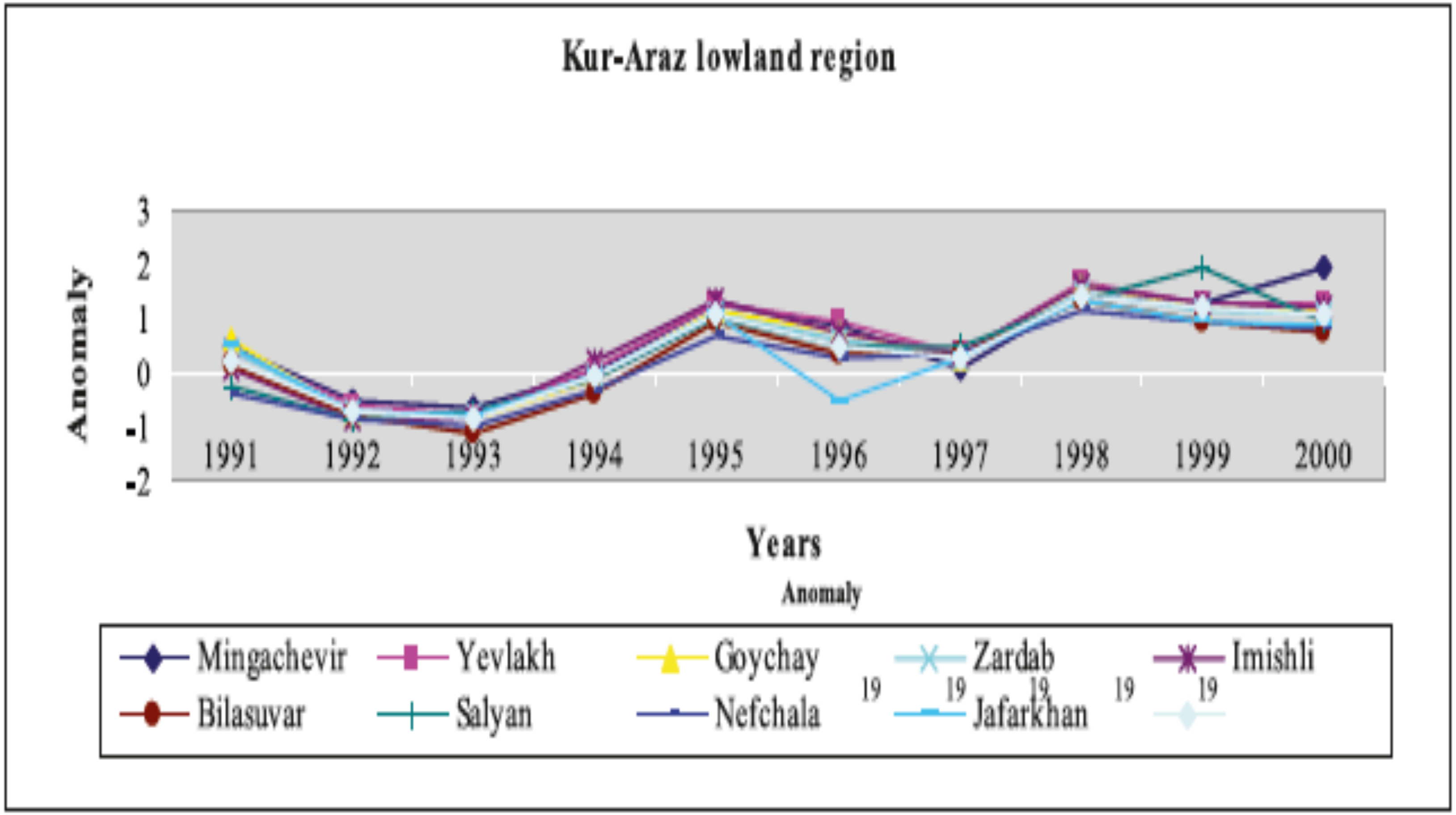
Anticipated Impact of Climate Change in the Caucasian Region

Ahmed Abou Elseoud

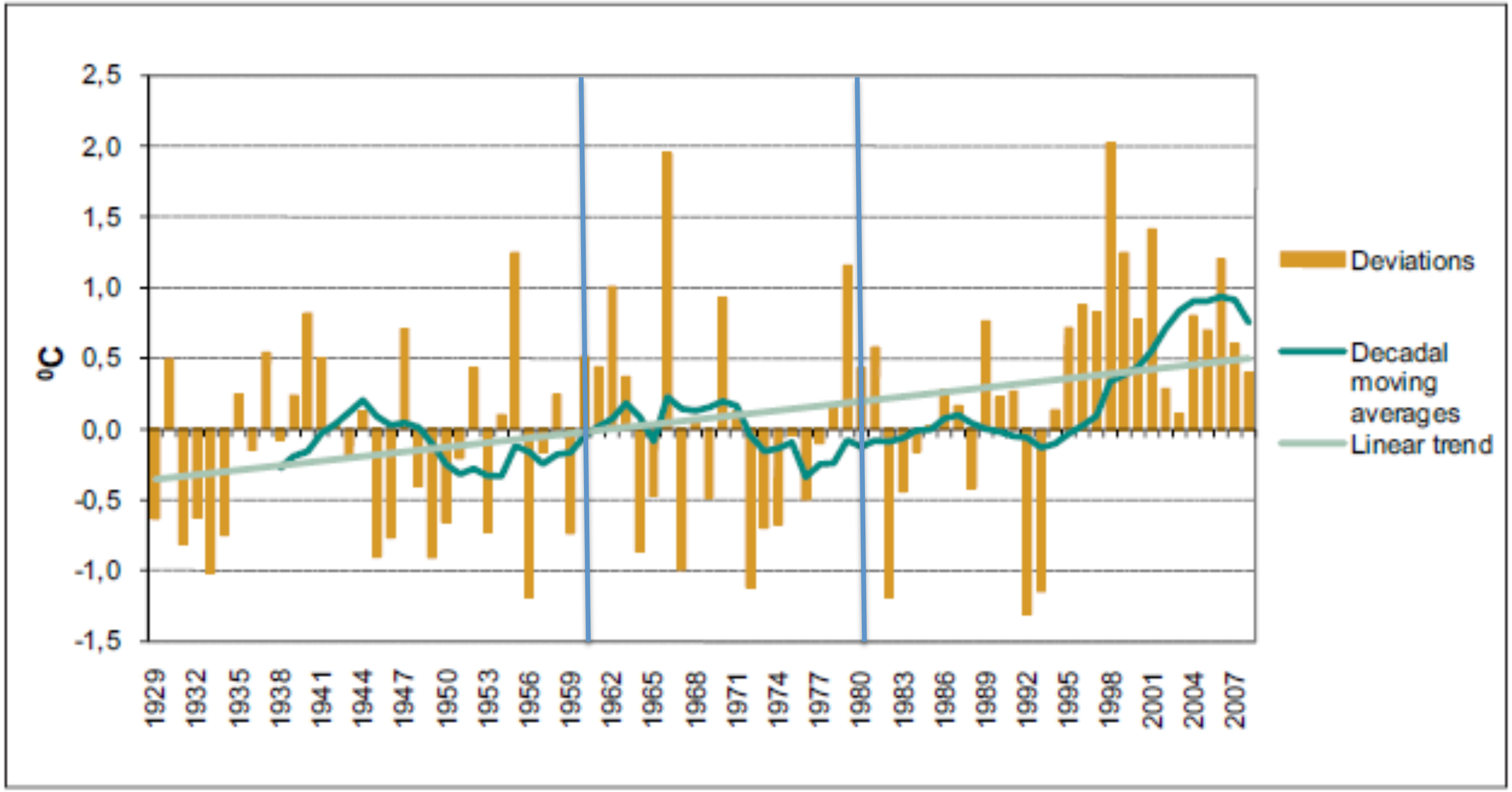
Senior Biomonitoring and Environmental Flow Expert

Are there any signs of Climate Change in the Caucasian Region?

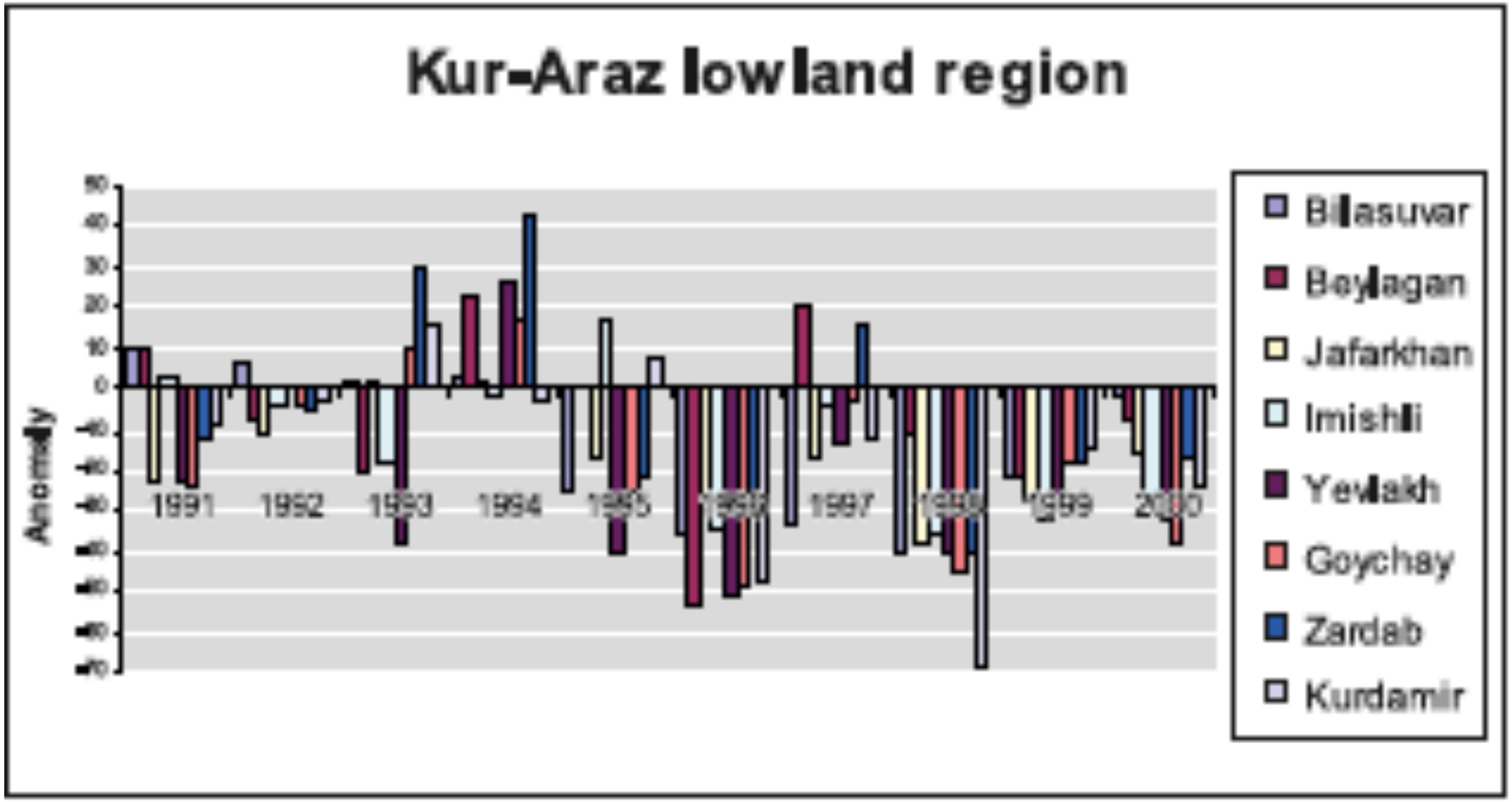
Change of mean annual temperature in Azerbaijan from the average 1961-1990



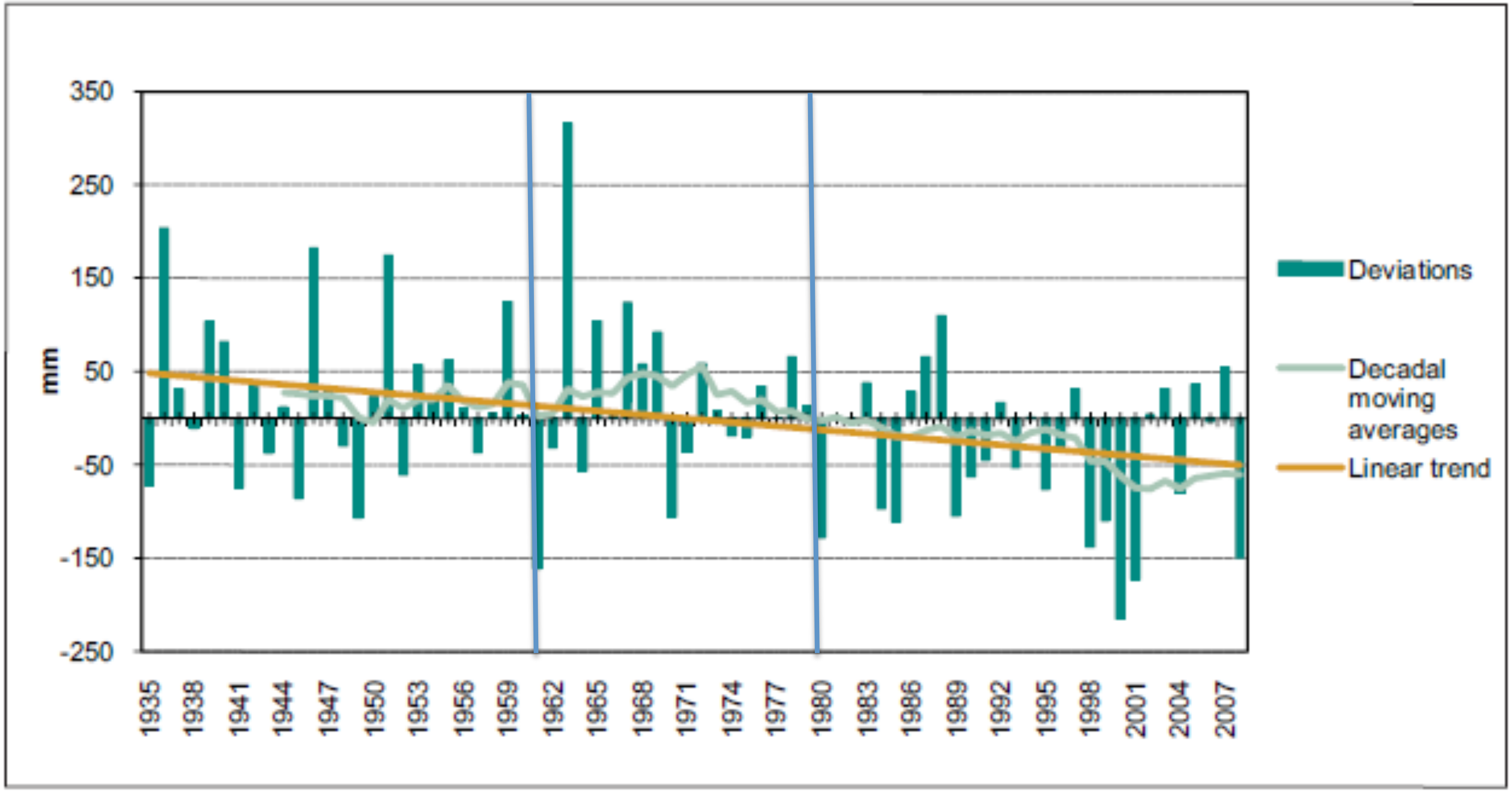
Change of mean annual temperature in Armenia from the average 1961-1990



Change of mean annual Precipitation in Azerbaijan from the average 1961-1990



Change of mean annual Precipitation in Armenia from the average 1961-1990



Georgia, annual precipitation 1964-1990 relative to 1937-1964

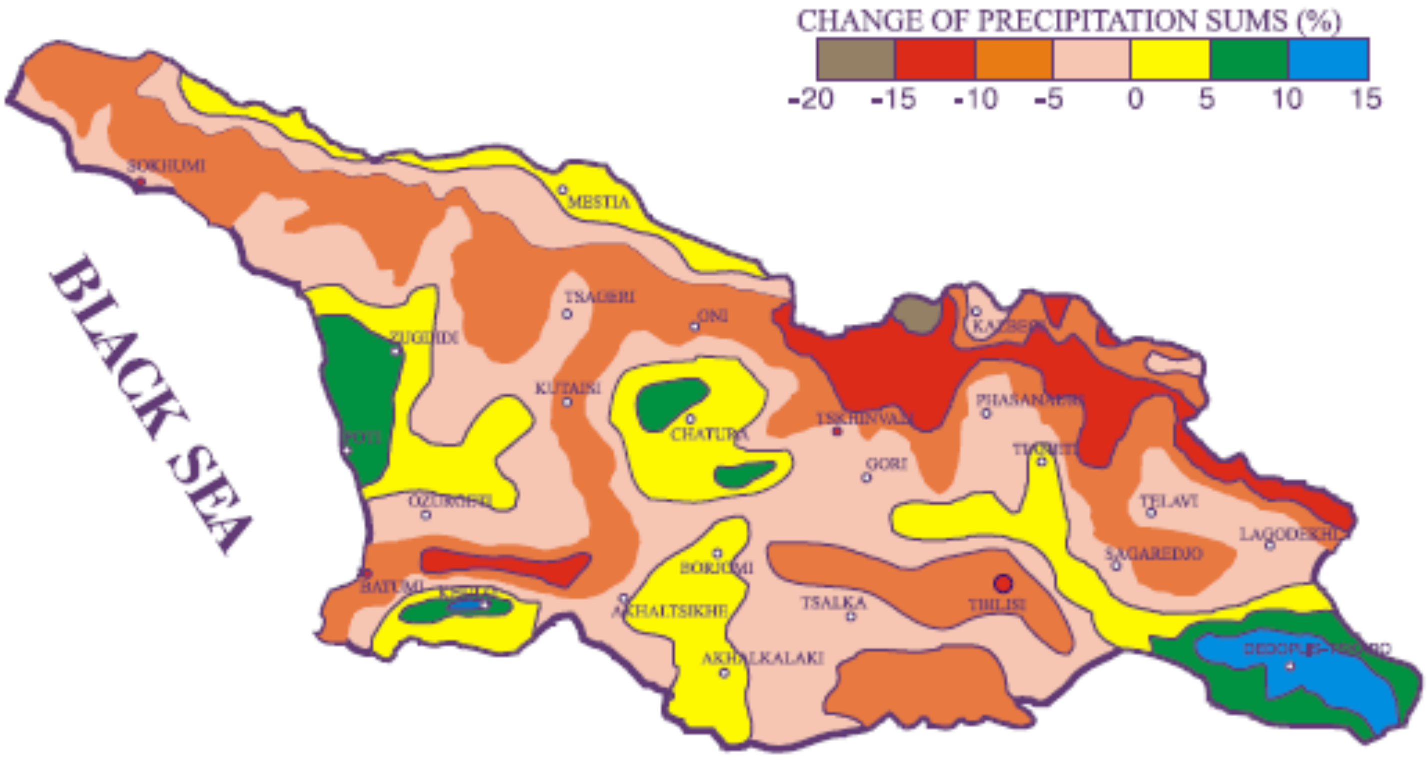
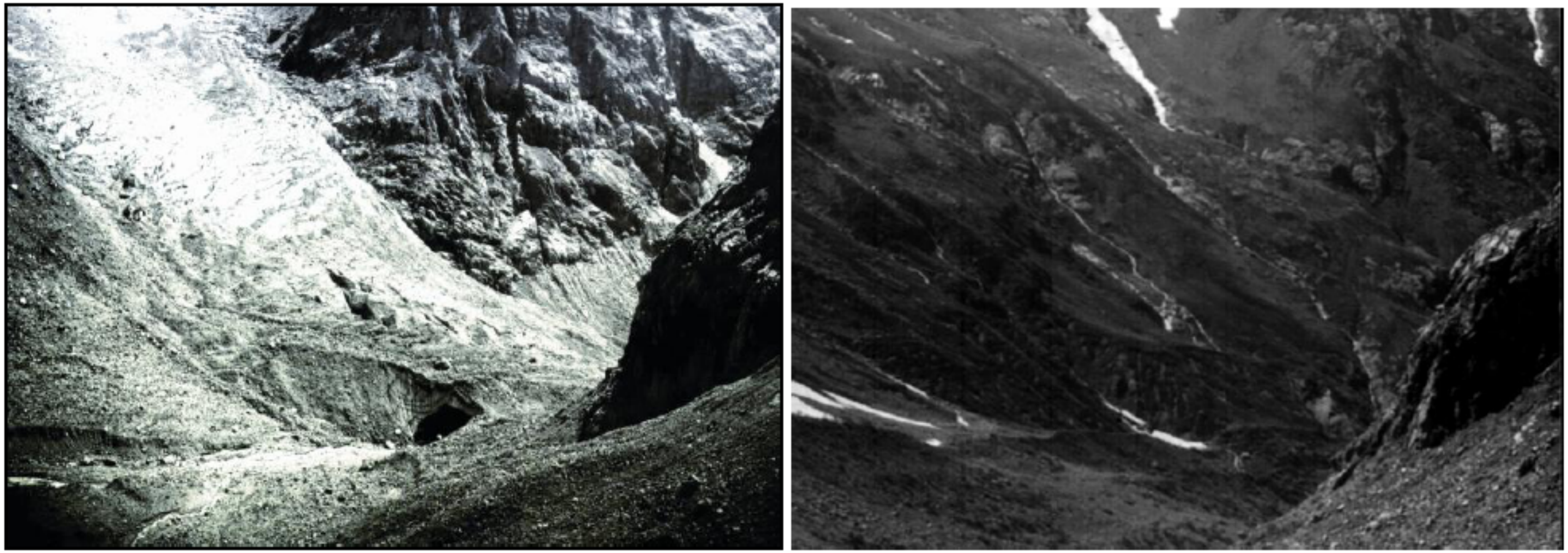


FIG. 7.1.6. ANNUAL ATMOSPHERE PRECIPITATIONSUMS
FOR 1964-1990 PERIOD RELATIVE TO 1937-1964 PERIODS

The glaciers of the Caucasus are melting rapidly

During the last century, the glacial volume in the Caucasus declined by 40%



the Labola Glacier, Georgia, 1972 (left) and 2002 (right)

The glaciers of the Caucasus are melting rapidly

During the last century, the glacial volume in Gusarchay basin decreased from 4.9 km2 to 2.4

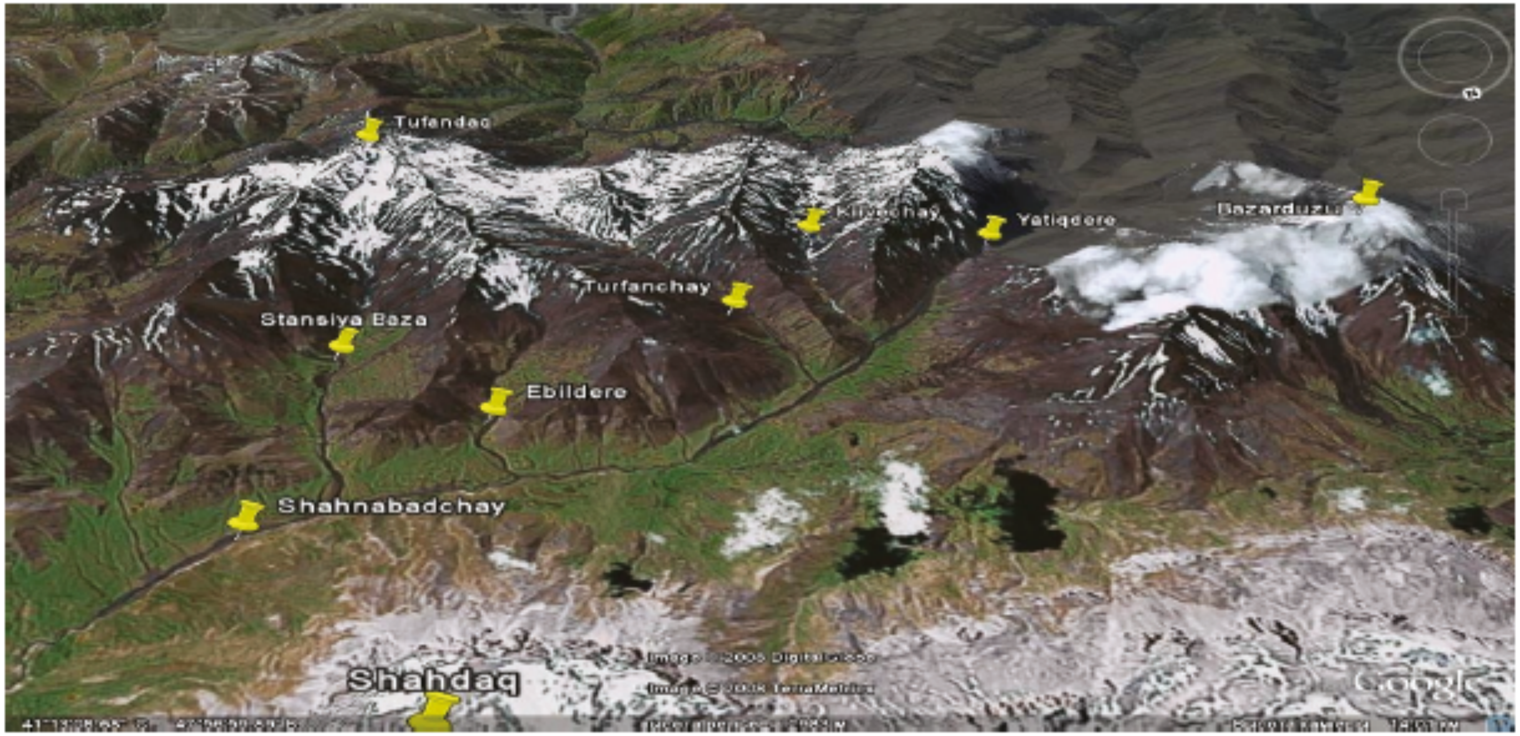
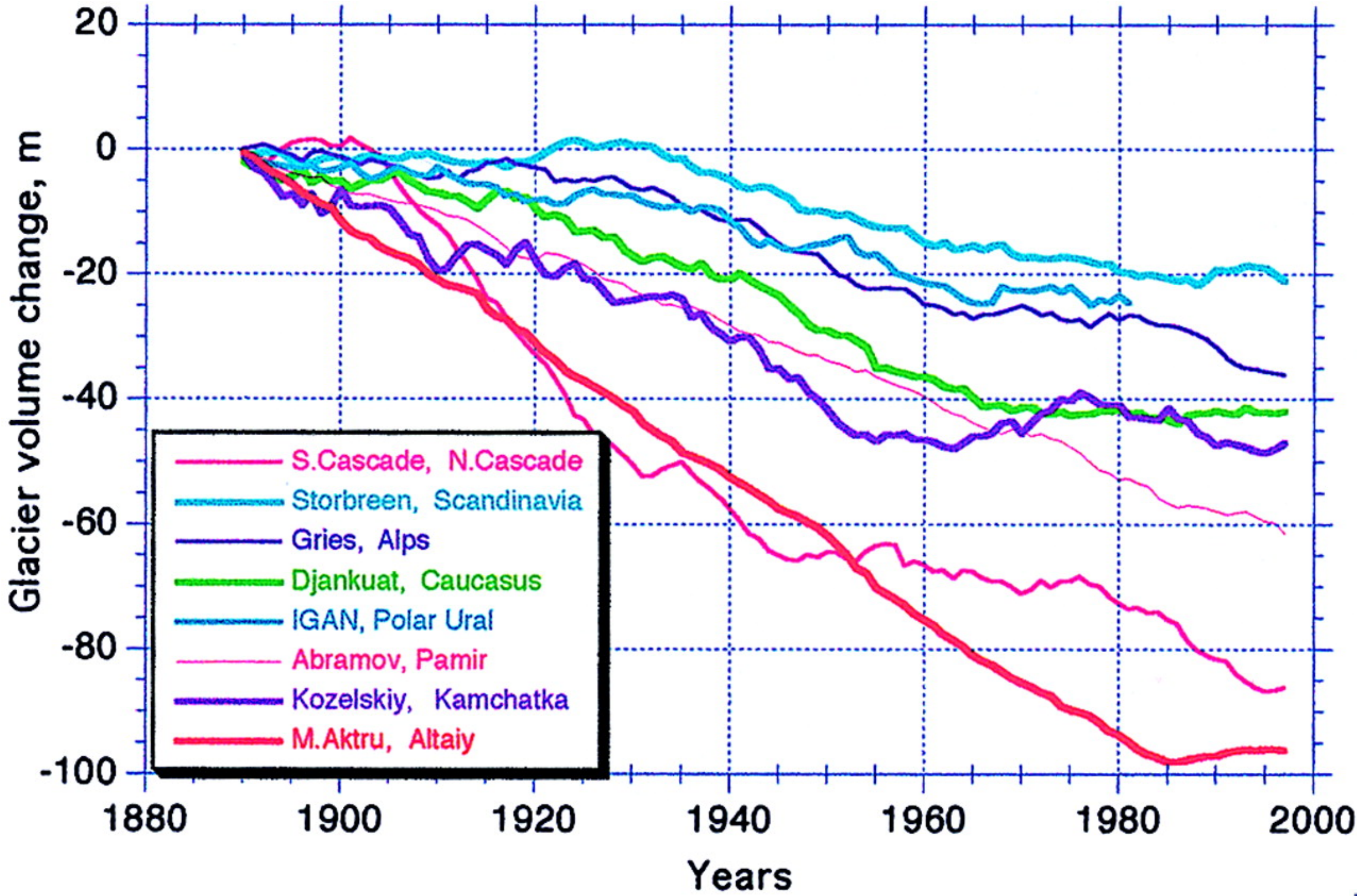
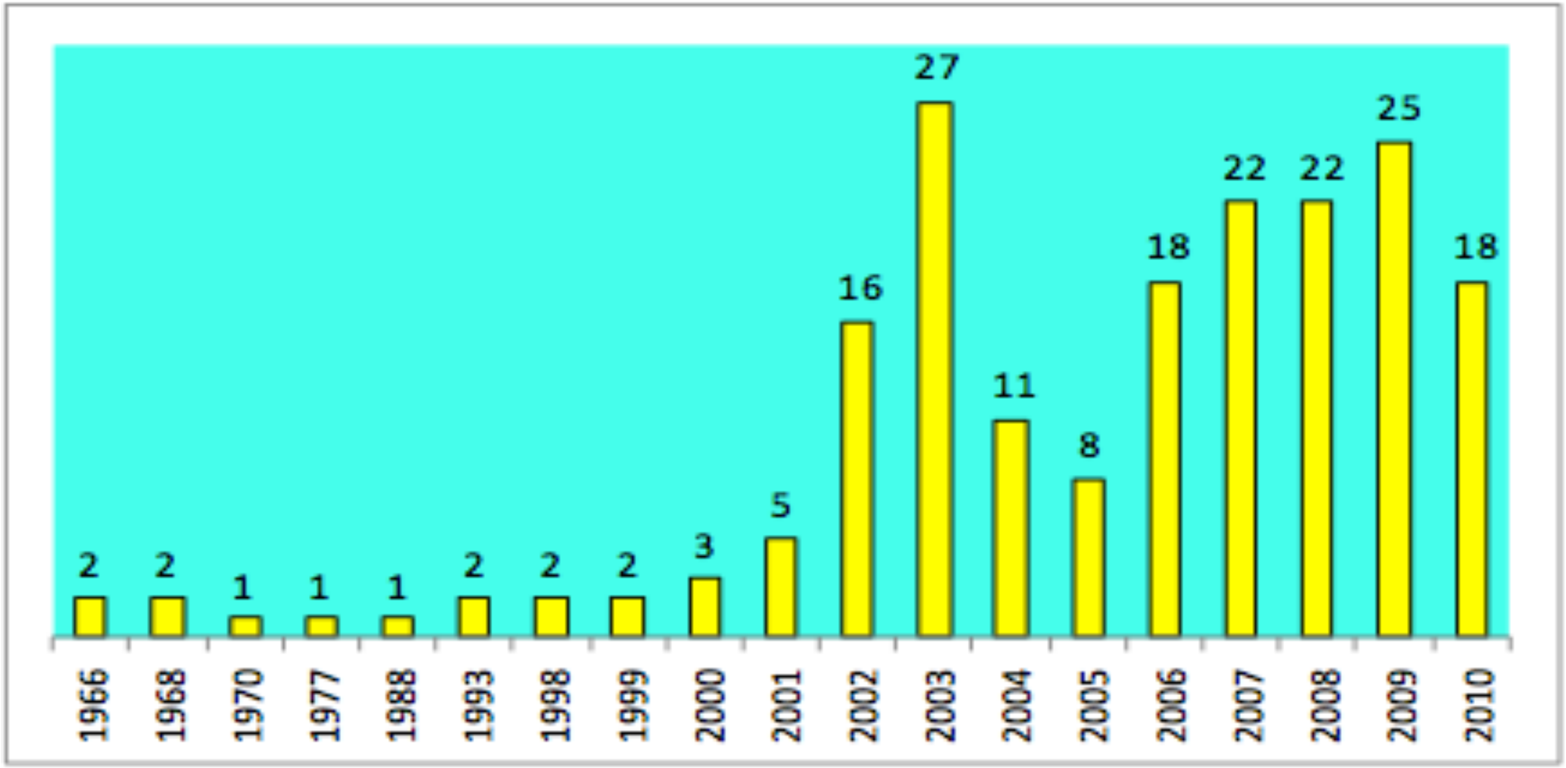


Figure 5.3-3. View of glaciers of Gusarchay basin from satellite

volume changes for glaciers in different geographical regions

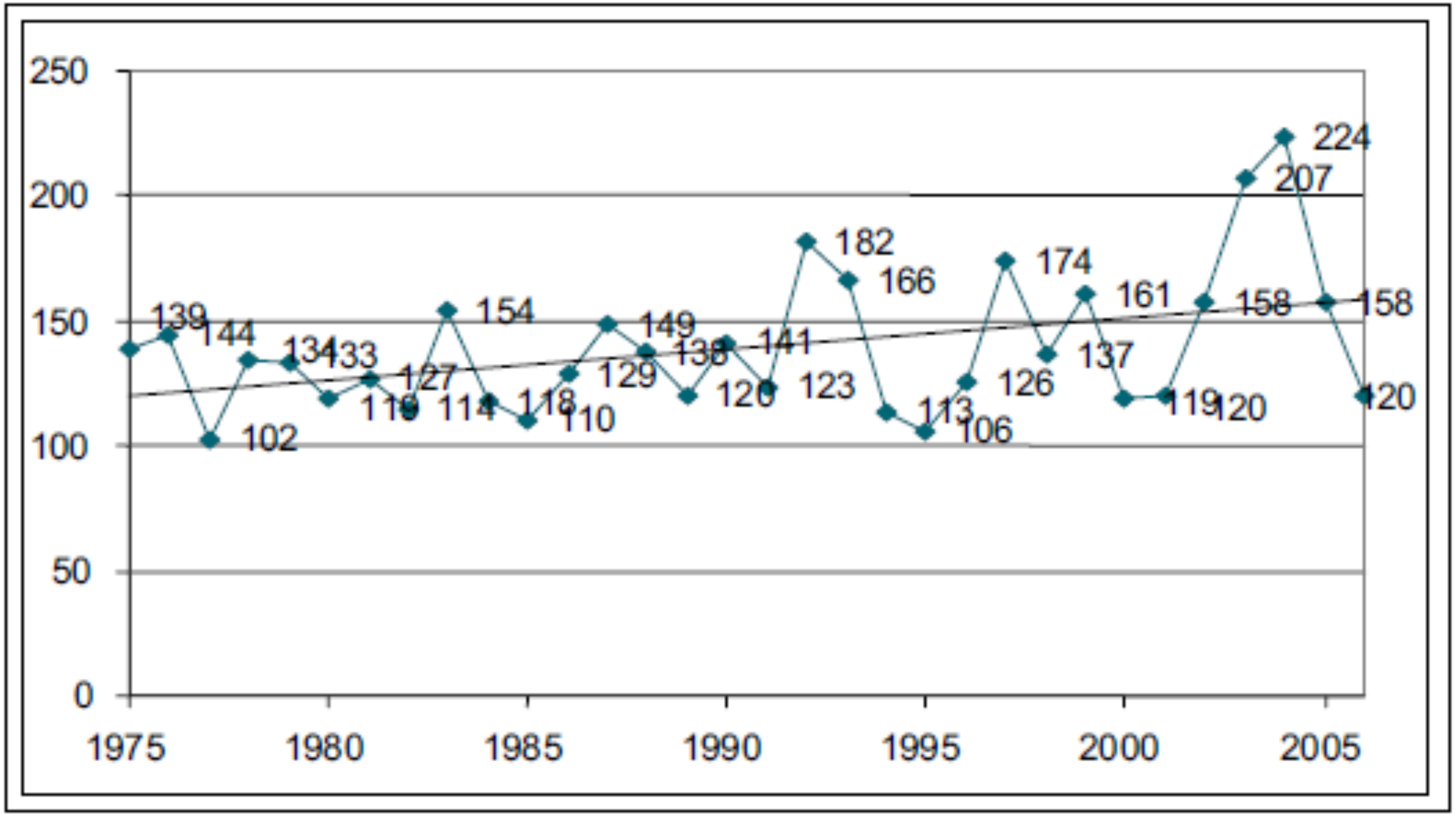


Impact on flooding and mudflows – number of floods in Azerbaijan

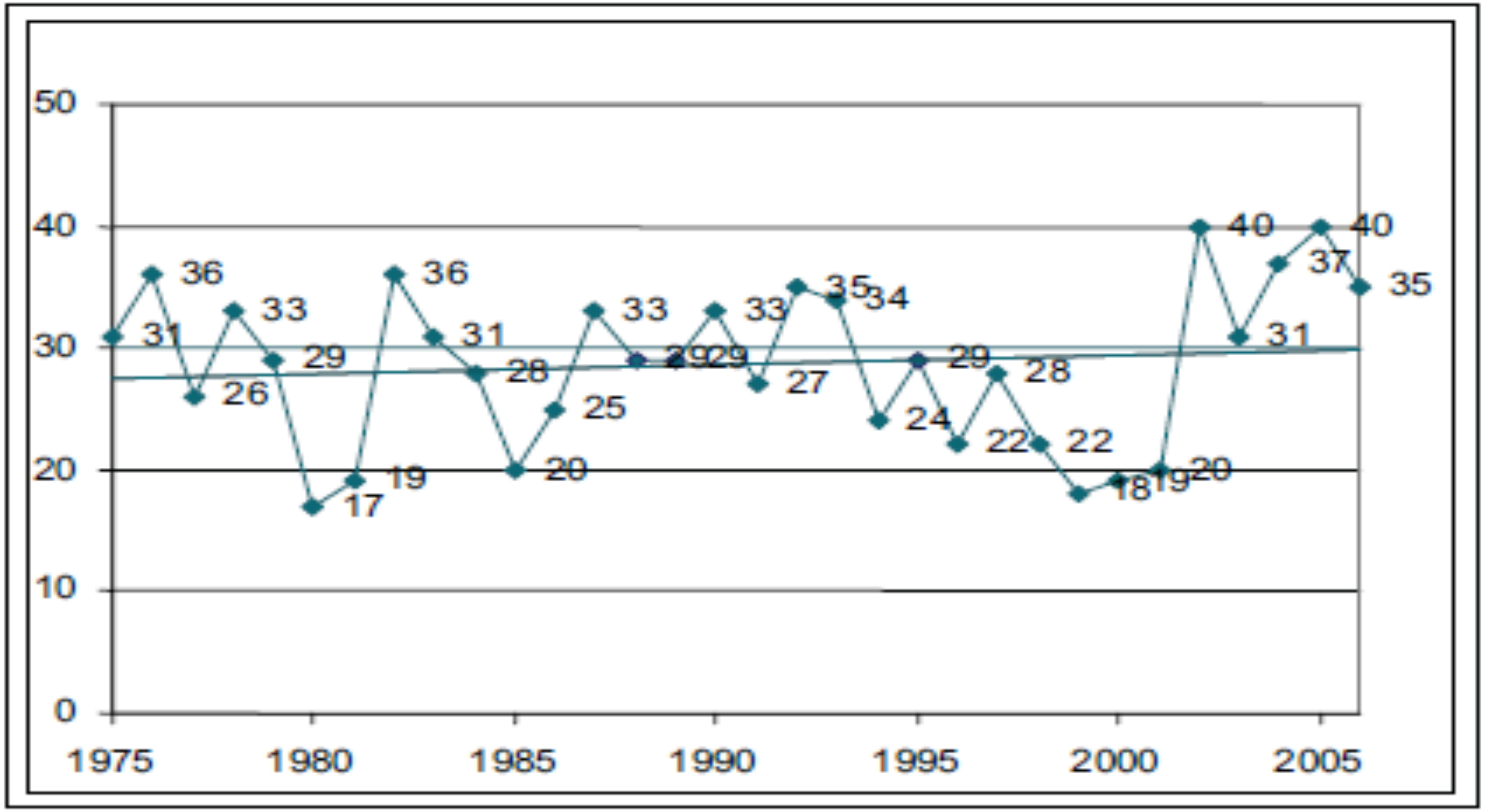


Flooding causes annual economical loss of 18-25 million US

Total Number of Extreme Events/year in Armenia (1975-2006)



Number of Extreme rainfall events/year in Armenia (1975-2006)

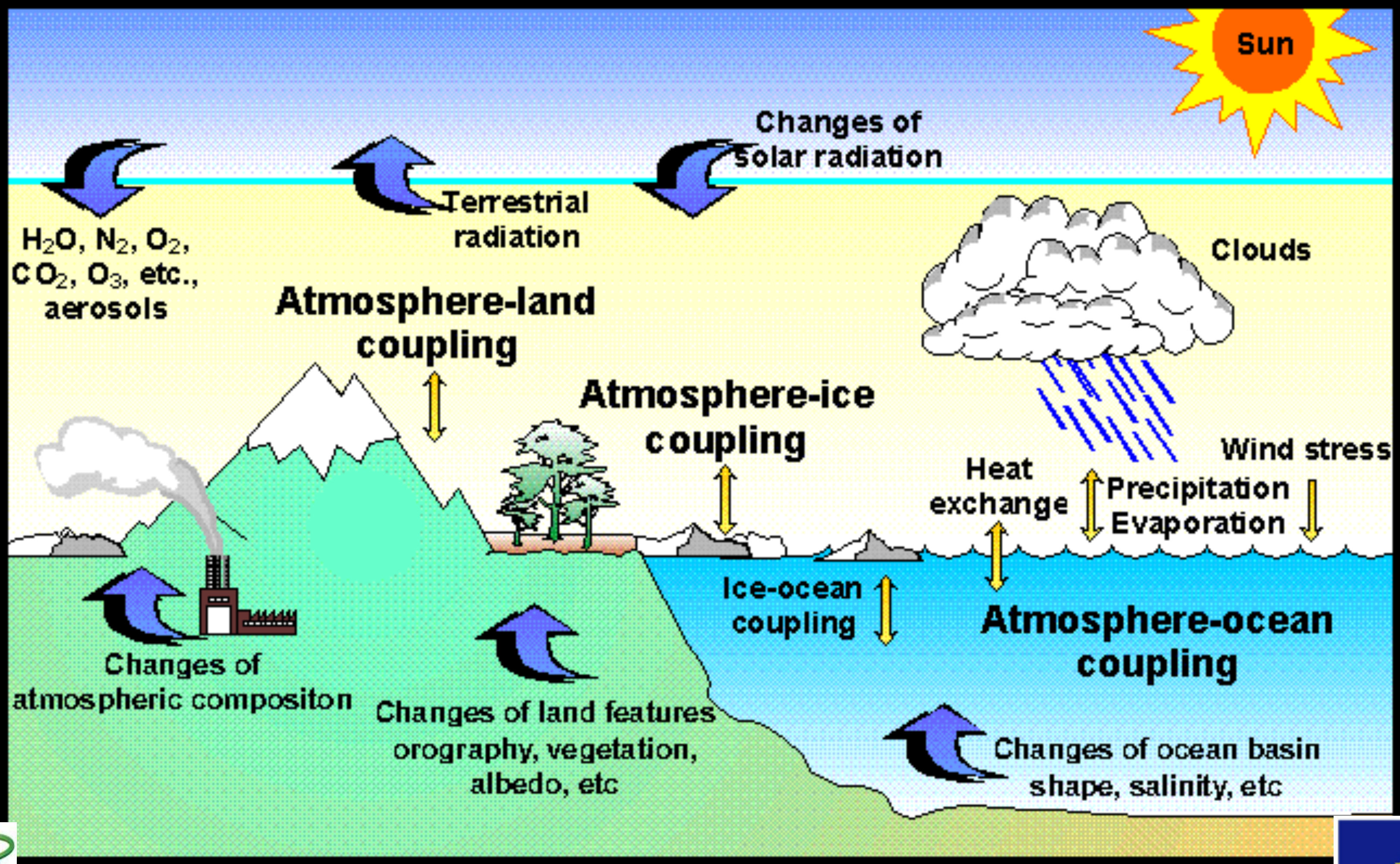


Yes, The Climate is changing in the Region

Then, How can we Predict the Future Changes in the Climate?

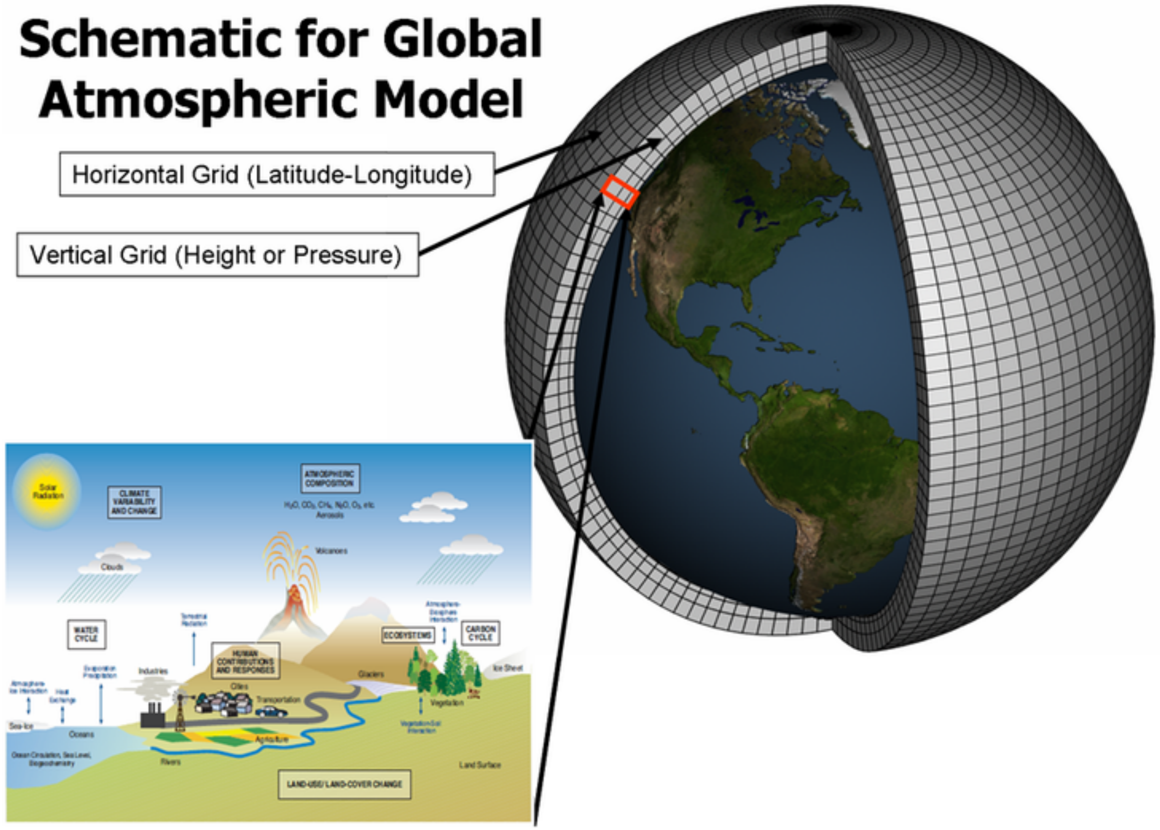
Using the Mathematical Models for Predicting the Future Change in the Climatological Conditions

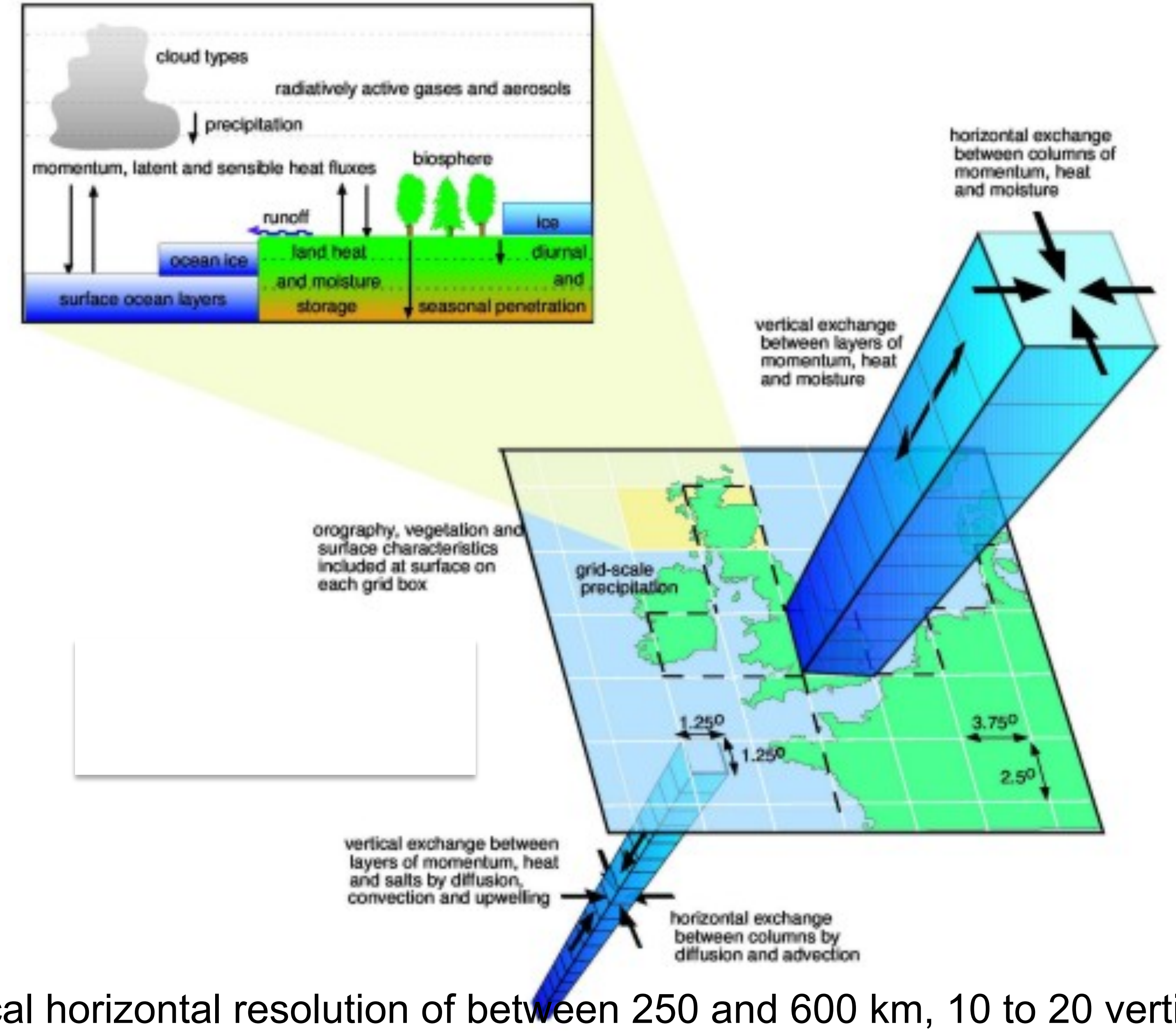
The Climate system



General Circulation Models (GCMs)

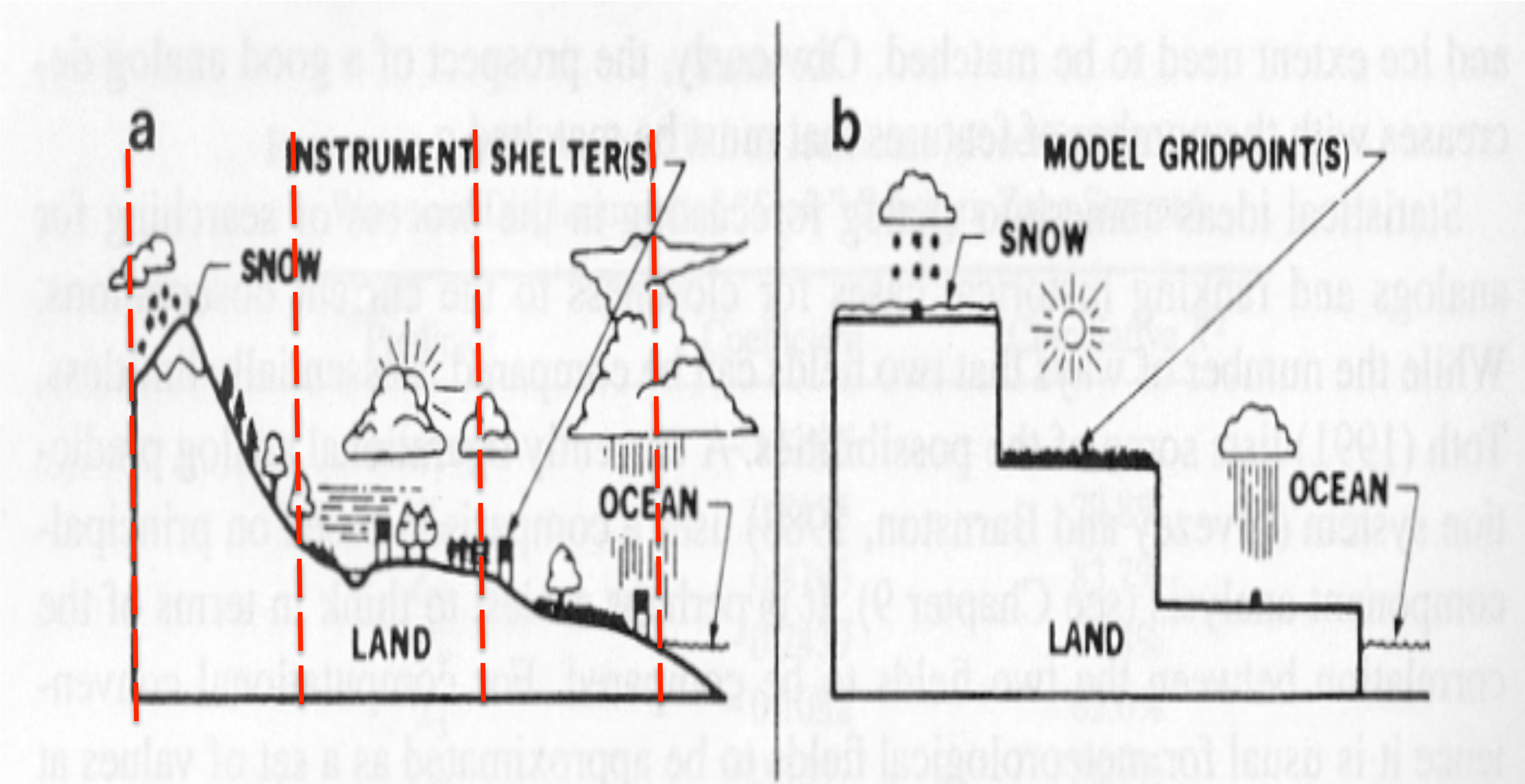
- Numerical models, representing physical processes in the atmosphere, ocean, cryosphere and land surface
- Used to provide geographically and physically consistent estimates of regional climate change





GCM typical horizontal resolution of between 250 and 600 km, 10 to 20 vertical layers in the atmosphere and sometimes as many as 30 layers in the oceans.

The differences between the real world (a) and the world as represented by GCMs (b)



Complexity of GCM

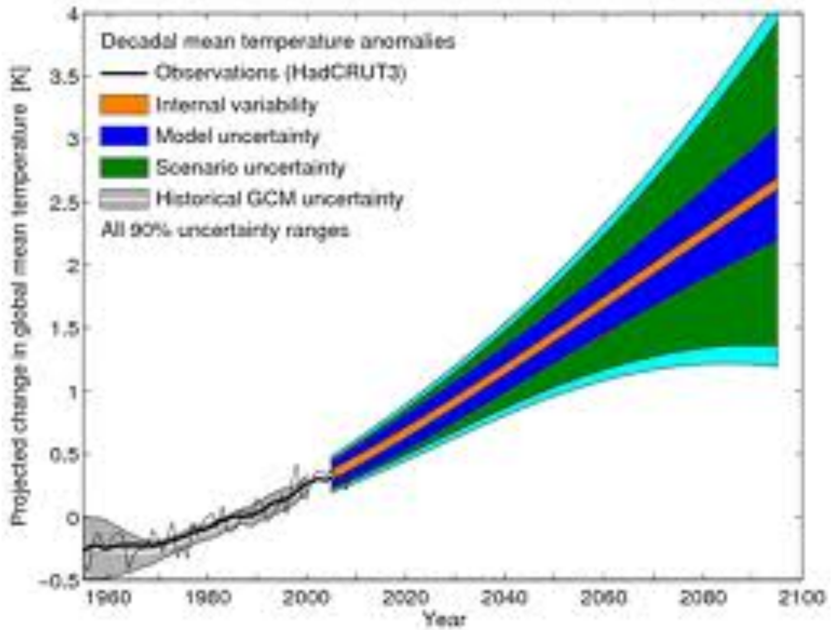
Mid-1960s	Mid 1970s-1980s	1990s	Present Day	2000-2010
Atmosphere/ Land Surface	Atmosphere/ Land Surface/ Vegetation	Atmosphere/ Land Surface/ Vegetation	Atmosphere/ Land Surface/ Vegetation	Atmosphere/ Land Surface/ Vegetation
Ocean	Ocean	Ocean	Ocean	Ocean
	Sea Ice	Sea Ice	Sea Ice	Sea Ice
	Coupled Climate Model	Coupled Climate Model	Coupled Climate Model	Coupled Climate Model
		Sulfate Aerosol	Sulfate Aerosol	Sulfate Aerosol
		Carbon Cycle	Carbon Cycle	Carbon Cycle
			Dust/Sea Spray/Carbon Aerosols	Dust/Sea Spray/Carbon Aerosols
			Interactive Vegetation	Interactive Vegetation
			Biogeochemical Cycles	Biogeochemical Cycles
				Ice Sheet

Hardware Behind the Climate Model

- Geophysical Fluid Dynamics Laboratory

Uncertainty of Global Models

- The large size of the model cell
- many physical processes, such as those related to clouds, cannot be properly modeled
- The difficulty in simulating various feedback mechanisms in models:
  - water vapour and warming,
  - clouds and radiation,
  - ocean circulation and ice and snow albedo.
- For this reason, GCMs may simulate quite different responses to the same forcing



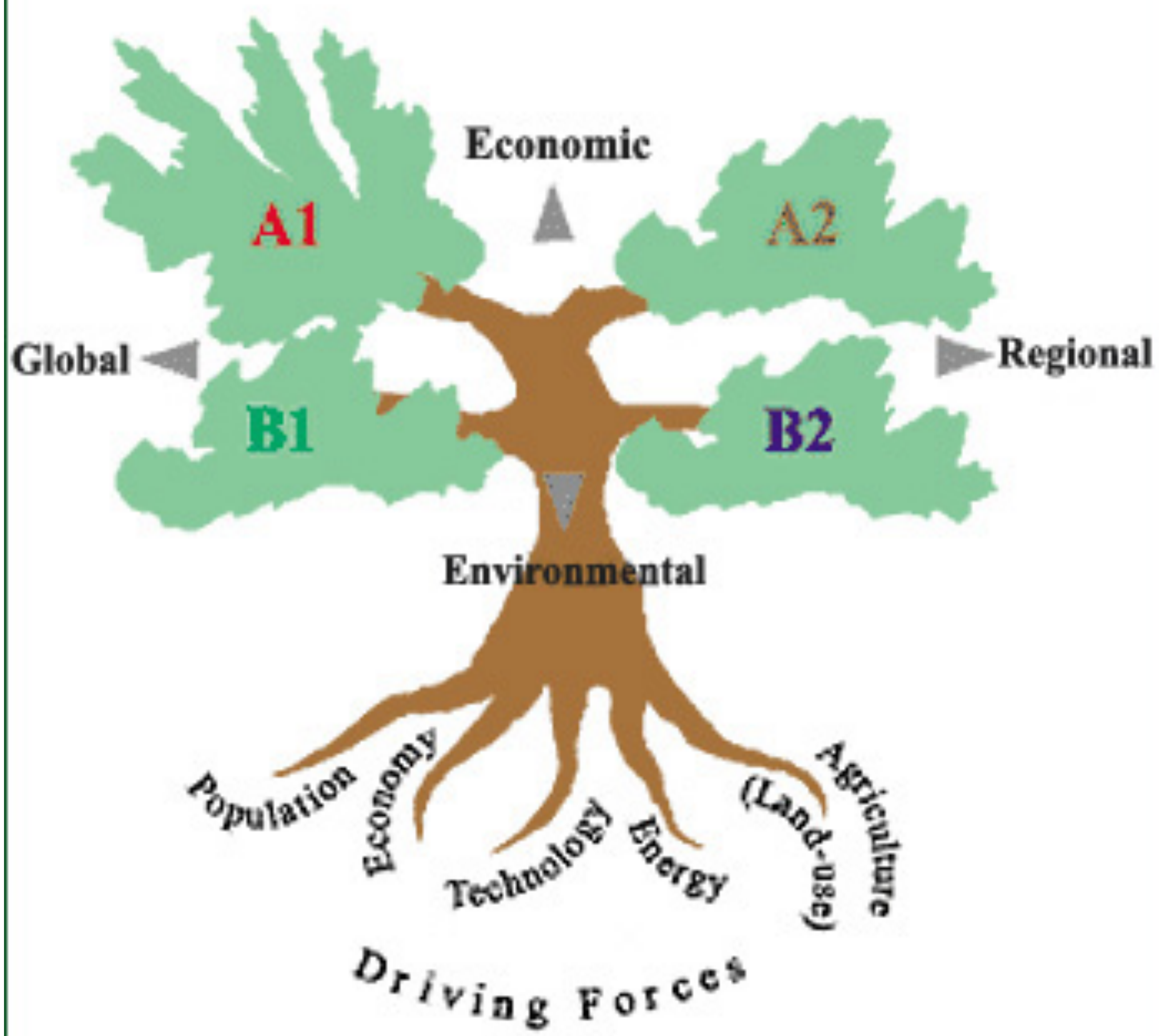
Special Report on Emissions Scenarios (SRES)

It was a report prepared by the Intergovernmental Panel on Climate Change (IPCC) on future emission scenarios to be used for driving global circulation models to develop climate change scenarios.

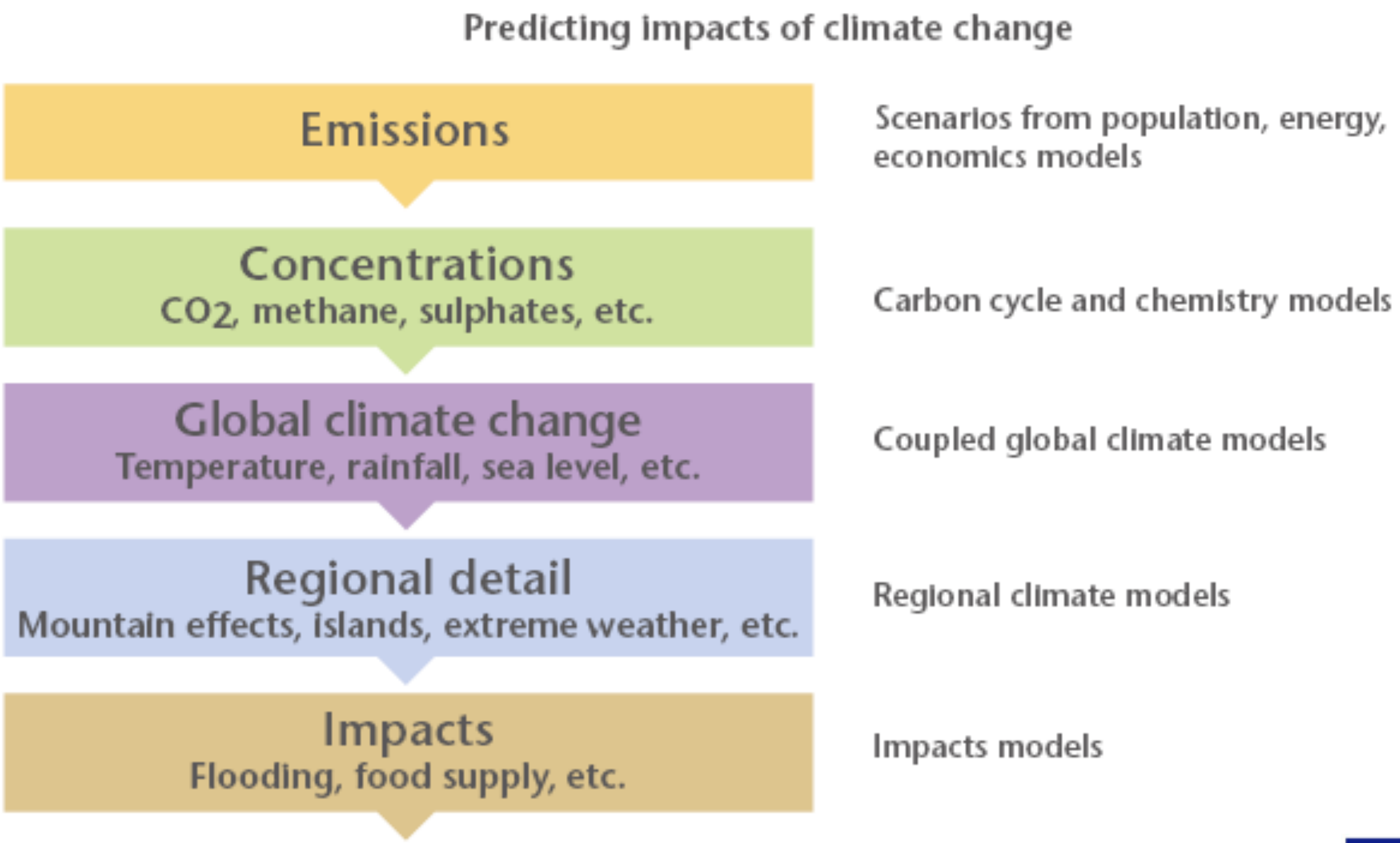
SRES Greenhouse Gas Scenarios

Scenario	Description
A1	very rapid economic growth; low population growth; rapid introduction of new and more efficient technology; economic and cultural convergence and capacity building people pursue personal wealth rather than environmental quality
A2	strengthening regional cultural identities; an emphasis on family values and local traditions; high population growth; less concern for rapid economic development
B1	rapid change in economic structures "dematerialization" and introduction of clean technologies; emphasis on global solutions to environmental and social sustainability; concerted efforts for rapid technology development; dematerialization of the economy
B2	emphasis on local solutions to economic, social, and environmental sustainability; a heterogeneous world with less rapid, and more diverse technological change; strong emphasis on community initiative

SRES Scenarios



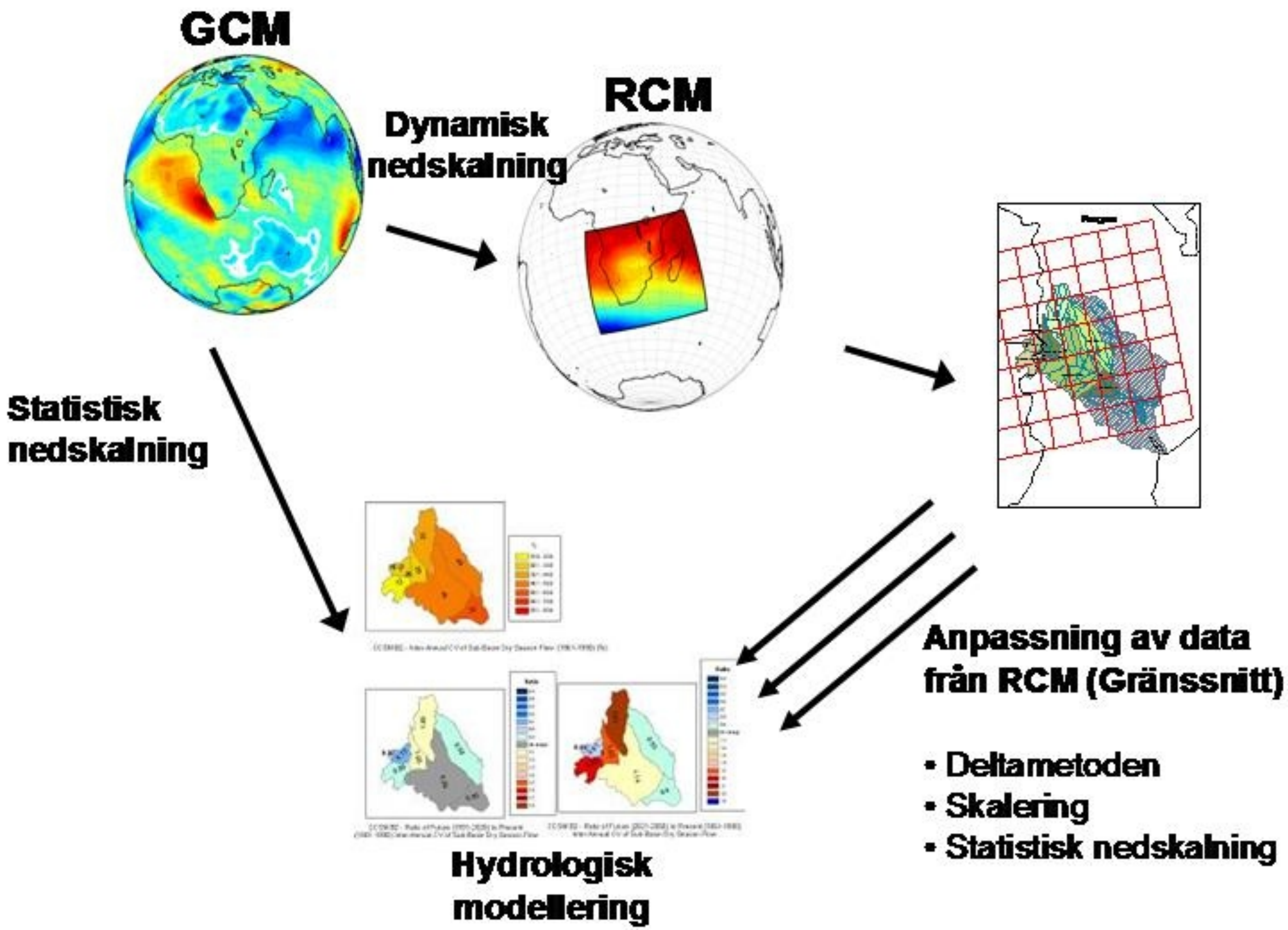
Regional details of Climate Change Modeling Process



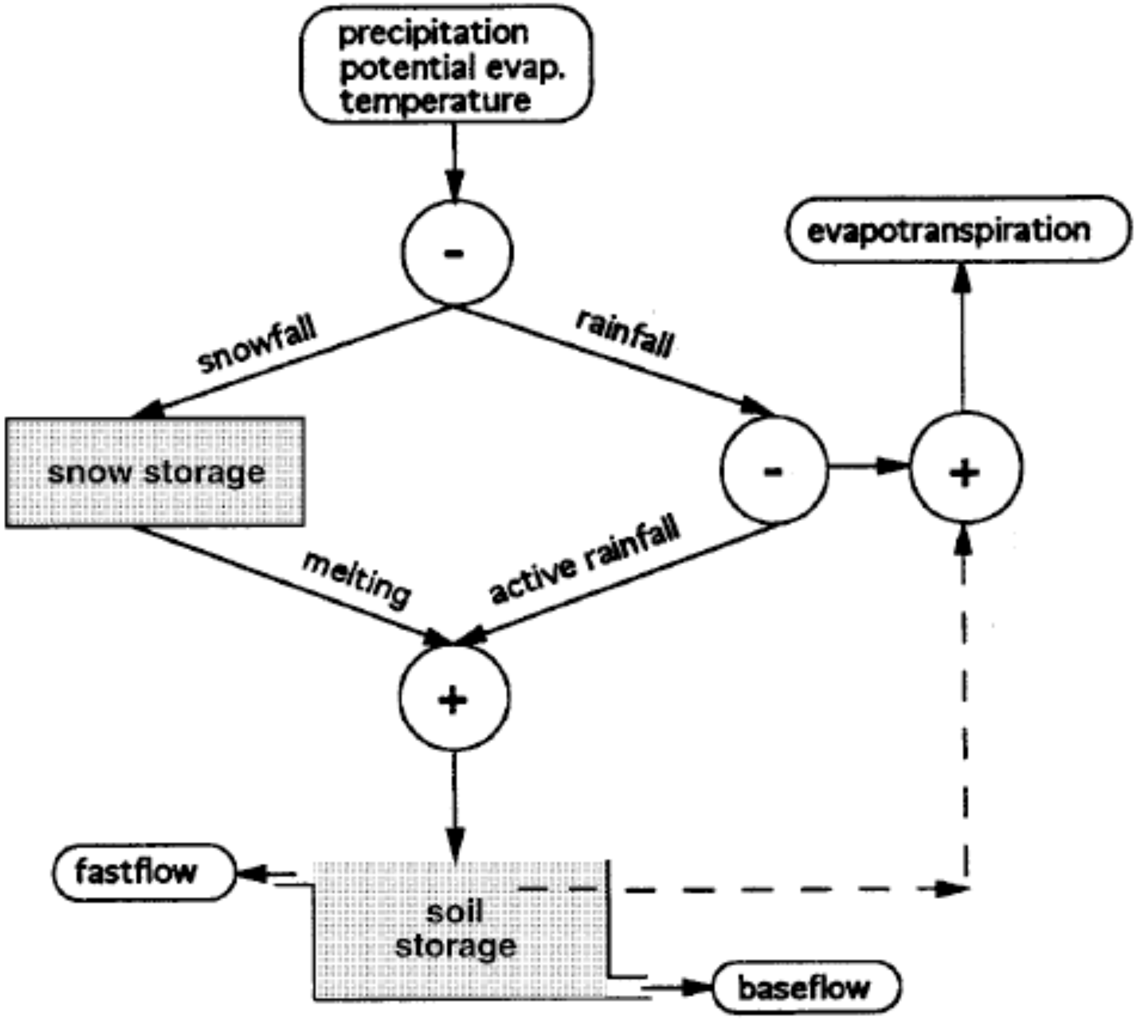
Downscaling Models

- **Primary Goal**: To produce local to regional scale climate information, generally from coarse-resolution global-scale climate models
- **Secondary Goal**: To improve the reliability of short timescale climate information
- **DOWNSCALING RESULTS**: Effects of increasing spatial resolution on:
  - precipitation patterns
  - precipitation extremes
  - snow depth simulation

The Regional Climate Models (RCM)



Modeling the Impacts of Climate Change on Water Resources



Potential Impacts of Climate Change on the region

Projected change in mean annual Precipitation

% change (2080-2099 vs 1980-1999)

Model	Armenia (%)	Azerbaijan (%)	Georgia (%)
HadCM3	-22	-10	-11
ECHAM5	-20	-5	0
GFDL 2.1	-31	-15	-24
GISS ER	-20	-23	-20

- All models project that all three countries will experience precipitation declines by the end of the century
    - 20 – 31% in Armenia,
    - 5- 23% in Azerbaijan,
    - 0 – 24% in Georgia

Projected change in mean annual Temperature

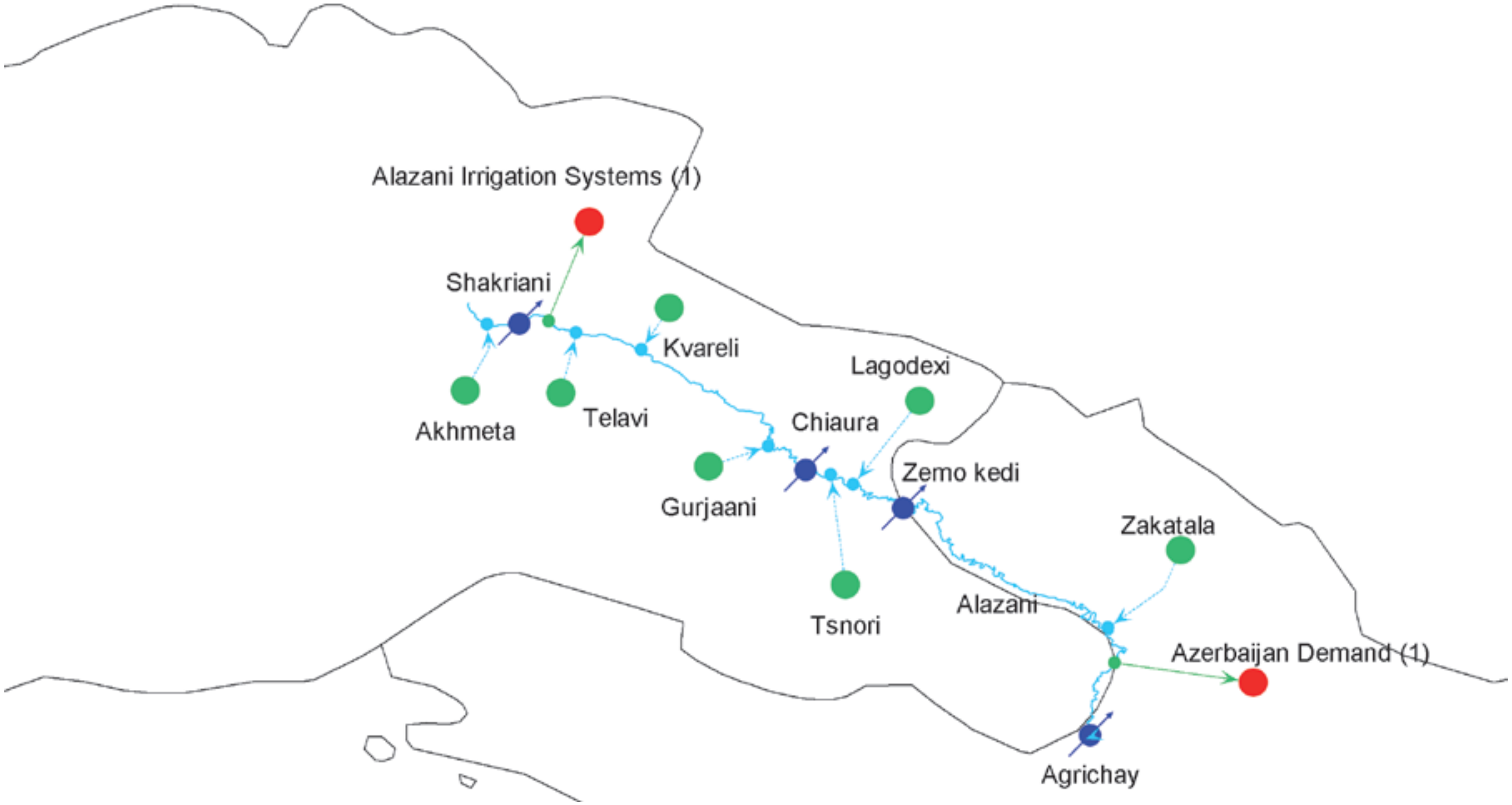
% change (2080-2099 vs 1980-1999)

Model	Armenia (ºC)	Azerbaijan (ºC)	Georgia (ºC)
HadCM3	5.5	4.1	5.5
ECHAM5	5.2	4.0	4.3
GFDL 2.1	4.4	3.6	4.1
GISS ER	4.8	4.1	4.8

- it is projected that the whole region will experience a significant rise it mean annual Temperature by the end of this century:
  - In Armenia 4.4 ºC – 5.5 ºC,
  - In Azerbaijan 3.6 ºC – 4.1 ºC,
  - In Georgia 4.1 ºC – 5.5 ºC

Impact of Climate Change on Transboundary Rivers

Alazani (Ganikh) River



Forecasted reduction of hydrological flow due to climate change

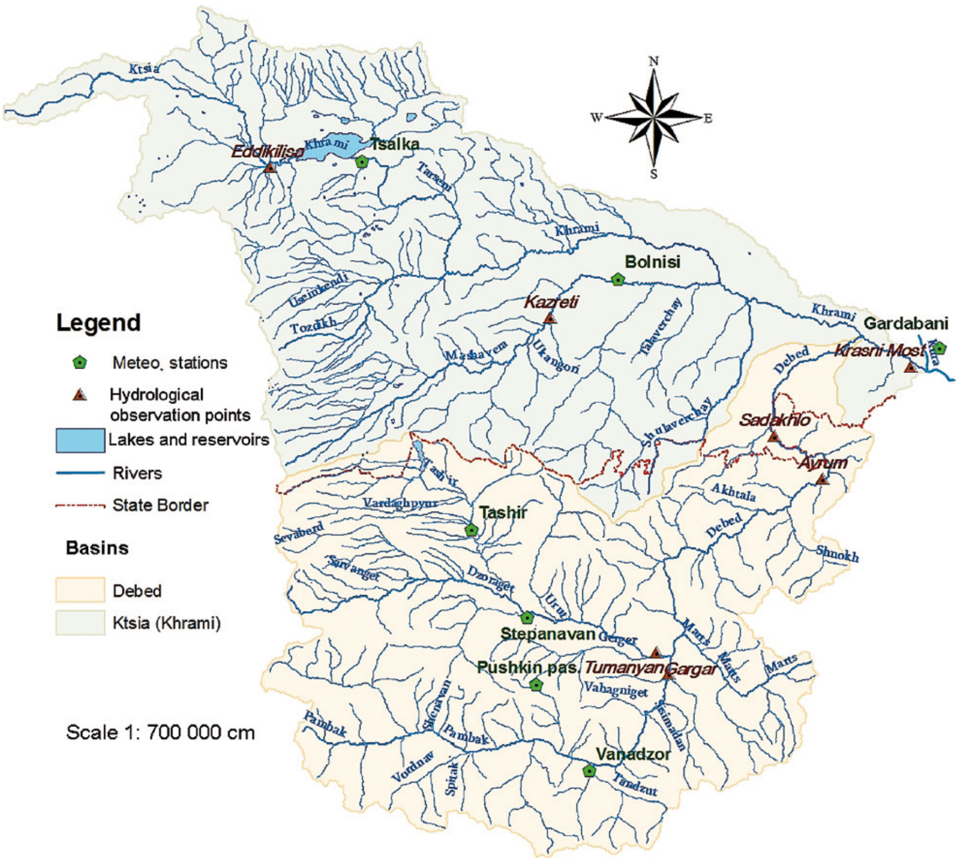
The Alazani (Ganikh)River

Streamflow gauge	Baseline 1960-1990 (million m3)	Change 2020 – 2050 vs Baseline (million m3)	Change 2070 – 2100 vs. Baseline (million m3)	Change 2020 – 2050 vs. Baseline (%)	Change 2070 – 2100 vs. Baseline (%)
Shakriani	1336	-508	-356	-38%	-27%
Chaiura	1874	-821	-482	-44%	-26%
Zemo kedi	3118	-1439	-873	-46%	-28%
Agrichay	35012	-2060	-1229	-59%	-35%

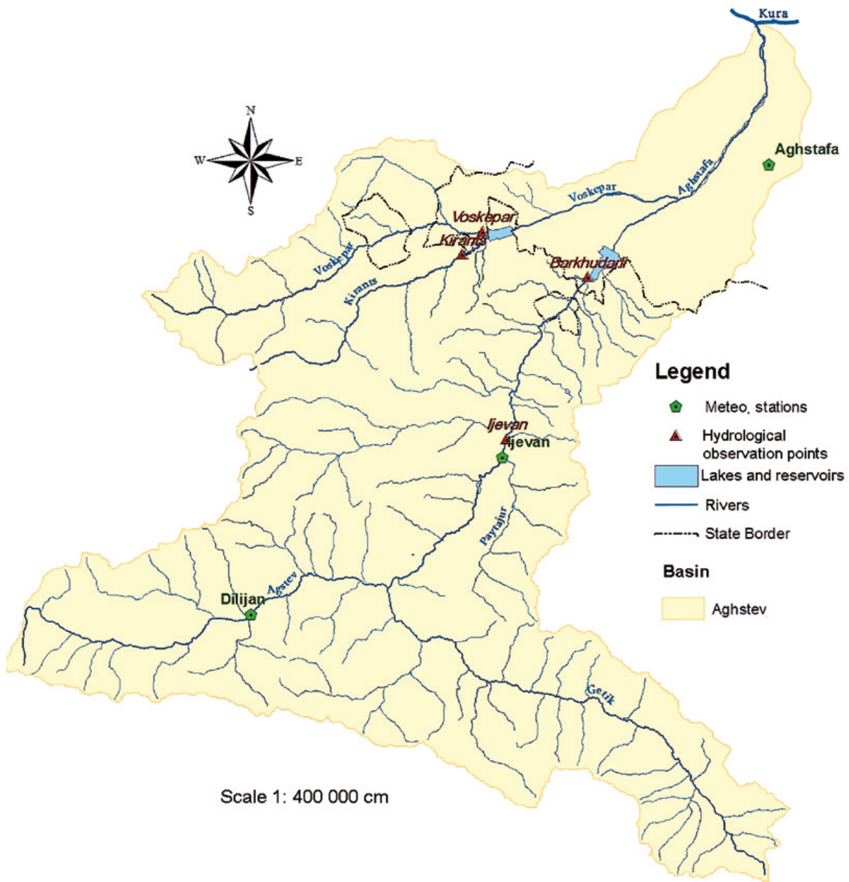
streamflow is projected to decline dramatically:
26 - 35% in the Alazani (Ganikh)
by the end of this century

Khrami & Aghstev River Basins

The Khrami-Debed River Basin



The Aghstev River Basin



Forecasted reduction of hydrological flow due to climate change

Aghstev Basins

Hydological Station	1961 - 1990	2011-2040 million m3 (%)	2041-2070 million m3 (%)	2071-2100 million m3 (%)
Barkhudarli (Aghstev River)	255	225 (-12)	177 (-31)	104 (-59)
Ijevan (Aghstev River)	286	255 (-11)	196 (-31)	108 (-62)
Voskepar (Kirants River)	67	58 (-14)	42 (-37)	19 (-72)

streamflow is projected to decline by
59 - 72% in the Aghstev River
by the end of this century

Forecasted reduction of hydrological flow due to climate change

Khrami-Debet River Basin

Hydrological Station	1961 – 1990 million m3 (%)	2011-2040 million m3 (%)	2041-2070 million m3 (%)	2071-2100 million m3 (%)
Ayrum (Debed River)	1054	937 *(-11)*	669 *(-37)*	402 *(-62)*
Gargar (Dzoraget River)	480	427 *(-10)*	343 *(-29)*	215 *(-55)*
Sadakhlo (Debed River)	924	819 *(-11)*	585 *(-37)*	365 *(-61)*
Tumanyan (Pambak River)	336	300 *(-11)*	240 *(-29)*	160 *(-53)*
Yeddikilisa (Khrami River)	267	242 *(-9)*	201 *(-25)*	147 *(-45)*

stream flow is projected to decline by 45 - 62% in the Khrami-Debet by the end of this century

Empowered lives.
Resilient nations.

Impact of Climate Change on Agriculture Water Demands

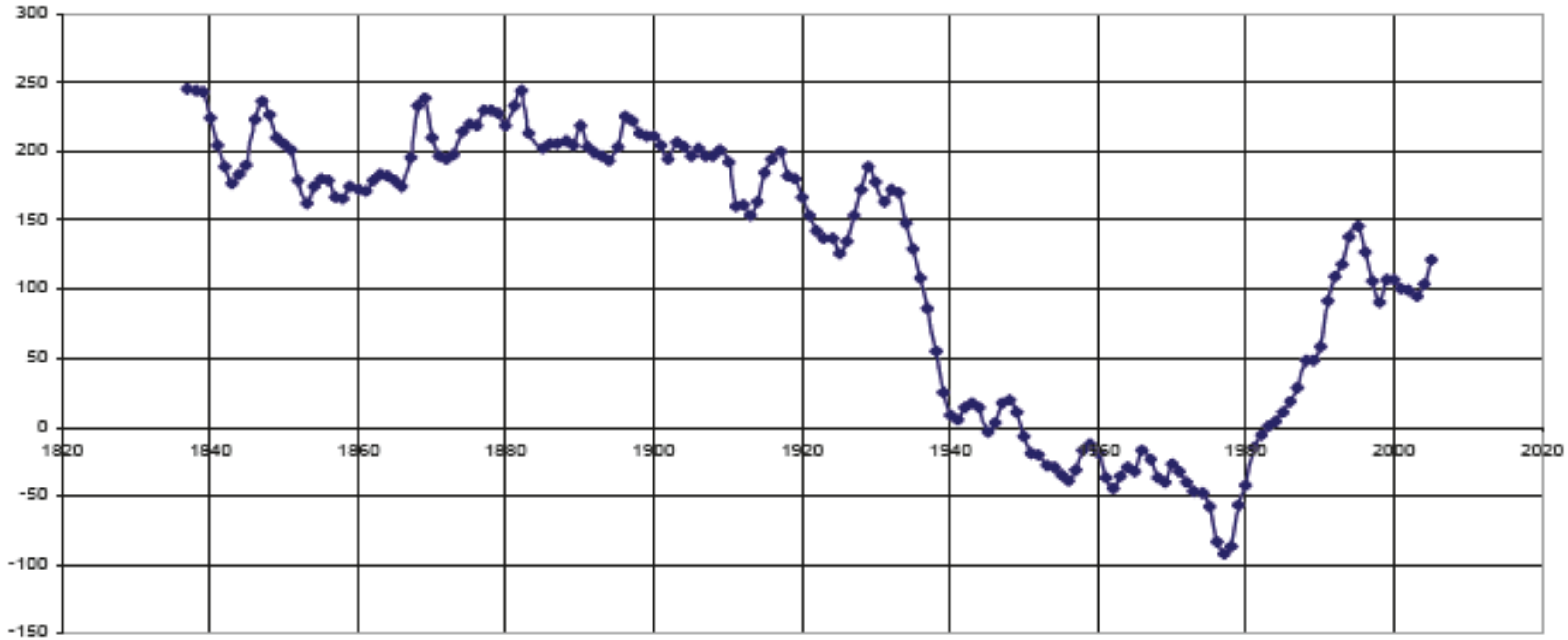
Projected impact on Crop Water Requirements by the end of this century

- ***In the Ararat Valley***
  - *crop water requirements (CWR) for winter wheat and vegetables are projected to increase 19 – 22% and 19 – 23%, respectively, compared to 1967 – 1982*
  - *irrigation water requirement (IWR) is projected to increase 35% - 36% and 38% - 42% for winter wheat and vegetables, respectively.*
- ***In Belakan***
  - *there is expected a slight increase in CWR,*
  - *but IWR is projected to increase from near zero to about 50 mm and 110 mm for spring wheat and pasture, respectively (2076 - 2100 vs. 1998 – 2010).*
- ***for Dedoplistskaro***
  - *irrigation requirements for winter wheat, pasture and sunflower are expected to increase 114%, 82%, and 50%, respectively, compared to the 1991 – 2005*

Forecasted water quality changes due to climate change (increase in BOD_5)

River-observation point	Baseline (mg/l)	2011-2040 (mg/l)	2041-2070 (mg/l)	2071-2100 (mg/l)
Pambak-Vanadzor	7.7	9.5	12.0	17.8
Debed-Ayrum	6.0	7.4	10.4	17.4
Dzoraget-below Gargar	0.7	0.9	1.1	1.8
Khrami-Red Bridge	6.7	8.3	10.4	16.4
Aghstev-Barkhudarli	7.0	8.8	11.3	20.4
Aghstev-Ijevan	6.5	8.1	10.5	19.0
Voskepar-Kirantz	0.3	0.4	0.6	1.3

Impact on Coastal areas



- Sea Level in Caspian Sea Fluctuated between -25 mBS to -30 mBS since year 1830

Caspian Sea Level Rise

Table 5.3-2. Area of inundated lands at two different levels of the Caspian sea, by zones

Zone	Length of the coastline, km	Inundated area, km^2	
		-26.50 mBS	-25.00 mBS
From the Samur river to the Absheron peninsula	152.4	42.3	71.7
Absheron peninsula	289.6	38.2	60.1
From the Absheron peninsula to the Kura river mouth	208.3	372.3	1118.0
From the Kura river mouth to the Astara river	87.7	31.7	59.8
Total	**738.1**	**484.5**	**1309.6**

- The maximum Sea Level rise in Caspian Sea (-25 mBS) would case an economical loss of 4.1 Billion USD

Malaria is back to the Region

- In Armenia, malaria was exterminated in 1960 but reappeared after 1996 where 1156 cases was recorded in 1998
- Also in Georgia, the first cases of malaria were detected in 1996 and between 1998 and 2002 the number of cases increased 30-fold.
- An alarming upsurge in malaria in Azerbaijan also occurred during the mid-1990s with more than 13,000 cases reported in 1996.
- Although the situation with malaria since then has been brought under control, increasing risks due to climate change impacts on water resources in particular are looming.
- other infectious diseases are likely to spread as a result of the climate change

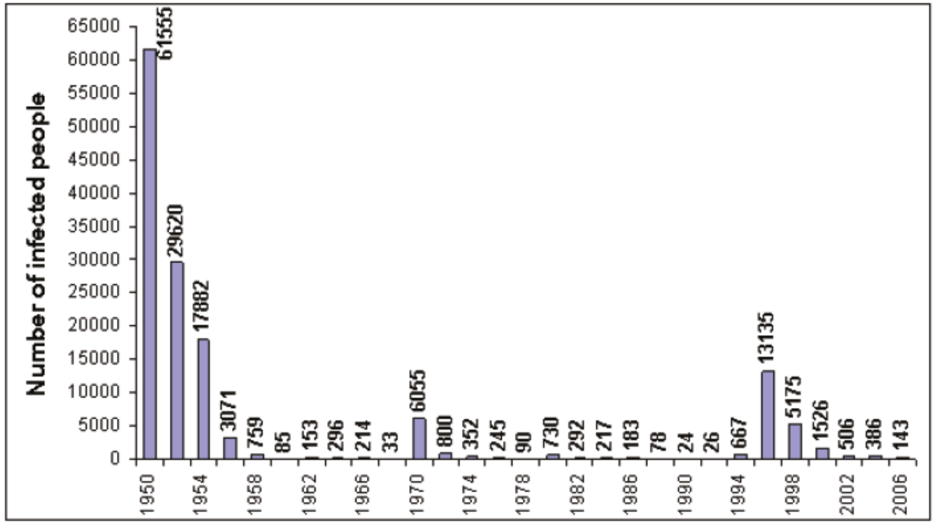


Figure 5.3-6. The number of people in Azerbaijan first time infected with malaria

Thank you

Climate Change Adaptation in the Caucasian Region

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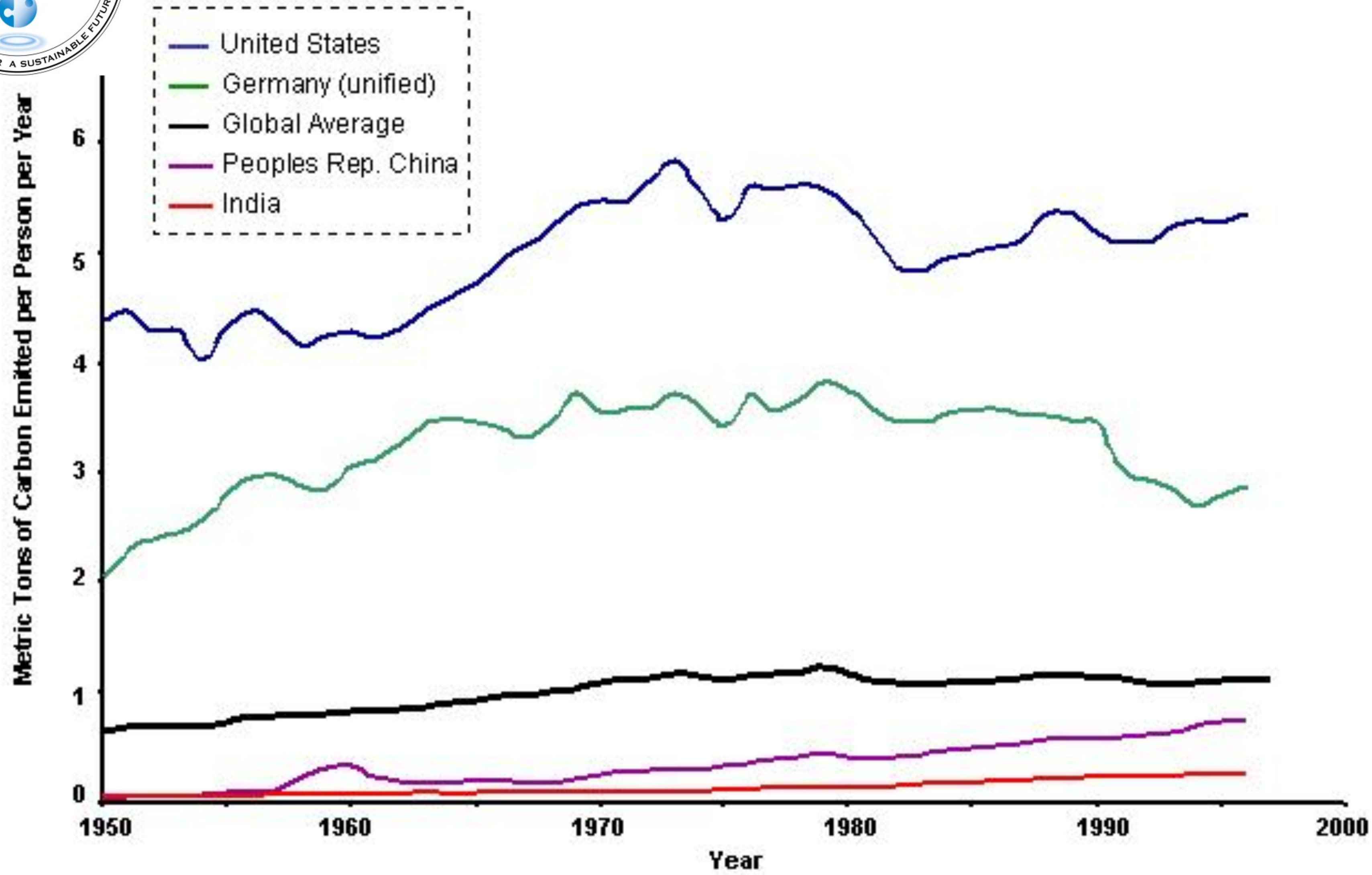
International Agreement to combat Global Warming

- In 1970 First World Climate Conference
- In 1988 The establishment of the Intergovernmental Panel of Climate Change (IPCC)
- In 1992 The Framework Convention on Climate Change signed in Rio Summit
- In 1997 The COP3 Adopted the Kyoto Protocol for GHG Emission Reduction

Kyoto Protocol Principals

- Industrialized countries undertake several commitments to reduce GHG emissions by at least 5% below 1990 levels by year 2008-2012
- No commitments from Developing Countries
- Creation of the Clean Development Mechanism (CDM)
- The establishment of the Carbon Trade Stock Market

Per Capita Emission Estimates



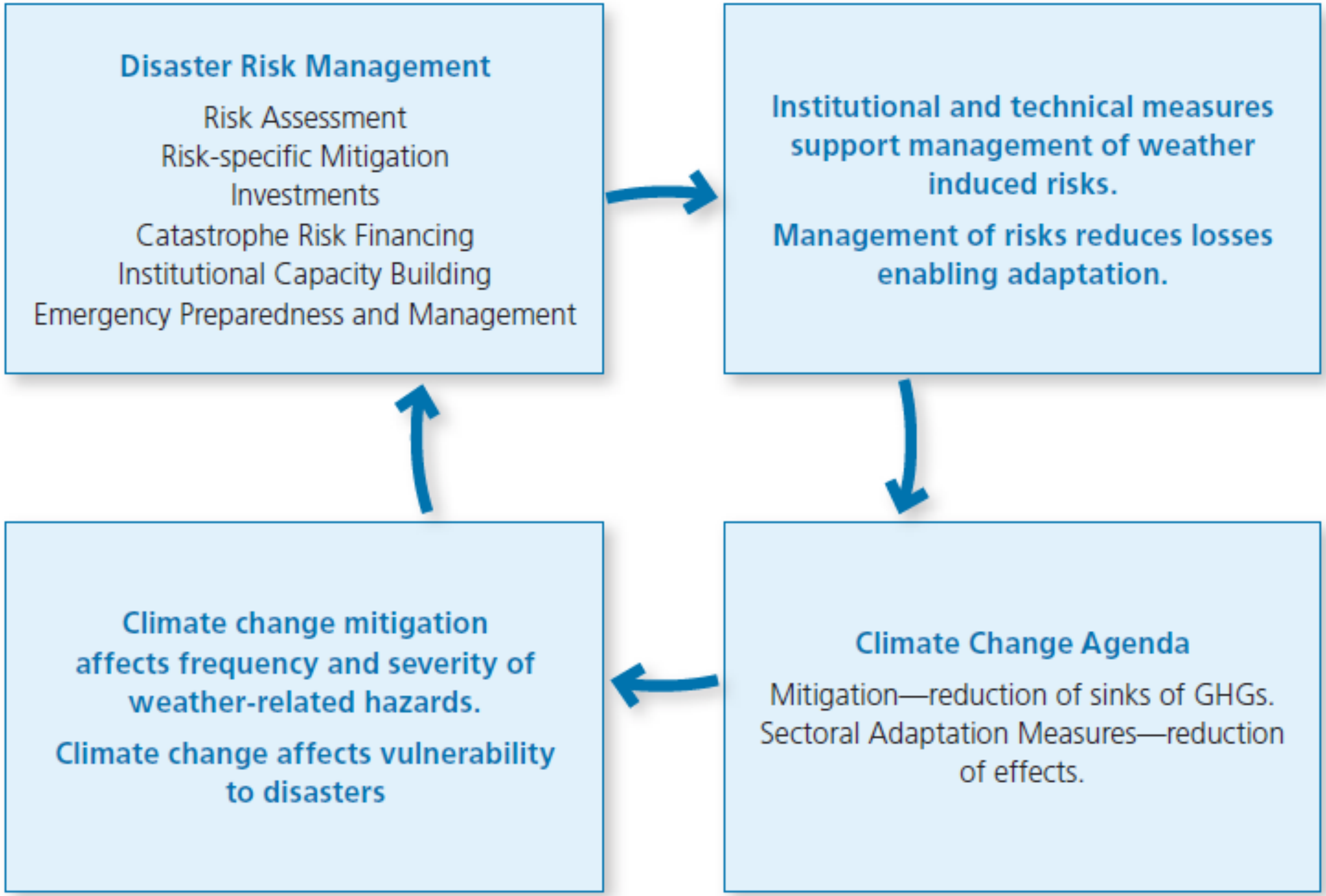
Source: Marland, *et.al.*

Top Ten Emitters

(In 2010)

1. China:	7,711 MT	25.4%
2. US:	5,425 MT	17.8%
3. India:	1,602 MT	05.3%
4. Russia:	1,572 MT	05.2%
5. Japan:	1,098 MT	03.6%
6. Germany:	766 MT	02.5%
7. Canada:	541 MT	01.8%
8. S.Korea:	528 MT	01.7%
9. Iran:	527 MT	01.7%
10. UK:	520 MT	01.7%

Climate Change and Disaster Risk Management



What we can do to address climate change? Adaptation and mitigation?

Adaptation is necessary…………..

Area of Adaptation

- Physical
- Institutional
- Social

Adaptation

some specific measures

Water supply, irrigation, and drainage systems:

- Provide economic incentives for irrigation improvement projects, advanced micro-irrigation technology, such as sprinklers and drip irrigation, can reduce water consumption by 30 to 70%
- increased efforts and financing for breeding drought resistant crops, particularly wheat
- integrating livestock, horticulture and specialized agriculture

Options for Adaptation

- effective monitoring of water usage in the basins
- Other water conserving techniques include mulching and conservation tillage
- Apply Municipal water conservation measures:
  - water metering,
  - rainwater harvesting,
  - higher efficiency appliances (e.g. faucets and toilets),
  - wastewater re-use
- regional cooperation of all three countries is *essential* for effective climate change adaptation in the transboundry river basins

Adaptation

some specific measures

Mitigate the combined effects of land degradation and climate change:

- The improvement and rehabilitation of irrigation systems
- The planting of windbreaks to reduce soil erosion.
- Measures to increase productivity
  - weed control,
  - ploughing and seeding of degraded areas with new seed types,
  - the removal of stones in pastures.
- Ameliorating soil fertility through the use of gypsum in alkali soils and chemical fertilizers in saline soils.
- Increasing water storage during the May – October months.

Adaptation

Some specific measures

- **Use near-term climate prediction:**
  - Accurate six-month to one-year forecasts could possibly reduce losses due to weather variability.
- **Other management adjustments:**
  - Virtually all components of the farming system from planting to harvesting to selling might be modified to adjust to climate

Adaptation: Institutional Measures

- Improved/good governance, including active civil society and open, transparent and accountable policy and decision making processes
- Mainstreaming climate change, climate issues into all national, sub-national, and sectoral planning processes (e.g. PRS, National Strategies for Sustainable Development)
- Community empowerment, they can participate in the assessment and feed their knowledge to provide useful climate-poverty information
- Access to good quality information, Early warning system helps to prevent disaster impacts
- Reducing vulnerability of resource base to climate change, variability and extreme events (e.g. embankment to protect from floods, cyclone centre, etc)

Adaptation: Institutional Measures

- Providing Knowledge and Advice (e.g. agriculture extension for farmers)
- Giving technology (e.g. water pumps for irrigation, nets for fishing etc)
- Building climate proof infrastructure (e.g. roads, water etc.)
- Providing School and Education (e.g. free education)
- Providing health services (e.g. free for poor)
- Climate change fund/budget

Current CC Financing Initiatives

Existing International Financing Initiatives

- Multilateral Initiatives
  - Global Environment Facility: SCCF; LDCF; SPA
  - Adaptation Fund
  - African Development Bank: CEIF; CBFF
  - UNDP: UN-REDD Programme (FAO, UNDP, UNEP); MDG Achievement Fund (MDG-F)
  - World Bank: Climate Investment Funds

- Bilateral Initiatives
  - Cool Earth Partnership (CEP, **Japan**)
  - Environmental Transformation Fund: International Window (ETF-IW, **UK**)
  - Global Climate Change Alliance (GCCA, **European Commission**)
  - International Climate Initiative (ICI, **Germany**)
  - International Forest Carbon Initiative (IFCI, **Australia)**
  - Etc.

Current CC Financing Initiatives

The Clean Development Mechanism (CDM)

- Twofold aim:
  - Mitigation for AI Parties
  - Sustainable Development for DCs
- Estimated at US$ 7.4 billion
- Expected exponential growth

- Marginal impact:
  - Poor regional distribution: only 2% of projects globally

Current CC Financing Initiatives

Azerbaijan Project proposals on CDM

#	Sector	Number of project proposals	GHG reduction rate, thousand tons/year CO_2 eq.
1	Energy, including	17	13675,4
2	Alternative energy	9	1775,0
3	Agriculture	2	3331,0
4	Wastes	3	287,1
5	Forestation and afforestation	3	62,7
	Total	**34**	**19131,2**

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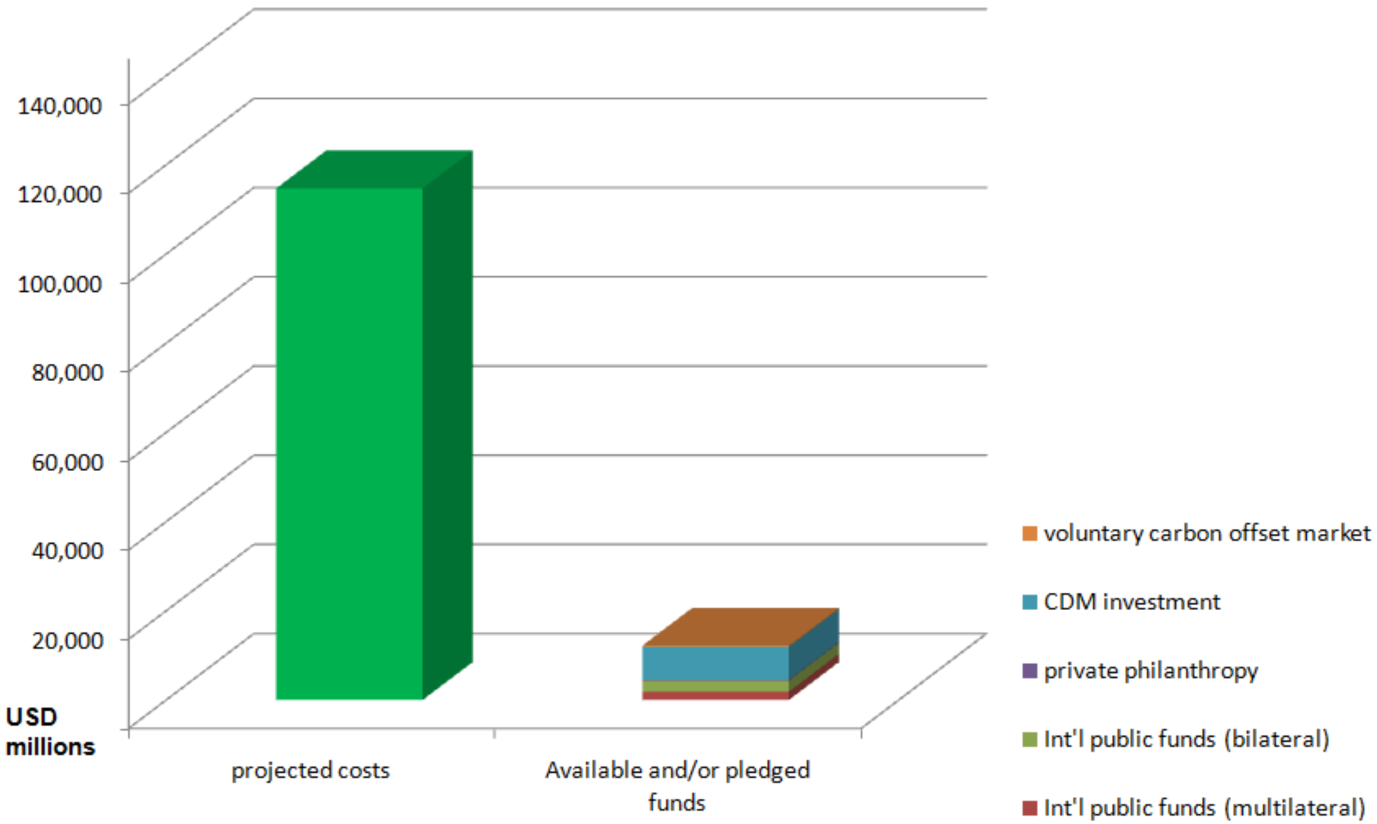
Current CC Financing Initiatives

The Funding Gap in current funding initiatives

Climate change finance in developing countries: costs vs. funds available (per annum)

Sources: www.climatefundsupdate.org, Capoor & Ambrosi (2008), Design to Win (2007)



Post-Kyoto

- Negotiators picked up discussions toward a new global climate treaty in Bonn, Germany this week.
- In the 2011 17th Conference of the Parties (COP17) in Durban, leaders initially agreed to put together a plan that would limit Earth-warming emissions.
- negotiators have set goals of building support for funding developing nations to the tune of $100 billion a year by 2020

Post-Kyoto

- Negotiators picked up also constructing a global, legally binding climate agreement that extends the Kyoto Protocol.
- While countries agreed in Durban to sign the deal by 2015
- The European Union and groups of developing countries are divided over details of how the Kyoto Protocol should be extended.
- Qatar will host the next round of annual climate negotiations in November 2012.

Thank you