Contributions of Changes in Land Use/Land Cover, Water Use, and Climate to the Hydrological Cycle Across the Central Asian States

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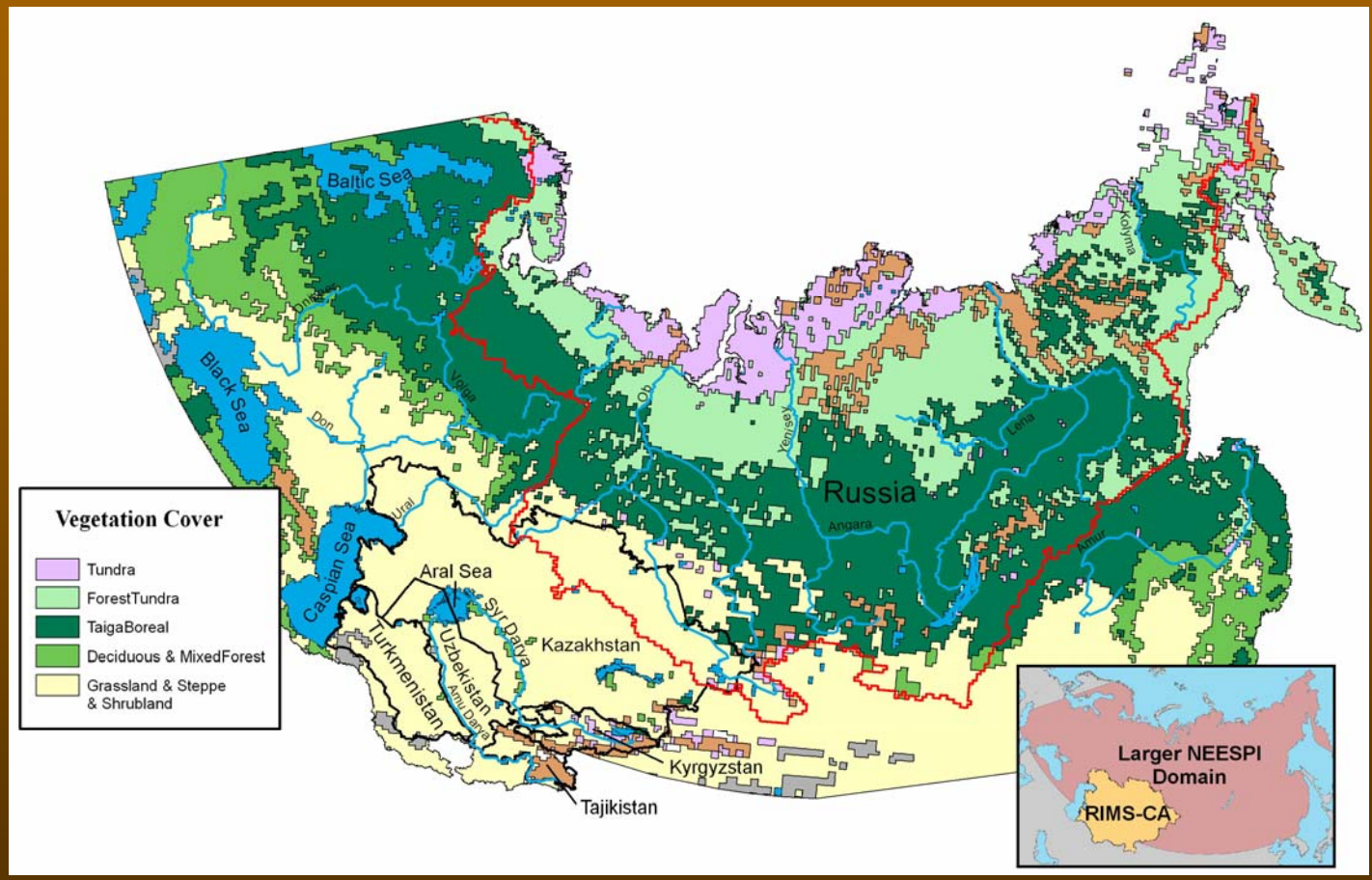
Domains for two NEESPI projects

Role of land cover and land use change in hydrology of Eurasian pan-Arctic



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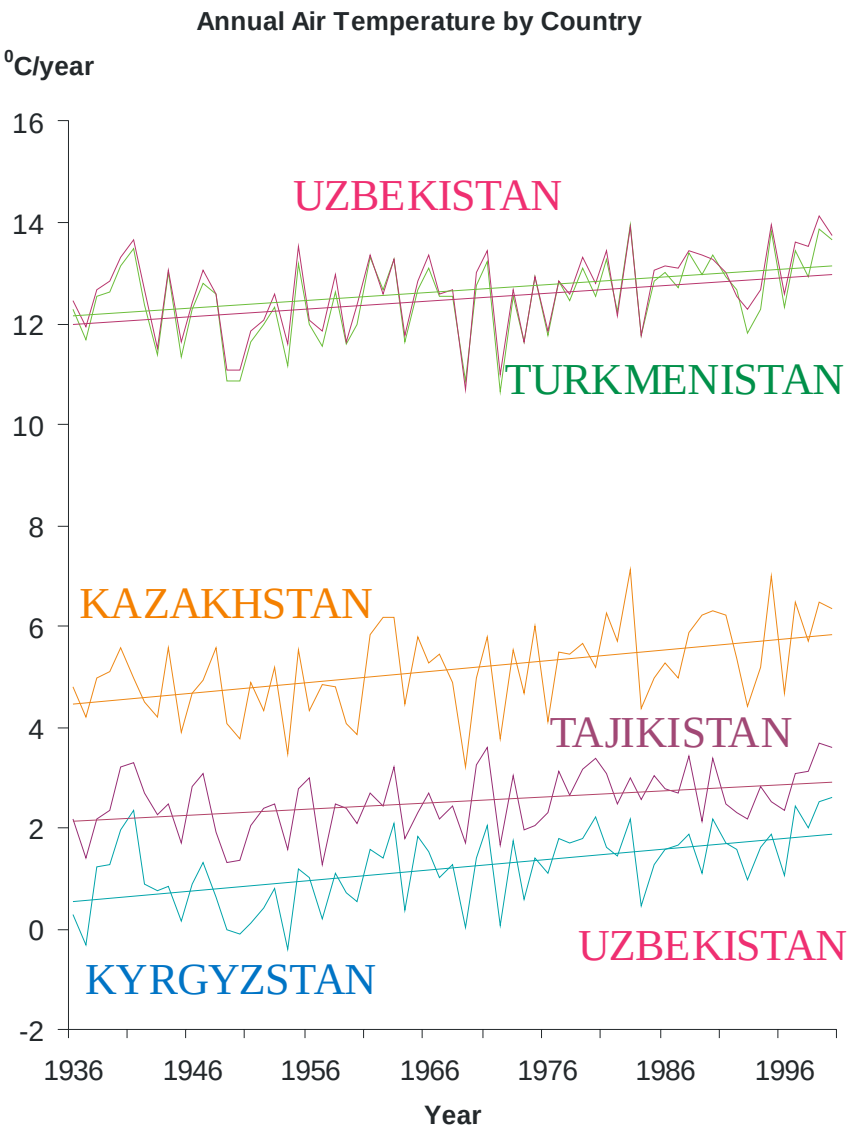
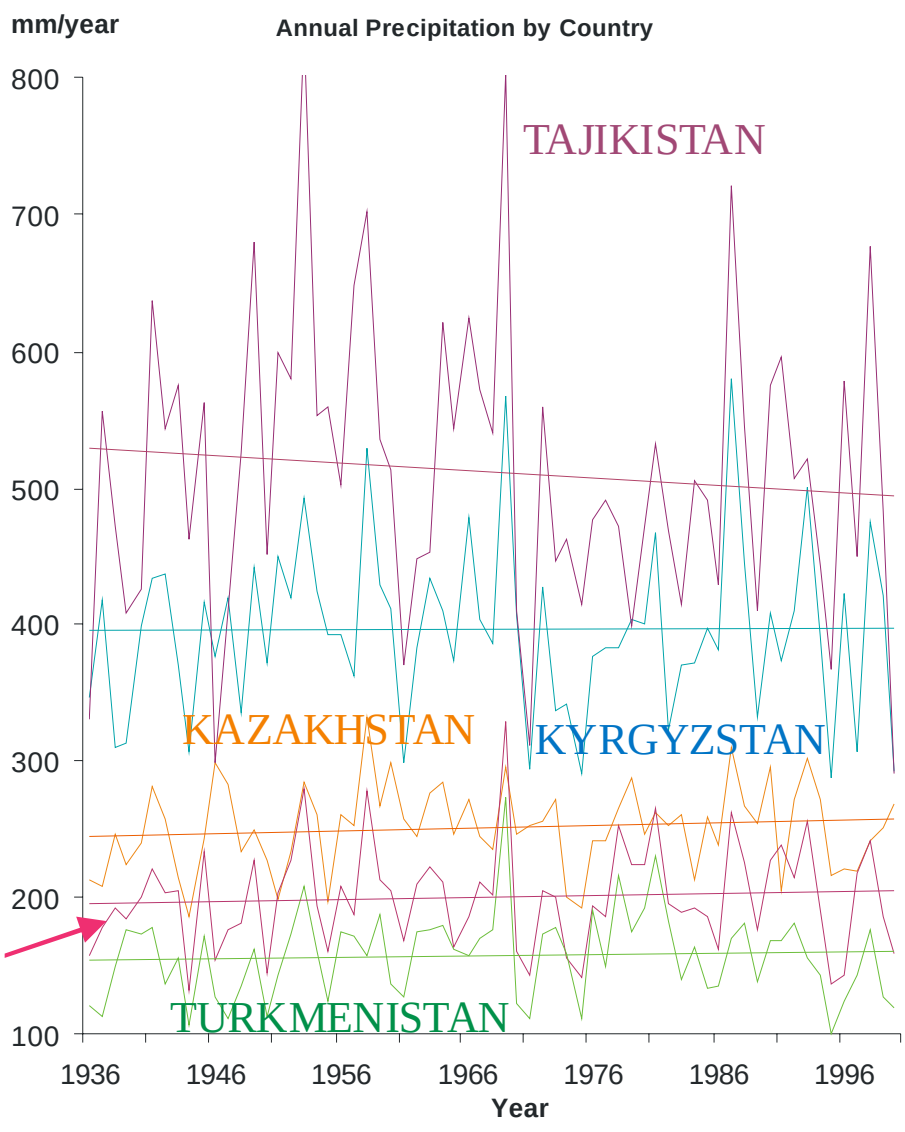
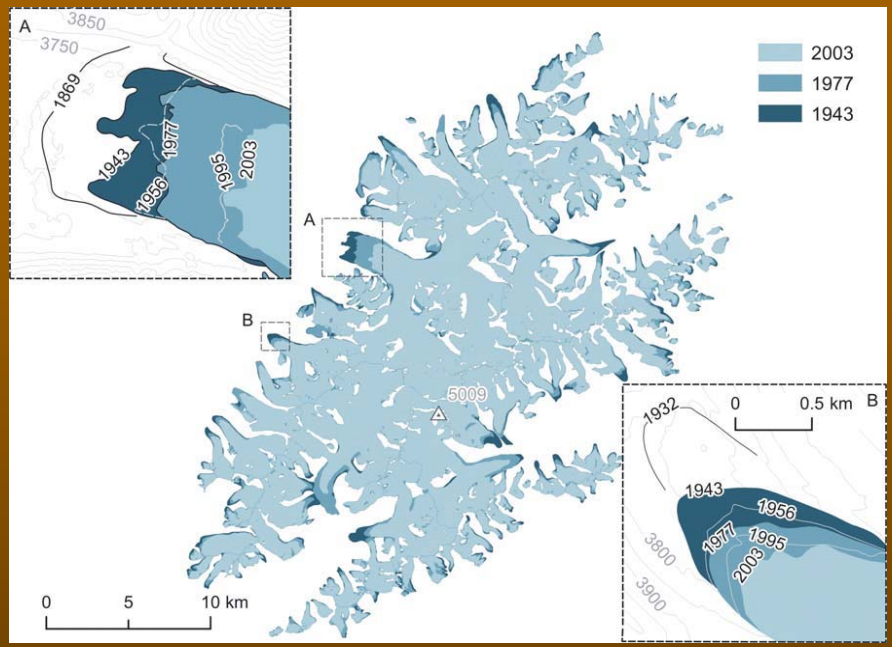
Climate Change

Climate variability in Central Asia (by country)





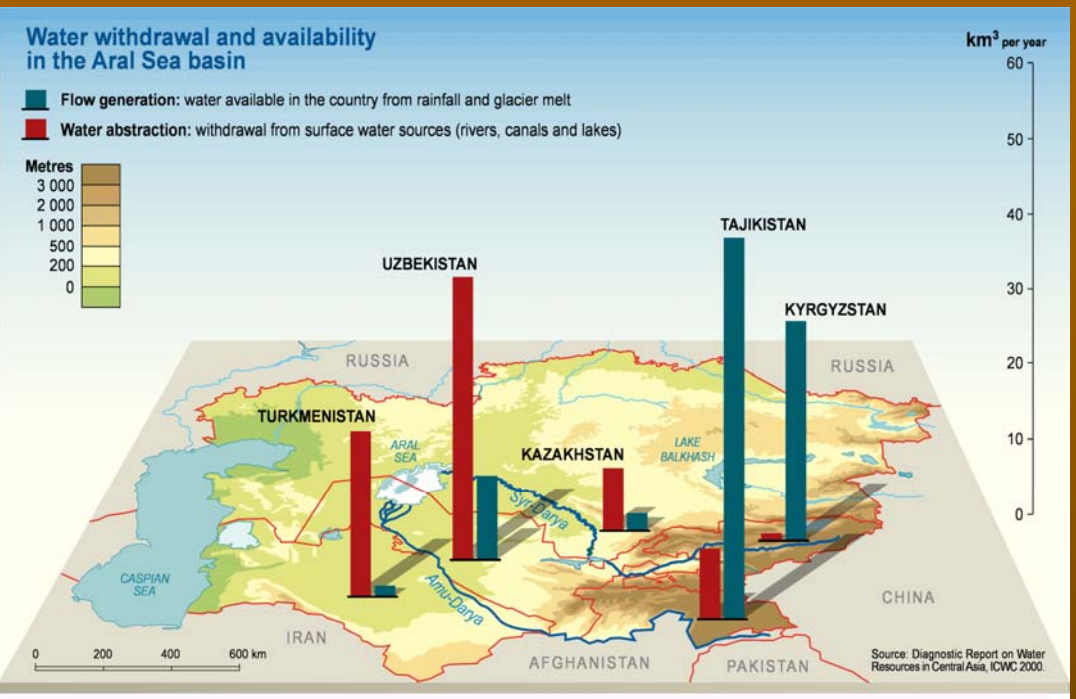
Changes in Tien Shan Glaciers (example of deglaciation)

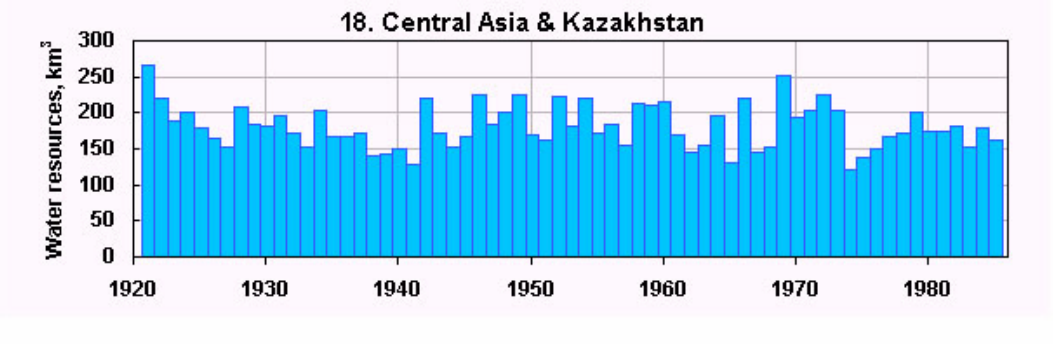


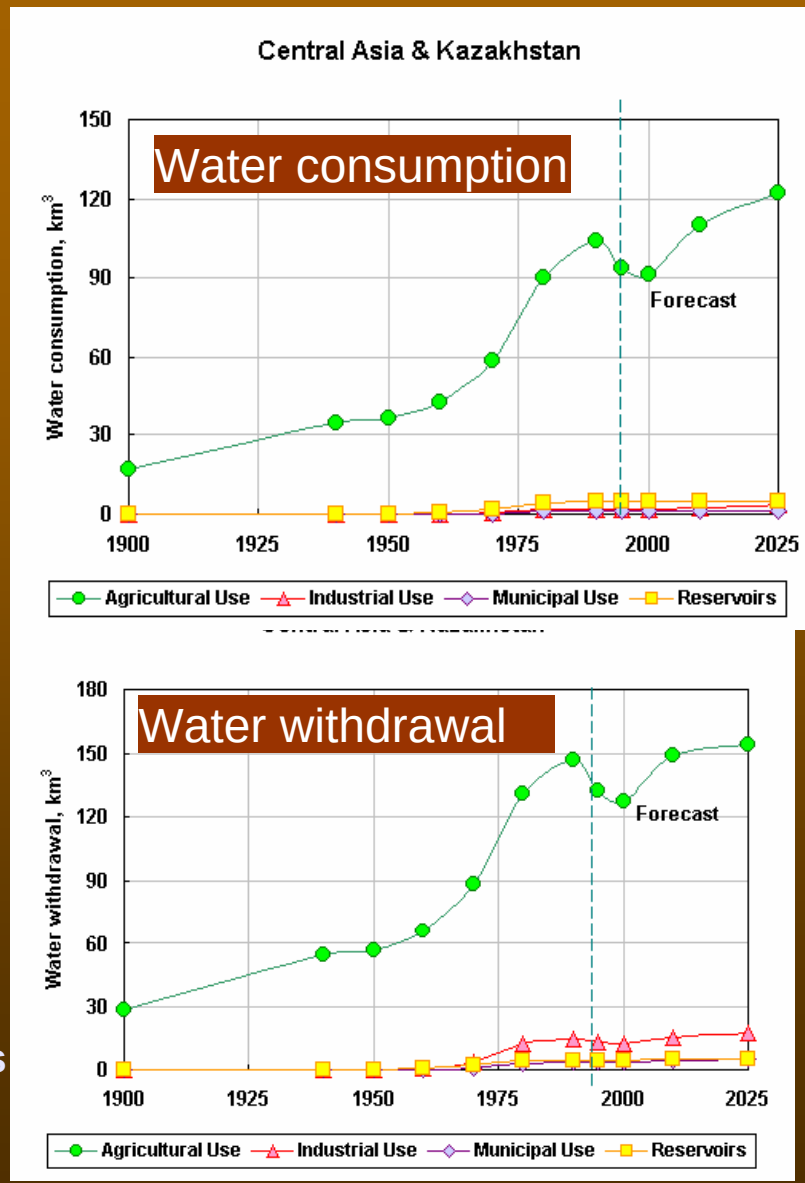
(a) Akshiirak glacier area changes between 1943 and 2003. Petrova Glacier terminus positions since 1869 (A), Davidova Glacier terminus positions since 1932 (B) and in 1977 (aerial photographs) before its surface elevation and terminus advanced in 1978 (b). (From Aizen et al, 2006) (Used aerial photographs and ASTER images for change-detection)

Water Use, Land Cover and Land Use Change

Water resources and water use







Tajikistan and Kyrgyzstan ~ 80% of total water resources
Uzbekistan and Turkmenistan – 75% of total water use

WORLD WATER RESOURCES AND THEIR USE
JOINT SHI/UNESCO Report

Some Water and Land Use Issues in Central Asia

- ***Inefficient irrigation with soil sterilization problem***
- ***Salinization and desertification of lands due to the Aral Sea shrinkage***
- ***Pollution of surface and ground waters***

Virgin Lands **program, end of 50's, 230 000 km2 of loess steppe in Northern Kazakhstan was transformed to arables.**

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Challenges for progress :

A) Bring together physical and human dimensions worlds (data, models)

B) Ranking the major forcings on the water system.

- **Climate change**
- **LCLUC**
- **Engineering (Water Use)**

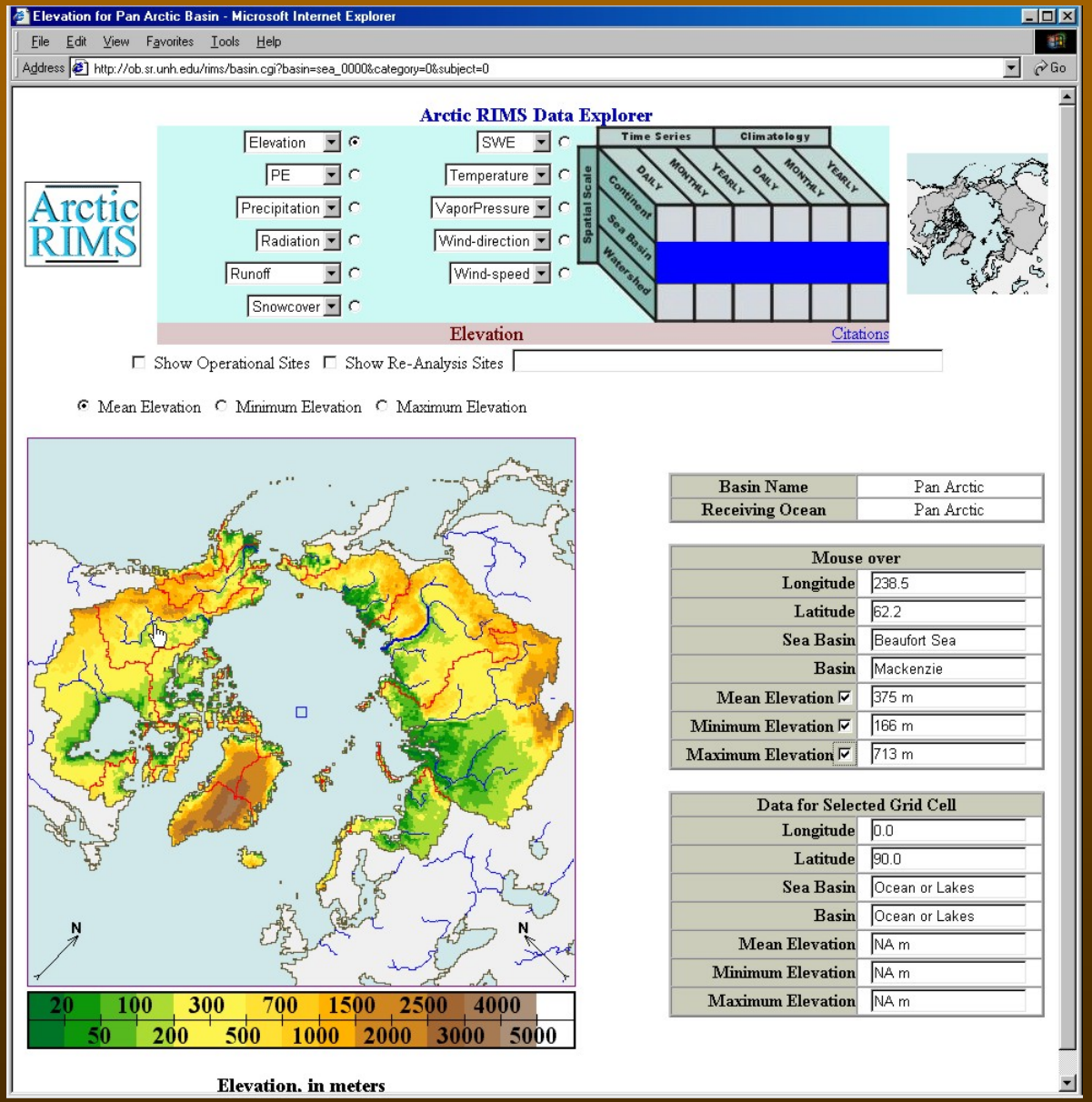
(C) Do this for historical, contemporary and future system states

GOAL: Data Consolidation *(Creation of an integrated NEESPI Central-Asian data and analysis system, built on our current Arctic-RIMS framework)*

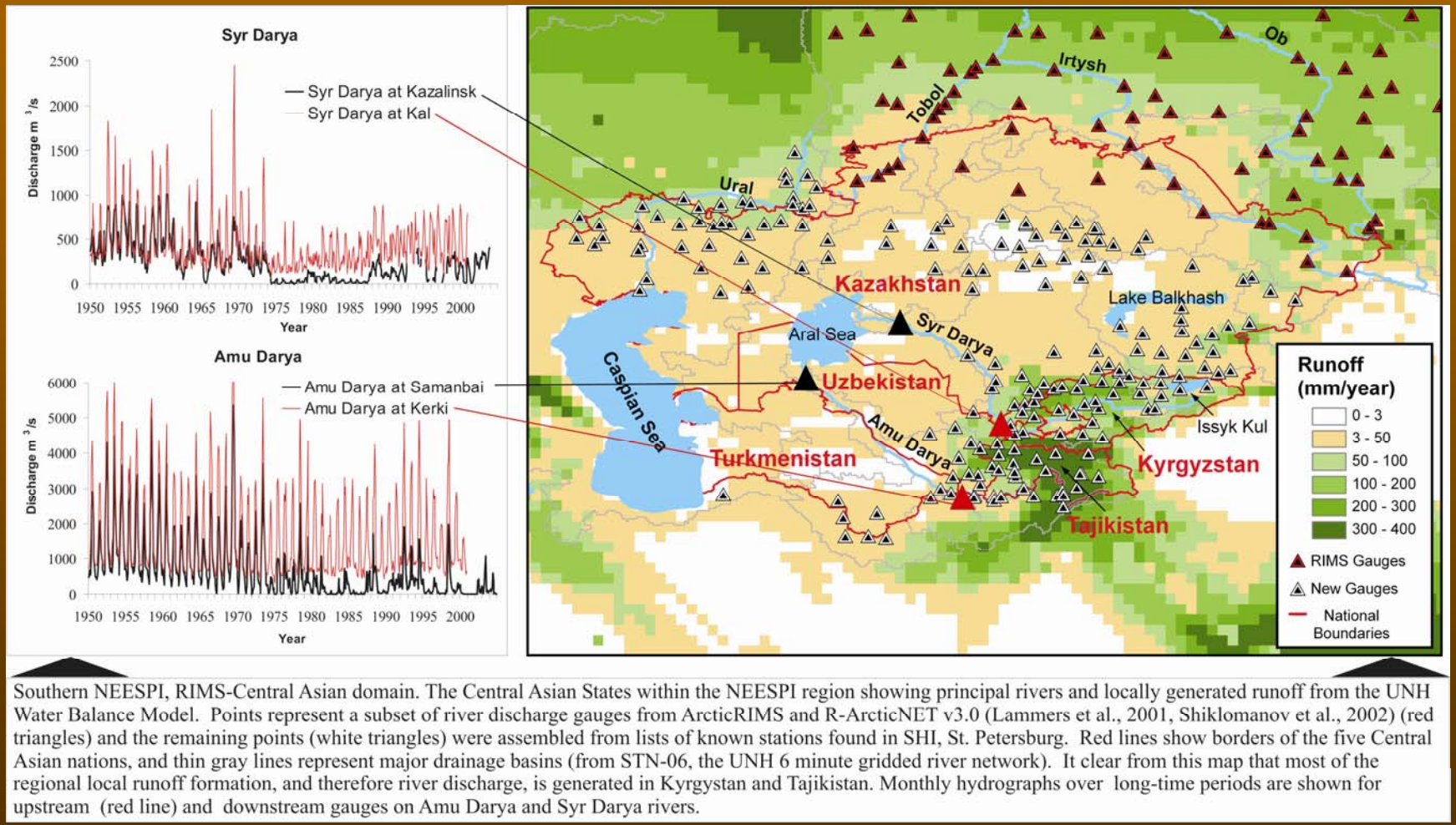
ArcticRIMS DATA SYSTEM
A Regionally Integrated Monitoring System

- Coordinated Geospatial Data Sets
- On-screen Roving and Interaction
- Data Mining Tool
- Multi-Dimensional Queries
- Archival, Real-Time Station Data and Gridded Fields
- Web-based with On-line Data Downloads
- http://RIMS.unh.edu

NEW: Operational satellites data; water use; land cover change.



New River Discharge and Water Use Data for Central Asia
(ready to be integrated in CA-RIMS)



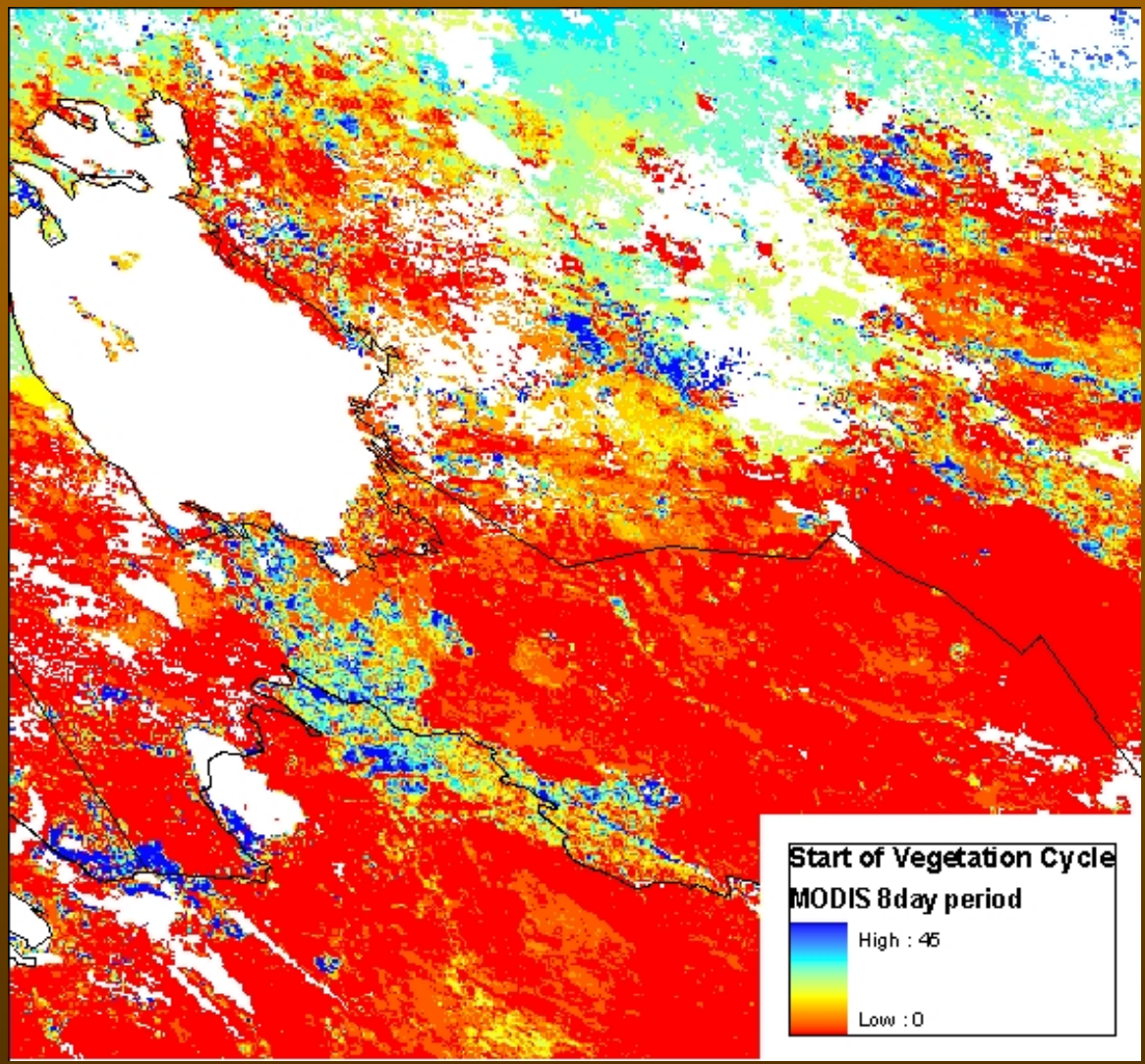
Southern NEESPI, RIMS-Central Asian domain. The Central Asian States within the NEESPI region showing principal rivers and locally generated runoff from the UNH Water Balance Model. Points represent a subset of river discharge gauges from ArcticRIMS and R-ArcticNET v3.0 (Lammers et al., 2001, Shiklomanov et al., 2002) (red triangles) and the remaining points (white triangles) were assembled from lists of known stations found in SHI, St. Petersburg. Red lines show borders of the five Central Asian nations, and thin gray lines represent major drainage basins (from STN-06, the UNH 6 minute gridded river network). It clear from this map that most of the regional local runoff formation, and therefore river discharge, is generated in Kyrgystan and Tajikistan. Monthly hydrographs over long-time periods are shown for upstream (red line) and downstream gauges on Amu Darya and Syr Darya rivers.

Historical in situ data

698 New River Discharge Gauges (monthly discharge, monthly and max sediment discharge, max and min daily discharge

97 River Gauges with annual water use data (withdrawal, diversions, inlets)

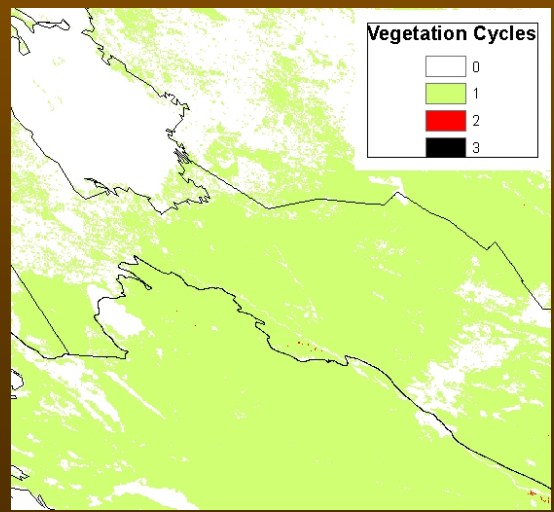
New remote sensing data for RIMS-CA



Start of Vegetation Cycle MODIS 8-days period

Data for CA derived from the MODIS reflectance products (500m spatial resolution, 8 days temporal resolution):

- Number of growing seasons
- Timing of growing seasons
- Wetlands/Irrigated Areas



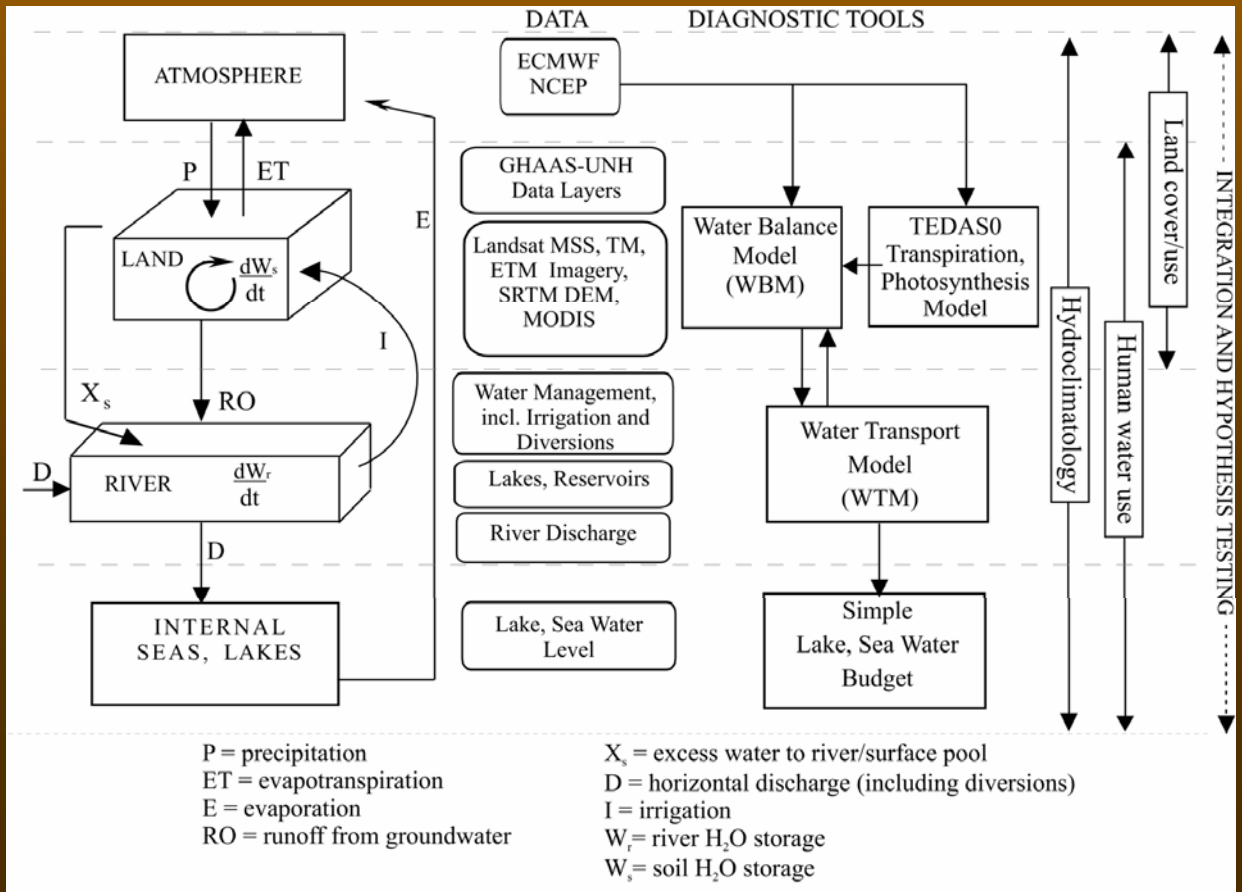
Number of vegetation cycles

GOAL: Diagnostic Analysis: ***To execute a series of hydrological simulation experiments to directly test the proposed hypothesis.***

Two components:

Combined Impacts: ***To assess the net impact of the combined effects of natural and anthropogenic sources of change in the patterns of hydrological variability in Central Asia.***

Relative Contributions: ***To identify and rank the sources of change on the hydrology of Central Asian States.***



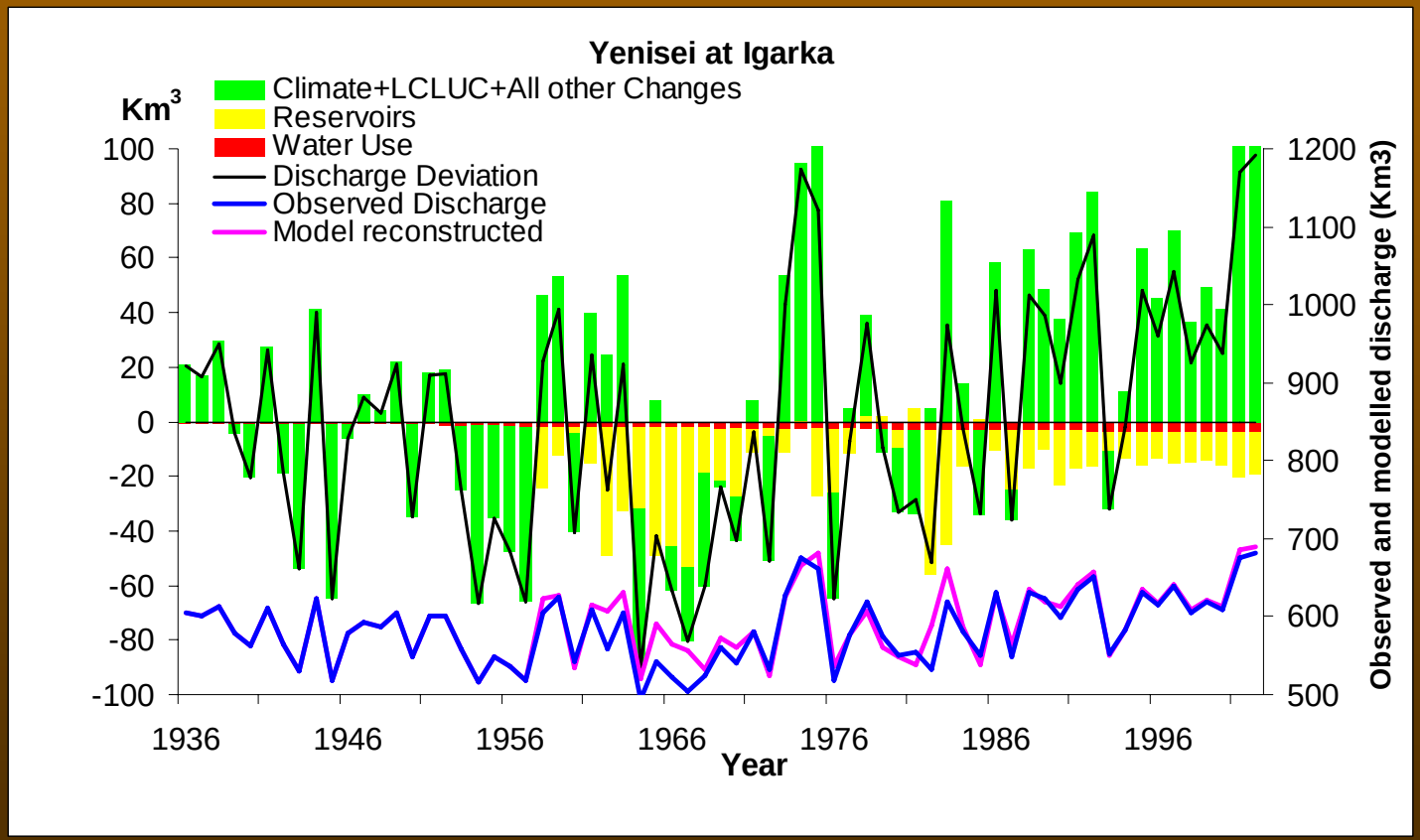
EXPERIMENTS STRATEGY

Table: Central Asian Change Assessment Experiments

Historical (Present Day)			*Future*
GOAL 1	GOAL 2		GOAL 3
Comprehensive Scenario (Baseline)	*Single Change Scenarios*	*Paired (Coupled) Scenarios*	*Future Scenario*
C1: Combined Land use/cover, human water use and climate changes, Present conditions representing the past 50 years	**S1:** Land use/cover change only	**P1:** Land use/cover and human water use changes only	**F1:** Develop data sets and simulations based on expertise from the research community via special sessions organized specifically for this task at the NEESPI meetings throughout the life of the project.
	S2: Human water use change only	**P2:** Land use/cover and climate changes only	
	S3: Climate change only	**P3:** Human water use and climate changes only	

What is a major contributor to changes in CA water cycle ?

1. **Progressive change in climate & climate variability,**
2. **Land use/cover change**
3. **Water engineering.**

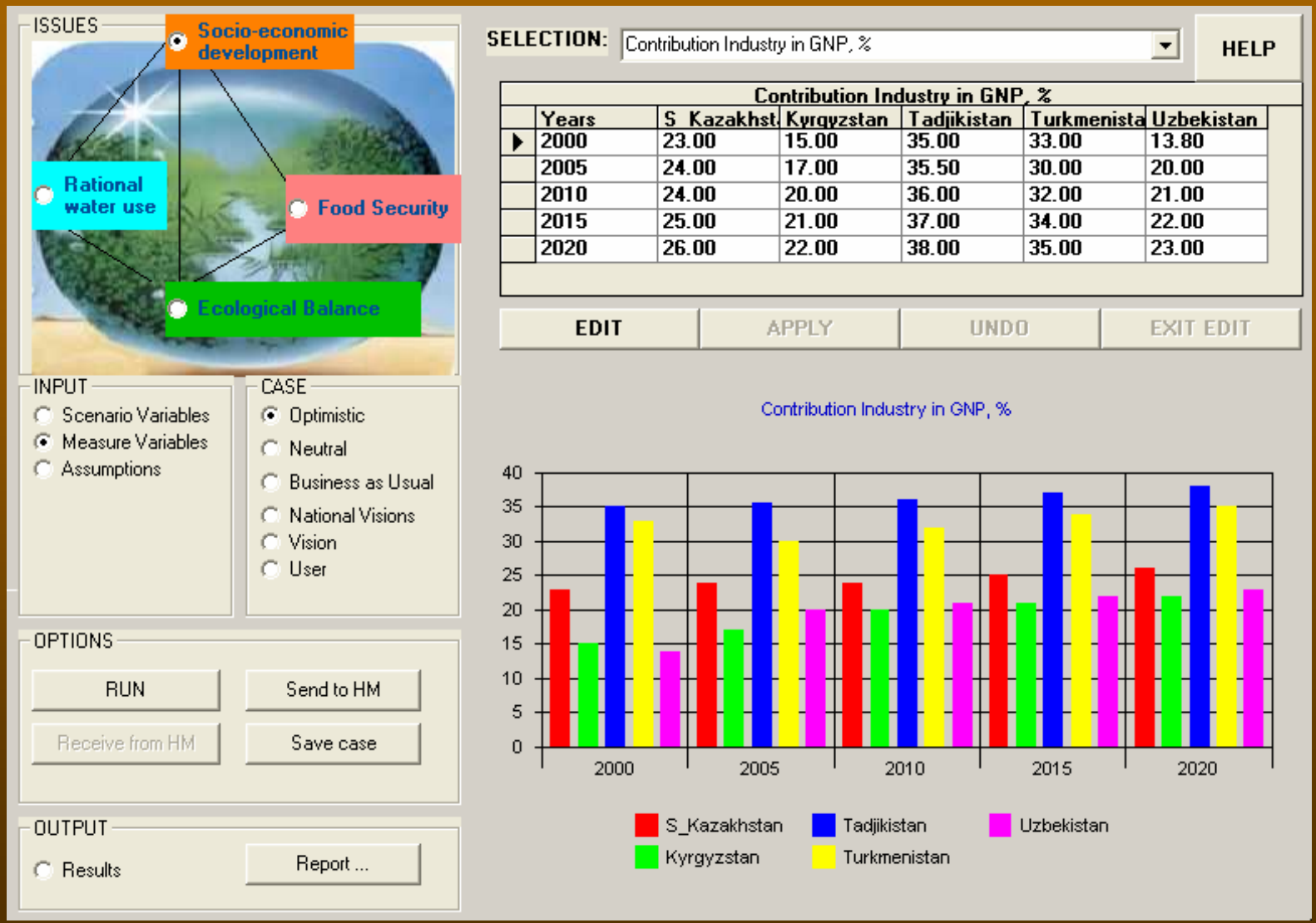


Contributions of different Earth system components contributing to Yenisei river discharge variation (updated from Shiklomanov, 1996)

GOAL: Future Trends: ***To assess how vulnerable the NEESPI Central Asian human and economic system is to ongoing changes in the land use/land cover, water use and operation of major water engineering works, and climate change.***

Climate Model Future Scenario Characteristics			
Profile	**SRES A1B**	**SRES A2**	**SRES B1**
Population growth	Low	High	Low
GDP growth	Very high	Medium	High
Energy use	Very high	High	Low
Land-use changes	Low	Medium/High	High
Resource availability	Medium	Low	Low
Pace of technological change	Rapid	Slow	Medium

We incorporated in our experimental tools regional SED SIC model



Socio-economic development model SIC ICWC for land and water development scenarios

THANK YOU