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Institutional challenges and the contribution of capacity building"

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PREFACE

Natural resources, especially water and arable land, are essential means of livelihood in Central Asia where the majority of the population lives in rural areas, ranging from 42% in Kazakhstan to 74% in Tajikistan. However, land and water resources are limited due to geographic conditions but also due to their unsustainable use. The conference focuses on current developments of natural resources and their use in Central Asia, comprising the five former Soviet countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.

The Central Asian landscape is dominated by deserts and semi-deserts as well as high mountain areas. The location in the centre of the Eurasian continent and the distinct topography of large altitudinal differences of more than 7000 m from the Caspian Sea to the mountain ranges of Tien Shan and Pamir determine the region's climate. It is characterized by large precipitation differences between the arid lowlands and more humid mountainous zones as well as high temperature amplitude between cold winters and hot summers. Central Asia is to a large extent a water-limited region with run-off generating mainly in mountain areas due to snow and glacial melt. Furthermore, high seismic activity in the mountain areas makes them particularly prone to gravitational mass movements like earthquakes and landslides. This extreme landscape is home to very diverse ecosystems comprising deserts, oases, agricultural land, and mountainous vegetation hot spots. They are all threatened by the impacts of climate change that can lead to extended dry periods and accelerate the melting of glaciers, thereby reducing the water availability in future.

These landscape ecological, geographical and physiographical features determine availability and usability of land and water for agriculture, energy production, and industrial purposes also increasingly revealing issues related to conflicting interests. Agricultural land use is restricted to certain areas due to the geographic conditions and its dependency on irrigation. Although land and water are such precious resources for agriculture, an unproductive and wasteful use is prevalent in Central Asia, in both, subsistence farming and export oriented cotton production. This unsustainable land and water use to this day originates in the Soviet heritage of eroded irrigation systems and inefficient farm management practices but also in institutional problems arising after independence like incomplete land reforms, weak rural institutions, and poor water governance structures. Furthermore, underdeveloped marketing chains owing to the landlockedness and the plunge of former target markets hamper the income growth of farmers. Moreover, rangelands and pastures are often overused since livestock husbandry has become an important form of livelihood and capital accumulation in rural areas.

Recent developments put additional pressure on the natural resources in Central Asia: industrial recovery, especially in Kazakhstan, and a growing hydropower production in Tajikistan and

Kyrgyzstan, threaten the environment and demand increasing land and water resources. This does not only cause a conflict of use with agriculture it additionally leads to distribution related conflicts between the upstream and downstream riparian countries.

Altogether, the increasing scarcity of resources and conflicting forms of resource use endanger the welfare of the people in the region and hold potential to lead to political tensions. The International Conference and the Young Researchers' Forum discuss the situation of natural resources in Central Asia focusing on the aspect of conservation versus economic development, institutional challenges, and the contribution of research and education cooperation in this particular field. The Young Researchers' Forum gives young academics the opportunity to present their research and to enhance exchange and networking. The proceedings on hand comprise the abstracts of these presentations structured in the order of the three forum sessions. 1) Environment and natural resources: The session includes research on hydrological systems, geographical phenomena like gravitational mass movements and dust storms, biodiversity changes, and aspects related to agricultural production. 2) Institutions and the market: The second session portrays some institutional aspects of natural resource use like property rights and legal foundations, political influences, and production incentives and market behavior in agriculture. 3) Society and livelihoods: The session comprises research on socio-economic and socio-ecological effects of natural resource (over)use as e.g. food security, migration, and pasture-related challenges.

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SESSION 1: ENVIRONMENT AND NATURAL RESOURCES

SH. KENJABAEV [1], I. FORKUTSA [2], M. BACH [2], H.G. FREDE [2] :

PERFORMANCE EVALUATION OF THE BUDGET MODEL IN SIMULATING COTTON AND WHEAT YIELD AND SOIL MOISTURE IN FERGANA VALLEY

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1 ABSTRACT

Cotton (*Gossypium hirsutum L.*) and wheat (*Triticum aestivum L.*) are major crops grown in Uzbekistan and water shortage is considered as the main limiting factor for crop growth as well as sustainable economic development. The objective of this study was to adapt and test the ability of the soil water balance model BUDGET (ver. 6.2) to simulate cotton as well as wheat yield and soil water content under current agronomic practices in the Fergana Valley. Crop yield and soil moisture content data, collected and measured from sites in 2010 and 2011, were compared with model simulations. Results showed that the BUDGET can be used to predict cotton yield and soil water content with acceptable accuracy using the *minimum* approach. However, predicted wheat yield was high compared to the observed and reported yield. Overall, relationship between the observed and predicted cotton and wheat yield for both sites combined produced R^2 of 0.91 and 0.15, RMSE of 0.24 and 1.64 t ha^{-1}, relative Nash-Sutcliffe efficiency (E_{rel}) of 0.71 and -5.68 and index of agreement (d) of 0.48 and -0.54, respectively. Similarly, comparison of the observed and simulated soil moisture contents at the top 0-30 cm soil layer and soil water contents in 90 cm profile yielded R^2 of 0.88 and 0.71-0.88, RMSE of 2.74 %vol. and 21.4-28.7 mm, E_{rel} of 0.87 and 0.53-0.81, respectively and d around 1.0. Consequently, the BUDGET can be a valuable tool for simulating both cotton yield and soil water content, particularly considering the fact that the model requires relatively minimal input data. Predicted soil water balance can be used to improve current practice of irrigation water management, whereas simulated soil moisture content can be used to estimate capillary rise from groundwater in the UPFLOW model. However, performance of the model has to be evaluated under a wider range of agro-climatic and soil conditions in the future.

2 INTRODUCTION

Aridity of the climate in Uzbekistan makes water resources as the main limiting factor for sustainable economic development. Thus, agriculture, accounting about 90 % withdrawal of total available water resources in Uzbekistan, is impossible without irrigation (Qadir et al., 2009). At present, cotton and wheat are major crops in Uzbekistan, occupying annually about 70-80 % of the irrigated lands (Ibragimov et al., 2011). The furrow irrigation is the dominated method, which is currently practiced at 98 % of irrigated lands in Uzbekistan (Horst et al., 2005). Indeed, water use is hampered due to its inefficient supply and poor management (Pereira et al., 2009). Moreover, water requirements of major crops are not well known (Evett et al., 2007), contributing to excess water use or aggravating water scarcity situation.

Modeling to cope with the scarcity of water resources is an effective tool to develop new management approaches. Vast researches have been done in the past to model crop yield and soil moisture content under furrow irrigation in Uzbekistan (Cholpankulov et al., 2008; Evett et al., 2007; Horst et al., 2005; 2007; Ibragimov et al., 2007; 2011; Stulina et al., 2005), where irrigation scheduling was based on pre-defined soil water content (usually when soil moisture at the field capacity is depleted up to 60 to 75 %). In contrast, studies conducted at farmer's managed agronomical condition (Forkutsa et al., 2009; Reddy et al., 2013) are dearth. Moreover, there are some differences between actual and pre-defined performances of irrigation water scheduling at the field level. In fact, current irrigation scheduling is not based on pre-defined soil moisture content. Irrigation norms and application modes including required water for planning and distribution are based on Hydromodule zoning (GMR) of the irrigated lands (Kazbekov et al., 2009). The main objective of the present study is to explore the BUDGET in simulating cotton as well as wheat yield and soil moisture under current irrigation water management practices during the cropping period of wheat in 2009-2010 and 2010-2011 and cotton in 2010 and 2011 in Fergana province of Uzbekistan. Hence, findings of the research can be useful for the development of the future strategies to improve current irrigation management in Uzbekistan.

3 MATERIALS AND METHODS

3.1 Location and description of study sites

Two sites, namely Akbarabad in Kuva district and Azizbek in Koshtepa district in Fergana province of Uzbekistan, were selected as research objects.

The climatic condition of the study sites is characterized by data from the meteorological station "Fergana". The long-term (1970-2011) average annual temperature and precipitation are +14.3°C and 181 mm, respectively. During the study period (2009-2011), annual precipitation ranged from 172 mm in 2009 to 229 mm in 2011 with 35 % falling in summer period (April-September). In contrast, 80 to 82 % of annual evapotranspiration (1100-1200 mm) occurs during summer period.

Six fields in Akbarabad (C-164, C-165, C-172, C-174, C-176, C-180&181) with total area of 82.5 ha and two fields in Azizbek (C-13&14 and C-15&16) with total area of 36.5 ha were selected for investigation.

The lands at the sites are located within the GMR V and VIII, mainly flat and slopes are 0.002-0.005, northward. Soils, according to FAO and Russian classifications, are Calcic Gleysols and sierozem-meadow with infiltration rate ranging from 0.2-3.9 m day^{-1} to 0.2 - 2.0 m day^{-1} in Akbarabad and Azizbek, respectively.

3.2 Agronomic practices and field measurements

The main crop rotation in the sites during the study period comprised cotton and wheat as well as secondary crops (not considered in current study) following wheat harvest. In 2010 and 2011 the cotton varieties “An-35” and “C-6524” were sown on the beds of the leveled field with sowing depth, beds width and seeding rate of 3-6 cm, 60 cm and 25-32 kg ha^{-1} in Akbarabad and 4-6 cm, 90 cm and 30-40 kg ha^{-1} in Azizbek, respectively. Winter wheat variety “Kuma” in Akbarabad and “Kroshka” in Azizbek were broadcast sown in 2009 and 2010 at a seeding rate of 200-210 and 220-250 kg ha^{-1}, respectively, incorporated by cultivator into cotton stubble.

Irrigation of cotton was performed with an alternate furrow irrigation (except charging irrigation), whereas wheat was irrigated by each furrow. The amount and salinity of irrigation water applied to the fields was measured in-situ.

In general, all agronomical practices (tillage, weeding, irrigation and fertilization) in the sites were decided by the farmers. Crop yield was taken from farmers and additionally weighted manually at harvest at plot size of 1 m² within 3-5 different locations of each field in 2011. The leaf area index (LAI) of cotton and wheat at the stage of full canopy cover was measured using hand held LAI meter (AccuPAR LP80, Decagon Devices, Inc.) in 2011. 14 soil samples from two pits (7 horizons in each) were collected in 2011 between C-164 and C-172 (AKpit-1) and C-176 (AKpit-2) in Akbarabad for soil physical and chemical analysis. The soil texture data for Azizbek site (C- 13, AZpit-1, 9 horizons) were obtained from the past research work (Stulina et al., 2005). Hence, soil data from AKpit-1 was assumed to be representative for the fields, such as C-164, C-165 and C- 172, and AKpit-2 for C-174, C-176 and C-180&181, whereas AZpit-1 for C-13&14 and C-15&16. Based on the fraction of sand, silt and clay (Fig. 1), soils, according to USDA classification, were classified as loam (*L*), sandy loam (*SL*) and silty loam (*ZL*).

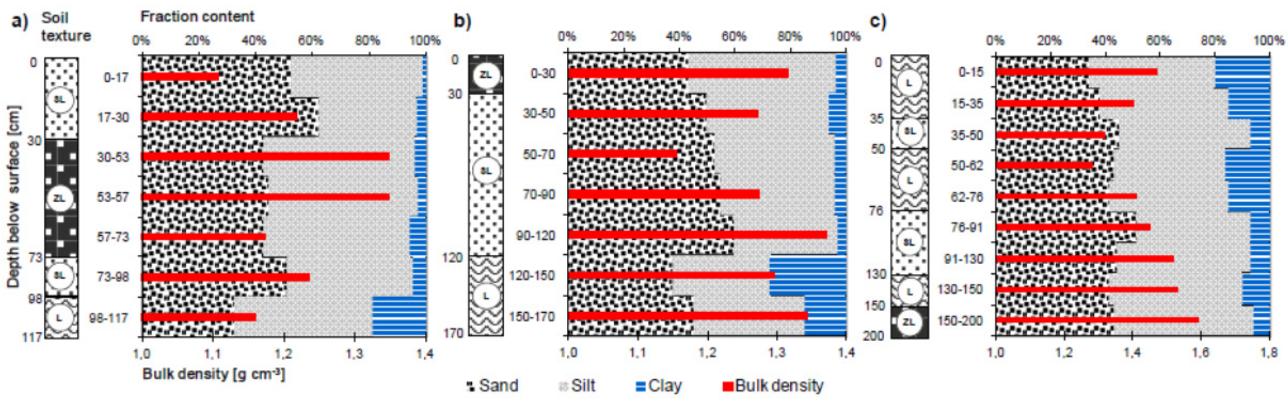

Figure 1: Soil texture, fraction content and bulk density in Akbarabad site - AKpit-1 (a) and AKpit-2 (b) and Azizbek site - AZpit-1 (c).

The soil samples to measure soil water content were collected using hand operated auger (Eijkelkamp, Giesbeek, the Netherlands) at 30, 60, and 90 cm depths on the ridge of the furrows at the center of cotton and wheat fields before as well as after irrigation in 2011. In addition, hourly soil moisture content was continuously recorded using soil moisture sensor (Decagon EC-5), which was wired to a Decagon Em50 series data logger. The sensors were installed at the center of cotton field (C-13) at 20, 40 and 60 cm depths on the ridge of the furrow in 2011.

3.3 Model BUDGET

3.3.1 Model description

The BUDGET constitutes a set of subroutines describing various processes involved in water extraction by plant roots and water movement in the soil profile. The model considers water storage in a soil profile affected by infiltration of rain and irrigation water including withdrawal of water by crop evapotranspiration and percolation for a given period (Raes, 2002). Simulations are performed in daily time-steps. Finite difference technique is used to solve one-dimensional vertical water flow and root water uptake. Estimation of infiltration and percolation rates is based on exponential drainage function.

Calculation of transpiration and separation of soil evaporation from evapotranspiration is based on the ground cover at maximum crop canopy, whereas on-site LAI measurements can be used to adjust ground canopy cover at specific growth stages. Relative yield decline, due to water stress during the growing stages, is based on yield response factor (K_y). Three approaches, such as *seasonal*, *minimal* and *multiplicative* approaches are considered in the BUDGET to estimate expected crop yield. Further details of the subroutines, concepts, rationale, approaches and procedures used to simulate the processes in the BUDGET are given in its Reference Manual (Raes, 2002).

3.3.2 Model input

The inputs of the model consist of climate, crop, soil and irrigation management data. Calculated daily reference evapotranspiration (ET_O) and daily rainfall recorded at the "Fergana" weather station were used as climate input parameters in the model. ET_O was calculated using "*ET_O Calculator*" (Raes, 2009a) based on the FAO Penman-Monteith equation (Allen et al., 1998).

The length of crop growth stages (including the sensitivity stages), dual crop coefficient (k_{cb}), soil water depletion fraction for no stress (*p*), salinity tolerance values (*ST*) and K_y for cotton and wheat were derived from indicative values presented by Allen et al. (1998), Ayers and Westcot (1994) and Doorenbos and Kassam (1979). The growing stages of crops were adjusted to local conditions based on the field observations. The 40/30/20/10 percent water extraction pattern (S_{max}) over the crop roots were selected, which assumes the greatest root water uptake near the soil surface and declines with the increase of the depth. The S_{max} at the top and at the bottom of the soil profile was assumed to be 3.5 and 0.5 mm day^{-1} for cotton and 2.4 and 0.6 mm day^{-1} for wheat, which are within the range of the model default crop parameters. The soil water content at the anaerobiosis point was taken as 5 %vol. below the soil water content at saturation (Raes 2009b). The soil hydraulic parameters, such as soil moisture at field capacity (θFC) and wilting point (θWP) were measured at the laboratory of Scientific Research Institute of Irrigation and Water Problems (SRIIWP), Tashkent. In addition, soil moisture content at θFC, θWP and saturation (θS) were calculated through pedotransfer functions (PTF) in the SPAW model developed by Saxton and Rawls (2006). The saturated hydraulic conductivity (K_{sat}) was calculated using the Rosetta model (Schaap et al., 2001). Sets of soil data from AKpit-1, AKpit-2 and AZpit-1 were separately used to calculate K_{sat} in Rosetta through five hierarchical Artificial Neural Network (ANN) models (for more details refer to Schaap et al., 2001). The drainage characteristic (τ) was calculated as a function of K_{sat} (Raes, 2002). Five soil compartments were considered as soil input data and thus weighted average values of θS, θFC, θWP and τ and effective K_{sat} (Radcliffe and Simunek, 2010) were aggregated from 7 layers of AKpit-1 and AKpit-2 and 9 of AZpit-1.

3.3.3 Model calibration

Crop parameters of cotton and wheat were considered in calibration of the model using field measurements conducted at C-13&14 and C-180&181 in Azizbek and Akbarabad sites in 2011, and tested for other fields with respective soil parameters. Calibration of crop parameters consisted of determining the k_{cb}, K_y, rooting depths and sensitivity stages that lead to the best fit of the observed crop yield. Calibration of soil parameters considered selection of θFC, θWP and K_{sat} from measured and predicted values that lead to the closest match between simulated and observed soil moisture.

3.3.4 Model evaluation

In this study, the model output, such as crop yield and soil moisture was considered for the evaluation of the model. The determination coefficient (R^2), root mean square error (RMSE), relative Nash-Sutcliffe efficiency (E_{rel}, Krause et al., 2005) and the index of agreement (d, Willmot et al., 1981) were used as the error statistics to evaluate model outputs.

4 RESULTS AND DISCUSSIONS

4.1 Irrigation management and crop yield

Six fields out of ten, especially C-174 in 2010 and C-13&14 in 2011 cultivated with cotton were under-irrigated, which created water stress condition and impacted crop yield. However, high yield of cotton under less irrigation amount in C-174 comparing to C-13&14 can be explained by relatively high rainfall in 2010 (107 mm) and different agronomical management. In contrast, winter wheat in majority of the fields was over- irrigated, where, according to Abdullaev et al. (2009), evapotranspiration during the growing period was not considered. In general, three to four irrigations with total irrigation amount 280-500 mm and five to seven irrigations of 380-960 mm, applied during the growing period of cotton and wheat, respectively (Tab.1). The irrigation depth and amount are along the line (except wheat irrigation at C-180) with recommended amount by the GMR (Stulina, 2010). Moeover, they correspond with observations of Bezborodov et al. (2010) and Devokta et al. (2013). The average salinity of irrigation water in Akbarabad and Azizbek sites was 1.13 dS m^{-1} and 0.68 dS m^{-1}, respectively.

Table 1: Area, growing period, precipitation, potential evapotranspiration, irrigation and yields of cotton and wheat grown at fields in Azizbek and Akbarabad in 2009-2011

Year	Field ID	Crop type[1]	Area (ha)	Sowing - harvesting dates[2]	P^3 (mm)	$ET_o{}^4$ (mm)	Irrigation: amount (mm) x number (n)		Yield (t ha^{-1})
							Recom.[5]	Obs.[6]	
2009-2010	C-13&14	Wheat	20.2	14.10.09-21.06.10	215	522	460x6	483x5	3.10
	C-172	Wheat	7	05.10.09-21.06.10	215	542	460x6	411x5	3.50
	C-176	Wheat	10	05.10.09-21.06.10	215	542	460x6 (320x4)	382x5	4.00
2010	C-15&16¤	Cotton	16.3	19.04.10-15.10.10	93	798	490x4	357x4	3.42
	C-165	Cotton	13	14.04.10-05.10.10	89	793	490x4	332x3	3.04
	C-174¤	Cotton	13	06.04.10-17.10.10	107	842	490x4 (340x4)	253x3	3.39
	C-180&181	Cotton	26.5	07.04.10-15.10.10	107	834	340x4	288x3	2.10
2010-2011	C-15&16	Wheat	16.3	15.10.10-21.06.11	99	576	460x6	718x7	4.89
	C-180&181	Wheat	26.5	20.10.10-15.06.11	96	541	460x6 (320x4)	960x6	3.52
2011	C-13&14¤	Cotton	20.2	15.04.11-11.10.11	33	889	490x4	280x3	2.84
	C-164	Cotton	13	05.04.11-07.10.11	33	920	490x4	488x4	3.20
	C-165	Cotton	13	04.04.11-03.10.11	33	914	490x4	483x4	3.79
	C-172	Cotton	7	04.04.11-06.10.11	33	918	490x4	435x3	2.15
	C-174¤	Cotton	13	04.04.11-30.09.11	33	905	490x4 (340x4)	498x3	3.20
	C-176	Cotton	10	04.04.11-09.10.11	33	835	490x4 (340x4)	473x4	3.80

[1] intermediate crops after wheat harvest were not included; [2] last harvest date was taken for cotton; [2] precipitation (P) during the growing period ("*Fergana*" weather station); [4] potential evapotranspiration (ET_o) during the growing period (calculated using "*ET_o calculator*"); [5] recommended total amount and number of irrigation according to GMR V (values in parenthesis pertain to GMR VIII) according to Stulina (2010); [6] gross irrigation within the growing period. Note, charging irrigation in cotton fields (indicated by symbol ¤) was used in the BUDGET as pre-sowing irrigation.

Cotton yield, measured during the study period and reported by farmers, is within the range of average yield reported by Provincial Statistical Department (Oblstat, 2012). However, average wheat yield reported by farmers (Tab.1) has deviated from those measured at the sites as well as from those reported by Oblstat (2012) for the districts where the sites are located (Fig. 2). Hence, wheat yield measured at the field was used to compare with modeled yield.

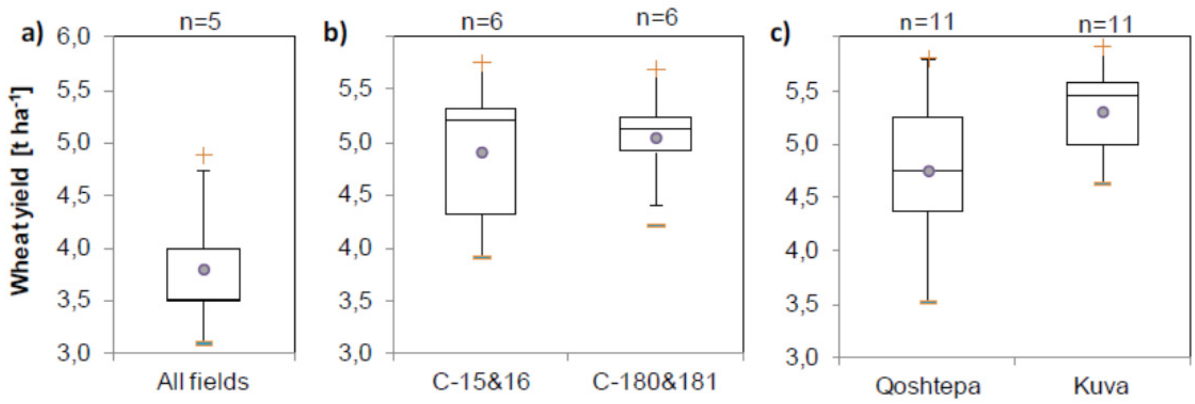

Figure 2: Box plots describing grain yield of winter wheat reported by farmers (a), field measured (b) and averaged in districts for 2000-2010 (c) and number of samples *n*. Line and dot inside the box: median and mean value; box: 25th -75th percentiles (interquartile range); whiskers: data values less than or equal 1.5 times the interquartile range, plus and minus: maximum and minimum values.

4.2 Soil moisture content

Results of comparison between simulated and observed soil moisture contents (SMC) between two irrigations of cotton (field C-13&14) cultivated in Azizbek in 2011 are plotted in Fig. 3. The simulated SMC using laboratory measured θFC (pF 2.0) and θWP (pF 4.2) and corresponding $Ksat$ calculated using the Rosetta (ANN5) as input gave better result (Fig. 3a) comparing to those inputs calculated using the SPAW (Fig. 3b).

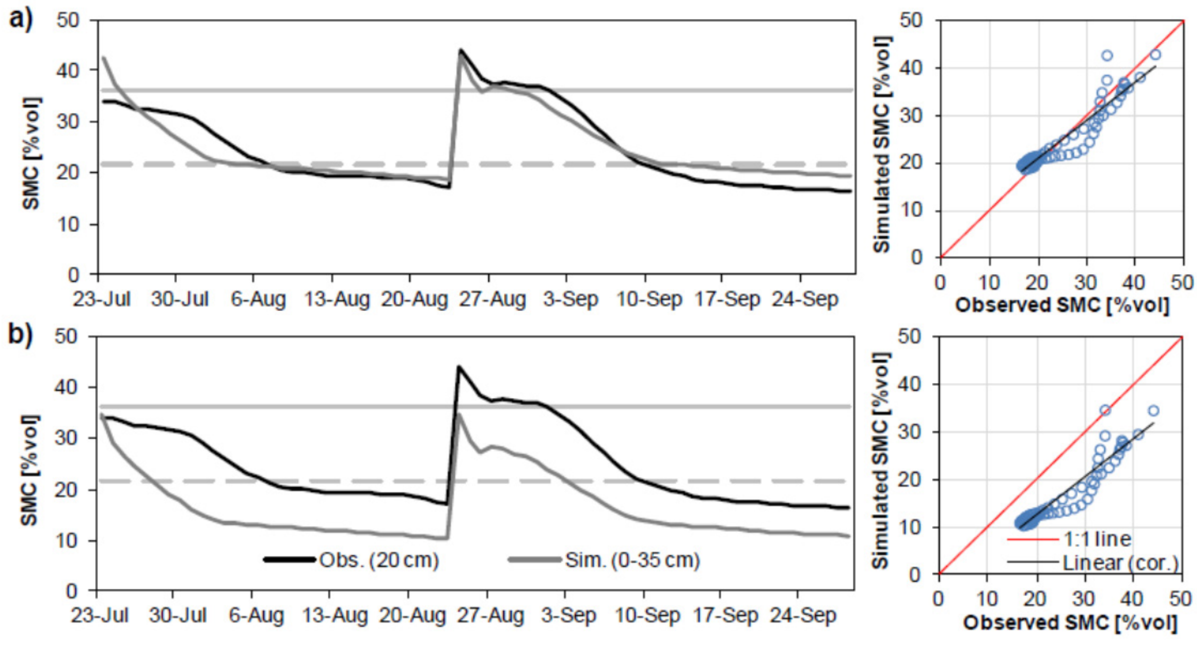

Figure 3: Relationship between simulated and observed soil moisture content at the top 0-30 cm layer for C-13&14 in Azizbek site. Straight and dished horizontal lines represent soil moisture at θFC and θWP, respectively: using laboratory measured soil input (a) and the SPAW calculated soil input (b).

It should be noted that statistical analysis (Tab. 2) in terms of R^2, E_{rel} and d are almost similar in both soil inputs (Fig. 4a and b, right). However, RMSE of 2.72 % volume was 3-fold lower when θFC and θWP were based on the laboratory measured soil inputs. This can be explained by underestimation of θFC and θWP in the SPAW. Hence, laboratory measured soil hydraulic parameters were used as default soil input data for further model simulations.

Table 2: Statistical comparison of observed and modeled soil moisture content (0-30 cm) and total soil water content (0–90 cm layer) for all sites (2011)

Variable	Field	R^2 (-)	RMSE	E_{rel} (-)	d (-)	Refer to
Soil moisture content (%vol.)[1]	C-13&14	0.88	2.72	0.87	0.99	Fig. 3a
		0.87	8.84	0.99	0.98	Fig. 3b
Soil water content in 90 cm (mm)[2]	C-165	0.88	21.36	0.78	0.99	Fig. 4a
	C-174	0.71	28.72	0.53	0.99	Fig. 4b
	C-180&181	0.75	22.82	0.59	0.99	Fig. 4c

[1] between two irrigations; [2] for growing period (the unit of RMSE corresponds to the variable's unit).

Soil water contents (SWC), at the 90 cm of soil profile for cotton (C-165 and C-174) and winter wheat (C-180&1881) cultivated in Akbarabad in 2011, are plotted in Fig. 4. Results presented in Tab. 2 show that the R^2 values ranging from 0.71 to 0.88 indicate large fraction of the variation of observations is explained by the model. The RMSE has value of 21.4 mm for C-165 and 28.7 mm for C-174. The efficiency and agreement indices, E_{rel} and d, have values 0.53-0.78 and around 1.0, respectively. The low goodness of fit in terms of RMSE and E_{rel} can be explained, as soil parameters were not calibrated and used as selective basis from the available and calculated data. In general, the SWC simulated by the BUDGET are in line with the observed data (Fig. 4). Moreover, the model is able to simulate SWC above θFC, which have been confirmed by rising groundwater table after irrigations (not shown in this paper). Studies of soil moisture simulations, by Stulina et al. (2005) and Cholpankulov et al. (2008) using RZWQM and ISAREG models, respectively, yielded similar results. However, the first requires a detailed set of input parameters, whereas the latter does not consider SWC above the θFC.

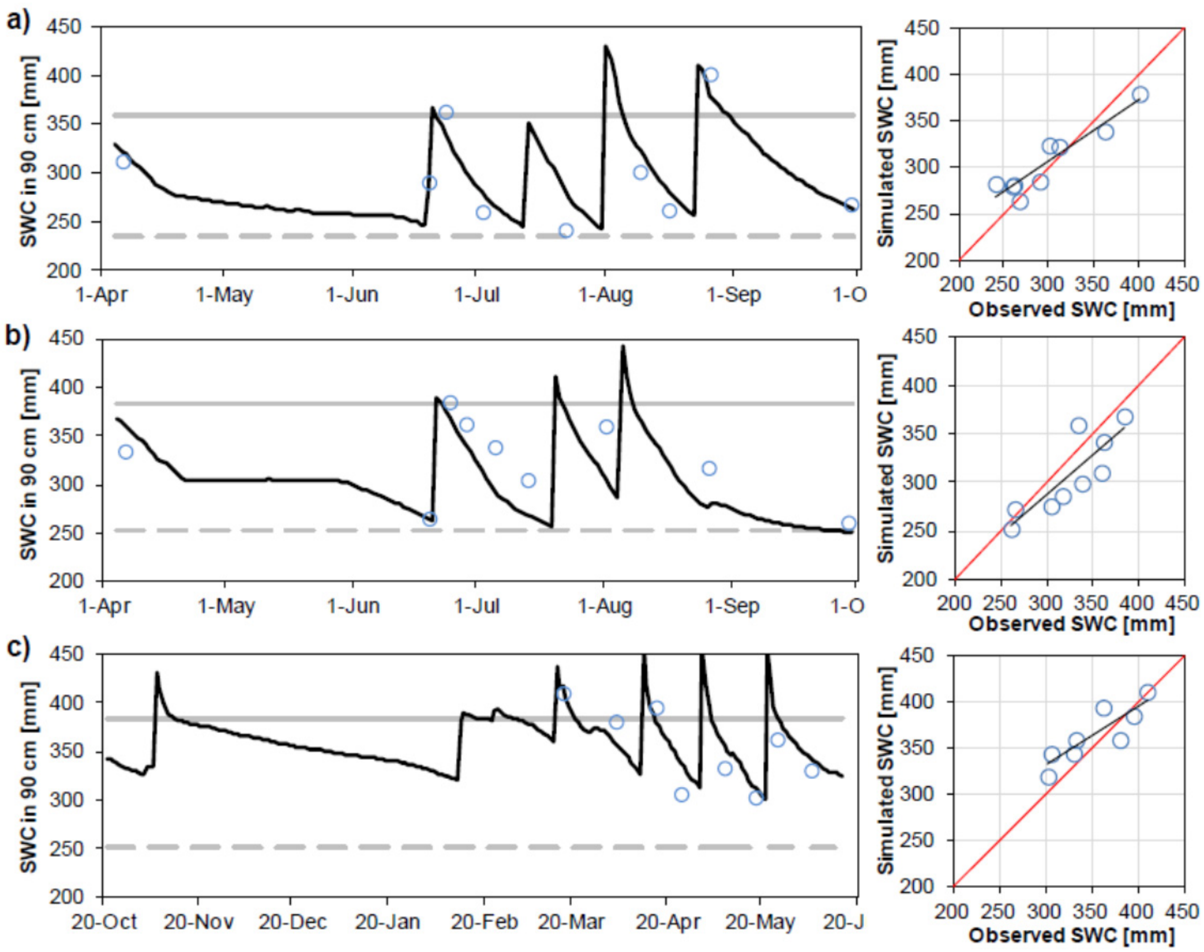

Figure 4: The simulated (full line) and observed (dot) soil water content (left) and their comparison (right) in 90 cm of cotton for C-165 (a) and C-174 (b) and winter wheat for C-180&181 (c) in Akbarabad (straight and dished horizontal lines represent soil moisture at θFC and θWP, respectively).

4.3 Yield estimations

Fig. 5 shows the relationship between the observed and modeled yield of cotton (seed and lint yields together) and wheat (grain yield) for all the fields combined. The results in this figure refer to simulations performed with the *minimal* approach (Raes et al., 2002), considering the relative transpiration (T_{actual}/T_{crop}). The potential (maximum) yield of cotton was reckoned to be 4.65 and 4.5 t ha^{-1} for varieties of "C-6524" and "AN-35", respectively (Ibragimov et al., 2008), whereas yield of wheat 6.0 t ha^{-1} which have been observed during 2000-2010 in Fergana province (OblStat, 2012).

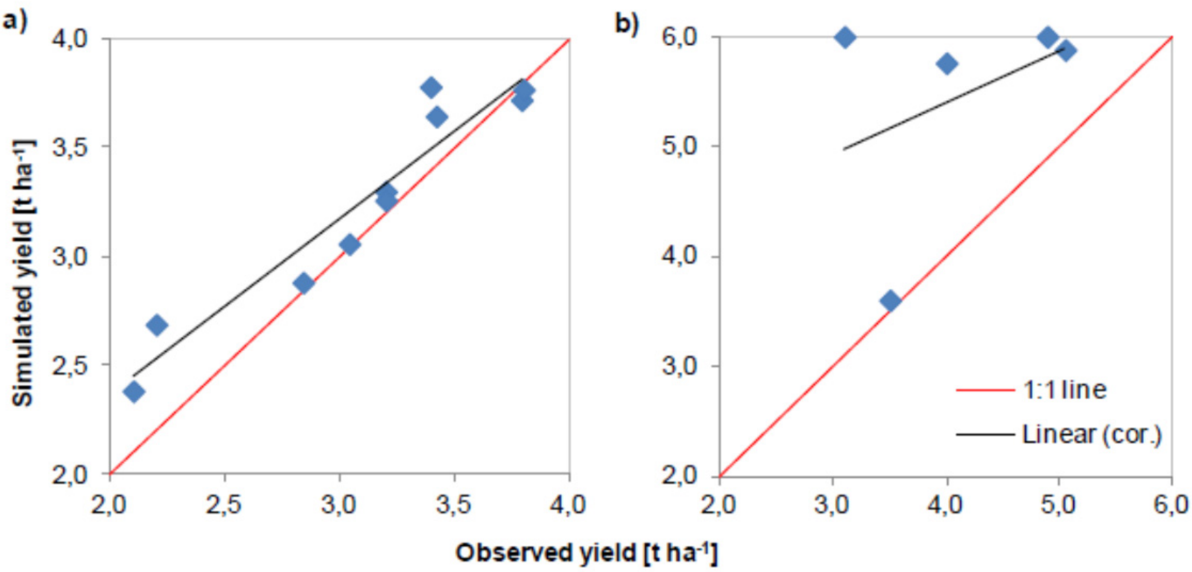

Figure 5: Relationship between observed and modeled yield of cotton (a) and wheat (b) for all the sites combined.

Observed and modeled cotton yield was correlated well giving the R^2 of 0.91, the RMSE of 0.24 t ha^{-1}, the E_{rel} of 0.71 and d of 0.48 (Tab. 3). However, the model has over-estimated wheat yield resulting poor correlation and high statistical errors. Hence, model can be used to simulate crop yield decline accurately under water stress condition (Raes et al., 2006), which was a case regarding cotton irrigation in the sites.

Table 3: Statistical comparison of observed and modeled cotton and wheat yield for all the sites combined (2010-2011)

Variable	R^2 (-)	RMSE	E_{rel} (-)	d (-)	Refer to
Cotton	0,91	0,24	0,71	0,48	Fig. 5a
Winter wheat	0,15	1,64	-5,68	-0,54	Fig. 5b

5 CONCLUSIONS

The current wheat irrigation practiced in Fergana province compared with recommended norms by the GMR shows high non-beneficial/ highly unsustainable water use, where actual crop water requirement, contributions from groundwater and use of the available soil water are not taken into account. Hence, it makes high water loss as deep percolation and rise of groundwater level.

Simulations of soil water content were performed using two sets of data, e.g., measured physical soil parameters and estimated one with the help of pedotransfer functions (PTF). Results show that caution is needed to use soil parameters directly derived from PTF, which leads to miss-estimation of soil moisture content, where even statistical estimators (R^2, E_{rel} and d) are similar. In general, the Budget can simulate soil water content and cotton yield with relative accuracy under current farmer-managed field condition in Fergana valley. Hence, the model can be a useful tool to develop an irrigation strategy under water deficit conditions that guarantee an optimal response to the applied water. Nevertheless, this work describes the first attempt to use the BUDGET for Central Asian conditions, further performance of the model is needed to consider wider range of soil, crop and management conditions.

6 ACKNOWLEDGEMENTS

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REFERENCES

Abdullaev I., De Fraiture C., Giordano M., Yakubov M., Rasulov A., 2009. Agricultural water use and trade in Uzbekistan: Situation and potential impacts of market liberalization. Water Resources Development 25, pp. 47-63.

Allen R., Pereira L., Raes D., Smith M., 1998. Crop evapotranspiration - guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper No. 56, FAO, Rome, Italy, p. 300.

Ayers R., Westcot D., 1994. Water quality for agriculture. FAO Irrigation and Drainage Paper No 29, rev.1, Rome Italy.

Bezborodov G., Shadmanov D., Mirhashimov R., Yuldashev T., Qureshi A., Noble A., Qadir M., 2010. Mulching and water quality effects on soil salinity and sodicity dynamics and cotton productivity in Central Asia. Agriculture, Ecosystems and Environment 138, pp. 95-102.

Cholpankulov E., Inchenkova O., Paredes P., Pereira L., 2008. Cotton irrigation scheduling in Central Asia: model calibration and validation with consideration of groundwater contribution. Irrigation and Drainage 57, pp. 516-532.

Devkota M., Martius C., Lamers J., Sayre K., Devkota K., Gupta R., Egamberdiev O., Vlek P., 2013. Combining permanent beds and residue retention with nitrogen fertilization improves crop yields and water productivity in irrigated arid lands under cotton, wheat and maize. Field Crops Research 149, pp. 105-114.

Doorenbos J., Kassam A., 1979. Yield response to water. FAO Irrigation and Drainage Paper No. 33. Rome, Italy, p. 193.

Forkutsa I., Sommer R., Shirokova Y., Lamers J., Kienzler K., Tischbein B., Martius C., Vlek P., 2009. Modeling irrigated cotton with shallow groundwater in the Aral Sea Basin of Uzbekistan: I. Water dynamics. Irrigation Science 27, pp. 331-346.

Evett S., Ibragimov N., Kamilov B., Esanbekov Y., Sarimsakov M., Shadmanov J., Mirhashimov R., Musaev R., Radjabov T., Muhammadiev B., 2007. Neutron moisture meter calibration in six soils of Uzbekistan affected by carbonate accumulation. Vadose Zone Journal 6, pp. 406-412.

Horst M., Shamutalov S., Goncalves J., Pereira L., 2007. Assessing impacts of surge- flow irrigation on water saving and productivity of cotton. Agricultural water management 87, pp. 115-127.

Horst M., Shamutalov S., Pereira L., Goncalves J., 2005. Field assessment of the water saving potential with furrow irrigation in Fergana, Aral Sea basin. Agricultural Water Management 77, pp. 210-231.

Ibragimov N., Evett S., Esanbekov Y., Kamilov B., Mirzaev L., Lamers J., 2007. Water use efficiency of irrigated cotton in Uzbekistan under drip and furrow irrigation. Agricultural water management 90, pp. 112-120.

Ibragimov N., Evett S., Esenbekov Y., Khasanova F., Karabaev I., Mirzaev L., Lamers J., 2011. Permanent beds vs. conventional tillage in irrigated arid Central Asia. Agronomy Journal 103, pp. 1002-1011.

Ibragimov P., Avtonomov V., Amanturdiev A., Namazov S., Zaurov D., Molnar T. Eisenman S., Orton T., Funk C., Percival E., 2008. Uzbek Scientific Research Institute of Cotton Breeding and Seed Production: Breeding and germplasm resources. Journal of Cotton Science 12, pp. 62-72.

Kazbekov J., Abdullaev I., Manthrithilake H., Qureshi A., Jumaboev K., 2009. Evaluating planning and delivery performance of Water User Associations (WUAs) in Osh Province, Kyrgyzstan. Agricultural Water Management 96, pp. 1259-1267.

Krause P., Boyle D., Base F., 2005. Comparison of different efficiency criteria for hydrological model assessment. Advances in Geosciences 5, pp. 89-97.

OblStat, 2012. Annual report for crop production in Fergana province. Provincial Department of Statistics, Fergana, Uzbekistan.

Pereira L.S., Paredes P., Cholpankulov E.D., Inchenkova O.P., Teodoro P.R., Horst M.G., 2009. Irrigation scheduling strategies for cotton to cope with water scarcity in the Fergana Valley, Central Asia. Agricultural water management 96, pp. 723-735.

Qadir M., Noble A., Qureshi A., Gupta R., Yuldashev T., Karimov A., 2009. Salt- induced land and water degradation in the Aral Sea basin: A challenge to sustainable agriculture in Central Asia. Natural Resources Forum 33, pp. 134-149.

Radcliffe D., Šimůnek J., 2010. Soil physics with HYDRUS: Modeling and applications, CRC Press, Taylor & Francis Group, pp. 373.

Raes D., 2002. BUDGET - a soil water and salt balance model. Reference manual, version 5.0. K.U.Leuven, Institute for Land and Water Management, Leuven, Belgium, p. 79.

Raes D., 2009a. The ETo Calculator: Evapotranspiration from a reference surface. Reference manual, version 3.1. FAO, Rome, Italy, p. 38.

Raes D., 2009b. UPFLOW - water movement in a soil profile from a shallow water table to the topsoil (capillary rise). Reference manual, version 3.2. FAO, Rome, Italy, p. 21.

Raes D., Geerts S., Kipkorir E., Wellens J., Sahli A., 2006. Simulation of yield decline as a result of water stress with a robust soil water balance model. Agricultural Water Management 81, pp. 335-357.

Reddy J. M., Jumaboev K., Matyakubov B., Eshmuratov D., 2013. Evaluation of furrow irrigation practices in Fergana Valley of Uzbekistan. Agricultural water management 117, pp. 133-144.

Saxton K., Rawls W., 2006. Soil water characteristic estimates by texture and organic matter for hydrologic solutions. Soil Sci. Soc. Am. J. 70, pp. 1569-1578.

Schaap M., Leij F., van Genuchten M., 2001. ROSETTA: a computer program for estimating soil hydraulic parameters with hierarchical pedotransfer functions. Journal of Hydrology 251, pp. 163-176.

Stulina G., 2010. Recommendations on hydromodule zoning and irrigation regimes of agricultural crops. “IWRM-FV” Project Rreport, SIC ICWC and IWMI, Tashkent, p.48 (*in Russian*).

Stulina G., Cameira M., Pereira L., 2005. Using RZWQM to search improved practices for irrigated maize in Fergana, Uzbekistan. Agricultural Water Management 77, pp. 263-281.

Willmott C., 1981. On the validation of models. Physical Geography 2, pp. 184-194.

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RADAR REMOTE SENSING FOR SURVEYING AND MONITORING OF EARTHQUAKES AND MASS MOVEMENTS IN SOUTHERN KYRGYZSTAN

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1 INTRODUCTION

Kyrgyzstan is landlocked mountainous nation of around five million people, which borders China, Kazakhstan, Tajikistan and Uzbekistan. The total area of high mountainous terrain, alpine meadows and pastures exceeds 70% of the Republic's territory, whereas the greater part of the Kyrgyz Republic is occupied by the Tien Shan Mountains. Kyrgyzstan is a highly active seismic region and has been shaken by numerous significant earthquakes as a consequence of the ongoing collision between the Indian and Eurasian tectonic plates. In the result, the mountainous country is faced with a large variety of natural hazards (mainly earthquakes, large landslides and floods) which frequently lead to the occurrence of natural disaster (e.g., 1994: about 1,000 landslides failed and 115 human fatalities; 2008: Nura earthquake M=6.6, 74 human fatalities and 150 injured, 90 glacial lakes endangered for regularly occurring outburst floods). Under these conditions, there is high demand for efficient and spatially differentiated hazard assessment requiring an improved understanding of natural processes with high hazardous potential. Since large areas with often limited accessibility are affected, satellite remote sensing plays an important role in contributing to improved process knowledge in this region (Roessner et al., 2005). In the presented work the potential of advanced remote sensing techniques based on Synthetic Aperture Radar (SAR) satellite data is investigated for characterizing spatio-temporal surface changes related to mass movement and earthquakes. Methodological focus has been put on using Differential SAR Interferometry (InSAR) based on data from different satellites for detecting surface displacements as a consequence of slope instabilities and earthquakes in Southern Kyrgyzstan. In the presented work we focus on one study site of high landslide activity in the Osh province and on another study site which has been affected by the recent destructive Nura earthquake in 2008 (Fig.1).

Case study 1 – landslides: Osh province is one of the most landslide-prone areas in Central Asia. In this region outlined in Figure 1 topography ranges between 800 m and 3500 m with regular winter snow coverage in the higher areas.

Case study 2 – earthquakes: On 5th October of 2008, the 6.6 magnitude Nura earthquake struck Alai region, killing about 74 people, injuring many and destroying dozens of buildings in the southern province of Osh. The area most affected was the village of Nura situated in a mountainous region close to the border with China. Seismic shaking of this earthquake affected large parts of Southern Kyrgyzstan as well as the border region with Uzbekistan, Tajikistan and China.

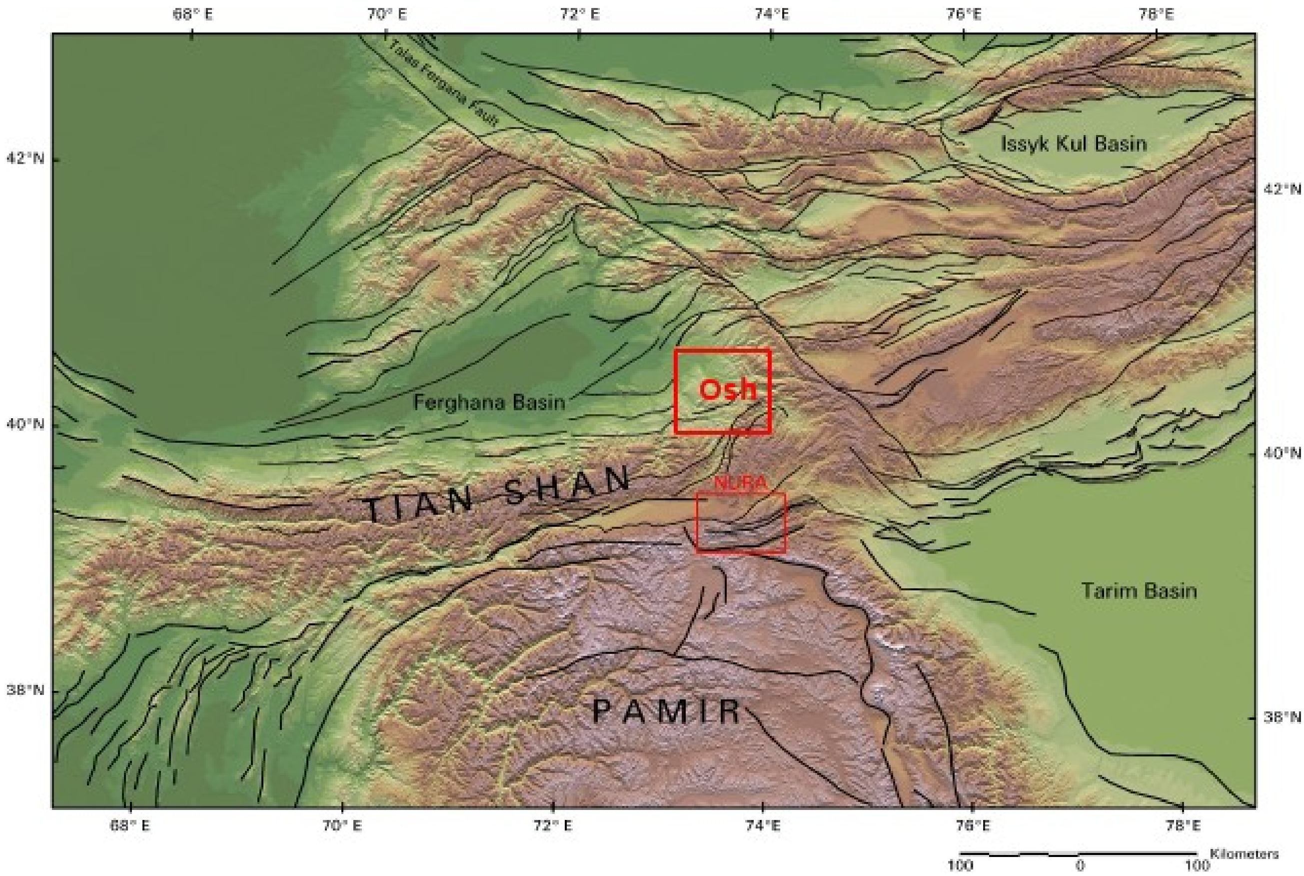

Figure 1. Tectonic map of the Pamir - Tien-Shan region showing the active faults overlaid on the colour- shaded topographic relief based on SRTM data (after TAYLOR & YIN (2009) and KALMETIEVA et. al. (2009). The red boxes indicate the case study areas: Osh province and Nura earthquake.

2 METHODOLOGY AND REMOTE SENSING DATA

Differential SAR Interferometry (InSAR) allows detecting ground deformation of the Earth's surface occurring among others in connection with earthquakes and slope instabilities. InSAR extracts such information about the Earth's surface using the phase difference between two SAR images of the same area. These two complex SAR images are taken from slightly different positions by the same antenna at two different acquisition times. Their combination and differentiation according to phase forms the radar interferogram. Differential InSAR comprises of the idea of subtracting the topography-related phase from the interferogram in order to retrieve line-of-sight (LOS) surface displacement. Only in the ideal case of an image pair with a very small baseline, this effect of topographic phase contribution becomes negligible.

In this study InSAR processing has been performed using ALOS-PALSAR and ENVISAT radar data. PALSAR is an L-band sensor onboard the Japanese ALOS Satellite with a wavelength of

23.6 cm and the C-band sensor of the European ENVISAT satellite has a wavelength of 5.6 cm. Thus, PALSAR uses a longer microwave wavelength which is known for achieving good coherence even in densely vegetated areas (Rosen et al. 1996). The ALOS data used in this study were provided by the JAXA ALOS Research Program (Proposal P610). For case 1 – landslides - a total of 26 ascending ALOS/PALSAR raw SAR data sets were received from JAXA covering the study area during the time period between 2007 and 2010. For case 2 – Nura earthquake - we used 22 ascending PALSAR and 10 descending ENVISAT images. InSAR processing has been performed using the SarScape software.

The raw PALSAR scenes were processed to single-look complex (SLC) images. All SLC images were processed in the zero-Doppler coordinate system, simplifying the interferometric processing. The best combinations for InSAR pairs with small baseline were chosen to derive the interferograms. The SRTM DEM (90 m resolution) was used to remove the topographic phase. In order to exclude decorrelated areas from the study, we performed Goldstein filtering. During InSAR analysis, the data were processed in the radar coordinate system obtained by the SAR satellite. In a second step the results were converted to the ground-based UTM coordinate system by using elevation data. In this process, pixels holding information are rearranged according to their longitude and latitude within the UTM coordinate system. For the SAR-based earthquake analysis InSAR was complemented by the pixel offset method using the SAR amplitude images in order to derive displacements.

3 RESULTS AND DISCUSSION

CASE 1 – LANDSLIDES

For this study we selected InSAR datasets with less than 300 m perpendicular baseline and a temporal baseline of less than 14 month. In total, 38 InSAR ALOS/PALSAR pairs from the ascending mode with an off-nadir angle of 34.3 degrees were processed and interferograms were calculated. In the ascending orbits, these side-looking observations are made from the west. Applying the InSAR method, only one-dimensional displacements in the satellite's line of sight can be observed. Therefore, the SAR interferograms only show such displacements where the surface moves towards or away from the satellite along this line of sight. Analysis of the processed interferograms shows very good coherence also for pronounced mountainous terrain and vegetated slopes (Fig. 2). This figure also contains the results which were obtained for this area by analyzing TerraSAR-X data using the same InSAR technique (Motagh et al., 2010). The analyzed time periods comprise of a more than one year period between July 2008 and August 2009 for ALOS and an 11 days period in August 2009 for the TerraSAR-X data which is embedded within the ALOS time period (Fig. 2).

The results show that ALOS/PALSAR maintains very good coherence even during a long period of time of more than one year in this mountainous and vegetated area. Thus, the data area suitable for mapping mobilization of slopes related to landslides. So far, for the study area 18 of such areas could be identified for the analyzed three years time period of ALOS-PALSAR data availability. They still need to be verified using results obtained from interpretation of optical satellite remote sensing data and field investigations carried out in September of 2011 and 2012. Comparison with results obtained by TerraSAR-X data analysis show that mobilization was detected in the same area. Due to the short analyzed time period of 11 days, only one smaller area was identified. Thus, it can be concluded that the results obtained by the two systems are consistent and can be used complementary in order to assess short- and long-term landslide activity in this area. In this context it would be desirable to analyze ascending and descending interferograms for the same area and time period in order to increase the extent of slopes for which InSAR can be applied successfully to monitor mass movement (Motagh, et al., 2010).

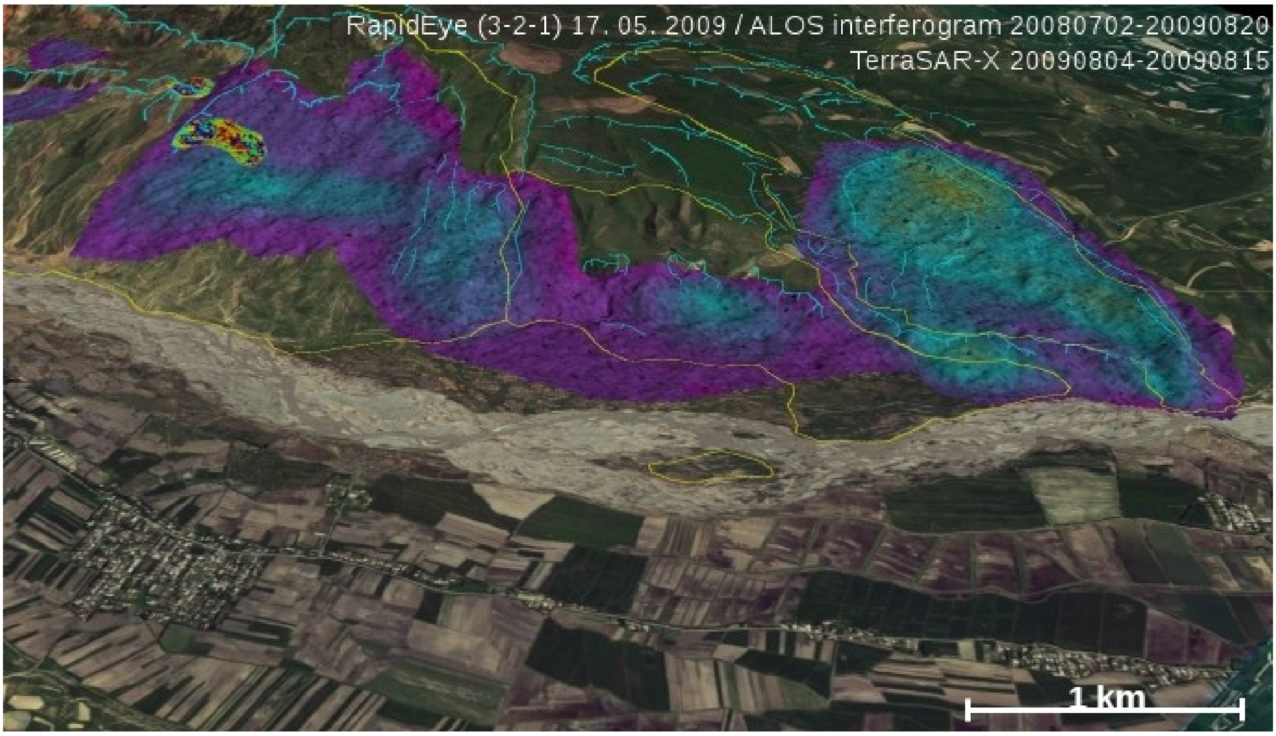

Figure 2. View of landslide prone slope near Uzgen, Osh province. Results from ALOS/PALSAR showing mobilization of entire slope (blue to violet color) and compared with TerraSAR-X results which show a local slope failure (upper left corner color changes from green to red).

CASE 2 – NURA EARTHQUAKE

For this study we selected suitable InSAR ALOS PALSAR datasets with less than 250 m perpendicular baseline and a temporal baseline with less than 30 month. In total, seven InSAR pairs were processed and interferograms were calculated. Additionally, suitable ENVISAT datasets were selected applying the same baseline constraints. In the result 10 descending ENVISAT images were processed.

The Nura earthquake has been situated in the area of the water divide between the Tarim and the Tadjik west basin. Applying the InSAR technique to the earthquake area has resulted in reliable deformation measurements mostly on the footwall of the Frontal Pamir Thrust in the eastern part of Alai valley (Fig.3). In particular, the ENVISAT data are strongly suffering from layover originating from the surrounding area of high topographic relief and steep slopes. Additionally, in the area close to the epicentre of the Nura earthquake the interferometric phase is highly decorrelated in all interferograms, most likely due to snow coverage. In the ascending ALOS interferograms we measure a large and sudden change of negative and positive line-of-sight displacements that amount to about -36 cm and 48 cm, respectively in the area north-east of the ep-icenter at the footwall of the Irkeshtam thrust fault. In contrast, in the corresponding descending ENVISAT interferogram in total there are only two fringes visible which compare to ~6 cm line-of-sight displacement. Such large differences in the measured line-of-sight displacements between ascending and descending images are to be expected only for a considerable amount of horizontal deformation. Some far-field deformation can be observed in both interferograms (Teshebaeva et al., 2012).

Due to the described limitations of the InSAR methods for the Nura area, pixel offset measurements using the SAR amplitude images has been carried out in addition to the displacement measurements of InSAR. However, they are often strongly affected by noise. Our offset measurements in azimuth direction (the satellite flight direction) using the ALOS data show a clear left-lateral component of movement at the Irkeshtam thrust fault (Fig. 3). This observation is supported by the azimuth offset measurements using the descending ENVISAT data. Even though their quality is poorer compared to the results obtained from the ALOS data, they also show a clear change in the azimuthal offsets across the Irkeshtam thrust fault. These changes have the opposite leading sign compared to the ALOS azimuth offsets, which is to be expected due to the nearly opposite flight direction (Fig.3). The settlement Nura destroyed by the earthquake is located close to the outcropping of the Irkeshtam thrust fault. At this location we measured the highest structural displacement situated at the footwall of the so far defined Frontal Pamir Thrust using both of the described SAR based remote sensing methods.

The results from surface displacement, pixel offset measurements and the distribution of seismic aftershocks (Krumbiegel et al., 2011) allow the determination of an active thrusted part limited by a very prominent topography gradient defined as co-seismic active inverse faults partly with slip components. These findings are in accordance with the results from previous geodynamic investigations in this region. Recent studies of Strecker et al. (2003), Burtman (2000), Arrowsmith and Strecker (1999), Burtman and Molnar (1993), Nikonov et el. (1983), Davidzon et al.(1982) reveal the active closure of the Alai Valley for late Pleistocene up to recent times which is concurrent with GPS data analysis carried out by Zubovich et al. (2010), Mohadjer et al. (2010), Reigber et al. (2001). Thus, these investigations underline the definition of the most active segment of the Pamir-Alay collisional structure. The obtained results suggest the existence of an active fault pattern of constructional upthrusting strain which may be interpreted as recently formed active wedge and possibly as northward propagation at the eastern termination of the Alai Valley into its footwall.

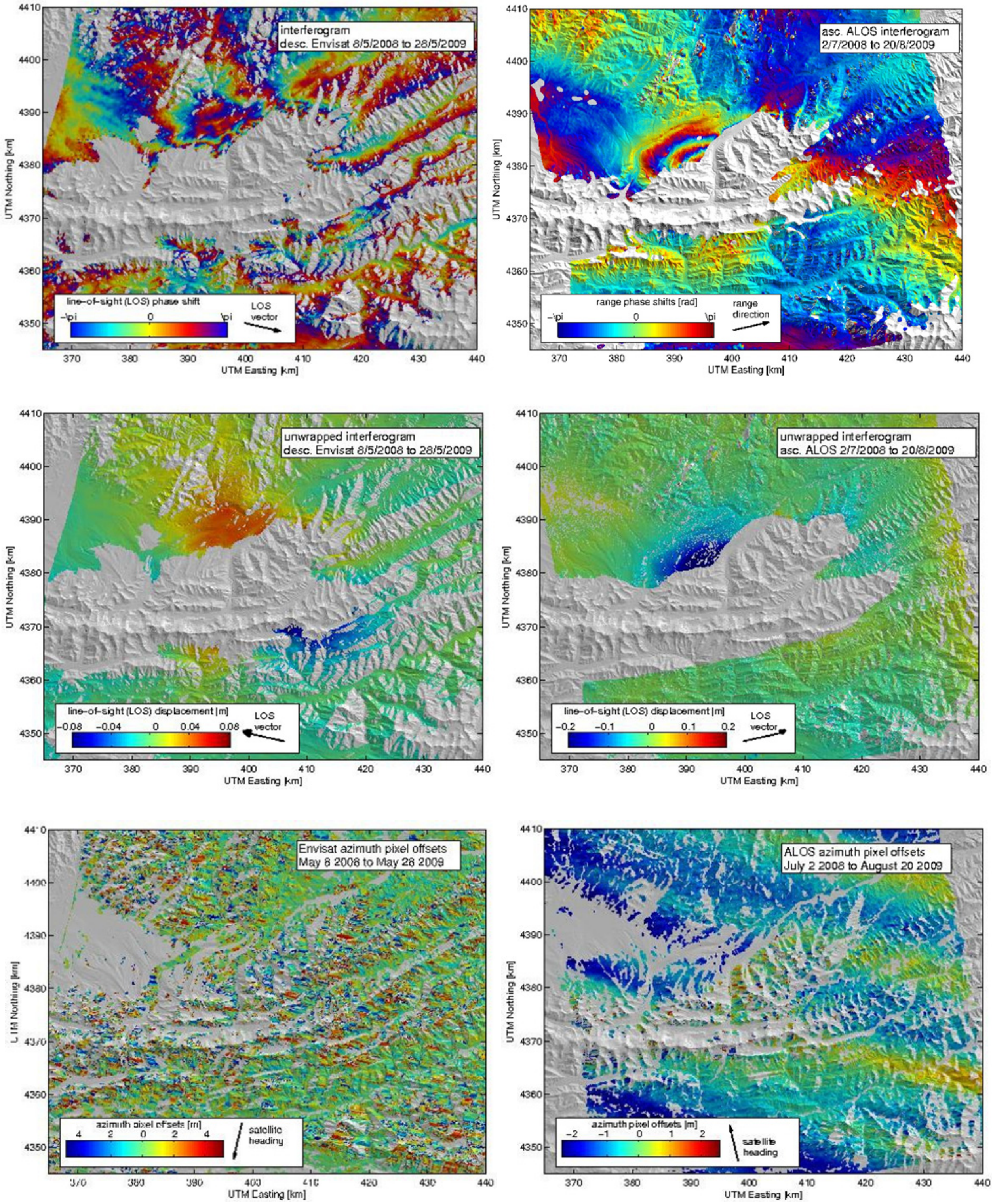

Figure 3. Surface displacement measurements from SAR products of (right panels) ALOS satellite (L- band sensor, wavelength 23.6 cm) and (left panels) ENVISAT satellite (C-band sensor, wavelength 5.6 cm). Interferograms (top panels) are filtered and areas of incoherent interferometric phase are masked. Middle panels show unwrapped interferograms and right panels azimuth pixel offset measurements, corresponding to horizontal movement on the surface in the satellite's flight direction.

Ongoing work is focusing on detailed analysis of the deformation patterns and on source model estimation of the Nura earthquake. The expected results will support studies of stress change caused by the earthquake and analyses of active tectonics in the area. Thus, they will contribute to an improved understanding of surface manifestation of seismic activity in this high mountainous area in support of improved seismic hazard assessment.

REFERENCES

Arrowsmith, J. R., and M. R. Strecker (1999), Seismotectonic range front segmentation and mountainbelt growth in the Pamir-Alai region, Kyrgyzstan (India-Eurasia collision zone), Geol. Soc. Am. Bull., 111, 1665–1683, doi:10.1130/0016-7606(1999) 111<1665:SRFSAM>2.3.CO;2.

Burtman, V.S., 2000, Cenozoic crustal shortening between the Pamir and Tien Shan and a reconstruction of the Pamir–Tien Shan transition zone for the Cretaceous and Paleogene: Tectonophysics, v. 319, p. 69–92.

Burtman, V.S., and Molnar, P., 1993, Geological and geophysical evidence for deep subduction of continental crust beneath the Pamir: Geological Society of America Special Paper 281, 76 p.

Davidzon, R.M., Kraidenkov, G.P., and Salibaev, G.K., 1982, Stratigraphy of Paleogene deposits of the Tadjik Depression and adjacent territories: Dushanbe, Tadjikistan, Donish, 151 p. (in Russian).

Kalmetieva Z.A., Mikolaichuk A.V., Moldobekov B.D., Meleshko A.V., Jantaev M.M. and Zubovich A.V (2009): The atlas of earthquakes in Kyrgyzstan.- CAIAG Bishkek, 2009, 76 p. ISBN 978-9967-25- 829-7.

Krumbiegel C., Schurr B., Orunbaev S., Rui He, Pingren L., and the TIPAGE Team, 2011. Geophysical Research Abstracts, Vol. 13, EGU2011-4846.

Mohadjer, S., Bendick R., Ischuk, A., Kuzikov, S., Kostuk, A., Saydullaev, U., Lodi, S., Kakar, D.M., Wasy, A., Khan, M.A., Molnar, P., Bilham, R., Zubovich, A., 2010, Partitioning of India-Eurasia convergence in the Pamir-Hindu Kush from GPS measurements: Geophysical Research Letters, v.37, L04305, doi:10.1029/2009GL041737.

Motagh M., Teshebaeva K., Wetzel H., Anderssohn J., Roessner S., Kaufmann H., Surveying and monitoring of mass movement in Kyrgyzstan using X-band and L-band SAR Interferometry. 15th ARSPC conference, 2010, Alice Springs, Australia.

Nikonov, A.A., Vakov, A.V., and Veselov, I.A., 1983, Seismotectonics and earthquakes in the convergent zone between the Pamir and the Tien Shan: Moscow, Nauka, 240 p. (in Russian).

Reigber, C., Michel, G.W., Galas, R., Angermann, D., Klotz, J., Chen, J.Y., Papschev, A., Arslanov, R., Tzurkov, V.E., and Ishanov, M.C., 2001, New space geodetic constraints on the distribution of deformation in central Asia: Earth and Planetary Science Letters, v. 191, p. 157–165.

Roessner, S., Wetzel, H.-U., Kaufmann, H., Samagoev, A., 2005, Potential of satellite remote sensing and GIS for landslide hazard assessment in Southern Kyrgyzstan (Central Asia), Natural Hazards, 35, 3, 395-416.

Strecker, M. R., G. E. Hilley, J. R. Arrowsmith, and I. Coutand, 2003, Differential structural and geomorphic mountain-front evolution in an active continental collision zone: The NW Pamir, southern Kyrgyzstan, Geol. Soc. Am. Bull., 115, 166–181, doi:10.1130/0016-7606(2003)115<0166: DSAGMF>2.0.CO;2.

Teshebaeva, K.; Sudhaus, H.; Echtler, H.; Motagh, M.; Roessner, S.; Schurr, B.; Wetzel, H.-U.; Zubovich, A., 2012, InSAR analysis of the coseismic deformation related to the 2008 Nura earthquake, Pamir- Alai mountains. In: Publikationen der Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation e.V. ; Bd. 21, 249-255 pp.

DAVRON ABSALYAMOV

EFFICIENCY OF WHEAT AND COTTON PRODUCING FARMS IN UZBEKISTAN: A STOCHASTIC FRONTIER APPROACH

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1 PROBLEM STATEMENT

In the recent decades agricultural production in Uzbekistan has been facing problems in relation to environment and agricultural management systems especially with regard to the efficiency and the productivity of agricultural enterprises. The sharp decrease of total factor productivity after independency in 1990 can be traced back to inefficiency and misallocation of resources (Djalalov, 2006, p.122). Although statistical data shows steadily increasing partial productivity of land and labor since 1996 land degradation, low level of mechanization, partial water scarcity and the use of low-productive labor appear to prove the opposite. An increase in agricultural production by increasing area is not possible since the irrigated area itself is decreasing and not able to keep up with population growth. Further irrigation expansion due to increasing budget constraints and marginal quality of new reclaimed areas for agricultural use has been exhausted (Lerman, 2008, p.483). Agriculture plays a very important role in the economy of Uzbekistan. Besides the fact majority of population lives in rural areas and roughly one forth of labor force is employed agriculture contributes 20% to the GDP of Uzbekistan (State Committee of the Republic of Uzbekistan on Statistics (2013).

The productivity of wheat and cotton producing farms can be raised either by adoption of improved production technologies or increasing technical efficiency or both. Due to non-availability of information on farm level efficiency in wheat and cotton production in Uzbekistan this study is designed to provide estimates of technical efficiency and its main determinants using data obtained from a significant sample of farms.

The costs of input resources such as land, labor and capital especially fuel and mechanization in the past years have significantly increased. High population growth and associated decrease of irrigated land per capita require policy makers to provide incentives for farms to obtain maximal output at the given input level (technical efficiency) and furthermore to use them in right proportion in order to produce at the lowest possible cost (allocative efficiency). In the light of the above it is also to be discussed whether “optimization” i.e. increasing of farm size per decree in 2008 were justified and reasonable (scale efficiency). Agricultural production can be increased by increasing above mentioned efficiencies which can be caused as result of economic, social and ecological factors.

The specific feature of the current study is to estimate impact of environmental factors such as water availability and provision, soil quality on technical efficiency level of farms.

2 RESEARCH QUESTIONS

The main question of the study is how efficient are wheat and cotton producing farms in Uzbekistan and what are the main sources of inefficiency?

Other specific questions of the study are:

How do ecological factors such water scarcity, soil salinity and other farm- specific, farm-size specific and region-specific factors affect farm efficiency?

What is the pattern of input use and production output for wheat and cotton producing farmers?

How is the production of state-ordered commodities organized?

3 METHODOLOGICAL APPROACH

Stochastic frontier approach bases on a non-deterministic frontier which imposes the assumption that any deviation from the frontier is the result of random error and error term representing technical efficiency (Aigner, Lovell and Schmidt, 1977; Meeusen and van den Broeck, 1977). If we formulate these in stochastic frontier function it can be written as:

$$Y_i = f(X_i, \beta) + \varepsilon_i$$

or

$$Y_i = f(X_i, \beta) + V_i - U_i$$

Where Y- observed output, i, β- vector of parameters, ε_i - error term for observation which consist of two parts in his turn: V_i - two sided symmetric, normally distributed random error representing usual statistical noise, identical independent and identically distributed; and U_i – one sided error term representing technical inefficiency.

In the current study we are interested in the stochastic frontier of input oriented production function. It is more of importance as the farmers in Uzbekistan are obliged to fulfill fixed state-order quotas for wheat and cotton. Concerning parametric form of production function Cobb-Douglas and Translog are mostly used and well known functions which can be applied within their abilities and limitations.

In order to separate technical efficiency of each decision making unit from composed error term assumption on the distribution of errors representing technical inefficiency should be made. There is a number of error distributions with respect to the one sided error (inefficiency): Half-normal, exponential and truncated distributions are considered as the most used ones in the literature. Jondrow et al. (1982) developed a method for decomposing the total error term for the half-normal case. The expected value of technical inefficiency u_i conditional on the composed error term ε_i is:

$$E\,(u_i|\varepsilon_i) = \frac{\sigma\lambda}{(1+\lambda^2)}\left[\frac{\varphi(\varepsilon_i\,\lambda\,/\,\sigma)}{\Phi(-\varepsilon_i\,\lambda\,/\,\sigma)} - \frac{\varepsilon_i\,\lambda}{\sigma}\right]$$

Where:

φ (.) – Density of the standard distribution Φ(.) – Cumulative density function

$\lambda = \sigma u / \sigma v$

$\sigma = (\sigma u^2 + \sigma v^2)^{1/2}$

The objective of conducting a stochastic frontier model is not only to determine technical efficiency scores, but also to investigate the key factors of efficiency differences. In singe stage inefficiency effects model proposed by Battese and Coelli (Battese, Coelli, 1995) inefficiency levels are defined to be exogenous factors' explicit functions. It uses also ML estimation and specified as:

$$\mu_i = \delta_0 + \delta_j Z_{ij}$$

μ_i – mean technical inefficiency

Z_{ij} – matrix of exogenous variable assumed to have influence the farmers decision δ_j – vector of parameters to estimate β and δ, together with the variance parameters:

$\sigma^2 = \sigma u^2 + \sigma v^2$ and $\gamma = \sigma u^2 / (\sigma u^2 + \sigma v^2)$

Maximum likelihood approach is based on the estimation of β and δ, together with the variance parameters σ2 = σu2 + σv2 and γ = σu2 / (σu2 + σv2)

The marginal effect of a Zij variable on the technical efficiency is calculated as follows (Olsen and Henningsen, 2011):

$$\frac{\partial TE}{\partial Z_{ij}} = (1-\gamma)\left(\frac{\phi\left(\frac{\mu_*}{\sigma_*}-\sigma_*\right)e^{-\mu_*+\frac{1}{2}\sigma_*^2}}{\sigma_*\phi\left(\frac{\mu_*}{\sigma_*}\right)} - \frac{\phi\left(\frac{\mu_*}{\sigma_*}-\sigma_*\right)e^{-\mu_*+\frac{1}{2}\sigma_*^2}}{(\sigma_*\phi\left(\frac{\mu_*}{\sigma_*}\right))^2}\right)\frac{\partial\mu}{\partial Z_{ij}}$$

4 EXPECTED RESULTS

Preliminary results show that factors experience of farmers, number of workers, car (dummy) positively affect on farm efficiency in cotton production. Age, education and manure seem to have negative effect on efficiency. The negative impact of education can be reasoned by the fact that the most of educated farmers in the surveyed area have another educational background than agricultural sciences.

In wheat production there are few studied factors that could explain the farm inefficiency. They are water scarcity and car (dummy). Matter-of-course water scarcity has negative effect of farm efficiency. Owning car by farmers positively influences farm efficiency.

There are many other factors such soil salinity; distance to the local market, to the field and to main water source, region, family structure – studying their impact currently is in progress. It is expected that generally, distances, soil salinity have negative impact on farm efficiency.

REFERENCES

Aigner, D. J., Lovell, C.A.K., Schmidt P.J. (1977) “Formulation and Estimation of Stochastic Frontier Production Function Models”, Journal of Econometrics, 41, 21- 37.

Battese, G.E. Coelli, T.J. (1995) “A model for technical inefficiency effects in a stochastic frontier production function for panel data”, Empirical Economics, 20, 325-332

Djalalov S. (2006) A Comparative Analysis of Trends in Agricultural Productivity in Central Asian Transition Economies, in: Policy Reforms and Agriculture Development in Central Asia, Natural Resource Management and Policy, 2006, Volume 28, Part II, 109-129.

Jondrow, J., Lovell C.A.K., Materov, I.C., Schmidt P. (1982). “On the Estimation of Technical Efficiency in the Stochastic Frontier Production Function Model”, Journal of Econometrics, 19, 233-238.

Meeusen, W., van den Broeck, J. (1977) “Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error”, International Economic Review, 18, 435-444.

Olsen, J.V., Henningsen, A. (2011) “Investment Utilization, Adjustment Costs and Technical Efficiency in Danish Pig Farms” FOI Working paper.

State Committee of the Republic of Uzbekistan on Statistics (2013) Statistical Yearbook of Uzbekistan 2012, Tashkent 2013.

Lerman, Z. (2008) Agricultural Development in Central Asia: A Survey of Uzbekistan, in: Eurasian Geography and Economics, 49, 481-505.

ILKHOMJON ASLANOV

DUST STORMS, DUST TRANSFER AND DEPOSITIONS IN THE SOUTHERN ARAL SEA REGION

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1 INTRODUCTION

Aeolian processes as manifested by dust and sand storms (DSS) are natural events that occur world-widely in arid regions (Orlovsky et al 2009). The vast distribution and existence of desert landscapes indicates that these regions are a very important source of dust storms in historical time but in more recent times the action of humans has created another source on the desert margins in semi-arid areas that previously were stable (Youlin et al 2001). Dust storms are the type of natural disaster which is most likely to occur in arid and semiarid regions in the world, such as central and eastern Asia, the Sahara Desert and some regions in Australia, North America and elsewhere. It is believed that there are two major factors which influence dust storm formation: one is the surface conditions which have been identified to play an important role in sand and dust material source in the deserts and poorly vegetated areas in the world (Sun&Zhao 2008). High solar radiation and evaporation, high risks due to wind and water erosion caused by the above mentioned relief and soil conditions, high mineralization of both surface water and ground water, the scarce vegetation cover as well as the nearly year round deficit of soil moisture – all are natural factors for desertification is such a crucial factor (Opp 2005). Although Asian dust's significant environmental and social impacts during its transport process has stimulated a concerted research effort to better understand its transportation characteristics, progress in understanding dust transport from individual key dust source areas has remained limited. Dust transport also has considerable impact on human society if highly populated regions are on the transport pathway. Dust transport can bring pollutants into residence areas (Gao &Washington 2010). The quantitative prediction of dust storms is impossible unless the entire dust cycle, consisting of dust emission, transport and deposition, can be correctly predicted. In recent years, dust emission schemes have been developed that account reasonably well for the impacts of atmospheric forcing and land-surface properties on dust emission (Sun&Zhao 2008). An area's potential for dust storm generation is related to its climate (its precipitation patterns, prevailing wind direction and speed, and normal location of low- and high- pressure centres). The world's arid desert and semi-arid climate zones correlate with the major deserts. Sand and dust storms are frequent in Central Asia because of semi-arid areas. (Groll et al 2009). (Fig.1)

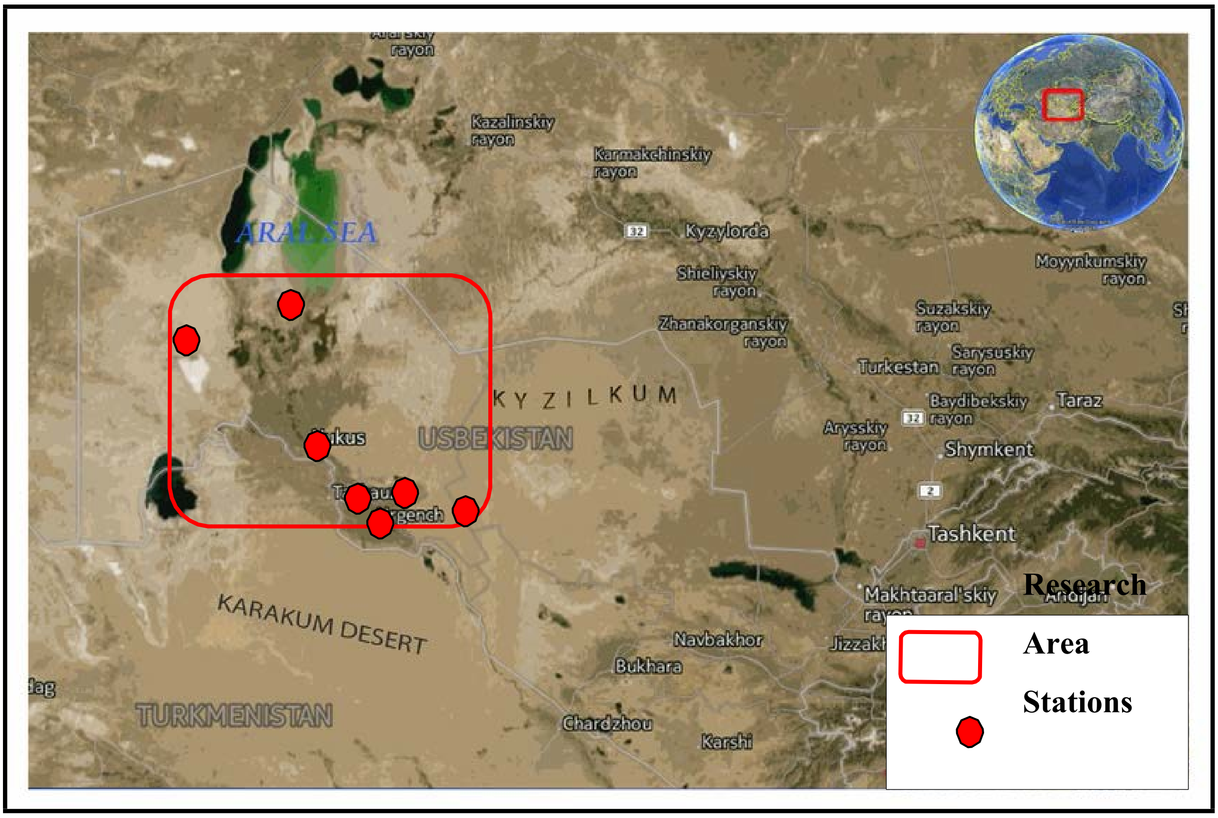

Fig. 1

The main factors of dust storms rise are recurrence of strong winds and vast area of dust emission sites, where the latter is the subject of change. During the last decades owing to the crisis situation in the Aral region the total area of dust emission sites increased significantly because of the shrinking of the Aral Sea and consequent drying of its exposed bottom and deltaic areas of Amudarya and Syrdarya Rivers (Orlovsky et al 2004).

2 PROBLEM SETTINGS AND OBJECTIVES

The Aral Sea problem has formed by the relations between humanity and nature and human attitude without affection by seeking to development to the environment. During the one generation life the Aral Sea had already dried and there is a desert instead of it. Under conditions of the Aral Sea ecological crisis, natural ecosystems within a 400 km radius of the seashore have undergone transformations. In region of Aral Sea crisis cause many problems depends and affects each other (Fig. 2).

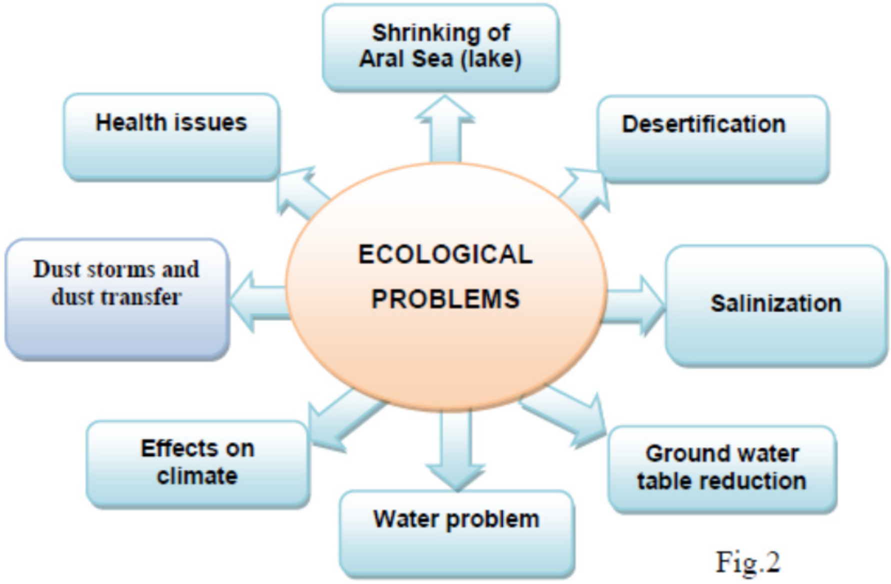

Fig.2

In my research I point out one problem in this region dust storms and dust transfer. The aim of this research approach is to analyses spatial and temporal distribution of dust deposition in the southern Aral Sea region. Dust occurrence and its effects lead to the modification of the mineral structures of the arable land. Productive soils are degraded and salinized, the agricultural productivity is decreasing. study the influence of negative chemical elements in soil.

3 MATERIALS AND METHODS

The spatial and temporal distribution of the dust deposition was analyzed using passive deposition sampler installed in 7 stations in the region. The sampler design was longevity required for long-term measurement program. Each sampler consists of a plastic tray (diameter 23cm) as dust and sand sink, filled with artificial grass. (Fig. 3) A soil sample was collected in field work 2011, in 6 stations. It was taken 3 soil levels (Fig.4). Meteorological data's collected 7 stations include temperature, precipitation, wind direction, wind speed and dust storms.

The dust samples were weighed using a precision scale with an accuracy of 0.0001 g. the grain size distribution was analyzed by means of microscopic grain size counts (analyzing for representative subsamples per dust sample using 0.2 g of sample material).

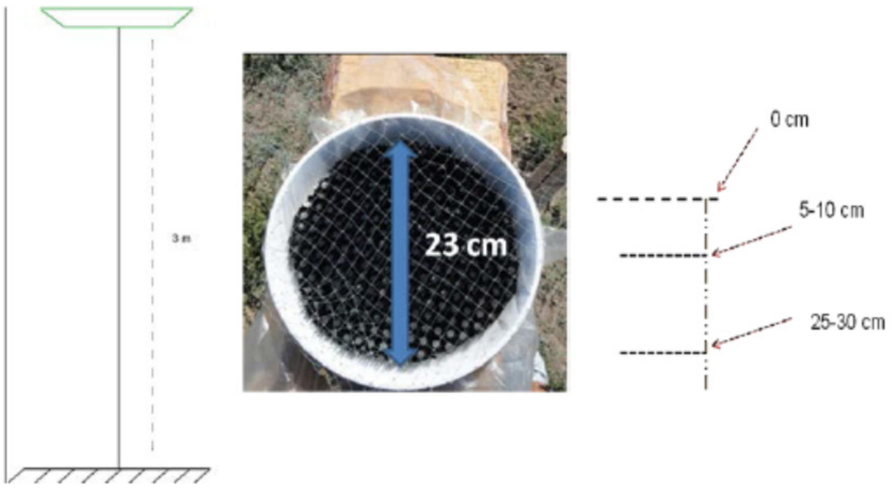

Fig.3

Fig.4

4 RESULTS AND CONCLUSION

An analysis by sampling station reveals much more deposition of dust.

Average dust deposition in Buzubay was around 1000 kg per hector in year around and there are more effect Kyzylkum. On the other hand, other 3 stations were more affected by Aralkum (Drybed). The most distribution of dust lasts 7 month (April to October) in a year. (Fig. 7)

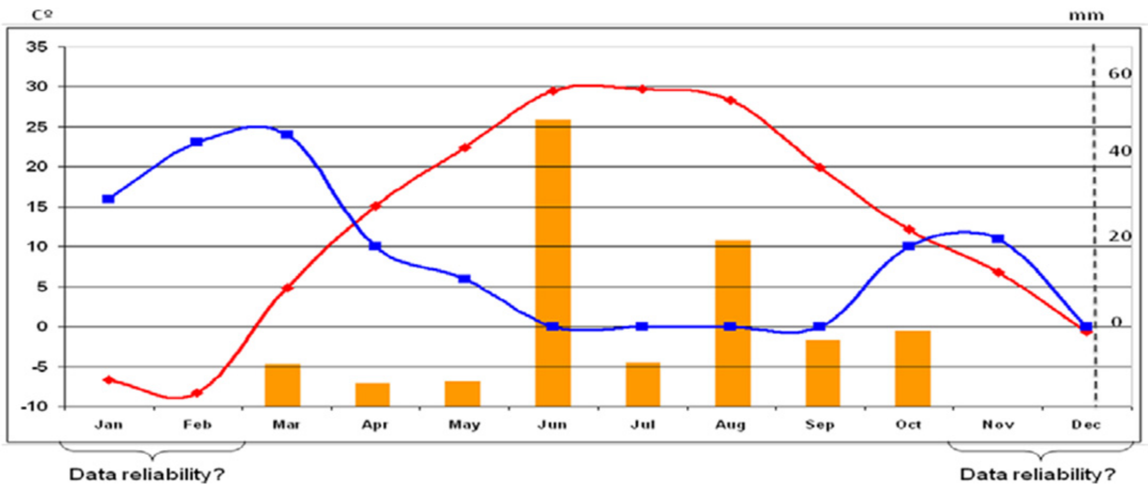

Fig. 7

The grand size distribution of the collected dust samples are also very different in Buzubay station (75 % medium silt (0.002 – 0.00063 mm) and other 3 stations were more effected by Aralkum. Jaslyk 55 % coarse, medium, fine sand (2 – 0.063 mm), Muynak 50 % coarse, medium, sand (2.0 – 0.2 mm), Takhiatash 68 % coarse, medium, fine sand (2 – 0.063 mm). The results from the chemical analysis of the dust samples revealed 4 major elements HCO3, SO4, Cl and Ca. There are not big differences between stations. However, Buzubay main chemical element is HCO3, other 3 station are Cl and SO4, which means Muynak, Jaslyk and Takhiatash stations were mostly affected from Aralkum.

REFERENCES

Arnagel'dyev A.A., Kostuykovsky V.I. Eolian processes in the Aral sea Basin. // Problems of desert development 3, 2000.

Ataniyazova. A. Health and Ecological Consequences of the Aral Sea Crisis.//The 3rd World Water Forum Regional Cooperation in Shared Water Resources in Central Asia Kyoto, March 18, 2003.

Babaev A.M., Breburda J. Mapping desertification monitoring in Turkmanistan// Problems of desert development 3, 2000.

Esanov P., Amanov A. Soil ecological monitoring in Aral sea basin. // Problems of desert development. International magazine No 5.1999. Ashgabat.

Gao H. and Washington R. Transport trajectories of dust originating from the Tarim Basin, China.// *Int. J. Climatol. 30: 291 – 304* 2010.

Izrail Yu. A., Anokhim Yu.A. Monitoring of ecological climatic changes in the Aral Sea Basin. Problems of desert development 3-4, 1998.

Opp Ch. Desertification in Uzbekistan//Geographische randschau. Vol. 1, No. 2/2005.

Otajonov I.SH. Ecological situation Priaral region and it's social effect's.//Social- economic problems Priaral region and this geographic resolve. Urgench 2010.

Semyonov O.E. Falling of sandy salty aerosol on the surface of the Priaral region. Problems of desert development 3-4, 1998.

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IS ROGUN A SILVER BULLET FOR WATER SCARCITY IN CENTRAL ASIA?

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1 BACKGROUND AND MOTIVATION

Intersectoral and interstate conflicts over the use of limited water and energy resources are aggravating in all arid regions throughout the world, and particularly in the Aral Sea basin of Central Asia. Tremendous expansion of the irrigated areas to produce cotton starting from the 1960s led to a heavy dependence of the economies on irrigated agriculture. Irrigation development reduced environmental flows in the basin and caused a gradual desiccation of the Aral Sea, once the fourth largest lake in the world. The emergence of the five independent Central Asian states in the current territory of the Aral Sea Basin, after the dissolution of the Soviet Union in 1991, added new challenges for sharing basin resources.

The resume of construction of Rogun dam, with a height of more than 300 m and active storage of over 10 km³, by Tajikistan in 2008 in the Vakhsh tributary of the Amu Darya River in upstream of Nurek reservoir led to fierce intergovernmental debates. Tajikistan intends to increase its national energy security and to gradually grow export revenues from electricity generation through this project with a maximum electricity generation capacity of 3600 MW. The country argues that the construction of the dam also increases water availability to downstream regions. In contrast, downstream Uzbekistan and Turkmenistan are concerned that inappropriate operation of the reservoirs by the upstream country may substantially harm irrigation benefits that are essential for the livelihoods of the majority of the population in these two countries.

Despite many debates and controversial arguments by both parties over the results of the construction of the dam its impact of Rogun Dam on agricultural production and livelihoods in the downstream regions has not been assessed in detail. This study uses an integrated hydro-economic model to address the potential impact of Rogun Dam on downstream water availability and irrigation benefits.

2 METHOD

Datasets used in the model are based on different sources, including national statistical reports and the databases of the previous studies. Particularly, data on river flows, regional water uses, cropland areas, and crop yields are based on the CAREWIB database (SIC-ICWC 2011). Reservoir topological parameters and their production and storage volume parameters are based on the databases of previously developed models, such as ASBOM (SIC-ICWC 2003) and EPIC (McKinney and Savitsky 2001). Crop production data were derived from reports by governmental organizations (SIC-ICWC 2008).

River simulation and crop production optimization models are combined using an integrated hydro-economic model following previous integrated river basin models for the Maipo (Cai et al. 2006) and Mekong River basins (Ringler 2004). The model allows analyzing water allocation among different sectors and regions over different seasons and is based on optimization of overall gains from irrigation, power production, and environmental systems across the Amu Darya basin. Flow data that reflected a normal water year are used for the base simulations. Based on data availability, all prices are estimated at the levels of 2006.

3 RESULTS

According to our results, the construction of Rogun Dam has negligible impacts on water releases to downstream areas if all riparian countries strive for optimal basinwide benefits (Fig. 1). Water releases from the Nurek reservoir to downstream irrigation needs may decrease slightly but without considerable impact on irrigation water availability. This result holds after construction is completed and the reservoir is filled and under various levels of natural water supply (river runoff). The construction of Rogun Dam irrigation may slightly decrease benefits under normal water supply and inconsiderably increase in drier years (Fig. 2). Specifically, irrigation benefits across the Amu Darya basin are expected to be about US$ 1759 million without the Dam and US$ 1744 million with the Dam under long-term average water supply. Under reduced water supply (80% of normal), irrigation benefits are anticipated to be US$ 1474 million without the Rogun Dam and US$ 1507 million with the dam.

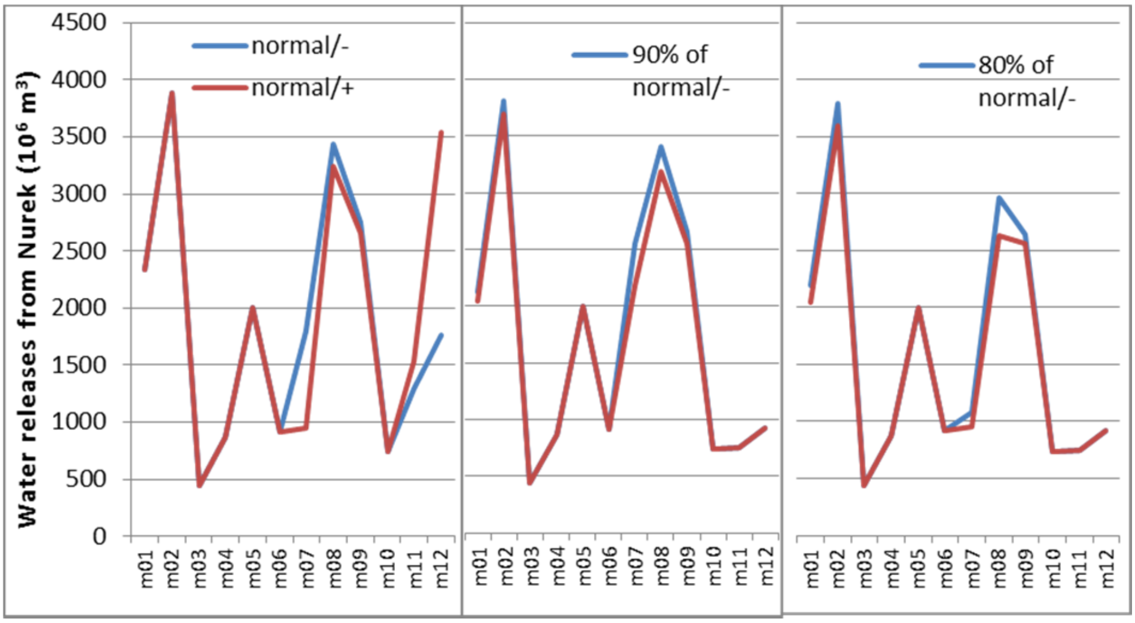

Figure 1. Downstream monthly water releases from the Nurek reservoir in the Amu Darya River under various levels of water availability

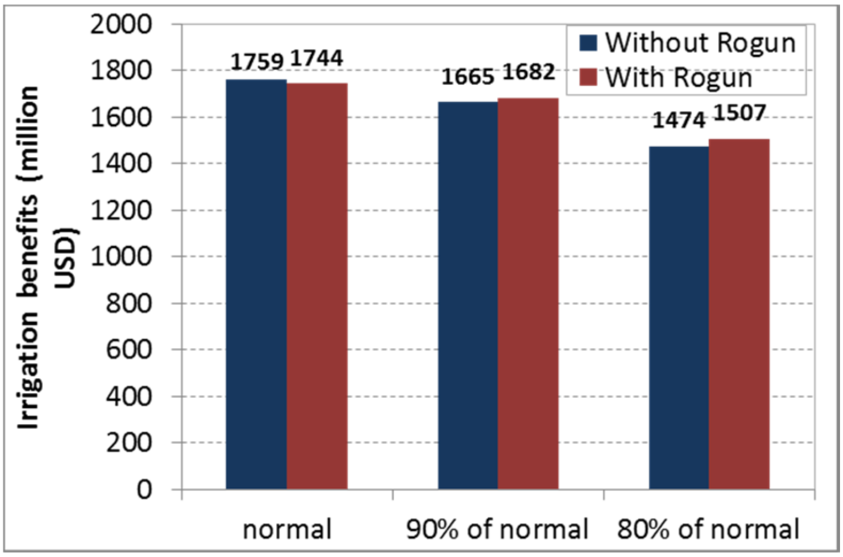

Figure 2. Irrigation benefits with and without Rogun Dam under various levels of water availability

While the construction of Rogun Dam does not impact irrigation considerably, it substantially improves power production levels and benefits (Figure 3). Power production benefits in the Amu Darya basin may increase from US$ 395 million to US$ 557 million under average water flows. Under 80% of normal water supply, power generation benefits are lower but the construction and operation of the dam increases the benefits from US$ 320 to US$ 429 million. (Electricity prices are varied between US$ 0.03-0.05 per m^3 in summer months and US$ 0.05-0.07 per m^3 in winter months.).

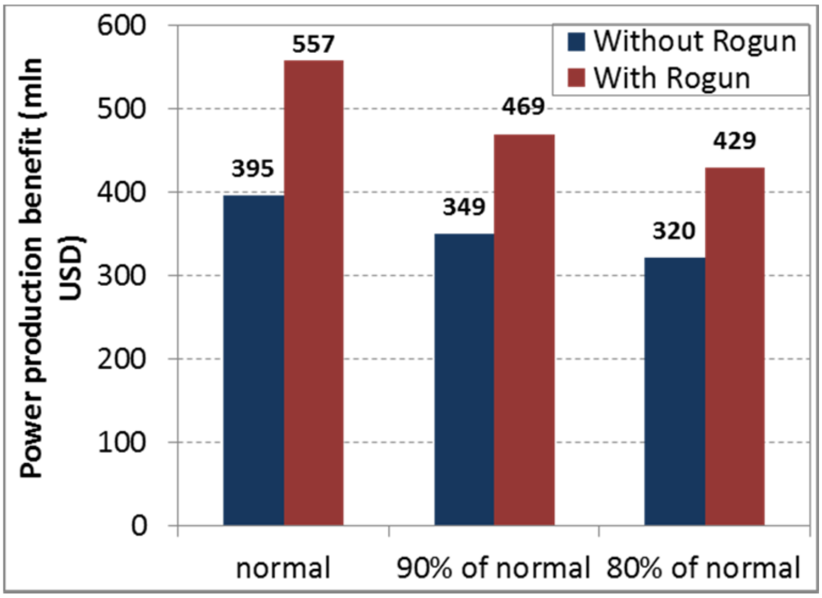

Figure 3. Power production with and without Rogun Dam under various levels of water availability

4 CONCLUSION

The construction of Rogun Dam has negligible impact on downstream irrigation if the reservoir is operated to maximize basinwide benefits. At the same time, the new reservoir can significantly improve energy security and somewhat ameliorate adverse impacts from low flows in dry years. As such, the construction of Rogun Dam is not a silver bullet for water scarcity but can significantly alleviate the energy deficit in the Amu Darya basin. A comprehensive assessment of the advantages and disadvantages of the construction of the Dam requires additional, long-term impact analyses, which would assess alternative dam filling options, as well as operation rules that only maximize hydropower production to the possible detriment of downstream irrigation benefits in the basin. Under such consideration, Rogun Dam might turn out to be considered rather more explosive than any silver bullet might have indicated.

REFERENCES

Cai X., C. Ringler, and M.W. Rosegrant, 2006. Modeling Water Resources Management at the Basin Level: Methodology and Application to the Maipo River Basin. IFPRI Research Report 146. IFPRI, Washington DC, US

McKinney D.C., and A.G. Savitsky, 2001a. EPIC Modeling System Guided Water, Salt and Energy Management Problems. Available from: http://www.ce.utexas.edu/prof/mckinney/ papers/ aral/EPIC/EPICmodel.html.

Ringler, C., Huy, N.V., 2004. Water Allocation Policies for the Dong Nai River Basin in Vietnam: An Integrated Perspective. EPTD Discussion Paper No. 127. International Food Policy Research Institute, Washington DC.

SIC-ICWC, 2003. The database of the Aral Sea Basin Optimization Model (ASBOM). Excel file. Tashkent, Uzbekistan.

SIC-ICWC, 2008. Crop production costs and revenues across the regions of Uzbekistan in 2006. Unpublished database. Tashkent, Uzbekistan.

SIC-ICWC, 2011. CAREWIB (Central Asian Regional Water Information Base) database. SIC-ICWC, Tashkent, Uzbekistan.

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ASSESSING THE RECENT GLACIER RETREAT IN CHON AND KICHI NARYN CATCHMENTS, KYRGYZ REPUBLIC

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1 ABSTRACT

The spatial pattern of glacial retreat in Central Asian highlands are more intensive in last decades and impact on water resources are noteworthy in arid regions of Kyrgyz Republic. This research is an effort to assess the recent glacial retreat in Chon and Kichi Naryn catchments. The study conducted for period of 45 years (1965-2010) using 1:25000 scale topographic maps and ALOS/AVNIR satellite imagery shows that glacier area decreased by 21.3% in total. The dramatic changes have happened in south-facing glaciers than north facing glaciers with areal loss of loss of 23.6% and 19.8% respectively. The accelerated changes in glacial retreat will have compounding effect on shortage of water in densely populated areas and also increase in frequencies glacial induced hazards.

2 INTRODUCTION

The issue of water availability and the probable potential effects of climate change on water resources are of paramount importance to arid and semi-arid regions of Central Asia. In the last decade the consumption of water increased exponentially at regional and local level, which will further turn water supply security as major challenges to these countries the supply initially will be affects by accelerated shrinkage of glaciers threatened by climate crisis in upcoming days. Majority of the catchment area of the region fall within irrigation (Report of Eurasian Development Bank, 2009) and water demand in this region will increase in connection to food and energy security will further intensify the water war between the states in the region. Expected decrease in glaciers will lead to reduction in river runoff in summer resulting in deficit of water in Central Asian region. The stable retreat of modern glaciations happens because of global warming and ambiguous change of precipitations in high-altitude zone of Tian-Shan. There are few research yet done on comprehensive understanding and evaluation on current state of glaciers in Central Asian region. The present study aim is to fill this knowledge gap in Central Asian region while contributing contribution to recent retreat of glaciers due to climate change in Naryn basin.

3 DATA AND METHODS

The satellite imagery was acquired during ablation period with minimal cloud cover were used in the study to reduce potential uncertainty in glacier mapping. The boundary and termini positions were delineated 1:25 000 topographic maps based on aerial photography collected in 1960s and ALOS AVNIR-2 satellite data sets during 2008 – 2010. The topographic maps were scanned at 700 dpi and digitized contour interval and identified spot heights were used to produce a DEM (Digital

Elevation Model) for the study area. The remotely sensed images were co-registered and orthorectified using the corrected topographic maps. ALOS/AVNIR-2 (70×70 km) were used consists of four bands from a visible to near-infrared radiometer with a spatial resolution of 10 m (JAXA, 2009). The ALOS data was ortho-projected using topographic map (1:25,000) and Shuttle Radar Topography Mission (SRTM3. The data was further rectified by using 50 ground control points, evenly distributed across the image.

The outlines of glaciers were extracted manually using visual interpretation of pan-sharpened ALOS (AVNIR-2) images (2008–2010) at high resolution (10 m). The areas of the extracted glacier polygons were computed using ArcGIS 9.2 resulting in a total sample size of 15 glaciers in the Akshyirak massif, 126 in the Borkoldoy, 130 in the Jetim, 89 in the Jetimbel, 80 in the Naryn, 41 in the Sook, 95 in the Terskey (south slope glaciers) and 78 in the Uchemchek mountain ranges. Validations of some glaciers were done during field visit from 2010 to 2012 by using GPS ground check points.

4 RESULTS

Characteristics of glacier distribution

The characteristics of glaciers distribution in the study area was analyzed by finding the statistically relation between topographic parameters (mean, min., max. elevation, area size class, slope, aspect) and extracted and delineated glacier polygon data from ~2010. Majority of the parameter have clearly shown the evidence of regional characteristics of glacial distributions. For example, the relation of glaciers' area and aspect demonstrates the tendency of majority of large glaciers to be concentrated in northern aspects. Thus, 513 glaciers with areas of 435.2 km^2 that account for 74.3% of the total area are located in the three sectors, northwest, north, and northeast.

The distribution of glaciers classified according to area class (0.1-0.5 km^2, 0.5-1 km^2, 1-2 km^2, 2–5 km^2, >5 km^2) for eight mountain ranges from 1965 to 2010. In three mountain ranges, the distribution of each glacier size class is almost similar: glaciers with areas of less than 1 km^2 occupy 78% of the Jetimbel mountain, 86% of the Naryn mountain, and 84% of the Sook mountain and no glaciers are larger than 5 km^2 (Table 1). In the Akshyirak mountain, small glaciers with areas less than 1 km^2 occupy 11.5% and larger glaciers more than 5 km^2 occupy 48% of the total investigated glacier area. In other the Borkoldoy, Jetim, Terskey and Uchemchek mountain ranges, the distribution of glacier size classes nearly similar: glaciers with area of less than 1 km^2 occupy from 39% to 50%, and larger than 5 km^2 glaciers occupy from 14% to 28%. The unusual distributions of glacier-area are found in the Borkoldoy mountain (5170 m), in the Terskey mountain (4840 m) and in the Jetim mountain (4825 m) and lowest glacier located in Uchemchek mountain range (3510 m). The average height of glaciers found in the study region is 4223.

Table 1. Derived glacier parameters (~2010) for the eight mountain ranges

Study area		Akshyi-rak	Borkol-doy	Jetim	Jetim-bel	Naryn	Sook	Terskey	Uchem-chek
Area (%)	0.1 – 0.5 (km^2)	2	11	15	24	46	14	18	19
	0.5 – 1 (km^2)	10	27	30	54	38	72	22	30
	1 – 2 (km^2)	18	14	6	17	0	14	8	24
	2 – 5 (km^2)	23	26	29	5	16	0	24	13
	5 > (km^2)	47	22	20	0	0	0	28	14
Aspect (%)	N	2	32	48	55	39	58	3	40
	NE	0	20	15	16	33	16	7	12
	E	0	0	2	6	4	6	9	0
	SE	0	5	5	0	0	4	39	0
	S	0	2	1	0	0	0	32	0
	SW	9	2	3	1	0	6	3	0
	W	9	8	2	2	6	4	2	14
	NW	80	31	24	20	18	6	5	34
Number of glaciers measured		15	126	130	89	80	41	95	78
Glacier in ~1962 (km^2)		39.9	142.0	125.1	58.7	33.3	31.4	91.0	64.0
Glacier in ~2010 (km^2)		32.9	112.5	97.8	44.3	23.6	24.9	71.9	52.6

5 CHANGES IN GLACIER AREA FROM ~1965 AND ~2010

The retreat of glaciers extracted from repeat satellite imagery were marked everywhere in upper Naryn basin since ~1965. This fact is derived from the feature of glaciers' form as well as by repeated observation, moreover comparison of remote sensing data of different years. In short span of time period approximately 1965 to 2010 total areas of the 654 studied glaciers had decreased by 21.3% of the value from 585.4 to 460.5 km^2. The glacier area decreased by 17.4% in the Akshyirak mountain, 20.8% in the Borkoldoy, 21.9% in the Jetim, 24.6% in the Jetimbel, 28.9% in the Naryn (North slope glaciers), 20.8% in the Sook, 20.9% in the Terskey (South slope glaciers) and 17.8% in the Uchemchek mountain ranges (Figure 1), and the greatest decrease in areal extent of studied glaciers was in the Naryn mountain (28.9%), followed by the Jetimbel (24.6%) and Jetim mountain range (21.9%).

Thus, total percentages of glacial loss in study area are to be further investigated in changes in the different size classes. The small glacial areas are sensitive to microclimatic changes and local glaciological factors (Jóhannesson et al., 1989; Kuhn, 1995; Nesje and Dahl, 2000). The relative abundance of glaciers in the different size classes strongly affects on the total percentage glacier area loss. About 89% of glaciers are less than 1 km^2 in area. Regions dominated by small glaciers are generally more sensitive to change because of the shorter response time to climate variability for small glaciers (Bahr D et al., 1998). In fact, comparing glacier size classes and glacier shrinkage, the Naryn mountain range, with its many small glaciers (<1 km^2) experienced large glacier shrinkage (28.9%). In contrast, the Akshyirak mountain has many large glaciers (>5 km^2) and glacier shrinkage was smaller (17.4%).

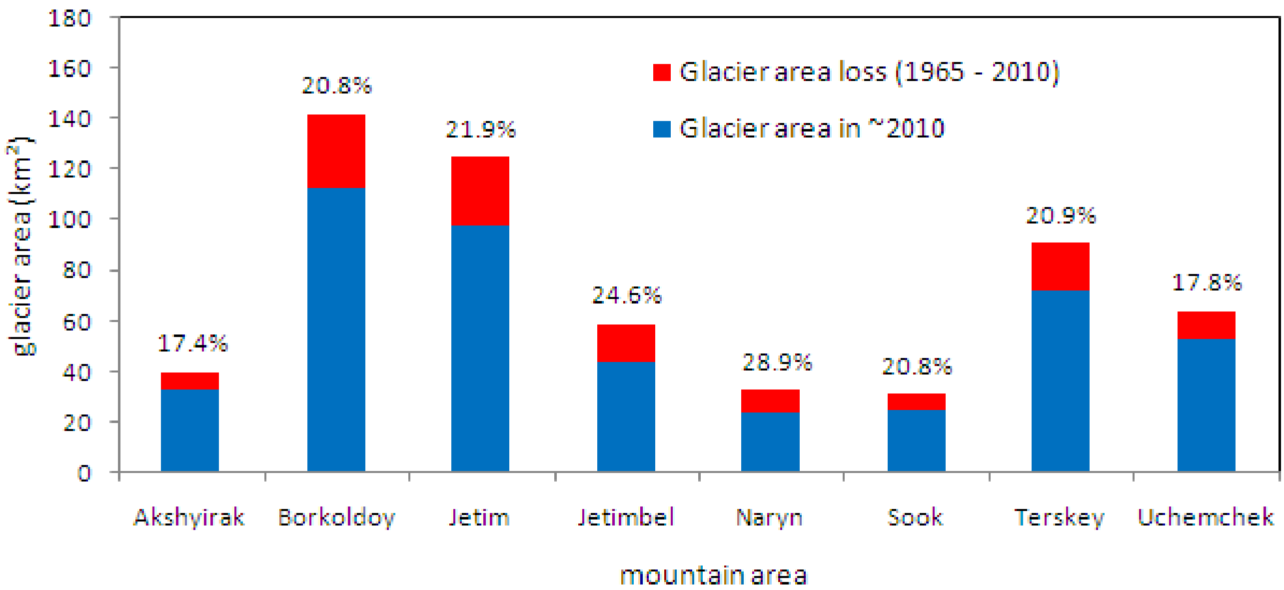

Figure 1. Changes in total glacier area in eight mountain regions for ~1965 and ~2010

There are also dramatic differences marked in the changes between glaciers located on the northern and southern slopes. The northern slope having 513 glaciers decreased in total area by 19.7% and while the 78 glaciers found in southern slopes reduced in total area by 24.1% between. The first reason is more direct solar radiation in southern slopes in the study region which is favourable for glaciers' ablation. And second cause is mountain's asymmetry nature (Glacier Inventory of the USSR, 1977). Generally southern slope should have shallow steepness as northern slope but there are long flanks in southern slopes. This local typical configuration of southern slopes will contribute to formation of larger glaciers but such types of glaciers' area are subjected to more ablation leading to large loss of area in the study region.

6 CONCLUSION

Glaciers of the Chon Naryn and Kichi Naryn basins decreased significantly in area between ~1965 and ~2010 with the total glacier retreat of 21.3%, due to increasing summer temperatures. The above glacial shrinkage is due to variation in regional climate and distribution of different size of glaciers according to elevation. The largest glacier shrinkage occurred in the Naryn range (28.9%), because of dominating small-scale glaciers and with north facing slopes. The strong glacial retreat can produce large quantities of water in short time period may cause hazard in down-stream area, and continuing glacier shrinkage will be the cause deficiency of water and energy in the region. The present state of glaciers are to be evaluated and monitored scientifically for reasonable development and utilization of regional water resources, water cycle models and regional economic planning. Hence more detail research are needed to validate the calculation made here with help reliable glacier field data. More simulation and projection are needed to understand trend of climate change and their impact on glacier properties and runoff variability.

REFERENCES

Agrawala, S., Barlow, M., Cullen, H., Lyons, B., 2001. The drought and humanitarian crisis in central and southwest Asia: a climate perspective of climate, IRI Report. http://iri.columbia.edu/outreach/publication/irireport/SWAsia/index.html.

Aizen, V.B., Aizen, E.M., Melack, J.M., 1995. Climate, snow cover and runoff in the Tien Shan. Water Resources Bulletin 31 (6), 1–17.

Aizen, V.B., 2002. Paleoclimatic and glaciological reconstructions in Central Asia through collection and analysis of ice cores and instrumental data in the Tien Shan and Altai Mountains DOE/INEEL *Technical Report*

Bahr, D. B., Pfeffer, W. T., Sassolas, C., et al. Response time of glaciers as a function of size and mass balance: 1. Theory. J Geophys Res, 1998, 103: 9777–9782

Bolch, T., 2007. Climate change and glacier retreat in northern Tien Shan (Kazakhstan/ Kyrgyzstan) using remote sensing data. Global and Planetary Change 56, 1–12.

Dikich, A.N., Hagg, W., 2004. Climate driven changes of glacier runoff in the Issyk-Kul basin, Kyrgystan. Zeitschrift für Gletscherkunde und Glazialgeologie 39, 75–86.

Dikih, A. N. Lednikovyi stok reki Naryn I senariy vozmojnogo ego izmenenia pri potoplenii klimata. Izvestia NAN KR. 1999 (in Russian).

Glacier Inventory of the USSR (Katalog Lednikov SSSR), 1973. Tom 14, Central Asia, V. 1, Kyrgyzstan, Part 4. Leningrad, Hydro-meteoizdat, (in Russian).

Glacier Inventory of the USSR (Katalog Lednikov SSSR), 1977. Tom 14, Central Asia, V. 1, Kyrgyzstan, Part 5. Leningrad, Hydro-meteoizdat, (in Russian).

Hagg, W., Braun, L., 2005. The influence of glacier retreat on water yield from high mountain areas: comparison of Alps and Central Asian. Climate and Hydrology in mountain areas. John Wiley & Sons, Ltd, pp. 263–275.

Hagg, W., Braun, L.N., Kuhn, M., Nesgard, T.I., 2007. Modeling of hydrological response to climate change in glacierized Central Asian catchments. Journal of Hydrology 332, 40–53.

Hagg, W., C. Mayer, A. Lambrecht, D. Kriegel, E. Azizov. 2012. Glacier changes in the Big Naryn basin, Central Tian Shan. Global and Planetary Change. GLOBAL-01857; No of Pages 11.

JAXA [Japan Aerospace Exploration Agency], 2009. About ALOS. http://www.eorc.jaxa.jp/ALOS/en/about/about_index.htm (accessed on 30 April 2009).

Johannesson, T., Raymond, C.F., and Waddington, E.D., 1989. Timescale for adjustments of glaciers to changes in mass balance, J.Glaciol., 35(121), 355-369.

Kotlyakov, V. M., 1988. Mass balance and USSR glacier fluctuations for the period from 1958 to 1985 *Data Glac. Stud.* 62 224–40, (in Russian).

Kuhn, M., 1995. The mass balance of very small glaciers. Z. Gletscherkd. Glazialgeol., 31(1–2), 171–179

Kutuzov, S., Shahgedanova, M., 2009. Glacier retreat and climatic variability in the eastern Terskey Alatoo, inner Tien Shan between the middle of the 19th century and beginning of the 21st century. Global and Planetary Change 69, 59–70.

Kuzmichenok, V.A., 1990. Izmenenie lednikov hrebta Akshiirak c 1943 po 1977 godi. Moscow, Main Deprtment of Geodesy and Cartography of the USSR, 1 map sheet in scale of 1:50,000 (in Russian).

Kuzmichenok, V.A., 2008. Digital models of humidification characteristics of Kyrgyzstan (Mathematical and cartographic modelling). Bishkek, publication of the Kyrgyz-Russian Slavic University, p. 237.

Li, B., Zhu, A., Zhang, Y., Pei, T., Qin, C., Zhou, C., 2007. Glacier change over the past four decades in the middle Chinese Tien Shan. Journal of Glaciology 52, 425–432.

Narama, C., Kääb,A., Duishonakunov, M., Abdrakhmatov, K., 2009. Spatial variability of recent glacier area changes in the Tien Shan Mountains, Central Asia, using Corona (1970), Landsat (2000), and ALOS (2007) satellite data. Global and Planetary Change 71, 42–54.

Narama, C., Shimamura, Y., Nakayama, D., Abdrakhmatov, K., 2006. Recent changes of glacier coverage in the western Terskey-Alatoo range, Kyrgyz Republic, using Corona and Landsat. Annals of Glaciology 43, 223–229.

Nesje, A. and Dahl, S.O., 2000. Glaciers and environmental change. Key issues in environmental change. Arnold, London and New York. 203 pp.

NSIDC, 1999. World Glacier Inventory. National Snow & Ice Data Center, Boulder, CO. Nye, J.F., 1952. The mechanics of glacier flow. Journal of Glaciology 2, 82–93.

Olyphant, G.A., 1986. Longwave radiation in mountainous areas and its influence on the energy balance of Alpine snowfields. Water Resources Research 22, 62–66.

Paul, F., Kääb, A., Maisch, M., Kellenberger, T., Haeberli, W., 2002. The new remote-sensing-derived Swiss glacier inventory. I. Methods. Annals of Glaciology 34, 355–361.

Report of Eurasian Development Bank. The impact of climate change on water resources in Central Asia. 2009. 43 p. (in Russian)

Wenbin, W., Kaiming, L., 2011. Monitoring Glacial Shrinkage Using Remote Sensing and Site-Observation Method on Southern Slope of Kalik Mountain, Eastern Tian Shan, China. Journal of Earth Science. Vol. 22, No. 4, p. 503–514.

I. RADCHENKO, I. FORKUTSA, L. BREUER AND H.-G. FREDE :

HYDROLOGICAL MODELLING IN ARID CATCHMENTS WITH DATA SCARCITY (FERGHANA VALLEY, CENTRAL ASIA)

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ABSTRACT

With the global warming it is essential to study water resources in the arid regions like the Ferghana Valley (~79,000 km² with surround highland) in Central Asia, where agricultural production heavily depends on irrigation. Main water resources for irrigation are currently provided by the Naryn and Karadarya river systems. The surrounding mountainous areas of the valley with their large glacial water storages play a big role in the annual water balance of these rivers. The decrease of glaciers due to the global temperature rise will most likely lead to the runoff reduction. An impact analysis of the climate change on the water resources is of utmost importance both for economic as well as ecological issues in the region.

The overall objective of the study is to estimate the relative contribution of small-sized catchments with mainly precipitation driven runoff (in total 19 catchments) and the large Naryn and Karadarya rivers which are dominated by glacial melt water to the Ferghana Valley water balance under current and future climatic conditions. Any future model-based prediction of the water resources availability is depended on a thorough understanding of the hydrological cycle under current conditions. Therefore, the aim is at investigating the water balance of the small surrounding catchments using the conceptual HBV-light model. In this study it is shown the model setup for the Kugart River (1,010 km²), Kurshab River (2,010 km^2), Akbura River (2,260 km²) and Shakhimardan River (1,180 km²) catchments in Kyrgyzstan. Model setup is highlighted especially in the view of data availability limitations. Thus, the MODAWEC model that calculates daily meteorological data from monthly is applied for the four studied catchments (the correlation coefficient for generated and measured average temperature varies from 0.84 to 0.91). The HBV-light model is employed successfully for measured allocated climate data and generated (temperature) allocated data to the central part of the basins with the Nash-Sutcliffe efficiency coefficient (NSE) both for calibration (1980-1983) and validation (1984-1985) periods in the range of 0.50 to 0.89 for the studied basins. The acceptable parameter sets for the model after using of threshold (NSE $\geq$ 0.50, NSE log $\geq$ 0.50, and the difference in annual water balance $\pm$ 20 mm) ranges from 21 to 558. Thus, the hydrological modelling using generated meteorological data and the HBV-light model will be applied for the remaining 15 small catchments that discharge into the Fergana Valley. And for the assessment of climate change impact on the water resources in the Ferghana Valley it is planned to apply the different climate change scenarios in the near future.

TSYCHUYEVA, NATALYA [1]; OTTE, ANNETTE [2]; SPIVAK, LEV [1]:

THE ANALYSIS OF LAND COVER CHANGES IN MOUNTAIN REGION USING REMOTE SENSING DATA

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1 PROBLEM STATEMENT

Livestock is one of the priorities of agricultural production in Kazakhstan and Central Asia as a whole. Kazakhstan is the five world leaders by area of rangeland resources. Pastures occupy more than 70% of the country and are a unique potential for the development of economy and environmental sustainability. Therefore, the issue of security feeding lands and their quality is important. During the planned economy mountainous territory used as summer pastures – dzhaylyau, often these areas were overgrazed and complete degraded. A similar situation was in 1990, when the territories near the villages were completely shot down, and in other hand, distant pastures and hay fields are not used at all. Pastures degraded by unregulated grazing, loss of irrigated pasture, exemptions for industrial facilities, landfills and human settlements, lack of control over the condition and use of pastures, non-land laws and other reasons [1]. Such drastic changes in land use could affect to phytodiversity of pastures and their nutritional value.

The art production of the problem of obtaining information on the state of the land cover is solved with using remote sensing techniques to quickly get enough information about the full range of condition and productivity of pasture ecosystems. Nowadays, remote sensing, as a method of rapid and large-scale monitoring of agricultural land, not has an alternative. Therefore, the development of methods of application of space data to assess and food supply is today an urgent task.

The purpose of this study is to investigate phytodiversity of mountain pastures, as an indicator of socio-economic changes, using remote sensing data.

As the region of research was chosen the mountainous part of Karasay district of Almaty oblast. This area was used as a summer pasture for sheep and cattle, and horses grazing. The animals were driven out from the flat part of the Almaty oblast. Since 1996, part of the mountainous territory belongs to the Ile-Alatau National Park. This area became more interesting for research, cause of possibility to observe the consequences of changes in land use and track the direction and speed of natural revegetation.

2 METHODOLOGICAL APPROACH

Research is aimed to address the following questions:

What are the temporal and spatial changes in land cover of a mountainous region in Central Asia during last 30 years? How are changes in land cover connected to phytodiversity? What are the drivers of land cover and phytodiversity changes?

Methodological concept of the research project consisted of three main phases: (I) developing a landscape classification and definition of the spatial changes in land cover, (II) validation of classification and modeling changes of phytodiversity, and (III) analysis, which is the cause of such changes and interactions between ecological and social processes.

The studies will develop recommendations for the sustainable land use and the decision to use this method in other mountain regions of Central Asia.

GIS of the project was created with the involvement of all possible geographical material for the study area. For development GIS we used ArcGIS 10.0 software from ESRI Company. In the process of conducting scientific research and practical work in the project area GIS database is continuously replenished.

The geodatabase contains a variety of their characteristics and purpose data: raster, vector, grids, and statistical tables. Raster data includes cartographic material and satellite images. Thus, the database contains topographic maps of the 1980s, the scale of 1:200 000, 1:100 000 and 1: 50 000. Thematic maps of the 1970s and 1980s: a map of soils and geobotanical maps of scale 1: 100 000. As the data for digital elevation model (DEM) we used SRTM model established in 2000 according to data from the radar satellite [2]. The resolution of this model is 60 m, which corresponds to the DEM derived from maps of scale 1:100 000.

The next step of our research was to determine the basic habitat types, based on the physical location data: the elevation, angle and slopes exposition. Background information was obtained on the basis of the SRTM digital elevation model. Using the extension module Spatial Analyst in the ArcGIS 10.0 software we calculated the basic parameters of the ground to the center point of each pixel (60m * 60m), as well as additional parameters, such as eastness and northness, showing the relative location of the slope of the northern and eastern direction. All data were recorded after the calculation in a single table using an Extract Multi Values Tool. Data from landcover maps has also been entered in each point. The whole process of calculation was built in Model Builder module and represents the following sequence. These calculations allowed us to create a single database with information on the physical parameters of the terrain and land surface at each pixel.

The use of cluster analysis in software Statistica 10.0 it possible to identify the 7 most significant clusters, taking into account all the possible combinations of different angles, heights and slope exposure, and then based on them to create a map of unique spatial sites. The resulting spatial sites represent the most important differences in the topography of the area.

The purposes of our study include the establishment of a unified methodology to use satellite imagery and digital elevation model data for the period of 30-40 years. In this regard, we tried to find the same characteristics of satellite imagery and make them a similar transformation. In our opinion Landsat satellite imagery best suited for this task, the data also are in a free catalog on the official website of the NASA [3]. The basic principles that we follow - is to use public and, if possible free data, which is important for research in the Central Asian region.

In vegetation seasons of 1970-80 years on the territory of Trans-Ili Alatau mountain we have selected space image with a lack of cloud cover and the good quality of the scene. The image LM21610301975190AAA05 date 09/07/1975 was taken from Landsat Multispectral Scanner (MSS) with 60 meters spatial resolution and consist of four spectral bands. A similar scene was taken in 2011 from Landsat Thematic Mapper (TM) camera that stays in satellite Lansat-5. Scene number is LT51490302011197IKR01 date 16/07/2011. This image consists of seven spectral bands with a spatial resolution of 30 meters. The images have different number of channels, but they have 4 same bands, and each band is useful for capturing different land cover aspects.

Processed images were subjected to multiple stages of classification. Thus, the method of expert decoding allowed allocating urbanized areas and gardens. Then use the method of supervised classification allocated classes of glaciers, water bodies, forests and shrubs. Calculating of vegetation index NDVI (Normalized Difference Vegetation Index) allowed dividing remaining area into classes with different projective cover and the amount of green biomass, like: bare soils, pastures with low, medium and high volume of green biomass. Thus, remote sensing data allowed creating "Maps of Land Cover in 1975 and 2011" with a total amount of classes 12. Thus the following classes of the underlying surface were obtained to landcover map:

«Water bodies» – this class includes moraine lakes, reservoirs and lakes; "Ice" - a class includes the glaciers and snowfields; "Rocks" - a class includes open rocks deposits, picks and cliffs; "Open soil" – plots free of vegetation, sometimes with erosion, on the slopes of low mountains and hills, also broad areas for parking at the roads; "Grasslands with low green biomass" - areas with natural herbaceous vegetation cover used for grazing and hay with a projected cover (20-50%); "Grasslands with high green biomass" areas with natural herbaceous vegetation cover used for grazing and hay with a projected cover (50-100%); "Solid bushes" - class includes continuous shrubs of wild rose and spirea in the middle mountain, junipirus cover shrubs in alpine areas; "Forest" - includes a pine forest on the slopes of middle mountains and deciduous forest along the river floodplains; "Arable land" - cultivated fields; "Settlements" - settlements, cottages and individual buildings; "Cloud cover and shadows".

The result is shown in Figure 1.

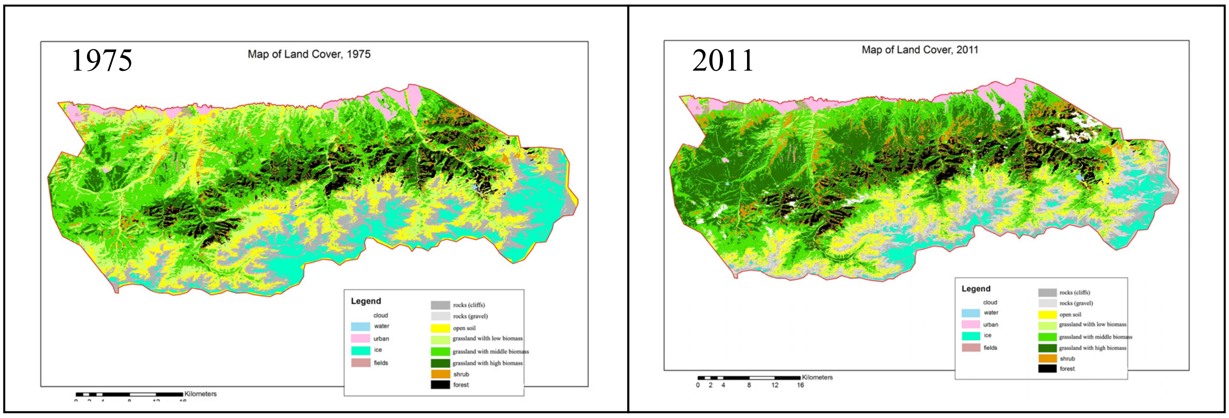

Figure 1 - Maps of Land Cover in 1975 and 2011based on remote sensing data

Verification carried out by the classification of satellite imagery in 2011 by ground-based data from field work, as well as by high-resolution satellite image GeoEye. The area covered by satellite imagery includes the most of classes of landcover map. Boundaries of classes from Landsat images are aligned with the boundaries of classes dedicated by expert detected method. Checking the interpretive features of different classes based on thematic processing of remote sensing data has confirmed the basic criteria for recognition of these territories. According to the materials of field work in July 2011 (50 points) the following conformance was taken. Accuracy assessment of the following classes: 100% - forest, 81% - class of shrubs, 95% - accuracy of the rocks. Total accuracy is more than 92%.

Maps of Land Cover of 1975 and 2011 were compared and as a result showing the changes of classes for the last 35 years. For this purpose, the method of Change Detection in software ENVI 4.7 used. According to the results of the calculations obtained table of changes in each class of units of area and percentage of the area of all classes. This information makes possible to determine the nature of changes in each of the classes, as well as create a map of class changes. Thus, half of the area of glaciers class went to a class of rocks. This confirms the fact of glaciers degradation. Territory with open soils in 1975 now covered with grasses with low biomass in 47% of the class area.

Next step, we combined the data of calculations with information about relief and got the values in which topographical clusters the landcover changes are most pronounced. In other words, in the territory with some slopes, altitude and exposure the melting glaciers is most prominent, and where it did not happen. So, this analysis forecast the territories with which topographical features land cover changes will occur in the future.

The next step was to determine the changes occurring in phytodiversity of pastures. For this we digitized geobotanical map 1985 scale 1:100 000 [4], contains the full list of dominant plants. All information has been entered into the geodatabase. The field works in the summers 2010-2011, during which were described in detail 50 points of observation. Information on the species composition at these points let us to compare with the species composition in 1985.

The studies identified the following specific changes: grain types (eg, Helictotrichon pubescen) at some points no longer dominate, and became species forming herbs, on the one hand, increases the amount of green biomass, but at the same time affects the food potential of pastures. At many sites, recorded improvement in the vegetation, which is likely due to the lower presser of grazing, as the increased role of grain grasses, special attention should be paid to Helictotrichon pubescen and fewer Ligularia macrophilla. At the same time, there are areas where there is still an intensive grazing. In such territory is marked disturbance average cover (Ligularia macrophilla and Aconitum). Also, there is a restoration of bushes. Previously, they were burned to make way for pasture grass vegetation.

3 DISCUSSION OF RESULTS

The reasons for such changes could serve a number of factors. One of the most significant in this region: changes in pressure on pastures and land use change, and climate change (taken into account components, such as precipitation and temperature).

As already mentioned the study area since 1996 belongs to the National Park, and therefore intensive agricultural activities are prohibited. However, there are some areas which are in private ownership, which still is an intensive grazing. It is in these small areas, revealed changes associated with overgrazing. On the contrary, the area affected by overgrazing in the past, now restored, has a high green biomass and could be used in the power saving mode for haying, which would increase the share of cereals in the grass and forage quality improved pastures.

Climate changes have occurred in the area in the direction of a small increase in rainfall, as recorded at the meteorological stations, and has influenced the increase of green biomass. As a whole, any changes in land use must be justified and beneficial both economically and environmentally, to maintain the stability of the area.

REFERENCES

Torehanov A.A., Alimayev I.I. Natural and sown pastures in Kazakhstan .- Almaty, 2006.- 416p

http://srtm.usgs.gov/

http://landsat.gsfc.nasa.gov

Map of grassland Kaskelen District. -M 1:100000. – 1985.

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ESTIMATION OF PHREATIC EVAPORATION IN IRRIGATION AGRICULTURE USING STABLE ISOTOPES

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1 ABSTRACT

Agriculture in the Aral Sea basin is the main consumer of water resources and due to the current agricultural management practices inefficient water usage causes huge losses of freshwater resources. There is huge potential to save water resources in order to reach a more efficient water use in irrigated areas. Therefore, research is required to reveal the mechanisms of hydrological fluxes in irrigated areas. This paper focuses on estimation of one of the crucial components in the water balance of irrigated areas - phreatic evaporation (E_p), i.e. evaporation from (shallow) groundwater - using stable isotopes of water. Our main objective was to estimate the rate of phreatic evaporation on sites with different soil texture and ground water tables (GWT) and investigate the relationship between these environmental parameters and the E_p rate. Soil samples were collected in various soil depths from irrigated areas in Ferghana Valley (Uzbekistan). The soil water from these samples was extracted via a cryogenic extraction method and analyzed for the isotopic ratio of the water isotopes (2H and 18O) based on a laser spectroscopy method (DLT 100, Los Gatos USA). A total of 18 soil profiles in fields under cotton have been analyzed. Estimations of phreatic evaporation rates were evaluated in dependence of soil texture and groundwater table. Annual amounts of water losses via phreatic evaporation were calculated between 104 to 349 mm, accounting for 35.1 % of mean irrigation water. Ep rates significantly increase with decreasing depth to GWT. There also exist difference of Ep rate between different soil texture classes with lower rates on sandy and loamy soils as and higher rates on clay. We conclude that site specific groundwater level managing can reduce phreatic losses substantially, providing an efficient and easy adaptable way to improve irrigation and leaching practices.

2 INTRODUCTION

More than 90% of the water resources in the Aral Sea basin are used for irrigation (UNEP, 2005). This excessive utilization of water resources is the major reason that led to the drying out of the Aral Sea in the past decades (Micklin, 2007). There is huge potential to save water resources and increase land and water productivity in order to reach a more efficient water use in Central Asia, and to potentially restore the Aral Sea.

Water balance in the irrigated territory of Central Asia has been in the focus of research of many scientists for many years (Amanov, 1967; Ganiev, 1979; Kharchenko, 1979; Yakubov et al., 1985; Dukhovny, 1993; Ikramov, 2000).They have investigated various water balance elements, including water intake, return flow of irrigation water into the channel and river system, evaporation, transpiration, soil moisture, and groundwater dynamics.

In recent years, a groundwater table (GWT) rise has been observed in many irrigated areas of Central Asia as a result of inefficient irrigation practices (Ikramov, 2000; Ibrakhimov et al., 2011). This has also been observed by measurements of GWT dynamics over the vegetation periods in Ferghana Valley which will be in the focus of this study (IWRM Ferghana, 2002). A rising GWT induces a rise of the capillary fringe. This dynamic largely contributes to salinization of soils where a secondary precipitation of groundwater salts occurs by the transport into the unsaturated zone. The raised capillary fringe also maintains adequate soil moisture conditions in the root zone. This is a potential positive though not intended side effect for plants which are provided with an additional water source. However, the raised groundwater table is prone to indirect evaporation loss of groundwater through the unsaturated zone, which we will refer to as phreatic evaporation (E_p) subsequently. Studies on water losses through phreatic evaporation in Central Asia remain sparse. Ganiev (1979), Ikramov (2000) and Parfenova (1982) used lysimeters for long-term monitoring of upward and downward water fluxes. Ganiev [1979] estimated that 80 - 930 mm a^{-1} of water is lost through phreatic evaporation in cotton fields at various GWT depths.

However, lysimeter studies often are invasive and costly (in case large soil columns are used) or do not represent processes over an entire soil column down to groundwater. Therefore, isotope studies with much less destructive character provide an alternative to assess phreatic evaporation. More importantly, the isotope approach allows the investigation of hydrologic processes in the vadose zone in a more integrated way.

In recent years, stable isotopes of water have been used in studies to estimate evaporation from groundwater. The method makes use of the fact that during the process of evaporation, light and heavy isotopes fractionate, e.g. light isotopes of oxygen and hydrogen evaporate earlier than heavy isotopes, thus leading to an enrichment of heavy isotopes in the soil water. The theoretical background was first established through the development of a model by Craig and Gordon (1965) which describes the movement of isotopes that evaporate from an open water surface into the atmosphere. Zimmermann et al. (1968) describe an exponential depletion of deuterium with depth in a saturated soil profile, causing a distinct signature of the isotopes in the soil column. Muennich et al. (1980) and Barnes and Allison (1983) extended this concept to unsaturated soils. Fractionation of isotopes is due to different chemical potentials of the isotope species. This difference causes a slightly increased affinity for the vapor phase for lighter isotopes (Barnes and Turner, 2006). The effect can be used to identify hydrological processes and sources. The isotopic signature in a soil column can be used to quantify the intensity of upward water fluxes and the amount of evaporation from groundwater. Brunner et al. (2008) applied the concept in an arid catchment in north-western China to estimate phreatic evaporation rates. They found that in particular for very shallow GWTs (< 0.5 m), evaporation rates equal 0.55 m a^{-1} with potential evaporation approximately 1.4 m a^{-1}.

In this study we want to refine our knowledge of water losses through phreatic evaporation in agricultural areas in Uzbekistan. We make use of the stable water isotope approach that has the advantage of providing an integrated measure over relatively long periods of time. The aim of our study is to investigate the spatial patterns of the phreatic evaporation rate on irrigated cotton fields in Ferghana Valley. In specific, we want to quantify the relationship between various environmental parameters such as soil texture and groundwater table to the phreatic evaporation rate. The results will be essential for water management planners in order to allow a more sustainable use of irrigation water in the area.

3 METHODS

3.1 Study area

Our sampling sites are located in Ferghana Valley, Uzbekistan (Figure 1a). Ferghana Valley represents an intermountain depression surrounded by the Tien-Shan and the Alai Mountain Ranges. The valley is approximately 300 km long from west to east and up to 150 km wide from north to south, forming area of 22,000 km² (Maksudov and Abdullaev, 2001). The continental climate conditions in the region are characterized by a mean temperature of 27°C in July and -1.3°C in January (Chub 2007). The mean annual precipitation in this region is 150-200 mm (Chub 2007), while potential annual evapotranspiration is approximately 850-1200 mm (Chub, 2007). The Ferghana Valley is drained by the Syr Darya River (Figure 1b) and numerous mountain streams that are fed by glaciers in the mountains (Horst et al., 2005). The Great and the North Ferghana Canals deliver water from Kara Darya and Naryn to areas situated north and south of the Syr Darya (Figure 1b). Their waters are used for irrigation. The mean annual gross irrigation amount varies between 270 and 880 mm, and depends on soil type and GWT (Legostaev and Mednis, 1971).

The study area is located within a proluvial plain (Stulina et al., 2005) where the soils were formed from material which was washed down from the mountains (Jefferson, 2004). The prevalent soil types of the region are grey soils, which are heterogeneously layered, mainly light textured, gypsum-bearing and contain high contents of carbonates (Stulina, 2002). The particle sizes span the whole range from clay to sand with the dominant grain sizes in the lighter fraction (Stulina, 2002).

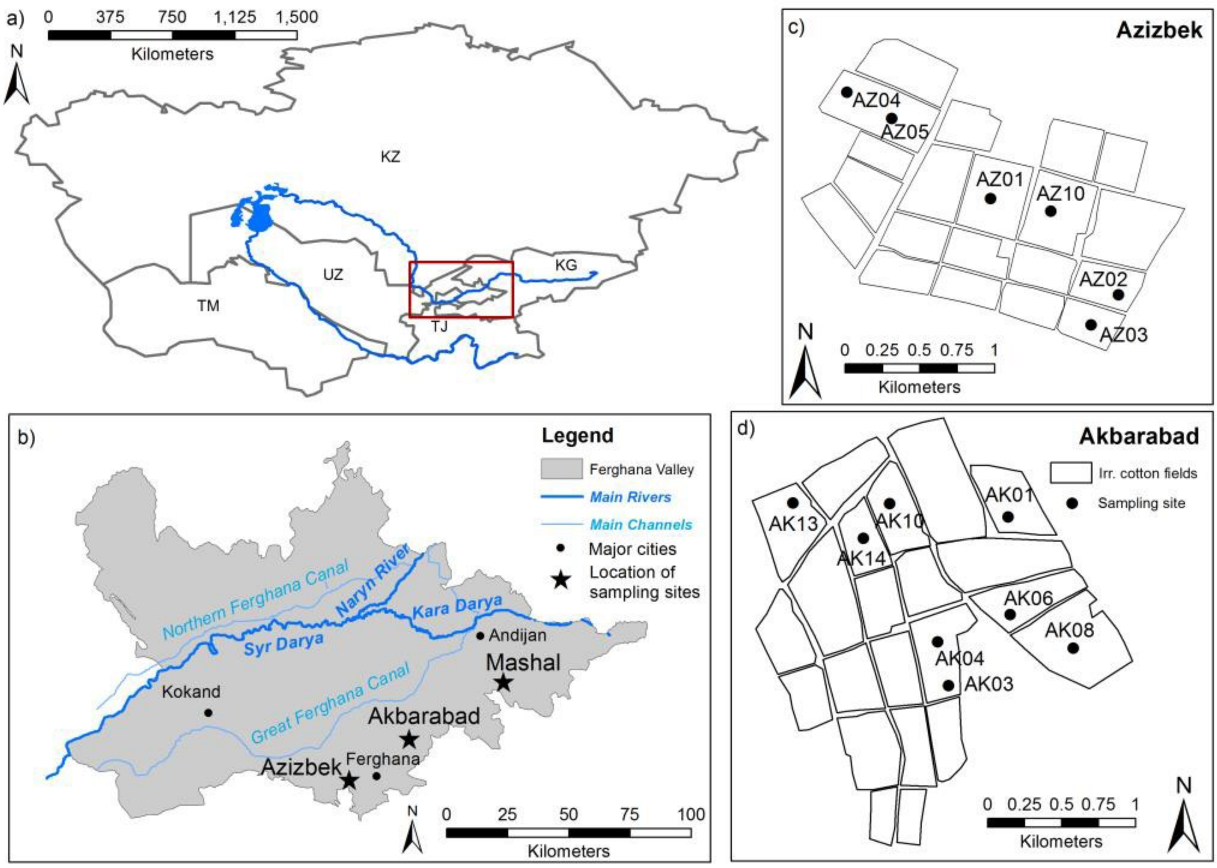

Figure 1. The location of Ferghana Valley in Central Asia (KG = Kyrgystan, KZ = Kazachstan, TJ = Tadjikistan, TM = Turkmenistan and UZ = Uzbekistan) (a) and the location of the three Water User Associations (WUAs) Akbarabad, Azizbek and Mashal in Ferghana Valley (b). The sampling sites within the WUAs Azizbek and Akbarabad are shown in (c) and (d), respectively.

3.2 Field work

Sampling was done on irrigated cotton fields in the three Water User Associations (WUAs) Azizbek, Akbarabad and Mashal (Figure 1b) which are situated in the southeast of the valley (Figure 1b). Soil samples were collected for isotope analysis of the soil water in July and August 2010. We used a stratified sampling design with soil type and depth to GWT as stratifying variables. Soil type and groundwater maps were provided by the Scientific Information Centre of Interstate Coordination Water Commission (SIC-ICWC). Soil types and depth to GWT were each classified into 3 classes (sand, loam, and clayey loam and 0-1 m, 1-2 m and 2-3 m, respectively). Both variables were combined which resulted in 9 sampling classes for the two WUAs Azizbek and Akbarabad. From each resulting class, 2 replicates were taken. In case no combination of soil type and depth to GWT was present in either of the two WUAs, samples were alternatively collected at 2 sampling points in the WUA Mashal. This applied for the combination clayey loam and depth to GWT < 1 m. Our sampling design added up to 18 samples collected in all three WUAs. The sandy and loamy soil sites were collected on consecutive days to increase the number of samples per soil type.

Soil samples were taken from surface soil till GWT in 0.1 m increments (from the surface to 0.5 m depth) and in 0.3 m increments (from 0.5 m depth to GWT), in order to determine the isotope profile over depth. Soil samples were filled into airtight glass vials (100 ml), sealed with Parafilm® to avoid evaporative losses and weighed. The soil samples were kept cool until water extraction in the laboratory to avoid evaporation loss. Additionally, soil samples were collected for analyses of soil moisture, bulk density and texture. Gravimetric water content and bulk density were analysed in the laboratory of the Ferghana affiliate of Central Asian Scientific Research Institute of Irrigation (SANIIRI). Samples of rain, irrigation and groundwater were sampled in 2 ml glass vials, sealed airtight with Parafilm® and also analysed for water isotopic signatures.

3.3 Soil water extraction

Soil water was extracted by cryogenic vacuum distillation at the Institute of Landscape Ecology and Resources Management (ILR) water isotope laboratory of Justus-Liebig-University, Giessen, Germany (Orlowski, 2010). The principle of the cryogenic vacuum distillation is to evaporate soil water at 70° Celsius under static vacuum ($2 \cdot 10^{-2}$ mbar). The evaporated water was captured and stored in Dewar flasks filled with liquid nitrogen. Before starting the extraction, atmospheric gas was completely drawn off the system to avoid changes of the original isotope composition. The extraction process was conducted for 3 h to assure that all water had been withdrawn. After extraction, the trapped water was subsequently thawed at room temperature. The water was then transferred into glass vials (2 ml). Soil samples were weighed before and after extraction to calculate gravimetric water content and compare them to the water content which was measured in SANIIRI shortly after sampling in the field to check whether water losses due to diffusion during soil storage occurred.

3.4 Isotope analyses

The isotopic composition of soil waters was determined using a liquid water isotope analyzer (DLT 100, Los Gatos Research) based on an off-axis integrated cavity output spectroscopy (OA-ICOS). This methodology uses the different absorption properties of molecules to determine the isotopic composition of a sample. The optical absorption is converted into the isotopic composition in the water sample by comparing it with a standard water sample of a known isotopic composition.

Our lab analyses followed the IAEA operating procedure (International Atomic Energy Agency, 2009). The DLT 100 was used in combination with a LC-PAL autosampler (CTC Analytics). Each sample was injected 6 times from which the values of the first three injections were discarded to reduce memory effects, and the results of the remaining three injections were averaged. See also details given on the lab procedure in Barthold et al. (2010). All values are reported in per mil [‰] units relative to Vienna Mean Ocean Water Standard (VSMOW). Accuracy of the measurements for ^{2}H and ^{18}O are 0.56 ‰ and 0.13 ‰, respectively.

3.5 Calculation of phreatic evaporation

We applied the concept of Barnes and Allison [1983] to estimate phreatic evaporation rates in soil profiles with varying texture classes and GWTs. They propose a relationship between depth to groundwater and evaporation rate which in turn can be included in a groundwater model to calculate phreatic evaporation. Brunner et al. [2008] adopted the method, where the phreatic evaporation rate formula relates two environmental processes: Ficks law on isotopic composition between air/water and Darcy`s law on capillary rise in a soil profile:

$$\lambda = z_v + z_l = \frac{1}{E_P}\left(\theta \cdot f \cdot D + f \cdot D_v(n-\theta)\frac{N^{sat}}{\rho}\right) \qquad (1)$$

with λ – decay length of isotopes in soil profile (-); z_v and z_l – length scales of vapor and liquid water diffusion (m); E_p - phreatic evaporation rate (mm a^{-1}); θ – gravimetric water content (g cm^{-3}); f – tortuosity factor of soil (-); n – porosity factor of soil (m^3 m^{-3}); D (D_v) – self-diffusion (molecular) coefficient for liquid (vapor) water (m^2 s^{-1}); N_{sat} – density of saturated water vapor (kg m^{-3}); ρ – density of liquid water(kg m^{-3}).

To estimate the amount of irrigation water lost through phreatic evaporation, 3 different GWT classes were grouped and the mean annual E_p rate (estimated with δ^2H) was calculated for each class. Mean annual irrigation amounts for the same GWT classes were calculated using the concept of hydromodel zones by Legostaev and Mednis (1971) in order to estimate how much of the irrigation water is lost through phreatic evaporation. The classes are 0 – 1 m (class 1), 1 – 2 m (class 2) and 2 – 3 m (class 3).

4 RESULTS AND DISCUSSION

4.1 δ^2H in the soil profile

The isotopic composition of soil water on all sites depict the distinct profile over depth as described in Barnes and Allison (1983).We present the δ^2H composition of three of the profiles that differ in soil texture in Figure 2. The range of δ^2H values of soil water in sandy and loamy soils between 1.2 and

0.2 m depth are similar (-82 – -84 ‰). In the same depths of a clayey loam soil in WUA “Mashal”, deuterium is more depleted, the values of δ^2H range between -88 - -90 ‰. Isotopic composition (δ2H) of groundwater and irrigation water is in the range of -79.4 - -82.2 ‰ and -78.9 - -82.6 ‰, respectively, in WUA “Akbarabad”. WUA “Mashal” is located upstream of WUA “Akbarabad” and hence, the groundwater here is with a value of -87.3‰ for δ^2H much more depleted. This indicates that these are the source waters for the clayey loam soil. However, the soil water in the sandy and loamy soil are in parts even more depleted than the irrigation and groundwater and indicate mixing processes in the deeper soil layers.

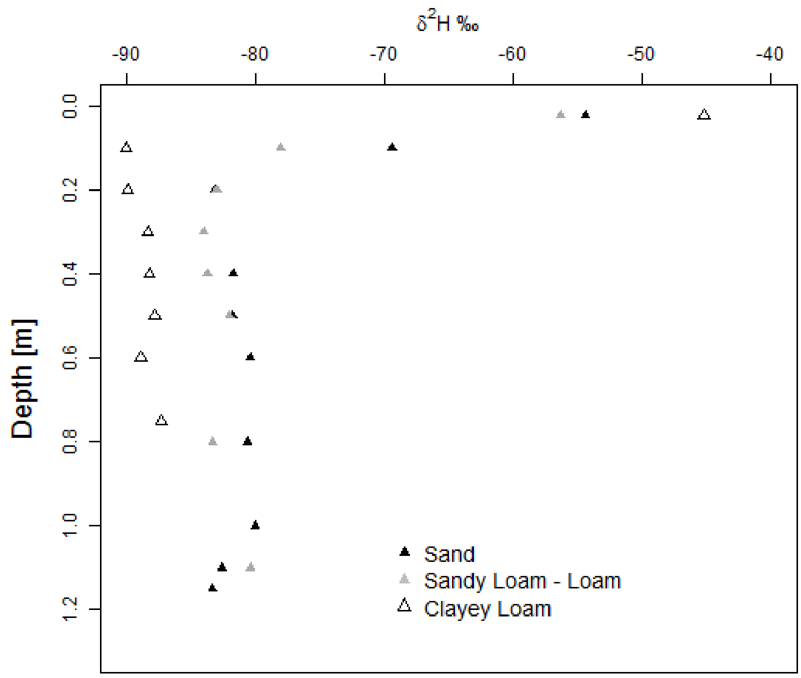

Figure 2. Example of deuterium enrichment in the upper soil layers of a sandy, loamy and clayey loam soil.

Above a depth of 0.2 m, soil water δ^2H increases in sandy and loamy soils, whereas the δ^2H enrichment in the clayey loam soil starts only above 0.1 m. At the ground surface level (0.02 m) the clayey loam soil is more enriched with heavy isotopes (-45‰) compared to loamy (-56.3‰) and sandy (-54.3‰) soils. Even when considering the accuracy of isotope measurements, these differences indicate a variable strong influence of soil texture on natural processes, i.e. evaporation. In the clayey loam soil, the capillary water rises higher than in loamy or sandy soils. This condition promotes evaporation of near surface soil water in clayey soils and may lead to this pronounced difference between δ^2H enrichment in near surface soil layers in clayey loam versus loamy and sandy soils. While soil water in clayey soils is more enriched in near surface soil layers than loamy and sandy soil, enrichment processes do not occur below a depth of 0.1 m. In contrast, in sandy and loamy soils enrichment takes place also in deeper depths than in the clayey loam soil. However, enrichment in loamy and sandy soils does not occur in depths below 0.2 m. The question now arises, which situation promotes a greater loss of water: clayey loam soil with higher water holding capacity but allowing evaporation in a very small surface soil layer only- or loamy and sandy soils where the pore space is much smaller?

4.2 Phreatic evaporation rate

The isotope profiles of all sites were used to estimate the phreatic evaporation rate by fitting an exponential curve to the isotope profile. This provides a decay length value (λ) (Table 1) which is a crucial factor of Equation 1. Solving Equation 1 for E_p results in an annual evaporation rate of 45-154 mm a^{-1} in sandy soils, while in loamy and clayey loam soils it reaches values of

129-245 mm a^{-1} and 167-349 mm a^{-1}, respectively (Table 1). These values were estimated using the $\delta^{2}H$ profiles. EP values estimated using $d^{18}O$ result in slightly lower values (Table 1). Among the 18 sites, 1 profile showed an $R^2 < 0.6$ indicating a high uncertainty of the estimated E_p rate (AK07 on sand, Table 1). This uncertainty may be due to errors during the sampling campaign. This profile was excluded from further analysis. Also, samples from one clay loam site were lost which is why this class is represented by only 5 samples.

Soil texture	Ground water table by classes,	GWL	R^2 of ^{2}H and ^{18}O	Field code	^{2}H			^{18}O		
					λ	R^2 of λ	E_P, mma^{-1}	λ	R^2 of λ	E_P, mma^{-1}
sand	0-1	0.8	0.99	AK06	0.073	0.879	154	0.079	0.923	143
		0.8	0.99	AK08	0.086	0.909	147	0.091	0.933	141.6
	1-2	1.05	0.96	AK07	0.219	0.341	45	0.355	0.403	28
		1.7	0.99	AK04	0.071	0.913	139	0.073	0.926	135
	2-3	2.1	0.99	AK03	0.095	0.68	104	0.098	0.69	101
		2.6	0.76	AK05	0.101	0.769	107	0.158	0.914	68
sandy loam-loam		1.10	0.99	OK07	0.064	0.859	226	0.061	0.865	237
		1.10	0.88	OK08	0.077	0.906	188	0.116	0.782	125
		1.2	0.95	OK04	0.059	0.779	245	0.071	0.859	203
		1.2	0.99	AK10	0.079	0.857	182	0.074	0.86	194
	1-2	1.5	0.96	AK11	0.053	0.776	230	0.064	0.87	190
		2	0.96	AK14	0.100	0.846	150	0.111	0.898	135
		2	0.93	AK01	0.124	0.844	129	0.174	0.848	113.0
		2.1	0.97	AK13	0.098	0.914	132	0.114	0.96	113
	2-3	2.4	0.95	AK02	0.094	0.82	131	0.115	0.897	107
Clay loam	0-1	0.75	0.99	MA01	0.048	0.88	349	0.065	0.87	258
	1-2	1.7	0.98	OK02	0.073	0.908	215	0.089	0.934	177
		2.2	0.99	OK03	0.078	0.87	198	0.075	0.875	206
		2.5	0.97	OK10	0.092	0.762	178	0.096	0.808	157
		2.6	0.93	OK09	0.090	0.743	167	0.139	0.816	108

Table 1. Estimated phreatic evaporation rate (Ep) in different soil types and at various groundwater tables (GWTs) is provided with the goodness-of-fit (R^2) for each profile (AK = WUA Akbarabad, AZ = WUA Azizbek, Ma = WUA Mashal.

The main objective of our study was to quantify the amount of water evaporating from groundwater under water management, and to investigate the influence of soil texture and depth to GWT on the estimated E_p rate. We plotted the estimated E_p rate in groups of soil texture as a function of the groundwater table (Figure 3). The E_p rate decreases with increasing depth to GWT. Linear regressions show that the E_p decreases are significant on a 0.01 significant level for all soils except for the clay loam estimated with $\delta^{18}O$ (Table 2). Figure 4 not only shows the significant influence of the GWT on the E_p rate (slope of regression > 0) but also shows the different y-intercepts that are produced by the different texture classes sand, loam and clay loam indicating differences in Ep due to the different texture class. The Ep rate increases from sandy soil to clayey loam soil. Ep rates estimated with ^{2}H and ^{18}O isotopes in sandy soil profiles give with very close values, which is not the case for loamy and clayey loam soil profiles. In these soil profiles, Ep rates estimated with ^{2}H are higher than with ^{18}O in most of the cases. The reason for that may be uncertainties of the water extraction process of soil samples. Further experiments on water extraction indicate that soil water in loamy and clayey loam soils have not been completely extracted during 3 hrs. The correlation coefficients (R^2) of ^{2}H and ^{18}O are 0.99 for sandy soil and 0.93-0.99 for isotopes of loamy and clayey loam soil (Table 2). However, these differences are not significant from each other.

Our results indicate that Ep increases with decreasing particle size. This contradicts the findings of Coudrain-Ripstein et al. (1998) who showed that soil texture does not influence the Ep rate. However, a test for statistical significance of this relationship due to the small sample size of clayey loam sites is not possible yet.

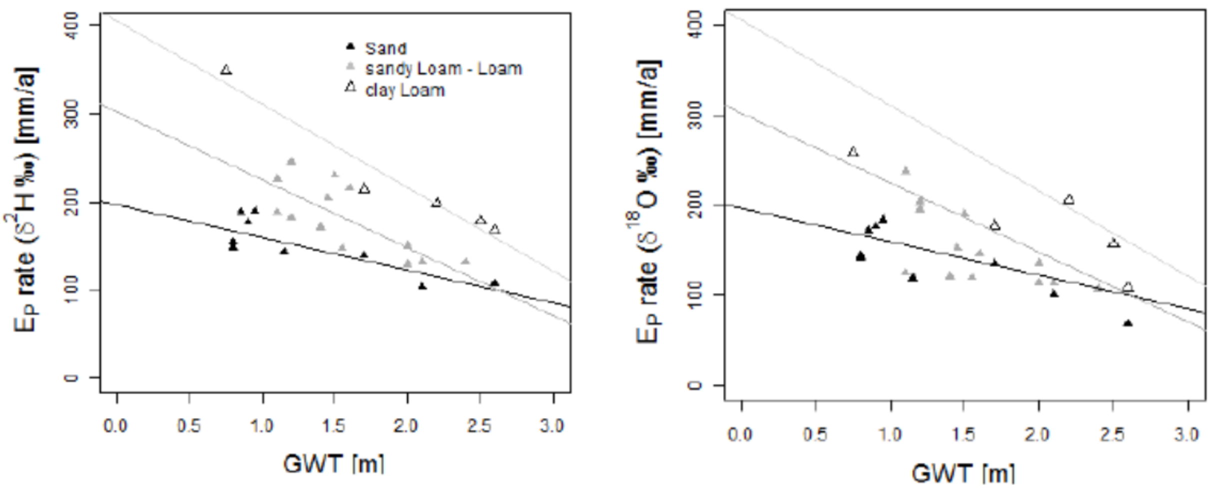

Figure 3. Relationship between phreatic evaporation rate (Ep) and depth to groundwate table (GWT) of soils with different texture.

We compared annual Ep rates estimated in our study with those calculated by Ganiev (1979) for the same region. Overall it is visible that in all soil profiles Ep rate is at maximum when the GWT is shallow (Figure 5). Annual Ep rates in loamy soils are much lower than in clay loam soils, despite that clay loam soils allow evaporation only in a very small surface soil layer (Figure 3 and Table 1). Our findings correspond well with results from Ganiev (1979) only for sandy loam soils. The author estimated annual Ep rates for sandy loam soils between 120- 230 mm at GWTs between 1 and 2 m (Figure 5), while our values are 129-245 mm a^{-1}on ^{2}H and 113- 237 mm a^{-1} on ^{18}O at the same GWT range (Table 1). Annual Ep rates for clay loam in our study are much lower (167-349 mm a^{-1} on ^{2}H and 108-258 mm a^{-1} on ^{18}O) in comparison to those from Ganiev (1979) (340-810 mm a^{-1}).

These differences between Ep rates in our study and in the experiment of Ganiev (1979) could be attributed to the fact that with the isotope approach we estimate the evaporation rate only, while in lysimeter studies evapotranspiration is calculated. In addition, some Ep rates estimated by

Ganiev [1979] are equal to potential evapotranspiration (1000 mm a^{-1}) or to the amount of applied irrigation water for cotton (270-880 mm as cited in Legostaev et al. [1971]).

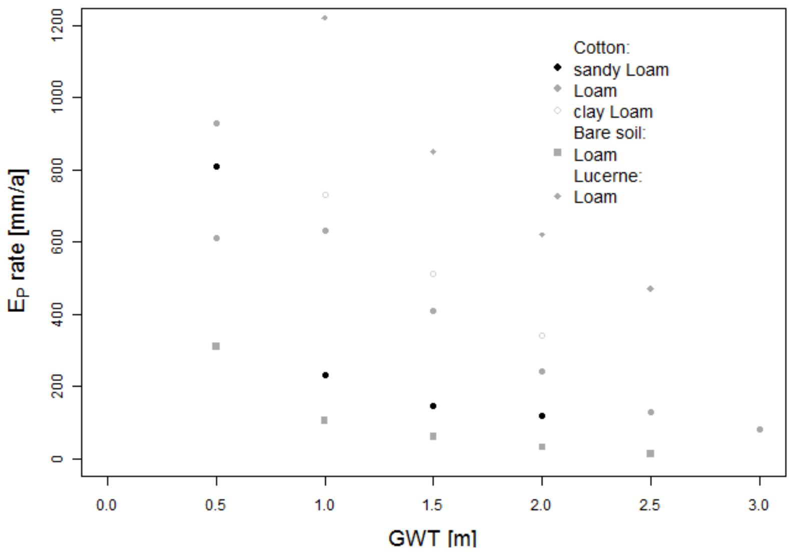

Figure 4. Estimated phreatic evaporation rates (E_P) in different soil types at various groundwater tables measured with lysimeters by Ganiev (1979).

The share of irrigation water to E_P was calculated for the 3 GWT classes 0 – 1 m (class 1), 1 – 2 m (class 2) and 2 – 3 m (class 3) from mean annual E_P rate for each GWT class and mean annual irrigation amounts for the corresponding hydromodel zone which are 500 mm (class 1), 613 mm (class 2) and 740 (class 3). Mean annual E_P for shallow GWTs (class 1) is 217 mm a^{-1} which is 43% of the mean irrigation water in hydromodel zones with GWT between 0 – 1 m. The mean E_P for class 2 is 184 mm a^{-1} (30 % of irrigation amount) and for class 3 it is 144 mm a^{-1} (19 % of irrigation amount). The annual mean E_P of all GWT classes is 181 mm a^{-1}. This is 29 % of the mean irrigation water amount on the three hydromodel zones. The differences of lost water through E_P depending on GWT already indicate that a more efficient management of the GWT would reduce water that is actually needed for irrigation.

5 CONCLUSIONS

We applied a stable isotope approach to estimate phreatic evaporation in irrigated cotton fields in Ferghana Valley, Uzbekistan, and established a relationship between the phreatic evaporation rate and soil texture and groundwater level. Our results show that due to their larger water holding capacity clay soils lose more water through evaporation than loamy and sandy soils. The results show that evaporation from groundwater is a major component of the field scale hydrological cycle in the study area, in particular when the groundwater table is close to soil surface. Water that is transported into the atmosphere through phreatic evaporation is not used for biomass production by plants and hence not used in an efficient way. Decreasing phreatic evaporation by introducing adjusted irrigation schemes hence could improve water use efficiency in irrigation agriculture in the study region. Further studies will assess whether there is a threshold depth of GWT which decreases phreatic evaporation significantly and thus a “GWT threshold target” could be implemented into field water management plans. A more profound look at the temporal development of GWTs and E_p rates can also help to develop efficient water management plans.

ACKNOWLEDGMENTS

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REFERENCES

Amanov, H., 1967. Estimation of total water consumption in cotton field with high groundwater level. Hydrotechnique and Melioration 7, 57-61. (In Russian).

Barnes, C.J., Allison, G.B., 1983. The distribution of deuterium and 18O in dry soils: 1. Theory. Journal of Hydrology 60, 141-156.

Barnes, C.J., Turner, J.V., 2006. Isotopic Exchange in Soil Water, in: Isotope Tracers in Catchment Hydrology, Advances in Water Resources. Elsevier, Amsterdam, pp. 157-163.

Barthold, F.K., Wu, J., Vaché, K., Schneider, K., Frede, H.G., Breuer, L., 2010. Identification of geographic runoff sources in a data sparse region: hydrological processes and the limitations of tracer-based approaches. Hydrol. Process.

Brunner, P., Li, H.T., Kinzelbach, W., Li, W.P., Dong, X.G., 2008. Extracting phreatic evaporation from remotely sensed maps of evapotranspiration RID D-1372-2010. Water Resour. Res. 44.

Coudrain-Ribstein, A., Pratx, B., Talbi, A., Jusserand, C., 1998. Is the evaporation from phreatic aquifers in arid zones independent of the soil characteristics? Comptes Rendus Acad. Sci. Ser II-A 326, 159-165.

Craig, H., Gordon, L.I., 1965. Deuterium and oxygen-18 variations in the ocean and marine atmosphere, in: Stable Isotopes in Oceanographic Studies and Paleo-Temperatures. Consiglio Nazionale delle Ricerche Laboratorio di Geologia Nucleare, Pisa, pp. 9-130.

Chub,V., 2007. Climate change and its impact on hydrometeorological processes, agro-climatic and water resources in the Republic of Uzbekistan. «Voris-Nashriyot» Tashkent (InRussian)

Dukhovny, V.A., 1993. Land reclamation and water resources management in the arid zone. (In Russian).

Ganiev, K.G., 1979. Evaporation and infiltration of groundwater. Tashkent, Uzbekistan. (In Russian). Hillel, D., 2003. Solute Movement and Soil Salinity, in: Introduction to Environmental Soil Physics. Academic Press, pp. 167-186.

Horst, M.G., Shamutalov, S.S., Pereira, L.S., Gonçalves, J.M., 2005. Field assessment of the water saving potential with furrow irrigation in Fergana, Aral Sea basin. Agricultural Water Management 77, 210-231.

Ibrakhimov, M., Martius, C., Lamers, J.P.A., Tischbein, B., 2011. The dynamics of groundwater table and salinity over 17 years in Khorezm. Agricultural Water Management 101, 52-61.

Ikramov, R., 2000. Principles of water-salt regime management of irrigated lands in Central Asia under condition of water resources shortage. “HydroInGeo”, Tashkent (In Russian).

International Atomic Energy Agency, 2009. Laser Spectroscopic Analysis of Liquid Water Samples for Stable Hydrogen and Oxygen Isotopes, Trainings Course Series. Vienna.

IWRM Ferghana, 2002. Integrated Water Resources Management in Fergana Valley (No. 7). SIC ICWC, Tashkent, Uzbekistan.

Jefferson, I., 2004. The engineering geology of loess ground: 15 tasks for investigators- programme of loess research. Engineering Geology 74, 33-37.

Kharchenko, S.I., 1979. Hydrology of irrigated lands. Hydrometeoizdat, Leningrad. (In Russian). Legostaev, V.M., Mednis, M.P., 1971. Irrigation regime and hydromodule zone of Uzbekistan. Tashkent, Uzbekistan (In Russian).

Letolle, R., Mainguet, M., 1995. Der Aralsee: Eine ökologische Katastrophe, 1st ed. Springer. Maksudov, A., Abdullaev, M., 2001. Geography of Central Asia. Ferghana State University, Ferghana, Uzbekistan.

Micklin, P., 2007. The Aral Sea Disaster. Annual Review of Earth and Planetary Sciences 35, 47-72. Micklin, P.P., Williams, W.D., 1996. The Aral Sea Basin, NATO ASI Series. Springer-Verlag.

Muennich, K.O., Sonntag, C., Christmann, D., Thomas, D., 1980. Isotope fractionation due to evaporation from sand dunes. 2. Mittl. Zentralinst. Isot. Strahlenforsch 29, 319-332.

Orlowski, N., 2010. Construction and specification of a cryogenic vacuum extraction device for application in stable water isotope analysis (MSc Thesis).

Parfenova, N.I., 1982. Prognoses of mineralisation of groundwater in irrigated areas. Hydrotechnique and Melioration, 7 (in Russian).

Stulina, G., 2002. Water and Salt Transfers. Experimentation and modelling with RZWQM, ISAREG and KCISA (No. Final scientific report). Department of Agricultural Engineering, Institute of Agronomy, Technical University of Lisbon, Lisbon, Portugal.

Stulina, G., Cameira, M.R., Pereira, L.S., 2005. Using RZWQM to search improved practices for irrigated maize in Fergana, Uzbekistan. Agricultural Water Management 77, 263-281.

UNEP, 2005. Severskiy, I., Chervanov, I., Ponamarenko, Y., Novikova, N.M., Miagkov, S.V., Rautalahti, E. and Daler. D. Aral Sea, GIWA Regional assessment 24. University of Kalmar, Kalmar, Sweden.

Yakubov, K.I., Kurbanbaev, E., Petrakova, S.K., 1985. Water-salt regime of Southern Karakalpaki´s soils and its management. Karakalpakistan, Uzbekistan (in Russian).

Zimmermann, U., Ehhalt, D., Muennich, K.O., 1968. Soil - water movement and evapotranspiration: Changes in the isotopic composition of the water. Proceedings of the Symposium on Isotopes in Hydrology, Vienna, 567-85.

SESSION 2: INSTITUTIONS AND THE MARKET

FREDERIKE GEHRIGK , THOMAS HERZFELD , INSA THEESFELD

FARMERS' PERCEPTIONS OF LAND AND WATER PROPERTY RIGHTS: DISCREPANCIES BETWEEN DE JURE AND DE FACTO RIGHTS IN TAJIKISTAN

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1 PROBLEM STATEMENT

With about 85 % of irrigated agricultural land in Tajikistan, irrigation schemes play a central role for commercial crop production of dekhan farms[1] (peasants) but also contribute to food security for households by cultivating kitchen gardens or presidential land[2]. However, many structural and institutional problems in the land and water sector hinder the efficiency and sustainability of Tajik agriculture.

A weak water governance system, which is especially characterized by unclear accountability, in-transparency and particularly indistinct responsiveness in the water system, is inhibiting the ongoing implementation of water reforms. On the level of farm household groups that use a common channel, those users of irrigation systems face the typical asymmetry in the common pool resource dilemma between head and tail enders (Sehring 2006; Rowe 2010). Besides this governance challenge, also high variability of water availability over the year and increasing salinization of groundwater is challenging water allocation and availability among water users. The Water Code is aimed to define the de jure property rights over water, where water is also stated to be exclusive state property. For irrigation systems, the code declares that the Ministry of Land Reclamation and Water Resources operates under the so called '*Mirob*[3]' on the national and basin level, and Water User Associations (WUA) at the field level taking over operational tasks. In contrast to those defined responsibilities, public participation in operating and maintaining irrigation infrastructure on-farm and between farms is not clearly defined.

However, it is not simply the water sector which is challenging farm households. Land reform is an ongoing process, where land remains state property and farmers can get inheritable use rights for unlimited time. Anyhow, many local farmers are not aware about the status quo of the reform and

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1 *Khojagi-i-Dekhoni',* Since 1992 dekhan farms are reallocated former collective and state farms (kolkhoze, sovkhoze). Organizational forms: 1) Collective dekhan farms, 2) individual dekhan farms, 3) family dekhan farms, overall 30 % of agricultural output are produced on dekhan farm land (TajStat 2011), ranging from 5 – 200 ha on 65 % of arable land (Lerman and Sedik 2008).

2 With the Presidential Decree in 1995 and 1997 75 000 hectares were distributed to very poor rural households for subsistence farming, this land is surrounding the household or near the village, around 60% of total agricultural output is produced on 20 % of arable land by households plots and presidential land (TajStat 2011)

3 Mirob are increasingly established as public agencies responsible for water delivery, maintenance of off-farm irrigation and drainage infrastructure (including canals and pumps).

consequently about the farm restructuring process. Officially, different legal forms of farm types exist for which every farmer could obtain a land certificate. But the different types at hand and the procedure to apply for certificates of individual land shares (e.g. dekhan farms) are often unknown or in-transparent to farmers as well as to local officials (Mandler 2013; Robinson et al. 2010; Robinson et al. 2008). Even if farmers hold certificates for a dekhan farm, self-classification into one of the different organizational forms is difficult, as certificates have less validity to farmers and classification often only exists on papers. According to official statistics of the Land Committee, land allocation in form of issuing land certificates is continuously progressing. Thus, transparency of land titling should improve steadily. Overall, dynamics in land allocation takes shape in four different processes: 1) farm restructuring and individualization takes place, that means the former members of kolkhozes receive individual land shares; 2) new farmers (from other villages or even foreigners) apply for land certificates of dekhan farms; 3) population increase expands the demand for kitchen gardens and affords to allocate more land to household plots to secure food security, 4) redistribution of former agricultural kolkhoz land with less quality or unused land to presidential plots.

Along with more individual farming also the water sector is being challenged as more individual users nowadays are using the former centrally planned and organized irrigation infrastructure and now face to overcome the common pool resource challenge. Among others, this increases transaction costs of getting access to and allocation of water in irrigation canals.

For land and water resources, farmers now hold their individual property rights which should be legally stated in the land and water codes, the de jure rights. Anyhow, in reality land and water allocation and management is often carried out according to the farmers 'perceptions of their rights. Those perceptions are expressed in the de facto rights of the farmers.

This paper is aimed to determine the discrepancies between de jure and de facto (property) rights of the different farm households with respect to land and water resources for the case of Tajikistan.

2 THEORETICAL FRAME

For this study, the theory of property rights is used, which is further supplemented by the concept of bundles of rights (Schlager and Ostrom 1992). Property rights determine someone's authority to undertake a particular action. It describes the sanctioned behavioral, economic and social relation among resource users referring to a specific object or resource. The bundle of rights further distinguishes the property rights into 1) use rights (access, withdraw, exploit), 2) control/ decision making rights (manage, exclusion), 3) alienation rights (rent, selling, transfer). Farmers use resources according to their perceptions about their bundles of rights, so what they perceive as being authorized to do (de facto). These actions undertaken can differ from what is stated in the formal laws, the de jure rights (Schlager and Ostrom 1992).

The conceptualization of the bundles of rights is beneficial to analytically and descriptively identify the perceptions of property rights arrangements among the different rights holders compared to what is stated in the law (Johnson 2007). As various actors are present in the land and water sector in Tajikistan, it is important to reveal the complex situation and to understand who is holding what types of rights. The descriptive findings can further help to indicate relations between the users as for instance decision making rights indicate power choices, or holding the full bundle of rights enables someone to even change existing rules.

3 METHODOLOGICAL DESIGN

With the problem background and the theory at hand, the following hypotheses are derived: H1: The perception of bundles of rights of land and water differs between legal forms of farms.

H2: The perception of the bundles of rights of large-scale dekhan farmers coincide more with the de jure rights of land and water stated by the laws than the perceptions of other farmers.

H3: The perceptions of control and decision making rights for land and water are attributed to a few large-scale dekhan farms in each village.

For this paper data from a farm household survey conducted in March – May 2013 are used. In total 380 respondents were surveyed in one northern (Bobojon Gafurov) and one southern district (Bokhtar). Both districts count among the main agricultural areas in Tajikistan but differ substantially in land reform outcomes. To test the hypotheses, descriptive statistics for groups of different legal forms of farms (household plot, presidential plot, dekhan farms) and origin of farm operator are applied.

4 EXPECTED RESULTS

The post-Soviet case offers a unique opportunity for studying the property rights regimes, where the land and water property rights trajectory is now placed between incremental changes through ongoing land and water reforms and continuity of local elites' remaining soviet allocation mechanisms. As only few actors remain strong in the rural transition process, various peasants tinker their own joint local governance system based on their perceptions of their property rights. The perceived property rights for land are stronger and displayed by holding the full bundle of rights, although it is a state property and only use rights exist. For instance selling is not allowed by law, but perceived to be possible or even practiced by a limited number of farmers. In contrast, water property rights are perceived weaker in most parts of the bundles. Allocation and decision making about volumes and opening the gates is not perceived to be a farmer's property right as it is stated in the law. This sector is still very much organized in the former soviet system, where former kolkhoz irrigation managers are still in place and WUA are implemented on the basis of old kolkhozes. One can determine less variance of the perceived property rights of land and water on the meso-level, so less between the farmers within one village. But rather on the macro level, as a high variance between the regions and villages is at hand.

The results of this research are relevant in further assessing potentials of land use productivity in Tajikistan and pointing to sources of conflict. Based on these findings, further research will investigate particularly linkages of land and water governance systems to point out e.g. the relevance of land reallocation and its impacts on water management in terms of access to and availability of water.

REFERENCES

Johnson, D.R. (2007): Reflections on the bundle of rights (Vermont Law Review, 32). Online available: http://lawreview.vermontlaw.edu/files/2012/02/johnson2.pdf, 15.07.2013.

Lerman, Z.; Sedik, D. (2008): The Economic Effects of Land Reform in Tajikistan. Policy Studies on Rural Transition, No. 2008-1.

Mandler, A. (2013): Knowledge and Governance Arrangements in Agricultural Production. Negotiating the Access to Arable Land in Zarafhsn Valley, Tajikistan. In: ZEF Working Paper (106).

Robinson, S.; Higginbotham, I.; Guenther, T.; Germain, A. (2008): Land Reform in Tajikistan: Consequences for Tenure Security, Agricultural Productivity and Land Management Practices. In: Roy Behnke (Hg.): The Socio-Economic Causes and Consequences of Desertification in Central Asia. Springer Netherlands (NATO Science for Peace and Security Series), 171–203.

Robinson, S.; Whitton, M.; Biber-Klemm, S.; Muzofirshoev, N. (2010): The Impact of Land-Reform Legislation on Pasture Tenure in Gorno-Badakhshan: From Common Resource to Private Property? In: Mountain Research and Development, 30 (1), 4–13.

Rowe, William C. (2010): Agrarian adaptations in Tajikistan: land reform, water and law. In: Central Asian Survey 29 (2), 189–204.

Schlager, E.; Ostrom, E. (1992): Property-rights regimes and natural resources. A conceptual analysis. In: Land economics, 68 (3), 249 – 262.

Sehring, J. (2006): The Politics of Irrigation Reform in Tajikistan. Discussion Papers No 29, Justus Liebig University Giessen, Center for international Development and Environmental Research (ZEU), http://EconPapers.repec.org/RePEc:zbw:zeudps:29.

TajStat (2011): Tajikistan in Figures 2011. Dushanbe: Statistical Agency under the President of the Republic of Tajikistan. Dushanbe, Tajikistan.

AHMAD HAMIDOV [1], MUKHAMADKHAN KHAMIDOV [2], ANDREAS THIEL [1]

INSTITUTIONAL ANALYSIS OF IRRIGATION MANAGEMENT IN UZBEKISTAN USING QUALITATIVE COMPARATIVE ANALYSIS: CASE STUDIES OF WATER CONSUMERS ASSOCIATIONS IN BUKHARA REGION

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1 ABSTRACT

Given the fact that water consumers associations (WCAs) in Uzbekistan were established about a decade ago in a top-down fashion to maintain on-farm water facilities, using fuzzy set Qualitative Comparative Analysis tool this paper attempted at determining sets of conditions that are necessary and sufficient to achieve an outcome. The study followed the logic of abductive approach, where sets of theories were adjusted based on the empirical field stint. Institutional economics perspective was applied to identify rural farmers' behavior in the management of common pool resources (CPRs). The study took place in Bukhara region – southwestern part of Uzbekistan – and involved focus group discussions with members of fifteen WCAs using semi-structured interview format. Three sets of conditions (appropriate chairmanship skills [ACS], proper water allocation [PWA], and effective participatory governance [EPG]) were found to be important for explaining the outcome (improved maintenance of irrigation canals [IMC]). The analysis of necessary conditions indicated that neither condition ACS nor PWA nor EPG is necessary for IMC on its own. The same finding was apparent for the complements of the three conditions, ~ACS, ~PWA, ~EPG. In the meantime, the analysis of necessary conditions for unions of conditions (logical OR) revealed that the terms of PWA OR EPG (i.e. PWA+EPG) is necessary to achieve the outcome. However, their presence is not sufficient. The result for sufficiency analysis highlighted that no single condition alone is sufficient to achieve IMC. The results for combinations of conditions showed that the presence of ACS AND PWA AND EPG (i.e. ACS*PWA*EPG) is sufficient for achieving the outcome, IMC. Therefore, it is reasonable to believe that when these conditions are present simultaneously, there is a great chance of improving CPR use within WCA territories.

2 INTRODUCTION

With the dissolution of the former Soviet Union, previous collective farming system (*kolkhozes* and *sovkhozes*) that was practiced in most former socialist countries also collapsed. Unlike some other neighboring Central Asian nations that followed Washington Consensus and quickly adopted land privatization policy, Uzbekistan has followed a cautious approach, by first sub-dividing the large collective farms into smaller family oriented cooperative farms (Noble et al., 2005). During this process, there was an ambiguity over who shall be responsible for on-farm water management, meaning water distribution among consumers, canal maintenance, and resolving potential conflicts over water allocation (Abdullaev et al., 2010). As a result, the Uzbek government faced a huge dilemma to figure out sustainable irrigation farming system and contracted Central Asian Research Institute of Irrigation (SANIIRI) to study the experience of other countries with regard to water allocation system. This is due to the fact that during 1990 and 2000, the government experienced significant downfall in providing adequate funding to invest in operation and maintenance of on-farm irrigation and drainage canals. Finally, SANIIRI completed its study in the beginning of 2000 and presented its recommendations to Uzbek government by advising to create a farmer-oriented water consumers association (WCA). As such, wide-scale establishment of WCA started in the country, mobilized by local governments and donor community. The main idea behind this reform was that WCA members would act collectively to operate and maintain their internal irrigation and drainage canals. The benefits that they would receive from this common pool resource (CPR – irrigation systems) can be shared across all members and those who do not contribute can be excluded. This theoretical idea did not materialize in practice as most of the WCAs currently experience institutional and financial constraints. WCAs have lack of autonomy and financial independence. As a result, canals are outdated and cooperation among members has diminished.

The main objective of this study is to find out appropriate conditions that can explain the improvement of canal maintenance within WCA territories. By using fuzzy set qualitative comparative analysis (fsQCA) technique, the study attempted at determining sets of conditions that are necessary and sufficient to achieve the outcome, improved maintenance of irrigation canals.

Theoretical arguments and empirical evidences emphasize that in the context of transition, appropriate chairmanship skills is important to achieve successful management of CPRs. Therefore, the study hypothesize that current WCA chairmen have limited leadership skills to improve CPR condition. Additional hypothesize included that proper allocation of water resources within the territories of WCAs is important for members to invest into the improvement of the CPR (i.e. irrigation infrastructure) and receive benefits from it. Last but not least, effective participatory governance shall allow community members to influence in the design and implementation of everyday internal rules. Through members' participation it is possible to improve information flows about the CPR and get acquainted with members' preferences. These theoretical arguments are detailed in the next section.

3 COLLECTIVE ACTION FOR COMMON POOL RESOURCE USE

After wide range of discourse that took place among scholars for sustainable CPR management, each set out conditions (factors) that they believed to be decisive in sustaining the CPR. These theoretical assumptions were derived from different research findings across the globe. For instance, Wade (1987) determined sets of factors - *the resources, the technology, relationship between resources and user group, user group, noticeability, relationship between users and the state group size, clear boundaries, and ease in monitoring and enforcement* – that may lead to successful management of shared natural systems.

Ostrom (1992) suggests the attributes of the resource (i.e. *feasible improvement, indicators, predictability, and spatial extern*) and of the appropriators (i.e. *salience, common understanding,* *low discount rate, trust and reciprocity, autonomy, and prior organizational experience and local leadership*) that can increase the likelihood that self- governing associations will form and survive for longer period. Achievement of sustainable resource use requires that one draws on cultural endowments and their knowledge of local resources to find innovative solutions that fit local conditions (*ibid*).

3.1 Leadership

There are number of examples of successful collective action in the context of CPR that is related to leadership skills of the person(s) within a community. Poteete et al. (2010) note that leadership is one the most well studied social factor, which contributes to sustained CPR regimes. Baland and Platteau (1996) synthesized number of empirically-driven literatures and asserted that good leaders are important to help people become aware of the real challenges that they confront with, mobilize users into a coordinated unit to manage the resources, and make sure that rules and enforcement mechanisms are fair. They further characterize good leader as being relatively young, literate person with vast experiences in the area of his/her expertise, and who is bounded into traditional societal structure (*ibid.*).

In fact, the very early discourse on leadership skills in the context of CPR comes from Ostrom's (1992) propositions on attributes of resources and of appropriators. She points out that when appropriators (resource users) have learned at least minimal skills of leadership through participation in other local groups, there is substantial chance that self-governing associations are formed and survived for longer period (*ibid.*).

In terms of characteristics of a leader, Meinzen-Dick et al. (2002) puts emphasize that leaders are seen to be important actor mediating the society and contributing to build trust among members. A leader should also be accountable to his/her employees, i.e. farmer groups (*ibid.*).

In her dissertation, Zavgorodnyaya (2006) studied performances of Uzbek WCAs employing collective action theory to determine factors that influence to the success or failure of WCA establishments. She concluded that when the chairman has water engineering background and connected to traditional societal structure, the success is most probable (*ibid.*). This was also confirmed by the research findings of Hamidov and Thiel (2011).

Taking into account these theoretical and empirical findings on the importance of leadership skills of WCA manager for successful collective action to govern CPR, the study hypothesized that when a WCA chairman has charismatic leadership skills, has high education background in the area of irrigated agriculture with vast experience in the irrigated farming practices, then there is a good chance to achieve successful collective action on irrigation canal maintenance.

3.2 Resource appropriation

In her paper, Ostrom (2000) further highlights the importance of benefit flows that irrigation systems provide. She emphasizes to the fact that the amount, timing, and technology used to withdraw a flow of resource units (i.e. water) is important to achieve sustainable CPR use (*ibid.*).

Therefore, this study included an additional condition 'proper water allocation' that may influence to the improvement of CPR status.

In fact, Ostrom (1992) asserts that appropriation (water allocation) and provisions of resources (irrigation infrastructure) are intertwined. In this research, we concentrate on the provision issue as an action situation looking at this little nature-related puzzle acknowledging that it goes with an overall picture of water appropriation. In the meantime, appropriation issue is mapped as an exogenous (explanatory) factor to explain canal maintenance outcome. The issue of water allocation requires broader action arena where farm-level water allocation maybe influenced by the certain political decisions at the national and international levels, by climate change discourse, and involves various actors in the decision-making process. By contrast, the study believes that when this small piece of problem heals, i.e. infrastructure provision, it may improve general water allocation problem.

Theesfeld (2009) investigated the potential forms of collective action among Bulgarian villagers for managing their irrigation water during the process of transition. Her findings included that chaotic water appropriation rules associated with unreliable irrigation water allocation left little room for successful cooperation. She found that the absence of monitoring system for water appropriation increased transaction cost of guarding farmers' fields around the clock (Theesfeld, 2009: 18).

In addition, Abdullaev et al. (2010) studied collective action in the irrigation sector in Central Asia. They highlight the importance of water appropriation issue in the area due to the emergence of hundreds of individual farmers who cultivate different irrigation intensive crops. As a result, this situation has increased problems with water allocation particularly, during water scarcity season. There are cases where frequent clashes between appropriators are apparent (Abdullaev et al., 2010: 1035).

3.3 Theory on participatory governance

Additional condition that influences the action situation in the context of transition is active involvement of resource users in the decision-making process to manage and maintain CPRs, which was mainly empirically-driven contribution. The concept of participatory governance has actively been pursued by various donor agencies in developing countries to promote citizen participation and to involve them in public decisions (Speer, 2012: 2379). Anderson and van Laerhoven (2007: 1090) point out that participatory governance is defined as institutional arrangements that facilitate the participations of ordinary citizens in the public policy process. In this research, we use the term of participatory governance to provide an explanation of WCA members' participation during the decision making process on canal maintenance activities. Speer (2012: 2381) notes that explanatory factor for effective participatory governance includes allowing community members to influence the design and implementation of everyday rules. Through members' participation it is possible to improve information flows about the CPR status and get acquainted with members' preferences.

4 METHODOLOGICAL APPROACH

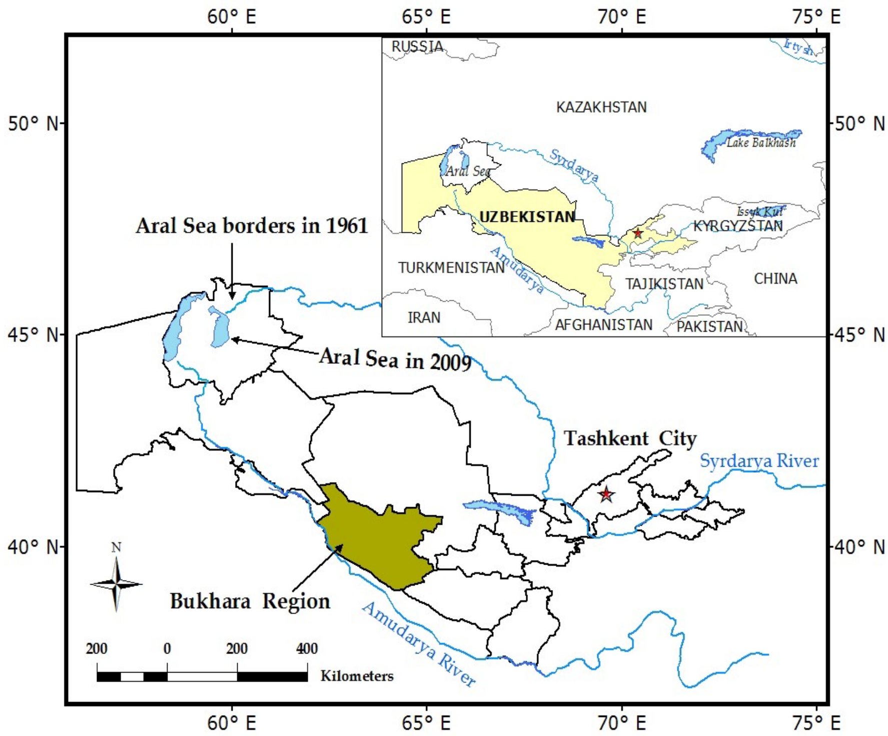
The sequence of empirical process in this research follows the logic of abduction approach. The researcher, equipped with the theoretical tool of Collective Action, conducted the empirical investigation to identify conditions that influence cooperation among WCA members in managing the CPR, with particular focus on issues related to infrastructure provision. Additional theories that were applied during the empirical process included Shared Mental Models and the theory of Transition Economics. These combined theories provided some explanations about the research problem but did not provide full picture of the process. It was observed during the empirical field visits that some form of participatory governance together with the importance of water allocation were additional important conditions that afore-mentioned theories did not prevail. As a result, the observed phenomenon was able to explain with additional conditions, which led to an expansion or modification of the existing theories (Schlueter and Koch, 2011:385). This process is called an abductive approach to research (Reichertz, 2011). In order to conduct qualitative interviews with WCA members, the field visit took place during 2011-2013.

The first field visit took place during October-December 2011. The main aim was to understand the rules that WCA members follow in practice and test sets of conditions from Collective Action theory. Members of the two WCAs (Khalach Kalti and Karvonboshi Tezguzaro) were invited for focus group discussions (FGDs). Canal maintenance and application of excessive water for leaching purposes were directly observed in the field.

The follow-up field visit happened during August-November 2012. Most of the time in the field was spent to carry out FGDs and individual interviews with WCA members. Various social events (such as: wedding, cotton-post harvest parties, and informal dinner with local authorities) were attended by the investigator. Last but not least, in order to communicate research findings and to fill-up important gaps, the final field visit to Bukhara region took place in March 2013.

The study areas are located in *Vobkent, Romitan, Peshku, Shofirkon,* and *Gijduvon* districts of Bukhara region, southwestern part of Uzbekistan, in the lower reaches of Amudarya River, which is the major water source for all water sectors in Bukhara (Figure 1).

Figure 1: Location of the study region



Source: own illustration.

The region covers an area of about 42,000 km² and approximately 400 km south of the remainders of the Aral Sea. Total irrigated area of the region is accounted at 275.1 thousand ha. Total population is about 1.4 million, of which about 60% live in rural areas and depend on irrigated agriculture. The region consists of 11 districts plus the city of Bukhara as an administrative center.

Bukhara is characterized with diverse ethnic population, frequent water shortage, severely salinised soil and groundwater, high waterlogging, and geographical proximity to the Aral Sea. The region has typical arid continental climate with cold dry winters and very hot summers. For instance, during summer period the temperature goes as high as +47°C (e.g. observed in July, 2005) and during winter as low as -29°C (e.g. noted in January, 2008). In some instances, due to the freezing of lower-layers of soil horizons, which happened in 1969, 1976, 1984 and 2008 years, it caused difficulties in conducting agro-technological activities in due time, which delayed starting of vegetation season (Jurayev and Khamidov, 2012). Annual precipitation in the region is determined at 120- 140 mm, which falls mostly outside of growing season in autumn-winter period. Local potential evapotranspiration is about 2000 mm/year greatly exceeds precipitation. Thus, large scale irrigation for cultivated crops is essential to this area.

4.1 Case selection steps

Five steps were followed to figure out appropriate cases for this research and selected based on the following criteria: In the first step, the total number of WCAs functioning in Bukhara Region of Uzbekistan was obtained from the Amu-Bukhara Basin Irrigation System Authority (BISA), which consisted of 124 cases. Using the most similar cases design approach, two irrigation system authorities (ISAs) subordinated by the Amu- Bukhara BISA were randomly selected which share geographic borders with each other (*Kharkhur-Duoba* and *Toshrabod-Jilvon*) as well as share relatively similar climatic characteristics. The interaction between ISAs and WCAs were also included in the selection criteria that may also influence the outcome. With this, we reduced the number of WCAs for 63 representing five districts of Bukhara. In the next step, we selected 45 WCAs that varied in their outcomes to ensure that cases with good and badly maintained irrigation systems are included. Since it is difficult to obtain such evaluation reports for individual WCAs, as the best indicator we relied on the fact of collection rate for irrigation services. In the fourth step, we eliminated WCAs that strongly differed from other WCAs in key characteristics (size of resource, number of members, and date of establishment). Thus, we left with only 26 WCAs in the selection that share similar characteristics that might affect the outcome. In the final step, we selected fifteen cases that included WCAs from each five districts that may serve as representatives for the entire Bukhara region. The list of selected cases is given in Appendix 1.

4.2 Empirical methods

The empirical work was based on the qualitative interviews. A semi-structured interview format was developed for conducting qualitative study. Selected WCAs were invited for focus group discussions (FGDs), a method used as part of the group interview. The unit of analysis of this study is the water consumers association, i.e. a group of farmers' legal organization. Since the main empirical data collection phase came to the fall season, where farmers were busy with cotton harvesting, in addition to FGDs the study conducted an in-depth interview with individual WCA members. During the selection of participants (i.e. WCA members), the following basic criteria was respected: i) the average number of participants in the group was between 4 and 6; ii) a moderator had an assistant for recording the discussions and keeping notes; and, iii) the group was relatively homogenous (age, education, profession).

Selection of participants was done prior to the field visit based on the secondary data received from Amu-Bukhara BISA. Apart from the above-mentioned criteria, representativeness of WCA members for the entire WCA operational area was also considered. As such, WCA chairmen was contacted by the researchers and requested to gather selected members into a WCA office for FGDs. In addition to WCA members, a separate individual expert interview was carried out with each WCA chairman to acquaint with achievements and potential constraints for WCA success.

Audio recording was used to record interviews when respondents agreed. All recorded interviews and discussions were then transcribed, and similar to the field notes, entered in to a computer. Using fsQCA software, the researcher carried out qualitative data analysis. It is important to note that the absence of access to quantitative data that was difficult to obtain from the Statistical Committee, and lack of resources and accessibility to carry out widespread survey with resource users prevented using quantitative data analysis (such as efficiency analysis using stochastic frontier, data envelop analysis, and distant function approaches). QCA may provide alternative analysis options when collection of such intensive and trustworthy quantitative data is not possible. Furthermore, QCA allows the impact of different institutional aspects on decision making where quantitative analysis has limitations. However, conclusions of the study could be compared with such quantitative approach when data becomes available, which may be considered as further research direction in the future.

4.3 Analytical tools for data analysis - fuzzy set QCA

Qualitative comparative analysis (QCA) method was used in order to compare the cases and determine necessary and sufficient conditions to achieve the high levels of canal maintenance within WCA territories in Bukhara region. QCA is a methodological tool, which was introduced by the American social scientist Charles Ragin in late 1980^{th} (Wagemann and Schneider, 2010). It is a research approach and analytical tool that provides the possibility to compare intermediate number of cases and to examine conditions that are necessary and sufficient for a given outcome. This analytical technique offers the opportunity to better understand different cases and to capture accurately the characteristics of cases. QCA has been well-accepted by many social scientists since it builds upon certain theories to provide local explanations or interpretations of individual cases.

In this study, we believe that QCA is a useful instrument in the context of WCA comparisons in order to identify combinations of conditions for better maintenance. In particular, this study uses fsQCA as it provides different elements that can have differing degrees of membership in sets (Wagemann and Schneider, 2010). These degrees vary between 0 (fully out) and 1 (fully in). This is the latest version of QCA developed by Ragin in response to much criticism for his initial crisp-set QCA (csQCA).

A crisp-set is Ragin's early developed tool that takes into account dichotomy, i.e. either fully in in the membership set or fully out. In political science sphere, there were many comparative cases on democratic membership of a country. When using the csQCA, the researcher selects conditions and outcomes either present or absent. However, the degree of vary in conditions and outcomes are not included in csQCA. Recall that fsQCA was developed to overcome the issue of complexity in the real world. Wagemann and Schneider (2010) note the importance of fsQCA since its flexibility enables social scientists to make qualitative differences among membership sets.

4.3.1 Conditions and outcome

Prior to field visit this study had developed a list of independent variables (in QCA language, conditions) that may be necessary/ sufficient to achieve the outcome. Accordingly, preliminary measures had been developed to test in the field condition. Schneider and Wagemann (2010) informed that the selection and definition of conditions and an outcome is subject to changes based on the preliminary findings throughout the research process. Therefore, new sets of conditions and measures have been developed after the extensive interviews with resource users. In the meantime, fuzzy set values (or membership scores) were assigned for each measure reflecting the degree of qualitative difference (Table 1).

Table 1: List of conditions and outcome with fuzzy-set value definitions

Conditions	Measures	Definitions of fuzzy-set values
Appropriate chairmanship skills (ACS)	Charismatic chairman	1: The chairman is able to communicate effectively with WCA members and gained their trusts
		0.5: The chairman has been appointed by external actors and WCA members respect him
		0: The chairman has gained no trust among the members and has no skills to effectively communicate with WCA members
	Educated chairman	1: The chairman had water management specialization with university degree
		0.75: The chairman had university degree but not specialized on water
		0.5: The chairman had a secondary degree with specialization on water/agriculture
		0.25: The chairman had a secondary degree with no water/ agriculture related
		0: The chairman completed primary education
	Experienced chairman	1: The chairman has vast experience in the area and is working since *kolkhoz* period
		0.67: The chairman has been working in the area since WCA establishment
		0.33: WCA chairmen have been changed frequently and the current one is the latest with little experience
		0: The chairman is new with no previous experience
Proper water allocation (PWA)	Access to irrigation water	1: Requested water amount fully received in due time during the study period
		0.5: Requested water amount was not received but it did not affect crop productivity
		0: Requested water was not received and farmers failed to fulfill the quota for strategic crops
	Dispute resolution mechanism	1: No major disputes within WCA territory over water allocation
		0.75: Emerged disputes are solved internally without any external interventions
		0.5: Emerged disputes are solved with the help of local authorities
		0.25: Courts are involved in solving/reviewing disputed situations
		0: Frequent disputes over water allocation are apparent and no clear mechanism exists
	External environment	1: Local authorities (such as: BISA and ISA directorates, local *khokimiyats*, or VCA officials) do not intervene in the decision- making process of irrigation water distribution at WCA-level
		0.5: External actors attempt at advising/advocating but their intentions never materialize
		0: Local authorities constantly interfere with WCA's internal water allocation decisions
Effective participatory water governance (EPG)	Frequency of meetings	1: Meetings with WCA members over CPR are held every day
		0.75: Meetings with WCA members over CPR are held once a week
		0.50: Group meetings for discussing CPR issues take place once a month
		0.25: Group meetings for discussing CPR issues take place few times a year
		0: No meetings happen at the WCA
	Participation of group members	1: All members attend frequent/regular meetings
		0.67: When members are unable to attend the meetings, they send their representatives
		0.33: Not all members/representatives are present during the meetings
		0: Very few members attend the meeting

Outcome	Measures	Definitions of fuzzy-set values
Improved maintenance of irrigation canals (IMC)	Nature-related transaction	1: Un-maintained canals have no major implications to other neighboring associations
		0: Un-maintained canals have negative externalities to other associations
	Engagement of external authorities	1: Local authorities do not intervene in WCA's canal maintenance activities
		0.5: Local authorities attempt at advising/advocating canal maintenance activities but their intentions never materialize
		0: Local authorities interfere with WCA's decision-making process on canal maintenance
	Mobilization of social activities	1: Members support mobilization of social activities (e.g. *khashars*) in canal maintenance and fully take part
		0.5: Not all WCA members are active in canal maintenance
		0: Members are reluctant to support and take part in collective canal maintenance activities
	Role of households	1: Local households provide their full support during canal maintenance activities
		0.5: Not all households are active in canal maintenance
		0: Local households do not provide full support during canal maintenance

4.3.2 Calibration of fuzzy sets

In fuzzy-set QCA, it is important that membership scores are assigned for the investigated cases (Schneider and Wagemann, 2010: 403). These membership scores are generated through calibration of sets (*ibid.*). During this process, a list of qualitative anchor points for each fuzzy set shall be developed to clarify how to distinguish a case that is more in than out in the membership score set (Ragin, 2000; Basurto and Speer, 2012). Three main thresholds in fuzzy set indicate the anchor points: 0 (full non- membership), 0.5 (cross-over point), and 1 (full membership). Theoretical arguments are required to determine whether the observed empirical evidences qualify for set membership scores above or below these anchor points (Schneider and Wagemann, 2010: 403). Since the calibration is crucial to fuzzy-set QCA, the researcher should be transparent, open, and replicable during the process of assigning membership scores (Ragin, 2006: 298).

The anchor points in this study were developed based on the theoretical considerations derived from Collective Action theory as well as empirical evidences supported by theoretical arguments of resource appropriation and participatory governance. This study followed Basurto and Speer (2012) technique to transform quantitative and qualitative data into membership scores. Accordingly, their technique of data calibration was employed, which includes the application of content analysis to the data in accordance with the series of criteria that are derived from both theory and case knowledge. Appendix 2 provides the list of conditions and the outcome with the final set membership scores.

5 DISCUSSION OF RESULTS

Once data matrix was developed for the study, fsQCA software was employed to run the analysis for determining necessary and sufficient conditions to achieve the high levels of outcome. Schneider and Wagemann (2010) inform researchers to carry out the analysis of necessary conditions first. The analysis of necessary conditions in fsQCA looks at which individual factors may be necessary for the outcome to take place (Kent, 2008). In an XY plot, all cases with high proportion of necessary conditions should be located around or below the bisecting line (*ibid.*).

The analysis of necessary conditions to achieve improved maintenance of irrigation canals within the territories of WCAs indicated that none of the three conditions alone, i.e. neither condition ACS nor PWA nor EPG is necessary for the outcome IMC on its own. The same finding was apparent for the complements of the three conditions, ~ACS, ~PWA, ~EPG. In this study, we use consistency score 0.90 as a threshold for accepting a condition to be necessary (Emmenegger, 2010: 12). As can be seen in Table 2, all consistency scores are below our threshold. Consistency and coverage were calculated using the fsQCA software (Rihoux and Ragin, 2009). According to Ragin (2006: 291), consistency assesses the degree to which the cases sharing a given condition agree in displaying the outcome under investigation. With another word, consistency indicates how closely the subset relation of cases is approximated. In the meantime, coverage assesses the empirical relevance or importance of a consistent subset (*ibid.*).

Table 2: Analysis of necessary conditions

Conditions tested	**Consistency**	**Coverage**
Appropriate Chairmanship Skills (ACS)	0.823	0.724
~ Appropriate Chairmanship Skills (~ACS)	0.593	0.627
Proper Water Allocation (PWA)	0.841	0.770
~ Proper Water Allocation (~PWA)	0.558	0.564
Effective Participatory Water Governance (EPG)	0.651	0.814
~ Effective Participatory Water Governance (~EPG)	0.779	0.607
Proper Water Allocation OR Effective Participatory Water Governance (PWA+EPG)	**0.904**	**0.730**
The tilde sign (~) refers to the negation of a condition (or absence)		

The analysis of necessary conditions can also be executed for unions of conditions (i.e. logical OR). Schneider and Wagemann (2007: 59) reiterate that good theoretical arguments are needed for combining the conditions. This procedure is called *functional equivalence* in QCA term. Therefore, we performed additional analysis to determine whether unions of conditions may be necessary to achieve improved maintenance of irrigation canals within WCA territories. The result shows that the term of PWA OR EPG (i.e. PWA + EPG) is necessary to achieve the outcome, meaning that PWA+EPG is a superset of IMC. At this combination, consistency score shows 0.904 with significantly high coverage. However, the presence of PWA OR EPG is not sufficient for attaining the presence of outcome.

In accordance with the result, one can summarize that the presence of proper water allocation or effective water participatory governance, or both is a necessary condition for having improved canal maintenance, but it may not be a sufficient condition. This finding corroborates our theoretical expectations that improved canal maintenance can not necessarily be attained with the presence of a single condition. Since the phenomenon under study is complex to explain, the result is also derived from causal complexity.

Graphical representation of the relationship of the necessary analysis is shown in Figure 2 below. As can be seen from this figure, most cases are around or even on the bisecting line. Recall, for necessity, each case's fuzzy membership score in A must be equal or greater than its fuzzy membership in outcome Y (i.e. $A \geq Y$). With another word, in XY plot, most cases shall be around or below the diagonal line. As we can see from Figure 2, most cases are indeed, around or below the diagonal line.

At the same time, however, there are few cases that are above the bisecting line. This means that while the presence of proper water allocation, effective participatory governance, or both is a necessary condition for the outcome to take place, their presence is not sufficient. The clear contradicting the argument necessity is WCA 9 (*K.Murtazaev*). Ragin (2000) suggests that when such cases appear, the researcher may reflect this as the condition that is 'usually' necessary for the outcome. He further reiterates that in such instances, it is important to provide appropriate theoretical and substantive argumentation and auxiliary evidence. In the case of *K.Murtazaev* WCA, despite having a low fuzzy membership score in PWA or EPG, fuzzy membership score in the outcome of this case was significantly higher. As can be seen from data matrix in Appendix 2, the fuzzy membership score for a condition PWA was set at 0.34 and a score for a condition EPG at 0.00. Nevertheless, the outcome was set at 0.70. When we closely consulted with the case, it was obvious that despite frequent cut-off water resources for members and the absence of effective participatory governance, the WCA was able to improve its canal condition. Local households were effectively supporting canal maintenance. Since WCA was located in the desert zone with difficulty to access to water resources and was rather considered as a downstream of a water course, un-maintained canals did not have major implications to neighboring WCAs or other actors situated in the adjacent area.

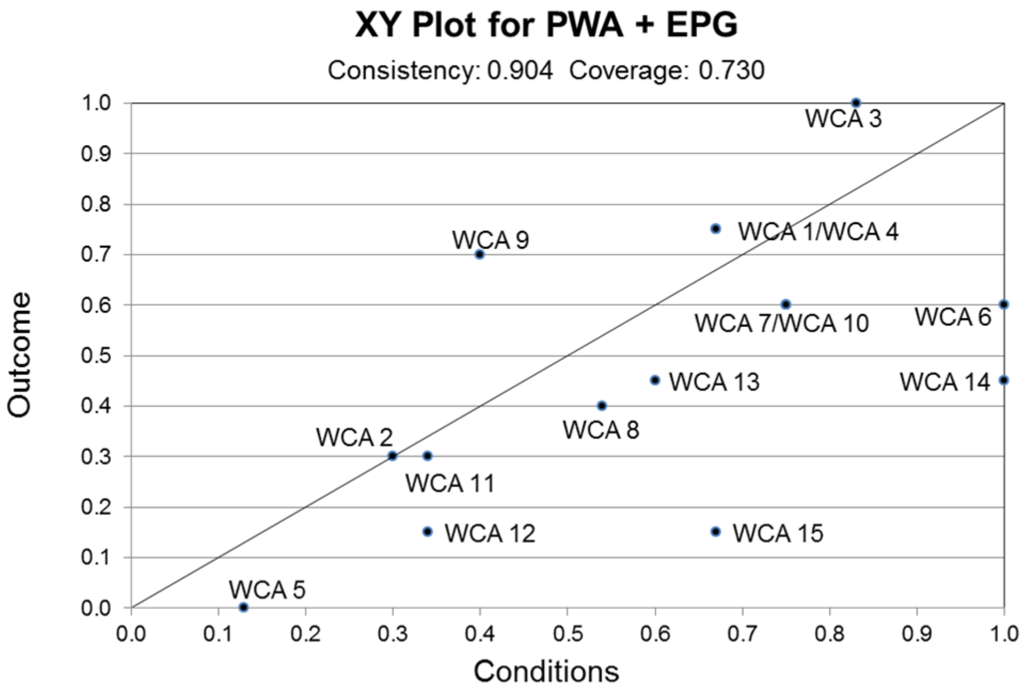


Figure 2: Necessary condition for the outcome 'improved maintenance of canal'

The result for sufficiency analysis highlighted that no single condition alone is sufficient to achieve improved maintenance of irrigation canals within the territories of WCAs. Since the analysis of the presence as well as the absence (~) of individual conditions for sufficiency to achieve the outcome did not answer the question, we then turned to the investigation of the combinations of conditions (logical AND). The results pointed out that the presence of ACS AND PWA AND EPG (i.e. ACS*PWA*EPG) is sufficient for achieving the outcome, meaning that ACS*PWA*EPG is a subset of IMC (Table 3). The consistency score shows 0.916 and the coverage value is 0.575, which are high and satisfying, respectively. This means that simultaneous occurrence of appropriate chairmanship skills and proper water allocation and effective participatory governance is sufficient for improved maintenance of irrigation canals. This finding corroborates our theoretical expectations, where improved canal maintenance can happen in the presence of several conditions. Therefore, it is reasonable to believe that when these conditions are present simultaneously, there is a great chance of improving CPR use within WCA territories. Truth table result is provided in Appendix 3.

Table 3. Sufficiency analysis

Solution	ACS*PWA*EPG	→	IMC
Single WCA coverage	WCA 3, WCA 6, WCA 10		
Consistency:	0.916		
Raw coverage:	0.575		
Unique coverage:	0.575		

The results of the sufficiency analysis are graphically displayed in Figure 3. Note that for a condition or a combination of conditions to be sufficient, all cases should be located around or above the bisecting line (i.e. A ≤ Y). In another word, a case's score on the outcome should not be lower than the level set by its score on relevant sufficient conditions. Recall, the contrast here with necessity. In this figure, we may note that most cases are around or even on the bisecting line. As was the instance with the necessity analysis, there was only one case but different – WCA 15 (*Khavzak Guliston Jilosi*) – clearly below the bisecting line, which contradicts the argument of sufficiency. The case of WCA 6 (*Kumrabot Chrotuk Suvi*) is rather close to the bisecting line that supports sufficiency condition. Ragin (2000: 114) reaffirms that it is usually difficult to find perfect subset relations for fuzzy sets than for crisp sets. This means that some more flexibility is needed and perfect sufficiency cannot be the only goal of such an analysis (*ibid.*).

As for the WCA 15 case, the higher membership scores in all explanatory conditions in comparison to the membership score on the outcome did not produce positive outcome. In fact, the result showed that despite the fact of having high level of chairmanship skills of the WCA manager together with proper water allocation mechanism but the absence of effective participatory governance does not lead to improved canal maintenance. When we looked at the case more closely, it was confirmed that WCA chairman has been working as the manager since its establishment – January 2007 – and had worked during the *kolkhoz* period as the main hydro-technician, but still, these characteristics did not help enforcing collective action among members to manage common pool resources in an effective way. Furthermore, proper water allocation for agricultural crops during the full vegetation season did neither improve nor lead to the positive outcome. During the discussion with resource users and personal observation, it was obvious that irrigation canals were in poor conditions. This is because WCA canals pass by many households who use water to irrigate their backyards but refuse participating in canal maintenance. There is no legal back-up to charge households and the WCA was incapable of addressing this constraint.

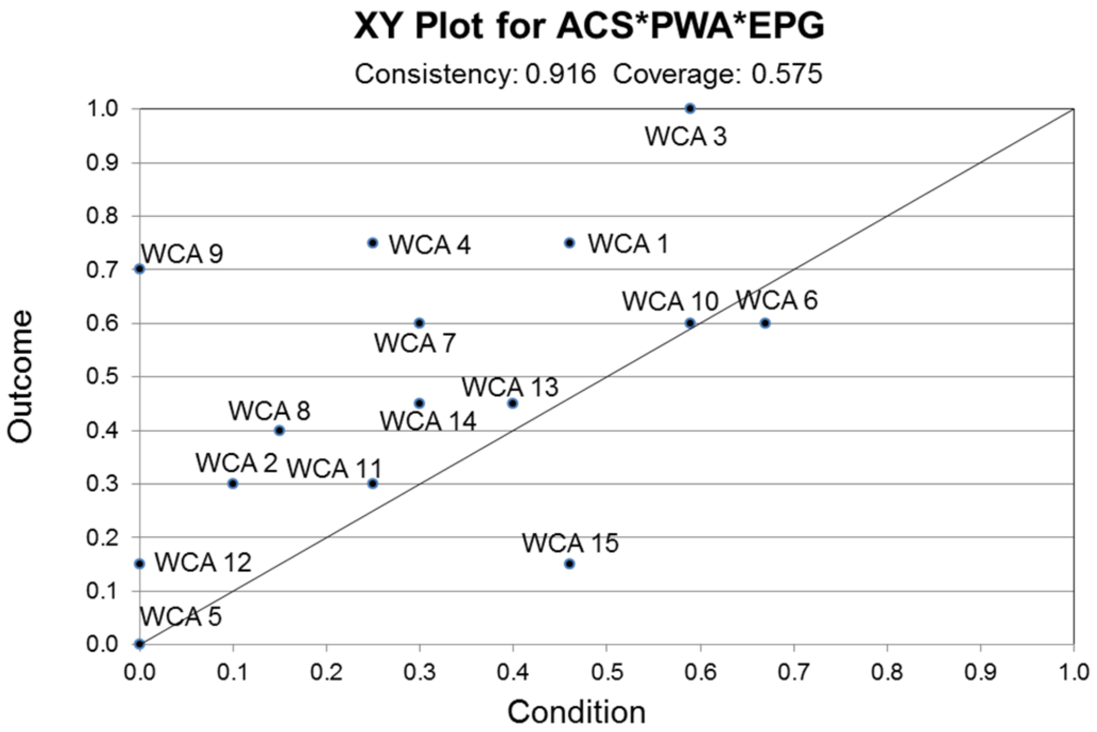


Figure 3: Plot of 'IMC' against 'ACS*PWA*EPG'

Overall, the results indicate that improved maintenance of irrigation canals is expected when high levels of three conditions are combined, i.e. appropriate chairmanship skills (ACS), proper water allocation (PWA) and effective participatory water governance (EPG). This is not a surprising finding as the theoretical arguments also highlight the importance of appropriate chairmanship skills, proper water allocation, and participatory governance that induce group of farmers to maintain their commonly owned canals in an effective manner. Through the analysis it was possible to prove that single condition alone is not sufficient but rather multiple conditions are involved in the management of CPRs. The combination of an appropriate chairman with charismatic leadership skills, high technocratic education and vast experience in the area, together with proper water allocation (uninterrupted access to irrigation water, clear dispute resolution mechanism over water allocation, and effective external environment) and effective participatory water governance (frequent WCA member meetings and full participation of the members) seem to motivate local resource users to effectively invest both financial and labor resources into canal maintenance. Combinations of these three conditions are found to be sufficient to ensure that group of farmers act collectively and achieve improved maintenance of canals.

According to the sufficiency analysis, WCA 3 (*Khalach Kalti*) had higher levels of canal maintenance in comparison to other neighboring WCAs. During the FGD, it was noted that this WCA had 2073 hectare of irrigated land, of which 52% were devoted to cotton production and about 30% for cultivating wheat. According to the chairman, the WCA decided to charge ISFs per hectare basis. The total amount of expected costs to distribute water to individual farm's territories was divided into the total hectare that WCA serves.

Since it was yet to install individual metering for each farm, the decision was made per hectare basis and amounted at UZS[1] 25,000 per hectare. It is important to note that about 50 percent of the members use lift irrigation. Electricity costs are thus an additional burden to farmers. Most WCAs that use pumps have huge debts from electricity companies. In order to overcome these challenges, the general assembly of the WCA decided to calculate the whole expenses for the entire year including potential electricity

costs and costs associated with pump maintenance. These costs were equally divided into all members. As a result, the amount charged for ISF reflects the costs for water distribution, electricity cost, and maintenance of pumps.

The initial hypothesis that derived from the theory included that the skills of a chairman is essential to improve the management of a CPR. In accordance with the *Khalach Kalti* WCA's formal papers, the WCA employed five workers: a chairman, a chief accountant, an agricultural machinery driver, and two *mirabs* (irrigators). In fact, the researcher was informed that the chairman was aware of water skills and did not employ *mirabs*. All activities related to water allocation within the territory was carried out by the chairman per se. The chairman was elected by the members during the WCA general assembly and has served since *kolkhoz* period. He was a head of *kolkhoz* during the socialism as well as the chairman during the post-*kolkhoz* period. The chairman acquired vast experience through working in the area and was well-accepted by the community and local authorities. According to local water officials and the WCA members, using his reputation and networking abilities the chairman was able to overcome issues related to water scarcity.

Additional advantage of the chairman included that he was a farmer and the member of the WCA, simultaneously. Therefore, he was less dependent on the members' ISF contribution as a salary. This was the case with the accountant as well who was a part- time employer at the WCA and was a farmer with about 100 ha of irrigated land. The priority of the WCA was to collect ISF contributions to mainly pay-off electricity costs and maintain irrigation facilities (including pumps). The salary was the least concern for both. Due to his own farm profits, the chairman was able to purchase a private car to monitor fields during the vegetation period for water allocation and organize collective action for maintaining irrigation facilities.

Despite the fact that the chairman was able to solve issues related to water allocation to his members, he was less optimistic about his future position. During the discussion, it was obvious that he was less enthusiastic to continue his job as he felt incompetence in water engineering. He obtained high degree with Agronomy specialization. Since he is not from water background, he seems to lack theoretical and empirical skills in water distribution and measurement. There were incidents when he was unable to verify the amount of water flowing to each member's field.

Another example that fulfilled sufficiency condition includes WCA 6 – *Kumrabot Chortuk Suvi.* This WCA is rather controversial case, where high levels of ACS, PWA, and EPG did not lead to the high levels of IMC (see Figure 3) but it was sufficiently adequate to achieve the outcome. Most interviewed WCA members reiterated that water delivery for farm gates have been

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[1] Local currency in Uzbekistan is called Soum (or UZS). 1 Euro ≈ 2700 UZS

sufficient and the chairman using his technocratic skills was able to establish a discipline among water consumers. The chairman had high degree from Irrigation University with the background of hydro-engineer. Using farmers' ISFs contributions, the chairman was able to install water metering to each member's gate and provided water according to the agreed amount. In the beginning of each vegetation period, it was noted that the chairman sits together with each farmer and determines the amount of water he/she needs. Unlike other WCAs, this chairman seems to know different approaches for calculating water amounts in case consumers break measurement devices. He has been in this position since end-2006. Note that this WCA was established in April 2006.

Members of the *Kumrabot Chortuk Suvi* WCA reaffirmed that frequent meetings are held in the WCA to discuss issues related to maintenance, water availability, and ISF contributions. Most members seem to attend these meetings and raise the questions related to maintenance activities and water disturbances by external actors (such as local households). All consumers agreed that collective action is important to conserve water resources and improve crop productivity. The chairman was accepted by the group of members as a competent leader to overcome various water-related challenges. There were some incidents that farmers attempted at free-riding and utilizing water without any payments for its service. However, the chairman was able to solve the issue, despite involving external actors, i.e. local prosecutors. At the end, the chairman was able to win the debate.

Last but not least, WCA 10 – *Labirut dehkonlari* – was also found as the positive case in our research. The head of the association graduated from Irrigation University with water engineering specialty. He has been as the head since its establishment. It is important to highlight that the head understands water issues very well and established a discipline among resource users. The WCA has 1138 ha total irrigated area and about 13 farmers are members of the association. According to the chief-accountant, ISF collection rate is also relatively high but most members contribute as an in-kind (e.g. hays, cotton stems, and wheat) because the state does not provide cash for strategic crops (cotton and wheat) in due time. According to the members, once a year General Assembly approves the chairman's candidacy and he continues his position. As of 2012, there were no major complaints about the chairman by the members. As for the access to irrigation water, in 2012 farmers received up to 6 times to irrigate cotton. This is a very good considering that in water shortage period, maximum 4 times of irrigation was allowed. When water is required to a farmer's field, he/she submits application to the WCA about 5 days prior to irrigation. Farmers believe that WCA is an important agency to take over water-related responsibilities. Without WCA, transaction cost of dealing with the state on water issues would have been extremely high. Members also noted that the WCA organizes meetings very often and the chairman seems to deal with external actors quite competently. If external actors intervene to WCA's decision-making process, the chairman would interfere and if distracting suggestions, oppose against their statements.

It is interesting to note that the result also provides some interesting regularities and crucial differences. Recall, despite higher levels of chairmanship skills and proper water allocation mechanisms, alone they are not sufficient conditions, as can be seen from WCA 15 (*Khavzak Guliston Jilosi*). Despite higher levels of ACS and PWA, this particular association has lower level of canal maintenance. The same phenomenon was found with WCA 1 (*Shohruhdaryo*

Sohili), where the presence of appropriate chairmanship skills of the manager and proper water allocation did not prevail to attain improved canal maintenance. The chairman has been in the position since February 2009 who had worked as an 'irrigator' in the area during the *kolkhoz* and follow-up *shirkat* eras. In fact, during the discussion it was clear that the reason why current head did not become the president of WCA at first was due to the family reason. He seemed to be involved in his daughter's medical check-ups. According to the members' statements, the chairman had a strict and nasty discussion with farmers from the beginning. He informed the members that he would do utmost to bring water to the territories of individual members and in return, farmers shall contribute towards ISF payments as well as canal maintenance activities. Otherwise, access to adequate amount of water would be cut-off. In the instance where WCA is unable to deliver water in due time with required amount, the WCA chairman accepted any penalties. As a result, mutual agreement with full of promises were agreed between the users and the WCA. The chairman and the members pointed to the fact that all parties have been fulfilling their promises. Unfortunately, the chairman as well as the members admitted that irrigation canals were in a poor state of the art. This is mainly due to the fact that WCA lacks agricultural machinery (i.e. excavator) to organize constant canal maintenance. On top of that, irrigation canals go through local households' backyards, where effective canal maintenance is difficult to organize. There were no appropriate mechanisms yet to involve vast number of local households into canal maintenance.

Another interesting and worth for exploration finding included that the presence of both proper water allocation and effective participatory governance simultaneously, do not lead to the presence of outcome either. This was the instance with WCA 13 – *Gishti Kavali Mirishkori* – where, the chairman with relatively low profile in regards to experience and education but assuring proper water allocation and having effective participatory governance within the WCA still could not support addressing the issue of canal maintenance. Focus group discussion with resource users indicated that irrigation canals were designed inappropriately, where WCA irrigated lands are located in a higher areas making water conveyance quite challenging. In short term, the WCA is able to solve but members seek long-term solution requiring huge investments for digging and reconstructing canals out of concrete. Additionally, maintenance seems to be very difficult due to the reluctance of local households to involve in canal maintenance. Since the irrigated area is located in a densely populated zone, the negotiation with local households over canal maintenance or canal construction had been challenging. WCA members reiterated that the association has no capacity to invest into large-scale canal construction or maintenance. WCA seem to be very incompetent to deal with such issues.

6 CONCLUSIONS

This study employed a fuzzy set QCA analytical tool to compare number of WCA cases to determine sets of conditions to explain the outcome 'improved maintenance of irrigation canals'. Collective action theory along with the concept of resource appropriation and the theory of participatory governance were employed to identify potential sets of conditions that may affect the use of common pool resources. However, there are limited literatures out there exploring the combination of conditions, as was used in this paper. Furthermore, sufficient/necessary conditions to attain the CPR use have also been less explored by scholars in the area of institutional economics.

Based on this analysis, we may summarize that in the context of Uzbek water consumers associations, none of the three conditions - developed in accordance with theoretical and empirical knowledge - alone is necessary to achieve improved maintenance of canals. The results indicate that the presence of proper water allocation or effective water participatory governance, or both is a necessary condition to expect a high level of canal maintenance within investigated WCA territories. However, their presence is not sufficient.

In the meantime, the analysis of sufficient conditions point out that improved maintenance of irrigation canals is expected when high levels of three conditions are combined, i.e. appropriate chairmanship skills, proper water allocation and effective participatory water governance, the outcome showed relatively high consistency score. Thus, it is reasonable to conclude that improved maintenance of irrigation canals is expected when all three conditions are present, simultaneously.

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REFERENCES

ABDULLAEV, I.; KAZBEKOV, J.; MANTHRITILAKE, H. and JUMABOEV, K. (2010): Water user groups in Central Asia: Emerging form of collective action in irrigation water management. In *Water Resources Management* 24 (5), pp. 1029–1043.

ANDERSSON, K. and van LAERHOVEN, F. (2007): From local strongman to facilitator: Institutional incentives for participatory municipal governance in Latin America. In *Comparative Political Studies* 40 (9), pp. 1085–1111.

BALAND, J. and PLATTEAU, J. (1996): Halting degradation of natural resources. Is there a role for rural communities? Rome, Oxford, New York: Food and Agriculture Organization of the United Nations; Clarendon Press; Oxford University Press.

BASURTO, X. and SPEER, J. (2012): Structuring the calibration of qualitative data as sets for Qualitative Comparative Analysis (QCA). In *Field Methods* 24 (2), pp. 155–174.

EMMENEGGER, P. (2011): Job security regulations in Western democracies: A fuzzy set analysis. In *European Journal of Political Research* 50 (3), pp. 336–364.

HAMIDOV, A. and THIEL, A. (2011): Institutional change in transition: Review of conditions for sustainable water consumers associations in semi-arid Uzbekistan. International Association for the Study of the Commons (IASC) European Meeting: Shared Resources in a Rapidly Changing World. Agricultural University of Plovdiv, September 14-17, 2011. Plovdiv, Bulgaria.

JURAYEV, U. and KHAMIDOV, M. (2012): Influence of phytoremediation plants on soil salts. Kiev, Ukraine.

KENT, R. (2008): Using fsQCA: A brief guide and workshop for fuzzy-set qualitative comparative analysis. Department of Marketing, University of Stirling, Scotland, UK, pp. 1–12.

MEINZEN-DICK, R.; RAJU, K. and GULATI, A. (2002): What affects organization and collective action for managing resources? Evidence from canal irrigation systems in India. In *World Development* 30 (4), pp. 649–666.

NOBLE, A.; HASSAN, M. and KAZBEKOV, J. (2005): Bright Spots in Uzbekistan, reversing land and water degradation while improving livelihoods: Key developments and sustaining ingredients for transition economies of the former Soviet Union. International Water Management Institute. Colombo, Sri Lanka (Research Report 88).

OSTROM, E. (1992): The rudiments of a theory of the origins, survival, and performance of common-property institutions. In *Making the Commons Work: Theory, Practice, and Policy*, pp. 293–318.

OSTROM, E. (2000): Private and common property rights. Workshop in Political Theory and Policy Analysis, and Center for the Study of Institutions, Population, and Environmental Change, Indiana University, United States, pp. 332–379.

POTEETE, A.; JANSSEN, M. and OSTROM, E. (2010): Working together: Collective action, the commons, and multiple methods in practice. Princeton, NJ [u.a.]: Princeton Univ. Press.

RAGIN, C. (2000): Fuzzy-set social science. Chicago: University of Chicago Press.

RAGIN, C. (2006): Set relations in social research: Evaluating their consistency and coverage. In *Political Analysis* 14 (3), pp. 291–310.

REICHERTZ, J. (2003): Die abduktion in der qualitativen sozialforschung. Über die entdeckung des neuen. 2nd ed. Wiesbaden: VS Verlag für Sozialwissenschaften.

RIHOUX, B. and RAGIN, C. (2009): Configurational comparative methods. Qualitative comparative analysis (QCA) and related techniques. Thousand Oaks: Sage.

SCHLUETER, A. and KOCH, M. (2011): Institutional change in the forest sector: Trust and mental models. In *European Journal of Forest Research* 130 (3), pp. 383–393.

SCHNEIDER, C. and WAGEMANN, C. (2010): Standards of good practice in qualitative comparative analysis (QCA) and fuzzy-sets. In *Comparative Sociology* 9 (3), pp. 397–418.

SCHNEIDER, C. and WAGEMANN, C. (2007): Qualitative comparative analysis und fuzzy sets: Ein Lehrbuch für Anwender und jene, die es werden wollen. Opladen [u.a.]: Budrich.

SPEER, J. (2012): Participatory governance reform: A good strategy for increasing government responsiveness and improving public services? In *World Development* 40 (12), pp. 2379–2398.

THEESFELD, I. (2009): From power misuse to leadership in Bulgaria's irrigation sector. Workshop with assistance of Indiana University Bloomington, pp. 1–27. Available online at http://dlc.dlib.indiana.edu/dlc/handle/10535/161.

WADE, R. (1987): The management of common property resources. Collective action as an alternative to privatization or state regulation. In *Cambridge Journal of Economics* 11 (2), pp. 95–106.

WAGEMANN, C. and SCHNEIDER, C. (2010): Qualitative comparative analysis (QCA) and fuzzy-sets: Agenda for a research approach and a data analysis technique. In *Comparative Sociology* 9, pp. 376–396.

ZAVGORODNYAYA, D. (2006): Water user association in the Republic of Uzbekistan. Theory and practice. PhD Thesis, Center for Development Research (ZEF). University of Bonn, Bonn, Germany.

Appendix 1: List of selected cases in Bukhara region

WCA Name	**Case**	**District**
Shohruhdaryo Sohili	WCA 1	Vobkent
Komil Zilol Suvi	WCA 2	
Khalach-Kalti	WCA 3	
Utabek	WCA 4	Romitan
Kokishtuvon Suv Yullari	WCA 5	
Kumrabot Chortuk Suvi	WCA 6	
Omon Kudrat	WCA 7	Peshku
Zandani-Zilol Suvi	WCA 8	
K Murtazaev	WCA 9	Shofirkon
Labirut Dehkonlari	WCA 10	
Karvonboshi Tezguzaro	WCA 11	
Sarmjon Mirishkori	WCA 12	Gijduvon
Gishti Kavali Mirishkori	WCA 13	
Govshun Mazragan Sahovati	WCA 14	
Khavzak Guliston Jilosi	WCA 15	

Appendix 2: Assigning membership scores for selected cases

Case	**Conditions**			**Outcome**
	ACS	PWA	EPG	IMC
WCA 1	0.87	0.67	0.46	0.75
WCA 2	0.27	0.10	0.30	0.30
WCA 3	0.93	0.83	0.59	1.00
WCA 4	0.40	0.67	0.25	0.75
WCA 5	0.67	0.00	0.13	0.00
WCA 6	1.00	0.67	1.00	0.60
WCA 7	0.43	0.75	0.30	0.60
WCA 8	0.15	0.15	0.54	0.40
WCA 9	0.40	0.34	0.00	0.70
WCA 10	0.90	0.75	0.59	0.60
WCA 11	0.25	0.34	0.30	0.30
WCA 12	0.43	0.34	0.00	0.15
WCA 13	0.40	0.60	0.54	0.45
WCA 14	0.46	1.00	0.30	0.45
WCA 15	0.63	0.67	0.46	0.15

Appendix 3: Truth table for the analysis of sufficient conditions for the outcome 'improved maintenance of irrigation canals'

ACS	PWA	EPG	Outcome	Consistency	Cases
0	0	0	0	0.646	WCA 2, WCA 9, WCA 11, WCA 12
1	**1**	**1**	**1**	**0.916**	**WCA 3, WCA 6, WCA 10**
0	1	0	0	0.867	WCA 4, WCA 7, WCA 14
1	1	0	0	0.877	WCA 1, WCA 15
0	0	1	0	0.840	WCA 8
0	1	1	0	0.881	WCA 13
1	0	0	0	0.733	WCA 5
1	0	1	0	0.898	No Cases

GULMIRA GAFAROVA , OLEKSANDR PEREKHOZHUK , THOMAS GLAUBEN

PRICING BEHAVIOUR OF KAZAKH, RUSSIAN AND UKRAINIAN EXPORTERS IN THE INTERNATIONAL WHEAT MARKET

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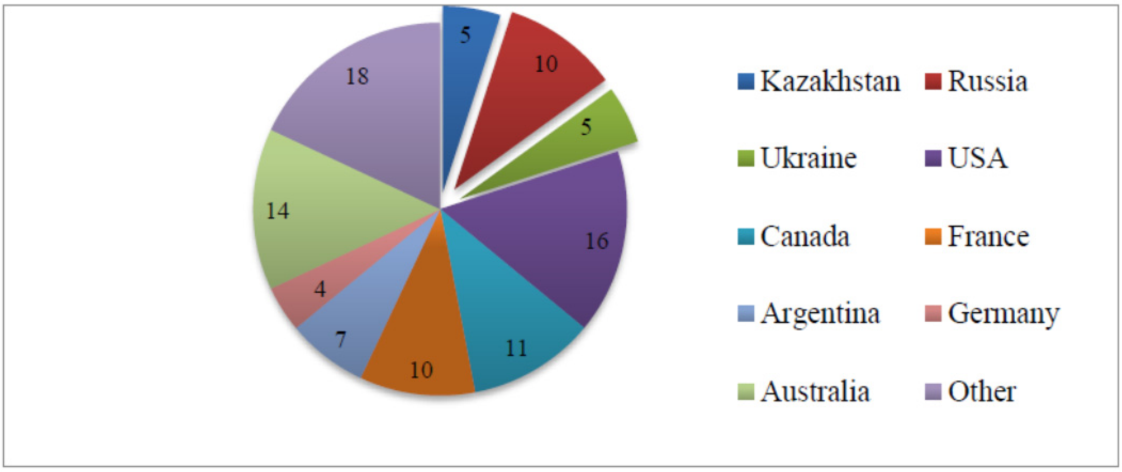
1 PROBLEM STATEMENT

It is argued that the pricing behavior of the main wheat exporters of the world - the USA, Argentina, the EU, Canada, Australia, Russia, Ukraine and Kazakhstan determines the world wheat prices and affects global food security in a large extent (OECD/FAO, 2012, p. 209). It is also broadly discussed that the former Soviet Union countries – Kazakhstan, Russia and Ukraine, (KRU) have more chances to raise grain production and support the world food security, since they have enough potential to expand grain area and increase yields (Tothova, Meyers and Goychuk, 2013). Due to the geographical location (being close to the European Union countries, Middle East and Northern Africa), steady domestic market, and close relationship between domestic and world prices, KRU countries are important players in international grain market (Lioubimtseva, 2010). Because of two reasons – restructuring total agricultural production, consumption and trade (moving to open market economies in the 1990s); and large increase in grain production (during the 2000s), KRU has become main grain exporting region (Liefert, Liefert and Luebehusen, 2013). Figure 1 shows that total share of KRU was 20% in 2012.

Figure 1. Export share of the main wheat exporters in 2012, (%)



Source: United Nations Commodity Trade Statistics Database

It is expected that Russia will achieve the highest export share (17%) in the wheat market in 2021 (OECD/FAO, 2012, p. 126-7). Changing market shares of main wheat exporters affect world price volatility significantly (OECD/FAO, 2012, p. 129). Different trade policies - export bans by Kazakhstan in 2007-08, and Russia in 2010; quotas by Ukraine in 2007-08; and export taxes by Russia in 2007-08 significantly affect the provision of the importing countries with wheat products and bring uncertainty to the world wheat market (Goetz, Glauben and Brümmer, 2010).

There are a lot of empirical studies which examine the pricing behavior of agricultural good exporters and find pricing-to-market behavior by grain exporters in the destination countries. By investigating mainly the U.S., Canadian and Australian wheat exporters' pricing behavior, Pick and Carter (1994), Yang and Lee (2001), Lavoie (2005) and others argue that wheat exporters exercise pricing to market behavior, meaning that they price discriminate (set different prices) and achieve different markup of prices over marginal costs in some destination countries due to the exchange rate volatility. One of the recent studies by Pall et al. (2013) considers pricing behavior of the Russian exporters and concludes that Russia can implement the price discrimination in Armenia and Azerbaijan, but it does not exert market power in the world wheat market.

2 RESEARCH QUESTION

The main goal of this study is to examine: how does the effects of exchange rate fluctuations on price markups differ across wheat exporting countries – Kazakhstan, Russia and Ukraine? If KRU countries are able to exercise pricing to market behavior and get market power in international wheat market for the period 1996-2012? Which exporting country is expected to adjust prices to achieve foreign currency price stability in the destination markets? Pricing-to-market model will be used to check the existence of market power.

3 METHODOLOGICAL APPROACH

In order to test the pricing behavior of Kazakh, Russian and Ukrainian exporters in international wheat market, the pricing-to-market model (PTM), which was introduced by Krugman (1986) and developed by Knetter (1989), will be extended in this study:

$$\ln p_{it} = \lambda_i + \theta_t + \beta_i \ln e_{it} + u_{it} \quad \forall i = 1, \ldots, N \text{ and } \forall t = 1, \ldots, T$$

where a dependent variable - p_{it} is a wheat export price in export country's currency to importing country i in period t. The independent variables - λ_i and θ_t represents the country effect and time effect respectively; e_{it} is the destination-specific exchange rate (ER) expressed as units of the domestic currency in export country's currency in period t. The parameter - β_i denotes the elasticity of the domestic currency export price with respect to the exchange rate. And finally, u_{it} is an i.i.d. error term $N(0, \sigma_u^2)$.

The PTM occurs when the exporters maintain or increase the export prices in response to the currency depreciation relative to the importer's currency. Krugman (1986) summarizes the PTM situation as the following: PTM occurs when export prices increases, or does not change as the currency of the importing country appreciates. PTM is price discrimination and arises when a change in bilateral ERs between an exporter and some buyers causes the changes in the ratio of prices paid by the buyer (Pall. et al., 2013). The PTM model investigates if an exporter can differentiate export prices in different importing countries in response to exchange rate shifts. The PTM is connected to markup over marginal cost, and so, imperfect competition (Jin and Milijkovic, 2008).

The historical bilateral ER data are available from the International Monetary Fund (IMF), OANDA – online ER source; and Russian Federal State Statistics Service (ROSSTAT). Exchange rate data for Tajikistan, Turkmenistan and Uzbekistan are built by converting old currencies to the new one. Similarly, exchange rate data for the EU countries which accepted the euro in 1999 is fixed to the euro for the 1996-1998 periods. Export quantity and value data are provided by the United Nations Commodity Trade Statistics Database (COMTRADE). The harmonized code description for the wheat is categorized as "wheat and meslin" (HS code is 1001).

The number of destination countries varies across the exporting countries: 46, 69 and 62 for Kazakhstan, Russia and Ukraine, respectively. However, the data is unbalanced panel, since not all the countries import wheat from Kazakhstan, Russia and Ukraine each year.

4 DISCUSSION OF RESULTS

The PTM model is estimated by using a fixed-effects regression for each exporting countries separately. According to the regression results, there is evidence of PTM (significant β) in 7 out of 46 observed countries for Kazakhstan[1], 4 out of 69 for Russia[2]; and 7 out of 62 for Ukraine[3]. The Kazakh wheat exporters stabilize the local currency prices in Albania and the United Kingdom (negative β), but amplify the effect of exchange rates in Azerbaijan, Cyprus, Germany, Dominica and Lithuania (positive β). Similarly, the Ukrainian wheat exporters stabilize the local currency prices in Djibouti, Egypt and Eritrea, but amplify the effect of exchange rates in Belgium, Bulgaria, Thailand and Uzbekistan. However, the Russian wheat exporters amplify the effect of exchange rates in all the countries, where they exercise PTM behavior.

Additionally, Kazakh exporters observe price discrimination with constant markup (in case of significant λ, but not significant β) in Greece, Iran, Lebanon, Moldova, Poland, Tajikistan and Uzbekistan. In the same way, Russia achieves price discrimination with constant markup in Armenia, Bangladesh, Germany, Finland, the United Kingdom, Iran, Iraq, Syrian Arab Republic and Turkmenistan, whereas Ukraine in Philippines.

In case of other countries the null hypothesis of competitive pricing cannot be rejected (λ and β are not significant). It means, Kazakhstan in 32 countries (including Kyrgyz Republic and Turkmenistan); Russia in 56 countries (including Kyrgyz Republic, Tajikistan and Uzbekistan) and Ukraine in 54 countries (including Tajikistan) either face with the perfect competition, or get common markup with their competitors in the imperfect market. It should be mentioned that Kyrgyz Republic and Turkmenistan is not included in the estimation for Ukraine, since the number of observations for those countries was few and dropped from the sample.

In conclusion, especially Kazakhstan owns large market share in Central Asian countries over the last 17 years. Kyrgyz Republic is a wheat competitive market for the Kazakh and Russian wheat exporters. Kazakhstan achieves price discrimination with constant markup in Tajikistan and Uzbekistan, but acts as a perfect competitor in Kyrgyz Republic and Turkmenistan. Russia

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1 Albania, Azerbaijan, Cyprus, Germany, Dominica, the United Kingdom and Lithuania

2 India, Japan, Romania and Saudi Arabia

3 Belgium, Bulgaria, Djibouti, Egypt, Eritrea, Thailand and Uzbekistan

faces with perfect competition on all Central Asian countries, except Turkmenistan. Ukraine pursues PTM in Uzbekistan, but competes with other exporters in Tajik wheat market. The PTM results for Kazakhstan are not expected, since Kazakhstan is the main wheat exporter to Central Asian countries and it was anticipated that it gets market power and exercises pricing to market behavior in those countries. Although Central Asian countries imports more than 90% from Kazakhstan, Kazakh exporters do not price discriminate in these countries, but either face with competition or get constant markups.

In case of Caucasian countries, KRU countries do not have enough market power to price discriminate; they face with perfect competition in Georgia. Although Kazakhstan gets market power in Azerbaijan, Russia and Ukraine compete with other exporters in Azerbaijani wheat market.

Most interesting results are obtained for those destination countries, which import in big quantity from KRU countries. For example, KRU countries face with perfect competition in Egypt (except Ukraine, since it pursues PTM), Turkey, Republic of Yemen, Greece and Spain.

The general conclusion of PTM model is that KRU countries still are not the biggest exporters of wheat, which exercise price discriminating behavior in the destination countries. However, they have great opportunities to become important players in the international wheat market.

REFERENCES

Goetz, L., Glauben, T. and Brummer, B. (2010): Impacts of Export Controls on Wheat markets during the Food Crisis 2007/2008 in Russia and Ukraine. Selected Paper, Agriculture and Applied Economics Association 2010 Annual Meeting, July 25-27, Denver, Colorado, USA

International Monetary Fund (IMF), http://www.imf.org/external/

Jin H. J., and Milijkovic, D. (2008). Competitive structure of U.S. Grain Exporters in the world market: A dynamic panel approach, Journal of International Economic Studies, Vol. 12(1): 33-63

Knetter, M. M. (1989): Price discrimination by U.S. and German Exporters. The American Economic Review, 79(1): 198-210

Krugman, P. (1986): Pricing to Market when Exchange Rate Changes. Working Paper No. 1926, Cambridge, MA, National Bureau of Economic Research

Lavoie, N. (2005): Price discrimination in the Context of vertical differentiation: An application to Canadian Wheat Exports. American Journal of Agricultural Economics, 87(4): 835-854

Lioubimtseva, E. (2010): Global food security and grain production trends in Central Eurasia: Do Models Predict a New Window of Opportunity? National Social Science Journal, Vol. 41 (1): 154–165.

Liefert, O., Liefert, W. and Luebehusen, E. (2013): Rising Grain Exports by the Former Soviet Union Region Causes and Outlook, ERS/USDA Outlook WHS-13A-01.

OANDA http://www.oanda.com/currency/converter/

OECD/FAO. (2012): OECD-FAO Agricultural Outlook 2012-2021, OECD Publishing Pall, Z., Perekhozhuk, O., Teuber, R. and Glauben, T. (2013): Are Russian Wheat Exporters able to price discriminate? Empirical Evidence from the Last Decade. Journal of Agricultural Economics, 64(1): 177-196

Pick, D.H. and Carter, C.A. (1994): Pricing to Market with Transactions Denominated in a Common Currency. American Journal of Agricultural Economics, 76(1): 55-60

Russian Federal State Statistics Service (ROSSTAT) http://www.gks.ru/wps/wcm/connect/ rosstat_main/ rosstat/en/main/

Tothova, M., Meyers, W. and Goychuk, K. (2013): Productivity growth and variability in KRU: evidence and prospects. The Public Trade Policy Research and Analysis Symposium "Productivity and Its impacts on Global Trade", June 2-3, 2013, Seville, Spain.

United Nations Commodity Trade Statistics Database http://comtrade.un.org/

Yang, S-R. and Lee, W-J. (2001): Exporters' Market Power in Agricultural import markets in Korea. American Agricultural Economics Association 2001 Annual meeting, Chicago, U.S.

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THE IMPACT OF WTO ACCESSION GROWTH ON AGRICULTURAL SECTOR OF TAJIKISTAN

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1 PROBLEM STATEMENT

The agriculture sector in Tajikistan is important for economic growth and expanding of export potential, thus to improve country's balance of payment. The share of agriculture in the national GDP amounts to almost 20 percent. Transfer from the agricultural sector to the state budget in the form of tax revenue in 2009 was equal to 33 percent. The share of the agriculture sector in exports (via cotton, vegetables and fruits) was 30 percent in 2008 (AS, Tajikistan in Figures, 2010).

Tajikistan is part of multilateral free trade agreements within the CIS[1], Eurasian Economic Community, the Economic Cooperation Organization (ECO) and CAREC[2]. The country also has bilateral trade agreements with most CIS countries and Pakistan, Afghanistan, Turkey, China and Iran. The main trading partners are Afghanistan, China, the European Union, Kazakhstan, Iran, the Russian Federation and Turkey.

Due to participation in regional trade agreements, such as the CIS free trade zone agreements and Eurasian Economic Community (EAEC) the share of duty-free imports is 80 percent of total imports. Many goods under the EAEC agreement come under preferential treatment and are untaxed (ADB, CAREC countries, 2012). Assessing the level of import tariff protection in Tajikistan is complicated by the complex tariff system (ADB, CAREC countries, 2012). The simple average import tariff for all goods in Tajikistan with most favoured nations (MFN) were 8.4 percent for 2000-2004 and 7.9 percent for 2005-2012. For agriculture commodities, the simple averages were 10.5 and 11.4 percent respectively, for non-agricultural commodities the simple averages were 8.1 and 7.4 percent respectively (WTI, Tajikistan: Trade at a glance, 2009/10). Until January 2013, Tajikistan used mixed, specific and combined import tariffs. During 1999-2005, the simple un-weighted average import tariff was 7.5 percent, which had increased by 2.5 percent compared to 1995-1998. In 2005, the maximum tariff rate was 15 percent and custom fees levied on imports were 0.15 percent (ADB, CAREC countries, 2012). Export taxes were levied for two commodities – cotton fiber (10 percent) and 3 percent for aluminum (Laws of the Republic of Tajikistan on export tax for Cotton Fiber and Primary Aluminum). Tajikistan applied for WTO membership on the 29th of May 2001. After eleven years of negotiations, on 10th of December 2012 the General Council paved the way for Tajikistan's membership in the WTO by approving its accession package. Parliament (*Majlisi Milli*) of

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[1] CIS stands for Commonwealth of Independent States.

[2] CAREC stands for Central Asia Regional Economic Cooperation (CAREC) program, includes Afghanistan, Azerbaijan, the People's Republic of China, the Republic of Kazakhstan, the Kyrgyz Republic, Mongolia, Tajikistan, and Uzbekistan.

the Republic of Tajikistan, on the 9th of January 2013, ratified the accession and the country became a full-fledged member of the WTO on the 2nd of March 2013.

Tajikistan has committed to fully applying WTO provisions after the accession without any resources to transitional periods. As part of the accession, The weighted average "bound" tariffs for Tajikistan, based on agreement, is 8%, for agricultural 10.4 percent and for non-agricultural 7.6 percent. Tajikistan shifted its own tariffs to the *ad valorem* methodology under the WTO Harmonized System of classification.

The impacts of WTO accession on producers, consumers, state budget overall welfare change still have not been assessed. This paper is call to fill this research gap.

2 OBJECTIVES AND RESEARCH QUESTIONS

The objective of the study is analysing the impact of Tajikistan WTO accession on agricultural sector of Tajikistan. The research questions are:

a.) How country's recent WTO accession will influence the agricultural sector of Tajikistan?

b.) How consumers, producers and state budget will affect under country's WTO accession?

In this paper, all abovementioned research questions are tested under official and ten percent depreciated (experimental) exchange rates.

3 METHODOLOGICAL APPROACH

The main research tool for the analysis is a **partial-equilibrium net trade model**.

The partial equilibrium model is AGRISIM. The Model builds on a GAMS interface and uses GAMS/CONOPT2 – a non-linear optimization package.

AGRISIM model includes 17 countries and the rest of the world (ROW). The 27 countries of the European Union are considered one region (EU). The difference between the World and the 17 specific countries and 1 region included in the model are represented by ROW. Commodities included into AGRISIM are 14[3].

The initial supply, demand and income elasticities are taken from the SWOPSIM database. The new elasticity of supply is calculated using initial elasticity, bounds and weights around the initial elasticity.

In the Model two important exogenous factors are taken into account:

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3 Wheat, maize, coarse grain (oat, barley and rye), sugar, cotton, rice, soybean, oilseeds, beef, milk, pork, mutton and goat, poultry and eggs.

- Labour migrant remittances which lead Tajik national currency appreciation against the foreign exchange. Thus, one set of scenario run under 10 percent experimental depreciation of national currency against the foreign exchange;
- Population growth factor.

The latter included as a shift factor into the Model for all countries and region in order to reveal the global demand, supply and price changes.

The new elasticity of supply is calculated using initial elasticity, bounds and weights around the initial elasticity, commodity balances (domestic production, stock changes, net trade, feed use, seed use, waste, food demand, and statistical adjustment), total population in each country, producer prices, production quotas, subsidies (input, direct, general and single commodity transfer) and a multiplier for subsidies. While the new elasticities of demand and income is calculated using initial elasticities, bounds and weights around them, commodity balances and consumer prices.

The changes of consumers and producers welfare in scenario as a deviation from the base assumption are shown in Eq. 1 and Eq.2 respectively.

$$R^{C}_{i,r,sc} = -1 * \left[\frac{D^{F}_{i,r}}{\prod_j (p^{c}_{i,r})^{\varepsilon^{s}_{i,j,r}}}\right] * \left[\prod_j (P^{C}_{i,r,sc})^{\varepsilon^{D^F}_{i,j,r}}\right] * \left[\frac{\left(1+Sc^{\delta F}_{i,r}\right)}{100} * \frac{1}{1+\varepsilon^{D^F}_{i,r}}\right] * \left[\frac{((P^{C}_{i,r,sc})^{(1+\varepsilon^{D^F}_{i,r})}) - ((P^{C}_{i,r,BA})^{(1+\varepsilon^{D^F}_{i,r})}))}{1000}\right] \quad \text{Eq.1}$$

with:

$\left[\frac{D^{F}_{i,r}}{\prod_j (p^{c}_{i,r})^{\varepsilon^{s}_{i,j,r}}}\right]$ = Calibration parameter of demand function for commodity i in region r;

$\left[\prod_j (P^{C}_{i,r,sc})^{\varepsilon^{D^F}_{i,j,r}}\right]$ = Own and cross price elasticity of consumer price in scenario for commodity i in region r;

$\left[\frac{\left(1+Sc^{\delta F}_{i,r}\right)}{100}\right]$ = Shift of demand in scenario for commodity i in region r;

$1+\varepsilon^{D^F}_{i,r}$ = Change in consumer surplus for commodity i in region r;

$P^{C}_{i,r,sc}$ = Consumer price in scenario for commodity i in region r;

$P^{C}_{i,r,by}$ Consumer price in base year for commodity i in region r.

$$R^{P}_{i,r,sc} = \left[\frac{S_{i,r,by}}{\prod_j (P^{IP}_{i,r,by} - P^{Quo}_{i,r,by})^{\varepsilon^{S}_{i,j,r}}}\right] * \left[\prod_j (P^{IP}_{i,r,sc})^{\varepsilon^{S}_{i,j,r}}\right] * \left[\frac{(1 + Sc^{\delta S}_{i,r})}{100}\right]^{dt} * \left[\frac{P^{IP}_{i,r,sc}}{P^{IP}_{i,r,by}}\right] * \left[\frac{1}{1 + \varepsilon^{S}_{i,r}}\right] * \left[\frac{((P^{IP}_{i,r,sc} - P^{Quo}_{i,r,sc})^{(1+\varepsilon^{S}_{i,r})}) - ((P^{IP}_{i,r,by} - P^{Quo}_{i,r,by})^{(1+\varepsilon^{S}_{i,r})})}{1000}\right] \quad \text{Eq.2}$$

with:

$\left[\frac{S_{i,r,by}}{\prod_j (P^{I}_{i,r,by} - P^{Quo}_{i,r,by})^{\varepsilon^{S}_{i,j,r}}}\right]$ = Calibration parameter of supply function for commodity i in region r;

$\left[\prod_j (P^{IP}_{i,r,sc})^{\varepsilon^{S}_{i,j,r}}\right]$ = Own and cross producer incentive price elasticity for commodity i in region r;

$\left[\frac{(1 + Sc^{\delta S}_{i,r})}{100}\right]^{dt}$ = Shift of supply function in scenario for commodity i in region r;

$\left[\frac{P^{IP}_{i,r,sc}}{P^{IP}_{i,r,by}}\right]$ = Ratio of producer incentive price for commodity i and region r in scenario and base years;

$1 + \varepsilon^{S}_{i,r}$ = Change in producer surplus for commodity i in region r;

$P^{IP}_{i,r,sc}$ = Producer incentive price in scenario for commodity i in region r;

$P^{IP}_{i,r,by}$ = Producer incentive price in base year for commodity i in region r;

$P^{Quo}_{i,r,sc}$ = Price of quota in scenario for commodity i in region r;

$P^{Quo}_{i,r,by}$ = Price of quota in base year for commodity i in region r.

Using the respective equations the model also calculates production, yields, seed and feed used, food demand, area allocated to each crop and/or number of livestock, waste, net trade, prices (reference country border price, border price, producer price, producer incentive price, retail price, quota rents, minimum farmgate price, transmission of border price into domestic market, farmgate price to producer incentive price, farmgate price to retail price), production quota, clearing of the market per level and overall market, income and population growth as shift factors, producer and consumer surplus, budget and total effect of change in policy.

4 SIMULATED SCENARIOS AND RESULTS

"Basis for simulated scenarios". Many studies are devoted to the impact of remittances on development of different sectors of an economy and on exchange rate changes in developing worlds (for instance see: Cox Edwards and Ureta, 2003; Woodruff and Zenteno, 2007; Fajnzylber and Lopez, 2008; Yang (2008); Adams and Page, 2004;, Acosta et al. 2008; Acosta, Lartey and Mandelman, 2007; Lopez, Molina, and Bussolo, 2007; Mundaca 2005, Acosta et al. 2009;

Amuedo-Dorantes and Pozo, 2004; Acosta, Lartey, and Mandelman, 2007; Lartey, Mandelman, and Acosta, 2008; Amuedo-Dorantes and Pozo, 2004, Rajan and Subramanian, 2005; Winters and Martins 2005; Lopez, Molina, and Bussolo, 2007.

Calculation of the set of exchange rates for Tajikistan clearly shows that the domestic currency during the last 6 years has appreciated against foreign currencies, due to the stable inflow of remittances, although the country has a trade deficit where imports exceed exports by 2.5-3 times. Thus, the model was run under the *official exchange rate* and under the 10 percent *depreciation (experimental) of exchange rate*. The latter enables examination of the effects of exchange rate changes on producers and consumers welfare changes.

Another important factor which was taken in this paper into account is population growth. Tajikistan faces rapid population growth due to its high birth rate. Population growth leads to demand increases and shifts the demand curve upward along the supply curve. In this case, if domestic demand increases owing to population growth, it will not necessarily entail domestic supply growth, so imports will increase. Taking into consideration that Tajikistan has limited land resources and stable population growth is in place, the welfare effect will be significant. Considering a population growth factor for all countries enables showing the impact of global demand change. Thus, for all countries, a population growth factor is considered in both exchange rates. For Rest of the World (ROW) countries, a weighted annual population growth is calculated. Such a shift factor allows showing global population growth in supply and demand changes in Tajikistan. The project year being 2016 allows revealing the effect in the nearest future.

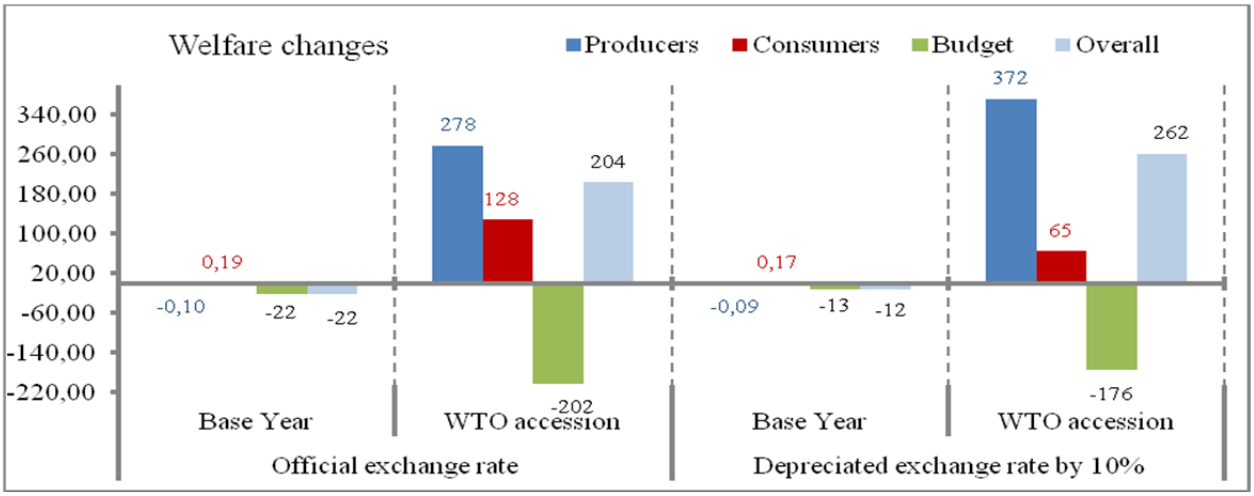
"Interpretation of the results". WTO accession which assumes the liberalization scenario reveals the impact of applying bounded ad valorem tariffs of the WTO, on welfare change for all countries and region included into the Model.

"Welfare changes". The Model reveal the changes on supply, demand, feed, producer, consumers, border and producer incentive price, yield changes, budget effect, nominal rate of protection changes, production activity levels, supports of producers, etc. In this paper due to limitation of its length will interpreted and discussed the changes on producers, consumers and overall welfare changes, and overall budget effect.

Theoretically, if the gains exceed the losses, the Kaldor-Hicks criterion will be met[4]. In general, should expect an improvement in the welfare of both producers and consumers, compared to the base year, under both official and depreciated exchange rates. The effect on producer gains is significantly higher under a depreciated exchange rate. A ten percent depreciation of the national currency in foreign exchange leads to an increase of producer gains up to 34 percent, compared to the same using the official exchange rate **(Figure 1).**

[4] An outcome is efficient if the gain of gainers exceeds the loss of the losers; in welfare economics this is known as the Kaldor-Hicks criterion. Named after Nicholas Kaldor and John Hicks, also known as Kaldor– Hicks efficiency.

Figure A1. Welfare change

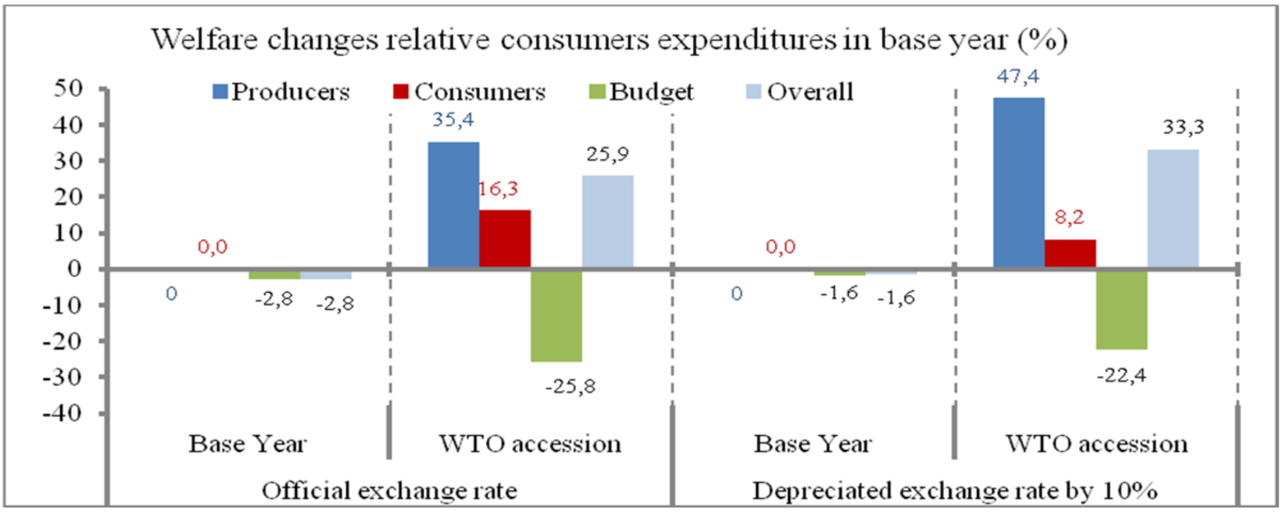


Source: own compilation based on AGRISIM simulation results

The reverse situation can be expected in the case of consumers, i.e. their gains are higher under the official exchange rate, so that consumer gains are 2 times higher than in WTO accession scenario at the official exchange rate, rather than at a 10 percent depreciation of the TJS against foreign currencies. In WTO accession scenario, one should definitely and logically expect a loss to the budget under both exchange rates. Overall gains in WTO accession scenario are 28 percent higher under a depreciated exchange rate, than under the official exchange rate **(Figure 1).**

Welfare changes relative consumer's expenditure and relative to producer revenue in base year are reveal in figures 2 and 3 respectively. The budget loses, while producer, consumer and overall welfare gains compared to the base year. The losses of budget are less under a depreciated rather than the official exchange rate. The gain of producers and overall gain in liberalization scenarios under a depreciated exchange rate exceeds the same figure under the official exchange rate. The inverse case can be observed in the case of consumers, i.e. the percentage gain of consumers under the official exchange rate exceeds the same under a depreciated exchange rate **(Figure 2).**

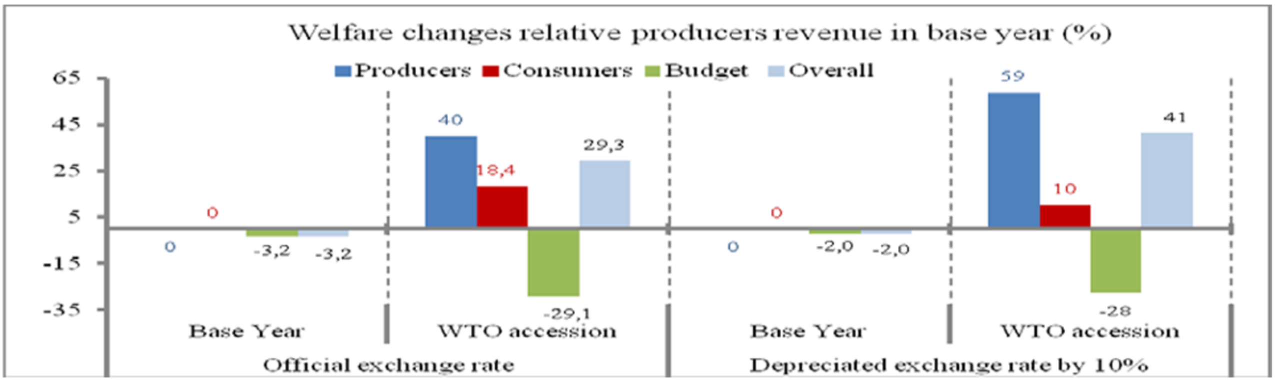
Figure A2. Welfare change relative to consumer expenditure in a base year



Source: own compilation based on AGRISIM simulation results

The budget will lose relative to producer revenue in the base year. Producer, consumer and overall welfare will improve and the improvement under a depreciated exchange rate exceeds the improvement under the official exchange rate **(Figure 3).**

Figure A3. Welfare changes relative to producer gross revenue in a base year



Source: own compilation based on AGRISIM simulation results

The simulated above scenarios further are allow the laying of the basis for policy implications.

5 DISCUSSION

Turning back now to the research questions, discussion part will be based on state budget effects, producer, consumer and overall welfare changes under the influence of remittances, population growth, and WTO accession scenario.

Many studies have theoretically confirmed and empirically proved that as a result of the depreciation of a national currency, commodities produced in the country become relatively cheaper, and the other way around.

This study shows that, as a whole, remittances play an ambiguous role in the development of different sectors of economy. On the one hand, remittances can become a cause of growth of some sectors of the economy (transportation, trade, financing, etc.), while on the other hand, they are an obstacle to the development of some real sectors of the economy (manufacturing, agriculture, etc.). Poverty reduction, growth of the transport sector, the construction boom in the private sector, growth of the trade sector, an increase in aggregate demand, reduction of the level of unemployment tension in domestic labour markets, an increase in the paying capacity of the population, etc., are among the positive effects of labour migration and consequent remittances. The negative effects of labour migration and remittances are: the effect of foreign purchases (the excess of imports over exports), inflation, stagnation of some sectors of the economy and might the cause of appearance of symptoms of Dutch Disease, the strengthening of the national currency, increasing consumer price indices, interest rate growth during the economic boom, etc.

What should be noted, in general, is an improvement in the welfare of both producers and consumers, in WTO accession scenario, compared to the base year, under both official and depreciated exchange rates.

This study has showed that the steady inflow of labour migrant remittances is cause for appreciation of the national currency, which results in increased domestic demand. The increase in consumption in the country is largely offset by imports, as domestic producers become less competitive compared to foreign producers, due to the strengthening of the national currency.

An experimental ten percent depreciation of the national currency in foreign exchange has shown that in WTO accession scenario compared to the base year, production of agricultural products increases while the increase is less under the official exchange rate.

The effect on producer gains is significantly higher under a depreciated exchange rate. A ten percent depreciation of the national currency in foreign exchange leads to an increase of producer gains up to 34 percent, compared to the same using the official exchange rate. The reverse situation can be expected in the case of consumers, i.e. their gains are higher under the official exchange rate, so that consumer gains are 2 times higher than in WTO accession scenario at the official exchange rate, rather than at a 10 percent depreciation of the TJS against foreign currencies.

One should definitely and logically expect a loss to the budget under both exchange rates. Although, it should be noted that the loss to the budget is 15 percent less, in WTO accession scenario, under a depreciated exchange rate than under the official. Overall gains in WTO accession scenario are 28 percent higher under a depreciated exchange rate, than under the official exchange rate.

The net trade situation for all commodities will be worse under the official exchange rate than a depreciated exchange rate. In other words, the net trade situation will remain unchanged or improve more under a depreciated exchange rate compared to the situation under the official exchange rate.

To conclude, producer gains exceed losses by consumers under a depreciated exchange rate. The effect of the country's accession to the WTO has a positive effect both on producers and consumers, with substantial losses to state budget. However, producer and consumer gains prevail over budget loss and therefore an overall gain will be ensured, thus Kaldor-Hicks criterion will met. The effect of producer and overall gains are more, losses by consumers and in the budget are less under a depreciated exchange rate. The depreciation of the national currency ensures an increase in producer and a decrease in consumer welfares. The overall effect is smaller in simulated scenarios under the official exchange rate.

6 CONCLUDING REMARKS

Agriculture plays a significant role in the economic growth of Tajikistan. There is no implicit support of agricultural producers through concession on taxes and interest rates. In the first half of the 1990s, all prices were liberalized and many trade barriers were removed. Now Tajikistan is still among the countries with economies in transition. After 12 years of negotiations, the country, on 2 March 2013 became a full- fledged member of the WTO.

As a whole, the simulated scenarios allow assessment of the changes in supply and demand of agricultural products within the country, net trade status changes, producer and consumer price changes, state budget, producer and consumer effects of different policy option. Moreover, simulated scenarios enable respective conclusions, thereby the basis for policy-related recommendations, as well as propositions for further research.

"Policy Implication". The government should avoid any taxation of agricultural sector, including the export tax (in case of cotton). These steps allow maximising producer's and consumer's welfare, will improve country's net trade situation and balance of payment (BoP). Elimination of any kind of intervention in the agricultural sector, especially in cotton sector, further, will lay the basis for expanding production, maximising export potential and minimising imports, thus, leading to an improvement of the country's balance of payment.

The government within the WTO agreement should financed expenditures for the provision of services such as research and development, training, inspection, infrastructure, public stockholding, and marketing and promotion. This step will allow increasing farmer income from agriculture and make them less vulnerable to economic downturn, remittances decrease and reduction of other sources of income.

REFERENCES

Acosta, Pablo, Cesar Calderón, Pablo Fajnzylber, and Humberto Lopez. 2008. What is the impact of international remittances on poverty and inequality in Latin America? World Development 36, no. 1

Acosta, Pablo A., Emmanuel K.K. Lartey, and Federico S. Mandelman. 2007. Remittances and the Dutch disease. Federal Reserve Bank of Atlanta Working Paper 2007-8

Acosta P. A., Baerg N. R., Mandelman F. S. November 2009. Financial development, remittances, and real exchange rate appreciation. Federal Reserve Bank of Atlanta. Economic review. Available at www.frbatlanta.org/filelegacydocs/er09no1_ABM.pdf

Adams, Richard H., Jr., and John Page. 2005. Do international migration and remittances reduce poverty in developing countries? World Development 33, no. 11

Agency on Statistics under the President of the Republic of Tajikistan. "Agriculture sector in Tajikistan", 2005 and 2010.

Agency on Statistics under the President of the Republic of Tajikistan. "Tajikistan in Figures", 2010.

Amuedo-Dorantes, Catalina, and Susan Pozo. 2004. Workers' remittances and the real exchange rate: A paradox of gifts. World Development 32, no. 8.

Armington, Paul, 1969, "A Theory of Demand for Products Distinguished by Place of Production", International Monetary Fund Staff Papers, XVI (1969), 159-78.

Caporale G.M., Gil-Alana L. A., Mudida R., September, 2012. Testing the Marshal- Lerner Condition in Kenya. Discussion Paper, DIW Berlin. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2160769

Cheng F., Orden D., 2006. Exchange rate alignment and producer support estimates (PSEs) for India. Am. J. Agric. Econ. 36, 233–243. htpp://www.gii.ncr.vt.edu/docs/AE.pdf

Custom Service under the Government of the Republic of Tajikistan. FOB and CIF prices, 2000-2010.

Dorosh P., Valdes A. December 1990. Effects of exchange rates and trade policies on agricultural in Pakistan. IFPRI, Research report 84.

Fajnzylber, Pablo, and J. Humberto Lopez, eds. 2008. Remittances and development: Lessons from Latin America. Washington, D.C.: World Bank.

Global financial crisis and its policy implications in East Asian emerging economies.

Available at http://www.tandfonline.com/doi/abs/10.1080/12265081003696429#preview

Hicks, John (1939). "The Foundations of Welfare Economics". *Economic Journal* (The Economic Journal, Vol. 49, No. 196) **49** (196): 696–712. Available at http://www.jstor.org/discover/10.2307/2225023?uid=2&uid=4&sid=2110172547 6891

Hsing Yu, April 2010, Volume 39. Global economic review: Perspectives on East Asian economies and industries.

Laws of the Republic of Tajikistan on export tax for Cotton Fiber and Primary Aluminium. http://www.tajikistan.jp/doc/Laws/laws_tax_code_ch43.htm

Lopez, Humberto, Luis Molina, and Maurízio Bussolo. 2007. Remittances and the real exchange rate. World Bank Policy Research Working Paper 4213

Lopez, Humberto, Luis Molina, and Maurízio Bussolo. 2007. Remittances and the real exchange rate. World Bank Policy Research Working Paper 4213.

Lartey, Emmanuel K.K., Federico S. Mandelman, and Pablo A. Acosta. 2008. Remittances, exchange rate regimes, and the Dutch disease: A panel data analysis. Federal Reserve Bank of Atlanta Working Paper 2008-12.

Kaldor, Nicholas (1939). "Welfare Propositions in Economics and Interpersonal Comparisons of Utility". *Economic Journal* (The Economic Journal, Vol. 49, No. 195) **49** (195): 549–552. Available at http://www.jstor.org/discover/10.2307/2224835?uid=2&uid=4&sid=21101725476891

Mundaca, Gabriela. 2005. Can remittances enhance economic growth? The role of financial markets development. University of Oslo.

Tajikistan: Trade at a glance. Available at http://info.worldbank.org/etools/wti/docs/Tajikistan_taag.pdf

Tax Committee under the Government of the Republic of Tajikistan. Tariff rates for imported and exported agricultural commodities and other taxes for 2000-2011.

World Trade Organization, October 2012, Available at http://www.wto.org/english/news_e/news12_e/acc_tjk_26oct12_e.htm

World Bank, World Trade Indicators 2009/2010. Available at http://info.worldbank.org/etools/wti/docs/Tajikistan_taag.pdf

World Development Indicators. Simple average applied import tariff for Most Favored Nation http://info.worldbank.org/etools/wti/docs/Tajikistan_taag.pdf

Yang, Dean. 2008. International migration, remittances, and household investment: Evidence from Philippine migrants' exchange rate shocks. Economic Journal 118

Mamadalieva Zuura

STATE OF WATER AND LAND USE IN SOUTH-WESTERN KYRGYZSTAN

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This paper has provided basic analysis of water and land resources condition and their use on the example of Suzak rajon of the Jalal-Abad province in the south-western part of Kyrgyzstan. After collapse of the Soviet system and in a process of transition to new type of economic relations, there is a high necessity in profound and complex evaluation of the natural systems and usage of their components. Study shows that the agro- climatic conditions are favorable for growth of cultivated and wild plants in the region. As well as, water resources quantity is sufficient to cover water needs. The main consumer of water is irrigated agriculture. Total water withdrawal from river is about 30%. Lands hold special place as a direct source of plant products. The most productive are irrigated arable lands. Boharic arable lands represent reserve of the economics of the region. Provision of land is low in the study area, particularly of arable land. The analysis shows that further combined consideration of these resources and agricultural productivity is highly needed. The paper provides recommendations for perspective development of water and land use.

Lyazzat Nugumanova

ANALYSIS OF FOSSIL FUEL SUBSIDIES IN KAZAKHSTAN

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1 INTRODUCTION AND OBJECTIVES

During the last decades the topic of fossil fuel subsidies has been gaining importance in the policy discussion. International Energy Agency (IEA) (2011) estimates that the total global fossil fuel subsidies in 2010 amounted to $409 billion. Kazakhstan is energy-rich country with significantly high subsidies on fossil fuels. Fossil fuel subsidies are a distortion which causes inefficient use of energy and natural resources, high CO2 emissions, distort the energy markets, put pressure on the state budget, and hinder investments into energy sector and renewable energy and thus long-term sustainable development in Kazakhstan. Removing fossil fuel subsidies could be in the long-term beneficial for Kazakhstan.

The main research question is to analyze macroeconomic effects of removing current distortions in the energy market using the computable general equilibrium model (CGE), GTAP. The specific objectives are to understand the issue and the extent of fossil fuel subsidies in Kazakhstan, analyze implications of these subsidies, and provide general policy suggestions on this topic. This paper first presents main data on fossil fuel subsidies, energy and environment in Kazakhstan, literature review, methodological approach suitable for this research and expected results.

Subsidization of fossil fuel consumption in Kazakhstan dates back to the Soviet Union times. Kazakhstan however is one of the many countries that provide high fossil fuel subsidies. International organizations such as IEA, OECD and IMF provide good data on the subsidies in developing and developed countries. Approximately two-thirds of the total subsidies are in the oil exporting countries (IMF, 2013). Among other former Soviet Union countries (FSU) that have high subsidies are Kyrgyzstan, Russia, Uzbekistan, Turkmenistan and Ukraine. For example, Uzbekistan has average subsidization rate of 60%, and fossil fuel subsidy account for 28.1% as a total share of GDP. Turkmenistan has average subsidization rate of 61%, and total fossil fuel subsidies account for 22.7% as a total share of GDP (IEA, 2012).

Total share of subsidies in Kazakhstan as a share of GDP in 2011 was 3.3%. The average subsidization rate was 32.6% and the subsidy per person amounted to $ 359.3. (IEA, 2012). Kazakhstan has artificially lower end user prices that are below full cost of supply and significantly lower the world market prices (IEA, OPEC et.al. 2011). Average subsidization of 32.6% means that consumers in Kazakhstan pay only 67.4% of the full price. As the table below shows subsidies in Kazakhstan are mostly targeted towards oil and electricity, and observing the dynamics since 2007 the total subsidies have been increasing.

Table 1. Subsidy by Fuel in Kazakhstan 2007-2011 (billion dollars)

	2007	2008	2009	2010	2011
Oil	1.29	1.65	0.41	2.03	3.19
Electricity	0.29	0.77	0.73	1.69	1.75
Natural Gas	0.17	0.29	0.21	0.22	0.33
Coal	0.00	0.00	0.47	0.38	0.58
Total	1.76	2.71	1.81	4.31	5.84

Source: IEA, 2012

Kazakhstan has second largest oil reserves and second largest oil production among the FSU countries. Kazakhstan has approximately 30 billion barrels proven oil reserves as of 2012 and is 13th largest exporter of oil in the world (U.S. Energy Information Administration, 2012). Total oil production in Kazakhstan has been steadily growing. Oil and electricity consumption in Kazakhstan has sharply declined in the 1990s due to economic decline, but since 2000 has been increasing.

CO2 emissions in Kazakhstan have declined in the 1990s and started to increase since 2000. Annual emissions inventory report prepared by Kazakhstan for United Nations Framework Convention on Climate Change (UNFCC) shows that energy activities are the main source of emissions.

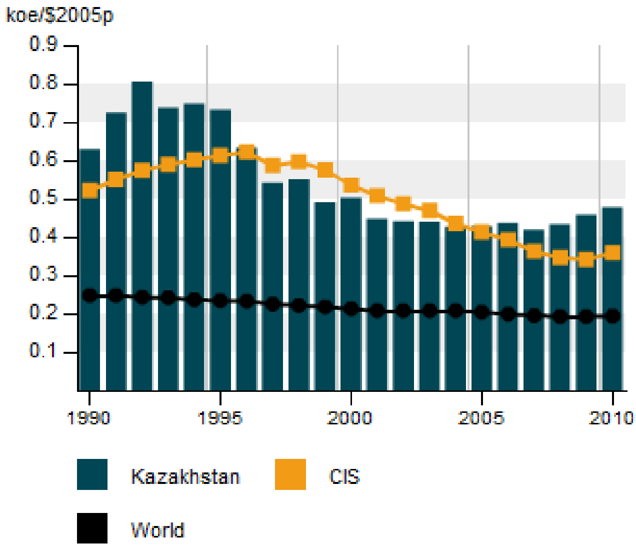
Table 2. CO2 Emissions by Sector in Kazakhstan 1990-2011 (million ton CO2 equivalent)

Sector	1990	1995	2000	2005	2008	2009	2010	2011
Energy	299,58	180,55	144,11	190,45	198,08	222,22	244,61	232,23
Industrial Processes	17,92	8,14	10,23	13,26	14,38	13,60	15,11	17,16
Agriculture	38,14	23,12	14,53	19,09	21,26	21,99	22,30	21,43
Land-Use, Land-Use Change and Forestry	-2,17	-7,29	-10,12	-2,86	-2,47	-2,48	-2,89	-3,09
Waste	2,74	3,11	3,09	3,47	3,74	3,84	3,95	4,07
Total with Land-Use, Land-Use Change and Forestry	356,21	207,63	161,85	223,41	235,00	259,17	283,08	271,80
Total without Land-Use, Land-Use Change and Forestry	358,38	214,92	171,96	226,27	237,47	261,65	285,97	274,89

Source: Ministry of Environment of Kazakhstan. National Inventory Submission, 2013

Total energy intensity in Kazakhstan is among highest in the world, where energy intensity is an indicator of total amount of energy necessary to generate one unit of GDP. Most of the FSU countries have high energy intensity and analyzing the figure below one can observe that the energy intensity is much higher than the world average.

Figure 1. Energy Intensity of GDP at Constant Purchasing Power Parities in Kazakhstan



Source: Enerdata, 2010

There is quite vast literature on the issue of subsidies in the energy and fossil fuel markets. Most international organizations advocate for the reform of fossil fuel subsidies. Energy subsidies are defined as “any government action that lowers the cost of production, raises the revenue of energy producers or lowers the price paid by energy consumers” (IEA,OECD, World Bank, 2010:5). There are various implications of fossil fuel subsidies on the economy, environment and society. Subsidies according to the Joint Report of IEA, OECD and World Bank (2010) “encourage wasteful consumption, exacerbate energy price volatility by blurring market signals, incentivize fuel adulteration and smuggling, and undermine competitiveness of renewable and more efficient energy technologies” (2010:9). Among the major effects that IMF (2013) identifies are fiscal burden on the state budget, wasteful consumption of energy, creating market distortions, negative impact on the environment, decreasing investments in energy infrastructure, less incentives to invest into renewable energy, rapid depletion of natural resources decreasing energy exports in case country is energy exporting, etc. Though subsidies are meant to protect consumers, most subsidies benefit high-income consumers (IEA et.al. 2011).

There is a limited scholarly literature that focuses on the analysis of Kazakh economy using CGE models. Most of the studies that implement general equilibrium models for Kazakhstan research trade and WTO accession issues. As to the author’s best knowledge there are no studies that focus on the economy-wide effects of distorting subsidies in Kazakhstan using CGE or GTAP models.

Several quantitative studies on the issue of energy and fossil fuel subsidies and case studies on specific countries have been published. Most of them focus on the impact of removing fossil fuel/energy subsidies. Burniaux and Chateau (2011) point out that most non-OECD countries provide consumer energy subsidies. Using ENV-Linkage model they simulate removal of subsidies which shows positive economic and environmental effects. Though oil-exporting countries face real income reductions, however this is compensated by welfare gains achieved through subsidy reforms. Birol, Aleagha and Ferroukhi (1995) look at the impact of the subsidy phase out and conservation policies in oil exporting countries such as Algeria, Iran and Nigeria. Both policies bring significant positive savings. Moreover the income from removal of subsidies could be used specifically for the lower income households. Lin and Li (2012) by simulating various policy options of removing fossil fuel subsidies come to the conclusion that the macroeconomic effects would be regionally disproportionate, with negative externalities for China, and positive for the rest of the world. Lin and Jiang (2011) using CGE model simulate reform of energy subsidies in China. The simulations show that the energy demand in China will significantly fall and the macroeconomic variables will be negatively impacted.

Riipinen (2003) simulated full energy liberalization in the FSU region using the GTAP model. The results show that energy market liberalization in FSU is beneficial to the EU, however FSU incurs welfare losses and at the same time increase in exports. Kerkela (2004) using GTAP model and database analyzes effects of energy price liberalization in Russia. The liberalization would have positive effect on GDP, increase trade between Russia and the rest of the world, increase welfare and decrease output for most energy products, except oil.

2 METHODOLOGICAL APPROACH AND DATA

This analysis is based on the CGE model GTAP, developed by Global Trade Analysis Project of Purdue University. CGE models have been increasingly gaining importance in the analysis of environmental and energy policies. The changes in energy policy have economy-wide effects, therefore it is important to take into account the activities of all agents and sectors in the economy, thus the CGE model seem to be the most appropriate in this case.

The GTAP model is a static, multi-sector, multi-regional model. Standard GTAP model is described in detail in Hertel (1997). GTAP model has a competitive economic environment, and a profit and utility maximizing behavior of consumers and producers. The GTAP model is based on two set of equations; accounting relationships and behavioral equations. The model is represented by main economic agents; regional household, private household, producer and government. Standard GTAP model is characterized by perfect competition in all markets, utility and profit maximizing behavior of producers and consumers. Private consumption behavior is represented by constant difference of elasticities. Government consumption is presented by Cobb-Douglas utility function. Trade flows are represented by bilateral matrices handled with Armington assumption. Variables such as population, technical change, policy variables, supply of endowment, numeraire-world price of endowment, slack variables and distribution parameter are exogenous in the model. Taxes and subsidies are the policy instruments in the model. They represent the connections between different market prices in the model which are agent, market and world prices. Quantities and prices are endogenous in the GTAP model.

The model is solved by General Equilibrium Modeling Package (Gempack) produced by Center of Policy Studies at Monash University. This software allows solving large non-linear equations models.

The following study is based on the GTAP data base Version 7 with 2004 as a reference year. The GTAP data base 7 includes bilateral trade, transport and protection matrices for 57 sectors and 113 regions. The Version 7 of data base is the first one that includes input-output table for Kazakhstan which enables to separately aggregate Kazakhstan. The data base for the purpose of this study was aggregated into six regions and eight sectors indicated in the table below.

Table 3. Model Regions and Sectors

Sectors	Regions
Wheat	Kazakhstan
Grains and Crops	Russia
Meat, Livestock and Fish	China
Processed Food	EU
Energy	FSU
Heavy Manufacturing	Rest of the World
Other Industrial Manufacturing	
Services	

In order to analyze and quantify economic effects of energy liberalization in Kazakhstan two set of scenarios based on standard GTAP model will be conducted. The purpose of these scenarios is to analyze partial and full energy liberalization and the economy-wide effects of such policy scenarios. The policy variables in GTAP model such as output tax/subsidies, consumer tax/subsidies, import tariffs, export taxes based on GTAP database are of the main interest in developing the scenarios.

3 EXPECTED RESULTS AND CONCLUSION

The Gempack software provides a number of output results. The focus in this study is the effects of simulations on GDP, welfare measured in equivalent variation, trade, import and export and output quantity changes. Moreover effects on such sectors as agriculture, food sector and manufacturing are important to consider. The liberalization scenarios are expected to be overall positive for Kazakhstan. The results are expected to be overall positive, though slight decreases in welfare and GDP are possible. Energy prices are expected to increase, which implies that the demand for energy will decrease, therefore one could assume that there would be slight increase in the export of fossil fuels. Further, the impact of policy changes on Kazakhstan’s main trading partner countries will be considered as well.

Kazakhstan actively promotes environmental and energy programs as a part of its general policy. Such national programs and strategies as Transition to Sustainable Development by 2024, Development of National Energy Saving Program, Program of Energy Development by

2030 and others emphasize the importance of developing energy efficiency, reducing energy intensity, reducing CO2 emissions, promoting renewable energy and sustainable growth. In order to achieve all these goals and get on a path towards sustainable development a functioning energy market, policies and institutions are necessary that provide incentives towards investments into new technologies, energy efficiency and renewable energy.

This paper lays ground for the further analysis of the complex issue of subsidies in Kazakhstan. The next steps would be to produce final results possibly with an updated tax and subsidies data for Kazakhstan and analyze it within the existing literature.

REFERENCES

Birol F., Aleagha A.V. and Ferroukhi R. (1995): The Economic Impact of Subsidy Phase out in Oil Exporting Developing Countries: a Case Study of Algeria, Iran and Nigeria. Energy Policy 23 (3): 209-215.

Lin B. and Li A. (2012): Impacts of Removing Fossil Fuel Subsidies on China: How Large and How to Mitigate?. Energy 44: 741-749.

Lin B. and Jiang Z. (2011): Estimates of Energy Subsidies in China and Impact of Energy Subsidy Reform. Energy Economics 33 (2): 273-283.

Burniaux J., Chateau J. (2011): Mitigation Potential of Removing Fossil Fuel Subsidies. A General Equilibrium Assessment. OECD Economics Department Working Paper No.853. Paris: OECD Publishing.

Enerdata (2010): Global Energy Statistical Yearbook2011. http://yearbook.enerdata.net/2010/2010-energy-intensity-GDP-by- region.html#/2010-energy-intensity-GDP-by-region.html (10.07.2013)

Hertel T.W. (1997): Global Trade Analysis: Modeling and Applications, Cambridge: Cambridge University Press.

International Monetary Fund (January 28, 2013): Energy Subsidy Reforms: Lessons and Implications. http://www.imf.org/external/np/pp/eng/2013/012813.pdf (04.07.2013)

International Energy Agency (2012): Fossil Fuel Subsidy Database. http://www.iea.org/subsidy/index.html (04.06.2013)

IEA (2011): World Energy Outlook 2011 Factsheet. Paris: OECD Publishing. http://www.worldenergyoutlook.org/media/weowebsite/2011/factsheets.pdf (04.06.2013)

IEA, OECD and World Bank (2010): The Scope of Fossil-Fuel Subsidies in 2009 and a Roadmap for Phasing out Fossil-Fuel Subsidies. Report prepared for G-20 Summit (Seoul). http://www.oecd.org/env/cc/46575783.pdf (01.06.2013)

IEA, OPEC, OECD and World Bank (2011): Joint Report by IEA, OPEC, OECD and World Bank on fossil-fuel and other energy subsidies: An Update of the G20 Pittsburgh and Toronto Commitments. Prepared for the G-20 Meeting of Finance Ministers and Central Bank Governors (Paris, 2011) and G-20 Summit (Cannes, 2011). http://www.oecd.org/site/tadffss/49006998.pdf (05.04.2013)

Kerkela L. (2004): Distortion Costs and Effects of Price Liberalization in Russian Energy Markets: a CGE Analysis. BOFIT Discussion Papers 2. Bank of Finland Institute for Economies in Transition.

Ministry of Environment of Kazakhstan (2013): National Inventory Submission Kazakhstan. Almaty. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php (05.06.2013)

Riipinen T. (2003): Energy Market Liberalization in the FSU-Simulations with the GTAP Model. Bank of Finland Discussion Papers No12.

U.S. Energy Information Administration (2012): Kazakhstan Analysis Briefs. http://www.eia.gov/countries/country-data.cfm?fips=KZ (05.05.2013)

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KAZAKH EMISSIONS TRADING SCHEME: LEGAL IMPLICATIONS FOR LAND USE

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1 PROBLEM STATEMENT

Kazakhstan ratified the Kyoto Protocol on 26 March 2009. As part of measures aimed at implementing the Kyoto Protocol, Kazakhstan is preparing for launching its first domestic emissions trading scheme (ETS). National cap-and-trade system is expected to be a key climate-policy instrument for reaching general commitments of the country to mitigate climate change. Emitters which are subject to the Kazakh emissions trading scheme are allocated with emission caps, which can be traded within national cap-and- trade scheme. Such emitters can reduce their own emissions and then sell excess of cap allowances on the market. If emitting more than allowed, they can buy allowances if any available, otherwise are obliged to pay strict fines defined by the government.

Domestic sectors, which are subject to Kazakh emissions trading scheme, were chosen with the intention to regulate key sectors and categories by one market-based tool. Kazakh ETS will cover companies emitting from twenty thousand tons of carbon dioxide equivalent per year.

In the time when Kazakhstan is actively investigating other options for reducing emissions to comply with its present voluntary commitments and future commitments under the Kyoto Protocol, establishment of a domestic emissions trading scheme may be a good option. That is why Kazakh ETS is taking serious attention of the government. In this way, the government intends to raise the interest of operators to move gradually to energy efficiency and low-carbon policy by their own initiatives.

2 RESEARCH QUESTIONS

GHG emissions can be reduced by several means such as establishing renewables, installing energy-saving technologies, and such others; however, GHGs can also be reduced through increasing GHG absorbing measures, provided within the land use, land- use change and forestry (LULUCF) sector of the Kyoto Protocol. Kazakh emissions trading scheme does not provide trading of carbon units in the LULUCF sector directly. Planting new forests to absorb carbon dioxide in the atmosphere is one viable option to employ forests to curb climate change. The idea of planting carbon offsets is now being implemented worldwide under the Kyoto Protocol and beyond it[1]. There are three major frameworks for LULUCF projects. First, avoiding

[1] Dieter Schoene and Maria Netto, ‘The Kyoto Protocol: What Does It Mean for Forests and Forestry?’ (2005) Unasylva 222 at 3

emissions by conservation of existing carbon stocks, second, increasing carbon storage by sequestration, and third, substituting carbon for fossil fuel and energy intensive products[2].

The aim of the study is to analyze how the LULUCF sector can be employed under current Kazakh emissions trading scheme.

3 METHODOLOGICAL APPROACH

According to the Resolution of the Government N128 dated 11 February 2008 quotation system and greenhouse gas emissions trading were expected to be launched in Kazakhstan back in 2008. In 2010-2011 the Government of Kazakhstan has returned to the issue of establishing a national quotation system and greenhouse gas emissions trading. With this purpose a draft law proposing amendments to a number of existing laws, including the Environmental Code and the Code of Administrative Offences as well as the Law "On Bankruptcy" was submitted to the Parliament. On 6 October 2011 the Upper Chamber of the Parliament accepted the draft law on the Kazakh emissions trading scheme. Adoption of the draft law was subject to the President's signature until it was signed on 3 December 2011 providing new provisions to the Environmental Code and the Code of Administrative Offences.

Methodological approach of the study is based on analysis of provisions regulating domestic emissions trading scheme and its implications to the LULUCF sector.

4 DISCUSSION OF RESULTS

Currently the new provisions incorporated to the Environmental Code and the Code of Administrative Offences outline several characteristics of the scheme including that a legally binding Kazakh emissions trading scheme will be based on the cap-and-trade system recognized worldwide. A nation-wide cap-and-trade system will cover medium and large companies which emit from twenty thousand tons of carbon dioxide equivalent and above per annum. Such emitters can either reduce their own emissions or trade allowances to meet their obligations.

The new amendments include basic requirements for the following important elements of the Kazakh ETS: a) allocation of allowances on GHG emissions on the basis of national allocation plans for GHG emissions; b) issuance of GHG certificates (permits); c) monitoring, reporting and verification of GHG emissions for regulated companies and installations; d) regulation of carbon units (Kazakh allowance and emission reduction units); e) trade of allowances and reduction units through designated trading platforms; f) administrative liability for failures to comply by emitting more than allowed and abusing validation and verification of reports on annual GHG emissions.

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[2] Felipe García-Oliva and Omar R Masera, 'Assessment and Measurement Issue Related to Soil Carbon Sequestration in Land-Use, Land-Use Change, and Forestry (LULUCF) Projects under the Kyoto Protocol' (2004) 65 Climatic Change 3 at 348

These elements are supported by the expanded glossary of the Environmental Code which contains already more than 20 new definitions related to the emissions trading scheme, including the definitions of ‘carbon registry’, ‘installation’, ‘trade of allowances’, ‘validation’, ‘verification’ and various carbon units. The new legislation also includes a number of provisions on the Kyoto flexible mechanisms and Kyoto carbon units (AAUs, RMUs, ERUs, CERs).

Kazakh emissions trading scheme does not provide trading of carbon units in the LULUCF sector directly. There is a domestic emissions reduction mechanism which defines a process of development and implementation of domestic projects aimed at reducing emissions and/or increase removals of greenhouse gas emissions in accordance with the procedure and criteria established by the environmental legislation of the Republic of Kazakhstan. Introduction to implementation of domestic emissions reduction projects that reduce emissions and/or enhance removals of greenhouse gases by sinks is provided in the provisions of the amended Environmental Code. The domestic emissions reduction mechanism generates project carbon units that are tradable on Kazakh ETS. It is where the Kazakh ETS can employ to the LULUCF sector of the country. This is similar to what the European Union did with regard to Joint Implementation and Clean Development Mechanism projects with its “Linking Directive”. In case of Kazakhstan domestic emissions reduction projects can be used by companies for partly surrendering of their allowances and are not subject to the requirements of the flexible mechanisms under the Kyoto Protocol.

Domestic emission reduction projects can be implemented in the economic sphere, including forestry and prevention of land degradation. The aim of domestic emissions reduction projects is to provide implementation of Kazakhstan's commitments to reduce greenhouse gas emissions by providing opportunities for implementation of projects in the territory of Kazakhstan, under domestic emissions reduction mechanism, in order to obtain domestic emission reduction units that can be used afterwards in domestic and international emissions trading schemes. It should be mentioned that domestic projects are not subject to the requirements of the clean development mechanism and joint implementation of the Kyoto Protocol and participation in domestic emissions reduction projects is voluntary.

In addition, provisions of the amended Environmental Code provide institutional arrangements, in terms of new competencies of the Government and the Ministry of Environmental Protection regarding implementation and regulation of the Kazakh ETS. Accordingly, the Ministry of Environmental Protection is the assigned regulating authority. Its competence covers the questions such as issuance of certificates (permits) on greenhouse gas emissions; review of installation passports and annual emission reports submitted by regulated companies; approval of monitoring plans on regulated installations; review and endorsement of domestic emissions reduction projects and periodic implementation reports submitted by their operators for getting offset credits; accreditation of validators and verifiers; and monitoring of compliance and enforcement with the ETS requirements. The assigned authority in the field of environmental protection, the Ministry of Environmental Protection, is also in charge for regulations on development of domestic emissions reduction projects and preparation of review and approval, accounting, reporting and monitoring of domestic emissions reduction projects. Most of these functions will be performed by the Committee of Environmental

Regulation and Control of the Ministry of Environment which is also the regulator of other environmental activities of large industrial companies in Kazakhstan. Some functions of the Ministry of Environment are designated to the subordinated organisation– Zhasyl Damu.

Maintenance of the domestic emissions trading scheme depends on a complex decision-making process with regard to the emissions trading rules. However, some aspects of the legal framework on the emissions trading scheme indicate that important steps in that process have already been taken. Development of the system brings multiple benefits to Kazakhstan, including the mitigation of negative effects on the economy from climate change, improvements to the economic, social, and physical well-being of the nation, increases in the energy efficiency of companies, the creation of large incentives for international investment inflows and new work places, and continued improvement of international relations. That is why Kazakh ETS may serve as a key instrument for implementation of the quantified emissions limitation and reduction commitment under the Kyoto Protocol.

Issues of how the LULUCF sector of Kazakhstan is linked to the Kazakh ETS were also discussed in this study. Domestic emissions reducing projects allow involvement of the LULUCF sector in the scheme. How LULUCF projects can be implemented through the domestic offset projects scheme is presented. In sum, involvement of the LULUCF sector through the domestic GHG reducing projects may be achieved if addressed properly. However, Kazakhstan lacks the level of understanding and acceptance of social or environmental responsibilities necessary to engage in such practices. In addition, project developers may face the complicated project submission process. However, involvement of Kazakhstan forestry project developers yields multiple benefits ranging from the mitigation of the potentially negative impacts of global warming to the improvement of the country's environmental image internationally.

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IMPACTS OF LIBERALIZATION ON AGRICULTURE AND TRADE: A CASE STUDY OF UZBEKISTAN

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1 ABSTRACT

The agricultural sector of Uzbekistan is still characterized by unsustainable production patterns and the agricultural institutions of the country are controlled to a large extent through government intervention. The Government takes the decision to grow cotton and wheat and fix the output prices. The decision about the production quotas for cotton and wheat leads to a restricted area and water availability for growing other crops. The country is affected by a locally occurring climate change as well as regional climate change threatens to aggravate existing water use conflicts. The current and expected climatic conditions are showing the additional irrigation applications for a sustainable and fruitful agricultural production. The partial implementation of reforms such as privatization and liberalization of agricultural markets affect the development of agriculture and agricultural trade in Uzbekistan. This paper highlights the major effects of market and price liberalization on agricultural trade using the partial equilibrium model AGRISIM which is based on the "Static World Policy Simulation Model" (SWOPSIM) of the U.S. Department of Agriculture (USDA).With the help of the model, changes in general economic conditions and policy intervention in agricultural markets and foreign trade are simulated. The study suggests that the issues of sustainable agriculture development and food security in Uzbekistan can be achieved through, liberalization of agricultural markets and trade specially wheat and cotton.

2 INTRODUCTION

The agricultural sector contributes 19 percent share in the country GDP (WORLD BANK, 2013) whereas about 20 percent share in the total labor force in 2011 (FAO, 2013). Despite a significant reduction of the agriculture in GDP i.e. 37% in 1991 (FAO, 2011), it is still important share holder in the economy. Agriculture provides the livelihood about 49% of the country population who live in the rural areas (ADB, 2012). The cotton is one of the most important crops in Uzbekistan. The cotton sector was strongly developed in the past which accounts as about 40 % of total agricultural output while at present its share is 19% and only 3.5 % contribution in national GDP (FAO, 2011).

Total agricultural land occupies 28.5 million ha which is 63 percent of the total land area. In which, 23.4 million ha can be considered poor or low productive pasture land and 4.2 million ha of arable land i.e. approx. 11 percent of the total land area. Due to its arid climatic conditions, arable agricultural output is almost entirely dependent on irrigation. The total irrigated area is 4.2 million ha in which 3.4 million ha cultivated under annual crops. Currently, the area under cotton is 1.3 million ha which is higher than other crops area (MAWR, 2012). Cotton is the main raw material for Textile industry. Therefore, agriculture also has a significant influence on other areas of the economy. It shares about 35-40 percent of all industrial output which contributes about 8 percent in GDP (ADB, 2012).

3 PROBLEM STATEMENT AND OBJECTIVE OF THE STUDY

Between 1981 to 1990, the annual growth rates of agricultural output barely exceeded 2%, and growth in farming products was less than 2%. Furthermore, in the early 1990s domestic agriculture experienced a significant recession along with the rest of the economy. During the 15 years (1992-2007) agricultural output growth rate was lower than population growth rate especially in rural areas. Therefore, it could not much contribute to improve the living standards (ADB, 2007).

Cotton was the dominant crop in Uzbekistan's agricultural sector during the Soviet period. The main constraint on higher agricultural productivity and growth is the state procurement system for cotton and wheat. Most of the agricultural land belongs to the States. The government sets prices and production targets for the wheat and cotton. During the early period in transition, national accounting was done by the Soviet system of material product balances which is not very reliable. But still it continues (SPOOR, 2005). The state order system reduces the effectiveness of farm restructuring. According to SIRAJIDDINOV und KASIMOVA (2001), at the beginning of 1990s, the major objectives of the state quota policy were to supply essential agricultural products to protect people from food deficits, increase agricultural productivity, increase rural employment, increase agricultural exports and decrease imports.

It means that throughout the decade (1991-2000) low procurement prices were paid to farms than world market prices. On the other hand, State Government provides the subsidized inputs (fertilizers, pesticides, fuels, seeds and water) to motivate the farmers to grow cotton and wheat. Private farming takes place under very unfavorable conditions and is often subject to the arbitrariness of regional and local institutions.

High costs of monopolies are widespread in processing and marketing channels of cotton and input supplies. To make better use of the considerable agricultural potential requires providing better incentives to farmers and more freedom to decide than under the existing state order system for cotton and wheat. Pricing and marketing reforms in cotton sector must be accelerated. The net burden of taxation on the cotton sector should be reduced in order to increase farm income (AHMEDOV, 2006).

In the starting of transition period, the main emphasis was on to develop the market- oriented economic system which led to significant reduction in agricultural production. Therefore, there was negative impact on food security, economic prosperity, consumer safety and environmental sustainability of production systems activities. At the same time, it has been forced to develop new trading relationships with other former Soviet states and the rest of the world, which led to the mandated expansion of the wheat area to meet local food needs (ABDULLAEV ET AL., 2009).

Thus, it is important to describe in detail about the developments in Uzbek agriculture and some of their impacts on natural resource use, and impacts of liberalization on agriculture and agricultural trade in Uzbekistan. The main objective of this paper is to analysis the impact of liberalization on the development of agricultural production and trade in Uzbekistan. This paper is divided in three more sections. Next section is related about methodology use to attain the objective of the study, following section describe the major finding of the study. Finally, the paper is concluded with some suggestions.

4 METHODOLOGY

To attain the main objective of the study, partial-equilibrium net trade model is used. The partial implementation of reforms such as privatization and liberalization of agricultural markets affect the development of agriculture and agricultural trade in Uzbekistan. For the empirical analysis using the partial equilibrium model AGRISIM (Agricultural Simulations Model) which has been developed at the University of Giessen, and which is based on the "Static World Policy Simulation Model" (SWOPSIM) of the U.S. Department of Agriculture (USDA), is the most appropriate for modeling the agricultural sector of Uzbekistan. AGRISIM is a partial-equilibrium, multi-commodity, multi-region model. It is comparatively static in nature, deterministic and has non-linear isoelastic supply and demand functions (PUSTOVIT, 2003; SCHMITZ, 2002).

Trade is calculated as net trade. Policy interventions are generally considered with changes in nominal protection rates (NPR), price transmission coefficients, minimum producer prices, production quotas and subsidies. Through shift coefficients in the demand and supply functions additional exogenous taken into account and their impact can be simulated, such as population, income growth and technical progress. The base version of the model from Weber includes nine commodities: wheat, coarse grains, rice, oilseeds, sugar, milk, beef, pork, and poultry meat. The current version of the model included 36 different agricultural commodities or products. The commodity groups will be calculated in four group's i.e. cereals (coarse grains, maize, and wheat), coarse grains (rye, barley, oats, sorghum, triticale, buckwheat, and other cereals), oilseeds (rapeseed, soybean, sunflower, and cottonseed), poultry meat (chicken, ducks, goose, turkey and other poultry). After the calculation of group commodities the list of commodities were defined. The 15 commodities includes into the AGRISIM Model, including nine vegetable and six animal products: such as: wheat, coarse grains, maize, soybean, cotton, rice, sugar, oilseeds, tobacco, milk, beef, sheep, pork, poultry, and eggs. Generally, in the Model, there will be 19 countries and region, including Central Asian countries, CIS countries, Asian countries, European countries, African countries, North and South American countries, such as: Australia, Brazil, Canada, China, Egypt, European Union (27 country member of EU considered as a one), India, Japan, Kazakhstan, Kyrgyzstan, Mexico, Russia, South Africa, Tajikistan, Ukraine, United States of America (USA), Uzbekistan and Rest of the World (ROW) included.

The database was recently updated to the year 2006 and based on above mentioned products as well as countries. The data from "FAOSTAT" FAO, PSE Statistics of OECD, USDA, World Bank, IMF data, State Statistical Committee of countries, central banks, ministries of economics, foreign trade ministries, ministries of agriculture, agricultural institutions, farms, and the Institute of agribusiness (IAB), Giessen, has been compiled.

The main structure of the model follows the suggestions of RONINGEN (1997). It describes a multi-market multi-region partial equilibrium model and the main structure of the model SWOPSIM (**S**tatic **Wo**rld **P**olicy **Si**mulation **M**odeling Framework (RONINGEN ET AL., 1991). The regions are connected with each other through a market equilibrium mechanism. The world market price which also belongs to market equilibrium mechanism, are influenced by domestic markets through domestic prices. The net trade is summed from all regions, which is calculated as the difference between supply and demand. The model was programmed in General Algebraic Modeling System (GAMS).

On the basis of current macroeconomic and base data, especially current agricultural situation in Uzbekistan, the dynamic scenario is formulated. The formulation of the scenario is: Yield growth + population growth + income growth per year in all Regions of Model + Reduction of the Input subsidies in UZB + Reduction of the positive and negative NRPs in UZB (NPR=0, Full Liberalization in UZB) It can be called as full liberalization scenario.

5 RESULTS & DISCUSSIONS

The simulation results (Table 1) shows the clear effects of the production, demand, price and trade and it is considered after the welfare economic evaluation. In this section the analysis is broadened to a sectoral level, taking into consideration the supply and the demand side, their interaction on national and international markets with respect to price formation, as well as the net trade and welfare effects of the scenario.

The results of the production effects show that production of beef 14.49%, coarse 67.13%, milk 30.55%, poultry 7.44%, rice 50.63%, wheat 29.57%, maize 52.53%, egg 32.33% and tobacco 21.82% compare to base year has increased. Where as in case of oils, pork, sugar, soybean, mutton-goat, and cotton production it has decreased 0.78 to 23.26%.

The domestic price changes generate corresponding demand reactions in Uzbekistan. The results also accept the demand theory. The demand of beef, oils, pork, poultry, sugar, wheat, maize, soybean, egg, mutton-goat is increased significantly with the range of 1.15 to 30.30%. In case of cotton demand in the liberalization, it is decreased by 1.16 percent whereas it is worse in case of tobacco i.e. 30.30%.

In the scenario, the net-trade position for wheat is changed from an import status of 380.46 thousand tons at base year to an export status of 1.31 million tons with liberalization. The same trend is noticed for the beef, coarse grain, milk, rice, and maize net-trade. The net imports of oilseeds, pork, poultry, sugar, soybean, and mutton-goat increase from 0.0003 thousand tons to a maximum of 985.10 thousand tons, whereas the cotton net export decreases from 949.0 to 813.60 thousand tons.

Table 1: Results of Production (PROD), Demand (DNAD), Farm Gate price (FGP), Border Price (BP), and Net Trade (NTRA) Effects

Comm.	**PROD**	**DNAD**	**FGP**	**BP**	**NTRA**
	change in %				**Tsd. Ton**
BEEF	14.49	5.35	-41.11	-11.31	49
COAR	67.13	-13.32	47.49	-22.56	371
MILK	30.55	-4.11	26.28	-8.62	2193
OILS	-12.89	30.30	-105.35	-105.34	-985
PORK	-5.49	8.40	-65.78	-5.96	-12
POUL	7.44	18.00	-109.61	-21.65	-16
RICE	50.63	-5.53	12.28	-10.33	193
SUGA	-0.78	1.15	-8.47	-2.08	-454
WHEA	29.57	3.27	-28.04	-53.84	1313
MAIZ	52.53	2.22	-5.70	-32.50	194
SOYB	-8.63	17.73	-67.87	-67.87	-26
EGG	32.33	7.33	-11.09	0.15	37
MUTG	-0.98	23.22	-332.58	-207.50	-28
COTT	-23.26	-1.16	37.28	-11.81	814
TOBA	21.82	-30.43	79.83	-0.00	20

Source: own calculation using AGRISIM, 2013

Producer price effects show that the prices are declined for all products in this scenario except coarse grains, rice, milk, cotton, and tobacco. It is because of a huge gap between domestic and international prices.

The world price decreases in the scenarios for all products, with the exception of egg. World prices for wheat, oils, soybean, and mutton-goat significantly decrease whereas in case of sugar, pork, milk, beef, and cotton it decreases slightly. Because the nominal rate protection corresponds to zero and increasing worldwide competitiveness. Domestic price effects actually influence by the global market.

Table 2 presents the results on welfare effects. The economic welfare effects for producers, consumers, and total welfare is positive changes. In the liberalization scenarios, the state budget became near about -522 million US$. On the other hand, total welfare is going very high because the producer rent is increasing more than 2200 million US$.

Table 2: Results of the Welfare effects

Indicators	Amount (Million US$)
Producer rent	2225
Quota owner	0,00
Consumer rent	316
Budget	-522
Total welfare	**2020**

Source: own calculation using AGRISIM, 2013

The main results of the policy simulations depend on assumptions of the model. Although, the simulation results should be treated with caution, it is believed that they are reliable and can contribute to the discussion on how the simulated policy can affect the regional production, sales, marketing, agriculture trade, income, production pattern and land and water use in Uzbekistan. In general, the market liberalization has a positive effect on the regional state order quota crops cotton and wheat sector. Concerning the policy effect with regards to the location of producers and consumers, the market and price liberalization and reforms about input subsidies are more beneficial for producers.

This process have need to be completed with exchange rate liberalization so that administered procurement prices are set at border price levels with the market exchange rate.

6 CONCLUSIONS & RECOMMENDATIONS

The agriculture is strongly limited due to the established state system of the low prices for end production. In spite of subsidized inputs like fuel, irrigation services, fertilizers, service of technical equipment and credit grants, the cotton production became unprofitable because the net implicit tax are very high. The production increases for almost products with liberalization, Uzbekistan imported most of the products which are included in the model except cotton. After the simulation, the results show that beef, coarse, milk, rice, wheat, maize, eggs, tobacco and also cotton are exported. Producer price increases due to demand growth and positive change of the negative nominal rate of protection. The market and price liberalization is favorable for the producer as well as consumers. In general, achieving sustainable development of agriculture and rural areas depend on reforms at the national level and creating favorable conditions at the international level. From the results we can summarize that the Uzbek agriculture and agricultural trade can be developed well with liberalization.

Agricultural markets liberalization is needed to provide appropriate incentives to farmers which motivate to farmers in the processing of agricultural products. State procurement quotas for wheat and cotton should be reduced or vanished. The farmers should have the freedom to sale their products and prices for these products should be liberalized.

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REFERENCES

ABDULLAEV, I., DE FRAITURE, CH., GIORDANI, M., YAKUBOV, M. and RASULOV, A. (2009): Agricultural Water Use and Trade in Uzbekistan: Situation and Potential Impacts of Market Liberalization, Water Resources Development, Vol. 25, No. 1, 47-63, March 2009.

ADB (2012): ASIAN DEVELOPMENT BANK, Sustainable agriculture and climate change mitigation project.

ADB (2007): ASIAN DEVELOPMENT BANK, Welfare improvement strategy of Uzbekistan, full strategy paper for 2008-2010.

AHMEDOV, K. T. (2006): Uzbekistan Economic trends and problems.

FAO (2013): Statistical Database of FAOSTAT, Website of Food and Agriculture Organization.

FAO (2011): Food and Agriculture Organization of the United Nations Regional Office for Europe and Central Asia, Agro-industrie-Outlook.

MAWR (2012): Statistical Report, Ministry of Agriculture and Water resources (MAWR) of Uzbekistan.

SCHMITZ, K. (2002): Simulationsmodell für die Weltagrarmärkte – Modellbeschreibung. In: Schmitz P. M. (ed.): Nutzen-Kosten-Analyse Pflanzenschutz. Kiel: Wissenschaftsverlag Vauk Kiel KG, Anhang III, 117-137.

SIRAJIDDINOV, N. and KASIMOVA, S. (2001): Development of rural entrepreneurship, Journal of Economical Review (in Russian), 5–6, pp. 21–22.

SPOOR, M. (2005): Uzbekistan's Agrarian Transition, Institute of Social Studies Centre for the Study of Transition and Development (CESTRAD).

PUSTOVIT, N. (2003): EU-Osterweiterung und WTO-Liberalisierung aus Sicht der ukrainischen Agrarwirtschaft – Wirkungsanalyse und Bewertung mit Hilfe eines partiellen Gleichgewichtsmodells. Agrarökonomische Monographien und Sammelwerke, Kiel: Wissenschaftsverlag Vauk Kiel KG.

RONINGEN, V. O. (1997): Multi-Market, Multi-Region Partial Equilibrium Modelling. In: FRANCOIS, J. F. and REINERT A. (eds.): Applied Methods for Trade Policy Analysis. A Handbook. Cambridge: Cambridge University Press, 231-257.

RONINGEN, V. O., SULLIVAN. J. and DIXIT, P. (1991): Documentation of the Static World Policy Simulation (SWOPSIM) Modeling Framework. Staff Report Nr. AGES 9151, Economic Research Service, US Department of Agriculture, Washington D.C.

SUTTON, R. W., SRIVASTAVA, P. J., and NEUMANN, E. J. (2013): Looking Beyond the Horizon, How Climate Change Impacts and Adaptation Responses Will Reshape Agriculture in Eastern Europe and Central Asia.

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POLICY-INDUCED DISTORTIONS TO FARMER INCENTIVES AND THEIR IMPACT ON AGRICULTURAL LAND USE IN THE KYRGYZ REPUBLIC

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1 STUDY BACKGROUND

22 years have passed since the Kyrgyz Republic (KR) became independent and since it started the transformation of its economy from a centrally-planned system into a market-oriented one. As one of the poorest countries within the former Soviet Union, Kyrgyzstan was hit the most by the cut of net transfers from other soviet republics and the loss of long supply chains producing machinery and equipment (Christensen & Pomfret, 2007). The Kyrgyz experience of transition comprised fairly rapid reforms including privatization of land, real estate and government-owned enterprises, as well as the liberalization of prices and elimination of producer subsidies, all of these undertaken within the first 10 years of transition. Further on, 262 large-scale state and 190 collective agricultural enterprises inherited from the Soviet times (the so called “sovkhozes” and “kolkhozes”) were reorganized into smallholder farms with the land size of 0,1-1 ha per household (Akramov & Omuraliev, 2009). During the harsh times of transition when hyperinflation and unemployment were widespread, urban-rural migration was prevalent as people were returning to their home villages to undertake subsistence farming to make the ends meet (Pomfret, 2006, p.73). Agricultural output dropped substantially within the first years of the transformation period (1990 - 1995), but started to recover from 1996 as a response to price liberalization and privatized agricultural land (National Statistical Comittee, 2011). Although the share of agriculture in total GDP has decreased (from 50% in 1996 to 25% in 2011) as other industries, such as gold mining and manufacturing were evolving, it is still one of the key economic sectors in Kyrgyzstan that contributes to about one quarter of the GDP and employs over 30 percent of the country’s economically active population (National Statistical Comittee, 2011). The livelihoods of around half of the total population in Kyrgyzstan directly or indirectly depend on agriculture (Christensen & Pomfret, 2007).

2 PROBLEM STATEMENT AND STUDY OBJECTIVES

Agricultural sector has all the potentials to become the driver of economic growth in KR, and not just serve the role of a “safety net”, but a number of critical issues has to be addressed in order to achieve this. Light (2007) suggests that government’s agricultural policies in Kyrgyzstan should cover three areas: (1) free markets and property rights; (2) productivity and investment, and (3) efficient markets and institutions. While the establishment of free markets and property rights seems to have gone well, the other two conditions critical for sustainable growth of agricultural sector and the economy overall, are not appropriately provided yet. Strategic aims of the Kyrgyz government in the agricultural sector consist of four main pillars: food provision, stability of agricultural markets, achieving competitiveness and improving trade, and environmental preservation and food safety (The World Bank, 2011). However it is unclear whether the implemented policies have been designed taking into consideration all the possible effects of these polices on rural incomes or relative incentives between the sectors. The evidence from other developing countries showed that most of the times their commercial policies were inconsistent, have sought only immediate effects and did not consider the long-run effects of the polices on different sectors of the economy. Taking into account that the poorest part of the country's population lives in rural areas and farming is the major source of their income, the effect of policies affecting farmer incentives should be studied rigorously. It is of crucial importance to understand if and to what extent do the policies affect agricultural prices. And if they do, how strong do the farmers respond to changing prices/market conditions? The main objective of the current study is thus to investigate the impact of distortions to farmer incentives induced by government's policies on the use of agricultural land. Specific objectives of the study include: (1) to identify whether and, if yes, how much the government protects or discriminates individual branches of the agricultural sector; (2) to investigate whether there is a significant difference between the governmental assistance provided to the producers of food crops and cash crops; (3) to assess the production response of Kyrgyz farmers to changing prices of own and competitive crops (price elasticities) in the short- and long-run; (4) to analyze estimated protection rates in line with estimated price elasticities to assess the effect of price distortions on agricultural land use.

3 METHODOLOGY

Nominal Rates of Assistance (NRAs) as the indicators of direct distortions to agricultural price incentives were estimated for 7 major agricultural commodities for the period of 2001 to 2011 following the methodology described in Anderson (2009). Formula below is used for calculating NRAs for each agricultural commodity:

$$NRA = \frac{P_{FG} - (P_W * E - C_T - C_H - C_M)}{P_{FG}} * 100\% \quad (1)$$

where P_{FG} is the farm-gate price of a commodity in Kyrgyz Soms (KGS); P_W is the world price or the reference prices for the commodity in USD; E is the nominal exchange rate of KGS-USD; C_T, C_H, and C_M stand for transport, handling/processing and marketing costs respectively, associated with the delivery of a product from the farm-gate point to the border. When accounting for transport costs, the study incorporates information on production quantity, distance between the major production areas for each crop to the border, average trucking fees per ton/km/m3 in US dollars and exchange rates to create time series of transport costs for each crop. Marketing and handling costs are assumed to be 15 percent of the producer price for wool, cotton and tobacco, as these products need some processing before they can be exported 1. Due to the absence of adequate information, it was not possible to adjust prices for quality and variety differences, but they are not likely to be as large as to influence the sign of distortion estimates.

[1] Assumptions on marketing and handling costs are based on findings of Christensen and Pomfret (2007) and The World Bank (2007)

NRAs thus show the share of price distortion as the share of the domestic price. Positive NRA indicates assistance from the government provided to the producers of a certain crop, and accordingly negative NRA implies that the sector is being taxed through government policies.

Information on agricultural and macroeconomic performance, trade and policies for the period studied has been compiled and analyzed with regard to estimated protection rates for individual commodities. At the second step of the analysis, regression techniques are employed to obtain price elasticities for major crops. Nerlovian approach of modeling supply response is utilized, where the area allocated for each crop is modeled as a function of expected prices and other exogenous shifters.

In this study the desired area devoted for each crop q_t^d in period *t* is assumed to be a function of expected relative prices (own price and the price for competing crops), p_{it}^e; where i stands for four major crops included in the model: wheat, cotton, potato and maize. The structural form of the model is:

$$q_t^d = \alpha_1 + \sum_{i=1}^{4} \alpha_{2i} p_{it}^e + u_t \qquad (2)$$

where α_1 and α_2 are the parameters to be estimated, and u_t stands for unobserved random factors.

As a farmer cannot fully adjust the allocation of his land in the short run, the actual area adjustment is just a fraction ∂ of the desired adjustment (Sadoulet & De Janvry, 1995):

$$q_t - q_{t-1} = \partial\left(q_t^d - q_{t-1}\right) + v_t \quad with\ 0 \ll \partial \ll 1 \qquad (3)$$

where q_{t-1} is the area allocated for the crop in the previous period, ∂ is the so-called *partial adjustment coefficient*, v_t is a random term.

Prices that prevail at the harvesting period cannot be observed, unless the prices are administered by the government and are announced during the planting period (Sadoulet & De Janvry, 1995). This is why farmers price expectations are assumed to be based on the mistake they made in the previous period:

$$p_t^e = \gamma p_{t-1} + (1-\gamma) p_{t-1}^e + w_t \quad with\ 0 \ll \gamma \ll 1 \qquad (4)$$

where γ is the fraction of the magnitude of that mistake, or the *adaptive expectations coefficient*; p_{t-1}^e is the price expected in the previous year, and w_t is a random error term.

Since q_t^d and p_t^e are not observable, the reduced form of the model is obtained by substituting (4) and (2) into (3):

$$q_t = \pi_1 + \sum_{i=1}^{4} \pi_{2i} p_{i,t-1} + \pi_3 q_{t-1} + \pi_4 q_{t-2} + e_t \qquad (5)$$

where π_1, π_2, π_3, π_4 are the parameters to be estimated, π_2 is the short run coefficient of supply response; e_t are the residuals.

Formula in (5) presents the final model estimated in this study. α_1 and α_2 are then obtained using the estimates of π_1, π_2, π_3, π_4. However, in this particular specification of the Nerlovian model, where no exogenous shifters are included, partial adjustment coefficient ∂ and adaptive expectations coefficient γ are not estimable. Our parameters of interest are α_2 and π_2, the long run and short run coefficients of supply response respectively. The structure of the residuals in the reduced form of the model display serial correlation, and Cochrane-Orcutt method is used to correct for it (Braulke, 1982).

4 DATA

The data used in this study is the secondary data on agricultural production, prices and trade compiled from the United Nations Commodity Trade Statistics Database (UN Comtrade), Food and Agricultural Organization of the UN (FAO), National Statistical Committee of the Kyrgyz Republic (NSC) and Ministry of Agriculture of the Kyrgyz Republic (MA).

Products considered in this study cover altogether around 50% of the total agricultural output in Kyrgyzstan. Based on the share of exports and imports in domestic production and consumption respectively, the products are classified into three groups: exportable, import-competing and home goods. Reference prices for traded goods are derived from the amount and value traded of that good in terms of export and import unit values. When appropriate reference prices are not available, as in the case of home goods, reference prices are derived from the agricultural trade data for Kazakhstan for it is the major trading partner of the KR and policy environment is considered to be liberal and close to one in Kyrgyzstan.

5 RESULTS

Kyrgyzstan's trade policy has been liberal with negligible tariffs on imports and no support to exports ever since the country has accessed the World Trade Organization (WTO) and even before when the producer subsidies were sharply cut in the early 1990-s. According to the Law on Customs Tariff as of 29 March 2006, the import tariffs on considered products were: 15% for milk, potato and tomato, 10% for onions, and none for others. The average customs tariff on imports was 5,04%. The tariff is applied only to imports from countries with which the Kyrgyz Republic does not have trade agreements, and hence does not trade much with. With this information in hand, one would not expect any major distortions to agricultural incentives caused by direct government intervention, because the latter does not seem to be significant.

The estimates of Nominal Rates of Assistance obtained for 7 agricultural commodities for the period of 2001 to 2011 are presented in Table 1. One should treat these results with caution because of the quality of available data on domestic and reference prices, as well as the impossibility to account for all the potential domestic trade costs from the production area to the border and vice versa.

Table 1 Estimates of Nominal Rates of Assistance for major agricultural commodities

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
wheat	56	63	52	34	52	43	31	35	27	8	29
potato	72	63	-8	12	12	52	55	37	52	62	51
tobacco	-38	-71	-54	-109	-107	-89	-105	-134	-199	-227	-180
milk	18	10	4	-39	-63	-34	-14	-15	-45	-69	-71
wool	35	0	-44	-42	-69	-3	32	21	26	-34	84
cotton	-17	-10	-4	34	22	38	33	31	29	24	52
maize	41	16	36	18	21	41	52	18	-13	-5	27

Source: Author's estimations

The estimates show that the Nominal Rates of Assistance for some products are substantially large indicating a strong intervention from the government on both directions, as the estimates are negative for some sectors and positive for others. The products considered can be divided into three groups: cash crops (cotton and tobacco as the major crops produced for export), food crops (wheat, potato, maize), and livestock products (milk and wool). As it can be seen from Table 1, food crops generally have positive NRAs which indicate that their producers enjoy assistance from the government, apparently targeting self-sufficiency in staple food. Positive NRAs for cotton starting from 2004 could obviously be attributed to improved integration of the domestic market for cotton into the world market (Christensen & Pomfret, 2007). Estimates of NRA for tobacco are remarkably negative. The main reason is suggested to be the poor access of farmers to the information on world prices for tobacco. The market for this crop is relatively small; there has been a dramatic decrease in the production of this crop in Kyrgyz Republic from about 54 thousand tons in 1990 to 10 thousand tons in 2011. The estimates of NRA for wheat, cotton and maize presented in Table 1 are generally consistent with the findings of Christensen and Pomfret (2007) for the period between 2001 and 2004.

Results of the regression analysis are presented in Table 2.

Table 2 Estimates of the Restricted Nerlovian Model of Supply Response (dependent variable: area allocated for each crop in year *t*, for the period of 2002-2011)

	Wheat		Cotton	
	Short run	Long run	Short run	Long run
Price_wheat/cotton in t-1	2225,7** (775,8)	6584,9		
Price_cotton/wheat in t-1			63,04 (28,41)**	124,09
Price_potato/cotton in t-1	-2114,9** (635,4)	6257,1	-127,18 (137,05)	-250,35
Price_maize/wheat in t-1	2023,5 (1171,3)	5986,7	-100,84 (253,33)	-198,5
Area in t-1	0,662** (0,218)		0,492 (0,133)**	
Constant	-61085,1 (191828,5)		16959,01	
Adaptive Expectations Coefficient, $\boldsymbol{\gamma}$	0,338		0,508	
Adjusted R sq.	0,73		0,95	

Source: Author's estimations. Note: *, **, *** represent p-values at 0,1; 0,05; and 0,001% confidence levels. Standard errors are in parentheses. *a* the respective variables is omitted.

Results in Table 2 indicate strong supply response to changing wheat prices of producers of wheat, both in the short and in the long run. Both for the case of wheat and cotton, the long run coefficients of supply response are higher than the short run response as expected, because farmers can better adjust the allocation of their land in a longer period. Data insufficiency related to incorporation of other explanatory variables, including exogenous factors, as well as related to the period observed in this study, has justified the use of the Restricted Nerlovian Model, as relatively less data-demanding.

The findings of the study indicate that agricultural prices in the Kyrgyz Republic are distorted from world prices. Nominal Rates of Assistance are generally positive for important food crops, such as wheat and potato, over the entire period considered; and protection rates for cotton have been positive since 2004. Negative estimates of NRAs for tobacco are suggested to be due to poor domestic market integration and farmers' access to information on world prices. For remaining crops NRA estimates are rather erratic, and could be the result of not a specific policy goal, but rather indicate the significant quality and variety differences that could not be taken into account in this study. The findings of the study indicate that agricultural and food policies have an impact on price incentives of farmers. Moreover, farmers' response to the increase of crop prices is significant positive, which leads to the conclusion that policy-induced distortions to price (farmer) incentives influence use of agricultural land in the Kyrgyz Republic. Further investigation is needed, possibly with a more comprehensive dataset that covers additional factors influencing supply response.

References

Akramov, K. T., & Omuraliev, N. (2009). Institutional Change , Rural Services , and Agricultural Performance in Kyrgyzstan. IFPRI Discussion Paper.

Anderson, K. (Ed.). (2009). Distortions to agricultural incentives: a global perspective (1955 - 2007) (Washington.). The World Bank. Retrieved from http://siteresources.worldbank.org/INTTRADERESEARCH/Resources/544824-1272467194981/DAI_Global_Perspective.pdf

Braulke, M. (1982). A Note on the Nerlove Model of Agricultural Supply Response. International Economic Review, 23(1), 241–244.

Christensen, G., & Pomfret, R. (2007). Distortions to Agricultural Incentives in the Kyrgyz Republic. The World Bank. Washington DC.

Light, M. K. (2007). Agriculture in Kyrgyzstan: Growth Engine or Safety Net?

National Statistical Comittee. (2011). Statistical Yearbook of the Kyrgyz Republic, 2006-2010. Bishkek.

Pomfret, R. (2006). The Central Asian Economies Since Independence. Princeton: Princeton University Press.

Sadoulet, E., & De Janvry, A. (1995). Quantitative Development Policy Analysis. Baltimore, Maryland, USA: The John Hopkins University Press.

The World Bank. (2007). Trade Audit Report of the Kyrgyz Republic. Washington, DC.

The World Bank. (2011). Kyrgyz Republic: Agricultural Policy Update, Volume 2. Main Report. Retrieved from https://openknowledge.worldbank.org/handle/10986/12863

UTKUR DJANIBEKOV, ASIA KHAMZINA, GRACE B. VILLAMOR, JOHN P.A. LAMERS

ECONOMIC ANALYSIS OF AFFORESTATION OF MARGINAL CROPLANDS IN UZBEKISTAN

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1 ABSTRACT

Irrigated agricultural production in Uzbekistan is threatened by the impacts of land degradation, irrigation water scarcity and climate change. The conversion of marginal croplands to tree plantations is an option for rehabilitation of nutrient-depleted cropland soils, saving of irrigation water, carbon sequestration, and improving population welfare. The economic benefits and impacts of tree planting on marginal croplands, and policies that may facilitate the adoption of this land use are not well known. We employed various methods at different scales to investigate economically viable options of afforestation on marginal croplands on example of irrigated drylands of Uzbekistan. This includes analyzing the impacts of afforestation supported by the carbon (C) sequestration reward on the rural livelihoods. At field level (one hectare), the stochastic dominance analysis was employed to investigate the financial attractiveness of afforestation on marginal farmlands under uncertainty. At the farm level, the expected utility method was employed to analyze effects of this land use change on farm incomes. To consider the bimodal structure of agriculture in Uzbekistan, the stochastic dynamic farm-household model was developed. The results indicate that due to benefits from non-timber products, afforestation is a more viable land use option on marginal lands than crop cultivation. Allowing the exemption of marginal lands from cotton cropping in favor of tree planting would incentivize afforestation. At the same time, the field level analysis indicates that due to variability in returns a substantial increase in C prices would make afforestation as financially attractive as crops on marginal lands. However, when considering uncertainties in land use returns at the whole farm level, afforestation would occur without the C incentives due to improved irrigation water use efficiency and reduced revenue risks through land use diversification. Through the considered farm-household wage-labor relationship, the benefits of afforestation on marginal croplands at farm would be also transferred to rural smallholders employed at this farm. This would mainly result from improved payment structure by tree products, particularly fuelwood and foliage for livestock fodder.

2 INTRODUCTION

Cropland degradation reduces agricultural production, costing about 400 billion USD annually on a global scale and affecting 1.5 billion people (Lal, 1998; Bai et al., 2008). In Uzbekistan, almost half of the arable land is saline and about 25% are classified as marginal, i.e., generating low profits for farmers from crop cultivation (MAWR, 2010; Djanibekov et al., 2012). Afforesting marginal croplands can increase the productive potential of land and contribute to climate change mitigation, efficiency of irrigation water use, and rural incomes (Djanibekov et al., 2012; Khamzina et al., 2012). Payments for such environmental services (PES) to the providers of these services through compliance (e.g., Clean Development Mechanism (CDM)) or voluntary markets could further incentivize afforestation on degraded croplands (Engel et al., 2008; Pagiola, 2008).

Various effects of environmental sustainable land use, e.g., afforestation on marginal croplands, and variability in its value necessitates considering different scales and outcomes that could influence land use decisions (Mendelsohn and Olmstead, 2009). However, previous studies assessing environmental sustainable land uses usually addressed one aspect and scale, and underlined thereby only a portion of its actual value. For instance, previous research compared opportunity costs of farm forestry with pasture and crop cultivation, to estimate returns from land use and derive PES (e.g., Olschewski et al., 2005; Djanibekov et al., 2012), and only a few have accounted for uncertainties and risks affecting decisions of land users (e.g., Knoke et al., 2011). At the same time, as land users make decisions in a farm system context, different effects can be investigated at such scale. The farm-scale analysis can capture land use diversification options, where strategies combining several land uses, e.g., tree plantations and crops, with independent revenue fluctuations may become an effective buffer against revenue risks. Yet, few studies have considered various returns of afforestation at farm level (e.g., Knoke et al., 2011; Castro et al., 2012). In addition, on larger scale, the economy-wide impacts of afforestation have been analyzed (e.g., Glomsrød et al., 2011; Paul et al., 2013). However, planting trees on marginal farmlands may change rural economy relationships (Djanibekov et al., 2013b). In most of the post-Soviet countries agricultural production is organized in a bimodal agricultural system, that comprises large-scale commercial farms with external economies of scale occurring through advantages in accessing inputs, credits and markets, and rural households/smallholders, whose incomes are limited to sales of their surplus crops and employment at large-scale farms (Lerman et al., 2004). Hence, introducing new land use policies in such a bimodal agricultural system would impact the rural population by altering employment structure on commercial farms. In contrast to previous studies, an explicit consideration of different scales (i.e., field, farm, and bimodal agricultural system), uncertainties in land use returns, and impacts of afforestation of marginal croplands on various rural population groups would help to address the multidimensional impacts on rural livelihoods. Thus, the study aimed to: (1) assess the monetary value of environmental services of tree plantations, e.g., carbon (C) sequestration within the framework of CDM, under uncertainty; (2) identify risk managing options of afforesting marginal croplands; and (3) analyze the direct and spillover effects of land use change to afforestation on rural livelihoods.

3 METHODS

3.1 Study area

The case study area is the Khorezm region and southern districts of the Autonomous Republic of Karakalpakstan, namely Beruniy, Turtkul and Ellikkala, located in the lowlands of the Amu Darya River, Uzbekistan. The area is characterized by an arid climate with an annual precipitation of about 100 mm that occur mostly outside of the crop growing season making crop cultivation feasible only through irrigation. Irrigated agriculture accounts for about 35% of region's GDP. The main agricultural producers are commercial farms (hereafter referred to as farms) and semi-subsistence smallholders/rural households. The land use decisions of farms are mainly determined by possible returns from land uses, policy settings, and market and production conditions. At the same time, farmers lack flexibility in land use decisions, as they follow the cotton state procurement policy, according to which (1) about 50% of the farmland have to be allocated to cotton cultivation, and (2) expected yield targets based on soil productivity scale have to be achieved (Djanibekov et al., 2013a). Half of the winter wheat (hereafter referred to as wheat) production at farm is purchased below local market prices (Djanibekov et al., 2012). Smallholders are the smallest agricultural producers in Uzbekistan (posses 0.2 ha), that produce for own consumption, and whose incomes are limited to sales of crop surplus and employment at farms (Djanibekov et al., 2013c). Production decisions of smallholders are also driven by their food consumption, amount of income available and income sources. Cotton and wheat are the major crops cultivated, including on marginal lands as this is imposed due to the state procurement policy. Crops such as rice and vegetables are vital to farmers for income and smallholder consumption, while maize is used as livestock feed (Djanibekov et al., 2013b).

Agricultural production is subject to various risks affecting rural livelihoods. For instance, over the last decades irrigation supplies varied between 5,500 and 21,000 m^3 ha^{-1} $year^{-1}$ (MAWR, 2010). The underdeveloped infrastructure, fluctuation of irrigation water availability, and lack of insurance options result in a high variability of crop prices. Yields are uncertain as a result of irrigation water variability, crop diseases and unfavorable weather conditions. Due to inherently low suitability for farming or degradation (Dubovyk et al., 2013) about 20–30% of arable lands in the study area are marginal (MAWR, 2010), which mainly belong to farms, and crop cultivation on such lands result in economic losses (Djanibekov et al., 2012). Although such marginal croplands can be afforested with certain tree species that provide both environmental and economic benefits (Djanibekov et al., 2012; Khamzina et al., 2012) currently farmers are not practicing such a land use change, due to prohibitive policies, ongoing farmland consolidation that restrains interest in long-term land use investments and the lack of knowledge among farmers about potential benefits and management activities of tree plantations (Kan et al., 2008).

3.2 Data sources

160 farms and 400 smallholders were surveyed during June 2010 and March 2011 to obtain information on their demographic composition, cropping pattern, input and output prices, crop production technologies and costs, and consumption structure. Prices of commodities were also monitored through weekly market surveys. The input costs, which included expenditures for saplings and seeds, field preparation, labor, machinery, fertilizers, transaction costs for market access, and transportation, were reported in Djanibekov et al. (2012). Transaction costs that may incur from land use change are those related to the preparation of arable farmland for afforestation such as machinery costs for proper leveling and labor costs related to digging holes for tree planting, as well as fees related to the official registration of the land use change. Besides, as

in the study we considered an afforestation activity within the framework of CDM we included transaction costs to cover the costs of CDM project design document preparation, validation, registration, monitoring and verification.

Quantity and quality of products of the three tree species recommended for afforesting marginal croplands, including *Elaeagnus angustifolia* L., *Populus euphratica* Oliv., and *Ulmus pumila* L., were collected from an afforestation study conducted in 2002- 2009 (Khamzina et al., 2008, 2009). The plantations were irrigated at rates of 1,600 m^3 ha^{-1} $year^{-1}$ during the first two years. From 2005 onwards, irrigation was stopped and trees relied entirely on the shallow and saline groundwater. Hence, soil properties, irrigation water availability and groundwater table are important biophysical inputs needed for conducting afforestation on marginal croplands in the region (Khamzina et al., 2012). The study included temporary Certified Emission Reduction (tCER) (1 ton of CO_2 content in above- and below-ground wood biomass) within the framework of Clean Development Mechanism (CDM), fruits, fuelwood, and leaves as fodder. Five crops were considered, i.e., cotton, wheat, rice, maize, and vegetables, as well as their by-products, i.e., cotton stem, wheat and rice straw, and maize stem. Crop yields are responsive to irrigation application (requirements lay between 5,300 and 26,500 m^3 ha^{-1} $year^{-1}$ depending on crop) and land productivity.

3.3 The models

To investigate the multidimensional aspects of afforestation on marginal croplands three approaches were used: (1) at the field scale (one hectare) the stochastic dominance (SD) analysis was applied to analyze variability in revenues of crops and tree species on marginal lands, and compare them in terms of the distribution of outcomes; (2) at the whole-farm level the expected utility (EU) approach was used to estimate the farm profit depending on the distribution of the profit and the risk mitigating option of afforestation; and (3) as the afforestation on marginal farmlands would impact not only farmers that planted trees but also would have spillover effects on rural households that are employed at these farms, the stochastic dynamic farm- household model was built to capture the interdependencies between these two actors through wage-labor relations (i.e., agricultural contracts). For all these three approaches Monte Carlo simulation was applied to generate variability of yields and prices of crop and tree products, and irrigation water availability. Covariance between yields and prices of crops, and irrigation water availability, as well as between yields of tree products were considered. In the SD and EU approaches, the net present values (NPV) were calculated over seven years using the discount rate of 14%. Within the SD and EU approaches the price for tCER was derived. To derive tCER prices with the SD approach, we considered a range of values that would make the NPV of afforestation equal to its opportunity cost (i.e., NPV of crops). In the farm-household model one farm and three heterogeneous groups of smallholders were considered, which differ with respect to income and expenditure sources (the description of the deterministic farm-household model is presented in Djanibekov et al. (2013b)). It was assumed that smallholder groups 1, 2 and 3 consisted respectively of 10, 6 and 4 households. The farm-household model covered 28 years and assumed three seven- year tree plantation rotations without a discount rate. In the EU and farm-household models, to address the reluctance level of land users to accept a bargain with uncertain incomes rather than another bargain with more certain but lower incomes the risk aversion degrees were considered. To simplify the interpretation of the findings the extremely risk aversion degree was presented. Based on the observed conditions in the study area, in the EU and farm-household model a total area of 100 ha was assumed, of which 23 ha are marginal, 56 ha are fairly, 20 ha are good, and 1 ha is highly productive. The average irrigation water availability in these two models was assumed to be 12,000 m^3 ha^{-1} $year^{-1}$. In the EU and farm-household models two scenarios were simulated: (1) business-as-usual (BAU) scenario assumed existing cotton policies, i.e., 50% of farmland was allocated for cotton with a production target of 2.4 t ha^{-1} $year^{-1}$; and (2) afforestation scenario assumed that farmers can plant trees on marginal croplands, and without fixing the cotton cropping area but the same yield targets as in the BAU.

4 RESULTS

4.1 Uncertainty in net present value of land uses

The NPV for crops varied between -2,971 and 20,424 USD ha^{-1} on marginal lands (Fig. 1a). The lowest NPV over seven years on marginal cropland were of cotton, ranging between -1,041 and 346 USD ha^{-1}. Rice had the highest returns on marginal cropland assuming an irrigation input of 26,500 m^3 ha^{-1} to achieve its maximum yield. Due to the relatively high NPV ranging between -900 and 11,700 USD ha^{-1}, investments in *E. angustifolia* would be more preferred on marginal lands than cotton, wheat, maize and vegetables. Returns of *P. euphratica* and *U. pumila* species were higher than those of cotton and wheat.

In those cases where the NPV of crops were higher than trees, suitable price levels of tCER for incentivizing tree farming were estimated that would foster more environmentally sustainable land uses (areas between the lines of the respective tree species in Fig. 1b). Depending on the variable returns from crop cultivation and considering the highest NPV of trees, the tCER prices would need to increase up to 68 USD $tCER^{-1}$ for *E. angustifolia*, 103 USD $tCER^{-1}$ for *P. euphratica*, and to 133 USD $tCER^{-1}$ for *U. pumila*. When tree plantations generate the lowest profits owing to low yields and market prices of tree products, while cropping, in contrast, generates the highest profits, the tCER price would have to be substantially raised to make afforestation financially attractive, i.e., up to 540 USD $tCER^{-1}$.

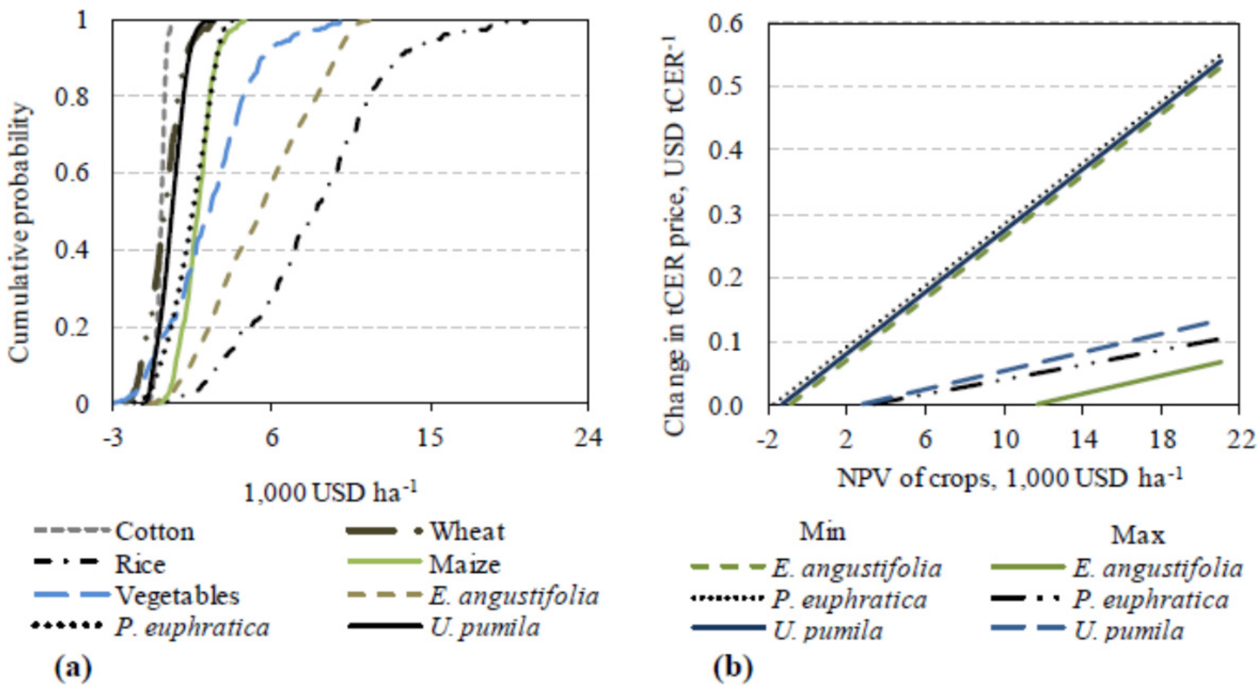

Fig.1: Stochastic dominance of trees and crops on marginal lands (a), and prices of temporary Certified Emission Reduction (tCER) under uncertainty of the net present values (NPV) of trees and crops over seven years (b).

Note: Min is the tCER price based on simulated lowest NPV of the respective tree species; Max is the tCER price based on simulated highest NPV of the respective tree species.

4.2 Land use diversification and farm income

Uncertainties in land use returns would affect farm activities. Using the EU approach, due to uncertainties in yields and prices of crops, and irrigation water availability, as well as the state procurement policy, in the BAU case, mainly cotton and wheat would be cultivated at farm (Fig. 2a). Not the entire farmland area would be cropped since about 2.5 ha of the arable land would be left fallow due to perceived revenue risk aversion. In the afforestation scenario, the flexibility of cotton procurement policy (removal of area-based target and remain only the output-based target) would lead to afforestation on marginal croplands. Planting trees on marginal croplands would increase the opportunity for cropping the most profitable crops, i.e., rice and vegetables, due to supplying irrigation water unused at afforested plots to these water demanding crops. Under the current tCER price level (4.76 USD $tCER^{-1}$) *E. angustifolia* would be the preferred choice on marginal lands. An increase in tCER revenues could enhance the preference for planting *P. euphratica*, owing to its increased biomass increment over time at the expense of the *E. angustifolia* area. In addition, the area of maize and wheat would decline as the price for tCER increases.

These land use changes would impact the income of farmer. In the afforestation scenario, establishing tree plantations on marginal lands would lead to gains varying between 60,000 and 1,170,000 USD, with tCER payments of 4.76 USD (Fig. 2b). In comparison, the returns of farmer following conventional land use practices on marginal lands would range from 15,000 to 930,000

USD over seven years. In addition to returns from tree plantations, the increase in farm income was caused by the expanded area of the most profitable crops – rice and vegetables. The lowest income would be caused by reductions in yields, prices, and irrigation water availability.

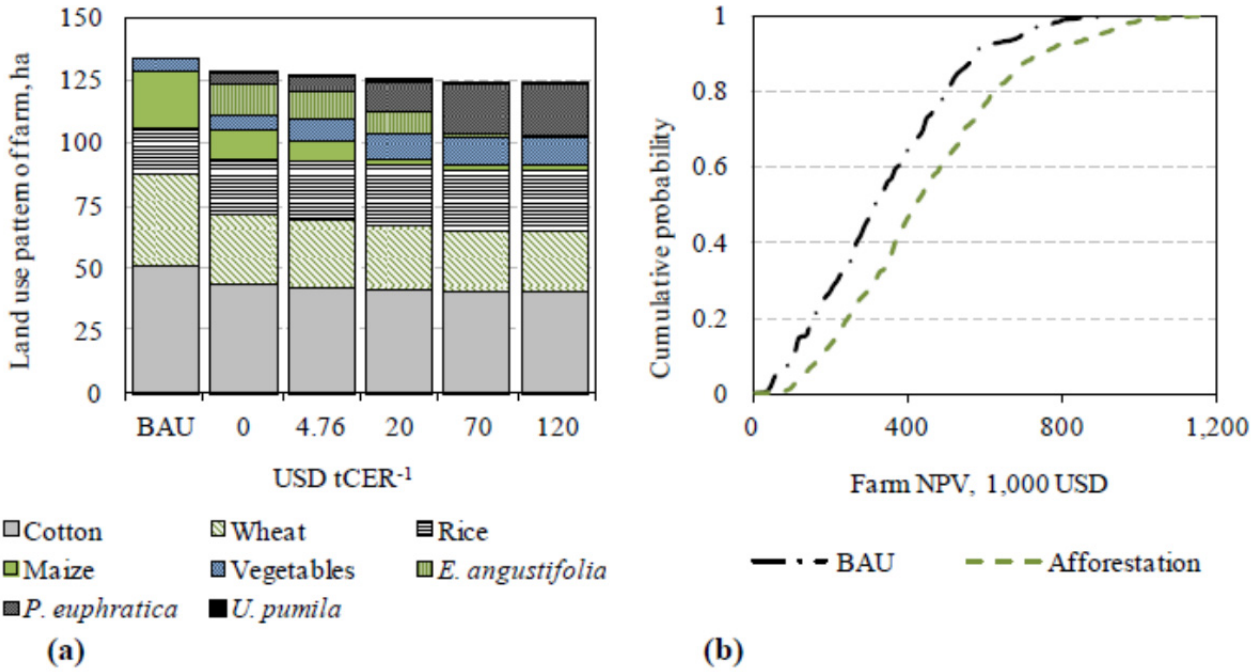

Fig. 2: Farm land use pattern (a) and cumulative distribution of the net present value (NPV) over seven years (b) in business-as-usual (BAU) and afforestation scenarios.

Given the reliance of tree plantations on the shallow groundwater (Khamzina et al., 2012), afforestation could be an option to secure farm production in years of irrigation water scarcity. The model results indicate the inclination of farmer for afforesting marginal cropland, to mitigate the income risk due to the reduced water supplies (Fig. 3). When assuming an annual lowest irrigation water availability of 4,000 m^3 ha^{-1} $year^{-1}$, marginal croplands would be entirely afforested and *E. angustifolia*, *P. euphratica*, and *U. pumila* would be planted on 17, 4.5 and 1.5 ha respectively, and the remaining farmland would be mainly cultivated with cotton (on about 70 ha) to fulfill the state production policy. At the average level of irrigation water availability, i.e., 12,000 m^3 ha^{-1} $year^{-1}$, the area of *E. angustifolia*, *P. euphratica* and *U. pumila* would be 11.1, 5.6 and 0.1 ha respectively. In the scenario of abundant irrigation water availability, i.e., 21,000 m^3 ha^{-1} $year^{-1}$, about 8 ha of marginal lands would be afforested whilst the rest would be allotted to rice and wheat.

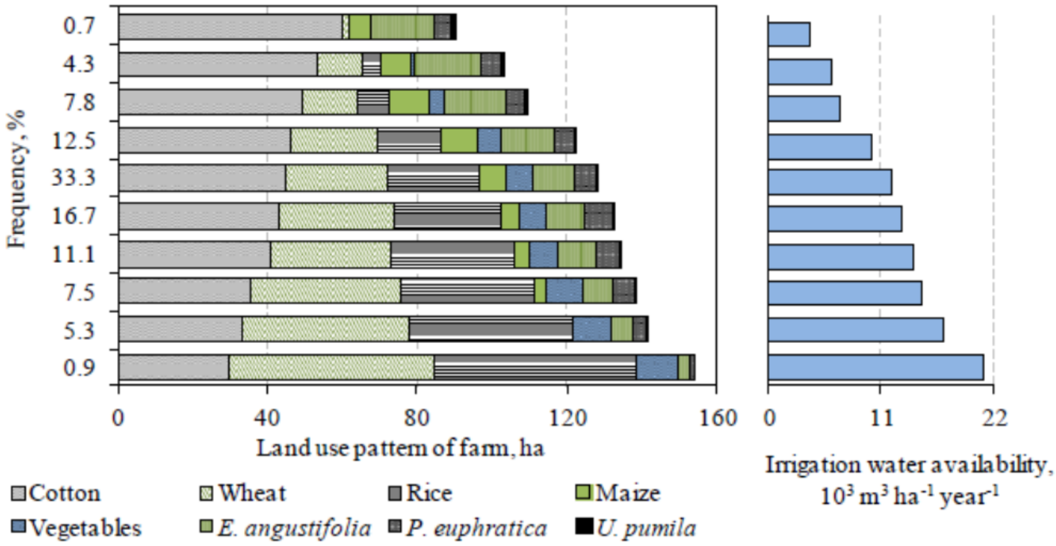

Fig. 3: Frequency of land use pattern of farm under different levels of irrigation water availability in the scenario of afforesation.

4.3 Spillover effects in the bimodal agricultural system

Introducing afforestation on marginal farmland would affect not only farm decisions but also the smallholders employed at such farm due to the existing wage-labor relationships. In the BAU scenario, cotton and wheat are dominating crops, and wheat would be rotated with rice and maize (Fig. 4a). The main crops cultivated by smallholders, would be wheat followed by rice and vegetables. In the afforestation scenario, the area of rice and vegetables would increase by about 40%, whilst cotton area would reduce by about 10% as a result of flexibility in the cotton procurement policy. The area allocated to wheat and maize would be smaller than in the BAU. The main trees planted in the afforestation scenario would be *E. angustifolia* followed by *euphratica* and *U. pumila*. The clear-cut of trees in year 21 would once again trigger changes in land use pattern. Accordingly, the cotton area policy would be restored and the area of this crop would occupy half of the farmland. The area of wheat and maize would also increase. Consequently, the area of the most profitable and irrigation demanding crops, i.e., rice and vegetables, would decline. In year 27, the land use pattern in the afforestation scenario would be similar as to the one observed in the BAU scenario.

These land use changes affected farm demand for labor services. According to the afforestation scenario, in the years of afforesting marginal lands, i.e., years one, eight and fifteen, and harvest, i.e., years seven, fourteen and twenty one, the employment of smallholders by farms would increase. In between these activities the employment at farm would reduce because of decreased labor demands, and consequently payments to smallholders would be lower than in the BAU. The inclusion of tree products in the payment structures would differ from year to year, as opposed to the BAU. In the afforestation scenario, the value of land allotted to remunerate the smallholder labor would decrease during the tree plantation period, gradually increasing after the tree harvest and reaching the level of the BAU scenario from year 27 onwards (Fig. 4b). Tree products would be one of the largest payments after land, with a fuelwood share of 20%, tree foliage of 3% and fruits of 4% of the total payment value over this period. In the BAU scenario, the main payment would remain as land, followed by grains and cotton stem. The least remuneration would be in the form of cash, because of its necessity to operate farms.

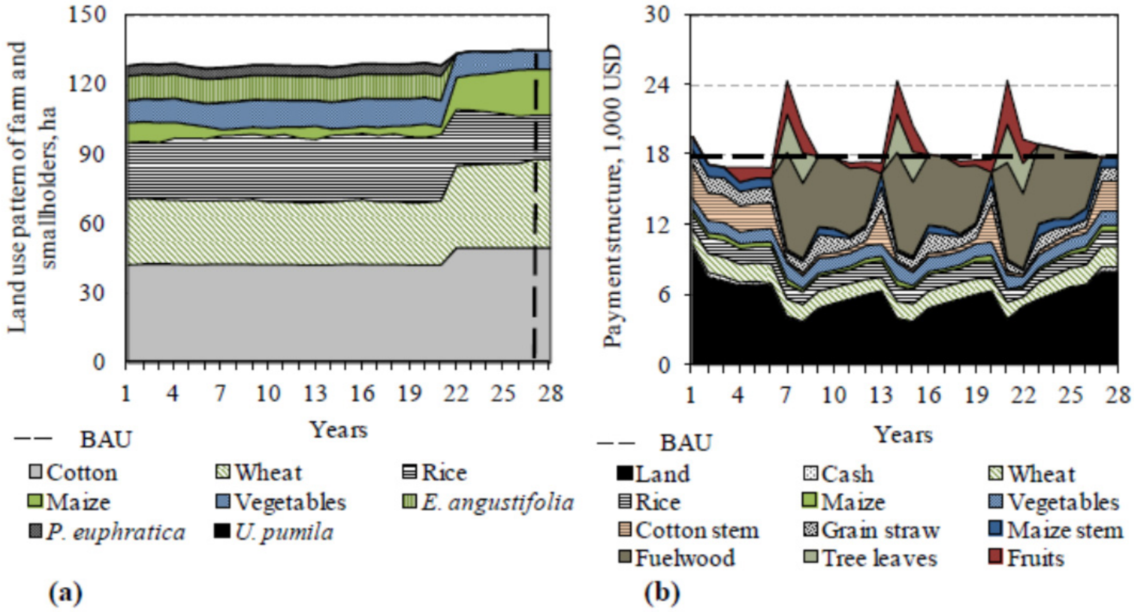

Fig. 4: Land use pattern of both farm and smallholders (a) and payments from farm to smallholders (b) over 28 years in business-as-usual (BAU) and afforestation scenarios.

4.4 Impact on rural livelihoods

Afforestation on marginal farmland would affect the incomes of farm and smallholders and would differ over the years (Fig. 5a and b). In this land use scenario the total farm income over 28 years would bypass the income in the BAU case by about 600,000 USD. This is caused by shifts in the cropping pattern towards the high-return crops such as rice and vegetables. Moreover, non-timber products, i.e., fuelwood, tree leaves, fruits and tCER, would generate revenues of around 630,000 USD over 28 years.

Due to the heterogeneity of smallholders' characteristics, their incomes would differ, and the largest one observed in group 2 (about 1,400 USD). Since less labor would be required at farm between the years of plantation establishment and harvest, the incomes of smallholders employed at farm would decrease. During those periods the incomes in total would be lower by about 5,000 USD than of the BAU case. The most affected smallholder type would be group 3, because of the high dependency of these household members on activities at farm. However, the harvest of tree plantations would substantially increase their incomes. Moreover, during the initial years after the cessation of the afforestation, namely years 22 to 26, the incomes of smallholders would be larger than under the BAU scenario. This is owing to the labor demanding activities at farm, as well as reduced energy and fodder expenditures by smallholders as a result of receiving fuelwood and tree leaves as payment in kind. A storage by farmer of tree foliage and fuelwood and their annual inclusion in the payment structure can substitute or complement respectively grain straw as fodder, and coal and liquefied petroleum gas (LPG) as domestic energy products beyond the duration of afforestation activity. The largest positive effect would relate to smallholders that largely depend on farming activities, i.e., group 3, for whom the total income over 28 years would increase by around 8% compared to the BAU scenario. As for groups 1 and 2, their incomes over 28 years would increase by 5% and 3% respectively, in contrast to the BAU case. The return to cropping on marginal lands after year 21 would eventually bring down the incomes of farm and smallholders to the levels in the BAU scenario.

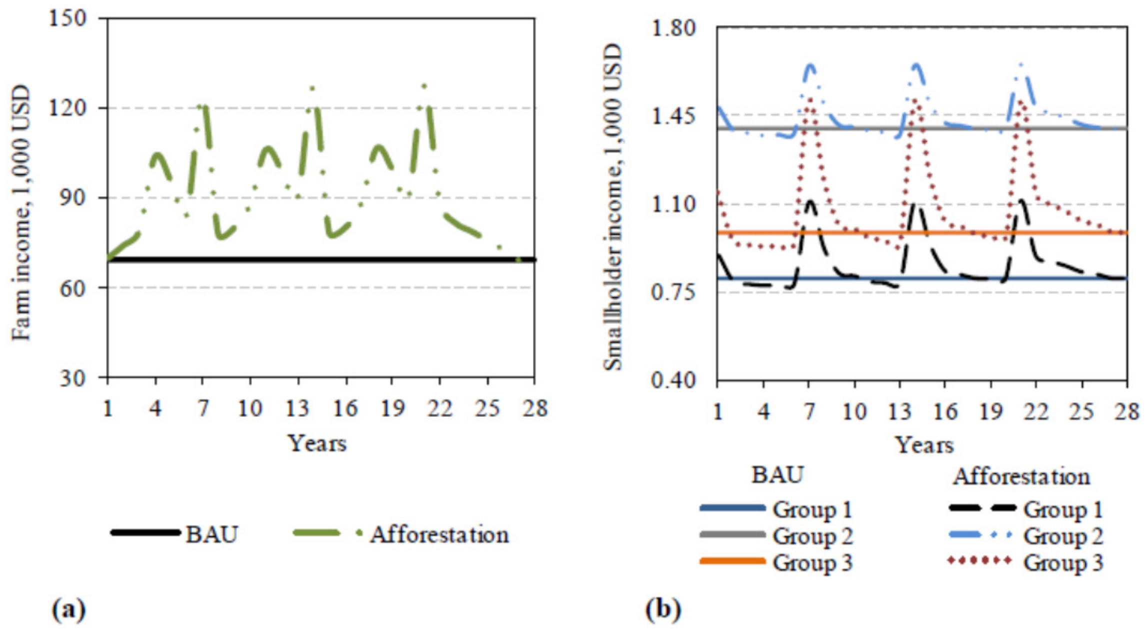

Fig. 5: Incomes of farmer (a) and individual smallholder per group (b) over 28 years in business-as-usual (BAU) and afforestation scenarios.

5 CONCLUSIONS

When considering uncertainties in land use revenues at the field level (i.e., one hectare) the current tCER prices of 4.76 USD requires an increase up to 120 times. This is hardly to be expected to implement, and thus would argue against an afforestation. At the same time, appropriately identifying the PES and scale of benefits reflect important issues. The findings showed, in addition, that an analysis at the whole farm level when afforestation of marginal croplands, rather than the field level alone, would lead to more realistic tCER prices, which may initiate land use changes to tree plantations, when considering various uncertainties affecting the farm revenues. This is because land use diversification through afforestation can be an option for farmers in order to hedge land use revenue risks. Hence, the diversification of land uses in farming could necessitate only minor adjustment of PES prices to initiate environmentally sustainable land uses. Besides, the flexibility in the cotton procurement policy, according to which farmers can decide the area of cotton cultivation and only have to deliver the state-determined production target, can be decisive for initiating afforestation on marginal croplands.

Moreover, the model findings illustrate that tree plantations could become the main income source when assuming decreased irrigation water availability and/or low crop prices and yields, reducing the repercussions of revenue risks. Due to the independent revenues of trees and crops, a farmer would select different tree species to diversify land uses. The lesser irrigation water demand of tree plantations compared to crops would allow a more efficient use of irrigation water, with that not used on marginal lands supplied to more productive croplands, and when using this would enhance grain and vegetables production. During water scarce years and when the irrigation water availability is lower than the average level, the afforestation practices would represent one of the main land uses on the farm, apart from cotton production.

The existing interdependencies in the bimodal agricultural system indicate that due to afforestation on marginal farmland not only the income of farmers adopting this land use would be impacted but also the income of smallholders employed at these farms. The annual change in working hours and inclusion of new tree products into the payment structure would diversify farm payments, and affect rural incomes. Given that afforested marginal croplands require less labor than crops between periods of tree plantations establishment and harvest, smallholders' employment on the farm would decline and consequently reduce their incomes. However, during the establishment and harvest of tree plantations the farm remuneration to smallholders would increase and outweigh the losses in previous years. This change is primarily caused from an increased employment at farm and the improved structure of agricultural contracts when including fuelwood and tree leaves into the structure of payments in kind. The inclusion of fuelwood and leaves as fodder in the farm payments has the potential to reduce the domestic energy and feed expenditures of rural households. Overall, the afforestation of marginal croplands in a bimodal agricultural system of Uzbekistan should be supplemented by additional policy measures to support smallholders' livelihoods during the periods of decreased demand for labor at farms due to the afforestation.

REFERENCES

Bai, Z.G., Dent, D.L., Olsson, L., Schaepman, M.E., 2008. Proxy global assessment of land degradation. Soil Use and Management 24, 223-234.

Castro, L.M., Calvas, B., Hildebrandt, P., Knoke, T., 2012. Avoiding the loss of shade coffee plantations: how to derive conservation payments for risk-averse land-users. Agroforestry Systems, 1-17.

Djanibekov, N., Sommer, R., Djanibekov, U., 2013a. Evaluation of effects of cotton policy changes on land and water use in Uzbekistan: Application of a bio-economic farm model at the level of a water users association. Agricultural Systems 118, 1-13. Djanibekov, U., Djanibekov, N., Khamzina, A., Bhaduri, A., Lamers, J.P.A., Berg, E., 2013b. Impacts of innovative forestry land use on rural livelihood in a bimodal agricultural system in irrigated drylands. Land Use Policy 35, 95-106.

Djanibekov, U., Khamzina, A., Djanibekov, N., Lamers, J.P.A., 2012. How attractive are short-term CDM forestations in arid regions? The case of irrigated croplands in Uzbekistan. Forest Policy and Economics 21, 108-117.

Djanibekov, U., Van Assche, K., Boezeman, D., Djanibekov, N., 2013c. Understanding contracts in evolving agro-economies: *Fermers*, *dekhqans* and networks in Khorezm, Uzbekistan. Journal of Rural Studies 32, 137-147.

Dubovyk, O., Menz, G., Conrad, C., Kan, E., Machwitz, M., Khamzina, A., 2013. Spatio-temporal analyses of cropland degradation in the irrigated lowlands of Uzbekistan using remote-sensing and logistic regression modeling. Environmental Monitoring and Assessment 185, 4775-4790.

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: An overview of the issues. Ecological Economics 65, 663-674.

Glomsrød, S., Wei, T., Liu, G., Aune, J.B., 2011. How well do tree plantations comply with the twin targets of the Clean Development Mechanism?—The case of tree plantations in Tanzania. Ecological Economics 70, 1066-1074.

Khamzina, A., Lamers, J.P.A., Vlek, P.L.G., 2008. Tree establishment under deficit irrigation on degraded agricultural land in the lower Amu Darya River region, Aral Sea Basin. Forest Ecology and Management 255, 168-178.

Khamzina, A., Lamers, J.P.A., Vlek, P.L.G., 2009. Nitrogen fixation by *Elaeagnus angustifolia* in the reclamation of degraded croplands of Central Asia. Tree Physiology 29, 799-808.

Khamzina, A., Lamers, J.P.A., Vlek, P.L.G., 2012. Conversion of degraded cropland to tree plantations for ecosystem and livelihood benefits, in: Martius, C., Rudenko, I., Lamers, J.P.A., Vlek, P.L.G. (Eds.), Cotton, Water, Salts and Soums - Economic and Ecological Restructuring in Khorezm, Uzbekistan. Springer, Dordrecht, Heidelberg, London, New York.

Knoke, T., Steinbeis, O.-E., Bösch, M., Román-Cuesta, R.M., Burkhardt, T., 2011. Cost-effective compensation to avoid carbon emissions from forest loss: An approach to consider price–quantity effects and risk-aversion. Ecological Economics 70, 1139- 1153.

Lal, R., 1998. Soil erosion impact on agronomic productivity and environment quality. Critical Reviews in Plant Sciences 17, 319-464.

Lerman, Z., Csaki, C., Feder, G., 2004. Agriculture in transition: Land policies and evolving farm structures in Post-Soviet Countries. Lexington Books, Maryland.

MAWR, 2010. Land and Water Use Values for Uzbekistan for 1992-2009. Mendelsohn, R., Olmstead, S., 2009. The economic valuation of environmental amenities and disamenities methods and applications. Annual Review of Environment and Resources 34, 325-347.

Olschewski, R., Benítez, P.C., de Koning, G.H.J., Schlichter, T., 2005. How attractive are forest carbon sinks? Economic insights into supply and demand of Certified Emission Reductions. Journal of Forest Economics 11, 77-94.

Pagiola, S., 2008. Payments for environmental services in Costa Rica. Ecological Economics 65, 712-724.

Paul, K., Reeson, A., Polglase, P., Crossman, N., Freudenberger, D., Hawkins, C., 2013. Economic and employment implications of a carbon market for integrated farm forestry and biodiverse environmental plantings. Land Use Policy 30, 496-506.

ANDREI DÖRRE

LEGAL ARRANGEMENTS AND PASTURE–RELATED SOCIO–ECOLOGICAL CHALLENGES IN KYRGYZSTAN

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1 PROBLEM STATEMENT

It has to be stated from the beginning that grasslands in Kyrgyzstan have a crucial economic importance from the macroeconomic national level down to the level of local households as supplier of natural animal fodder, as well as crucial ecological meanings such as for water and nutrient cycling, filtration, and soil formation. In spite of the vast expanse of pasture lands and the reduction of livestock numbers in the 1990s, the scope and diversity of pasture-related socio-ecological challenges have increased remarkably, and have come to endanger the continued provision of these services (Wilson 1997: 62– 63; Undeland 2005: 22). Degradation leads to a growing shortage of grassland, and pasture-related conflicts jeopardize the country's social integrity. Based on these facts, this presentation has two objectives. The first is to shed light on the importance of legal institutions for the emergence of pasture-related social and ecological problems. Second, it advocates for a participatory approach to the creation of institutional regulations regarding the management and utilization of natural resources. Including the local population in the pasture utilization-related institution-building process can make a decisive contribution to a sustainable development of the country's society by balancing different interests.

2 RESEARCH QUESTION

The hypothesis to be explored is that formal institutions, especially top-down-initiated legal rules, are decisively contributing to the formation of socio-ecological pasture- related challenges. I argue that it is misleading and insufficient to explain these problems through neo-Malthusian arguments of population growth and an unavoidable increase of resource degradation. The causes are much more complex. Rather, the problems can be understood as resulting from struggles between interest-driven actors with differing levels of power, the interplay of economic necessities, structural legal uncertainties, and the related lack of reliable planning opportunities. The central question, in this context, is how legal arrangements are stimulating the processes of socioeconomic stratification and disintegration of the society as well as those of pasture degradation. Based on findings obtained during field studies in the walnut-fruit forest region in Kyrgyzstan's southwest, I advocate for the integration of the principles of sustainable development for the society in economic, social, and ecological terms. Resource management responsibilities, access, and utilization rights need to be matched to the specifics of local contexts and legitimized through participatory approaches.

3 METHODOLOGICAL APPROACH

The line of argumentation and evidence of the presentation is based on insights gained during field studies between 2007 and 2013, in which I applied different research methods, including secondary and archival research, interviews, and observations. Pasture-related legal sources were reviewed with critical consideration of changes that were made to the most central contents and passages regarding ownership, management responsibilities, and allocation practices. Expert interviews were conducted for two reasons. First, I wanted to explore the research object, i.e., to learn about the basic characteristics, relations, and dimensions of pasture-related socio-ecological challenges. Second, I explored people's assessments and explanations of the transformations, meanings, and effects of codified regulations. Additionally, observations of pasture utilization as well as and guided interviews with pasture users and other and actors were conducted. The guidelines included questions regarding individual entitlements, perceptions and assessments of the legislation in general and its effectiveness and implications *in situ*, as well as individual usage practices. The aim was to compare the legal provisions with the reality on the ground.

4 STUDY AREA

The research area is located on the northern edge of the Fergana Basin on the south- facing slopes of the Tian Shan's Fergana Range within the district of Bazar Korgon. Mountain pastures at elevations between 1800 and 3500 m form a vegetation zone above extensive walnut-fruit forests that are a peculiarity in the otherwise sparsely wooded country. Over 50,000 people live within the forests and their surroundings. Their living depends considerably on local land and forest resources (Schmidt 2005: 93, 99–101; Schmidt & Doerre 2011: 2; Dörre & Borchardt 2012: 314–316). Another unique characteristic of the study region is the existence of different legal land categories that are important for the management and the allocation of grassland areas. Pastures are located on communal lands, and on areas of the so-called "forest fund" as well as the "national land reserve".

5 RESULTS

Kyrgyzstan's pasture legislation

After the dissolution of the USSR, all natural resource relations required new legislation. For pastures, a number of attempts were made to clarify the general legal guidelines for management, allocation, and utilization. The central, and so far valid, instruction adopted from the socialist era, is that contrary to the privatized arable land of former collective farms, pastures lasted exclusive state property (ZKRK 1991 art. 2; ZKKR 1999 art. 4 par. 2; ZKKR 2003 art. 4 par. 2; ZOP 2009 art. 3 par. 1). Regardless of this clear arrangement, discontinuities, ambiguities, and complicacy are characteristic of Kyrgyzstan's pasture legislation (Dörre 2012: 133): According to the Land Codes and the Regulation "On Pasture Lease and Use" (PPPAIP 2002), which was valid until 2009, local authorities were responsible for managing pastures located close to settlements. Rayon (district) and oblast' (province) authorities were responsible for grasslands located in an "average" and "far" distance from settlements, respectively. Here, individual leases obtained via auctions were the legal norm (ZKKR 1999: art. 4.2, 13, 15, 17; PPPAIP 2002: par. 10, 15). The State Agency on Environment Protection and Forestry and local national forest enterprises (leskhozy) were responsible for pastures of the forest fund (PPPAIP 2002: par. 4, 7, 10, 15, 39). Participation of the local users in management and allocation procedures was not envisaged. These regulations failed in practice.

Due to the lack of resources, many management organizations were unable to execute their duties. Informal resource allocations and competing and ecologically harmful utilization practices became widespread. Against this background, the new law "On pastures" (ZOP 2009), which had been initiated and promoted by powerful external donors like the World Bank, was established. This normative framework banned pasture auctions and leasing. Instead of the administrations of the district and provincial levels being responsible for the management and the allocation of pastures located on communal land and land reserve territory, irrespective of their distance from settlements, local pasture user committees and authorities became responsible for them. However, the regulation is not applicable on forest fund pastures, where the State agency and the leskhozy remain responsible (ZOP 2009: art. 1, 4, 15). Therefore, different legal regulations exist in the study area, which influence the pasture management and allocation regimes (Dörre & Borchardt 2012: 316). Therefore, the region is suitable to examine the effectiveness of Kyrgyzstan's legal pasture regulations.

A*n example of socio-ecological challenges in the walnut-fruit forest region: Rivalries over access and utilization on the pasture Kara Art*

Regardless of ecological problems on the pasture, induced to a degree by maladjusted utilization practices, an inter-local conflict over access and utilization forms unfolded on the forest fund pasture Kara Art. Though not directly utilizable for forestry purposes, the summer pasture was allocated in Soviet times to a collective farm (kolkhoz) based in the lowlands of the district. Subsequently, Kara Art was managed through this enterprise (KIRGIZGIPROZEM 1983a; GAOZh 1997). After 1991, the situation changed remarkably. After the withdrawal of the kolkhoz, inhabitants of the nearby settlements of Zhai Terek and Arslanbob partially took possession of the territory in search of new income opportunities: Whereas the Zhai Terekis were sufficiently provided with arable land, there existed a pressing need for pastures. On the other hand, in Arslanbob, a shortage of farmland was observable. As the area should serve both demands, a competition between cultivation and animal husbandry, locally unknown before, started. Legally, according to the ZKKR, the rayon administration became responsible for pasture management and allocation of usage rights. However, from the very beginning, the authority was incapable of fulfiling its duties. Therefore, Kara Art, as a part of the forest fund, was reallocated to the local state-owned leskhoz (GOP 1997). Although the rayon administration was designated by the Forestry code to allocate forest fund pastures like Kara Art (LKKR 1999 art. 19, 20), its influence relating to this matter became marginal. In contrast, within the State-owned forestry structures, individual actors such as managers and rangers became powerful gatekeepers controlling pasture access and started to exploit their positions for individual purposes. Informal allocation practices and maladjusted uses increased. Although the central role of the district administration in the allocation of forest pastures located in an "average" distance from settlements, as intended by the legal norms, the leskhozy revealed as the crucial stakeholders within the area of management and allocation of forest fund pastures. In this respect, the laws and regulations proved to be just ‘paper tigers.’

Pasture access based on temporal leasing contracts, as put forward by the ZKKR and PPPAID, was an exception, according to respondents during the field research. According to the management of the forest enterprise, slightly more than 60 pasture users were registered in Kara Art in 2007. According to my own observations, at least 80 users were present. Only few of them had a leasing contract and a ‘forest ticket’ (lesnoi bilet), both of which were necessary at that time for the use of forest fund pastures. The documents contain information on the leasing duration, the size, location, and demarcation of the plot, along with indicating the agreed usage form. Another 16 users were able to provide at least a lesnoi bilet. All other users utilized the pasture on the basis of informal agreements with the underpaid forestry staff. These unofficial or ad hoc fees did not correspond to the official sums established by the rayon administration. This can be seen as an evidence that the forest enterprise did not integrate the public authorities into processes of resource allocation. The rationale of this strategy of the forestry staff is that they can define the amount of the fees they charge without being controlled by a third party. Additionally, the income they gain can be retained without needing to divide it with anyone else. In many cases, the forestry staff enabled prohibited pasture practices such as farming, and ecologically harmful activities such as overstocking, goat keeping, and the cutting of living trees by not intervening.

As a result, a remarkable situation arose in which it became lucrative for the employees of the forest enterprise to allow certain harmful practices, not in spite of, but because of their legal ban. This is an important cause, if not the central one, for the emergence of socio-ecological pasture-related challenges in the walnut-fruit forest region. It accrues from the interaction of the economic needs of the users and forestry staff, the unreliability of the legislation and enforcement authorities, as well as the weakness of the public administration. The dilemma is obvious. On the one hand, informal agreements are expressions of creative handlings of impractical legal requirements and allocation procedures. Otherwise, such agreements hinder the management and control of pasture utilization. Such informal agreements allow those actors who are able to pay for the service to access the resource. Hence, they enforce the socio-economic stratification of the local communities. This practice also leads to tenure insecurity where it is not possible to sue for a land plot acquired informally. Finally, ecologically harmful usages were promoted. In summary, it can be stated that the informal agreements in the given example are fostering resource-related social conflicts between the local population, as well as ecological damages of the pasture (Dörre 2009: 122–124; Dörre 2012: 137–140).

6 DISCUSSION OF RESULTS

Kyrgyzstan’s pasture-related legislation consists of norms that are characterized as top- down-initiated, external interventions which have caused several unintended effects at the local level. The failure of these codified regulations seems to be caused by the attempt to formulate a generally valid and highly differentiated legal frame that neglects the characteristics of the country, which is distinguished by radical social transitions and at the same time is equipped with diverse, local-specific settings. The legislation rests upon certain untenable presumptions such as the existence of efficient institutions, authorities, and market mechanisms. It seems to be more useful to reduce the national regulations down to the necessary frame conditions and to enable local actors to find their own solutions that serve the respective socio-economic and ecological situations. These specific local and regional resource management, allocation, and usage regulations should be legitimized through the participation of local people within the processes of decision-making and institution building. Such attempts can make a decisive contribution to the integrated and sustainable development of Kyrgyzstan's society in economic, social, and ecological matters by balancing initially opposing interests. The newest pasture law follows this approach by allocating pastures and delegating legal resource responsibilities to local communities. To achieve the desired goal of an integrated and sustainable development of the society, this strategy has to be accompanied by capacity- building measures and by financial support to empower the responsible local organizations and actors to fulfill their duties.

References

Dörre, A. (2012): Legal Arrangements and Pasture-Related Socio-ecological Challenges in Kyrgyzstan. In: Kreutzmann, H. (ed.): Pastoral practices in High Asia. Agency of 'development' effected by modernisation, resettlement and transformation (= Advances in Asian Human-Environmental Research). Dordrecht/ Heidelberg/ New York/ London. Springer. pp. 127–144

Dörre, A. & P. Borchardt (2012): Changing systems, changing effects: Pasture utilization in the course of the post-Soviet transition. Case studies from Southwestern Kyrgyzstan. In: Mountain Research and Development 32(3). pp. 313–323

GAOZh Gosudarstvennyi Arkhiv Oblasti Zhalalabad (State Archive of the Zhalalabad Oblast') (1997): Istoricheskaya spravka na kolkhoz im. Engel'sa Bazar- Kurganskogo raiona Sovetskogo sel'soveta. Fond 434, opis' 1 (Historical information on the collective farm Engels of the Bazar Korgon Rayon, settlement council Sovetsk. Stock 434, inventory 1)

GOP Granicy otgonykh pastbishch (Borders of remote pastures). Postanovlenie N 236 B [GOP] 2.7.1997. Glava raionnoi administracii Bazar Korgon (Decree no. 236 B. 2.7.1997. Head of the rayon administration Bazar Korgon)

KIRGIZGIPROZEM Kirgizskii Gosudarstvennyi Proektnyi Institut po Zemleustroistvu Kirgizskoi Socialisticheskoi Respubliki (Kyrgyz State Design Institute for Land Management of the Kyrgyz Socialist Soviet Republic) (1983a): Karta Bazar- Kurganskogo Rayona Oshskoi oblasti Kirgizskoi SSR (Map of the Bazar Korgon Rayon of the Osh Oblast' of the Kyrgyz Socialist Soviet Republic). Scale 1: 50,000

LKKR Lesnoi kodeks Kyrgyzskoi Respubliki (Forestry code of the Kyrgyz Republic) N66. 8 iyuljy 1999 goda

PPPAIP Polozhenie "O poryadke predostavleniya v arendu i ispol'zovaniya pastbishch" (Regulation ''On Pasture Lease and Use'') N 360. 4.6.2002 goda

Schmidt, M.(2005): Utilisation and management changes in South Kyrgyzstan's mountain forests. In: Journal of Mountain Science 22(2). pp. 91–104

Schmidt, M. & A. Doerre (2011): Changing meanings of Kyrgyzstan's nut forests from colonial to post-Soviet times. In: Area 43(3). pp. 288–296

Undeland, A. (2005): Kyrgyz Livestock Study: Pasture Management and Use. Washington, DC: International Bank for Reconstruction and Development Wilson, T. (1997): Livestock, pastures, and the environment in the Kyrgyz Republic, Central Asia. In: Mountain Research and Development 17(1). pp. 57–68

ZOP Zakon Kyrgyzskoi Respubliki "O pastbishchakh" (Law of the Kyrgyz Republic "On pastures") N 30. 26 yanvarya 2009 goda

ZKKR Zemel'nyi kodeks Kyrgyzskoi respubliki (Land code of the Kyrgyz Republic) N 123. 9 iyul' 2003 goda

ZKKR Zemel'nyi kodeks Kyrgyzskoi respubliki (Land code of the Kyrgyz Republic) N 45. 2 iyun' 1999 goda

ZKRK Zemel'nyi kodeks Respubliki Kyrgyzstan (Land code of the Kyrgyz Republic) N 574-XII. 19 aprel' 1991

SHAKHZOD AVAZOV

SOCIO-ECONOMIC FEATURES OF THE AGRO-PASTORALISTS IN THE ZARAFSHAN VALLEY, NW TAJIKISTAN

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1 ABSTRACT

This paper analyzes the livelihood of the agro-pastoral communities of Western part of Tajikistan, the Zarafshan valley. The data were amassed on current fodder management practices in eighteen villages through households as well as agro-pastoralists and visual observation on local pasture areas. The interviews and discussions yielded more information on the decision-making processes that dehkans (farmers) employ to determine the quantity and composition of feed offered to livestock at particular times of the year. Among the influences to decisions were constraints to grazing and knowledge of appropriate lopping regimes for different animal fodder species. Varying degrees of access to off-farm fodder sources and the numbers of livestock kept by different households were also seen to affect fodder management decisions. Development activities aimed at labour use to fodder collection and the exchange of local knowledge regarding local fodder management are most likely to result in improvements in the levels of fodder supply for the majority of households in the short term. The variations were discussed within site-specific dehkan groups and between group representatives at a series of workshops. According to the results, stable type, number of cattle, size of cultivated land, labor availability per household, existence of small ruminant flock in the village, and the number of small ruminants were found to be most important factors affecting household economic status. It was concluded that more robust and long-term studies should be conducted using a wider variation in grassland quality to confirm the study findings.

2 INTRODUCTION

Tajikistan is a small landlocked country of about 143.1 thousand sq. km, which located between 67°31’ and 75°41’ E longitude, and 36°40’ and 41°05’ N latitude in the south-east part of Central Asia (Figure 1). Mountains cover 93 % of the total area and most of the country lies at over 3,000 masl.

Figure 1. Map of Tajikistan

Source: *http://www.un.org/depts/Cartographic/map/profile/tajikist.pdf*

2.1 Pasture Resources

Tajikistan is an agrarian country and pastures play a significant role in the national economy of the country. Therefore, pastures in the country are an important resource, which is 3.9 million ha or 83 % of agriculture land of the country (**Rakhimov et al. 2011**). In general, pastures in Tajikistan are distributed by according to their seasonality of use and also depending on their altitude. Summer pastures are used between June and August and are located from 2,200 to 3,400 masl; spring-autumn pastures are usually used from March to May and September to November and are located between 900 and 1,500 masl; winter pastures are used between November and March and are located 500 to 1,200 masl and all year-round pastures are located at the same level as winter pastures. The different regions are separated by high mountain ranges and are often isolated during the winter season (**Kodirov et al. 2010, Rakhimov et al. 2011**).

2.2 Grazing Management System

The high-mountain pastures of Tajikistan are a potential source of forage for livestock during summer season. A huge number of herds migrate to these areas in early summer, in beginning of May and return to lower elevations or plains in early autumn, in late of September. Traditionally this style of transhumance grazing has become well adopted and is the main animal production system of the country. It is a grazing system where animals move during the year to that places where fodder is available. The shepherds move their animals higher and higher as the snow pack melts. For centuries this system worked and made it possible to efficiently utilize of pasture resources in Tajikistan. However, in Soviet times the system was discontinued due to more intensive system of feeding, which based on conserving large amount of winter fodder and grain imports from other Soviet republics. This meant that the country has kept more animals than it could provide from own resources. Actually during the winter period livestock supported by grain import, and in the summer, some of them were sent to graze in the neighbour countries. After the collapse of the Soviet Union and the gain of independence, forage imports virtually stopped and the Soviet system became unstable. Furthermore, in conjunction with the Civil War (1991-1997) and changes in herd and farm ownership has led to significant reduction in animal numbers (**World Bank and SECO 2008**).

3 METHODS

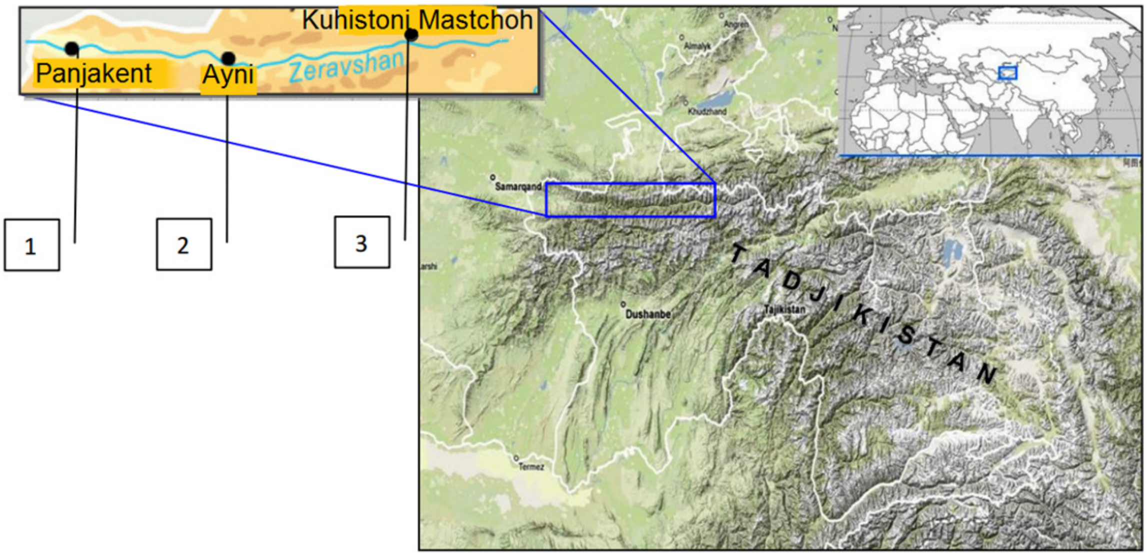
3.1 Study Area Selection and Description

The Zarafshan valley lies in the north-western part of Tajikistan. In the administrative relation this watershed concerns to Panjakent (PD), Ayni (AD) and Kuhistoni Mastchoh (KMD) districts. For the study these three districts were selected (Figure 2). Two surveys were conducted in the study areas. The first survey was conducted in between Dec’10-Jan’11, but the second was in between Nov’11-Dec’11.

Study areas differ in their land use management as well as in their bio-geographical resources. The KMD located on the upper reach of the Zarafshan River, being the remotest area of the Zarafshan valley. Zarafshan valley has a population of 301.9 thousand people; about 24 people per sq. km (**TajStat 2011a**). The Zarafshan valley includes the southern slope of the Turkestan ridge, Zarafshan and northern slope of Hissar ridge. The highest peak Chimtargha (5,489 m) stands to the west of the AD. Other peaks are Ok-Su (5,355 m), Kaznok (4,886 m), Saratogh (3,904 m). The valley is drained by the Zarafshan River which originates from Pamir Mountains.

The total area of the valley is equal to 1,251.1 thousand hectares, and from them 384.4 thousand hectares (30.7 %) are the areas of agricultural grounds. Almost all the territory of the valley, which is located closer to settlements, is subjected to grazing with high intensity. According to Safarov (2010) natural pastures and hayfields are 354.2 thousand hectares (more than 90 % from total area of agriculture land).

Figure 2. Case study of three districts of the Zarafshan valley.



Source: developed by author

The main means of livelihood of the people are pastoralism and crop production. Livestock husbandry contributes the lion's share to the livelihood of the people. The elevations of the study areas are various from 980 to 2,800 masl. The accessibility to the area mostly remains open for summer months. Jamoats in AD and KMD are practicing both livestock and crop production. But, the jamoats in PD rely more on crop production than livestock husbandry. According to the official statistics Anzob and Fondaryo jamoats (AD) are more pastoralists although crop production is gaining importance in these jamoats, too.

Presently, a total estimated population of the six research jamoats (Anzob, Fondaryo, Rudaki, Voru, Chinor and Ivan-Tojik) is about 60 thousand people and compared with the area of arable land, which is about 3,251.4 ha, it gives an average of about 0.05 ha of arable land per person.

3.2 Sample Selection and Research Design

Six *jamoats* Voru, Rudaki, Shing (PD), Fondaryo, Anzob (AD) and Ivan-Tojik (KMD) were purposively selected from all 24 *jamoats* of the Zarafshan valley. The given areas that were selected are the high altitude zones and the most grazing areas relate to these belt zones. Lists of all *jamoats* were obtained from the *Hokimiyati mahalli* (local authorities), and at the jamoat level 3 villages per jamoat were selected. But at the village level, lists of households were obtained from the local authorities through randomization method, 5 households per village were selected. Totally, 90 households were randomly selected for interviews. Mostly family heads were interviewed.

3.3 Data Collection

Some supplementary procedures to gather data and information were employed. These included key person interviews, focus group discussions, household surveys and field observation by researcher.

Household data was collected by questionnaires to a total of 90 selected household in the three districts between November and December 2011. Data on socio-economic characteristics of farming families, available resources as well as quantities and costs were gathered. The monetary and labour units are expressed in Tajik somoni (TJS) and Man day (MD), respectively.

According to the preliminary preparatory visit in December 2010 and January 2011, which included the field trip to different sites in Zarafshan valley, discussions with local authorities, village representatives, agropastoralists and meetings with prospective counterparts and institutions in Dushanbe, revealed the following selection of criteria:

1. Gradient of intensity of land utilization and degradation of summer pastures from intensively utilized areas. Furthermore, it is planned to exclude selected sites from utilization and thus to observe regeneration processes from different states of degradation.
2. Climate, altitude and rainfall gradient: grazing areas shall be investigated on different altitudes with different conditions of temperature, precipitation, vegetation and utilization. Shepherds usually go higher with their herds in different steps from early spring until late autumn, following the snow melting border.
3. Infrastructure availability such as water points for animals, maintained bridges and mountain paths on animal routes, road access, market distance, veterinary points etc.
4. Access rights of different user groups and assumed different types of pastures, e.g. heavily used interregional pastures, remote pastures, pastures closer to villages, mainly cattle pastures or sheep/goats.
5. Social gradients such as ethnicity, population of high social status and very susceptible groups.
6. Therefore the study timely since it will help to generate ideas on better ways to manage the pasture and other similar natural resources.

4 RESULTS AND DISCUSSION

4.1 Demographic and Socio-economic Characteristics

Socio-economic characteristics can influence the decision making process of livestock keeping, pasture use and grazing patterns. The main socio-economic attributes of the survey comprise sex, average and range of age, literacy rate and education level.

According to Table 1, at average more than 80 % of the interviewed respondents in all three selected districts were male. It means that men are the main decision makers in management of the household, basically in agriculture activity. Only 15.6 % and 26.7 % were found as female decision makers in the PD and the AD, respectively, which is also significant in the region. First of all, this fact may be the consequence of absent of husbands or sons, who are forced by economic circumstances to work abroad. Although, the range of age was from 25 to 75 years, the results show that the average age was around 50 years among the respondents.

Table 1. Respondents' characteristics in the study area

Features	Unit	PD	AD	KMD
Male	%	84.4	73.3	100.0
Female	%	15.6	26.7	0.0
Average age	yrs	49.9	45.6	49.5
Range of age	yrs	28-75	25-63	36-70

Source: Field survey, 2010/11

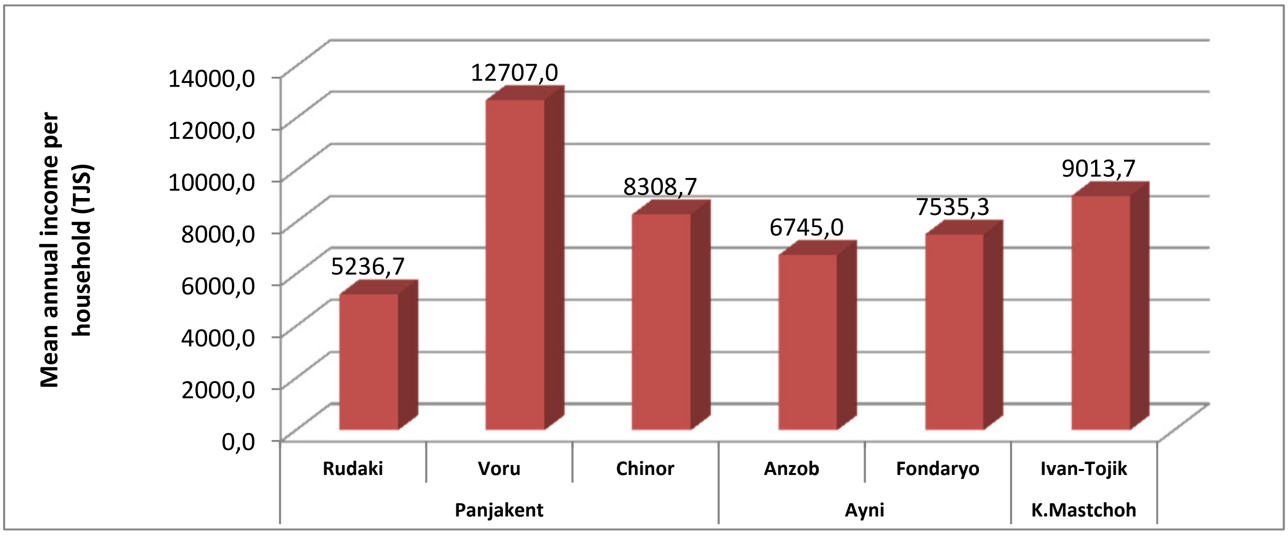
4.1.1 Education Level

Education levels of the respondents and their family members were also gathered in the study area. Results expose that 32.4 % of villagers are either dropped out of school at early primary level or did not study at school at all. There are various factors define whether a person continues with education or not in Zarafshan valley. These factors range from socio-cultural regulations to socio-economic issues in the community. Challenges such as forced marriages and poverty among others could be important restrictions to education improvement among the villagers in Zarafshan valley. But further observations showed that a significant part, i.e. 43.9 %, of the villagers achieve secondary level of education. An insignificant 7.8 % of the villagers attained university-level of education. Education of dehkans is very important because it influences the adoption of modern technology and methods to improve household livelihoods.

4.1.2 Household Income

The results below in Figure 3 comparative mean annual income of households show that Voru jamoat has the highest income level of 12,707 TJS annually per household. Taking into account an average household size of 6 in the study area, the figure translates to 5.9 TJS per person per day in Voru jamoat.

Figure 3. A comparative mean annual income of households in six jamoats of the Zarafshan valley.



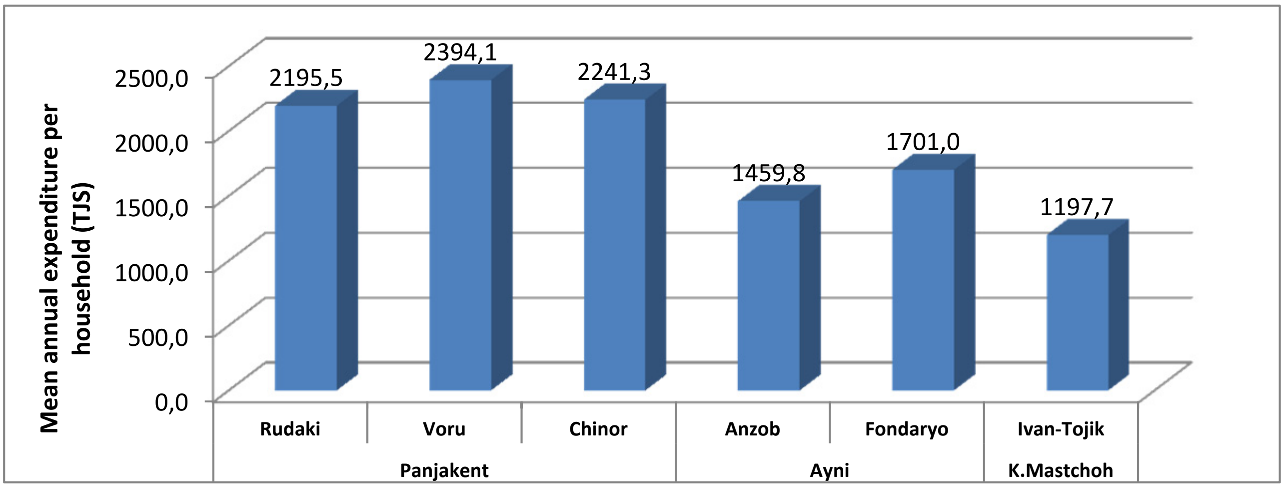
Source: Field survey, 2011.

The jamoats with lowest income levels include Rudaki and Anzob. They have annual income levels of 5,236.7 TJS and 6,745 TJS, respectively. Also considering an average household size of 6, these data translate to 2.4 and 3.1 TJS per person per day respectively. It means that individual households are poor where a daily income of less than US dollar per person is quite inadequate.

4.1.3 Household Expenditure

The farming household costs such as coal purchase, animal feeding and pastoralist service were surveyed in the study area. Results show that Voru, Chinor and Rudaki have the highest expenditure levels of 2,394.1 TJS, 2,241.3 TJS and 2,195.5 TJS annually per household, respectively (Figure 4). Ivan-Tojik and Anzob jamoats are with annually lowest expenditure per household which are 1,197.7 TJS and 1,459.8 TJS, respectively.

Figure 4. A comparative mean annual expenditure of households in six jamoats of the Zarafshan valley.



Source: Field survey, 2011.

5 LAND RESOURCE IN THE STUDY AREA

Undoubtedly, the land is one of the most important and valuable natural resources for all rural households. Moreover, the land is a major factor in the survival of the poor strata of the population of Tajikistan, including the Zarafshan Valley. Due to population increase, arable land size per person decreases which is a threat for future household food security. Most of the farmers hold less than 1 ha of land in Tajikistan (***Lerman & Sedik 2008:44, FAO 2013b***). Hence, farm lands in the study area were categorized into three different groups namely small farms, which are less 1 hectare of land holding, medium size farms, which are 1 to <2 hectares of land and large farms, which are >2 hectares of land holding. Shared or rented lands for cultivation were not taken into consideration, because many of the farmers (dehkans) rent out/in or share their land for few seasons only and this land can be withdrawn at any time by primary or secondary land users. Table 2 shows that small farms are in the majority in the AD and the KMD with 53.3 % and 46.7 %, respectively, whereas 60 % of farms in the PD are classified as medium class. In a result, 45.6 % of total selected households are classified as medium farm size in the study area.

Table 2. Distribution of households by land holding size in the study area

Districts	No. of households	Share of households (%)			Mean land holding size (hectare)			
		small	medium	Large	small	medium	large	total
PD	45	37.8	60.0	2.2	0.58	1.24	2.13	1.01
AD	30	53.3	26.7	20.0	0.27	1.33	3.94	1.29
KMD	15	46.7	40.0	13.3	0.63	1.42	2.46	1.19
Total	**90**	**44.4**	**45.6**	**10.0**	**0.47**	**1.28**	**3.41**	**1.13**

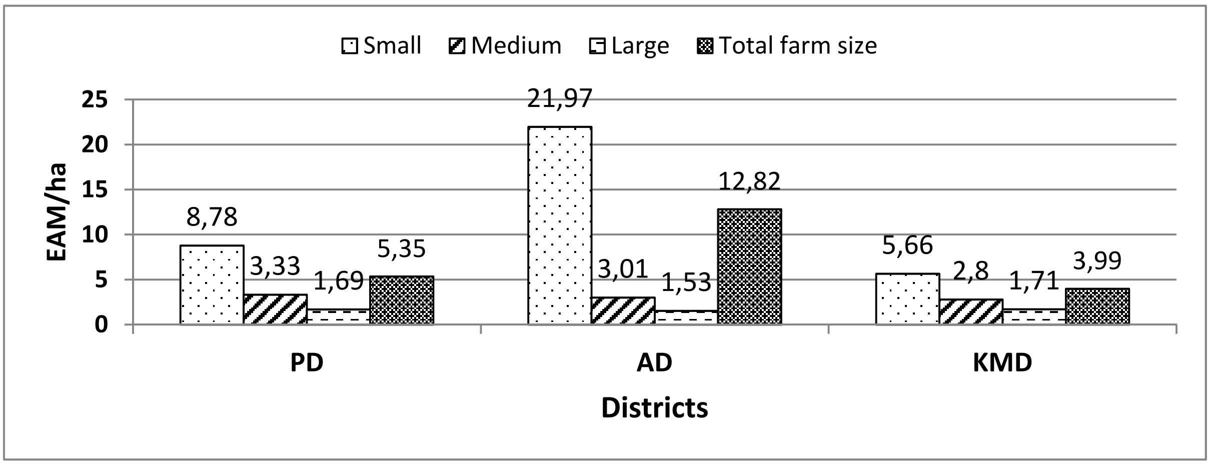
Note: small farms = <1 ha; medium farms = 1 - <2 ha; large farms = >2 ha

Source: Field survey, 2010/11

The comparison of the average land holding size among the study area has depicted that the landholders from the PD own a relatively lower land holding size in two classifications (medium and large) of the land size. The indicated results show that in total, the landholders of the PD with a total average of 1.01 ha own less land holding size, whereas with a total average of 1.29 ha, the landholders of the AD have relatively higher land holding sizes.

According to the economically active members (EAM) ratio per hectare by farm size categories (see Figure 5), more pressure falls to small farm size in all three research districts.

Figure 5. Ratio of economically active members (EAM) per hectare by farm size distribution.



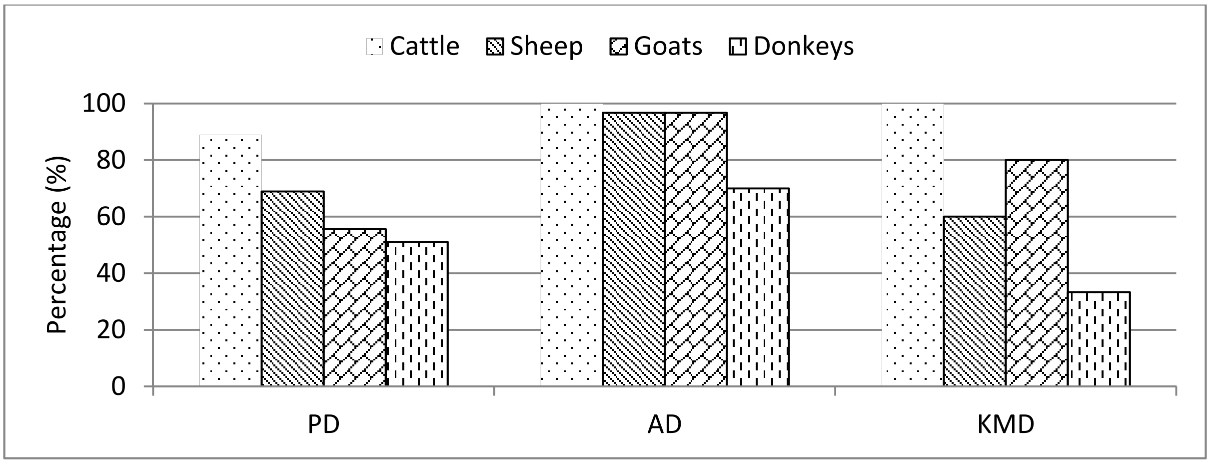
Note: EAM - 16-60 years age group, where men and women equal to 1.0 and 0.8 respectively.

Source: Field survey, 2010/11

6 LIVESTOCK AND ITS COMPOSITION

Animal husbandry is an integral part of the life of the rural areas in Tajikistan and especially in the Zarafshan Valley. Farmers, who do not own any livestock are considered to be poorest in the country as one of the main income sources in mountainous areas are derive from livestock keeping. Hence, considered as necessary for maintaining farm survivability, every household should have at least 1-2 cows or a few small ruminants (***Kurbanova, 2012:145***). Livestock numbers were estimated in order to analyzing the grazing pressure on near-village pastures as well as the fodder amount needed. Average livestock units range from 0.24 to 7.73 per household across all types of livestock. The highest proportion of livestock per household is observed in the AD. More than half of the surveyed households, i.e. 54.4 % own a donkey, which particularly served as transportation of different household's needs as well as hays from the hayfields, woods for the fuel and organic matters (dungs) from the livestock's summer rest points in the highlands.

Figure 6. Distribution of livestock types (%) among households in the study area



Source: Field survey, 2010/11

The Figure 6 demonstrates that almost all households in the study areas keep cattle; concretely every household in the AD and the KMD owns cattle. Families prefer to keep dairy cows than dry cows to enable the consumption of dairy products in the daily diet. In this regard, during the study were also given special attention to the presence of dairy cows in the household. Nearly every household in the AD also keeps sheep and goats; while the percentage is less in the other two districts.

7 LABOUR RESOURCES

Particularly, when the endowment with machinery and agricultural technology of a farm is low, human capital plays an important role in the economic development of the rural society. This is also the case for the Zarafshan Valley where labour is mainly provided by members of households and relatives. Hired labour is not practiced in the research sites. Instead, according to local tradition, people often support each other during the harvest, cultivation, and other activities of household farming. This tradition of mutual support is called "*hashar*". Labor compilation is consisted by different ages and gender groups, and then converted into the standard man-equivalent. According to calculation system used by Langemann (***1977:170***), coefficients of 1.0 and 0.8 were set for adult males and females of between 16-60 years, respectively. Furthermore, 0.5 was set for the group over 60 years and 0.3 for children of between 8-15 years. One man-day was considered as an 8 hour working day. Thus, the man-equivalent day was calculated by multiplying the number of man-equivalents of households with the number of hours, divided by 8 hour working day.

The availability of rural labour is often limited as there is a high percentage of temporarily labour migration of Tajik men to Russia and/or Kazakhstan. In the interviewed households the percentage of labour migrants amounts to 30-35 %. A result of the labour migration is that often women, elder men and children do the farming.

Thus it is necessary to look at the presence as well as the characteristics of the labour force in the households. In the current situation, the labor force plays an important role among the rural society. All the household members, who are able to work in the fields, are considered to be as household labour force.

Table 3. Household labour availability in the study areas

Characteristics	**Unit**	**PD**	**AD**	**KMD**
Availability of household labour force*	%	87.07	89.73	89.13
Average male labour (16-60 yrs)	man-equivalents	2.51	1.97	2.33
Average female labour (16-60 yrs)	man-equivalents	1.44	1.60	1.23
Average child labour (8-15 yrs)	man-equivalents	0.19	0.45	0.46
Average others (>60 yrs)	man-equivalents	0.19	0.03	0.17
Average household labour availability	man-equivalents	4.33	4.05	4.19

*Including children labour of between 8-15 years

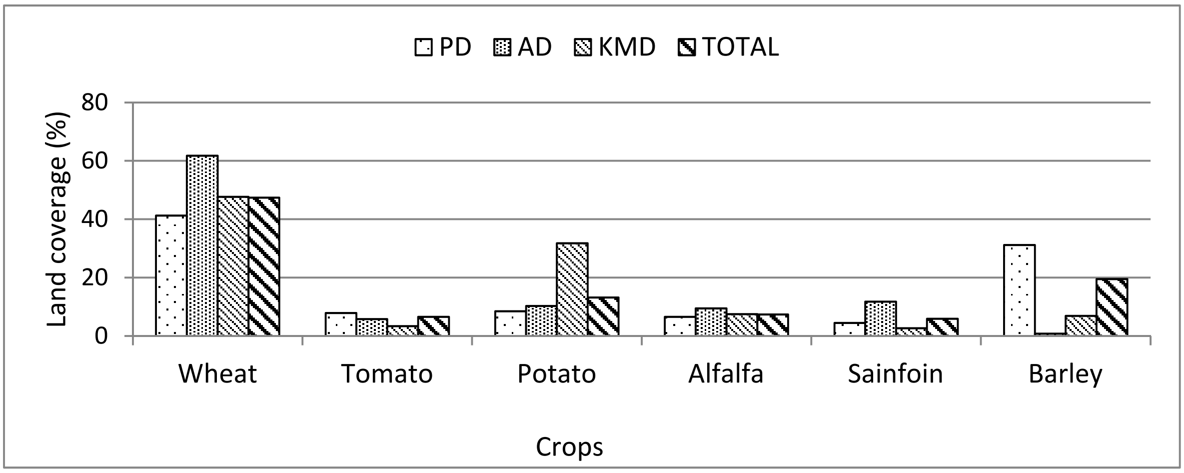
Source: Field survey, 2010/11

Table 3 indicates the presence of the adult labor force between 16-60 years including males and females. Besides, child labour between 8-15 years was also included in the calculation of available household labour force. This is because due to the absence of adult males in the households, who are the main wageworkers in the family.

8 CROP PRODUCTION: LAND ALLOCATION AND YIELDS

During the conducting research works in the study area, special attention was paid to the crops and forage cultivation in the cropping season 2010/11. Figure 7 demonstrates the percentage of land coverage by different crops among the study areas. The food and forage crops of wheat, potato, tomato, alfalfa (lucerne), sainfoin and barley are the main crops grown in in Tajikistan and in the Zarafshan Valley. In addition to the fodder crops of alfalfa and sainfoin also cereal crop residues and partly barley are used for livestock feeding. Compared to other crops grown in the study areas, in total, wheat occupied the highest percentage of land coverage, i.e. 47.4 %.

Figure 7. Land coverage by crops (%)



Source: Field survey, 2010/11

KMD is dominated by the cultivation of potato due to the good natural conditions, mainly its higher altitude which is favorable for potato. These results also reflect fact that more than 1,680 hectares of land allocated for potato in the KMD (**Tajstat, 2011b**). Thus, the KMD is characterized by the mass production of potatoes in the country allowing trade and additional income for the population of the KMD.

In the case of barley, the PD had a significant percentage of land coverage by barley (31.2 %) compared to the AD (0.8 %) and the KMD (6.9 %). The reasons behind this that at first, relatively more plain, rain-fed area available in the PD, and the second one is farmers in the PD prefer to cultivate more barley than alfalfa and sainfoin. Thus, the AD had the highest share of cultivating alfalfa and sainfoin, which is related to the higher livestock numbers in the AD.

Table 4. Average crop distribution by households (ha)

Crops	PD		AD		KMD		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD

Wheat	0.79	0.476	0.79	0.893	0.68	0.423	**0.77**	**0.610**
Tomato	0.10	0.106	0.06	0.025	0.04	0.012	**0.08**	**0.083**
Potato	0.14	0.113	0.12	0.180	0.41	0.335	**0.19**	**0.222**
Alfalfa	0.09	0.037	0.11	0.099	0.12	0.062	**0.10**	**0.064**
Sainfoin	0.09	0.050	0.49	0.025	0.09	0.035	**0.15**	**0.149**
Barley	0.66	0.325	0.04	0.013	0.29	0.396	**0.52**	**0.384**

Source: Field survey, 2010/11

The following table 4 shows an arithmetic mean value of cropland distribution by households among the study areas. The value for each crop was calculated taking into account only those households who grow these particular crops. Significant positions in the table occupied by wheat, barley and potato. Wheat had covered the highest average area in the PD and the AD, i.e. 0.79 ha of land for each, respectively. But households in the AD occupied the highest percentage of coverage of wheat area, which is 32.7 % more than that PD (see Figure 7). Likewise, the standard deviation of the average wheat area in the AD nearly 2 times higher than that PD, despite the fact that the average value of this crop is the same in both districts. In total, potato and barley, after the wheat, occupied the largest area coverage i.e. 0.19 and 0.52 ha of land per household, respectively. But compared to the PD and the AD, a significant part of potato cultivation is grown in the KMD. In the case of barley, a similar situation was observed with regard to the PD that is averaged 0.66 ha of land.

Table 5. Average production, yield and percentage of crops by regions

Crops	PD			AD			KMD		
	Prod. (kg)	Yield (kg/ha)	Sold (%)	Prod. (kg)	Yield (kg/ha)	Sold (%)	Prod. (kg)	Yield (kg/ha)	Sold (%)
Wheat	1583.3	1986.4	6.0	1285.4	2033.1	9.0	1255.6	1829.4	-
Tomato	421.2	4949.0	-	304.1	5029.3	-	194.0	4648.3	-
Potato	2026.3	15786.7	0.8	2181.4	17394.3	-	8710.0	21782.4	49.0
Alfalfa	628.9	6579.9	-	571.3	5677.1	-	727.5	6024.8	-
Sainfoin	180.8	1890.2	-	950.0	1947.2	-	176.3	2046.2	-
Barley	1178.4	1751.2	-	70.0	2041.7	-	386.7	1497.2	-

Source: Field survey, 2010/11

When the average production of crops by study areas was compiled, it was found that the farmers of the PD were producing the largest quantity of potato (2026 kg), followed by the wheat (1583 kg) and barley (1178 kg). In the case of the AD, potato production was leading (2181 kg), followed by wheat (1285 kg) and sainfoin (950 kg). But in the case of the KMD, the production of potato was observed highest (8710 kg), which is compared to the PD and the AD highest by 77 % and 75 %, respectively. Then after potato production in the KMD, followed by wheat i.e. 1256 kg, and alfalfa i.e. 726 kg (see Table 5).

9 CONCLUSIONS

Pastures of Tajikistan, including the Zarafshan pastures, have gone through many changes during the last century, especially in Soviet times in terms of property rights of the locals. The governments' policies were the major reasons for these changes. After the collapse of Soviet Union the new government faced an impasse to change nomadism to sedentarization, which the traditional systems have been gradually eroded. Inaccuracy of land reform and absence of laws for pasture management are among the key causes destroying the traditional systems.

To overcome the problem of pasture degradation, there is an urgent need to crystallize the government's role in managing pasturelands and how the government can play an effective role in achieving a sustainable management plan (Abolhassani 2011). In the case of the Tajik pasturelands, the role of the government has usually been inappropriate and it is due to the Tajik policy of not intending to manage rational the traditional system of pastoralism. However, finding an answer to the question of how the government can play an effective role in the transition requires more studies and research on the relationship between the government and communities in the present day (ibid).

References

Abolhassani L. 2011.Rangeland Management in Iran: A Socio-Economic Analysis and Case Study of Semnan Rangelands. Albert-Ludwigs-Universität Freiburg im Breisgau, Germany.

FAO 2013b. Accessed on May 7, 2013. Available at: http://faostat3.fao.org/home/index.html#DOWNLOAD

Kodirov K.G., Irgashev T.A., Kholov F.S. 2010. The Rational Management of Productivity of Fodder Crop and Fodder Lands in Conditions of Mountainous Areas of Tajikistan (in Russian). Dushanbe, Tajikistan.

Kurbanova B. 2012 Constraints and barriers to Better land Stewardship: Analysis of PRAs in Tajikistan. In Rangeland stewardship in Central Asia: balancing improved livelihoods, biodiversity conservation and land protection. Ed. by Squires V. Springer.

Langemann J. 1977 Tradition African Farming System in Easten Nigeria. An Analysis of Reaction to Increasing Population Pressure Weltforum-Verlag GmbH., Muenchen.

Lermann Z. and Sedik D. 2008 The Economic Effect of Land Reform in Tajikistan. FAO Regional Office for Europe and Central Asia, Policy Studies on Rural Transition No. 2008-1.

Rakhimov Sh., Strong P., Samiev Sh. 2011. “Current Situation Relating to the Pasture Sector Tajikistan”. International Conference “The Pastures of Tajikistan: Challenges and Perspective, June 28-30, 2011, Dushanbe, Tajikistan.

Safarov T.S. 2011. Presentation of “Current Situation of Pastures in Tajikistan” (in Russian). Republican Center for the Farm Privatization Support under the Government of the Republic of Tajikistan. Community Agriculture and Watershed Management Project by World Bank, Dushanbe, Tajikistan.

TajStat 2011a. Regions of Tajikistan. Agency for Statistics at the President of the Republic of Tajikistan.

TajStat 2011b. Agriculture of Tajikistan. Agency for Statistics at the President of the Republic of Tajikistan.

World Bank and SECO 2008. Priorities for Sustainable Growth: A Strategy for Agriculture Sector Development in Tajikistan. Technical Annex 3. Livestock Sector Review.

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HOW FRUIT CONSUMPTION MIGHT BE FRUITFUL FOR THE ECONOMY: ANALYZING EFFECTS OF IMPROVEMENTS IN FRUIT AND VEGETABLE AVAILABILITY AND ACCESSIBILITY IN UZBEKISTAN

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1 INTRODUCTION

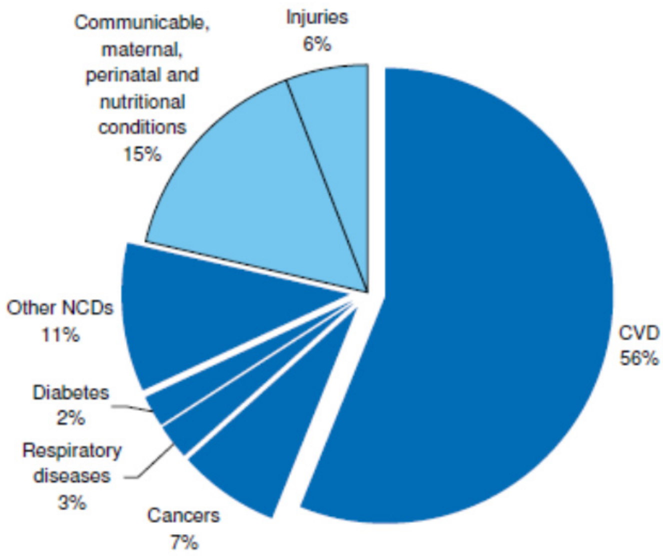
Over the past years, Uzbekistan has achieved a stable economic growth: Gross domestic product (GDP) has been growing over 8% per year for several years (The World Factbook, 2013). While economic growth has been relatively high, it has not significantly increased living standards: in 2003, 47 percent of the population was living beneath the absolute poverty line of US$2.15 per day (World Food Programme, 2008).

Findings from the most recent Uzbekistan Health Examination Survey (UHES 2002) showed that for all Uzbekistan, 21% of children less than five years of age were moderately/severely stunted and 7% were moderately/severely wasted, whereas 49% of children have some degree of anemia.In addition, vitamin A deficiency and Iodine deficiency are among another important public health challenges in the country.The prevalence of anemia among women of reproductive age (15–49 years) in Uzbekistan (60.4%) is the highest found in Central Asia (Kamatsuchi, 2006).Among both women and men age 40 and older, more than 50 percent were overweight and for women, about one-third of these were in the obese category.This indicates that many older individuals have an unhealthy lifestyle (i.e., low levels of physical activity and unsound dietary habits), predisposing them to disease and presenting a serious health challenge for Uzbekistan.

In general, the above-mentioned indicators of poor nutrition and food poverty are directly related to serious health consequences. In fact, although life expectancy has not decreased since the collapse of the Soviet Union, it still exhibits low value: in 2010, life expectancy at birth was 68 years in Uzbekistan compared with 79.6 years in European Union (World Development Indicators, 2013).

According to *The Global Burden of Disease Study 2010*, in terms of the number of years of life lost (YLLs) and disability-adjusted life years (DALYs) due to premature death in Uzbekistan, ischemic heart disease (16.32% of total YLLs; 11.48% of total DALYs), lower respiratory infections (16.35% of total YLLs; 11.06% of total DALYs), and cerebrovascular disease (7.53% of total YLLs; 5.17% of total DALYs) were the highest ranking causes in 2010.

Figure 1. Proportional mortality (per cent of total deaths, all ages) in Uzbekistan

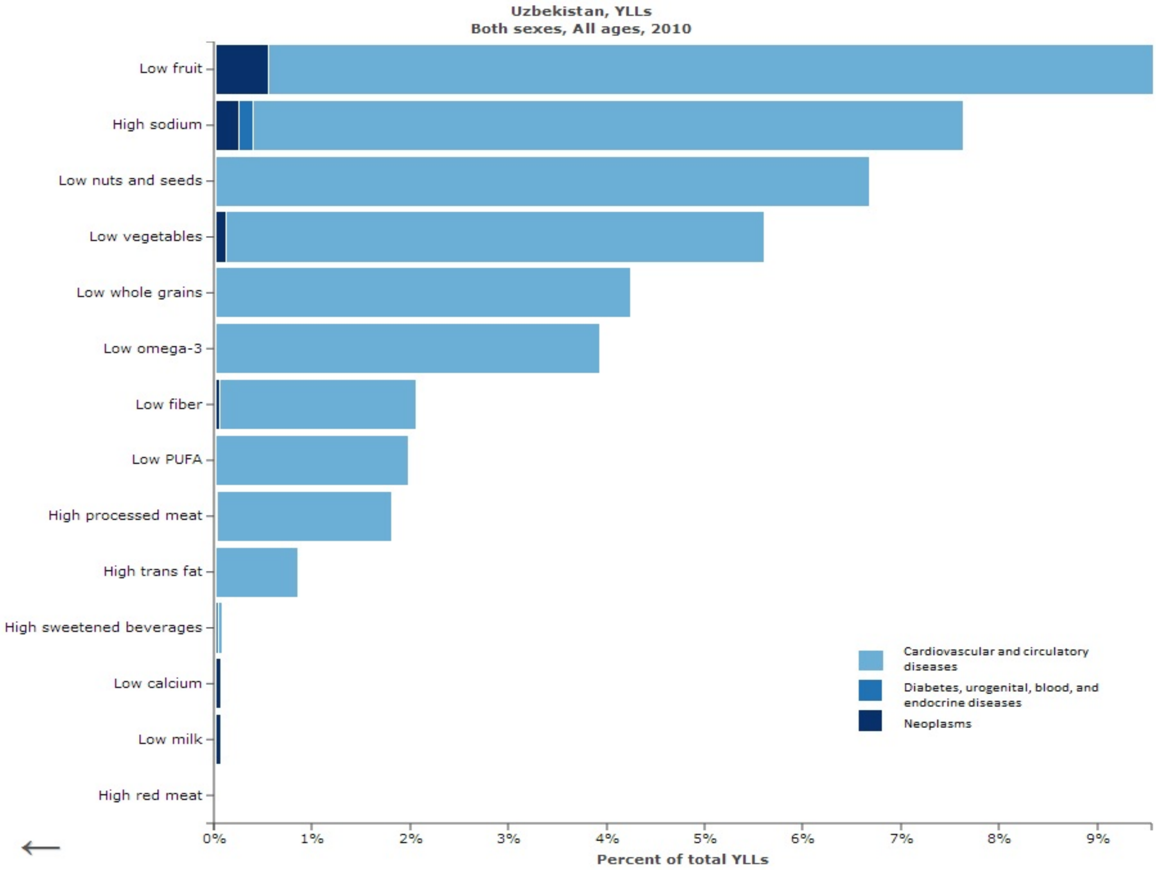


Source: WHO and WHO, 2011

At the national level, threats and impacts of NCDs include large-scale loss of productivity as a result of absenteeism and inability to work, and ultimately a decrease in national income. In 2010, the World Economic Forum placed NCDs among the most important and severe threats to economic development, alongside the financial crisis, natural disasters and pandemic influenza (WEF, 2010).

What are the main drivers of the less favourable health outcomes in Uzbekistan? The leading risk factor in Uzbekistan is dietary risks (22.07% of total YLLs; 15.81% of total DALYs) with 'diet low in fruits' and 'diet low in vegetables' being among the top constituent factors. Within this category, diet low in fruits attributes to burden of disease the most: burden of cardiovascular and circulatory diseases due to diet low in fruits is estimated at 9.01% of total YLLs (6.28% of total DALYs), and burden of neoplasms is 0.54% of total YLLs (0.37% of total DALYs) in 2010. Diet low in vegetables attributes to 341,925 YLLs due to cardiovascular and circulatory diseases and 6,904 YLLs due to neoplasms (GBD Compare, 2013).

Figure 2: Burden of disease attributable to leading dietary risk factors in 2010, expressed as a percentage of Uzbekistan YLLs



Source: GBD Compare, 2013

The natural and climatic conditions of the country provide ample opportunities for the development of fruit and vegetable production and food processing industry. Unfortunately, institutional transformations in agriculture in the past have promoted significant growth of cereal production, but not for fruit and vegetable production. As a result, consumption of healthy food in Uzbekistan is constrained by its seasonal and spatial availability and considerable price differences throughout a year, especially for rural population.

For example, the National statistics for 2004 shows considerable variation of carrot prices (from UZS 155 to UZS 1002, or more than six times) and tomato prices (from UZS 128 to UZS 1277, or ten times). A similar situation was observed in 2005 (Uzbekistan Economy, 2006).

The database of retail food prices collected by ZEF project "Economic and Ecological Restructuring of Land- and Water Use in the Region Khorezm (Uzbekistan)" demonstrates significant price fluctuations for tomato (by 610%) as well as for cucumber (by 355%) between winter and summer 2007. The data for 2008 show also significant inter-seasonal price differences (however, to less extent).

In their analysis of the results of the World Bank's Uzbekistan Regional Panel Survey (URPS) of 2005, Musaev, Yakshilikov and Yusupov (2010) argued that the diet of poorest households is mostly comprised of cereals, which is an inexpensive source of nutrients and much less consumption of other crops, especially fruits (Table 1).

Table 1. Mean consumption amount of food items (grams / capita / day) in Uzbekistan

	Cereals*	Dairy	Meats	Eggs**	Vegetables	Fruits
By region/urban and rural area						
Tashkent	426	130	74	0.27	219	46
Andijan	516	140	33	0.13	218	30
Kashkadarya	566	156	44	0.21	196	30
Urban	444	124	66	0.24	223	42
Rural	558	159	35	0.17	200	28
By income group						
Poorest	427	68	12	0.09	129	8
2nd quintile	505	124	22	0.13	176	17
3rd quintile	531	157	35	0.17	199	28
4th quintile	509	149	47	0.21	214	36
Richest	525	182	101	0.33	286	66

*   Includes grains, flour products, and pulses.

** In number of pieces.

Source: Musaev, Yakshilikov and Yusupov (2010)

Given the current volume of vegetable production and the stratification of the population in Uzbekistan according to income level only high income earners consume fruits and vegetables. Because of low solvency, a large number of citizens cannot buy natural sources of vitamins, especially during off-season. According to the Ministry of Health of Uzbekistan, vegetable consumption should be 142 kg per capita annually, 28 kg thereof in the winter period. The average Uzbek has access to only 84 kg of vegetables, 5 kg thereof in winter (Askarov and Nuppenau, 2010).

The consumption pattern of fruit and vegetables is therefore prone to considerable fluctuations. For instance, national household expenditure surveys over 2002-2005 identified that the share of grapes in the pattern of fruit and vegetable consumption varied from 0.06% in March to 24.2% in May, while for tomatoes the range of fluctuation was between 0.05% in February and 14.0% in June (Uzbekistan Economy, 2006). As a result, seasonal shortage in fruit and vegetables may contribute to NCD burden (Powles et al, 1996). In addition, one has to consider the fact that Uzbekistan, given its remoteness from major transportation routes, cannot easily resort to imports to smooth seasonality in consumption and is mainly oriented to domestic output, which is seasonal due to climatic conditions.

The harsh climate of Uzbekistan limits year-round production and therefore improvements in vegetable production under protective shelters are required. In fact, only 15% of the region's total vegetable production in Central Asia is available from November to March (Ali et al, 2006). In 2010 entrepreneurs, larger private farmers (up to 150 ha) and dekhan farmers set up 522 greenhouses covering 290 ha in Uzbekistan(IFAD 2011), which pales in comparison to that, for example, found in Italy (9,000 ha), Turkey (10,000 ha) and Spain (11,000 ha). Many farmers producing greenhouse vegetables can not cover their production costs, which keep them from commercial farming and encourage subsistence farming. It is necessary to enlarge this production area for reducing seasonality of vegetable supplies as well as for smoothening price fluctuations. For this to occur, the greenhouses require modernization as in most existing greenhouses, mechanized production systems do not operate, soil heating systems are absent, structures are not energy-efficient, and the soils are poorly drained and of low fertility (Buriev, Zuev and Medzhitov, 2003), (Askarov and Nuppenau, 2010).

The assortment of vegetable and fruit crops is extremely limited. Only about 20 vegetable varieties are cultivated to any extent with six main vegetable crops (tomato, watermelons, carrot, bulb onion, white cabbages and cucumber) and around 20 fruit varieties with three main fruit crops (grapes, apples, apricots). At the same time, crops from across the world are well suited for cultivation and seed production in Uzbekistan. The introduction of new varieties can increase yields and food quality, as well as provide consumers with a broader assortment of foods to select from (Mavlyanova, 2005), (Buriev, Zuev and Medzhitov, 2003).

2 PROBLEM STATEMENT

Vast majority of Uzbek population consume daily lower than 400 g of fruit and vegetables (146 kg/person/year), the minimum amount recommended by leading health agencies (WHO and Consultation, 2003), and the intake of fruits and vegetables for the poorest population is even worse (Musaev, Yakshilikov and Yusupov, 2010). Reciprocal determinism asserts that environmental and personal factors can dynamically interact with behaviors, such as fruit and vegetable consumption. There is some evidence that availability of fruits and vegetables (an environmental factor) may increase fruit and vegetable intake (Bere & Klepp, 2005; Cullen et al., 2003; Granner, 2004). Meanwhile, improvement of fruit and vegetable consumption has been associated with decreased incidence of cardiovascular events and cancers (Graham et al. 2007; He et al. 2007; Lock et al. 2005; WCRF & AICR, 2007; WHO and Consultation, 2003), the biggest contributors to the global mortality.

Given the importance of healthy diet and especially the adequate intake of fruit and vegetables, the current state of inefficient agricultural production in Uzbekistan has serious adverse consequences on the yields of fruit and vegetables, and thus on income of such farmers (mostly, dehkan farms and households), and would raise the prices paid by consumers of such food products, especially in off season. The impact of higher food prices would have the most significant effect on the poorest rural people for whom the necessity of healthy food consumption is of major importance due to the poor nutritional status.

The purpose of this research is, therefore, to investigate the effects of improved fruit/vegetable availability and accessibility on demand and public health in Uzbekistan. In addition, potential and existing constraints and opportunities to improve the availability and accessibility of fruit and vegetables as a key determinant of healthy diet will be explored.

No studies have examined the seasonal availability of fruit and vegetable supply in Uzbekistan, given its crucial role in contributing to healthy diet and thus to the people's well-being. The central contribution of this study is to provide a quantitative approach to the analysis of the sustainability of agricultural production systems that is based on solid scientific foundations. In addition, public health effects through increased fruit and vegetable consumption will be investigated for the first time in the context of Uzbekistan.

3 RESEARCH QUESTIONS

The main research question I address is as follows: What will be the effects of improved fruit and vegetable availability and accessibility on demand and public health in Uzbekistan?

The sub-questions include: What policies should be used to increase year-long fruit and vegetable supply to meet recommended dietary intake in Uzbekistan? What would be the effect of improved fruit and vegetable availability (supply) on the population consumption (demand)? What would be the effect of improved fruit and vegetable consumption on public health?

Objectives of the research include the following:

- To promote production and consumption of fruit and vegetables so as to improve nutrition and health and to help prevent non-communicable diseases;
- To advance science in the areas of fruit and vegetable production, distribution, increased consumption, and benefits for health.

4 METHODOLOGICAL APPROACH

Following the design of institutional framework of fruit and vegetable value chains in Uzbekistan (by example of Khorezm region) developed by Rudenko (2008), the existing value chains of fruit and vegetable supply (including both fresh and processed products) will be constructed and analyzed.

In the context of Uzbekistan, the horticulture and vegetable sectors are presented by various actors. Among them, main contributor of fruit and vegetable supply is a large group of rural small-holding households (*dehkans*) who are characterized by high share of home consumption. Another supplier domains include private farms that are specialized in gardening and vegetable growing as well as small processing units attached to private farms. As for food processing sector, the major suppliers consist of private companies, joint stock companies and joint ventures that are specialized in processing of fruit and vegetables, as well as regional associations of "MevaSabzovot", the coordinating structure for processors (Rudenko, 2008). Although import supply of fruit and vegetables plays minor role in Uzbekistan, it will be analyzed separately.

The destinations of fresh fruit and vegetables include the following consumer domains: home consumption by rural households, private consumers through local or regional fresh markets, municipal organizations (hospitals, schools, kindergartens, etc), agro-processing plants and wholesalers for further export.

For fruit and vegetable sectors of Uzbekistan the research of value chain will start with functional analysis (identification of functions along each chain, production stages and flows) and institutional analysis (identification and description of agents involved in the chain). Next, financial analysis will be performed to calculate value added, profits and transaction costs for each agent and the chain as the whole. In addition, financial profitability of activities within the chain, overall efficiency of the chain, the processes of price determination and transfers between agents will be identified. Following financial analysis, economic analysis will be performed to identify the boundaries of the value chain and the position of various actors within the chain and to develop the economic accounts corresponding to their activities.

Another method to be used in the current research is multimarket modeling. Multimarket models are policy tools that can be used to analyze a wide range of sectoral policy issues. Unlike partial equilibrium models, which typically focus on the dynamics in a single sector, multimarket models measure the interaction and interrelationships between markets in an economy. While lacking the sophistication of general equilibrium models in incorporating macro-level effects of the economy, multimarket models are useful in their ability to analyze the impact of changes in public policy at a sectoral level.

These policy changes can be traced to examine their effects on production, demand, household incomes, government revenue, international trade, and poverty levels. Further, since they are less demanding in terms of data and modeling requirements, generic multi-market models can readily be adapted to local circumstances to produce timely analyses that are comprehensible for policy makers (Lundberg and Rich, 2002; Stifel and Randrianarisoa, 2006).

A number of policy simulations could be conducted with the multimarket model. The specification of supply of fruit and vegetables, for instance, gives the practitioner the ability to consider policies aimed at improving agricultural productivity. A wide range of pricing policies can also be conducted with the model. This could include examining the impact of the removal of commodity and input subsidies on food supply, consumption patterns, and household income. In addition, policies related to exchange rate movements and tariff liberations can be conducted.

Based on data generated by value chain analysis multimarket simulation model will be set up in order to understand what policy is more preferable in terms of maintenance a year-long availability of fruit and vegetables in Uzbekistan and its effect on the population consumption. Therefore, in this research a multimarket model adaptable to the agricultural production system and policy environment of Uzbekistan will be used to analyze the effect of policy on fruit and vegetable supply and demand.

Separate markets for vegetables and fruits (including processing components) will be explicitly analyzed in the model with markets for cereals and animal products (meat and eggs) implicitly included in the model. Household survey information such as URPS 2005 as well as other statistical sources (FAO, previous studies) will be used to derive estimates of income and own-price and cross-price elasticities of demand for the entire set of interlinked markets. Producer survey information will be used to derive estimates of own-price and cross-price elasticities of supply for the set of interlinked markets. These estimates will be combined to create an appropriate system of demand and supply functions.

In this study, seasonal patterns for supply of fresh and processed fruit and vegetables will also be considered. This seasonal price variation and the inability of households to smooth their annual food consumption also manifest themselves in seasonal variation in calorie intake. Fruit and vegetable farming may vary in Uzbekistan depending on the region and corresponding climate conditions. According to the calendar of farming activities in the example of Khorezm region by Rudenko (2008), vegetables are mainly harvested in August-October whereas fruits and grapes are harvested starting from June until October depending on variety. There is some import of early fruits from neighboring regions available in spring and some fruits (for example, apples) can be found in the markets all year round. Vegetables from greenhouses appear on sale starting late spring, and some early vegetables are imported from other regions. Thus, to appropriately model the agricultural sector in Uzbekistan, a seasonal component must be built into the model and consider the welfare effects of policy efforts to reduce the observed price variability.

The model will be constructed with a combination of national/regional production and trade data and manipulation of household/farmer survey data. The survey will target fruit and vegetable producers (such as small-scale *dehkan* farmers, private farms, greenhouse farmers as well as fruit and vegetable processing farmers) in three regions of Uzbekistan. The main questions of interest during the survey will include: output flow for each fruit and vegetable crop (type of crop, area, yield, harvest, home consumption, selling quantity and price, storage), input flow (fuel, fertilizers and pesticides, labor), distance to markets, main production activities, other expenses (taxes and other payments, transportation).

For consumption component of the model, the national-representative data will be taken from the Uzbekistan Regional Panel Survey 2005 modeled after the World Bank’s standard Living Standards Measurement Survey (LSMS). The survey covered about 3,000 households from three regions – Andijan, Kashkadarya and Tashkent city.

In order to better understand functioning of agricultural system, public health and labor supply in Uzbekistan, the meetings with the following representatives are also planned during the field work: local Governments (*Khokimiyats*), national/regional officials from the Ministry of Agriculture and Water Resources, the Ministry of Health and Institute of Health and Medical Statistics, the Ministry of Labour and Social Protection, State Statistics Committee, water consumer associations, community (*makhallya*) leaders. In addition, discussions with health and nutrition experts from WHO, UNICEF and other international organizations will be very helpful.

In order to connect fruit/vegetable consumption with the health outcomes, comparative assessment of the contribution of potentially modifiable risk factors for the corresponding diseases is essential as it leads to prevention of disease burden. Starting from 1990, the Global Burden of Disease Study (GBD) with its updated versions of 2000 and 2010 provided global and regional comparative assessment of mortality and disability-adjusted life-years attributable to major risk factors (Lopez and Murray, 1996; Ezzati et al. 2004; Lim et al. 2013). Other factors that determine health outcomes (smoking, diets) will be controlled for.

Following the basic approach for assessing the effect of improved fruit and vegetable consumption on public health presented by Lim et al. (2013), the portion of disease burden caused by “diet low in fruits” and “diet low in vegetables” risk factors will be calculated holding other independent factors unchanged. In particular, the estimation of disease burden attributable to each risk factor will have five steps:

1) Selection of risk-outcome pairs to be included in the analysis based on criteria about causal associations (for instance, high-quality epidemiological studies and evidence to support generalisability of effect sizes to populations other than those included in the available epidemiological studies or satisfactory models for extrapolating them).For “diet low in fruits” risk factor the following outcomes were selected: the aggregate of oesophageal cancer, mouth cancer, the aggregate of nasopharynx cancer, cancer of other part of pharynx andoropharynx, and larynx cancer;trachea, bronchus, and lung cancers; IHD; ischaemic stroke; haemorrhagicand other non-ischaemic stroke. As for “diet low in vegetables”, the outcomes included the aggregate of mouth cancer, nasopharynx cancer, cancer of other part of pharynx andoropharynx, and larynx cancer; IHD; ischaemic stroke; haemorrhagic and other non-ischaemic stroke. In the current research, disease burden attributable to two dietary factors (“diet low in fruits” and “diet low in vegetables”) in Uzbekistan will be assessed for the above-mentioned risk-outcome pairs;

2) Estimation of distributions of exposure to each risk factor in the population of Uzbekistan. The national-representative data on dietary intake of fruit and vegetables will be obtained from the consumption module of the URPS2005;

3) Estimation of etiological effect sizes, often relative risk per unit of exposure for each risk-outcome pair. These relative risks will be obtained from the new meta-analysis of Lim et al (2013);

4) Choice of an alternative (counterfactual) exposure distribution to which the current exposure distribution is compared. An optimum exposure distribution (termed the theoretical-minimum-risk exposure distribution) was selected at the level of mean 300 g/day (SD 30 g/day) for dietary intake of fruits and mean 400 g/day (SD 30 g/day) for the one of vegetables according to Lim et al. (2013); and

5) Computation of burden attributable to categorical exposures of each risk factor with reference to a reference category (that is alternative (counterfactual) distribution of exposure) for each age, sex and cause according to the following formula:

$$PAF = \frac{\sum_{i=1}^{n} P_i(RR_i - 1)}{\sum_{i=1}^{n} P_i(RR_i - 1) + 1}$$

Where PAF is the population attributable fraction (burden attributable to risk factor), RR_i is the RR for exposure category i, P_i is the fraction of the population in exposure category i, and n is the number of exposure categories (Murray and Lopez, 1999).

5 EXPECTED RESULTS

In general, development of vegetable and fruit sector in Uzbekistan has been limited for many reasons, such as the weakening of agri-business that supported commercial operations, absence of specialization and regionalization of farming operations, rising costs of fertilizers and other inputs, and ineffective marketing structures (Buriev, Zuev and Medzhitov, 2003).

Presently, some vegetables and fruits not produced in Uzbekistan are still imported. Imported products compete in the internal market, despite their high prices, due to their high quality, packaging and standards. However, statistical data reflects the effect of import substitution and trade protectionism policies: the share of imports in food consumption in 2005 was relatively low for vegetables (0.2 %) and fruits (6.51 %). Self-sufficiency policy pursued by Uzbekistan so far is providing certain level of food availability in terms of quantity. However, ensuring the availability of varied and economically accessible food to the population requires a liberalized trade policy. Additionally, a more open trade policy will provide incentives to increase efficiency in food production and lower the market prices of internally produced foodstuffs (Musaev, Yakshilikov and Yusupov, 2010).

Since 2006, the Ministry of Health jointly with the WHO experts have introduced the main principles of healthy nutrition to prevent chronic non-communicable diseases in Uzbekistan such as diversifying the diet with various vegetables and fruits (preferably fresh locally grown), control over consumption of fats (replace a natural fat with plant oil), substitute tea drinking with consumption of fruit and vegetable juices and drinking water, and others (Khudayberganov, 2008). However, these propaganda measures on their own cannot increase the nutritional status of the population and increase the quality of life.

As dietary habits are embedded in cultural, economic and political structures, there should also be greater emphasis on promoting policies that target the determinants of fruit and vegetable consumption rather than simply targeting individual behavioural change because health education may be less important than lowering the price and improving the availability of vegetables and fruit especially in the context of developing countries such as Uzbekistan. Policy should aim to remove obstacles and enhance people's ability to eat healthy diets, including action on agriculture, subsidies, food labelling, nutritional claims, advertising, nutrition programmes, and differential food taxation. Priority should be given to the implementation of practical and affordable best buy interventions (Lock et al, 2005; WHO, 2011). As agricultural products already receive subsidies, it would make sense to modulate these in accordance with the scientific evidence on health benefits (Joffe and Robertson, 2001).

There is a need to investigate the impact that agricultural policy has on the structure of production, processing and marketing systems and, ultimately, on the availability of foods that support healthy food consumption patterns. Intersectoral initiatives should encourage the adequate production and domestic supply of fruits, vegetables and wholegrain cereals, at affordable prices to all segments of the population, opportunities for all to access them regularly without drastic seasonal fluctuations, and individuals to undertake appropriate levels of physical activity. (WHO, 2002).

BIBLIOGRAPHY

Ali, M., Mavlyanova, R., Wu, M., Farooq, U., Lin, L. and Kuo, C. G. 2006. Setting Research and Development Priorities for Market-oriented Vegetable Production Systems in Central Asia and the Caucasus. Proc. Increasing Market –oriented vegetable production in Central Asia and the Caucasus through collaborative research and development. 25-27 April 2005. Tashkent. Uzbekistan. p.105-137.

Analytical and Information Center, Ministry of Health of the Republic of Uzbekistan [Uzbekistan], State Department of Statistics, Ministry of Macroeconomics and Statistics [Uzbekistan], and ORC Macro. 2004. *Uzbekistan Health Examination Survey 2002 (UHES 2002).* Calverton, Maryland, USA: Analytical and Information Center, State Department of Statistics, and ORC Macro.

Askarov, U., &Nuppenau, E. A. 2010.An Analysis of Different Marketing Channels on Greenhouse Vegetable Market in Uzbekistan: A Case Study on Tomato and Cucumber.

Bere, E., & Klepp, K. I. (2005). Changes in accessibility and preferences predict children's future fruit and vegetable intake. *International Journal of Behavioral Nutrition and Physical Activity*, *2*(1), 15.

Buriev, H. C., Zuev, V. I., &Medzhitov, S. M. (2003). Status, problems and development perspectives of potato, vegetable and melon production in Uzbekistan. *Vegetable Production in Central Asia*, 117.

Cullen, K. W., Baranowski, T., Owens, E., Marsh, T., Rittenberry, L., & de Moor, C. (2003). Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior. *Health Education & Behavior*,*30*(5), 615-626.

Ezzati, M., Lopez, A. D., Rodgers, A., & Murray, C. J. (Eds.). (2004).*Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors* (Vol. 1). World Health Organization.

GBD Compare. (2013). Retrieved May 19, 2013, from Institute of Health Metrics and Evaluation, University of Washington: http://viz.healthmetricsandevaluation.org/gbd-compare/

Graham, I., Atar, D., Borch-Johnsen, K., Boysen, G., Burell, G., Cifkova, R., & Hemingway, H. (2007). European guidelines on cardiovascular disease prevention in clinical practice: executive summary Fourth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (Constituted by representatives of nine societies and by invited experts). *European heart journal*, *28*(19), 2375-2414.

Granner, M. L. (2004). Individual, social, and environmental factors associated with fruit and vegetable intake among adolescents: A study of social cognitive and behavioral choice theories. Dissertation Abstracts International: Section B: The Sciences and Engineering, 64, 3222.

He, F. J., Nowson, C. A., Lucas, M., &MacGregor, G. A. (2007). Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies. *Journal of human hypertension*, *21*(9), 717-728.

Joffe, M., & Robertson, A. (2001).The potential contribution of increased vegetable and fruit consumption to health gain in the European Union. *Public Health Nutrition*, *4*(4), 893-902.

IFAD (The International Fund for Agricultural Development). 2011. "Republic of Uzbekistan. Horticultural support project".Project Final Design Report.

Kamatsuchi M (2006). *Macroeconomic growth barriers in Uzbekistan*. Nutritional focus. World Bank Health, Nutrition, Population Unit, Human Development Network (HDNHE). Washington, D.C., World Bank.

Khudayberganov A.S. (2008). Rukovodstvo po zdorovomu pitaniyu (Guidance for Healthy Nutrition). Tashkent.

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., ...&Degenhardt, L. (2013). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, *380*(9859), 2224-2260.

Lock, K., Pomerleau, J., Causer, L., Altmann, D. R., & McKee, M. (2005). The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet. *Bulletin of the World Health Organization*, *83*(2), 100-108.

Lopez, A. D., & Murray, C. J. (Eds.). (1996). *The global burden of disease: A comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020*. Harvard School of Public Health.

Lundberg, M., & Rich, K. (2002). Multimarket models and policy analysis: An application to Madagascar. *Development Economics Research Group/Poverty Reduction Group, Environment and Infrastructure Team, mimeo*.

Mavlyanova, R. F. (2005).Evaluation of Global Sources of Root Crops for Breeding and Cultivation in Uzbekistan. *Vegetable Production in Central Asia*, 138.

Murray, C. J., & Lopez, A. D. (1999). On the comparable quantification of health risks: lessons from the Global Burden of Disease Study. *Epidemiology-Baltimore*,*10*(5), 594-605.

Musaev D, Yakshilikov Y, Yusupov K. 2010. Food security in Uzbekistan, UNDP.

Powles, J. W., Day, N. E., Sanz, M. A., & Bingham, S. A. (1996). Protective foods in winter and spring: a key to lower vascular mortality?. *The Lancet*,*348*(9031), 898-899.

Rudenko, I. (2008). *Value chains for rural and regional development: The case of cotton, wheat, fruit and vegetable value chains in the lower reaches of the Amu Darya River, Uzbekistan* (Doctoral dissertation, ZEF).

Stifel, D. C., &Randrianarisoa, J. C. (2006). Agricultural policy in Madagascar: A seasonal multi-market model. *Journal of Policy Modeling*, *28*(9), 1023-1027.

The World Factbook. (2013, April 8). Retrieved April 13, 2013, from The Central Intelligence Agency (CIA): https://www.cia.gov/library/publications/the-world-factbook/geos/uz.html

Uzbekistan Economy.(2006). Statistical and Analytical Review for the year 2005.*Centre for economic research and education/USAID "Bearing point" project, Tashkent*.

World Cancer Research Fund (WCRF), & American Institute for Cancer Research (AICR). (2007).*Food, nutrition, physical activity, and the prevention of cancer: a global perspective*. AmerInst for Cancer Research.

World Economic Forum (WEF). (2010). *Global risks 2010: a Global risk network report*. Geneva, World Economic Forum.

World Food Programme. 2008. "Poverty and Food Insecurity in Uzbekistan" (accessed February 16, 2011). http://documents.wfp.org/stellent/groups/public/documents/ena/wfp179011.pdf.

World Development Indicators. (2013, January 8). Retrieved April 13, 2013, from The World Bank: http://databank.worldbank.org/ddp/home.do

World Health Organization. (2002). *World Health Report 2002: World Health Report: Reducing Risks to Health Noncommunicable Diseases*. World Health Organization.

World Health Organization (WHO), & World Health Organization (WHO). (2011). Noncommunicable diseases country profiles 2011. *WHO global report. Geneva: World Health Organization*.

WHO, F., & Consultation, F. E. (2003).Diet, nutrition and the prevention of chronic diseases. *Report of a joint WHO/FAO Expert consultation. Geneva: WHO.*

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LAND USE, FOOD AND NUTRITION SECURITY – CASE STUDY IN RURAL UZBEKISTAN

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1 ABSTRACT

The present research is realised in the frame of the ZEU project "LUCA" (Land Use, Ecosystem Services and Human Welfare in Central Asia). LUCA builds a platform for joint analysis of land use effects for a whole region, involving participants from various countries of Central Asia.

In the transition from planned to market economies, the Central Asian Republics experienced rising poverty, food insecurity and malnutrition as well as serious degradation of water and land resources. The process to a market oriented economy has not been adequately supported by national institutional development. It resulted in a reduced living standard.

Land use strategies in Uzbekistan determine the level of food security. While the area of rangelands is vast, the livestock farming and production of grains, fruits and vegetables play a major role in food security and also are the basic source of rural population income.

More than 60% of Uzbeks live in rural area. Uzbekistan produces adequate calories to supply the population but almost 30 % lives below the food poverty line (IFPRI, 2006). The poorest population spends more than 60 % of income for food and takes a diet dominated by cereals. The existing system of the "state order" to produce cotton and wheat does not allow to growing up food crops in adequate amount.

The survey is focused on questions on the socio-economic situation, societal determinants of food supply, food consumption patterns, eating habits, and coping strategies managing food crisis on household level.

Markhamat region of Andijan province and Denau region of Surkhandarya province are the two most populated regions of Uzbekistan and presented as the study area.

The data collection is based on the own structured questionnaire, on the Household Food Security Survey Module (HFSSM), Food Consumption Score (FCS), and Food List Recall. Data analysis was done with SPSS.

The main results show the percentage of food secure and food insecure households as well as the food consumption status of these households concerning cash and food crops households are producing on their farm land and/or on their homestead plot.

The results show that the main indicator of the level of income, food security situation and food consumption status of household is the production strategy. Thereby the more households

produce cotton and wheat they will have less income, and a worse food security and food consumption status.

2 MOTIVATION AND RESEARCH QUESTIONS

The main motivation to conduct the research on food security is the lack of such a survey on household level. The set of studies on food security on macro level was conducted in Uzbekistan, but the majority of results are not generally accessible for open public by different reasons. Detailed information on land use, livelihoods, the socio-economic situation as well as data on the status of health and food in Uzbekistan are scarce.

The main objective of the study is to analyse empirically the current food and nutrition situation of farmers' household in the two research regions Markhamat and Denau.

Specific study objectives are in the following:

- To analyse the income, food and nutrition situation of households according to producing cash and food crops on farm land, and/or on homestead plot (incl./excl. livestock keeping)
- To analyse the relationship between homestead plot size and household's food security
- To analyse the share of income spent for food in households and share of preserved and consumed food produced on farmland and/or homestead plot
- To identify coping strategies for achieving food and nutrition security

3 DATA AND METHODS

<u>Selection of sample size:</u> Markhamat and Denau regions are the selected research areas as highly populated rural regions. In each region 110 farm households were investigated. Snowball effect was selected as an instrument for sample recruitment.

<u>Field research steps and procedure:</u> Before starting primary data collection several meetings with representatives of local authorities in both regions took place. Main general data needed for research was obtained from these sources.

<u>Pre-test of questionnaire:</u> Questionnaires developed for primary data collection were pre- tested in order to modify and/or aborted some questions. It is also necessary for proving the understandable of all questions and tables to be completed by respondents.

<u>Data collection:</u>

I. Primary data collection was conducted using the following questionnaires:
   1. Own household questionnaire includes: socio-demographic data, socio-economic data, dwelling unit data, crop production on farm land and homestead plot.

2. Modified HFSSM (Household's food security survey module) questionnaire focuses on self-reports of uncertain, insufficient or inadequate food access, availability and utilisation due to limited financial resources, compromised eating patterns and food consumption that may result.
3. Food consumption score (FCS) questionnaire is based on the frequency of consumption of one or more items from the eight food groups. Thresholds for separating groups of households are generated by using a weighted food consumption score.
4. Food list recall (for the last 7 days). Ideally, detailed food consumption surveys would be used to measure caloric intake; however, the cost and time limitations of surveying an adequate sample is needed mean that such surveys are rarely conducted. In spite of this limitation this kind of survey was conducted using the "Food list recall".

II. Secondary data was collected from the different database of local and international organisations as UNDP, FAO, World Bank, ADB, SDC, SIC ICWC, UzStat, etc, as well as from different literature and official web-sites.

Data processing: The study is based on different statistical methods in order to achieve the research objectives. There were descriptive statistics, t-test, U-test and Logistic regression. SPSS (versions 18 and 19) were used for these aims.

4 MAIN RESULTS

In both regions 4% of all households have borderline food consumption thereby 96% of households have an adequate food consumption. There is no statistically significance between the regions (U-test: p=0.21).

Further, 37% of all households have a high food security status, 24%- marginal, 34%- low, and 6% have a very low food security status. Again, there is no statistically significance between the regions (U-test: p=0.65).

Analysis shows that food secure household have 0.036 ha of the home stead plot, and food insecure households have 0.03 ha. In the same time potatoes and onions are more produced by food insecure households. But food secure households produce more tomatoes and cucumbers. Thereby the production on homestead plots also has influence on household` s food consumption.

Some results were obtained in the analysis of influencing of crops produced on farm land on the level of income. Hereby, those farmers who produced only cotton and wheat have an average 470000 UZS per month; those who produce cotton, wheat and food crops have 1600000 UZS per month; and those who produced only food crops on farm land have 3 Mio UZS per month. In order to better understand these results it is necessary to note that the minimum wage (or poverty line) in Uzbekistan in 2011 was 63000 UZS per person per month. The average yearly currency rate for 2011 was 1 €=2400 UZS.

To analyse the influence of education, household composition, level of income as well as production on homestead plots and farm land on food consumption status and food security status, Logistic regressions are used. Two different kinds of models were analysed. First, in the full model, all possible independent variables were included. The regression analysis indicates that household food consumption status as well as household food security status clearly depends on the kind of crop produced on the farm land. In these models, all other variables are statistically not significant. Deleting kind of crop produced as independent variables leads to the second, reduced model version. Here, the influence of education, household structure as well as income on food consumption

status and food security status is confirmed. Further, an increasing number of crops produced on the homestead plot increases the probability that the household is food secure.

These preliminary results indicate that land use strategies, especially the state order system, clearly influences food consumption and nutrition security in Uzbekistan. Diminishing the state order system as well as supporting production on homestead plots (in size as well as variety of crops) seems to be relevant strategies to reduce food and nutrition insecurity.

5 CONCLUSIONS AND RECOMMENDATIONS

Currently through the authorized bodies the State defines for farmers both the volume of production for the state order and areas of land occupied by strategic crops. Defining the production only by volume either than by land occupied will give the opportunity to reach the necessary volume of strategic crops production even from smaller areas. On the liberated areas the growing of food crops could be organized.

Following stage should be the decreasing of the state order volumes. Decreasing of the state order for cotton in the conditions of Uzbekistan will not mean the decreasing of the volumes of its production. The infrastructure for cotton growing is developed enough, in comparison with other crops, and the basic part of farmers at the first stages will not be interested in crop change. Introduction of the offered recommendation could lead the conditions for a crop choice. Thus, the economic freedom for farmers will be provided, and in turn, that is the extremely important for market mechanism introduction and functioning.

REFERENCES

IFPRI (2006). International Food Policy Research Institute. Uzbekistan's Road to Food Security.

FAOSTAT (2006). Uzbekistan Country Profile: Food security indicators. UNDP (2009). Food security in Uzbekistan.

SHAVKAT HASANOV AND FARHOD AHROROV

UZBEKISTAN'S AGRICULTURE- STATUS QUO, CHALLENGES AND POLICY SUGGESTIONS

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1 INTRODUCTION

Uzbekistan is a country of vast land with rich natural and oil resources. It is a dry, landlocked country of which 11% consists of intensely cultivated, irrigated river valleys. More than 60% of its population lives in densely populated rural communities. Uzbekistan is now the world's second largest cotton exporter and fifth largest producer, a large producer of gold and oil, and a regionally significant producer of chemicals and machinery.

Uzbekistan's economy depends heavily on agricultural production. As late as 1992, roughly 40 percent of its net material product has been generated in the agricultural sector, although only about 10 percent of the country's land area was cultivated. Agriculture is also the biggest industry, which accounted for 21.7% of GDP in 2007 and employed approximately 28% of labor force (WFP 2008, Hasanov and Ahmed 2011).

Sector growth trends reveal that industry's share of GDP has increased from 14% in 2000 to 24% in 2011 and the service sector from 37% in 2000 to 40% 2011. Agriculture's share of GDP has decreased from 30% in 2000 to 17.5% in 2010. However, agriculture remains important: around 49% of the population is in rural areas and 25% of the national workforce is directly employed in the sector. Moreover, agriculture provides 90% of domestic demand for agricultural products and 70% of domestic trade.

Table 1: The structure of Uzbek economy (% composition in GDP)

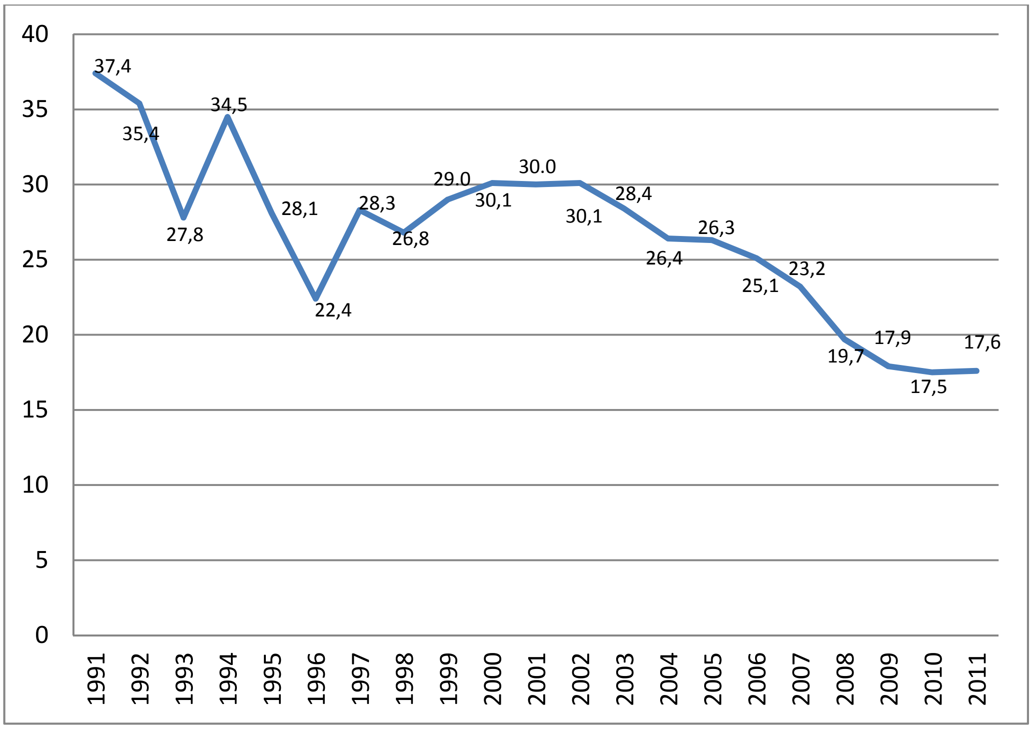
Sector	**2000**	**2005**	**2007**	**2011**
Manufacturing	14.2	21.1	21	24
Agriculture	**30.1**	**26.3**	**23.2**	**17.6**
Construction	6.0	4.8	5.9	6.1
Transport and communication	7.7	10.6	11.3	11.7
Trade	10.8	8.8	9.4	8.8
Others	31.2	28.4	29.2	31.8

Source: State Statistics committee of Uzbekistan, 2012

2 AGRICULTURAL PRODUCTION

In addition to its contribution to employment and GDP, agriculture is also of vital importance in terms of improvements in rural livelihoods, food security and self-sustainability. After independence in 1991, the country's agricultural system underwent significant structural changes resulting in the fall of total agricultural output to 16% by 1996. However, the implementation of land distribution initiatives and the engagement of an increasing number of households in agriculture and crop diversification have resulted in a significant increase in output since then, surpassing the levels attained in 1991[1]. Structural changes adapted to the type of land tenure available following the restructuring of large collective and state farms have resulted in the formation of private farms and the expansion of small household plots, which are now responsible for much of the growth in agricultural output over recent years, thereby leading to increased household incomes as a result of the strong productivity gains (World Bank Country Note 2010, Cornia et.al. 2003).

Figure 1: The share of agriculture in GDP, in %

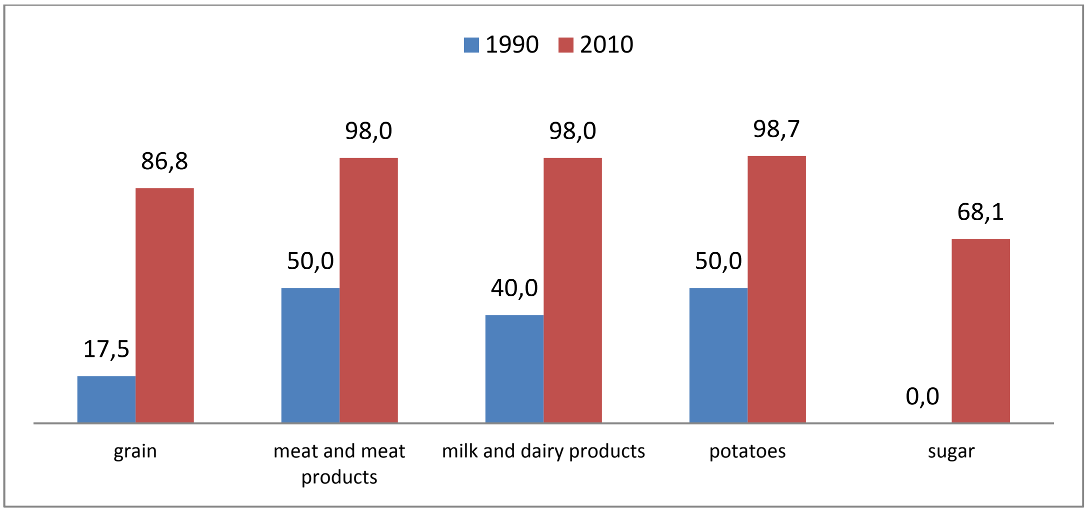


Source: State Statistics committee of Uzbekistan, 2012

Approximately 60 percent of the value of agricultural production comes from the crop sector and the remainder from the livestock sector. Cotton is the most important crop economically. This "strategic crop", produced in irrigated areas throughout the country, accounts for about 40 percent of cultivated land and makes up about 40 percent of export earnings. It makes Uzbekistan the fifth largest cotton producer and second largest cotton exporter in the world. Since independence, and as a result of the self-sufficiency food policy adopted by the Uzbek Government, wheat has become the second "strategic crop". It accounts for about 30 percent of the cultivated area. The rest of the cultivated area is used for growing fruits and vegetables (Uzbekistan continues to be one of the major suppliers of fresh and processed fruits and vegetables in the region), in addition to potatoes, tobacco and fodder crops. Animal husbandry in Uzbekistan is specialized not only in production of foodstuffs (meat, dairy products, eggs) but also in the production of raw materials that include cocoons of mulberry silkworms and karakul that are highly demanded in the world markets.

[1] World Development Indicators, 2009, The World Bank

Figure 2: Self-sufficiency of major agricultural products



Source: State Statistics committee of Uzbekistan, 2011

With regard to food consumption, there have been significant changes over the years. In the 1990s, the country imported over 82% of the total consumption of grain, 50% of the meat and meat products, 60% dairy products, 50% of potatoes, 100% of sugar and powdered milk and baby food. Nowadays Uzbekistan provides its own population all basic food products in the necessary volume in almost all products due to the development of domestic production (with the exception of sugar).

Estimates suggest significant differences in income and food consumption between urban and rural areas, with lower levels in rural areas, and hence there is an obvious case for concentrating policy on this imbalance. It is apparent that actions aimed at rural economic growth will have agriculture at their core, but emphasis on the wider rural economic development will also be important since, worldwide experience shows that agricultural growth alone is insufficient to raise rural income substantially. This is because agricultural earnings accrue mainly to those with access to the key factors of production (land and water) and because the linkages between agricultural growth and incomes in the rural sector as a whole are weak. As a result, addressing non-agricultural incomes and, hence, non-agricultural income sources is essential in rural development.

In 2010 agricultural output was valued at US$8.9 billion and accounted for 21% of exports. While cotton and grain are the most important crops in Uzbekistan, horticultural products contributed significantly to Uzbekistan's agricultural output in 2010. Table 4 below shows the contributions to GDP by agricultural product type for the period 1990 – 2010.

Table 2: Shares of major agricultural products in GDP (%), 1990-2010

Measurements	**1990**	**2000**	**2010**
Share of agriculture in GDP	33.4	30.1	17.5
Row cotton	15.9	3.6	19
Grain	1.4	3.4	2.0
Potato	0.3	0.8	1.4
Vegetables	1.3	2.4	2.3
Melons	0.5	0.3	0.3
Fruits	0.7	0.9	1.1
Grapes	0.8	0.8	0.9

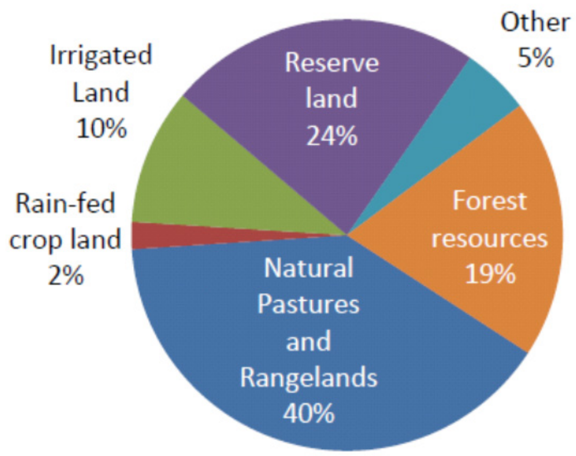
Source: MAWR –Ministry of Agriculture and Water Resources of Uzbekistan, 2011

Significant contributors to horticultural production are dekhan farms, which are small allocations of up to 0.35 hectare on irrigated lands, 0.5 ha on non-irrigated lands and 1 ha on land classified as desert. According to the State Statistics Committee, dekhan farms, originally introduced by Government as a food security measure whereby small-scale farmers as private sector operators could grow for their own subsistence and sell surpluses to local markets, accounted for a 63% share of total agricultural output in 2010 off 0.47 million ha of land. Private sector agriculture also includes leasehold farms made available under Government's land reform and rural restructuring policies. There are around 81,000 private leasehold farms in the country, more than 1.5 million people employed on these lands, with an average size approaching 150 ha. In 2010 private farms accounted for 35% of total agricultural output off 3.14 million ha (IFAD 2010).

3 AGRICULTURAL LAND USE AND MANAGEMENT

A large area of land is used for agriculture in Uzbekistan; with natural pastures occupying 40% of the country and rain-fed and irrigated cropland accounting for an additional 12%[2] (Figure 3). More than 85% of Uzbekistan's cropland is irrigated, comprising approximately 10% of the land area of the country.

Figure 3: Land use in Uzbekistan



[2] Centre for Hydrometeorological Service, Cabinet of Ministers, 2008. Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change, Tashkent

Source: Centre for Hydro-meteorological Service, Cabinet of Ministers, 2008.

Main agricultural areas are located in the basins of the Amu Darya and the Syr Darya rivers, which supply about 70% of irrigation water. Large expansion of irrigated lands during 1960s to late 1980s resulted in excessive water takeoff from these rivers causing drying out of the Aral Sea, increasing soil salinity, and other adverse environmental impacts (WFP 2008).

Farming is conducted by renting land in a permanent rental system. Since privatization of land has not been enforced, land is state-owned, except for special cases where law is enacted. Of the total land area, farmland is about 22,260,000ha (50%) and arable land is 4,050,000ha (9%). In 2008, about 2,750,000 people worked in agricultural sectors and of the total population, 63% were living in rural areas. Major agricultural products are wheat and raw cotton. As a raw material to export finished textile products, raw cotton is the major earner of foreign currency in Uzbekistan. Wheat is also an important crop for food self-sufficiency and is mostly produced to fulfill domestic demand.

Of the total crop cultivation area, wheat accounts for about 90% of the area and is grown on 1,380,000ha. As the biggest export product in agriculture, Uzbekistan's raw cotton ranks 5th in the world in terms of production volume following the U.S, India, China, and Pakistan and ranks second in terms of export volume. About 60% of its population is working in the raw cotton industry and in 2010, raw cotton accounted for about 20% of Uzbekistan's total export volume. As for the farming sector, the government has focused on increasing productivity and income through efficient marketing of raw cotton and wheat.

Table 3: Sown area of crops (1,000ha)

	1991	**2000**	**2005**	**2011**
Sown area, total	4,200.3	3,778.3	3,647.5	3,601.2
of which wheat	**487.2**	**1,355.8**	**1,439.7**	**1,432.6**
rice	159.6	131.8	52.5	23.1
maize	107.7	49.2	33.6	26.5
of which cotton	**1,720.5**	**1,444.6**	**1,472.3**	**1,329.2**
of which potatoes	40	52.2	49.8	73.6
vegetables	165.6	130	137.7	175.4
forage crops	**1,065.7**	**429**	**290.3**	**313**

Source: State Statistics committee of Uzbekistan, 2012

By area, cotton and wheat are by far the two major crops grown in Uzbekistan. Smaller areas are occupied by fodder crops, grapes, apples, barley, tomatoes, potatoes and rice. Although the area occupied by fruit and nut trees is relatively small in comparison to wheat and cotton, the prevailing climatic conditions are suitable for the expansion of their production area.

At commodity level, cotton lint, cattle meat, cow milk, wheat, tomatoes, grapes, and cottonseed made the most significant contribution to the average value of agricultural production in Uzbekistan from 2005-2007. Approximately 60% of the value of agricultural production is derived from the annual and perennial crop sectors, while the livestock sector produces the remaining 40%. Although field crops like cotton and wheat are grown extensively and occupy a large percentage of the cropping land, other crops like tomatoes, grapes, potatoes and apples make a significant contribution to the value of agricultural production on a proportional basis, as they can garner higher price[3] (UNDP 2010).

Table 4: Production of principal agricultural crops, 2004-2009 (1,000 tons)

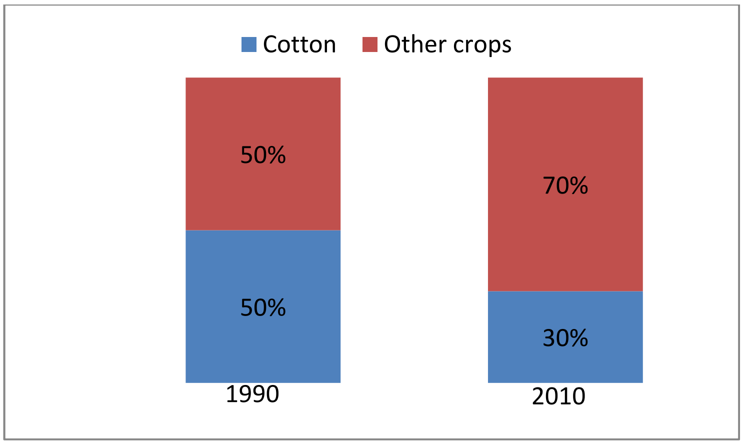
Crop	2004	2005	2006	2007	2008	2009
Cotton fiber	977	1,184	1,171	1,300	1,270	
Wheat	5,508	5,928	5,996	6,076	6,039	6,638
Vegetables	3,336	3,517	4,294	4,691	5,221	5,704
Potatoes	896	924	1,021	1,189	1,398	1,524
Fruit and berries		949	1,182	1,270	1,402	1,542
Grapes	589	642	804	879	7,925	899
Cattle and poultry	998	1,060	1,139	1,140	1,209	1,367
Milk	4,281	4,555	4,855	5,097	5,426	5,779

Source: State Statistics committee of Uzbekistan, 2010

During 1991 to 2011, sown area decreased by almost 600 thousand hectares. This is due to poor amelioration condition of soil, which forced the withdrawal of affected farm lands out of agricultural production. There have been significant changes in the structure of sown areas of crops. By reducing the area under cotton and forage crops, it was able to increase the share of areas under potatoes and vegetables and melons from 7.0% in 1991 to 8.2% in 2011; and grain crops from 25.7% to 44.6 % during the same period. Within the irrigated area too, this shift is vivid as depicted in Figure 10 below. The share of cotton fields in total irrigated areas has declined to 30% in 2010 from 50% in 1990, whereas the share of other crops rose to 70% during the same period. Accordingly, this trend is a clear indication of policy shift towards water-saving strategies in the country.

Figure 4: Share of cotton and other crops in total irrigated land (1990-2010)

[3] ftp://ftp.fao.org/agl/agll/docs/fertuseuzbekistan.pdf



Source: State Statistics committee of Uzbekistan, 2011

Such shifts have also made it possible to avoid shortages and rising food prices in the face of global financial crisis. Development of selected seed varieties, the use of new high-yield varieties of crops, and improvements of agriculture technologies have led to significant increases in the yield of food crops during the period 1991 to 2011 (Table 5).

Table 5: Average yield agricultural crops in all types of farming (ton/ha)

Products	**1991**	**2000**	**2005**	**2010**	**2011**	**In 2011 comp. to 1991, %**
Cotton(raw)	2.70	2.18	2.53	2.56	2.63	97.4
Wheat	1.25	2.76	4.15	4.65	4.78	382.4
Potato	8.70	12.93	17.03	19.19	19.60	225.3
Vegetables	18.80	18.38	21.58	25.54	26.36	140.2
Fruits and berryies	3.67	5.69	6.23	9.29	9.78	266.5
Grape	5.09	6.31	6.47	9.22	9.82	192.9

Source: State Committee of Statistics of Uzbekistan, 2012

Cotton production has great importance in achieving sustainable economic development of the country. It is quite well known that Uzbekistan is one of the leading producer and exporter of cotton in the world. Cotton fiber provides substantial part of the country's foreign currency earnings. As was indicated earlier, the production of cotton in the period 1991 to 2011 decreased by 24.7% due to the significant reduction of cultivated areas aimed at increasing food grain production for a rapidly growing population.

After independence, the government has set up strategic objective of ensuring the nation's food grain self-sufficiency. As a result, grain has now become one of the leading agricultural crops. During the 1991-2011 irrigated area under cereals increased by 5.2 times, the yield - 3.8 times, gross yield by 3.7 times, and the realization of the grain for state needs use by 19.6 times. While the rise in the number of modern combines reduced the duration of the season harvest, resulting in significantly reduced yield losses, it has led to "food grain independence" within a relatively short period turning Uzbekistan from a net grain importer to a net exporter.

As a result of the changes in recent years, climate and population growth in the world increased demand for horticultural products, potatoes, and other foods. Over the period 1991 to 2011, potato production has increased by 5.3 times, other vegetables by 2.5, melons by 1,4 times, fruit and berries by 3.6 times and grapes by 2.3 times. As a result, these crops have not only fully satisfied the needs of the country, but also to ensure their exports.

In recent years volume of commodity processing has also increased. Over the past five years, farmers, agricultural companies, processors and entrepreneurs have been importing small-scale technologies from abroad for processing fruits and vegetables. As a result, the volume of processed products increased by almost five-fold. Also the rapid creation of gardens for intensive farming production (intensive gardens) is being reconstructed in the degraded land areas, gardens and various farms.

The amount of the water used for the irrigation is now reaching the limit of available irrigation water supply, decided by the related countries. Moreover, since the independence, the irrigation and drainage facilities have not been properly maintained, managed or rehabilitated by water users association due to lack of funds. The capacity of these facilities is getting lower and lower. This situation is further accelerating the advance of salt damage. In future, in addition to paying heed to excessive groundwater development, the important tasks are the proper management of facilities through measures such as creation and use of the most effective irrigation areas, renewal of aging irrigation facilities, maintenance and management, planned utilization of water resources, and water saving cultivation techniques development. Although the maintenance and management of all irrigation waterways except trunk ones were transferred from government control to newly established water users' association, they are not functioning well due to financial difficulties and the lack of machinery and technology.

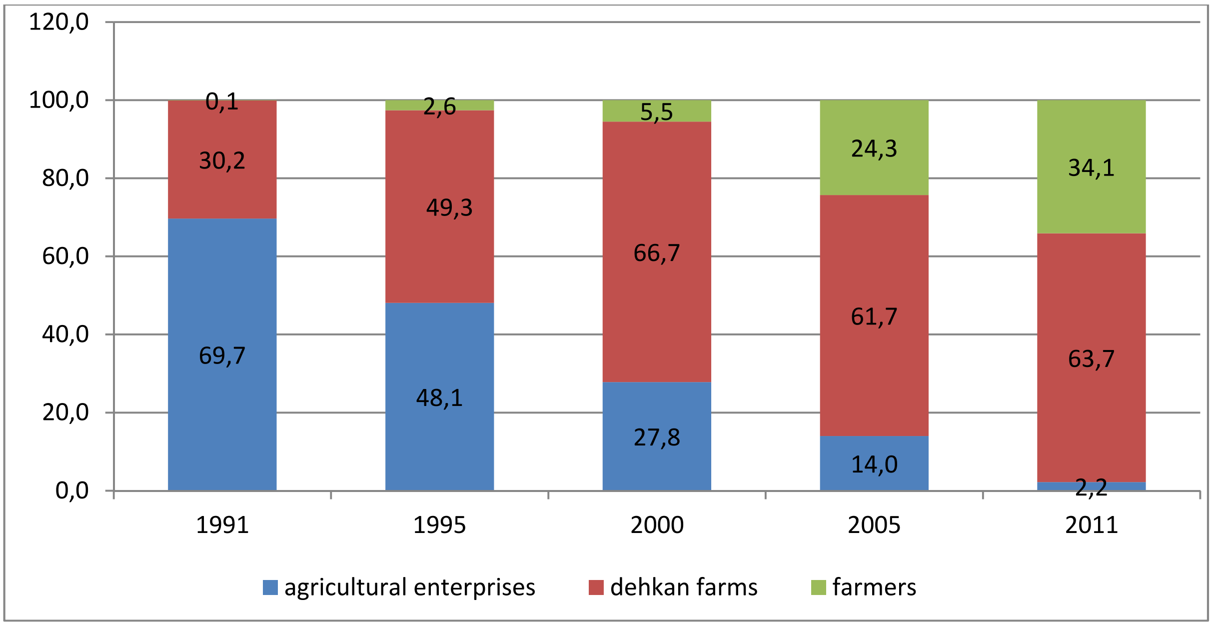
4 ORGANIZATION OF AGRICULTURAL PRODUCTION

After that, parts of the *shirkat* were split and privatized, and a large number of smaller private farms were born. The October 2003 presidential decree called for policies to split and dismantle inefficient *shirkat* and turn them into *private farms* by 2006, which is accelerating the country's efforts to privatize the agricultural sector.

There also existing household farms(*dehkan*), whose grows crops with a plot of less than 0.35 ha allocated to each family or raising livestock for their personal consumption[4]. They are allowed to sell excess produce at bazaars to earn cash. These function as a sort of safety network alongside the agrarian reforms.

Figure 4: Production structure by type of farms, % (1991-2011)

[4] Dehkan farms comprise very small land plots which average 0.17 ha and cannot exceed 0.35 ha if irrigated or 1 ha if unirrigated



Source: State Statistics committee of Uzbekistan, 2012

During the period 2003-2006, the government's agricultural policy was concentrated on private farming sector development, setting up of market and production infrastructure, improving provision of advance loans to farmers for agricultural production, and establishment of various forms of cooperatives by farmers.

The market and production infrastructure development was designed to service the newly emerging farming sector. Companies providing plowing and planting, veterinarian, insurance and mini-banks services, as well as supplying chemical fertilizer, fuel and lubricants are being established everywhere. As a result, private farmers' access to these services has been improved significantly. At the same time, there is huge untapped potential in developing the procurement system and improving the functioning of wholesale agricultural markets. Despite reorganization in progress, there still remains a lot to be done in terms of creating water user systems in compliance with market reforms and enhancing the effectiveness of the Water Consumers' Association.

Efforts to broaden and deepen the agrarian reform in the country create ample opportunities for the development of farms. During the implementation of the reforms a number of laws, decrees of the President of the Republic of Uzbekistan and the Cabinet of Ministers were adopted on the organization and development of farms. These reforms were primarily devised to support the development of farms and the necessary organizational, economic and legal conditions of land and water relations, financial and credit mechanism, the formation of the material and technical base of farms, service and legal services, and to improve the system of production, processing and marketing, and labor relations and activities in the field of training. Farmers as the main producers of agricultural products imposed today hope to increase the volume of production at the intensive basis, enhancement of processing of agricultural products, improve the profitability of agriculture, which ultimately will significantly raise the level of living in the countryside. In order to strengthen the economic interest of agricultural producers, the government has facilitated the simplification of accounting and relief to farmers in the form of payment of the single (unified) land tax return payment together with all applicable national (except excise tax) and local taxes and fees to agricultural producers. Additionally, for newly established farms, tax-free privileges of two years are given for lands. In the case of development of unused farm land, it is exempt from the single land tax for a period of five years. Farms specializing for cultivation of fruits and grapes are also exempt from the single land tax for a period of five years. Imports of farm inputs and foreign technological equipment for own use, are similarly exempt from customs duties.

5 OBSTACLES TO UZBEKISTAN'S AGRICULTURAL DEVELOPMENT AND MARKETING

For decades Uzbekistan irrigation water consumption has exceeded natural river flows, contributing to the desiccation of the Aral Sea. The use of irrigation water has not been efficient, and using high levels together with poor drainage have contributed to *salinity problems*. Such an irrational water use during the last 40-50 years has caused the biggest environmental crisis in the region – the drying up of the Aral Sea. According to one assessment, the Aral Sea crisis has led to direct and indirect socioeconomic costs totaling US$144 million (nearly US$5.7 per capita or 1.8% of GDP)[5].

Uzbekistan has identified a number of adaptation options for agriculture, including improvement of weather and climate monitoring, development of new adapted varieties, improvement of agronomic practices including minimum tillage, increase in water efficiencies and catchment management involving all stakeholders, improvement of pasture and fodder, and development of new livestock breeds. It is in the early stages of integrating these options into agricultural policies and practices at a farm level and of moving from a "top down" support delivery system to one that is demand driven and pluralistic. Its agricultural strategy objectives concern the maintenance of export revenues, food security and improvements in rural living standards. Uzbekistan has moved with land reform, creating a favorable environment for private farmer investment in land productivity.

There are ongoing programs to improve irrigation and drainage management and wetland rehabilitation, especially near the mouth of the Amu Darya River, to improve water management in the fertile Ferghana Valley, and to encourage farm productivity and agri-business development including improving the appropriate environment for financial access. These programs will improve resilience, especially if combined with further measures to liberalize the agricultural economy.

The total area of agricultural land consists of 17.8 million hectares, of which 25% is arable land. In the last 15 years the area of agricultural land decreased by more than 5%, and in per capita terms by 22%, mostly due to the creation of pastures, orchards, and vineyards. On average, there are 8 persons per each hectare of irrigated land. Demographic growth rates are far ahead of those of irrigated land, which has led to a reduction in irrigated farmland from 0.22 ha down to 0.13 ha per person. According to ADB estimates, if the current trend persists, the acreage of irrigated land will further decrease by 20-25% in the next 30 years[6].

[5] UNDP, "Water – a critical resource for the future of Uzbekistan", Tashkent, 2006

[6] UNDP, "Water – a critical resource for the future of Uzbekistan", Tashkent 2006

At the same time, the quality of agricultural land is deteriorating. Between 1990 and 2000, the average land quality grade fell from 58 to 55 (in bonitet score[7]). More than 3 million hectares of land is affected by soil erosion caused by wind and water – the average losses of fertile layer in a season has reached up to 80 tons per hectare. Area of pastures subject to erosion, which resulted from overgrazing, constitutes 7.4 million ha, while more than 5 million ha of pasture land is affected by desertification. Problems related to water and wind erosion are worsening because of the reduction in the area of forests, which fell from 8.5 million ha in 2000 down to 8.1 million ha in 2004. About 54% of the land is polluted by pesticides, and more than 80% has a high content of pollutants (IMF 2008).

Considering the limited land resources in the country, reductions in arable land per capita is likely to become a long term trend, and calls for strategic actions to be taken to enhance the effective use of limited land resources. According to World Bank estimates, annual losses in agricultural output in Uzbekistan due to land salinity/degradation are estimated to equal US$31 million, while the economic losses due to agricultural land taken out of use equals roughly US$12 million[8]. Activities to reduce land salinity incur major financial costs as well as labor, water, and technical resources. Even with government support, there is an acute shortage of funding for land rehabilitation, preservation, and enhancing yields. Today at least half of all irrigated land is in immediate need of improvement (rehabilitation).

About half of the irrigated lands is supplied with water by pumping stations. The total area of irrigated land in the reconstruction of irrigation systems requires about 36% from total, needs works on reclamation of melioration, through construction, and repairing of vertical drainage for draining saline water. This will assist in keeping lower the underground water level and the salinity degree.

There are also some problems related to pasture use. There have been trends of imbalance in the way pasture is used, wherein some pasture lands are extensively used for grazing leading to overgrazing while others are under-grazed. This, together with the unfavorable ecological situation in the area of the Aral Sea, leads to the degradation of pastures as the natural forage. In addition, population growth and the transformation of irrigated farmland into settlement expansion leads to the utilization of new and often non-suitable land for agricultural production. All these are associated with significant logistical costs. As a consequence it leads to reduced economic efficiency of agricultural production. Aside lands do not only reduce alfalfa forage for livestock, but also adversely affect the level of soil fertility, and hence the yields of major crops like cotton and wheat.

The infrastructure required for expansion of extension services has been put in place. However, the service provided to farmers is still insufficient. The existing infrastructure is largely limited to providing farm management and execution of activities related to technological processes. Certain infrastructure does not meet the needs; organized mini banks did not fully provide services to farmers as almost a third of them do not have internet connection; some of the sources on the realization of mineral fertilizers and fuel is not repaired and not equipped with modern equipment; most of the networks on the harvesting agricultural products and their implementation, as well as

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[7] Land quality rating, relating to potential production of a basket of crops, best land awarded 100 points.

[8] World Bank, "General state of the environment", 2002

networks to provide information and consulting are not financially stable. Currently, the service sector is experiencing difficulties due to lack of funds as well as ineffectiveness of the tax system. These reduce the efficiency of agricultural production and worsen the unemployment issue and the standard of living of the rural population. They can also lead to imbalances in the supply and demand for certain types of services.

In view of the demand for agricultural products, there is a need to develop new and highly productive crop varieties, improve the soil and climatic conditions of the regions, introduce modern farming techniques, provide local small tractors and agricultural machinery for the production of horticulture, viticulture, fruit and vegetables, etc. There are a number of difficulties in the implementation of and effective control over the quality of exported agricultural products. Lack of testing facilities and laboratories that meet to the international standards is also an area that requires attention.

Other issues that need to be addressed to enhance the role and importance of agriculture in the country's life include increasing the area of irrigated land, controlling pests and diseases, and improving logistics services in the agricultural sector.

Other unresolved problems are as listed below.

- Existing legislation is insufficient to establish a framework to promote self-management by farmers and support their activities, since they are mainly focused on increasing production. In addition, there is no unified basic law for regulating all trends of the sector.
- In spite of the measures taken to optimize farm size, there is problem of fragmentation of land, which does not allow for the use of well-planned crop rotation aimed at high yields and increase in funds for the purchase and use of a modern cost-effective technology
- Procurement prices for agricultural products are quite low compared to the growing costs. The main reason for this is the increase in the cost of fuel and fertilizer
- Bank loans are an important tool in the initiation and implementation of business plans by farmers, and acquisition of modern equipment and technology. But farmers are not willing to use the bank services despite their perceived benefits, since the applicable interest rates are quite high given their financial situation. There are difficulties in obtaining credit due to the high collateral requirement.
- Amelioration conditions of irrigated land are of great concern.
- The lack of stable and long-term partnerships with suppliers and processors, as well as customers in the domestic and foreign markets is also of concern.
- The relative high dependence of the republic on the water from neighboring countries.
- Limited capacity and dispersion of the internal market and the low purchasing power of the traditional markets of the CIS countries.

6 POLICY RECOMMENDATIONS FOR UZBEKISTAN'S AGRICULTURAL AND MARKETING DEVELOPMENT

MAJOR POLICY SUGGESTIONS

AGRICULTURAL PRODUCTION AND PRODUCTIVITY

The constraints related to agricultural production in Uzbekistan include less diversification and excessive dependence on water from neighboring countries. Moreover, soil fertility has fallen down on quality scores, which has reduced efficiency of production and productivity. Although measures have been taken to optimize farm size, there is problem of fragmentation of land, which restricts the possibilities for evidence-based crop rotation aiming at high yields, and limits the ability of farmers to raise their incomes and enhance the purchase and use of modern and cost-effective technology.

Consequently, diversification of crop types according to agro-ecology is helpful. Taking into account the prediction that the reduction in the arable land and deterioration of the existing land resources are to continue, there is a need for implementation of strategies, which aims at enhancing the effective use of the available limited land areas.

QUALITY OF LAND RESOURCES AND IRRIGATION

The constraints identified in this topic include inefficient use and overuse of water, poor drainage, salinity problem, poor amelioration efforts, escalation of soil erosion and deterioration of soil fertility. Accordingly, broadening measures like improved agronomic practices, water efficiency, catchment management, which are already being implemented by the government but still insufficient, are recommended to improve the situation.

SLOW PROCESS OF REFORM IMPLEMENTATION

Despite various measures and reforms the government is taking, the implementation is very slow and far too little to have meaningful effects. Especially the marketing liberalization is very sluggish. Moreover, the privatization process has been too slow. Hence, there is an urgent need to broaden and deepen the liberalization process especially in the marketing sector. Moreover, fostering public-private partnership in the implementation of these processes would be beneficial.

R&D AND EXTENSION SERVICES

The R&D activities for modern technologies are not consistent with the needs of production. The extension services are not sufficient and the extension network is very limited. Accordingly, there is a need to strengthen the link between research and extension. Moreover, enhancing the effective transmission and dissemination of research outputs and technology to farmers is required. There is also a need to increase investment in research institutions and capacity building.

7 CONCLUSION

Uzbekistan is a country with agriculture still contributing a good share in the overall economy of the nation despite its consistent decline in its contribution. The development of the sector has been constrained in many fronts including the slow transition of coming out of a command-type of economic policy from the past, problems related to degradation of land resources (salinity problems and deteriorating soil fertility), natural calamities like the drying up of the Areal Sea and the associated problem of dwindling water sources for irrigation, infrastructural problems in rural areas and underutilization of existing infrastructure, underdeveloped agricultural marketing system and associated inefficiencies, etc.

Traditionally the agricultural production in Uzbekistan has been dominated by cotton and wheat cultivation and is as such less diversified. However, following a series of reforms that have been implemented over time since independence, the sector has been increasingly diversifying away from these major crops to other subsectors with high potentials for income generation of farmers. In particular, the growth of incomes overtime has brought opportunities for the cultivation and marketing of high-value agricultural products including fruits, vegetables and livestock products. This further enhances related agro-processing businesses through forward and backward linkages.

The policy suggestions are proposed for implementation in phases/stages; namely, the initial/preliminary stage (to stimulate the development and introduction new varieties of plants and breeds of animal, agro-technology and enhance the productivities of crops and livestock); the diversification stage (to enhance the structure of sown areas through increasing areas under competitive crops); take-off stage (to create new enterprises based on modern technology and technological renovation export and processing agricultural products) and finally, maturation stage (for the implementation of measures to promote sustainable development and modernization of agriculture). Specific recommendations were given pertaining to some of the constraints identified; namely, agricultural production and productivity, quality of land resources, irrigation, reforms, R&D, extension, rural finance, and agricultural marketing.

REFERENCES

ADB (2006). *Uzbekistan: An Evaluation Study*

Cornia, G.A., McKinley, T., Spoor, M., Kotz, D.M., Saidova, G., Nasritdinkhodjaev, Z., Khaitov, A., Abduganieva, Y., and A. Tukhanov (2011). Growth and Poverty Reduction in Uzbekistan in the Next Decade. A Report Commissioned by the Poverty Group

Government of Japan (2006). *Country Assistance Program for the Republic of Uzbekistan*

Hasanov Sh. and Ahmed, M. N., (2011). *Agricultural efficiency under resource scarcity in Uzbekistan: A data envelopment analysis*. Business and Economic Horizons. Vol.4, No.11.

IFAD (2010). *Republic of Uzbekistan Horticultural Support Project*, A Final Report

IMF (2008). *Republic of Uzbekistan: Poverty Reduction Strategy Paper.* Country Report No. 08/34

UNDP (2010). *Rural Economic Development*, Policy Brief 2(15)

WFP (2008). *Poverty and Food Insecurity in Uzbekistan*

World Bank (2010). *Opportunities and Challenges for a Converging Agenda: Country Examples*

ISMAILOVA BASHORAT

THE ARAL SEA DESICCATION: SOCIO-ECONOMIC EFFECTS IN CASE OF THE REPUBLIC OF KARAKALPAKSTAN, UZBEKISTAN

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1 ABSTRACT

Previously prominent lake – the Aral Sea being rich in biodiversity maintained the livelihood of people. It ranked fourth place according to its size and it began shrinking in 1960. Its desiccation has triggered various problems which could be distinguished into three groups: environmental, social and economic. Due to timeframe and resource/data limitations not all categories of problems would be covered in this study. Some of the environmental issues will be taken into account, while all of them are interlinked (creating a vicious circle). But in the center of attention is the analysis of the social and economic impact of the Aral Sea desiccation in the region of KP. The literature review showed that most of the research is conducted in the agricultural sector, and the desiccation implications were considered more from the aspect of *causes*, missing out the long term effects of the Aral Sea desiccation. These long term effects are significant in the development of the region from social – health aspect, as health can affect the productivity, unemployment which means no/low income that in turn causes poverty and poverty is one of the main reasons for the environmental degradation to occur. It is a vicious circle of environmental degradation to worsen with health and simultaneously to affect the economic state. This study researched the health effects of the Aral Sea desiccation and with the help of 'ecosystem approach' pointed out the long term consequences of the currently existing health issues to the economy of KP.

2 INTRODUCTION

One of the prominent environmental disasters is the desiccation of the Aral Sea. Prior to the 1960s it used to be one of the largest terminal lakes [without outflow] and ranked fourth place in the world (Aladin et al. 2006, p.205). Being rich in biodiversity, the lake provided the people of the Aral Sea region with fishing opportunities in addition to hunting, reed reaping, and livestock breeding which had contributed to people's livelihood (INTAS 2001; Aladin et al. 2006; Breckle&Wucherer 2011). Its desiccation was due to the irrigation changes that occurred under the reign of the former Soviet Union (FSU), where Uzbekistan was to produce white gold – cotton (Wish-Wilson 2002, p.29; Kapuscincki 1994, p.258). For that two main rivers - the Amudarya and the Syrdarya, which feed the Aral Sea, were diverted from the Aral Sea to open virgin lands (Glantz 2007). Subsequently the lake had undergone various changes like high salinity of water, which caused decline of biodiversity not only in the lake but as well as in the deltas of the Amudarya and the Syrdarya. Since 1980s, the commercial fishing was discontinued owing to high salinity and high costs (Kulmatov & Soliev 2009). Later the salinity reached the level where no fish could survive, except some of the invertebrates (Roll et al. 2003, p.12; Aladin et al. 2008b, p.7; Aladin et al. 2009, p.180). In 1997 the Aral Sea was declared ‘biologically dead’ by the World Bank (Small & Bunce 2003). At present the Priaralye is known as a disaster zone (Martius et al. 2004). In spite of

large expenditure spent on it there were hardly tangible effects for the people as well as for the lake (Wish-Wilson 2002, p.32; Ataniyazova 2003, p.4). This human induced phenomenon brought imbalance to human life, environment and damaged economy. Karakalpakstan (Uzbekistan) and Kzyl Orda (Kazakhstan) have encountered the most challenges from the desiccation of the lake. However, the construction of the dam in the Northern Aral Sea have positively impacted the Northern Aral Sea and delta of the Syrdarya through a decrease in water salinity and increase in its volume. The number of fish increased and biodiversity is recovering in the Syrdarya delta including the northern Priaralye (Aladin et al. 1995, p.26). This study will shed light on the social impact – health factor. Its long term consequences to the economy were indicated with the help of ‘ecosystem approach.’ As the situation has not improved in Karakalpakstan in comparison to the northern Priaralye, the study focus was set to Karakalpakstan.

3 METHODOLOGY AND DESCRIPTION OF THE RESEARCH AREA

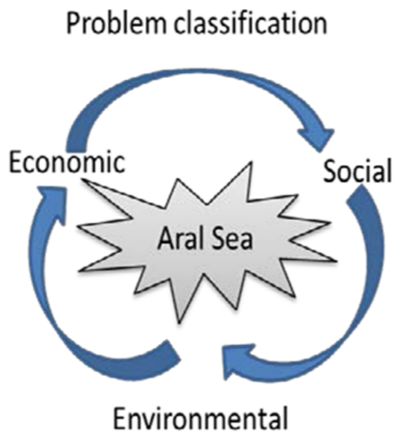
The work is based on a literature survey including different publications, secondary data and national statistics. As it was mentioned earlier, ecosystem approach was applied as well. This method was developed in Canada. “It is goal driven, and is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic and social factors…” in addition to involving the stakeholders in the respective area (Maltby 2000, p.210). Due to focus on KP, the analysis is narrowed to the Republic of Karakalpakstan[1] and does not present Uzbekistan as a whole. Karakalpakstan is located on the northern west of Uzbekistan and tail end of the Amudarya delta (Mamedov 2007). As it is located at the heart of the Aral Sea, changes in the environment (likewise other social and economic effects) were tremendously felt in the region (Ataniyazova 2003, p.1; Micklin 2010, p.203; MSF 2003, p.1).

4 MAIN CONSEQUENCES OF THE ARAL SEA DESICCATION

The overall aftermath of the Aral Sea shrinking could be classified into 3 groups: environmental, social and economic (Figure 1) and they will be summarized in the below provided scheme (Table 1).

Figure 1. Problem classification

[1] The population of Karakalpakstan was estimated to be over 1,6 million people in 2011 (CAWATER). 33% of the population is involved in agriculture, whereas the rest is engaged in other sectors (StatUz 2009). According to Stulina and Poltareva (GWANET 2008, p.3), the share of the unemployed was double with relation to Uzbekistan.



Source: Own illustration

Table 1. General consequences of the desiccation

Economic	Environmental	Social
Unemployment Loss of human capital Low production due to degraded soil and less fish Environmental degradation leading to economic losses owing to Climate change (drought, decline in precipitation, change in the seasons)	High salinity in water and soil Salt/dust storms Desertification Loss of biodiversity Decreasing soil fertility Water, air, soil contamination	Spread of illnesses/poor health Polluted environment to live around Malnutrition Migration

Source: Own presentation based on literature review

The three: economic, social and environmental aspects are pillars of the sustainable development. These three should be in balance, otherwise, chain of issues arise. All the aspects are interlinked, therewith affecting one another with either positive or negative spillovers.

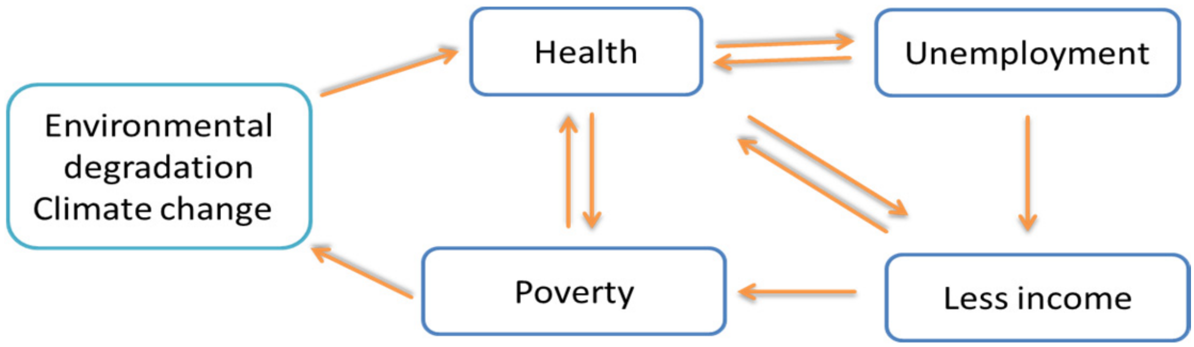
One of the long term effects of the disaster is poverty. The ADB indicates 50-70% of inhabitants of Karakalpakstan to be poor and from that 20% are severely poor (EJF 2005, p.29). Karakalpakstan has the lowest HDI among other regions in Uzbekistan (INTAS 2001, p.26). The livelihood of people in the region (KP) has been affected through unemployment. In fact, up to 60 thousand people have lost their jobs (income generation) and some companies working in the region have shut down due to worsened (environmental) conditions including freshwater deprivation (Ataniyazova 2003, p.1; Strickman & Porkka 2008, p.111). Unemployment peaks in the region. Moreover, wage was lower (1,3%) for nearly one decade from 1995 till 2004 in comparison to other regions of Uzbekistan and from that point on the amount of money for pension has been reduced.[2] Low payment (in addition to unemployment and production level) has contributed to low standards of living, because people had no sufficient means for basic consumption goods (MSF 2003, INTAS 2001). The living expenditure has been growing faster than the income, making the living expensive (Myagkov 2006). According to a finding of a household survey by the WB (the World Bank), food expenditure made up the largest share – 93% of monthly income (Small & Bunce 2003). Low payment and unemployment have urged many to leave to other regions of the country or abroad (majority go to Russia or Kazakhstan). In fact, highly qualified specialists have left the region (INTAS 2001, p.27; MSF 2003, p.25). The economic loss of human capital was estimated to equal 4,40 million USD per year or in total 55 million USD (INTAS 2001, p.27). Although there were ups and downs in the economy of the region owing to various factors gradually GDP is growing. However, the increasing GDP does not appear to reach the poor, because the proportion of the poor is highly visible, making up around 70% of the population. This could be confirmed through the reduction in per capita food consumption. Inhabitants of KP were observed to consume less food in contrast to Uzbekistan, mostly vegetables, grain and cucurbitaceae. This later leads to deprivation of protein and vitamin which in turn contributes to low energy and people not being able to maintain working life. Detriment estimations from low standards of living as well as high morbidity in the Southern Priaralye indicated to be over 2 mln. USD per year (GWANET 2007, p.3).

5 ECOSYSTEM APPROACH TO HUMAN HEALTH

As health began deteriorating owing to the above mentioned factors, it has in turn created its own causes and consequences which is little hard to distinguish in terms of causality. It could look like this 1) Environmental degradation –> poor health –> less employment opportunities –> less/no income –> less economic growth –>poverty –> environmental degradation, 2) environmental degradation –> unemployment –> less growth –> poverty –> poor health; and 3) Unemployment –> poverty –> environmental degradation –> health issues. This causality was also expressed in Figure 2.

[2] The pension is lower in comparison to Uzbekistan as a whole.

Figure 2. Implications of the Aral Sea desiccation



Source: own presentation

Determination of the link of the health factor changing with environment could be achieved through several methods. One of them is the ecosystem approach. This method keeps 'human being as integral part of the environment' (Forget&Lebel 2001, p.7). One of the main aspects of the ecosystem approach is interdisciplinarity which was not part of the earlier conducted researches (Maltby 2000). The link between environmental health and human health has been missed until today (Baylis 2011; Franz 2007). It could be one of the reasons for the previous research methods to fail to consider the link between ecosystem and health as well as other factors. As it was earlier mentioned, comprehension of the link between environment and human health is a base for sustainable development (Franz 2007). Most of the articles shed light on the causes of the existing issues in the Priaralye. For instance, in 2001 study was conducted by the project CLIMAN (INTAS 2001) concerning socio-economic effects of the desiccation, where the desiccation losses were evaluated in monetary terms. It included all the aspects (social, environmental and economic). For example, the calculation for the sector of economy included loss of fishery, hunting and other environmental sources which have been used to generate income. The project's evaluation was also more focused at the situation at that time (2001) and no long term effects were considered. Up today the focus has been on water management, which is important, however, the healthcare is another issue that needs to be tackled. Franz (2007) has conducted similar (interdisciplinary) study focusing on the relationship of environment and health. But she concentrated on infant mortality, so this study could help to close the gap in understanding the link between these two factors. However, no claim is made that this is the final and complete study that would explicate the relationship perfectly.

Another study which seemed to be interesting was conducted by Crighton et al. (2003) which was based on a survey conducted in KP to learn about the health effect of the Aral Sea disaster. The finding of a study was that people were less concerned about the environmental effects if there was a source of income (from farming or fishing) or had more relatives. Interestingly, people in Kungrad considered that their health was influenced from the environmental issues. They were not content with the place and would be likely to move in case they could not survive (Crighton et al., 2003, p.561). The scientists found the most severe illness in KP to be caused by the environmental degradation, one of the examples is the salt/dust storms to be main catalyst of worsening breathing illnesses including tuberculosis which is fatal and one of the main reasons for high mortality to exist (studies from Franz 2007, Semenza et al. 1998 and

O'Hara 2000 could be an example). Link between the factors could be initiated by the environmental degradation leading to unemployment or health issues (the causality is hard to distinguish). Although here (in case of the effects of the Aral Sea disaster to Karakalpakstan) it could be assumed that environmental degradation left many unemployed due to loss of fishery and hunting opportunities as it was generating significant amount of income in the livelihood of people. This has also certain effects to the health. But this link (environmental degradation –> unemployment/income –> health; environmental degradation –> health –> unemployment/income)[3] with its (direct and indirect) consequences has not been investigated in the region (KP), which could be a suggestion for further studies to be carried out (with the help of a survey or certain model). Theoretically, the longitudinal studies indicated the relationship between unemployment and health to be reverse, as unemployment could influence health and poor health causing joblessness (Gordo 2004, p.8). Moreover, there are factors that would affect and relate/connect both aspects which could be learnt from Jahoda's functional model and Warr's vitamin model (see Gordo 2004). Moreover, the link can be continued with further effects of health issues created by unemployment or vice versa. As both of the above mentioned occurs, the individual receives less/no income that diminishes the nutrition which leads to malnutrition (and poverty) causing other side effects (through loss of self-esteem, stress, anxiety, depression) to health (Gordo 2004, p.32). This link is a vicious circle health deteriorating and affecting to other factors which are on the link (Figure 2). The exploitation of natural resources is the only way for the people who have no job and unable to work because of health reasons. In taking any intervention measures the link has to be considered, otherwise it will continue degrading. In the literatures (reviewed for this work), the link between environmental degradation and health was mentioned, but the long term effects of health and other social implications have not been considered yet.

Depending on the health input, the health output could be different. Health input includes availability of potable water, availability of healthcare services, alimental composition of food and other similar factors which are better provided in the developed countries rather than poor/or developing countries (Weil 2007, p.1265 & p.1268). Some researches scrutinized the long term influence of childhood nourishment and the finding revealed that better diet contributes to enhancement of school completion, IQ, height as well as wage (-health outputs). Other studies have also confirmed the same in addition to health state of the child likewise to play a significant role in the school attendance and later in the wages (Weil 2007, p.1269). The students who were less absent would be more likely to have higher cognitive functioning through receiving better education which can positively affect future employment opportunities. Additionally, when the mortality is enhanced/decreased this could incentivize people to save for retirement, which simultaneously increases investment and <capital (Bloom&Canning 2008, p.1). Capital could lead to increase in capital's marginal product owing to the rise in labour input of healthy workers (Weil 2007, p.1265). Furthermore, better health plays significant role in the external investment and this can be confirmed from the construction project of the Panama Canal where yellow fever made many leave and the project was discontinued (Bloom&Canning 2008, p.8).

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[3] There might be also exogenous factors like political tensions, war and market distortions/failure which may affect the link. But this part was missed in this study as it is not the main objective of this study.

Health enhancement and longevity of the poor are the main purpose of economic development. It is also one of the methods to decrease poverty. The relationship between poverty and health in the long-run are robust. Illnesses are the outcome and not the cause of the existing issues (Weil 2007, p. 1265). Health is positively associated with income, for instance, high level of income encourages more healthy living through accessing secure potable water and sanitation including the ability to buy improved health care.

Some of the studies conducted led to a conclusion that health could be enhanced with interventions not having the income raised (Bloom&Canning 2008, p.3). Besides, factors like education can also affect health and health reversely can influence education through malnutrition and diseases where children are unable to attend classes or even if attend not able to receive better lesson having concentration problems (owing to lack of vitamin A, which is also causes 'pediatric blindness') and etc. (Bloom&Canning 2008, p.6). Girls are affected by iron insufficiency anemia and iodine insufficiency which becomes worse with menstruation. Poor health hinders the capacity to save and willingness to save. Moreover, it contributes to decrease in the present and collected household saving with the expenses for healthcare as the household might have to sell the household property which in turn contributes to poverty (p.7). Observing the direct impact of health on economic growth is another option to relate to. Here as well the issue of causality arises, but Bloom and Canning (2008, p.13) considers this not to be an issue with taking into account timing. Health seems to impact on economic growth mostly in the developing countries rather than developed ones (2008, p.13). This was statistically confirmed by one of the studies with positive and significant correlation (Bloom et al.2003, p.5) and finding of many studies indicated one year of life expectancy to raise the percentage of outcome by 4 (Bloom et al.2003, p.5; Weil 2007, p. 1271). Certainly, the health enhancement might decrease the per capita income, but the intervention measures to improve health should not be halted. Because with the promotion of family planning, healthcare services and decreased mortality the population growth is slowed down. This could be achieved through policies and giving incentives for people to have few children (Ashraf et al.2008, p.27). The above mentioned was conclusion from many studies which confirmed the effect of poor health on economic development which is also applicable to the case of Karakalpakstan. As Karakalpakstan also encounters the similar issue, where people's health is deteriorating and the further consequences (to economic growth) have not yet been considered. As it was mentioned, the health input determines the output. Hence, for better health output (productivity, workforce) the health inputs (at least healthcare services) have to be improved. At the onset, the health implications (unemployment or less productivity) are felt on the individual level, but in the long term its effects are significant for the economy of the respective region as it contributes to the decrease in income generation (Freeman 2003). Therefore, the side effects of health issues in case ignored could trigger further problems in the long run. This study could be a little reminder that some actions are needed to be taken to prevent further (unexpected and unwanted) implications and it could enable understanding the relationship between various factors (Figure 2) which could help to take the proper measures. Certainly it is hard to solve all the issues at once, as they have taken long time to develop, but at least some mitigation/moderation actions could be taken.

6 SUMMARY

This study has shed light on the socio-economic effects of the Aral Sea desiccation. The economy gradually deteriorated as the lake was a major agent for prosperity of the economy with fishery, resort area, enabling navigation and hunting opportunities at Priaralye. Gradually unemployment with its side effects (malnutrition, low standards of living) has increased. The earlier conducted researches have failed to link various factors and their further effects that could/would occur were missed. Most of the literature neither national nor international has given a thought to the further implications and no moderation actions are taken. The link/relationship and interaction between these three factors (environmental, economic and social-health) is of great significance in taking intervention measures. One of the methods to understand the relationship is 'ecosystem approach.' It is an interdisciplinary approach that has advantages in comparison to classical research methods with its interdisciplinarity and stakeholder involvement in handling the issues in the respective area. This link has been missed in the case of Aral Sea disaster. Hence, this study may help to comprehend this relationship. Moreover, the study was considered from the perspective of health and further implications of health (including hindering aspects for the economic growth and development). The healthy people can contribute to income generation and population growth could gradually decrease, as people have incentive for future perspectives when the health is in good condition. Hence, the link and relationship between these factors (environmental degradation –> unemployment/income –> health; environmental degradation –> health –> unemployment/income) has to be taken into account. The projects working in the region failed to address this, hence condition continues to worsen. Up today interaction of these factors have not been studied particularly in the Aral Sea region. Maybe it is one of the reasons for being unable to take the right mitigation actions. Following the guidelines from the ecosystem approach the case of KP could be investigated further, this would be a suggestion for further and precise research.

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REFERENCES:

Aladin N., Micklin P., Plotnikov I., Keyser D., Piriulin D., Smurov A., Cretaux J.- F., Egorov A., Ballatore T., Karimov B., Ermakhanov Z. and Boroffka N. 2006. Biodiversity of the Aral Sea and possible ways of rehabilitating and conserving its remnant water bodies. Extreme hydrological events in Aral and Caspian Sea region. The proceedings of International Scientific Conference.Moscow

Aladin N., Plotnikov I., Ballatore T. & Micklin P. 2008b. Biodiversity loss in a saline lake ecosystem: Effects of introduced species and salinization in the Aral Sea. In: Japan International Cooperation Agency: Study Reports: Country and Regional Study Reports: Central Asia and Caucasus. Vol.4. Retrieved from http://www.zin.ru/labs/brackish/pdfs/Biodiversity_loss_in_a_saline_lake_ecosyst em.pdf

Aladin N., Plotnikov I.Micklin P. & Ballotore T. 2009. Aral Sea: Water level, salinity and long-term changes in biological communities of an endangered ecosystem-past, present and future. Natural Resources and Environmental Issues: Vol. 15, Article 36. Available at: http://digitalcommons. usu.edu/nrei/vol15/iss1/36

Aladin N.V., Plotnikov I.S. & Potts W.T.W. 1995. The Aral Sea desiccation and possible ways of rehabilitating and conserving its northern part. Environmetrics. Vol.6: 17 – 29. John Wiley & Sons Ltd.

Ashraf Q.H., Lester A. AND Weil D.N. 2008. When does improving health raise GDP? NBER Working Paper Series. Working Paper 14449. Cambridge.

Ataniyazova O. 2003. Health and Ecological Consequences of the Aral Sea crisis. Prepared for 'the 3d World Water Forum Regional Cooperation. In Shared Water Resources in Central Asia.' Kyoto, Japan March 18 2003

Baylis D.L. 2011. Environmental (Degradation and Uncertain) Security: Rectifying the Conditions for Social and Environmental Degradation in Uzbekistan. The Arab World Geographer / Le Géographe du monde arabe Vol 14, no 3 (2011) 259-281. AWG Publishing, Toronto Canada.

Bloom D. and Canning D. 2008. Population health and economic growth. Working paper No.24. The International Bank for Reconstruction and Development/The World Bank

Breckle S.-W. & W. Wucherer. 2011. Hat der Aralsee eine Zukunft, 210 – 219. (in German)

Crighton E.J., Elliot S.J., Meer J. V.D., Small I. and Upshur R. 2003. Impacts of an environmental disaster on psychosocial health and well-being in Karakalpakstan. Social Science & Medicine 56: 551-567

EJF. 2005. White Gold: the true cost of cotton. Environmental Justice Foundation, London, UK. Last accessed on 01.02.2012 from http://www.ejfoundation.org/pdf/white_gold_the_true_cost_of_cotton.pdf

Forget G. and Lebel J. 2001. An ecosystem approach to human health. International journal of occupational and environmental health. Vol.7, No.2.

Franz J.S. 2007. Environment and health in Central Asia: Quantifying the determinants of child survival. Dissertation. University of St. Andrews. United Kingdom.

Freeman M.A. 2003. The measurement of environmental and resource values. Theory and methods. Second Edition. Resources for the future. RFF Pressbook. Washington DC. USA.

Gordo L. 2004. Unemployment and health: An analysis by means of better data and improved methodology. PhD dissertation. Technical University of Berlin

GWANET/Newsletter of GWANET Network No.2. 2007. Report on visiting the Urgench city to meet with stakeholders and hold workshop "Gender Aspects of Water Management in the Lowlands of Amudarya and Syrdarya" within the framework of the ADB project "GWANET – Gender and Water Network in Central Asia."

GWANET/Newspaper of GWANET Network No.4 (11): "Gender and Water in Central Asia" from Seminar, Almaty. April 3, 2008.

INTAS. 2001. Evaluation of socio-economic effects of the environmental catastrophe – desiccation of the Aral Sea (in Russian). Project INTAS- RFFI- 1733. Concluding report on Southern Aral. Vienna, Moscow, Tashkent. August 2001.

Kapuscinski R. (1994): Imperium. Granta Books, London, 254 – 264

Kulmatov R. and Soliev I. (2009): The Crisis of Aral Sea and Health of the Population in the Disaster Zone. Paper submitted from the 13th World Lakes Conference by the International Lake Environment Committee, China.

Maltby E. 2000. Ecosystem approach: from principle to practice. cosystem Service and Sustainable Watershed Management in North China International Conference, Beijing, P.R. China, August 23 - 25, 2000

Mamedov N. 2007. Karakalpak Literature. [Karakalpakskaya Literature]. Baku. Mutardjim.

Martius C., Lamers J., Ibrakhimov M. and Vlek P. 2004. Towards a sustainable use of natural resources in the Aral Sea Basin. Paper for STE-ICG Summer School “Water and Sustainable Development”

Micklin, P. 2010. The past, present, and future Aral Sea. Lakes and Reservoirs: Research and Management 15(3): 193-213.

MSF. 2003. The impact of the Aral Sea disaster and a worsening economic climate on the health and wellbeing of the people of Karakalpakstan. p 1-31

Myagkov S. 2006. Desertification in the near Aral Sea region and population migration. Viewed from http://www.sidym2006.com/imagenes/pdf/ponencias/9_s2.pdf

O'Hara, S.L., Wiggs, G., Mamedov, B., Davidson, G., Hubbard, R.B. "Exposure to airborne dust contaminated with pesticide in the Aral Sea Region." The Lancet 355 (2000): 627-28.

Roll G., Alexeeva N., Aladin N., Sokolov V. & Sarsembekov T. 2003. The Aral Sea Management Experience and Lessons Learned. Retrieved from http://www.worldlakes.org/uploads/Aral_Sea_15Jun03.pdf [07-08-2012]

Semenza J., Roberts L., Henderson A., Bogan J. & Rubin C.H. 1998. The American Society of Tropical Medicine and Hygiene 59 (6). pp. 941 – 946.

Small I. and Bunce N. 2003. The Aral Sea Disaster and the Disaster of International Assistance. Journal of International Affairs. Volume: 56. Issue: 2. P. 59+. Copyright 2003 Columbia University School of International Public Affairs; Copyright 2003 Gale Group [online library source]

Strickman R. & Porkka M. 2008. Water and Social Changes in Central Asia: Problems Related to Cotton Production in Uzbekistan. In Rahaman, M. and O. Varis (eds.). Central Asian Waters. Social, economic, environmental and governance puzzle. Helsinki: Water and Development Publications - Helsinki University of Technology.

Weil D. 2007. Accounting for the effect of health on economic growth. The Quarterly Journal of Economics

Wish-Wilson P. (2002): The Aral Sea environmental health crisis. Journal of Rural and Remote Environmental Health 1 (2): 29 – 34

ZHAMILIA SYDYGALIEVA

CAUSES AND IMPACT OF MIGRATION ON ECONOMIC DEVELOPMENT OF KYRGYZSTAN

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1 INTRODUCTION

Kyrgyzstan is one of the poorest Central Asian countries with lack of decent natural resources, political stability and an increasing number of (out)migration. The first steps of transition from planned economy to open market economy had severely affected the country living through three massive (out)migration flows, economic stagnation, increasing poverty rate, food insecurity and other social distracts of ethnic groups. For the past twenty years a large number of persons had emigrated/immigrated either permanently or on a temporary basis. Due to various interrelated factors, migration (specifically labour migration) is an escalated phenomena for the Kyrgyz population. According to the official statistics, approximately 600.000 of Kyrgyz citizens are in labour migration. However, due to geopolitical factors, irregular migration had been taking pace with current number of illegal migrants in Russia constitute nearly 500.000 people. For a country with 5.4 million people, migrants constitute approximately 20% from the total population is a dreadful number. The main recipient countries are Kazakhstan and Russia. The growing illegal migration with scaring numbers and other non-economic factors puts the migrants in potential risk zone.

The main goal of the work is to identify the migration process from Kyrgyzstan to Russia, the factors that result in migration, the pattern and behavior of migration. As the phenomenon of migration is growing, it attracts more attention from the side of research and development, although, the area is still understudied lacking in sound and reliable data. Study of the various migration theories and models help identifying the behavior of migration which in return identifies the steps that need to be taken towards the development in the given sphere.

The methodology used in the given work is study of quantitative data and assessment of qualitative data obtained through analysis of various surveys, public opinion, opinion of experts in both sending and receiving countries. As the migration process involves massive movement of population, it is important to involve them into analysis. The overall process from initializing to causes and implications of the migration is the key factor that can be used for regulation of migration drawbacks.

Economic reasons are the main cause for the (out-)migration from Kyrgyzstan and include both, push and pull factors. The push factors refer to the domestic situation of the sending country while the pull factors explain incentives from the perspective of the receiving country. The dual labour market theory developed by PIORE (MASSEY, et al. 1993, p.440) argues that the international migration is not caused by the push factors of the sending country, but by the pull factors of the receiving country as a result of the economic development and permanent need in labour. According to PIORE there are four fundamental driving sources for the demand of foreign labour at the advanced (receiving) country: 1) structural inflation, 2) motivational problems, 3) economic dualism, and 4) the demography of labour supply.

2 PUSH FACTORS WITHIN KYRGYZSTAN

Unemployment: According to the Kyrgyz Republic National Statistical Committee Report for 2009, the total number of unemployed consisted of 203.7 thousand people with 50.8% of men and 49.2% women out of which 43% are the population between 16-28 years. The total urban unemployment compiled 10.4% and rural unemployment 7.3% (NSCR, 2009). However, given numbers are compiled from the legally registered people. According to unofficial data, unemployment rate in Kyrgyzstan is as high as 20% out of the total population. The annual inflow of unemployed persons compiles 100 persons. Out of total unemployment, 80% of unemployed are the rural inhabitants most of whom probably reside in the capital city. The blame is not only on the drawbacks of the legislation such as political destabilization, ineffectiveness or absence of anti-crisis measures, weak governance of the internal economic resources, but also failure to develop the rural area. (SHAMSHIDINOVA, 2011).

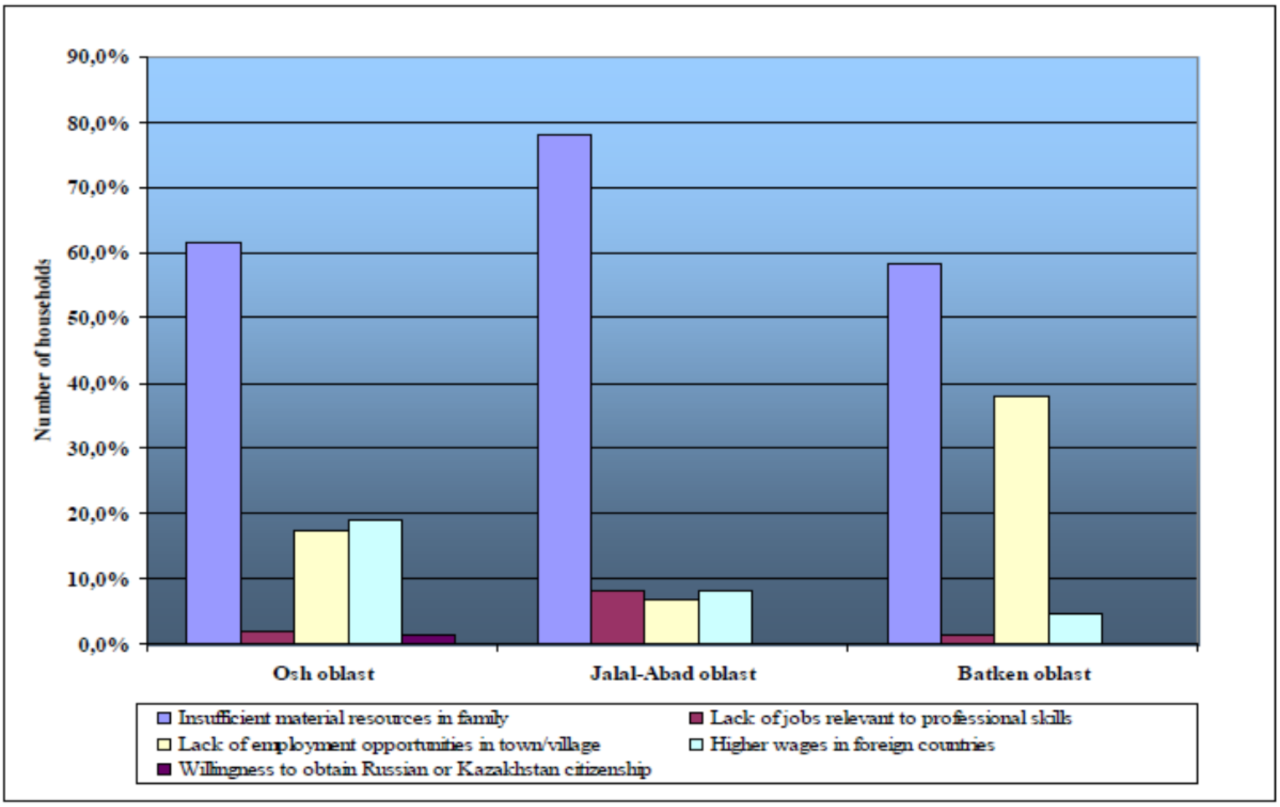
Low wages: According to the Kyrgyz Republic National Statistics Committee, the average monthly salary compiles 6870 KGS, however in 2011 the Ministry of Finance states that the monthly nominal wage has been increased to 8498 KGS (183.5 USD). The minimal salary is 600 KGS and the cost of living compiled 4286 KGS which means the average salary exceeds the cost of living twice (MINISTRY OF FINANCE KR, 2012).

Political instability: political instability is not only the cause for labour migration, but immigration in general. The tulip revolutions in 2005 and 2010 following with June 2010 ethnic clashes had severely affected the economy of the state. The local businessmen and merchants had severely suffered from looting during the riots. Those who can afford, move within or beyond the country for a more stable and prosperous life.

Education: the deteriorating education system influences on migration especially among the youth. Kyrgyzstan has 52 higher educational institutions (considering a little over 5 million people) that provide more social sciences than applied subjects. Over 200 000 students study economics, politics, law, diplomacy, international relations and only 11 000 are enrolled in technical departments. After the graduation, thousands of students have severe troubles with finding jobs (MARAT, 2009, p. 15).

The qualitative overview and quantitative survey conducted by OSCE, ACTED and European Commission identified the main reasons for migration in the southern region of Kyrgyzstan (see Figure 1). The survey showed that the major reason for migration is related to the economic situation in the family that pushes the family member outside the country.

Figure 1: Causes of migration per regions



Source: OSCE, ACTED, 2009, p.66

3 PULL FACTORS FROM RUSSIA

Kyrgyzstan is considered as one of the main provider of labour migrants to Russia. According to the official statistics, estimates vary between 350 000 to 400 000 legal migrants residing in Russia. Since there is a visa-free entry to Russia, the illegal migration unofficially is estimated up to 1 million of Kyrgyz citizens. Mostly migrants are employed in construction, import-export, service and agriculture.

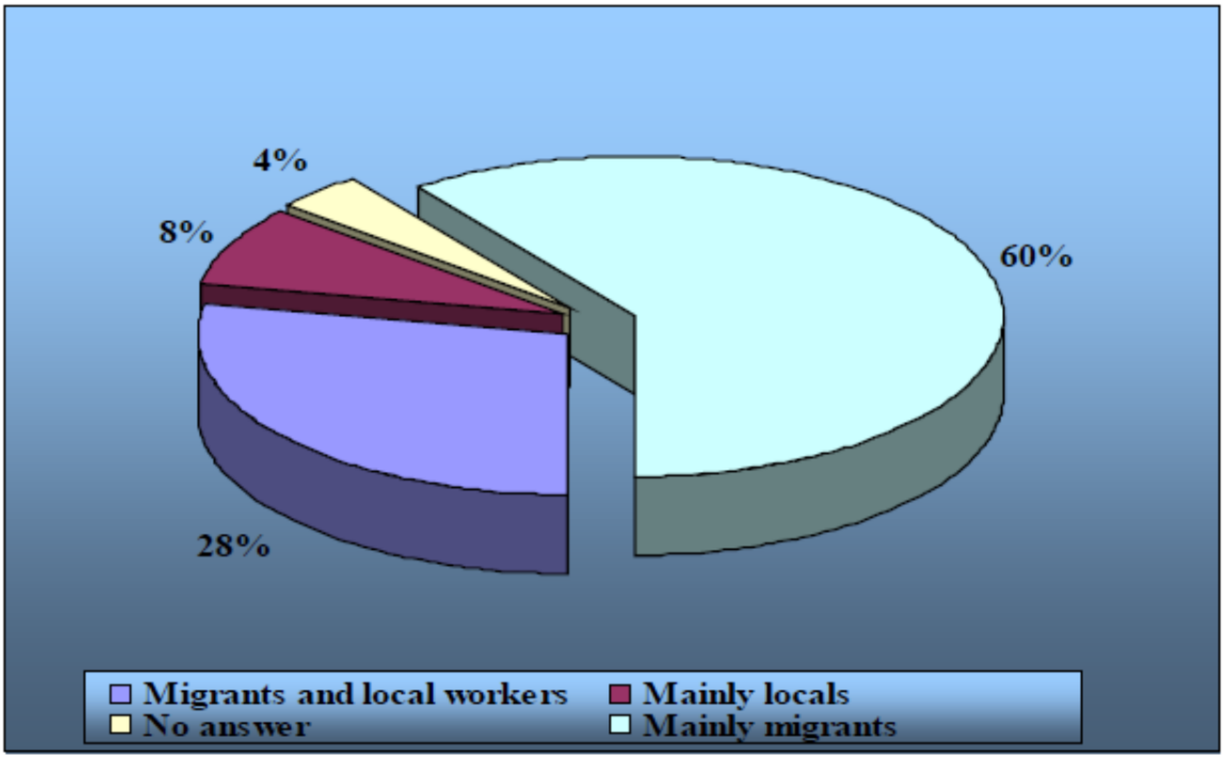
DEMAND FOR LABOUR IN RECEIVING COUNTRY:

Having a shrinking population with less labour capable society, the domestic public and private capital may decline over time without having attraction of human resources from outside. According to the Deputy Head of Federal Migration Service of Russian Federation, the current population of 142.9 million is holding only due to migrants, assumed that without migrants, nowadays the population of the Russian Federation would already constitute 135.4 million. Also the estimation of the production of goods and services by migrants composed 2 trillion Russian rubles (RUB), contributing 10% of total GDP (estimations for 10 months of year 2011).

As the number of irregular migration grows year by year, at the country of destination, in order to keep the livelihood and have an income, irregular migrants are usually employed in shadow economy. The problem is not only in willingness of migrant work to work for low wages, but it is also maximal utilization for the businessmen and contractors in the receiving countries. Since migrants are mostly employed in secondary labour intensive sector, the beneficiaries from the illegal migrants' work force are either the agencies hiring groups of migrants and taking the role of intermediaries or those who deal with migrants directly, people involved mainly involved in construction, service and agriculture.

Structural Inflation: The general myth regarding the migrants is that migrants take over the labour market by contributing to unemployment for the local population. However, over time there had already been created "migrant" sectors where the colleagues and surrounding population are migrants. (IOM, 2006) The survey conducted by IOM estimated that 8% of migrants work among the local population, 60% are employed in "migrant" sector and approximately 30% work in mixed sector.

Figure 2: Integration of migrants into Russian labour market



Source: IOM, 2006

Motivational problem: Some experts state that the native population of Russia has no interest in working on low paid jobs and in rural areas the high rate of alcohol abuse reduces the employment capability of the population (GORST, 2011).

Economic dualism: since the migrants are mostly employed in labour intensive sector, where labour is a variable factor, theoretically it is influenced by the capital, which stands as a fixed factor. According to some experts, for the contractors, migrants are a better solution rather than hiring a native worker due to several factors. The contractors are interested in hiring migrants illegally in order to avoid transaction costs and increase own profit. Approximately 20% of surveyed migrants are provided with food, 37% with housing, 12% have access to medical services. The experts state that such practice is implemented in order to isolate the workers and make them fully dependent on the contractor. For contractors shadow employment is a source of saving on salaries for migrant workers and taxes to the government.

Demography of labour supply: The survey conducted among women migrants identified that most of these women are divorced or had been abandoned by their husbands-migrants (the survey identified the growing tendency of husbands-migrants building a new family in the receiving country and leaving the families behind). And women decide to become migrant workers as for the same job they would get paid much higher than in home countries. It had been identified that women mostly use networks and connections with other migrants in search of a job, as many as 64% of women rely on informal connections. The survey identified that women usually are treated worse than men, 14% of women are deceived by the contractors and don't get paid and 20% of women migrants are paid less than stated in the contract (SHEVCHENKO, 2011). On the other hand, often women willingly accept oral agreement with contractors despite the high risk of not being paid, by this putting themselves at the risk of being deceived. The following table 1 shows the difference in wage of legal and illegal contracts.

Table 1: Average monthly wage based on the type of agreement with contractors (RUB)

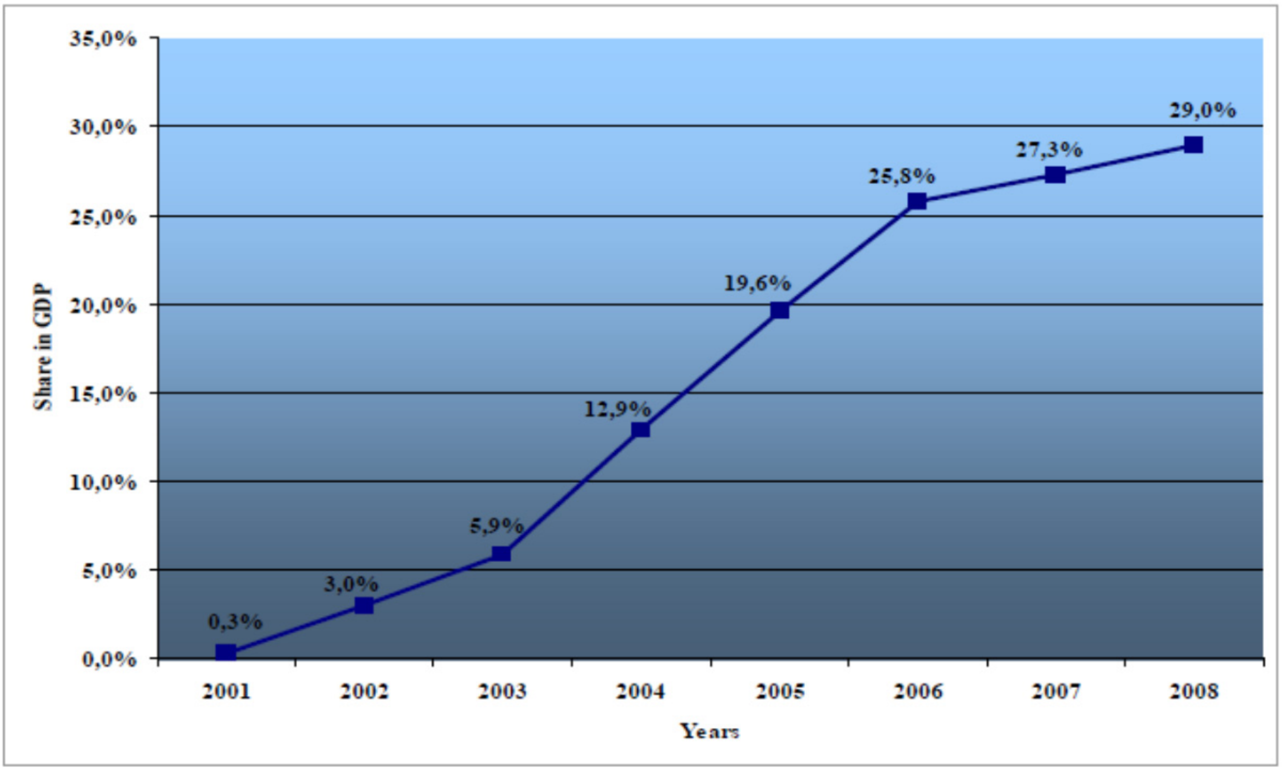
	Agreement signed with Contractor	Work permit for legal employment
Yes	14304	13710
No	15151	14982
Mean Value	14638	

Source: TYURYUKANOVA, 2011, p.33.

4 IMPACT OF LABOUR MIGRATION ON THE ECONOMIC DEVELOPMENT OF KYRGYZSTAN

Although the evidence on direct impact of remittances on economic growth and development is limited, certain assumptions can be made after analysis of certain sources and evidences. Most significant influence of the remittances is observed on the share of the national GDP. In 2008 the total amount of remittances reached 29% of the national GDP (see figure 3). Besides, the currency inflow from the remittances wired to the country has contributed to strengthening of the Kyrgyz currency. It should be taken into consideration that, here the remittances shown are the ones transmitted through formal channels. Unfortunately there is no specific data on remittances transmitted through informal channels or in kind, although World Bank Report on Remittances state that 22.2% of migrant workers transmit the remittances through friends and 1.4% bring the remittances when visiting the family (WORLD BANK, 2009).

Figure 3: Share of migrant remittances in Kyrgyz GDP (%)



Source: NATIONAL BANK OF THE KYRGYZ REPUBLIC, National Committee of KR

According to the National Statistical Committee of Kyrgyz Republic, the amount of remittances transferred only from Russia compiled to 1 billion 35 million USD in 2010. The drop in 2009 was due to the global economic crisis.

5 FURTHER ASPECTS OF MIGRATION AND ITS IMPACT ON KYRGYZ DEVELOPMENT

Although the economic factors dominate the migration trend in Kyrgyzstan, there are also other aspects which need to be mentioned such as modern slavery and brain drain, apart from which are possible costs and externalities from the irregular migration (MANSOOR/ QUILLIN, 2006, p.16):

- Income earned by illegal immigrants is not taxable
- Illegal workers offer unfair competitive advantage to firms that employ them
- Irregular migrants are not covered by a minimum wage or national wage agreements that causes a possibility of undercutting the wages for the low skilled
- Quality of migrants: skilled workers are more likely to enter through a legal channel whereas illegal migrants being low qualified may not have access through legal channels
- Health and safety regulations may not be the responsibility of the employers, (potential for migrant death or injury)

- Illegal migrants are not screened for diseases and viruses and during the stay have little or no access to healthcare, which could lead to public health externalities (spreading diseases among the local population)
- Little access to legitimate employment, poor living conditions, potentially exposed to the world of crime
- Irregular duration of stay whether employed or not.

6 INTERMEDIATE CONCLUSION

In general it is considered that with the appropriate measurement instruments and regulations, migration can create a win-win situation for both sending and receiving countries. Western experts identified through cost-benefit analysis that the overall benefit from liberalization of the migration regime is 25 times more effective than liberalization of the international and financial flows (IOM, 2005).

In case of Kyrgyzstan, labour migration has both positive and negative impacts. In terms of economic aspect, remittances are positive and the remittances contribute to the economic wellbeing of remittance receiving households and compose a feasible share of GDP. Knowledge and skills obtained during work can be implied in home country. Out migration also can influence the easement of the internal labour market.

Based on PIORE'S dualism theory, the behaviour of labour migration of Kyrgyzstan can be explained as following:

- international labour migration is largely demand-based and is initiated by recruitment of the receiving country in developed society
- since the demand for migrant labour force grows out of the structural needs of the economy, it is expressed through recruitment practices rather than wage offers, however, in the case of Kyrgyzstan, remittance play an inevitable role for the social and economic condition of Kyrgyzstan
- the low wages do not shift as they are held down by the contractors (not necessarily state)
- low-level wages may fall in case there is an increase in migrant workers (especially in the growing number of irregular migration)
- government policies do not necessarily influence the flow of migration unless there is a close collaboration and ongoing and extensive work applied in regulation.

One single model seems not to be applicable to the case of Kyrgyzstan labour migration as remittances play inevitable role for the macroeconomic development of the remittance receiving country. It is not only positively affects the economy, but also improves the living standard of the remittance receiving households, by which contributes to poverty reduction.

7 CONCLUSION

In a nutshell, the findings and analysis came to the conclusion that:

- international labour migration is largely demand-based and is initiated by recruitment of the receiving country in developed society
- since the demand for migrant labour force grows out of the structural needs of the economy, it is expressed through recruitment practices rather than wage offers, however, in the case of Kyrgyzstan, remittances play an inevitable role for the social and economic condition of Kyrgyzstan
- the low wages do not shift as they are held down by the contractors (not necessarily state)
- low-level wages may fall in case there is an increase in migrant workers (especially in the growing number of irregular migration)
- government policies do not necessarily influence the flow of migration unless there is a close collaboration and ongoing and extensive work applied in regulation.

In such a tangled and complex situation, the involvement of the state as well as second and third parties (NGOs, international community, diasporas in Russia, community leaders) is needed. As there is little attention paid by the government, the migrants lack not only professional knowledge, but also knowledge of their rights, cultural knowledge and norms of behaviour. The paper identified that illegal migration can never be eliminated, but it could be minimized as much as possible for the sake of legal migration.

REFERENCES

GORST, I. (2011): Russia's migrants living on the edge. In: http://www.ft.com/intl/cms/s/2/0d1569a0-2607-11e1-856e-00144feabdc0.html#axzz1ou5sYt9X (05.02.2012)

IOM (2005): World Migration: Costs and Benefits of International Migration. IOM. 2005, p. 164.

MANSOOR, A., QUILLIN, B. (2006): Remittances: Eastern Europe and the Former Soviet Union, the World Bank, pp.6-21

MARAT, E. (2009): Labour Migration in Central Asia: Implications of the Global Economic Crisis, Silk Road Paper, pp. 14-47

MASSEY, D.S., ARANGO, J., HUGO, G., KOUAOUCI, A., PELLEGRINO, A., and TAYLOR,

J.E. (1993): Theories of International Migration: A review and appraisal. In: Population and Development Review, 20(4), p.669-751

MF KYRGYZSTAN (2012): Outcomes of socio-economic development of KR for 2011 (Informatsiya ob itogah sotsial'no-economicheskogo razvitiya KR za 2011 god). Ministry of Finance. In: http://www.minfin.kg/index.php?option=com_content&view=article&id=990:2011-&catid=56:2010-10-05-10-28-02&Itemid=126 (29.01.2012)

SHAMSHIDINOVA, DPI (2011): Unemployment – symptom of illness known as “weakness of local self-governance” (Bezrabotitsa-eto symptom bolezni pod nazvaniem “slabost’ mestnogosamoupravleniya”). Development Policy Institute In: http://www.dpi.kg/ru/news/110418/95 (20.12.2011)

SHEVCHENKO, D. (2011): Married to migration (Zamujem za migratsiei). Demoscope Weekly, No. 475-476. In: http://demoscope.ru/weekly/2011/0475/gazeta024.php (12.01.2012)

WORLD BANK (2012): Kyrgyzstan, Quick facts. In http://go.worldbank.org/DH8AS06NL0 (12.01.2012)

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ENVIRONMENTALLY INDUCED MIGRATION AND DISPLACEMENT IN KAZAKHSTAN

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1 PROBLEM STATEMENT

In 2011 Kazakhstan officially recognized environmentally induced displacement of population by inclusion into the Law on Migration[1] a term "a displace" defined as *"a person displaced within the Republic of Kazakhstan in accordance with the displacement quota for internal migrants from settlements with adverse environmental conditions and a low development capacity to economically perspective areas of the Republic of Kazakhstan for permanent residence"*. In the country with few hot environmental spots in the past such as the Aral Sea region and surroundings of the Semipalatinsk nuclear testing site, environmentally induced migration is a familiar phenomenon. However, since those times environmental migration or displacement has not been thoroughly approached in Kazakhstan either in academic researches or normative regulations. The attempt of the Law On Migration 2011 to regulate environmental displacement of population has been the first one in this context. The researchers and experts[2] point to absence of methodology to identify ecological migrants and their needs and lack of relevant data to explain environmental roots, including indirect ones, of migration outflows as main obstacles to start implementing this norm.

In international practice and law the issues of recognition of enforced migration taking place due to unpleasable environmental situation have emerged around 20 years ago. Initially they were mostly connected to providing humanitarian aid to individuals affected by extreme weather events such as earthquakes, floods, tsunami etc. However, nowadays more acute and explicit consequences of climate change, an increasing number of natural disasters and ecological degradation of human habitats increase the relevance level of environmental migration of affected population. Often such people lose their traditional sources of income due to degraded lands, polluted waters or declining biodiversity, what closely links deterioration of a natural environment with impoverishment of local communities. In this regard, concerns of scholars and decision makers should lay in elaborating or adopting methodological tools to identify such people and their needs, determining a status of relevant human migration flows and introducing an environmental consideration within the migration management mechanism.

In the Central Asia region there was an example when ecological disaster caused massive outmigration. The degradation of the whole ecosystem occurred due to the Aral Sea's insiccation considerably affected structure and volume of migration out-flows from the region. It is generally

1 Law №477-IV signed by the President of the Republic of Kazakhstan on the 22nd of July 2011

2 Including: Buleshova and Joldasov, Environmental Change and Forced Migration Scenarios (EACH-FOR): Policy Brief – Kazakhstan, 2009 (available at http://www.each-for.eu/documents/D_2243_PB_Kazakhstan.pdf); Ilyasova, Nee and Tonkobayeva, Environmental migration and its consequences for the social policy based on the example of Kyzylorda Oblast (working report), UNESCO – Almaty, 2013.

acknowledged that environmental degradation of this region negatively influenced traditional employment opportunities and living standards of local communities, and also affected health of the population, predominantly – women and children. At the same time, there was, and still is, lack of information needed to determine scales, causes and other characteristics of migration processes in the region recognized as an ecological disaster zone[3]. Meanwhile, the experience of studying environmental migration in the Aral Sea region can provide a framework for exploration of environmental roots of migration flows in other regions of Kazakhstan.

Since its introduction into the Law On Migration in 2011 "the displacement quota for internal migrants", which means organized displacement of citizens' families from places with environmentally adverse conditions to economically perspective settlements granting a status of a displacee, have never been applied yet. Researchers maintain that there are still lots of questions regarding how the quota should be calculated and put into practice, for which settlements and regions, who and on what basis can enjoy this right.

In this research paper the author takes stock of existing theoretical frameworks, precedents in international law and practice engaged within migration – environment bond. The author makes attempt to apply one of the frameworks, Sustainable Livelihoods framework, to Kazakhstan. For this reason, data on demography, migration, income distribution, heath and state of environmental components are gathered and analysed for two regions of Kazakhstan - Kyzylorda Oblast and East Kazakhstan Oblast. The Kyzylorda Oblast represents the Aral Sea disaster zone where traditional lifestyle of local communities was nearly destroyed by the ecological crisis. The East Kazakhstan Oblast partly embraces the territory of the former Semipalatinsk nuclear testing site; however, presence of employment-providing industrial enterprises, as well as natural massifs keep the region quite attractive for residing.

2 RESEARCH QUESTIONS

- Does environmental consideration effect migration propensity of population in ecologically affected territories in Kazakhstan?
- What are the needs of those who migrate based on environmental consideration and those who stay in affected areas to be taken into account while shaping a migration policy?
- What possibilities do exist in practice and what arrangements are needed to ensure considering an environmental dimension within migration management?

2 METHODOLOGICAL APPROACH

To answer the research questions the author utilizes the pragmatic approach involving: literature review, expert opinion review, statistical assessment of data gathered for the time series 1999 – 2012 and earlier, and developing a theory suitable to explain all the quantity and quality data

[3] As stipulated from the Law №1468-XII signed by the President of the Republic of Kazakhstan on the 30th of June 1992.

collected. The research is conducted along the Sustainable Livelihoods conceptual framework considering access to natural capital together with financial, physical, human, and social capital as determinants of a household's livelihood strategy[4]. The list of reviewed literature includes academic articles, documents of international and national legislation and expert researches on migration issues conducted for international organizations in Kazakhstan. In order to gather competent opinions on the issues of environmental migration and displacement in Kazakhstan, the author interviews experts involved in the public discussions on migration issues. The statistical assessment is conducted to prove correlations between variables representing demographic, economic, social and environment tendencies. By means of data and methodology triangulation, the author constructs a theory interlinking all the findings.

3 DISCUSSION OF RESULTS/EXPECTED RESULTS

It is expected that application of the Sustainable Livelihoods framework to two Kazakhstan regions will demonstrate how environmental dimension interplays with other factors causing outmigration from ecologically damaged areas. Statistical analysis will expose correlations between variables representing tendencies in demography, income distribution, health of population and environment in two selected regions of Kazakhstan. The study will make an input to exploring and justifying the phenomenon of environmental migration in Kazakhstan. The outputs and outcomes of the survey might be useful for policy discussions of not only an effective migration management but also adaptation strategies to the changing climate in Kazakhstan.

4 De Sherbinin et al. Rural household demographics, livelihoods and the environment. Global Environmental Change – 2008 (available at www.ncbi.nlm.nih.gov/pmc/articles/PMC2351958/); Carney et al. Livelihoods approaches compared. Department of International Development (DFID, UK), 1999 (available at: http://www.start.org/ Program/ advanced_institute3_web /p3_ documents _folder/ Carney_etal.pdf)

Bisherige Veröffentlichungen in der Discussion-Papers-Reihe

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(erschienen in: "List-Forum für Wirtschafts- und Finanzpolitik", Bd. 27(2001), H. 1, S. 1-21.)

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(erschienen in: Wu et al. (eds) Flood Defence '2002, Beijing, New York 2002, pp. 802-808.)

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