Adaptation to Climate Change in Central Asia

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15th SCM of the CGIAR Regional Program for Central Asia and Caucasus

September 4, 2012

Adaptation to Climate Change in Central Asia and People's Republic of China

- **Funded** by the Asian Development Bank
- **Project duration**: December 2009 – December 2011
- **Participants**:
  - Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, *China*
  - ICARDA, IFPRI
- **Coordinator:** Dr. Aden Aw-Hassan (director of SEPR, ICARDA)
- **Implemented by:**

ICARDA: Dr. E. De-Pauw, Dr. R.Sommer, Dr. W.Göbel,
Dr. F. Delobel, Dr. I. Bobojonov, Dr. A. Nurbekov,
Dr. M.Glazirina, T. Yuldashev, A. Mirzabaev
IFPRI: Dr. E. Nkonya, Dr. E.Kato

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NARS partners

- Uzbek Cotton Growing Research Institute;
- Central Asian Scientific Research Institute for Irrigation, Uzbekistan;
- Institute of Soil Science of Tajik Academy of Agricultural Science;
- Institute of Soil Science after U.U.Uspanov, Kazakhstan;
- Kyrgyz Research Institute of Crop Husbandry;
- National Hydrometeorological Services of four countries
- Kazakh Research Institute of Agric. Economics and Development of Rural Areas
- Kyrgyz National Agriculture University
- Uzbek Research Institute of Market Reforms
- Tajik Research Institute of Agriculture Economics
- Research Institute of Economics of Tajikistan





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The specific objectives of the research project:

1. to analyze the current status of selected agro-ecosystems, their ecological significance and threats due to human induced non-climatic factors;
2. to develop climate change scenarios for the selected agro-ecosystems;
3. to assess the climate change impact on selected agro-ecological systems on the basis of the developed climate change scenarios
4. to develop scenarios for socio-economic impacts on poverty and food security
5. to develop options and strategies to adapt to climate change

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Project components:

A. GIS (*leader - Dr. Eddy De Pauw, head of GIS Unit, ICARDA*)
   - Agro-ecological characterization (Agro-Eco-Zoning, AEZ)
   - Assessment of land degradation
   - Climate change scenarios (regionally downscaled GCM results)
   - region-wide assessment

B. Crop modeling (*leader - Dr. Rolf Sommer, Soil Fertility Specialist, IWLMP, ICARDA*)
   - Model calibration and evaluation for wheat grown under currently prevailing climatic conditions in selected agricultural systems of the study region
   - Modeling of the impact of climate change on crop productivity utilizing the developed climate change scenarios for the selected agro-ecosystems

C. Socio-economic, livelihood analysis (*leader - Dr. Aden Aw-Hassan, director of SEPR, ICARDA)*

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Using GIS to develop a baseline dataset for planning adaptation strategies to climate change in Central Asia

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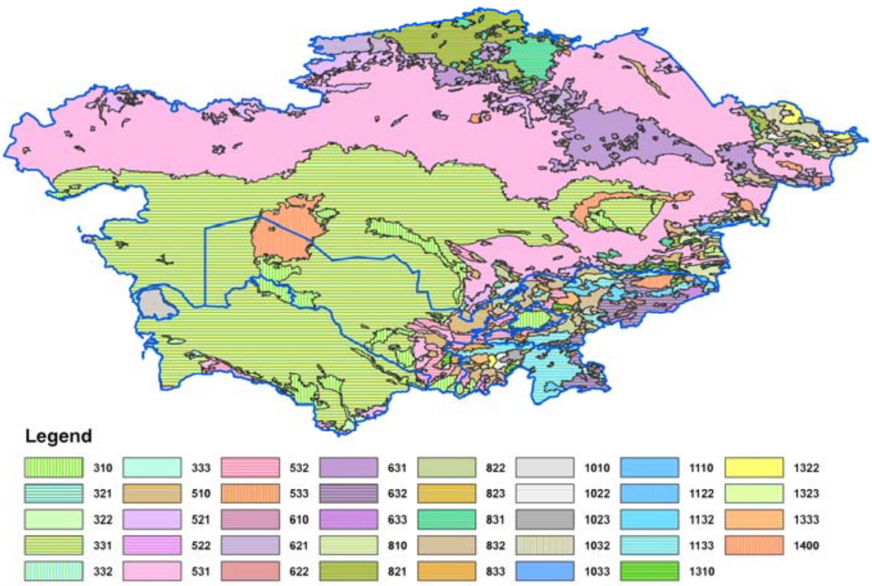
Agro-ecological zoning



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Climate change

GHG emission scenarios (IPCC, 2007)

A2: most pessimistic

Assumes a continuous population growth, increasing divergence between regions, less transfer of technological innovations

A1b: neither optimistic nor pessimistic

assumes population stabilization, continued globalized world, balance between fossil-intensive and non-fossil energy sources

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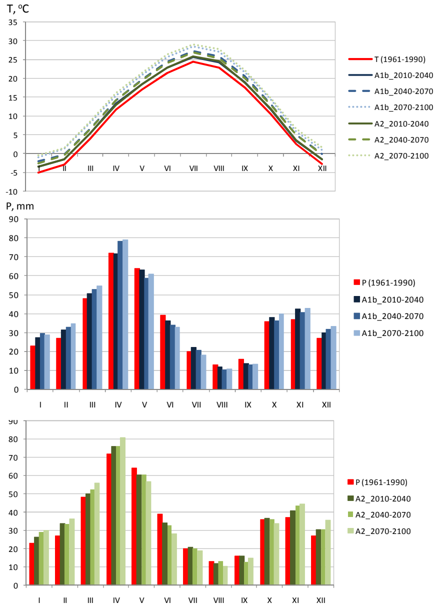
Climate change

3 “futures” represent three time period:
2010-2040, 2040-2070, 2070-2100

GCMs used in Simulation

No	Name	Country	Year	Resolution (degrees)
01	BCCR-BCM2.0	Norway	2005	2.8 x 2.8
02	CSIRO-MK3.0	Australia	2001	1.9 x 1.9
04	MIROC3.2	Japan	2004	2.8 x 2.8
08	CGCM3.1(T63)	Canada	2005	2.8 x 2.8
09	CNRM-CM3	France	2005	2.8 x 2.8
10	ECHAM5/MPI-OM	Germany	2003	1.9 x 1.9
12	GFDL-CM2.0	USA	2005	2 x 2.5

Average values over 7 chosen model for 2 GHG emission scenarios and 3 “futures” is used in analysis and in simulations



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Climate change

- The projections based on the downscaled multi-model ensemble indicate for most of the region a modest increase in precipitation.
- The trend towards higher precipitation could easily be countered by higher evapo-transpiration losses as a result of the increased temperatures. However, up to 2040-2070 no clear trend is anticipated, with about half of the region projected to experience a slight increase in aridity (0-10 points) and another half a slight decrease (0-10 points). For the period 2070-2100 a large increase is projected particularly in Kazakhstan, Uzbekistan, and Turkmenistan.
- The most significant changes are expected in mountainous areas as these are most sensitive to the impact of temperature rise. This may lead to wetter climate types in Kyrgyzstan, whereas a significant part of Kazakhstan is expected to evolve in a drier climate type with precipitation more concentrated in winter

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Biophysical assessment of the impact of climate change on crop productivity in Central Asia

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Site selection

Country	Wheat	Cotton	Potato
Kazakhstan	4	1	1
Kyrgyzstan	4	1	-
Tajikistan	5	3	2
Uzbekistan	6	2	1

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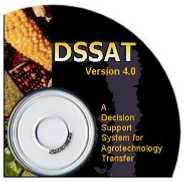
Selected Crop Models

CropSyst = "Cropping Systems Simulation Model"

multi-year multi-crop daily time step simulation model based on the understanding of plants, soil, weather and management interactions

Developers: Prof. C. Stöckle and R. Nelson

Distribution: free of charge after registration
http://www.bsyse.wsu.edu/cropsyst/



DSSAT = "Decision Support System for Agrotechnology Transfer"

software package integrating the effects of soil, crop phenotype, weather and management options

Details on the functionality of DSSAT model can be found in
Gijsman A., Ritchie, J. (2003) The DSSAT cropping system model, European Journal of Agronomy, 18, 235-265.

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CC impact on wheat grain yields (simulated in CropSyst)

Country	Site	Irrigation	CC impact on yield --------- Management level --------- Suboptimal	 Average	 Optimal	Change of yield across all Mgmt. levels %	 Mg/ha	
Kazakhstan	Astana	Rainfed	—	—	—	5	0.11	n.s.
	Kostanay	Rainfed	P	—	—	5	0.11	*
	Petropavlovsk	Rainfed	P	P	—	15	0.32	*
	Shieli	SI	—	—	P	10	0.31	*
Kyrgyzstan	Daniyar	SI	—	P	P	10	0.33	*
	KyrNIIZ	SI	—	—	P	14	0.42	*
	Uchkhoz	SI	—	—	—	0	-0.01	n.s.
	ZhanyPakhta	Rainfed	P	P	P	24	0.54	*
Tajikistan	Bakht	SI	—	—	P	4	0.15	*
	Faizabad	Rainfed	—	P	P	26	0.44	*
	Khorasan	Rainfed	P	P	P	27	0.47	*
	Shahristan	SI	P	P	P	14	0.5	*
	Spitamen	SI	N	N	—	-3	-0.09	*
Uzbekistan	Akaltyn	SI	—	P	P	25	0.47	*
	Akkavak	SI	—	—	P	9	0.43	*
	Khorezm	Full Irrig.	P	P	P	22	1.3	*
	Kushmanata	Full Irrig.	—	—	—	1	0.03	n.s.
	Kuva	Full Irrig.	P	P	P	18	0.75	*

Impact of climate change on wheat productivity: N = negative, P = positive, — no significant change; Yield increases refer to the average yields of the three different futures and two different emission scenarios in relation to historic yields

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CC impact on wheat grain yields

- Increasing winter and spring temperatures and an increase in CO_2 concentration positively affected yields at the majority of simulated sites in Central Asia.
- Slightly increasing annual precipitation amounts added only little to this positive effect (counterbalanced by an increase in evaporative demand).
- Overall shorter life cycle did not affect negatively biomass accrual and yield.
- Hot temperatures during flowering may become a problem in the long-term future in some southern areas and in the spring-wheat areas of northern Kazakhstan; crop breeding should address this issue.

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CC impact on cotton production (% of current productivity ; simulated in DSSAT)

Country	Site	A1b		A2	
		2011-2040	2071-2100	2011-2040	2071-2100
Kyrgyzstan	Kadamajay	13.6	-1	9.4	-10
Kazakstan	Sayram	7.5	10.3	9.8	8.7
Tajikistan	Spitamen	-8	-36	-11	-39
	Sharora-Gissar	-6.8	-28.5	-7.6	
	Yavan valley	-10.3	-15.7	-8.3	-19.7
Uzbekistan	Kasby	1.6	-36.4	7.4	-50.1
	Chimbay	11.6	-21.6	10.1	-31.6

Climate change effects on cotton in Central Asia are not alarming in the immediate future (2011-2040) but become severely alarming in the far future (2071-2100).

Tajikistan will be most negatively affected in the near future while the other countries appear to be somewhat better off in this same period. However the far future is a key concern for all countries.

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CC impact on potato yields (% of current productivity; simulated in DSSAT)

Country	Site	A1b		A2	
		2011-2040	2071-2100	2011-2040	2071-2100
Kazakstan	Almaty	-9.2	-1.7	-7.8	-1.2
	Aktobe	7.1	-8.1	-5.7	-4.6
Tajikistan	Jirgatal	45.7	68.5	63.5	72.6
Uzbekistan	Toyloq	13.3	23.7	13.6	17

The simulations show that Potato Production in Central Asia will gain substantially from future carbondioxide fertilisation effects. This will mitigate future climate change negative effects on Potato yields.

From the sites simulated, climate change does not appear to be a big threat on Potato production in Central Asia both in the near future and far future except in Kazakhastan where the results show mild negative effects.

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Economic Impact of Climate Change in Central Asia

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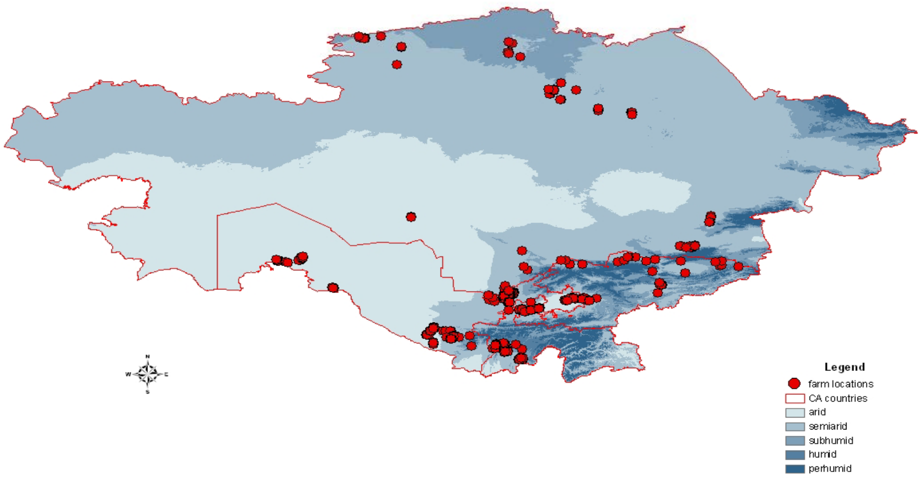
AEZs (aridity classes) and location of villages for household surveys



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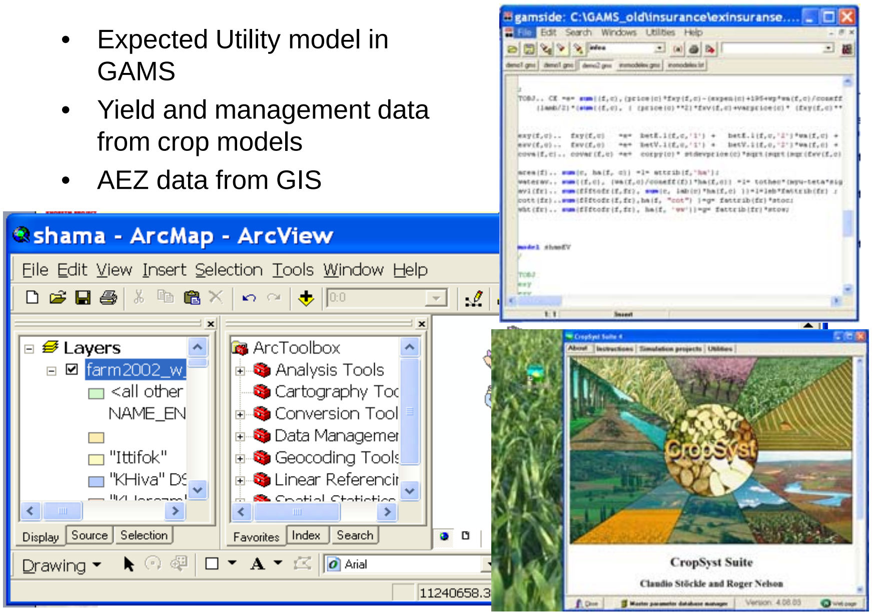
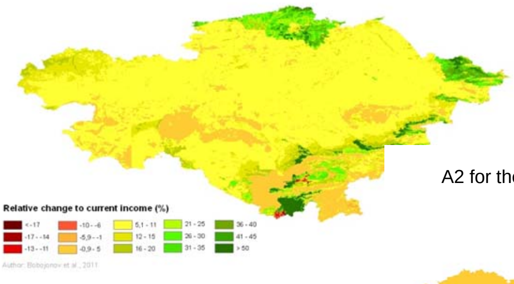
Bio-economic farm model

- Expected Utility model in GAMS
- Yield and management data from crop models
- AEZ data from GIS

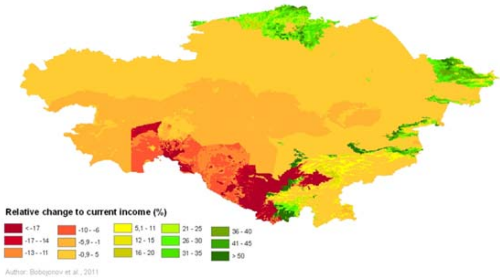


Some Results: Spatial change of expected farm income

A1b scenarios for the period 2071-2100



A2 for the period 2071-2100, 30% decline in irrigation water



CC impact on agricultural systems

- CC impacts on agricultural systems differently: Positive impact in the North, negative impact in the South
- Higher losses under A2 than A1b scenario
- Crop diversification could be best potential for improving income security under climate change
- On-farm hedging instruments are most likely function well for rainfed systems, but has limited effect in irrigated systems
- Strong state support and reliable transboundary water use agreements are most crucial for the livelihoods of rural people living in the irrigated areas

Outlook

- Methods for downscaling and regionalization of GCM outputs should be improved
- Crop modeling of irrigated crop production in Central Asia should be combined with hydrological/climatic estimates of snowfall and snowmelt in the mountains and the impact of climate change
- The number of crops considered in the investigation should be increased to assess CC impact on crop production systems
- The point level biophysical results should be up-scaling to the province/national level to make use for assessment of CC impact on livelihoods
- Impact of climate change on crop affection by diseases, pests and weeds should be assessed