Nukte* is translated as "游牧处". *Nukte* has a kind of controlling power over the society. This thesis explains the existence of the power of Dzungar. Dzungar had a dominant power around Ili region. To prove the fact, this thesis highlights the period between 17th century and 18th century to see how the missionary and the leaders of expedition groups were treated. They have left effective reports for this study. Moreover, based on the witnesses of the prisoners, we can predict the existence of Dzungar power, size of the horse riding army, and what happened inside the nomads.

The Ili Valley under the Russian Rule (1871-81): Between the Great Game and the Local Development

Jin Noda
Toyo Bunko (Oriental Library)

In 1871, the Russian military force invaded the Ili valley and banished the sultan of Ili or Kulja. From then on, the Russians occupied the region till 1881, when the treaty of Saint-Petersburg was concluded, deciding the reversion of the Ili region to the Qing China. This “Ili crisis” has often been analyzed in terms of international relationships, especially the Anglo-Russian rivalry. Although such “Great Game” perspective still has some validity, when we observe the situation of the Ili valley from the Russian viewpoint, archival documents show that the Russian government was motivated not so much by the anxiety about the England’s advance into the Eastern Turkestan as by the anticipation of the benefit of regional trades. It means that we can examine the Ili crisis by a different approach, i.e. concentrating on Russian intension regarding the Ili region.

The north part of Xinjiang or Zungharia, where Ili (present Yining) is situated, was well known for its fertility owing to rich water resources. In this connection, there were reclamation works under the Qing empire’s rule (from 1760s to 1864, when the Muslim rebellions exterminated Qing’s dominion over Xinjiang). It is remarkable that the Qing government moved Turkic Muslims from the oases of southern Xinjiang to the region around Ili to grow grains. These immigrants, known as Taranchis, formed Muslim colonies (*hui tun*). However, during the Qing reign, they suffered from the heavy taxation.

Concerning the Russian rule over the Ili region, we can refer to the statistics edited by a Russian orientalist, N. Pantusov. According to its data, the tax burden of the Taranchis was eased and their population grew up. The statistics also show that the local people (Sibes, Oirats, Chahar Mongols, Kazakhs, Han Chinese, Tungans,) steadily engaged in the agricultural production including livestock farming. As the Russians had aimed, the trade between Russia and Xinjiang through Kulja was recovered. On the whole, the Russian occupation brought about the stability of the region to some extent.

A Note on the History of *Jut* in Kazakhstan: Climatic Factors in Massive Loss of Livestock

Tomohiko Uyama
Hokkaido University

Jut (*zud* in Mongolian) means bad weather conditions that resulted in massive loss of livestock, and was one of the most serious disasters for Kazakh nomads. There were several patterns of *jut*: heavy snow; freezing after a temporary thaw; a cold winter after a dry and hot summer, etc. In this presentation, I will compare descriptions of *jut* in contemporary newspapers and other written sources with weather data in the late nineteenth and early twentieth centuries. I will demonstrate the complex relation between weather and *jut*, parallels with other natural disasters such as drought, possible impact of climatic changes, and above all, social factors of *jut*. In addition to the nomadic way of grazing, negligence of governing officials and political disorders aggravated *jut*. I will also partially attempt to compare the chronology of *jut*/*zud* in Kazakhstan, Mongolia and China.

Power Models in Nomadic Pastoralists' Societies of Central and Inner Asia: a Historical Perspective

Irina Morozova
International Institute for Asian Studies, the Netherland

Central Asia, especially its eastern part (present Mongolia), played a consistent role in the history of founding great Asian Empires and in their subsequent decline. In its vast space various tribal configurations and polities were established, and change was always reflected in the region's social and cultural transformation. In this paper, using the *longue durée* approach, I would like to give an overview of continuity of power models and social relations' patterns among the nomadic pastoralists' societies since the 13th century (also dwelling upon earlier periods) till present.

Nomadic pastoralism had been the basis of the economic and social life of Central Asian peoples since ancient times, even though agriculture and irrigation were known to them. The climatic change in the centre of Eurasia determined the economic change, and by the 13th century, the golden age of the Great Mongol Empire, Central Asia was a belt of steppes, semi-steppes and deserts, alternated by mountains – the zone of nomadic pastoralism as a prevailing type of economy. Determined by ecological and biological factors, nomadic economy formed the matrix of the nomads' social system and a model of government based on strict hierarchies of political elites, with aristocratic families at the top and the nobles of conquered and assimilated peoples at the bottom.

The cohesive force exerted by a powerful ruler served to stabilise the nomadic society, leading at times to the formation of the great Eurasian nomadic Empires. The paper presents a discussion on the nature of those military polities, the cult of the *qan* and socio-administration institutions among the Mongols, such as the decimal system, wings, *tümen* and *ulus*.

In the Middle Ages, and particularly since the 17th century, the Mongolian peoples, clenched between two growing Empires – Russia from the north and China from the south – could not consolidate into a military polity as in former days. Large-scale migrations of tribes practically stopped. In search for new stabilising factors, the Mongolian *qan*s observed the 'Tibetan model' – the pattern of relationships between the religious tutor and the secular ruler and the corporate system of administration and economy. Buddhism appeared as an additional source of legitimacy and leadership that could present a chance to neutralise the destabilising element in Mongolian society and contribute to the creation of a unified administrative system. However, since the 17th century Buddhism became a means for Qing to deconsolidate the Mongolian elites.

I identify four key constant elements of Mongolian society as it stood at the start of the 20th century: nomadic pastoralism, a local corporate system, a latent tendency toward unity under a strong leader, and a drive to political and cultural sovereignty from powerful neighbours. In the final part of my paper I examine how those factors overlapped and determined the course of Mongolia's socio-political development in the 20th century. Sketching how socialism became possible in the society of nomadic pastoralists and how it affected social composition, I end my paper with a question how current world capitalist socio-economic and cultural trends will influence the societies of Central Asian nomads.

Some Stages of Ecological (Environmental) History of Ili-Balkhash Region (Soviet Period)

Zhulduzbek Abylkhozhin
Institute of History and Ethnology, Kazakhstan

It is well-known that there is - in pre-industrial societies - the main counteragent of person's economical activity is manufacture force of nature. In other words, the phenomenon of manufacture is nothing else but mechanism of interaction of human activity with the natural environment. If to say about the culture, so this is the way of natural space adaptation to human interests. Exactly this is the most important function under the reproduction of such societies.

Result from this that the stability of human economical-cultural activity (particularly on his pre-industrial stages of history) determines by the balance of system "society – nature".

The Soviet Marxist-Leninist regime stroked this axiom off its logics. The ideology of this regime put at the head the "revolutionary-reformative force of mode of production." The policy of Soviets supported the other "system" – "state – nature". So, that's why different ideas of geographical determination (also its projections as environmentalism, possibilism, ect.) exposed to anathema.

By the same reason the ecology was pseudo-science, bourgeois quasi-science. Because the ecology – is the science about harmonious relations between human society and natural harmony. Meanwhile the Soviet **non-market economy** was absolutely extensive. That's why main resources of its development (**non-market economy)** was the strategy of endlessly expanded nature exploitation.

The policy of irrational nature resources exploitation in full measure became acquainted by Kazakhstan also. Particularly, its Ili-Balkhash region.

In frameworks of such (bellow mentioned) policy it is possible to stress out several tragic stages:

1) The demolishing of traditional structure of economy in 1920 yy.;
2) The force collectivization of Kazakh farms in 1930 yy.;
3) The mass sedentarization of nomad cattle-breeders.
4) The starvation and mass migration of inhabitants (population) outside the region (generally, to the western China regions) in 1930 yy.;
5) The Stalin's industrialization and its anti-ecological consequences (construction of cooper-smelting plant, Turkestan-Syberia railway, ect.);
6) The opening-up of *Tselina* in 1950-196 yy., the attempting of rice *Sovkhozs* development and its impact on water-resources balance of the region;
7) The impact of military-industrial objects on ecology.

Legacies and Ruins of Socialist Modernization in Almaty Region, Republic of Kazakhstan.

Mitsuko Watanabe[1], Yuki Konagaya[2], Tomohiro Akiyama[3] and Jumpei Kubota[1]

1: RIHN, 2: National Museum of Ethnology, 3: Aichi University

Regional developments during the Socialism are generally recognized as over-development with destruction of the ecological environment. However, in order to better understanding of environmental issues, it is important to clarify the actual situation of the development. This study aims to reconstruction of Socialist Modernization as the Environmental History. In this paper, we tried to clarify the historical changes of Landscape of Ordinary Life, based on an oral history, in the case of the Alma-Ata Kolkhoz and the Kazakhstan Sovkhoz, in the Almaty region, the Republic of Kazakhstan.

Developments during the Late Socialism and Historical Changes in Landscapes of Ordinary Life: In Kaipov, grain fields were reclaimed on the lower part of the alluvial fan after kolkhoz established in the 1930's. Following the construction of "Kazakhstan Sovkhoz" in 1957, orchards have been expanded on the central part of the alluvial fan. At the same time, infrastructure, such as wells and irrigation channel, were constructed. Besides, schools for children of Sovkhoz workers were built. With the expansion of Sovkhoz, populations of Kaipov grew and schools were extended from 4 grades to 10 grades. Thus, landscapes of ordinary life had been changed.

Use of Enforced Nature: The "Alma-Ata Kolkhoz" was specialized in livestock breeding. To breed and feed as many heads of livestock, nature around the Kolkhoz had been enforced. For instance, wells were drilled and water was transported by truck to ranches used during off-summer seasons. And, hay for livestock was also carried by truck. Until the Kapshagai Reservoir constructed in 1970, hay came mostly from the natural grass on pastures along the Ili River. However, the riverfront was submerged under water because of the construction of the Reservoir, brigade was built to compensate for the lost of natural grass land.

Division of Labor and Over Adaptation: Management of Kolkhozes and Sovkhozes under the socialist regime ramified into so fine a division of labor, such as stockman, hay producer, truck driver to transport water or hay. And, each labor was operated under strictly managed systems. The division of labor was so extreme that, once the Kolkhoz and Sovkhoz structures for maintaining and managing the systems tumbled down after the fall of the Soviet Union, everyone just could not sustain himself. In short, people had overly adapted themselves to the systems and could not survive without the institution.

Overuse of enforced nature could result a catastrophic destruction of the ecological environments. In this study area, crucial destruction of the ecological environments did not occur. it is because there were sufficient water resources flowing from the Tianshan Mountains into the Ili River. And, one of other major reasons may be that the most of Sovkhoz and Kolkhoz which had been reining the "enforced nature" under control tumbled before it gets out of hand. The use of "enforced nature" becomes uncontrollable without human involvement.

Genesis and Present State of Fauna of Ili-Balkhash Region, Kazakhstan

Roman Jashenko
Institute of Zoology, Kazakhstan

For studying the genesis of desert fauna of Ili-Balkhash region in condition of fossil absence it is necessary 1) to determine a formation of desert biota in corresponding to the palaeo-geographic data and modern distribution of endemic taxa of plants and animals 2) to carry out the zoogeographical analysis of modern fauna of investigated area and 3) to carry out the phylogenetic analysis of some groups of animals in correspondence with palaeo-geographic information and data on their modern distribution.

On the basis of zone and sectoral principles of biosphere division the desertic biota is divided into 5 subzones: cold temperate, warm temperate, semisubtropical, subtropical and tropical. Ili-Balkhash (Northern Туран) deserts as well as Central Asian deserts belongs to the cold temperate deserts.

Formation of an arid climate in Asia has begun from the top of Jurassic (more than 100 million years ago). In a Cretaceous period the Turan-Central Asian region was as hilly plain covered with savanna with small woods and lakes. From the top of Cretaceous and during whole Cainozoic the orographic raising of the region occurred, it was accompanied by decreasing of Tethys ocean and occurrence of continental plains in the west, interfering transferring of a moisture from Atlantic. In Palaeogene the basic mountain complexes (Altai, Khangai, Tien Shan, Sayan mountains, Kun-Lun, Nan-Shan that were not high, till 1500 m above sea level) were formed. Tibet sharply rose and Trans-Himalayan became a mountain ridge. At this time the general climate aridizations amplified (the basic landscape - deserted savannas), internal reservoirs and Tethys gulfs dried up. In Oligocene the climate cold snap begins. In a Neogene there was a raising of all regional ridges, in Pliocene they already become natural barriers on a way of continental air mass, the Himalayas almost completely detain the precipitation brought by the Indian monsoons. In Miocene the quantity of precipitation decreased to 200-300 mm., that corresponds to semi-desert. In Pleistocene there was a freezing in high mountains because of a cold snap, orogenesis has amplified. Now studied region represents outflow continental basin with a continental climate which is characterized by sharp fluctuations of temperature within days, small quantity of precipitation, weak overcast and the big duration of solar light.

The first stage of formation of desert biota concerns to Oligocene - Miocene when desert biotops appeared among the huge semidesertic plains in extra zonal conditions. The Initial stage of formation of desert flora and fauna had occurred in southern subzones - tropical, subtropical and semisubtropical. Through considerable time because of transformation of warmer subzones in Turan-Central Asian region, owing to orogenesis and climate aridization warm temperate and cold temperate subzones began to be formed, where the most ancient desert elements began to disappear gradually. In connection with a fast cold snap the formation of desert biota of northern subzones occurred because of sorting and extinction of existing desert elements of fauna and flora, instead of the progressive evolution. In this connection the fauna and flora of cold temperate subzone is much poorer than other subzones. As an example, the analysis of desert herpetofauna origin - the initial homogeneous Turan-Iran-Gobi fauna was divided in the end of a Neogene-beginning Quaternary at the period of Tien Shan raising. As a result, there are more than 20 species (9 endemics) reptiles now in Central Asia , 76 species (more than 20 endemics) in Turan and 136 species in Iran. The analysis of avifauna shows poverty of Central Asian (about 40 species) in comparison with the North Turan region (about 450 species). The same concerns to insect fauna, Turan fauna influenced on Central Asian, but not on the contrary.

Now the known invertebrate fauna of the Ili-Balkhash deserts includes about 1500 species of insects (from the studied 8 orders) from 527 genera 45 families, 43 species of spiders from 11 genera (fam. Theridiidae) and 3 species of solifugas сольпуг from 3 genera, 3 families, and also 82 species of molluscs from 33 genera 23 families. The fauna of land vertebrate animals consists of 343 species: 50 species of mammals, 269 species of birds (water and desert), 13 species of lizards, 7 species of snakes and 1 species of a turtle, 3 species amphibious. There are 14 native and 26 alien species from China and the Far East.

Land and Water Use for Irrigated Agriculture in the Lower Ili River Basin, Kazakhstan

Katsuyuki Shimizu, Yoshinobu Kitamura and Yusuke Tsukamoto
Tottori University

The Ili River generates from an offset of Tian Shan Mountains in China and flows into the Lake Balkhash through the southeast part of Kazakhstan. The lower Ili River basin is located at semi arid area, and the annual rainfall is 152 mm, especially, during the cropping period from May to August, the total amount of rainfall is about 57 mm. Therefore, irrigation is inevitable for agriculture. Akdara Irrigation District had been developed since 1960s in the lower part of the river and the total irrigated area is about 32,000 ha. In the irrigation district, major crops are paddy rice, alfalfa and wheat, however, currently area of wheat, barley and other crops has increased instead of alfalfa. Since the irrigation district was developed, paddy rice - upland crop rotation has been practiced. Since all canals are earthen canals, and total length of main and secondary canals are 270 km long, lots of seepage and evaporation occurs while water is conveyed and distributed to the fields.

After independence of Kazakhstan following the collapse of the Soviet Union, state farms were privatized and lost the support from government for their agricultural production. Therefore, the cropped area decreased by 50% in 1995 during the transition period of farm privatization. State farms became cooperatives and they were divided into smaller private farms. Recently, cropped area has recovered as it was, however, the annual water withdrawal from the Ili River has decreased from 750 Mm3 to 630 Mm3 due to increase of domestic water use for hydropower and other water use among riparian countries. The deficit of water for agriculture in the lower part has been concerned. In addition to that, in appropriate water management in the fields has a threat of salinity problem.

The authors, therefore, conducted the field survey in order to assess the land and water uses for agriculture. Firstly, GIS-based fundamental database is established which contains information on locations of canal and fields, elevation, cropping pattern, groundwater level and fields with problem such as malfunction of irrigation and drainage canals. Secondary, temporal and spatial distributions of cropping pattern, fluctuation of groundwater level and location of poor-drained fields are analyzed. Then, based on that, relation among elevation, groundwater level, cropping pattern and poor-drained fields is examined. Moreover, water balance of the irrigation district and its change are estimated. As a result, it is revealed that lots of seepage from canals and paddy fields raise ground water table at the whole farm level. Thus, soil water moves upward by capillary action from the raised groundwater table. In this way, water is supplied to upland crop fields through groundwater. Overall irrigation efficiency of the irrigated district is estimated as 0.23, however, considering that the seepage from paddy fields is effective as leaching salts in the field, about 45% of water withdrawal is used effectively.

Distribution Patterns of Soils and Vegetation in Foothills of Tienshan and Altai Mountains in Central Eurasia

Shinya Funakawa[1], Aya Makino[1], Kokoro Morioka[1], Konstantin Pachikin[2] and Wang Gensu[3]

1: Kyoto University, 2: Institute of Soil Sciences, Kazakhstan, 3: Institute of Mountain Hazards and Environment, China

Extensive survey on distribution patterns of soils and vegetation were carried out in foothills of Tienshan and Altai Mountains. Clear trends were observed for their distribution in terms of vertical zonation as well as west-to-east transition.

In Tienshan Mountain, soils in higher elevation were affected mainly by increasing precipitation and hence had lower pHs and higher contents of organic matter. For example, in the northern foothill of Tienshan next to China-Kazakh border (Ketmen range), the following relationships were obtained using multiple stepwise regression (n = 34, $p < 0.15$) for determining soil pH, soil organic carbon (SOC) and carbonate carbon (CO_3-C) in the surface 30 cm layers of soil:

pH(H_2O) = 32.3 – 3.38 ln (elevation [m]) – 0.395 cos (slope direction)

(r^2 = 0.82**)

SOC (Mg ha^{-1}) = – 707 + 106 ln (elevation [m]) + 34.8 cos (slope direction) sin (slope gradient)

(r^2 = 0.65**)

CO_3-C (Mg ha^{-1}) = 284 – 33.0 ln (elevation [m]) – 45.5 sin (slope gradient)

(r^2 = 0.46**)

where slope direction changes from N (0º) to N (360º) via E (90º), S (180º), and W (270º) as a numerical parameter. Calcisols (CL) were distributed in lowermost regions (below 1,400 m), and then Kastanozems (KS) (1,400–1,550 m), Chernozems (CH) (1,550–1,700 m), Phaeozems (PH) (1,700–2,400 m) and Umbrisols (UM) (above 2,400 m) were distributed with an increase in elevation. CH, PH and UM were often covered with broad-leaved or *Picea* forest typically on northern slopes. Such forest covers, however, noticeably decreased in Chinese Tienshan. In addition, the presence of spring ephemeral vegetation on CL in northern foothills in western half of Tienshan (Kazakh territory) should be emphasized from the viewpoint of potential advantage for livestock production.

On the other hand, in Altai Mountain, soil organic matter seems to decrease in higher mountains presumably due to decreasing temperature as well as growing period. In northern Kazakhstan, the zonal soils in the plain were KS and in mountains CH, Luvisols (LV) (or PH in western region) and Cambisols (CM) were successively dominated, whereas in Chinese Altai, dry soils such as CL distributed toward higher elevation (above 1,000 m) and LV zone was lacking. Thus, in both mountains, west-to-east transition toward drier moisture conditions was clearly observed, i.e., soils exhibited several drying features (high pH, shallow carbonate layers and low organic matter content) and distribution of forest vegetation decreased in Chinese Xinjiang.

Since average monthly air temperature (AT) and annual precipitation (PPT) can be simulated based on secondary dataset from established meteorological stations as follows:

AT = 51.2 – 0.901 (Latitude [degree]) – 0.00574 (elevation [m])

(n = 77, r^2 = 0.86**)

PPT = 2670 – 28.6 (Latitude [degree]) – 125 (Soil pH)

(n = 17, r^2 = 0.70**)

Based on these equations, climatic conditions for respective soil groups were analyzed. CL is estimated to be distributed in a dry region with precipitation of below 400 mm. In contrast, UM distribute under cool moist conditions with annual precipitation and average air temperature of above 600 mm and below 0ºC, respectively. While black soils such as KS, CH and PH distributed in narrow ranges of climatic conditions between CL and UM, LV occurs along the moist- or warmer-limits of the conditions of the black soils. Thus a possibility of regional mapping of soils based primarily on climatic dataset is realized.

What Has Happened with Central Asian Snow and Glacier Water Resources in the Last 100 Years?

Vladimir Aizen, Elena Aizen and Arzhan Surazakov
University of Idaho, USA

The last several decades central Asia suffered intensive droughts and lack of water for agriculture, fast growing economy and population. However, an exsiccation of central Asia is not a phenomenon according to ancient records and recent paleoclimatic (ice-coring) research. Even observational data for the last hundred years show some shifts in climate that impact on depletion of water resources. The early military topographic maps show that some Tien Shan glaciers retreated as much as 3 km during the last 100 years. Based on the aerial photography, Hexagon KH-9, Landsat ETM and ASTER data Tien Shan glaciers shrunk by 5% between the middle of 1940th and 1970th and 10% during the next 30 years (1,617 km^2). Evaluation of the Tien Shan snow cover for the same period by aerial snow surveys, AVHRR and MODIS data reveled 15% (approximately 120 000 km^2) seasonal snow covered area reduction. During the last thirty years, the duration of snow melt reduced by 30 days from the date of maximum snow cover to the date of its disappearance. Further decrease in snow cover will be accelerated due to increase of rainfall instead of snowfall in early spring months at high elevations, and consequently a lesser heat expenditure for snowmelt. The long-term weighted average of annual precipitation decreased by -0.36 mm for the last 30 years, which means that central Asia received 62 km^3 less water. The most significant decrease of precipitation after the middle of 1970th observed over 2000-3000 m a.s.l. accelerated the glacier recession. The Aral-Caspian desert and south-western Pamir are the exceptional areas where precipitation tends to increase in the last 30 years. The annual air temperature increased over all central Asia with 0.68°C difference in the means for the two thirty-year, before and after 1972 and generally attributed to summers. The maximum growth in annual air temperature observed since 70th at low elevations and at the northern regions of central Asia. Acceleration in annual air temperature over all central Asia increased for the last 30 years compared to previous 30 years. Maximum annual acceleration in air temperature observed at the northern regions of central Asia, i.e. in Mongolia and South Siberia, and max summer acceleration observed in Tien Shan. The Magicc&ScenGen model scenarios for central Asia simulate increase of air temperature between 1.8 and 4.4°C by 2100 while the humidification scenarios predict variations of annual precipitation ranged from reduction by 6%, which is more realistic, to growth by 54% (*UNEP, 2003*), that looks less realistic. Our simulation projects that minimum ratio for the river runoff could be ranged from 0.55 to 2.2 times of the current level. The large possible changes in river runoff indicates non-linear system response caused by the non-linear response of evapotranspiration and changes in precipitation. Increase of river runoff may take place due to increase of the glacier melt. An increase in mean air temperature of 4^{o}C and precipitation of 1.1 times of the current level could increase ELA by 570 m during the 21st century. Under these conditions, the number of glaciers, glacier covered area, glacier volume, and glacier runoff are predicted to be 94%, 69%, 75%, and 75% of current values. The maximum glacier runoff may reach as much as 1.25 times current levels while the minimum will likely equal zero. However, an increase in glacier melt in mountainous regions, while initially may be considered as a positive factor at the end will cause the runoff to decrease.

Calm before the Storm: the Legacy of Ideology-driven Agricultural Development in Kazakhstan

Kenichi Abe
Research Institute for Humanity and Nature

In the late Soviet era, Kazakhstan was invented as an agricultural export zone. Staple crops amenable to industrial-scale production, such as rice and cotton, were cultivated according to ideological precepts, rather than agronomic technique, with dramatic social and ecological consequences. In the lower Ili basin, the site of the current research project, rice production was realized through extensive construction of irrigation canals and introduced settlement of a non-Kazakh population into the sparsely populated areas, formerly the semi-arid lands of Kazakh pastoralists.

Such 'top-down' agricultural development projects can have unexpected results. Nationalized agriculture paid limited attention to agricultural efficiency, or even to agricultural productivity. State-sponsored 'farmers' were sometimes compensated according to the amount of water they used; environmental conditions and quality were simply unaddressed. Chronic over-irrigation produced saline soils unfit for cultivation, precipitated the deterioration of the Aral Sea and the fisheries formerly found there, devastated the riparian ecosystems along the Syr Darya and Amu Darya rivers, and sent dust storms far into their headwaters in Central Asia. The blessings of the state 'sustained' this system even as its ecological capital neared exhaustion.

After independence, lands belonging to Kolkhoz, the collective farm, and Sovkhozand, the state-owned farm, were divided, usufructs were put up for lease, and a new class of landed 'farmers' emerged. But these were 'farmers' in name only: the Soviet-era division of labor produced skilled tractor-drivers, for example, but not people practiced in the arts of plant cultivation. With the sudden demise of the institutional infrastructure underlying the entire complex, agriculture in Kazakhstan inevitably came to an abrupt halt. Ironically, this collapse allowed a short period of environmental relief.

Recently, however, the post-independence urban bourgeoisie has revived interest in the potential profit in agriculture. They have started to speculate in agriculture and organize agricultural enterprises in which former workers in Kolkhoz or Sovkhozand have been re-employed as de facto laborers on their own lands. Again, agricultural production is organized not as an essential food producing activity, but in order to exploit an economic niche. In both Soviet- and free-market-eras, in short, the character of agriculture has been determined by ideological goals and institutional power.

While any agriculture will in time transform its environment, the development of agriculture in Kazakhstan provides an unprecedented modern example of social-ecological collapse. After a period of calm following the Soviet production, and as newly empowered speculators cast their gaze on volatile export commodity markets, a new phase of agricultural development begs the question: what new storm lies on the horizon?