Kherlen River the Lifeline of the Eastern Steppe

Executive Summary,

Water Infrastructure Impacts Checklist and

Community Survey

Satellite image of Kherlen River basin in June 2014. (NASA MODIS Imagery 25 August 2013)

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FOREWORD

Headwaters of the transboundary Amur-Heilong River basin – the Argun, Kherlen and Shilka rivers – and several inner, closed basins lie in the eastern part of Dauria ecoregion shared by Russia, China and Mongolia. Indigenous 30-year climate cycle determines dynamics of eastern Dauria ecosystems, but impact of global climate change is also evident in the region. Droughts and floods are becoming more extreme through climate change, and recent rapid socio-economic changes in the region make local communities and ecosystems less resilient. Economic development and water use in three countries make it difficult to build an applicable transboundary mechanism to protect and sustainably use common water resources.

In 2013 the UNECE supported the RwB and Daursky Biosphere Reserve in production of a strategic assessment: “Adaptation to climate change in the river basins of Dauria: Ecology and Water Resources Management”, that was published in Russian, English and Chinese.

Rivers without Boundaries Coalition continues documenting and analyzing transboundary basins of Dauria. New report is focusing on water resources management in Kherlen\Kelulun River transboundary basin to promote climate adaptation, ecosystem-based river basin management approach, and strategic environmental assessment of development options related in water management in transboundary river basins of Dauria. Kherlen was selected as extreme example of discrepancy between development plans, ecosystem health requirements and cyclical availability of water resources. This Report provides detailed guidance on contents and process of the independent assessment of "Kherlen -Gobi Water Transfer Project". We hope that our recommendations will be taken into consideration by water managers, policy-makers and research community in all transboundary basins of Dauria.

Our research and fieldwork on Kherlen River and assessment of water transfer plans was supported in 2012-2016 by Whitley Fund for Nature, Conservation Leadership Programme, DIPA, WWF Amur Programme and others. Report preparation was made possible by Stockholm Environment Institute and the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Sincere thanks to all institutions who contributed to this long process.

This report is available in **English** with executive summary available in **Mongolian, Chinese and English at www. www.transrivers.org/2015/1515**

Special thanks to RwB-Mongolia Board Member -Tudevdorj Jamgan, who in spring 2015 undertook a long journey on a horseback along the Kherlen River to collect information for this report. Deep thanks to Solongo Zoright, who proofred and helped to edit the text and developed the report on Kherlen community survey and to Orkhon Amarsain for preparing publication of executive summaries in two languaages. And the last, but not the least I want to thank old friend and colleague Bart Wickel of Stockholm Environment Institute, who came to my rescue and provided tremendous input into compilation and editing of this report.

Please, send Your comments and suggestions for further research to simonov@riverswithoutboundaries.org

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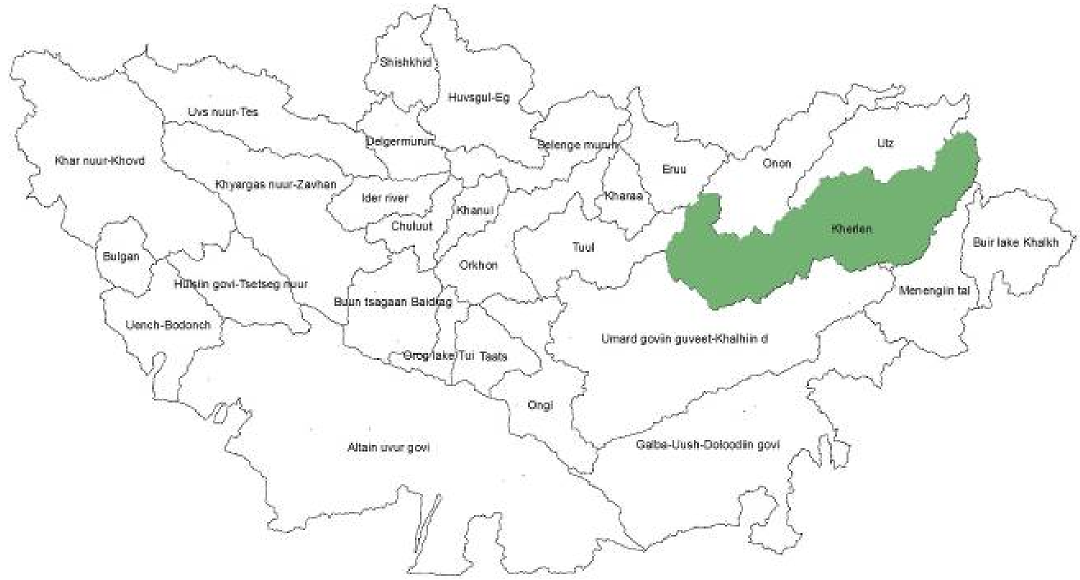
A spring in Dornod (by V. Kiriliuk)

Part I. Scarce waters – high ecological values

1. Management of Mongolia's scarce waters

Mongolia has much less water resources than any other country of continental East Asia and those resources require careful protection and management. Rapid and uncontrolled expansion of water-intensive activities such as mining, export oriented thermal power plants, coal-to-gas conversion plants may severely threaten precious sources, unless water resources allocation is deliberately limited by implementing rigorously defined environmental norms and by fully protecting community rights and access to clean and safe water. Other nations with water stressed regions, most notably Mexico, South Africa, Australia, China and the USA, have recently made drastic adjustments in water allocation to safeguard environmental flows. Mongolia still can avoid crisis by securing environmental flows before too much water is allocated to human use.



Kherlen river basin and other 28 river basins management units of Mongolia (Kherlen Water Authority 2013)

2. Transboundary rivers of Dauria –water wasted abroad?

Dauria is a highland region and many rivers flow out across the border. These rivers are of high ecological value and support globally important natural heritage sites: the Selenge River - the main source of Lake Baikal, the Onon– the largest tributary of the Amur River, the Ulz draining into Torey Lakes comprising the World heritage site "Landscapes of Dauria" and the Kherlen flowing into the Dalai Lake Ramsar Wetland. Together these unique transboundary rivers, however small, are supporting tremendous globally-important biodiversity values and the ecological balance of Mongolia and adjacent countries.

3. Biodiversity in River basins of Eastern Dauria

The Kherlen River is the longest river of Dauria Steppe and the most remote source of Amur River which drains into Pacific Ocean. The river starts in the alpine zone of Khentii Mountain range and runs over a distance of 1, 250 kilometers through cedar-pine forests, forest steppes and vast Eastern steppes to empty into Dalai (Hulun) Lake in Inner Mongolia, China. The area possesses very high level of biodiversity for a steppe zone, and it is included in the list of Global 200 priority ecoregions for conservation as the “Dauria Steppe”.

More than 40 endangered bird species breed in or migrating through the Lower Kherlen Basin and are listed on the IUCN Red List and in national Red Data Books of Russia, Mongolia, and China. Upstream just near the city of Baganuur, the Kherlen valley is a breeding site for the threatened cranes and bustards and Argali sheep. Thirty eight species of fish are observed in the Kherlen River at the Gun Galuut Nature Reserve near Baganuur, including the endangered Siberian Taimen.

4. Ecosystem dynamics: Influence of climate cycles on habitats in Dauria Steppe

The Dauria Steppe’s natural climate cycle, which typically spans 25 to 40 years, is a major force shaping regional ecosystems and peoples’ lifestyles. During the dry phase, which is the most critical for many species, a few habitat refugia remain. River floodplains still have relatively frequent flooding events and thus preserve more stable habitat in times of drought. The highly dynamic habitats of the Daurian eco-region are characterized by strong leaps and drops in biological productivity, and support high biodiversity of the Daurian steppes, including the before mentioned abundance of many mammal and bird species.

One of reasons for the rich biodiversity of the Kherlen river, is the low degree of human alteration of river processes, and its intact natural connectivity without interruption by dams from Khentii Mountains all the way to the Dalai Lake in China

Demoselle crane (Anthropoides virgo) By V. Kiriliuk

5. Conservation efforts and water management

Several parts of Kherlen River valley are protected in nature reserves. The Kherlen source is located in the Khan Khentii Strictly Protected Area. The river flows through the Gun Galuut, Khar Yamaat, Toson Khulstai nature reserves in Mongolia. The Dalai (Hulun) Lake Biosphere Reserve receives waters of Kherlen and Halkh rivers coming from Mongolia and is connected to Argun/Erguna River on the border with Russia and China. The Dalai lake is an important breeding, molting, and stopover site of water birds including endangered Swan geese. Dalai Lake Nature reserve forms part of the tri-national Dauria International Protected Area (DIPA) declared by all countries in 1994. Practically all existing conservation efforts are good examples of ecosystem-based-adaptation- they preserve resilience of biota and protect habitats to be used in all phases of climate cycle and during linear climate change.

In Mongolia Water Basin organizations have been formally established in 20 of the 29 Water Basins, including Onon (2012), Tuul (2012), Kherlen (2013) and Ulz (2014) basins. The Kherlen River Basin Authority is a state administrative organization that prevents water resource from water scarcity and environmental pollution, uses the inferred water reserves properly, restores water reserves, regulates interrelation between local and administrative departments and implements the integrated management plan for water reserve. In 2015 WWF -Mongolia supported development of the Kherlen River Basin Management Plan and in spring 2016 it was still undergoing public hearings.

Song-Liao Water Resource Commission (SWRC) headquartered in Changchun, Jilin Province is responsible for river basin management planning and technical supervision in all rivers in China part of Amur river Basin shared with Russia and Mongolia. The SWRC serves to manage the water resources and river courses of the basin in a “unified” manner and is responsible for “comprehensive harnessing, developing and managing major water control structures, doing the planning, management, coordination, supervision, and service to promote river harnessing and the comprehensive development, utilization and protection of water resources”. SWRC works with Hulunbuir Prefecture of Inner Mongolia and Dalai Lake National Nature Reserve (subordinate to Forest Administration) to manage Kherlen River and Dalai Lake. Given that there is very little water infrastructure associated with lower 200 kilometers of Kherlen River flow, the most persistent management question is adaptation to cyclical drought that regularly leaves river stretch in China dry.

Kherlen from Mongolian Border to Dalai lake has no dams and reservoirs-exceptional situation for a river in China (MODIS Imagery 2013)

6. Kherlen river –stronghold of nomadic culture and economy

The large human population and huge livestock economy of the region depends on Kherlen River. The total population in the Kherlen river basin in Mongolia is 110,000 people, and settlements, camps and roads tend to line along Kherlen River, where best living environment is to be found. In China the Kherlen river flows through the "New Right Barga Banner" of Hulunbuir prefecture, with population of 35,000 - mostly ethnic Mongols, engaged in livestock business. Dalai Lake also has important fisheries enterprises and tourist resorts.

7. Hydrology in fluctuating climate – river management issues

As it flows from forest into dry steppe Kherlen river loses water. The Kherlen annual average flow rate decreases from 648 million cubic meters at Baganuur to 530 million cubic meters at Mongolia-China border. The annual average river discharge into Dalai Lake is on average 483 million cubic meters. However, in dry years, like in 2007, Kherlen River total annual inflow into Lake Dalai decreased to only 38 million cubic meters and for 200 days in a single year it completely dried up in China.

Floods are most important hydrological processes that shape the vitality of Kherlen River valley. Flood water is mostly utilized for groundwater recharge, filling of oxbows and lakes and growth of pasture vegetation in vast 2, 900 sq. km. floodplain of the Kherlen river. Flood wave attenuation by the vast natural floodplain makes the Kherlen floods do not pose any danger to human settlements along the river.

8. Climate change and the path to adaptation

The Mongolian nomadic tribes have adapted to temporal and spatial change in availability of water and other resources due to natural climate cycles for centuries. Recent rapid socio-economic changes and loss of nomadic heritage, however, make ecosystems and local communities less resilient to this natural fluctuation in resources and more vulnerable to droughts and floods which are exacerbated by anthropogenic climate change.

It is important to understand that thus far changes in water availability in Dauria due to anthropogenic climate change, if any, have been an order of magnitude smaller than changes due to natural climate cycle. It is however likely that the impacts or timing of the climate cycles will change and that therefore the sustainability of adaptive measures for ecosystems and people increasingly less predictable. Drastically different cultures, differences in population density and the often highly unsustainable modes of economic development and water use in Russia, China and Mongolia, make it very difficult to build transboundary mechanisms for the protection of common water resources.

Kherlen River valley at Gun Galuut Nature reserve 150 km east of UB (by E. Simonov)

Part II. Existing and Planned Development and its Possible Impacts

9. Human impacts on Kherlen and adjacent rivers

Total water withdrawal in the Mongolian part of the basin is currently around 24 million cubic meters annually, or 5% of Kherlen river flow across the border. It is reasonable to assume that another 3-5% is used in Chinese part of the basin. Large coal mining operations are presently located near the Kherlen River in Baganuur and Choibalsan and are the main sources of industrial pollution. Livestock overgrazing coupled with warming changing climate also contributes to decrease in water quality and quantity. Water mineralization and turbidity increases manifold as Kherlen flows through the dry steppe.

Kherlen, Khalkh and Ulz rivers share similar natural features: they flow through Dauria Steppe and have large freshwater\brackish lakes at the rivermouths, acting as evaporation basins. However, degree of human development is very uneven in three basins. The Ulz River has no large population centers, but only mining industry, while the Khalkh river, also has no sizable towns and so far is practically pristine in Mongolia, but has considerable degree of tourist resort development in China. The Kherlen River basin is the only transboundary basin of the steppe that has sizable and diverse industries and several provincial centers , that actively use and pollute its waters.

Nevertheless the vast majority of water samples taken in Kherlen River basin appear “clean” or “very clean”. Despite presence of three industrial towns and a sizable livestock industry, the Kherlen River is still clean and resilient, largely because it retains natural flow character.

Sheep in Kherlen river valley (by J. Tudevdorj)

10. Planned industrial water supply projects

Early in the 21st century, when the Mongolian economy started to be driven primarily by Chinese market, mineral licenses were given to various foreign and domestic companies to develop large ore and coal deposits: Oyu Tolgoi, Tsagaan Suvarga, Tavan Tolgoi, Shivee-Ovoo, etc. Development, however, was slowed down by absence of readily available water sources in Gobi regions, due to both natural water scarcity and groundwater exploration lagging far behind industrial demand. Mining and processing of copper ore and coal washing require considerable amounts of water, but even more water is required by coal-energy and coal-gasification complexes that convert coal that is otherwise difficult to transport into easily exportable electricity and gas. In more recent plans, the Mongolian government also seeks to process mining products before exporting them. Several water supply projects emerged:

1) Prestige Group Schemes

From 2006 to 2014 the Prestige Group, a Mongolian engineering firm, has developed various water transfer schemes for delivering water from the Kherlen and Orkhon rivers to Gobi. All designs envision network of water transmission pipelines with water pumped as far as 530-540 kilometers to Tsagaan Suvarga and Zamiin Uud, and serve various users in between. All designs count with a water intake from a reservoir that block the river with a 25 meter high dam. In addition infiltration water intakes were envisioned on wide Kherlen floodplain downstream to pump subsurface water from alluvial deposits. Proposed water transmission volumes vary from 1 to 2 m^3/sec. (30-60 million m^3/year).

Kherlen-Gobi water conveyance project. (Water Center, 2010)

Well in Dornod Province (by E. Simonov)

2) "Monhydro construction" Sainshand Water Supply

This supply scheme would deliver water from the Kherlen over a distance of 225 to 260 kilometers directly to Sainshand and then fork to serve other users: Tsagaan Suvarga, Tavan Tolgoi, Oyu Tolgoi and Zamiin Uud (Ereenhot). The reservoir with a 20 meter high dam would be located 100 kilometers downstream from Baganuur and count with twice the volume (1.2 cubic kilometers) and a surface area (125 sq. km) compared to Prestige co. design. The company claims that it has special eco-hydrological software to justify "environmentally safe" withdrawals up to 20% of annual average flow or 60% of flow in dry years.

3) JETRO Study Design

This study on the Kherlen-Gobi Project released in2007, sponsored by the Japanese agency JETRO, contains systematic analysis of the available alternatives for water intake and water transport/distribution system as well as other finance and engineering aspects. The study compared 5 different water intake methods: a large dam on the river, a weir on the river, flood impoundment on the floodplain, a collection conduit and shallow wells to draw subsurface water from floodplain alluvium. Shallow wells were recognized as the least costly and most easily built water intake option with lowest environmental impact. The financial cost of the full project without large dam was estimated in 2006 at 800 million dollars. Japanese agencies and companies did not follow up on the study and did not consider providing funds for project implementation.

The massive water supply schemes designed for Kherlen-Gobi water transfer systematically lack solid environmental impact assessments and plan to withdraw up to 60% of river flow in moderately dry years.

Drilling shallow wells – a water intake option favored by the JETRO Study

11. Water Supply to Gobi – potential impacts and risks

Long-distance water transfers are marketed to local communities as an “alternative” to using local groundwater. However, most water management schemes and real life situations suggest that local aquifers (if available) will be used first, and if water is still lacking, subsurface water from the floodplain will be pumped into long pipelines. Only if the previous two options would fail to deliver enough water, a reservoir may be built on the river, because it is the most expensive solution. Each of these steps may have different environmental and social consequences.

a) Supply from local groundwater

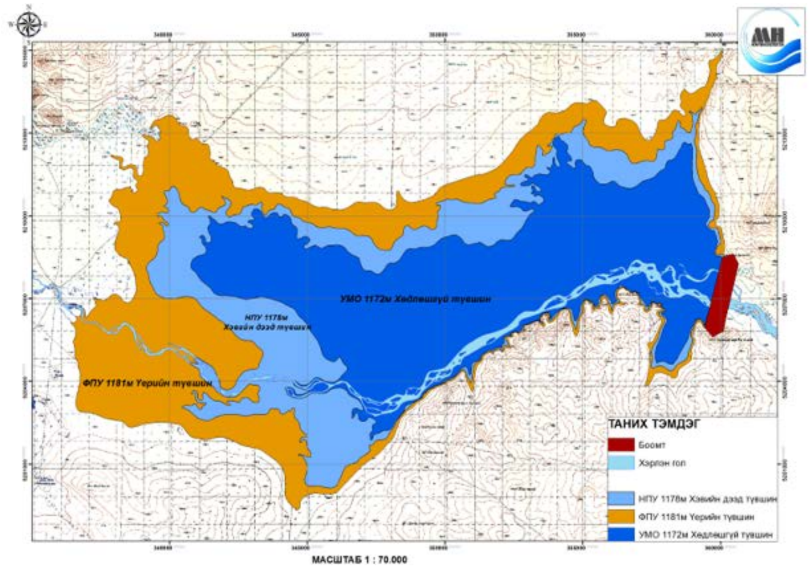
Once large-scale development occurs in certain Gobi area, inevitably local aquifers become the first target for large-scale exploitation. This has purely economic reasons: local groundwater supply systems costs much less than any long-distance water conveyance whether it is sourced from deep aquifers, subsurface alluvial deposits or a reservoir. Therefore local groundwater is threatened in any case with or without additional long-distance sources. The implications of local groundwater exploitation is beyond the scope of this report though as it is about the Kherlen river basin.

b) Supply from infiltration water intake in floodplain

Withdrawal of subsurface water from the Kherlen floodplain has potential for high impacts on the river ecosystem downstream. This impact may be serious, mainly during dry year sequences and during the low-flow season without ice (April-June). As the distribution of flow between months is very uneven, in drier years there will be many months when a 2 m^3/s withdrawal would render the river dry downstream from the water intake point. Water withdrawals would make the waterless period, typical for the Kherlen River, much longer and extend much further upstream into Mongolia. Nevertheless, if subsurface water is taken from alluvial deposits, the resulting flow reduction in the Kherlen River would be delayed and to a certain extent decreased by the alluvial aquifer, which receives its main recharge during floods. Most changes that may occur due to subsurface water intake are very similar in their mechanism and timing to regular natural changes that occur in dry phases of 30-year climate cycle.

There is no doubt that some amount of water could be taken from Kherlen in a manner similar to the way Ulaanbaatar uses alluvial infiltration water intakes, but the environmental limits are likely many times less than the 100 million cubic meters targeted in plans such as the ones proposed by “Monhydro construction”. The limits are also thought to be much more variable and fluctuate from year to year with variations of natural river flow.

Rigorous research is needed to establish thresholds for withdrawal above which some ecosystem functions or social values may be seriously affected, and limits need to be set for both the volume and timing of water withdrawals based on these thresholds. By setting environmental flow norms before large scale exploitation of water resources takes place excessive environmental, social and economic damage can be prevented and water can be managed in a climate resilient manner. Various examples of methods for environmental flow assessments and incorporation in national water laws and regulations are emerging from other often water stressed countries such as Mexico, South Africa, Australia, the USA and the European Union.



Reservoir planned by "Monhydro construction" with indication of dead volume level (dark blue), normal level (light blue), forced level (orange) - showing large are to be affected by water level fluctuation.

c) Supply from reservoir

Building a large dam may evoke many unwanted consequences and many of those cannot be mitigated. Many previous studies clearly stressed that this is a very dangerous option not to be pursued if viable alternatives are available.

A reservoir exacerbates water losses

Proponents of reservoirs say that "regulating the river would minimize negative effects on river flow. It is more likely however that a reservoir will drastically increase losses of water, due to evaporation from the reservoir surface, which according to some estimates could equal to intended supply volume.

Following these calculations, the design suggested by "Monhydro construction" would fail during the dry phase of climate cycle and unable to observe their own proposed "20% environmental flow norms". Due to evaporative losses the Chinese Water Ministry nowadays refuses to build reservoirs on water courses in dryland areas.

A reservoir would eliminate floods

A dam would significantly reduce hydrologic variability and change the morphology of the river downstream. Especially episodic flooding is important for pasture areas in the floodplain, bringing precious nutrients and moisture to the soil, and episodic recharge of shallow aquifers lower in the basin.

A dam would block migration of fish

The dam is planned between forested headwaters with many cold-water tributaries and the middle and lower reaches where wintering refuges are available in lakes and deep pools. Since the Kherlen River system is frozen to bottom in winter and too warm in hot summers many fish likely migrate from lower basin where they winter to spawning sites upstream. A dam built in between will abruptly decrease fish survival and likely eliminate most valuable fish over the 800 kilometer stretch downstream.

A reservoir would harm high biodiversity value areas.

The planned reservoir, depending on its location, would harm either Gun Galuut Nature Reserve or the Kherlen Toono Uul area which was identified by The Nature Conservancy as high priority area for future expansion of protected areas. A shallow reservoir would likely become a source of pollution, erosion and favorable habitat for many dangerous invasive species.

Negative socio-economic consequences

A dam would displace people from reservoir area; significantly contribute to desiccation of downstream areas all the way to Dalai Lake. The population estimate for the affected area is about 130-150 thousand people, many of them are traditional Mongolian herders. Sectors of economy that would suffer most would be livestock breeding, fisheries of Dalai Lake, nature tourism in both Mongolia and China and especially fishing tourism. On the economic side, the two greatest risks are likely rising corruption and seriously increasing national debt for this project cannot happen without state investment.

12. Impacts from Coal Industry and other sectors

In Kherlen river basin Baganuur (Tuv), Chandgana (Khentii) and Aduunchuluun (Dornod) are the three main coal mining operations. In the adjacent Gobi region, Shivee Ovoo and Tavan Tolgoi are two biggest coal deposits which would potentially be supplied by the planned water pipeline.

Coal is the world's most abundant but arguably, also most environmentally damaging fuel. At a global level it provides 40% of the world's electricity needs and is responsible for an estimated 44% of CO2 emissions and 8 to 10 % of anthropogenic methane emissions. Between 2000 and 2012 global coal consumption has grown with 60% (or 4% annually), largely due to rapidly increasing consumption in China and other non-OECD countries.

Most of Mongolian coal enterprises are developed for the Chinese market. To predict impact from this sector we use data from coal industry in China, where large scale impacts from coal enterprises have already become a major security issue and are subject to strict regulation.

Nowadays Chinese and international investors seriously examine the environmental sustainability of any proposed coal industry projects. Chinese investors require proof that sustainable water sources are available for development of Sainshand Industrial Complex.

The entire life cycle of coal, mining, thermal power plants, coal-to-gas and coal-to-liquid processing, all characterized by high water demands. When all proposed projects in Eastern Mongolia are added together their consumption far exceeds the volume that the proposed water transfer could deliver.

13. Future Water Balance and Climate Risks

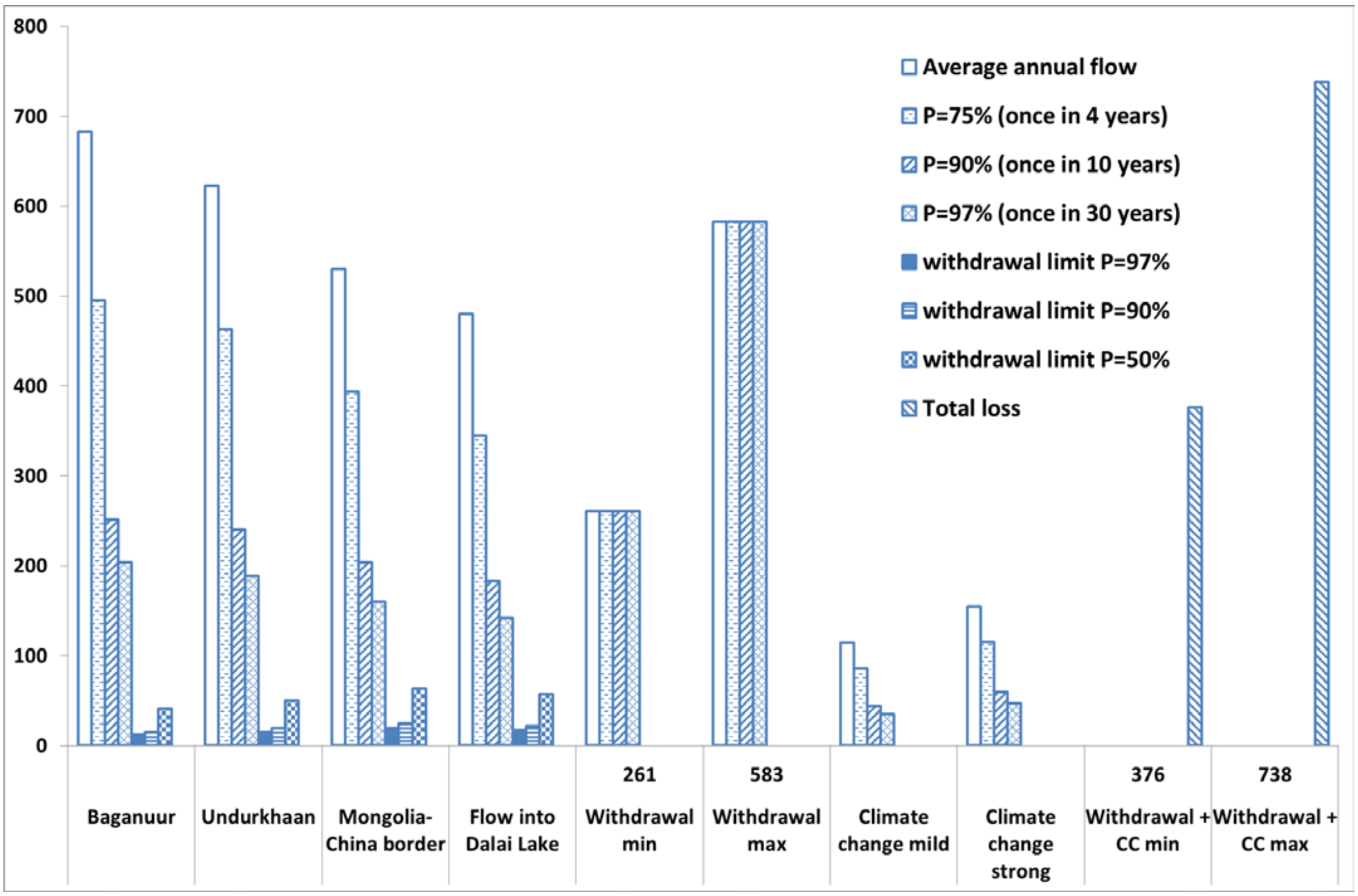
We calculated preliminary water balance estimates for Kherlen River basin in Mongolia by 2030, which takes into account industrial projects, municipal use, agriculture, evaporative from a potential reservoir and future water loss due to climate change.

This calculation shows that by2030 water consumption and losses could well equal or even exceed average river flow of the Kherlen at across the Chinese border. This illustrates that it is unrealistic to sustain environmental health of river valley and satisfy the currently projected demands. Cyclical change in flow volume typical for Kherlen River and uncertainty about anthropogenic climate change impacts make it impossible to meet such demands during dry phases of climate cycle.

Half of future consumption comes from economic activities within the Kherlen basin and the other half from projected demand based on the potential development of the long-distance water transfer and associated water losses from reservoir.

Downstream reaches of the river in China and the Dalai Lake Ramsar Wetland are severely threatened by planned developments. Even minimal consumption estimates would result in the water supply to Dalai Lake being reduced by 60 to 75%.

Even if all environmental norms are neglected and water resources at the border are equally divided between countries (following to international customary law) China would not be able to get its half at least every 4 years.



Kherlen river annual flow and predicted water consumption and loss due to climate changes by 2030 (in million m^3)

Part III. Environmental Safeguards for Kherlen River

14. Cumulative and Strategic impact assessments

A basin-wide Cumulative impact assessment (CIA) of all planned water supply projects and natural changes in Kherlen River basin is currently missing. Decisions about on the Sainshand and Gobi water supply may profoundly affect development prospects of the whole Kherlen River basin. An assessment of cumulative impacts of all water infrastructures should incorporate provision for environmental flows in Kherlen River-Dalai Lake ecosystem as related to flow of water, sediments and nutrients and include a full evaluation of climate variability and change

A strategic environmental assessment (SEA) of the Kherlen Gobi Project and all associated development plans should be conducted to arrive at better roadmap for development options available in Kherlen River Basin and adjacent Gobi areas. This SEA should create a framework for evaluating possible development scenarios in water sector against wide array of interrelated costs, benefits and limitations in economic, environmental, social and political spheres. Analysis of a wide array of available alternatives lies at the heart of strategic assessment.

15. Water supply alternatives in the light of climate adaptation

There are some alternatives for water supply of the Gobi region that should be further explored before considering tapping into the Kherlen River water resources:

A. Thorough assessment of Gobi groundwater and setting environmental limits to its use.

Groundwater supply potential of Southern Mongolia was conservatively estimated in 2010 by the Word Bank at 180 million cubic meters per annum and does not include results of explorations conducted in last 5 years. Exploitation and efficient management of groundwater in Gobi could prove to provide an effective means for securing a medium term water supply. According to some experts the Choir and Sainshand areas count with sufficient recharge to support a sizeable industry with groundwater.

B. Limiting development in Gobi, moving industries to water.

The Government of Mongolia needs to assess objectively the sustainability of, and limits to development in arid regions. Recurring attempts to plan development of water-thirsty industries (besides mining) in Gobi are likely to be unsustainable in a long term. If placing processing industries in Mongolia is economically justifiable, then it is likely to be most feasible in regions with sufficient water supply and well developed infrastructure.

C. Water Supply in fluctuating climate: appropriate adaptation measures.

With approximately 70 to 75% of Mongolia's water coming from subsurface alluvial deposits, current supplies are thought to be relatively sustainable and more adaptive to a changing climate than development of reservoirs, which would spur massive evaporative losses. Additional solutions to enhance water management should be assessed and utilized such as artificial recharge of aquifers, targeted construction of building in floodplains alternating use of surface and ground water sources, and water demand management in concert with different phases of climate cycle, etc.

Dauria lake bottom in dry phase of climate cycle. (by V. Kiriliuk)

Flood in Hulunbuir wetlands in Inner Mongolia. (by E. Simonov)

D. Basin-wide Climate Adaptation Planning

Environmental Flow norms should become of the foundation of river basin management plans, ensuring that human activities minimally disrupt flow patterns that sustain river health. Environmental Flow norms should explicitly link hydrological characteristics and requirements of aquatic ecosystems, flora and fauna in all stages of the climate cycle and should be based on ecological requirements both of Kherlen river valley and Dalai Lake ecosystems. Similar norms safeguarding fragile Gobi ecosystems should be developed for various local aquifers.

16. Transboundary river issues in Dauria

In 1994, Mongolia and China signed a water treaty which forms the foundation for transboundary cooperation around water management. The Chinese side has consistently requested a comprehensive bilateral evaluation of the Kherlen-Gobi Project and was finally assured by Mongolian side in 2013 that this water transfer is no longer planned. At the same time, China has been seeking to "improve" water flow from Khalkh to Orshun River, a scheme that would create a shortcut on this tributary that feeds in Dalai Lake, and which would effectively dry out Buir Lake, another Ramsar wetland site of international importance. In the worst case scenario China would seek “compensation” and demand Mongolia’s consent for diversion of the transboundary Halkh River. In this case the natural character of two Ramsar sites (Dalai and Buir lakes) will be lost in one shot.

Dauria already has a major negative example of a water transfer affecting a transboundary river. Despite protests from Russia a canal was built from the Hailaer/Argun River to "restore" Dalai Lake that over the past decade has been experiencing dropping lake levels due to the natural dry phase of climate cycle. This canal redistributes river waters into Dalai Lake, potentially stabilizing its dynamic wetlands, but also likely inflicting harm on the floodplain wetlands of transboundary Argun River in Russia.

17. Conclusion. Towards Sustainable Management of the Kherlen River Basin

The Kherlen River unites Mongolia and China and sustains the Dalai Lake Wetland of international importance. This great river with tiny flow volume is important life line for biodiversity and socio-economic stability of Dauria Steppe. This report aims to provide a timely warning. Although plans are drafted for deep transformation of the whole Kherlen river system, there still is enough time to consider more sustainable development options that would secure the resilience and adaptive capacity of its people and its ecosystems and support diverse economic activities in this river basin.

The Kherlen-Gobi Water-transfer schemes that have been promoted for years are associated with high risk of environmental disaster and international conflict, because:

Already announced water consumption plans practically equal to the total available water resources (annual average flow of Kherlen River).

Cyclical change in flow volume typical for Kherlen River makes such water consumption completely unrealistic during dry phases of climate cycle.

Planned demand exceeds environmental withdrawal norms suggested by Mongolian scientists by 1200%-2500%. It is completely impossible to sustain environmental health of river valley and satisfy this demand.

Half of consumption comes from economic activities planned within the Kherlen basin and 50% consists of long-distance water transfer and associated water losses from reservoir surface. It seems necessary to cancel plans for Kherlen Gobi water transfer and then proceed with optimization of development plans within the basin.

Downstream reaches of the Kherlen river in China and Dalai Lake Ramsar Wetland are severely threatened by planned development beyond possibility of repair by any imaginable mitigation measures. Even minimal consumption estimates result in water inflow into Dalai Lake being reduced by 60%-75%, which likely may lead to disappearance of that Ramsar Wetland.

Basin-wide Cumulative impact assessment (CIA) of all planned water supply projects and impacts from natural changes in Kherlen River basin should be carried out before any decision is made on specific large water engineering projects. Otherwise decision on Sainshand water supply (or other major supply project) may detrimentally affect development prospects for population of the whole Kherlen River basin. Worst from the range of possible climate change scenarios should be incorporated in the assessment. Assessment of cumulative impacts of all water infrastructures should incorporate provision for environmental flows in Kherlen River-Dalai Lake ecosystem as related to flow of water, sediments and nutrients.

Environmental Flow norms should become key components of river basin management plan, ensuring that any human activity does not disrupt flow patterns sustaining river health. Environmental Flow norms should explicitly link hydrological characteristics and requirements of aquatic ecosystems, flora and fauna in all stages of climate cycle. Environmental limitations should be based on ecological requirements both of Kherlen river valley and Dalai Lake ecosystems. Similar norms safeguarding fragile Gobi ecosystems should be developed for various local aquifers.

Strategic environmental assessment of the Kherlen Gobi Project and all associated development plans should be conducted to arrive at better roadmap for development options available in Kherlen River Basin and adjacent Gobi areas. Strategic environmental assessment should create framework for evaluating possible development scenarios in water sector against wide array of interrelated costs, benefits and limitations in economic, environmental, social and political spheres. Analysis of wide array of available alternatives lies at the heart of strategic assessment. The following directions for exploration of alternatives are already obvious:

A. **Thorough assessment of Gobi groundwater and setting environmental limits to its use.**

B. **Limiting development in Gobi, moving industries to water-abundant regions**

C. **Developing appropriate measures for managing water supply in fluctuating climate.**

D. **Preparing basin-wide climate adaptation plan**

After the results of strategic environmental assessment and cumulative impact assessment are incorporated into Kherlen River Basin Management Plan, there is a possibility to conduct environmental impact assessments for particular water-supply schemes.

All affected parties should be consulted in decision-making on water management, including:

- Communities and other land and water users along the Kherlen river in Tuv, Sukhbaatar, Khentii and Dornod provinces of Mongolia and in Right Barga Banner of Inner Mongolia, China;
- Mongolian-Chinese-Russian Dauria International Protected Area, that includes Dalaihu National Nature Reserve;
- Ramsar Convention Secretariat overseeing wetlands of international importance;
- China authorities and agencies, including Water Resources Ministry, Ministry of Environment, Ministry of agriculture (manages fisheries) and Forest Service (manages wetlands).
- Conservation NGOs, institutions conducting ecological research, human rights groups and other relevant sources of expertise.

Kherlen is the most important river of Daurian steppe with many local, national and global values. Water management planning should proceed without haste in transparent and participatory manner, keeping in mind strategic objectives of sustainable development and preservation of resilient and rich natural environment. We hope that our report will contribute to sound river basin management planning.

APPENDIX 1. WATER INFRASTRUCTURE IMPACTS CHECKLIST

The RwB analysis based on available insufficient data cannot substitute for environmental impact assessment, which has not been done for Kherlen-Gobi water supply project, although this Scheme was drafted 6-10 times by different entities. Tables below relate generic environmental and social impacts to specific situation of for Kherlen-Gobi water supply project.

Table 1 –Likelihood of generic negative environmental impacts in different parts of (Kherlen-Gobi) water supply project

	Environmental Impact type	**I. Likelihood it results from use of aquifers in Gobi**	**II. Likelihood it results from alluvial water withdrawal and transmission**	**III. Likelihood it results from large dam with reservoir**
	Disruption of free movement of aquatic animals	None	Low: excessive withdrawal may contribute to temporary drying of the river in driest years in low flow months	High – blocks migration of fish and other organisms. Fish passages built to overcome this problem are usually fully ineffective on dams higher than 10 meters. As a result some species go locally extinct above or below the dam and some in the whole basin for they no longer can reach breeding areas upstream.
	Disruption of flow of nutrients and sediments	None	Low or none	High– blocks or decreases movement of sediments and nutrients downstream. By slowing flows, dams allow silt to collect on river bottoms and bury fish spawning habitat. Silt trapped above dams, accumulates heavy metals and other pollutants. The river bed rises as the silt keeps building-up, increasing the vulnerability to riverside communities.
	Change of Natural Water Temperatures and ice regime	Low – may add to it through change in flow volume in natural springs	Low – may add to it through change in flow volume	Medium to High - By slowing water flow, most dams increase water temperatures. Other bigger dams may decrease temperatures by releasing cooled water from the reservoir bottom. Fish and other species are sensitive to these temperatures irregularities, which often destroy native population. Cold water also disrupts riverside recreational activities in summer.

	Reduction in Flow Volume up to complete drying of a river	Medium –High – some aquifers have low recharge rate and their levels drop. Some of them are connected to groundwater and surface water and cause their levels to drop as well	Medium –High may cause change in flow volume proportional to water diversion	Medium to High – in warmer and windier places huge amount of water evaporates from reservoir surface and less water flows downstream. Water is also lost to seepage in areas surrounding reservoir. Hydropower dams often completely stop river flow in off-peak hours.
	Degradation and Reduction in riverine/riparian /floodplain habitat diversity, especially because of elimination of floods.	None	Medium – massive water withdrawal may lead to decrease of high flows	High – Large Reservoir reduces flood pulse: floodplains do not get water and silt, backwater pools and oxbows are not cleaned by floods, braided channels simplify. Floodplain ecosystem is degraded and no longer maintains diversity of most productive habitats.
	Alter Timing of Flows	None	None	By withholding and then releasing water to generate power or store water for transmission reservoir can destroy natural seasonal flow variations that trigger natural growth and reproduction cycles in many species.
	Creating artificial waterbody with unnatural ecology	None	None	High – reservoir with artificially fluctuating level is highly unnatural ecosystem unsuitable to most native river species.
	Spread of invasive exotic species	None	Low- possibility that new species will be transported by water transmission	High. With change in water regime and habitat structure dam operation facilitates introduction of exotic species.
	Decrease Oxygen Levels in Reservoir Waters, build up of pollution and eutrophication	None	None to Medium. Sometimes water withdrawal can significantly decrease dilution of pollution in downstream sections of the river	Medium-High. Warm stagnant reservoirs are contaminated by high levels bacteria and algae, while organic matter decomposes at reservoir bottom and release pollutants. Reservoirs often reduce water quality and can emit highly potent greenhouse gases like methane. Heavy metals accumulate on reservoir bottoms with sediments.
	Decrease in native fish populations basin-wide	None	Low	High. Most of Kherlen river system is frozen to bottom in winter and too warm in hot summers. Fish has to migrate from lower basin where it winters to spawning sites upstream. Dam built in between will abruptly decrease fish survival (at least in 800

				kilometer stretch downstream of the dam).
	Increase in Predator Risk and change of fish communities	None	Low – lowering water levels may facilitate predation of some aquatic species	Medium to high – reservoir creation often results in build up of predator populations like pike, but then they eat up all prey and have a sharp decline. In reservoirs riverine fish communities (e.g. salmonids) are replaced by lake fish (loach, carp).
	Loss of terrestrial ecosystems	Low to medium. If poorly designed plant communities of large areas may be affected by lowering water table	Low- small area of water intake and pipeline construction is affected	High – Reservoir floods meadows, forests and other habitats displacing many native species
	Massive erosion and landslides	None	None	Medium to High. Erosion happens due to water fluctuation in reservoir and lack of sediments and artificial flushes downstream from the dam. Around Three Gorges Reservoir giant landslides necessitated forced relocation of additional 500 000 people. Erosion often activates downstream from the dam since water lacks sediment load.
	Climate change	Low-Medium - If poorly designed large areas may be affected by lowering water tables	Low-Medium. Iridizations of river valley may happen downstream from the point of withdrawal.	Low- High. Local climate changes around reservoir, but most change occurs immediately downstream with added humidity and fogs in winter due to unfrozen stretch of moving water below dam.
	Increase in earthquakes	No(?)	No	Medium-High. Large dams are known to increase magnitude and frequency of earthquakes, especially when reservoirs are filling or emptying relatively fast.
	Dam\machinery kills aquatic life	None	None	Dam water release structures kill fish and smaller organisms due to water pressure and direct cutting by turbine blades.
	Faulty Design consequences and risk of breach or failure	Low	Low	Medium-High. Dams often fail to release water at rates prescribed by agreed regulations, thus causing sudden flooding or drying of river valley. Many dams have collapsed, some causing huge human and material losses due to action of giant wave released downstream. In 2007 Zeiskaya Hydro in Russia could not hold the flood and washed away part of Ovsyanka village downstream.
	Increasing disease - Health risks	Low, may theoretically cause deterioration of sanitary conditions through reducing water available to	Low, may theoretically cause deterioration of sanitary conditions through reducing water available to local rural	Medium. In warmer climates shallow reservoirs are best breeding habitat for vectors of various diseases like mosquitoes contributing to outbreaks of malaria, schistosomiasis etc. In colder climates some dams create damp unhealthy environment, especially harming in winter when people breath in ice particles

		local rural people.	people.	formed due to unfreezing river surface.
	Salinization and degradation of soil resources	Medium	None	High. This will likely happen along reservoir margins as well as in desiccated floodplains downstream. some experts say it will only intensify already active salinization.
	Limiting movements of wildlife, people and cattle	Low-Medium	Medium	Medium-High. Reservoir will obstruct old river-crossings for 30-50 kilometers of its length. Ice cover downstream from the dam will be likely replaced by open water for some 10-several hundred kilometers downstream (likely 10-30 km in case of Kherlen River)

Table 2–Likelihood of generic Socio-economic and political impacts in different parts of (Kherlen-Gobi) water supply project

	Socio-economic problems	**Likelihood it results from use of aquifers in Gobi**	**Likelihood it results from alluvial water withdrawal and transmission**	**Likelihood it results from large dam with reservoir**
	Cost	Low-Medium	Medium-High	High. In case of Kherlen dam option would add from 200 to 400 million USD to other costs of water supply project.
	Low quality of supplied water	High. Some deep aquifers in Gobi have very mineralized water containing toxic substances.	Low-such water from floodplain is cleaner than water directly take from the same river, because it is filtered.	Medium. Surface water is normally less clean than subsurface water.
	Price of maintenance and decommissioning	Low	Low.	High. When dam is no longer needed there is high cost of removing it and rehabilitating areas previously covered by reservoir water and often toxic sediments.
	Loss of community control over water--transfer of control from local level to central government or corporate control	Low-Medium	Low-Medium	High. Dam makes all residents of river valley downstream to depend on mercy of the reservoir operator who manages water releases.
	Redistribution of wealth	High	Moderate	High. The purpose of the dam is to take water enjoyed by all population and make it serve specific economic enterprises. Large dams do it at a scale much larger than other water

				infrastructure.
	Displacement of local residents	Low-Medium	None to medium. Hundreds of people could be affected by 500-10 km. pipeline route, but most of them not resettled.	High. Anyone who lives in place of created reservoir and subsurface inundation zone around it would be displaced and needs resettlement
	Loss of livelihood (pastures, fisheries, etc.)	Low-Medium	Moderate- may affect downstream communities, especially in dry years	High. Anyone who lives in place of created reservoir and subsurface inundation zone around it can no longer use these areas. In addition fish stocks are often decreased basin-wide and floodplain pastures desiccated for several hundred kilometers downstream. It is quite often that local fishermen relying on seacoast or lake where dammed river emptied lose rich fisheries or other source of livelihoods.
	Influx of newcomers (e.g. construction workers).	Low	Low	High – construction requires many workers normally brought from different region or other country, which may cause competition and conflicts with local population
	Corruption and ineffective spending of public money	Medium	Medium-high	High. This is actually the dam is so much preferred option for officials and engineering firms – much larger portion of benefits go into their pockets and much more questionable expenditures are made. Large complex projects are very difficult to control, in contrast to building a well.
	Increasing debt burden	Medium	Medium	High. To build dams governments take loans and often cannot pay them back.
	Increasing cost during construction	Low	Low	High. Recent **study from Oxford University** shows that an average the cost of large dam construction worldwide has been twice larger than written into initially approved projects and construction lasted 2-3 times longer than planned. This is

				more than overspending and delays in case of lighter water infrastructure and roads.
	Risk of stranded assets	Low	Moderate-High -	Moderate-High. Likelihood that water supply system is no longer needed is high and for energy supply it is even higher. Harkhorin irrigation and hydropower system is a classic example: hydropower plan has been shut down and irrigation complex uses 10-15% of the originally irrigated area in Orkhon River Valley.
	Potential for transboundary conflict and difficult negotiations	None	Low-Medium. Customary international law envisions that each riparian country is entitled to part of transboundary water resource as long as it does not substantially harm the neighbor.	Medium-High. Dam has so many more consequences for downstream country than just a water withdrawal, that it is likely to create much greater controversy with neighbor country.
	Threat to fulfilling obligations under conventions	Low	Medium	High. Both on Selenga and Kherlen there are areas subject to protection under international conventions. Harming ecological integrity of such areas normally goes against country's obligation under those conventions.

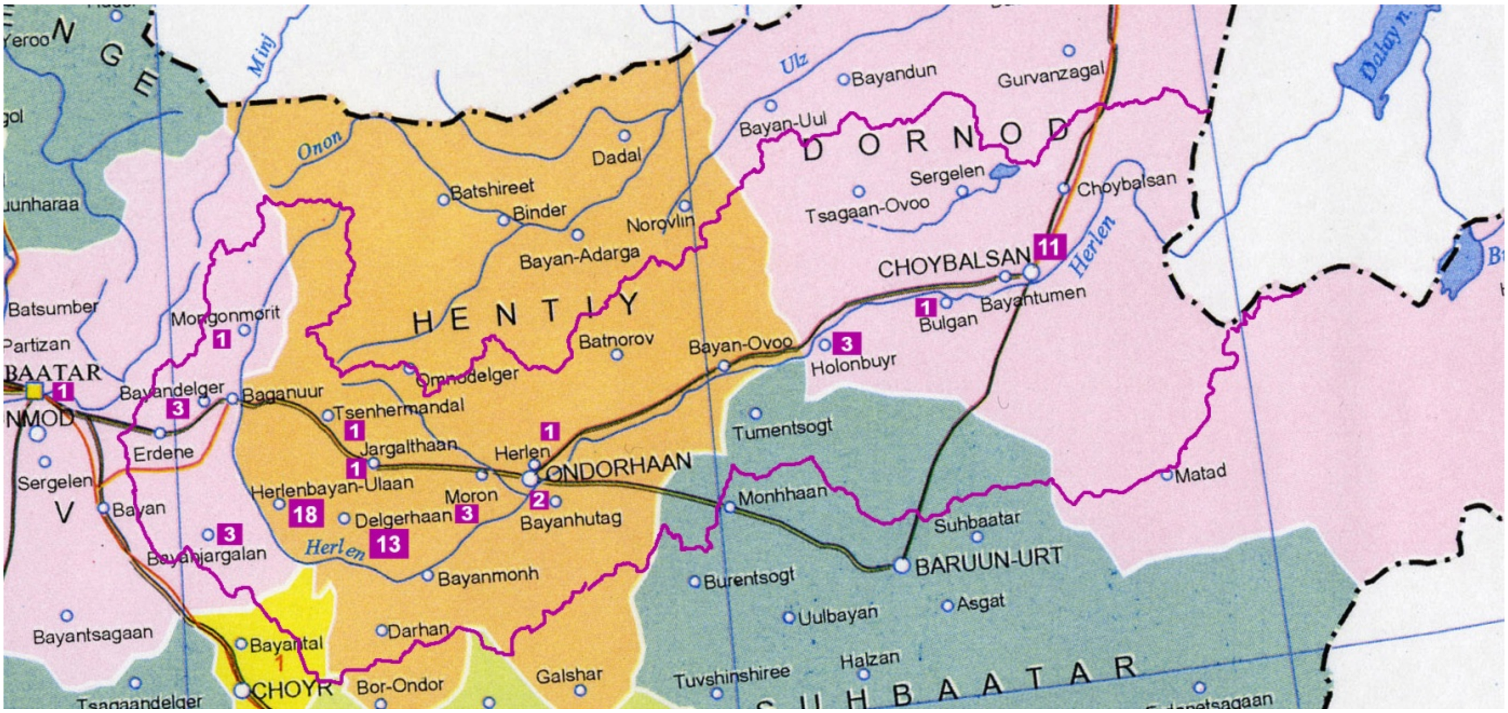
Herder's holiday at Moergol wetland. (by Simonov)

APPENDIX 2. KHERLEN COMMUNITY SURVEY RESULTS

Kherlen river local community survey, April 2015

In spring 2015, RWB conducted basic survey to collect information from local people living in Kherlen river valley. RwB-Mongolia Board member J.Tudevdorj traveled by horse to various herders' camps in Kherlen valley. In total 68 surveys have been taken. The spring is one of the busiest parts of the year for Mongolian nomadic herders because of the new offspring season. Therefore, in some cases surveys have been taken during rush hour by reading questions to participants and getting answers by word of mouth. This and busy schedule of some participants could have had effect on survey completeness and quality. Survey results have been processed and summarized by RwB Project staff.
The survey questions are structured in 3 sections. The first part (Q1-Q7) covers basic information of survey participants. The second part (Q8-Q15) focuses on basic information about participant's knowledge on Kherlen river in order to get general idea on survey participant's relation to Kherlen river. The third part (Q16-Q28) covers participant's knowledge and their impression on a project concept to build reservoir on Kherlen river with purpose of transferring water to Gobi region. Number of respondents to each question is noted as (N=68).

<u>Survey questions and results</u>

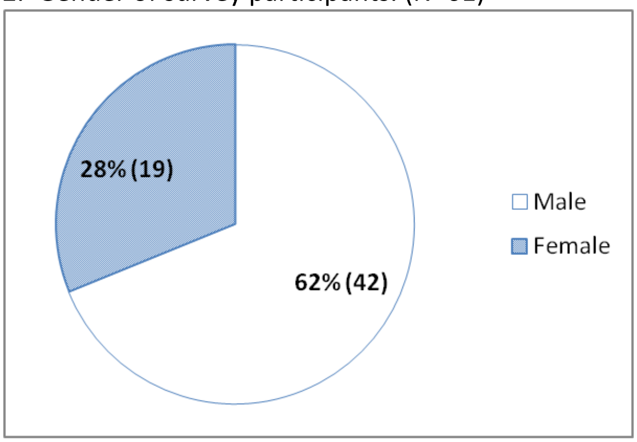


Location of survey participants' households\herders camps. (Pink boundary represents Kherlen riverbasin boundary. Numbers in pink rectangles represents number of survey participants in that location)

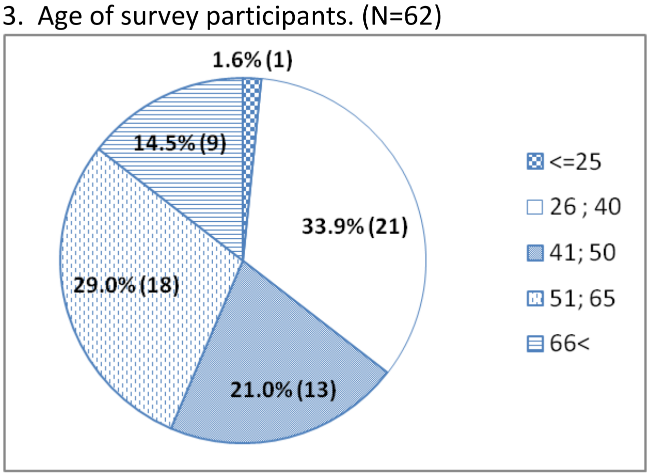
1. Location of survey participants. (N=62)

Aimag	**Hentii – 39**	**Dornod – 15**	**Tuv – 7**	**Ulaanbaatar – 1**
Soum	Delgerkhaan – 13	Kherlen /Choibalsan/ - 11	Mungunmorit – 1	Ulaanbaatar – 1
	Murun – 3	Hulunbuir – 3	Bayandelger – 3	
	Tsenkhermandal – 1	Bulgan – 1	Bayanjargalan – 3	
	Jargaltkhaan – 1			
	Kherlenbayan-Ulaan – 18			
	Kherlen – 1			
	Chingis – 2			

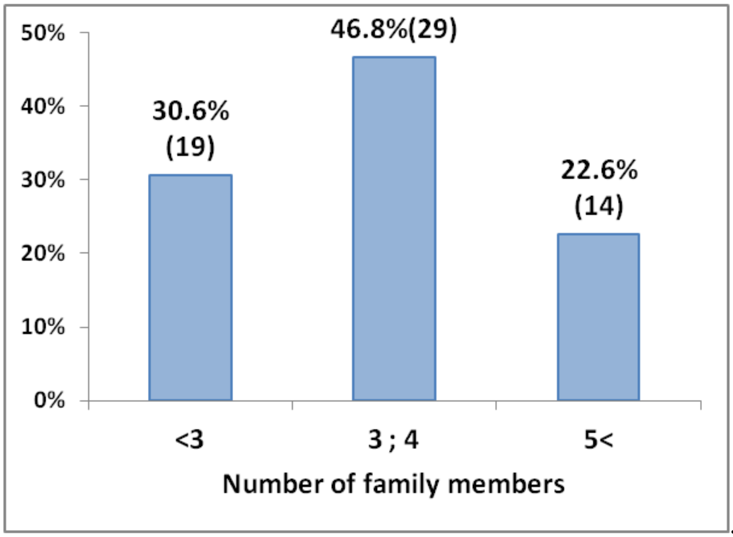
2. Gender of survey participants. (N=61)



3. Age of survey participants. (N=62)

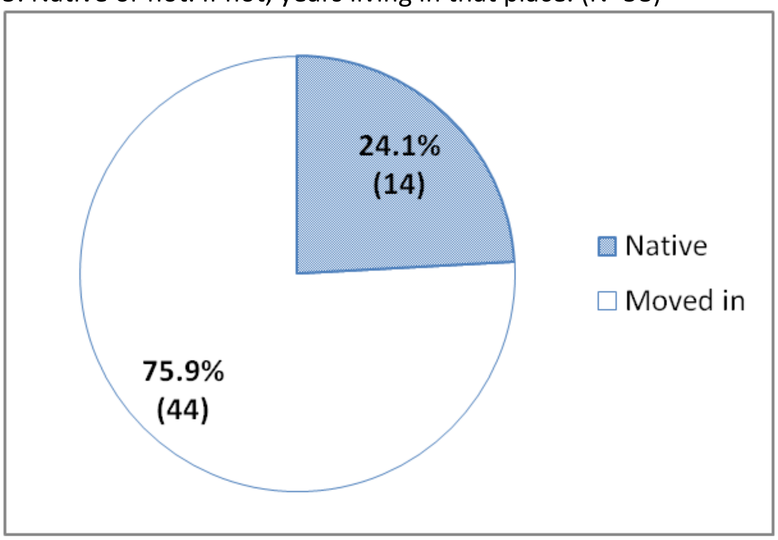


4. Number of family members. (N=62)

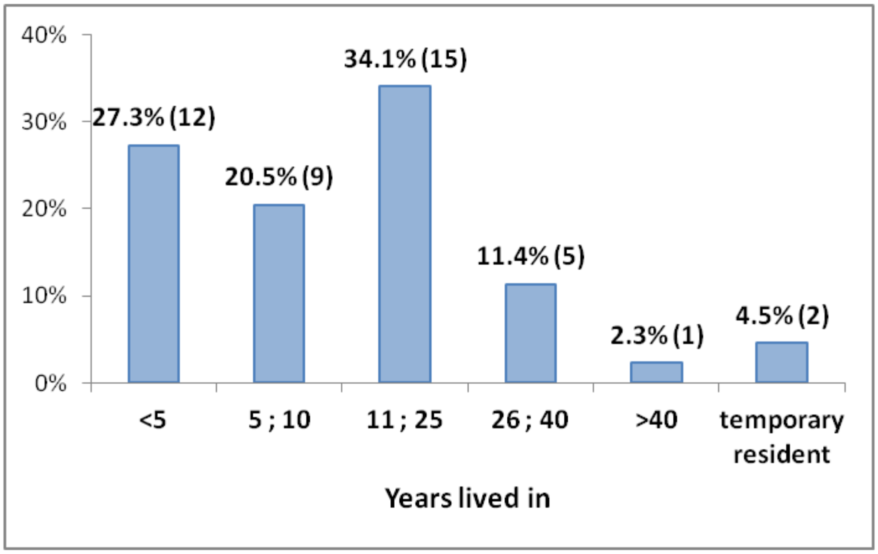


Estimating from number of family members, survey participants represent around 240 people.

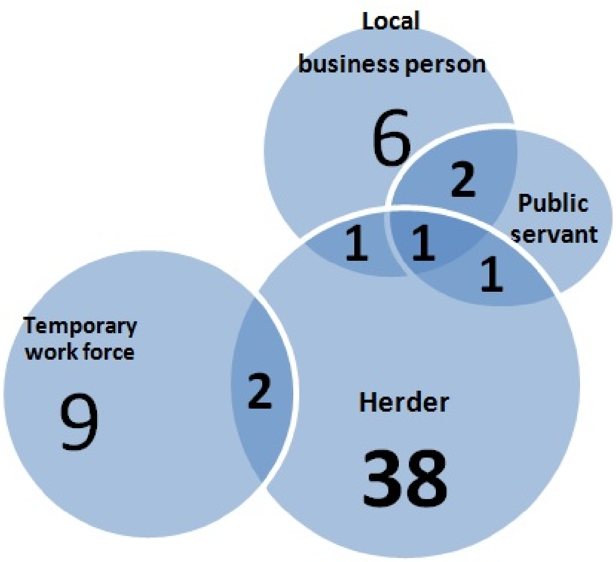
5. Native or not. If not, years living in that place. (N=58)



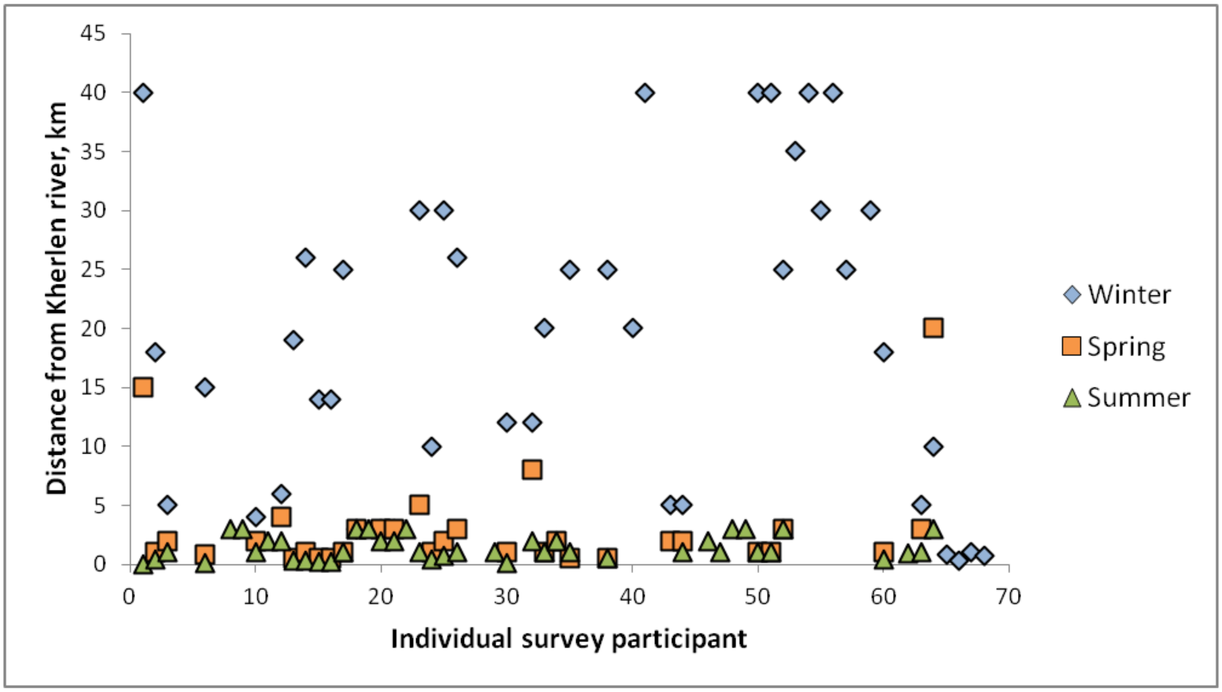
About three quarter of participants have moved in from other region. Following graph shows how long they have been living in that location.



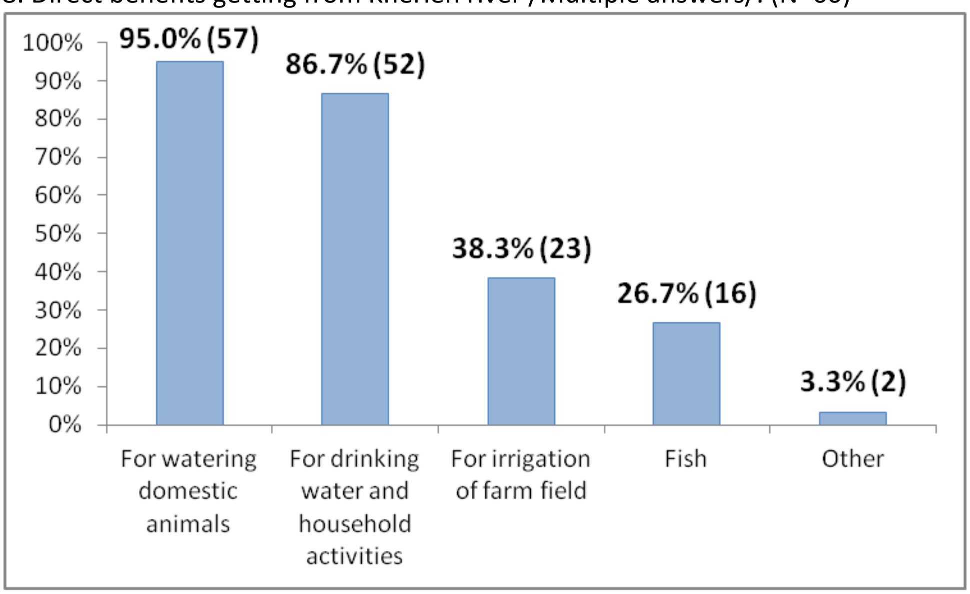
6. Occupation of survey participants /Multiple answers/. (N=60)



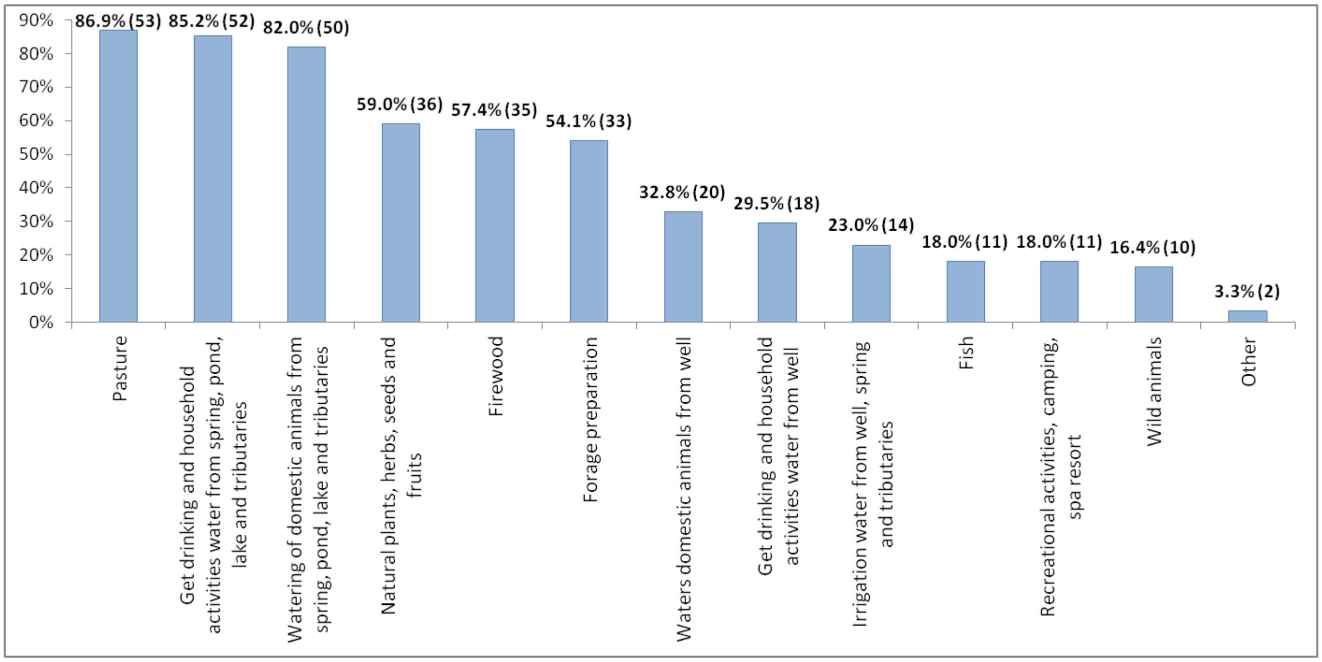
7. Distance of survey participants' households/camps from Kherlen river. (N=60)



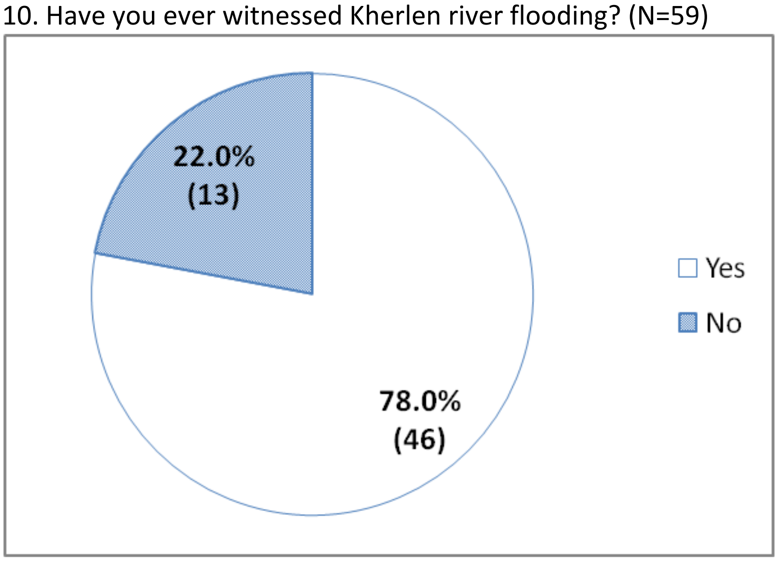
8. Direct benefits getting from Kherlen river /Multiple answers/. (N=60)



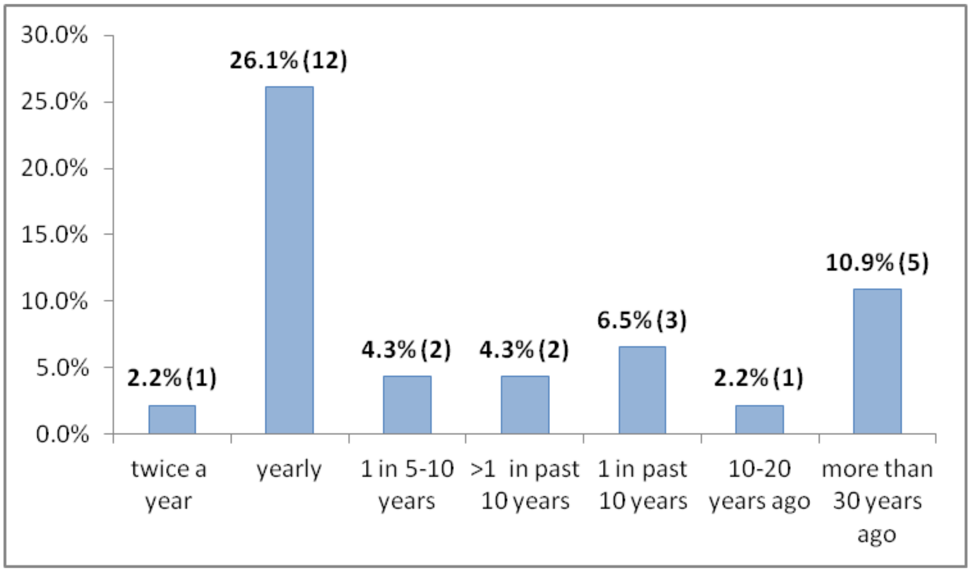
9. Benefits getting from ecosystem of Kherlen river basin and its floodplain /Multiple answers/. (N=61)



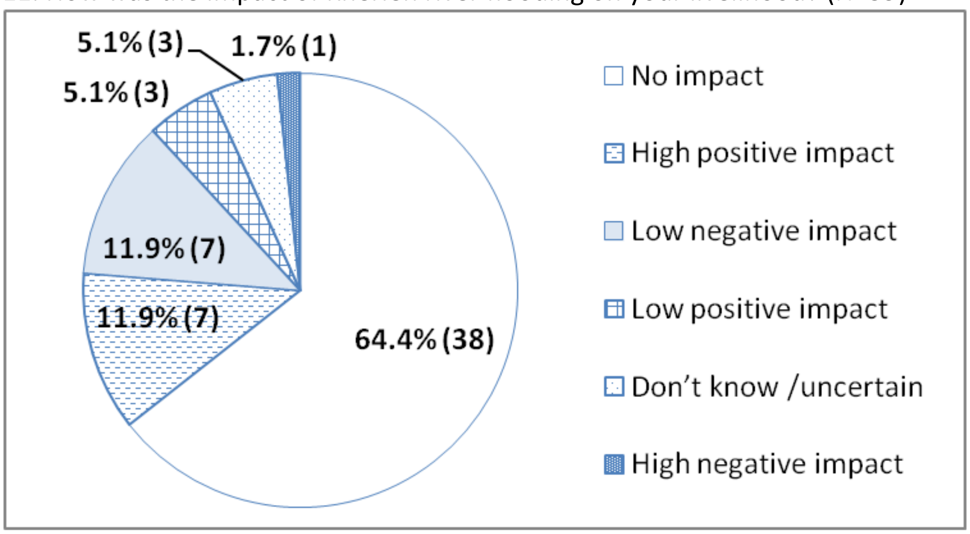
10. Have you ever witnessed Kherlen river flooding? (N=59)



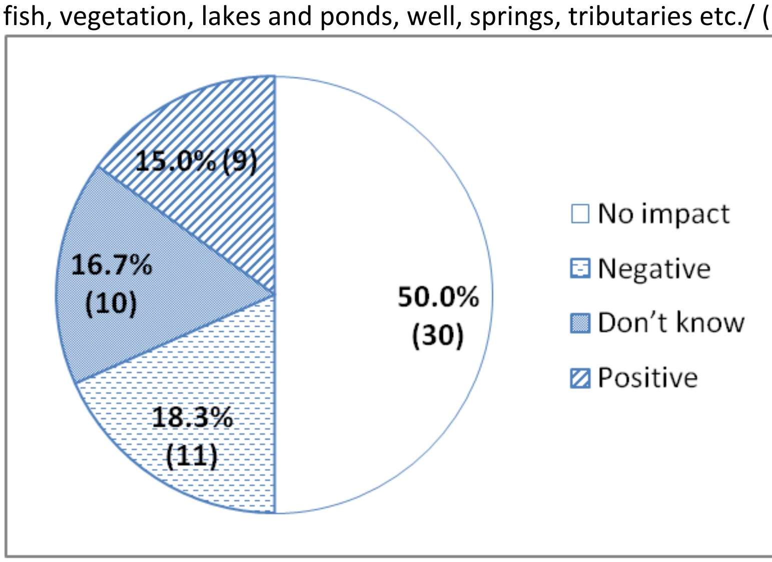
If yes, how often do you observe it?



11. How was the impact of Kherlen river flooding on your livelihood? (N=59)

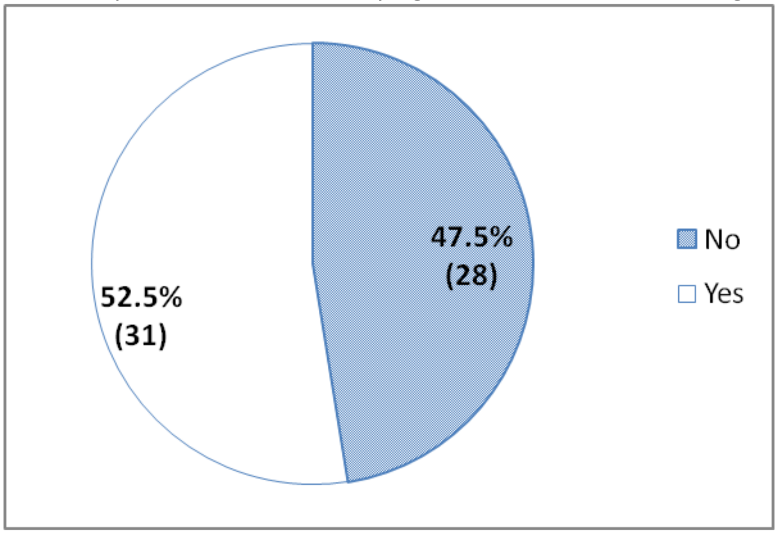


12. What kind of impact did you observe on environment when Kherlen river flooded? /On domestic and wild animals, fish, vegetation, lakes and ponds, well, springs, tributaries etc./ (N=60)

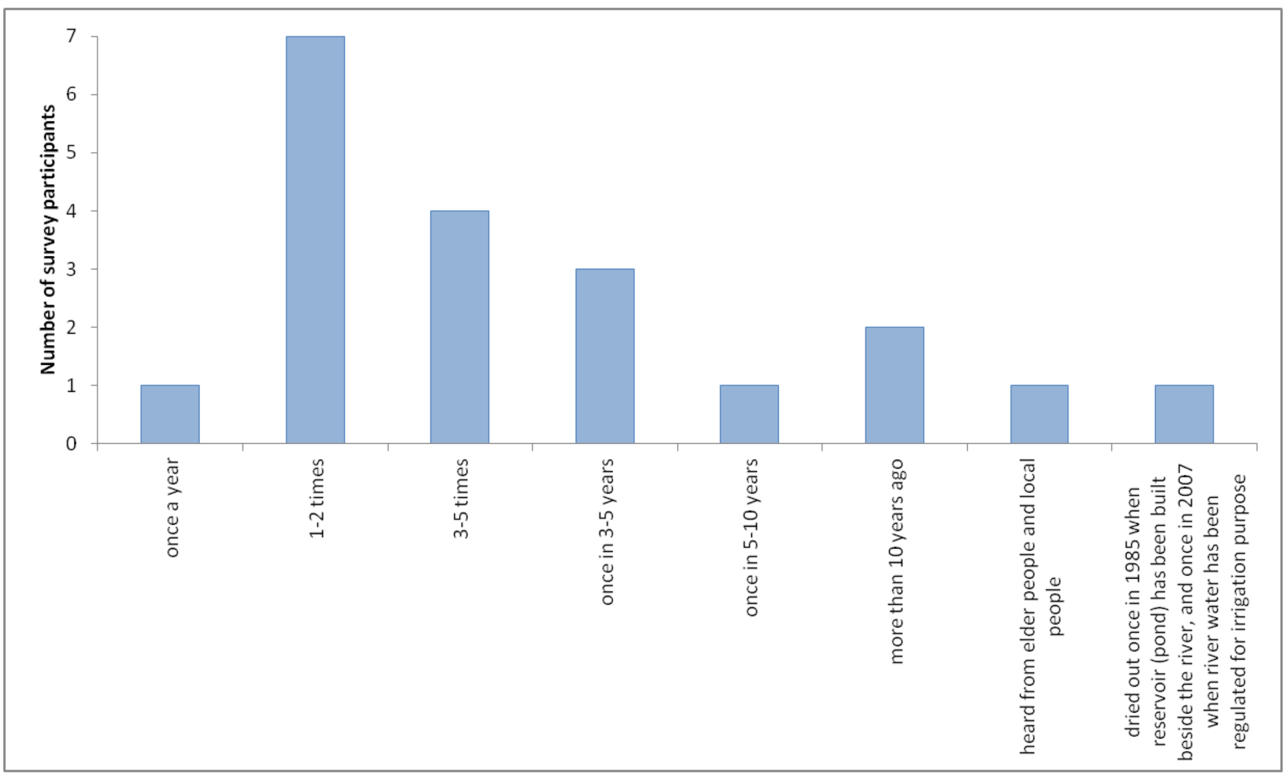


Examples of participant's voluntary answer on impacts they observe in environment when Kherlen river flooding occurs:
Positive – increase in water levels of wells, ponds, lakes (2 individuals)
Negative – water will be muddy, polluted (3 individuals)

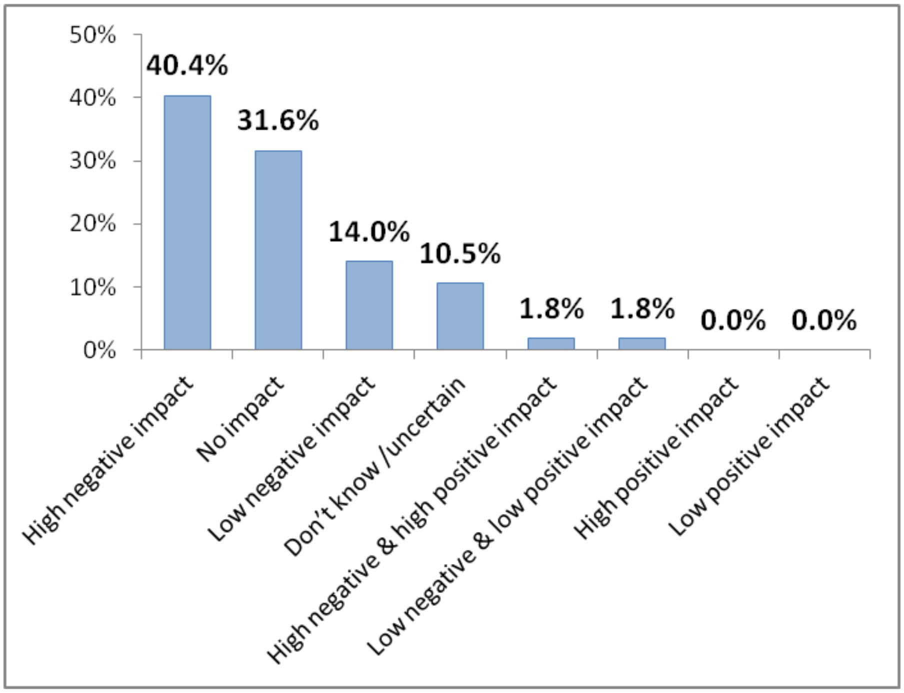
13. Have you ever witnessed drying of Kherlen river and drought? (N=59)



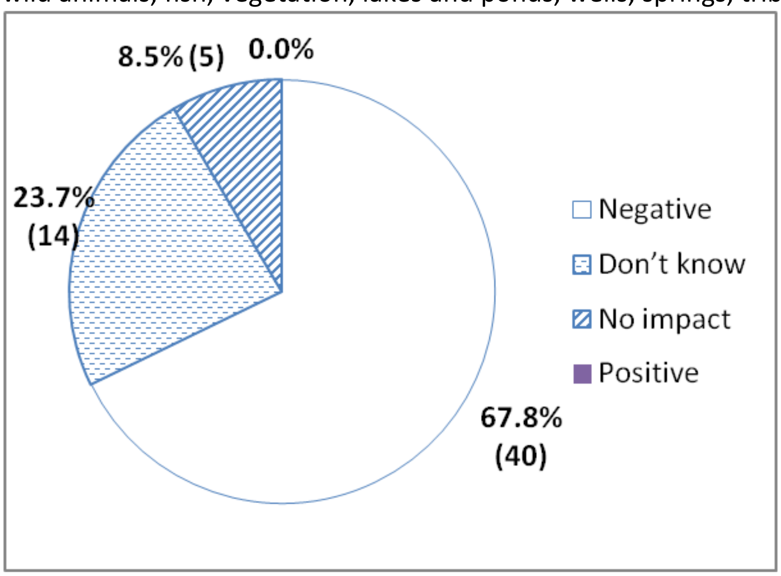
If yes, when, how many times and how often?



14. How was the impact of drying of Kherlen river and drought on your livelihood? (N=57)

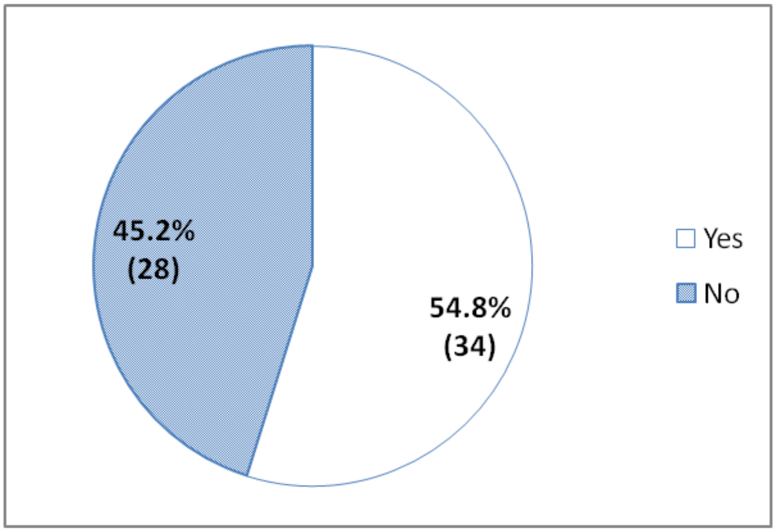


15. What kind of impact did you observe on environment during droughts and drying of Kherlen river? /livestock and wild animals, fish, vegetation, lakes and ponds, wells, springs, tributaries etc./ (N=59)

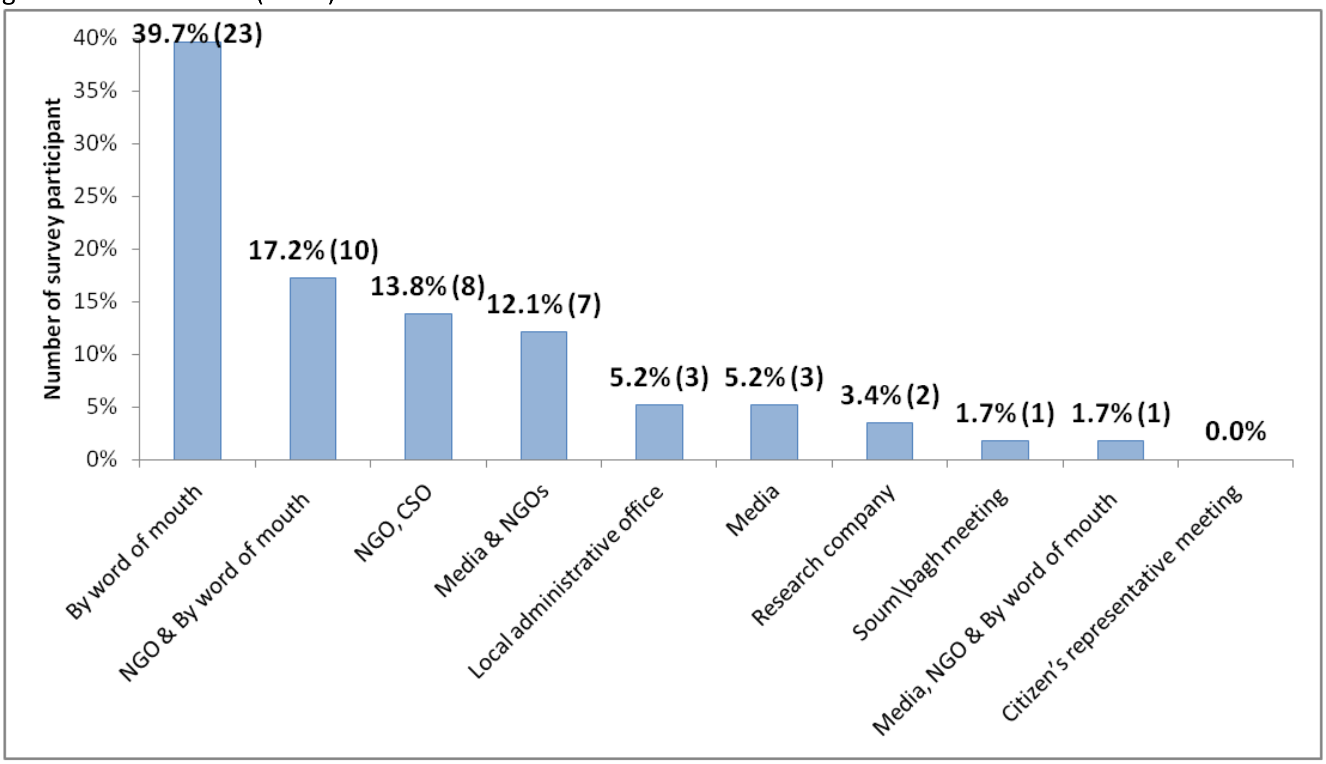


Examples of participant's voluntary answer on impacts they observe in environment when Kherlen river dries out or drought occurs: Low growth of pasture leads to economic loss due to livestock malnutrition and frequent moving (7 individuals); Dry out and decrease of lake water, springs and ponds (4 individuals); Increase of desertification, sand movement, and dry out of all things (2 individuals);

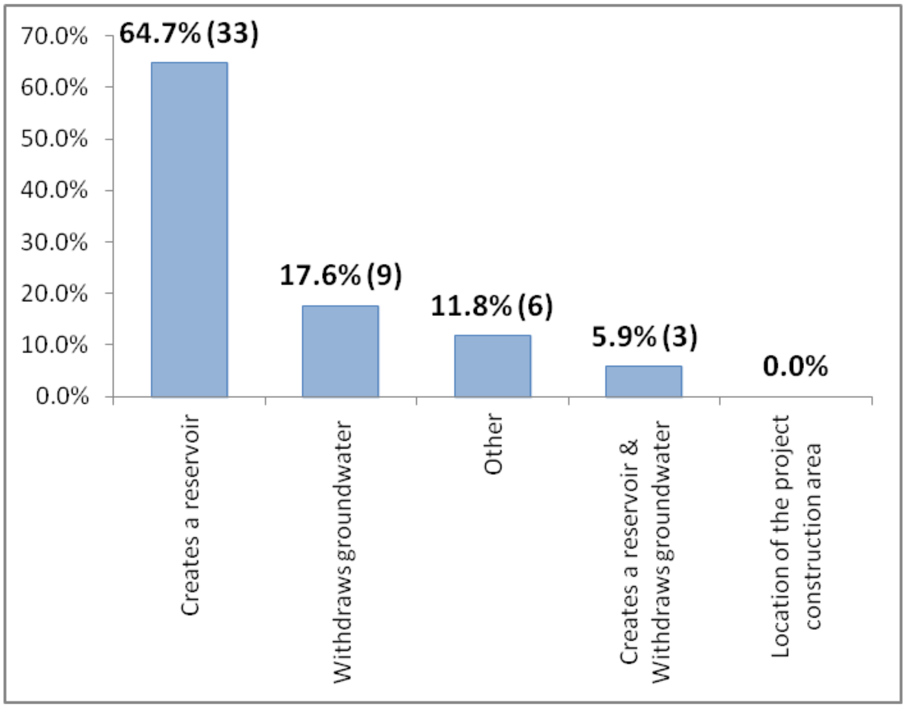
16. Have you ever heard about a project to withdraw water from Kherlen river and transfer it for use in the southern region? (N=62)



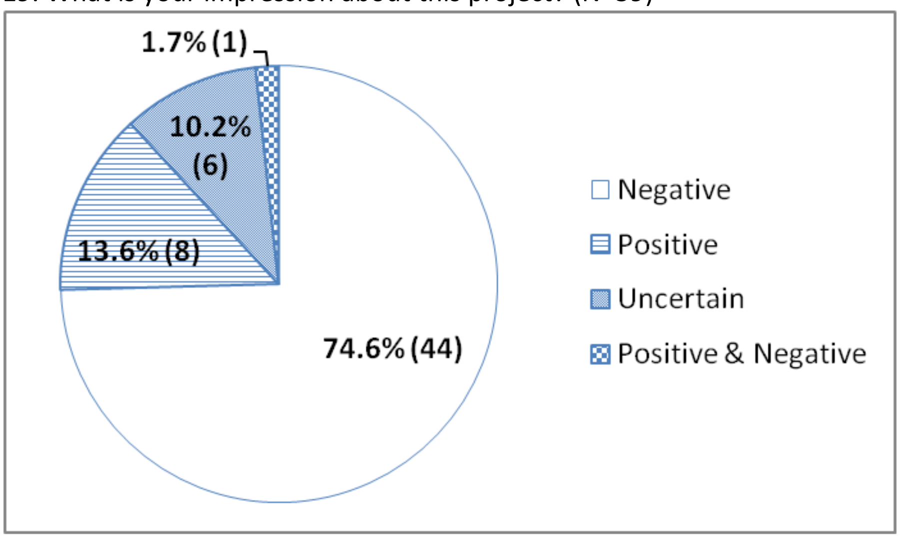
17. If you ever heard about a project to withdraw water from Kherlen river and transfer it to Gobi region, where did you get the information? (N=58)



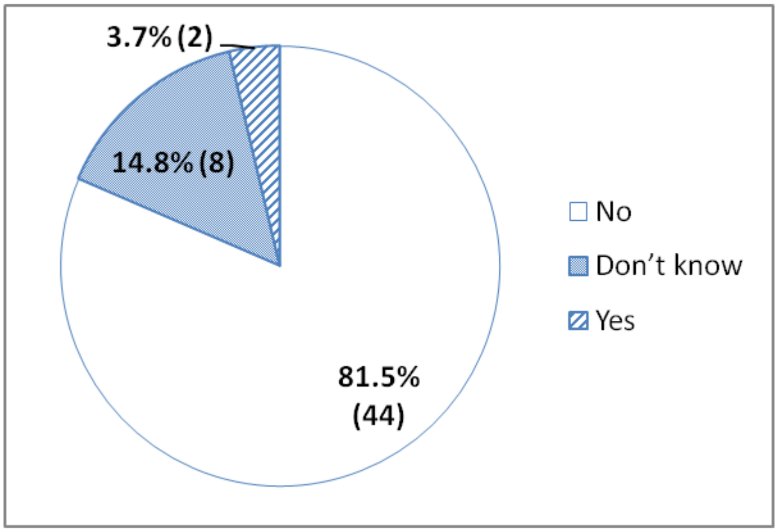
18. What was the information you get about this project? /Multiple answers/. (N=51)



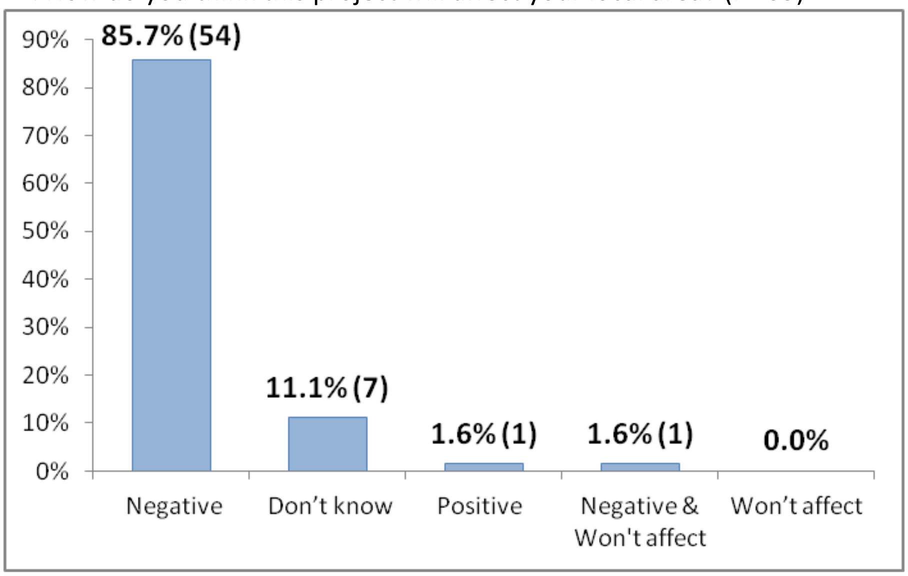
19. What is your impression about this project? (N=59)



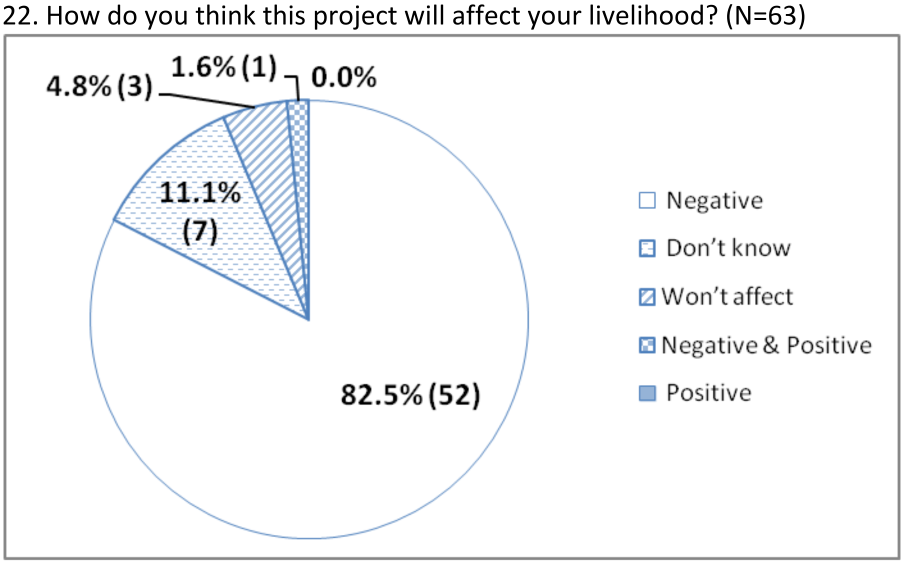
20. Have you ever seen water exploration and research activities and facilities? (N=54)



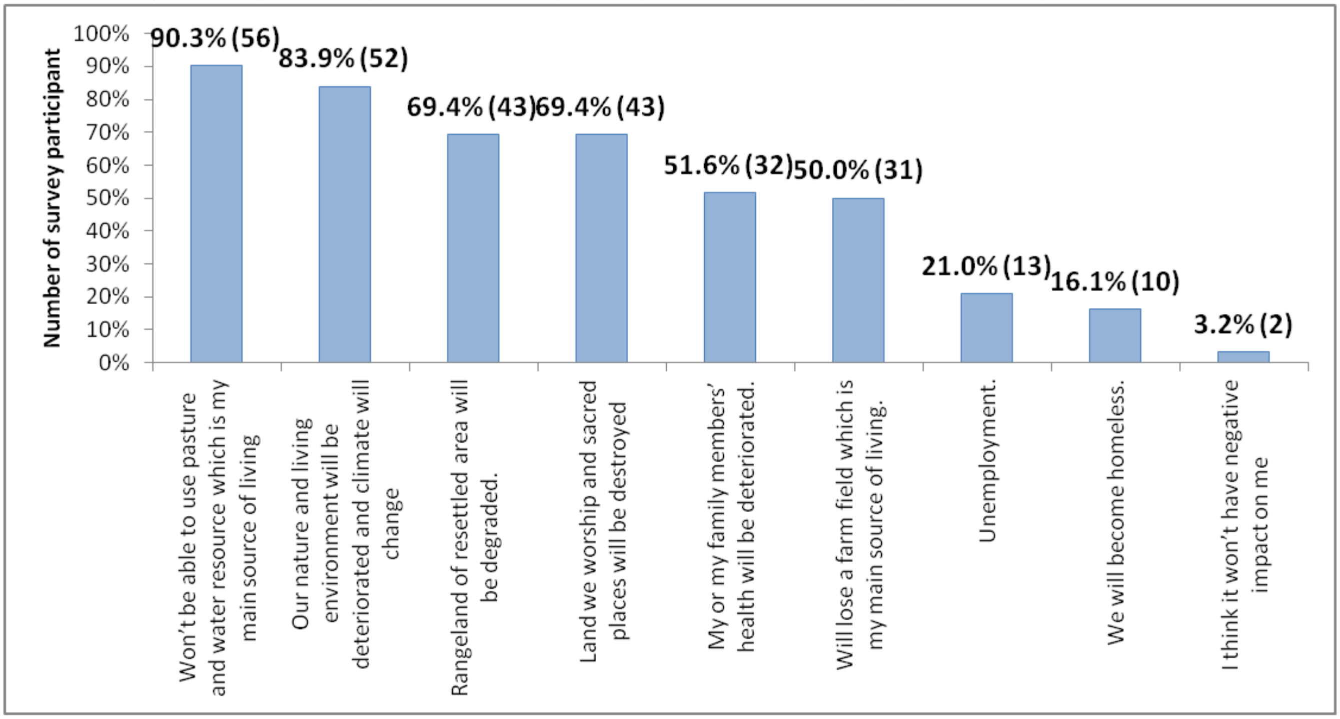
21. How do you think this project will affect your local area? (N=63)



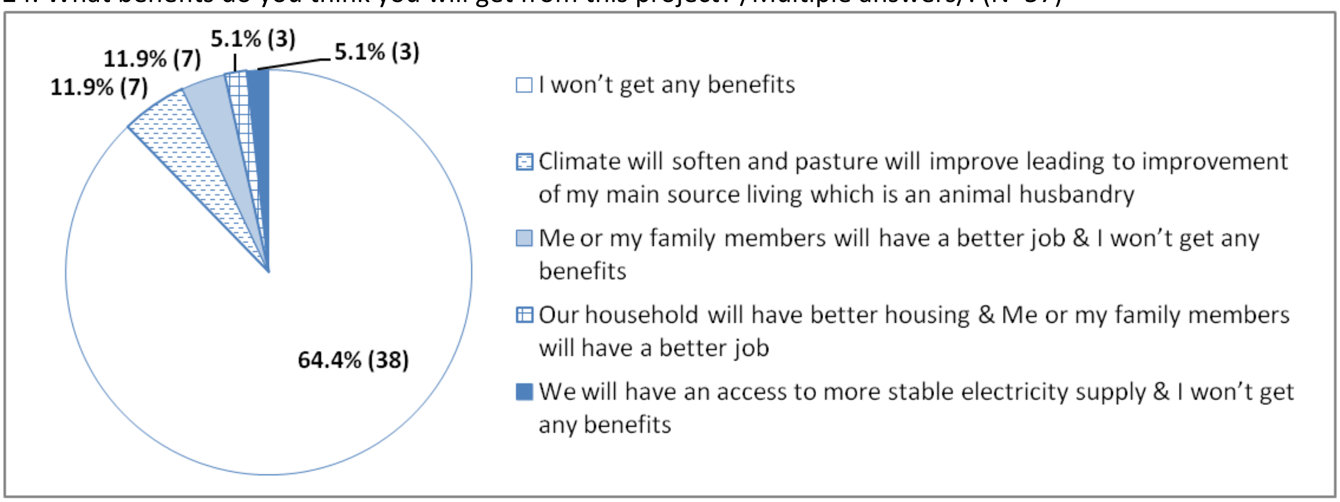
22. How do you think this project will affect your livelihood? (N=63)



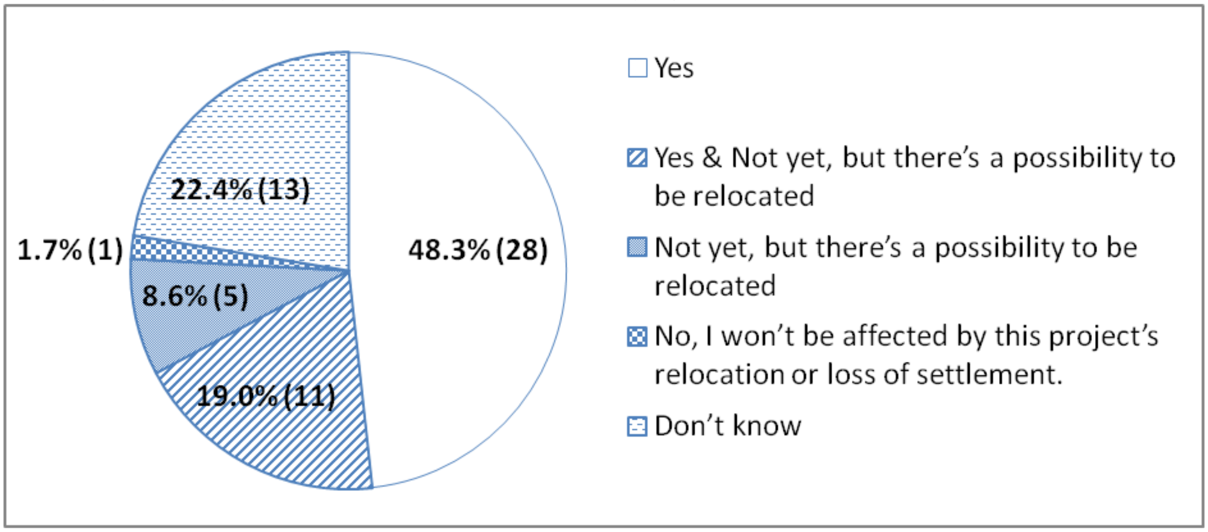
23. What negative impacts do you think could possibly come out of this project? /Multiple answers/. (N=62)



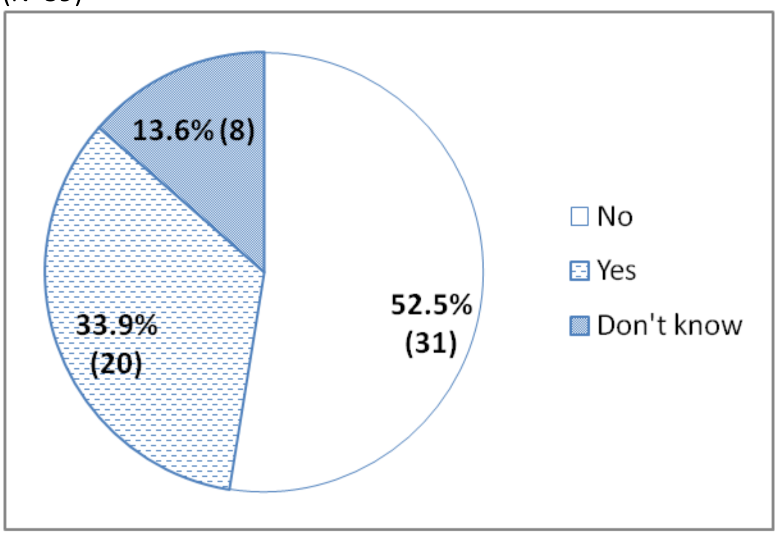
24. What benefits do you think you will get from this project? /Multiple answers/. (N=57)



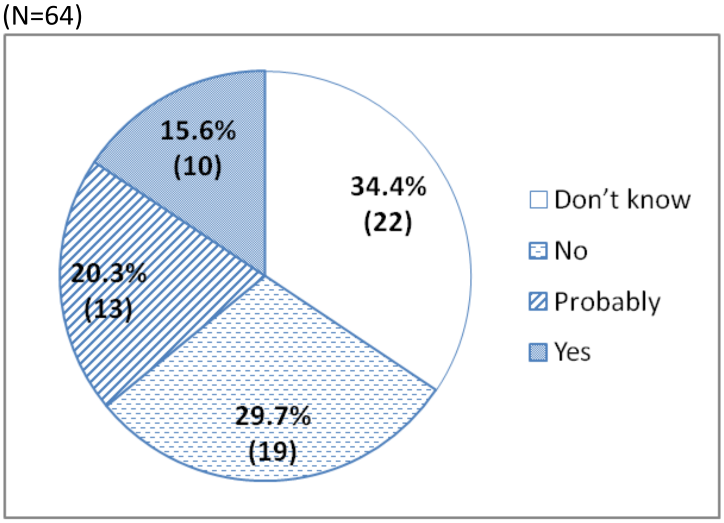
25. Will you be displaced/resettled as a result of this project? (N=58)



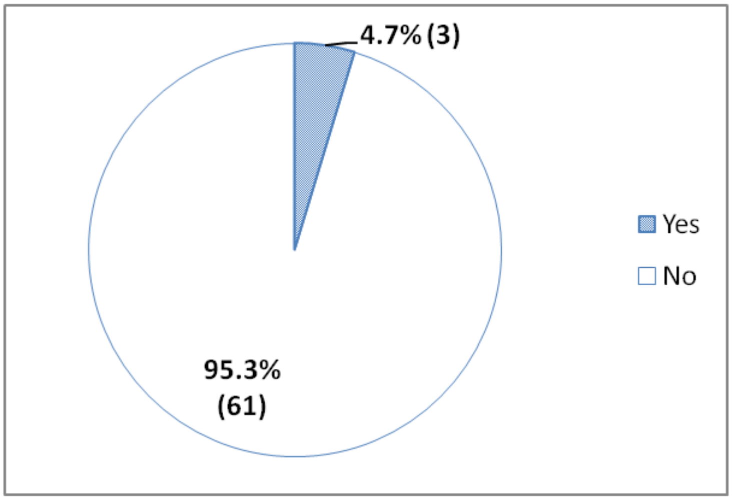
26. Do you have enough information required to give your concrete and knowledge based comments on the project? (N=59)



27. Do you think if you've been consulted, your comments and position will affect the project implementation? (N=64)



28. Have you ever been called for consultations and for your opinions on national or regional level development objectives by government administrative bodies or any of its agencies? (N=64)



RwB-Mongolia Board member J.Tudevdorj during 2015 survey. Photo by J.Tudevdorj.