Government of Pakistan

Ministry of Climate Change

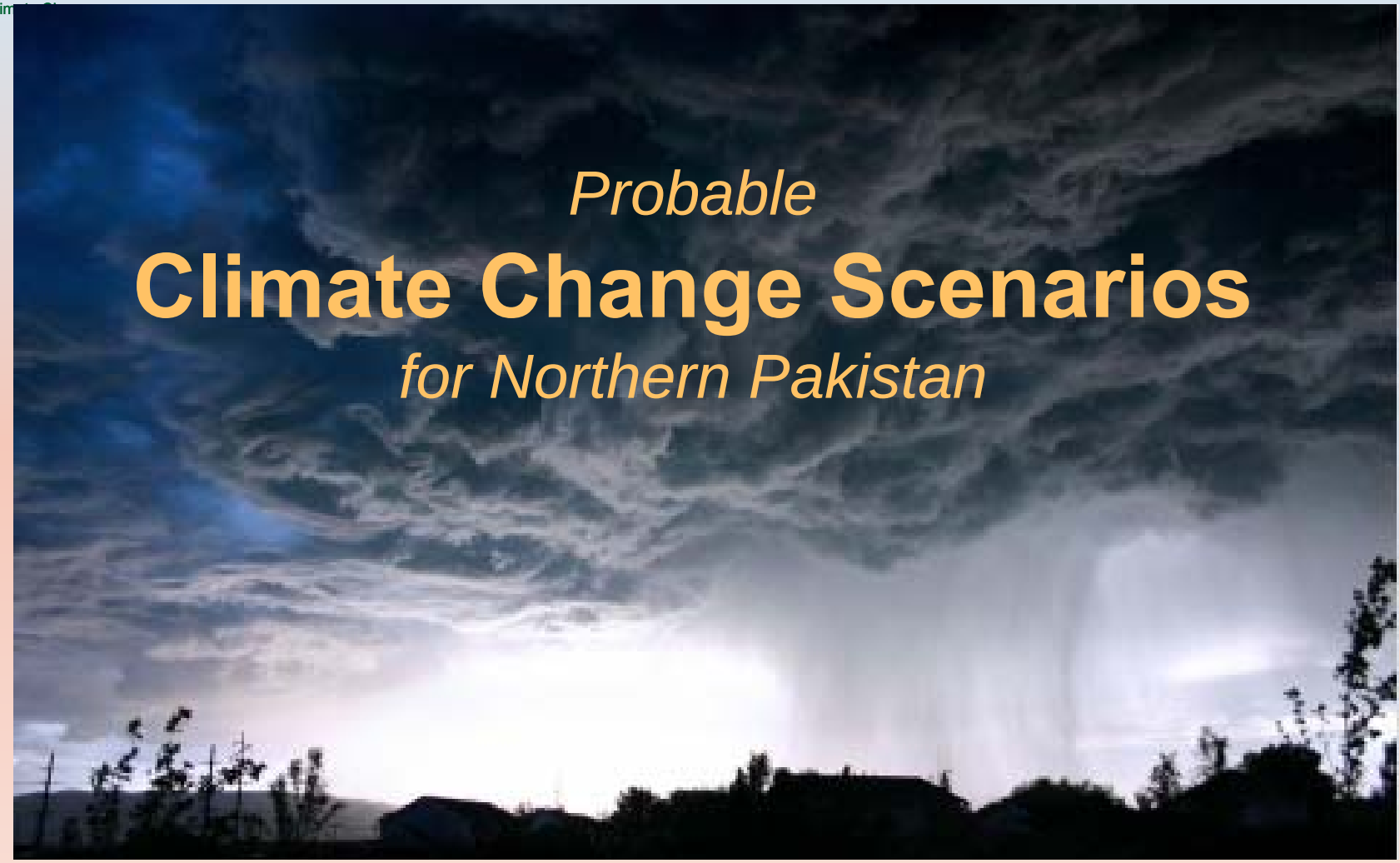
Adaptation of mountain agricultural systems to climate change induced water variability in northern Pakistan

Dr. Shahzad Jehangir
DIG Forests

ICIMOD Conference on Action for Adaptation, 23-25 July 2015, Islamabad

Government of Pakistan

Ministry of Clim



Probable

Climate Change Scenarios

for Northern Pakistan

ICIMOD Conference on Action for Adaptation, 23-25 July 2015, Islamabad

Government of Pakistan

Ministry of Climate Change

Climate Change Projections for HKH

- In Hindu Kush-Himalaya, warming is predicted to be well above the global average, which can be seen even in global climate projections
- Many climate models project that **monsoonal flows will weaken**, which would lead to a precipitation decrease
- Model projections show an **increase of precipitation in December, January and February**
- These projections are uncertain, as they depend on poorly known changes in the monsoon regime and El Niño patterns

Source: *Mountains and Climate Change From Understanding to Action (2009), Centre for Development and Environment (CDE), Institute of Geography, University of Bern*

Government of Pakistan

Ministry of Climate Change

Climate Change Projections for Pakistan

A. Coarse resolution (~300 km x 300 km) projections using outputs of 17 GCMs for A2 and A1B scenarios (IPCC defines)

B. Fine resolution (~50 km x 50 km) projections by dynamic downscaling of GCM outputs for A2 scenario using RCMs: RegCM3 and PRECIS

Base period: 1961 – 1990

Futures: 2020s = 2010 – 2039

2050s = 2040 – 2069

2080s = 2070 – 2099

Source: GCISC, Pakistan

Government of Pakistan

Ministry of Climate Change

Projected Temperature Changes for 2080s

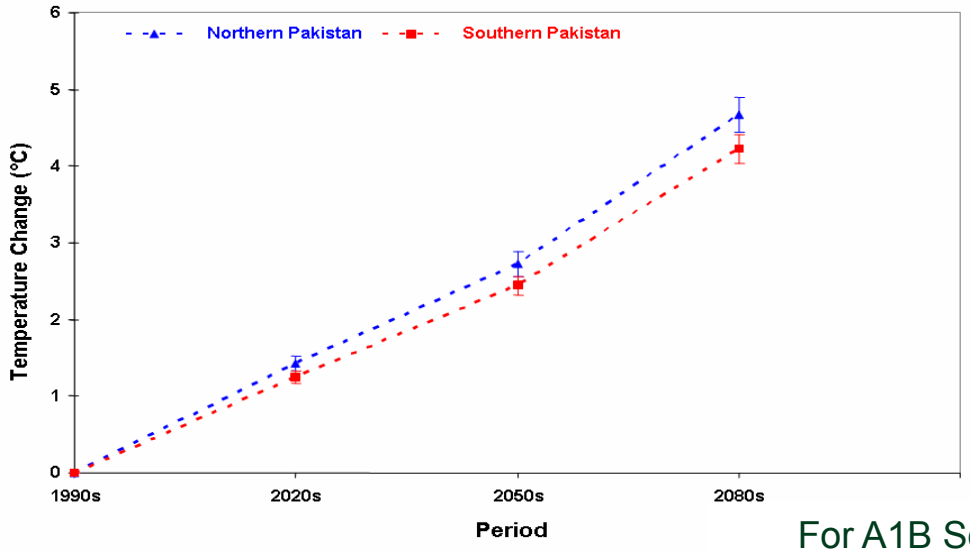
GCM ensemble for A2 Scenario ΔT (°C)

	Pakistan	Northern Pakistan	Southern Pakistan
Annual	4.38 ± 0.44	4.67 ± 0.23	4.22 ± 0.18
Summer	4.13 ± 0.26	4.56 ± 0.28	3.90 ± 0.26
Winter	4.47 ± 0.20	4.72 ± 0.24	4.33 ± 0.18

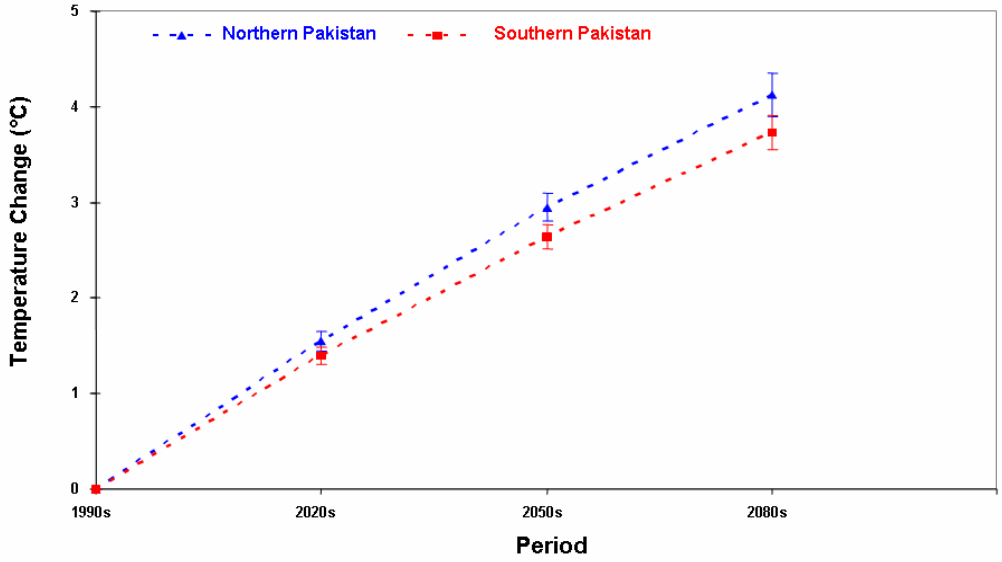
- Temperature increases in both summer and winter are higher in Northern Pakistan than in Southern Pakistan
- Temperature increases in Northern and Southern Pakistan are higher in winter than in summer

Source: GCISC, Pakistan

For A2 Scenario, based on ensemble of 13 GCMs (Global ΔT = 4.0 °C in 2100)



For A1B Scenario, based on ensemble of 17 GCMs (Global ΔT = 2.8 °C in 2100)



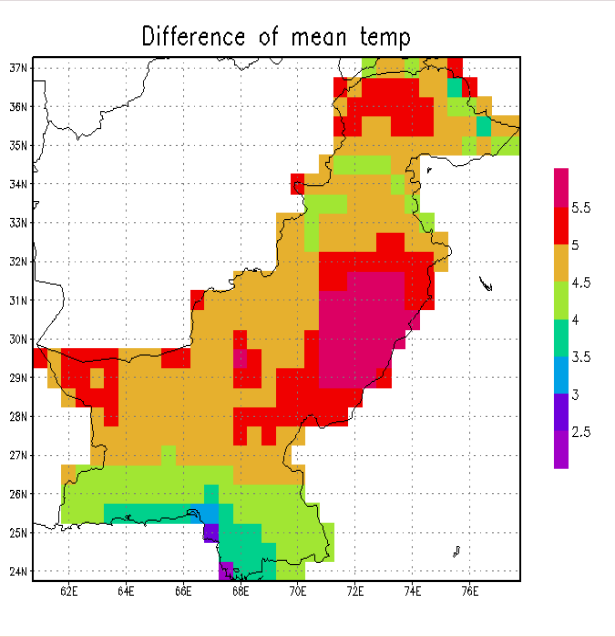
Source: GCISC, Pakistan

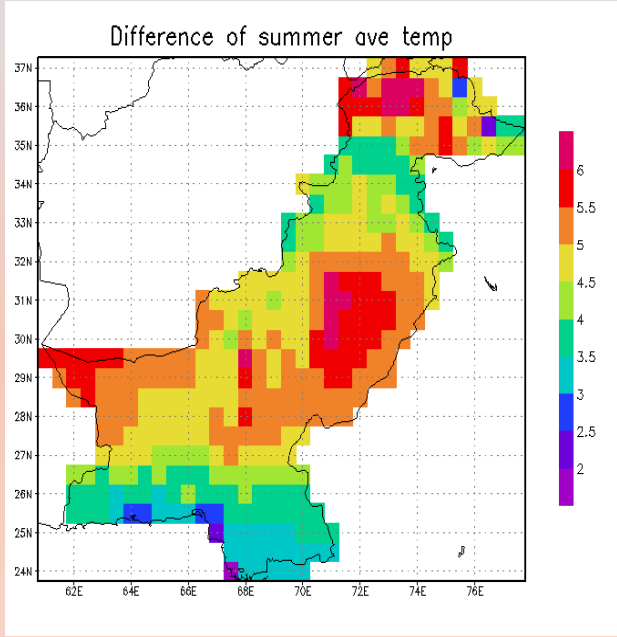
Government of Pakistan

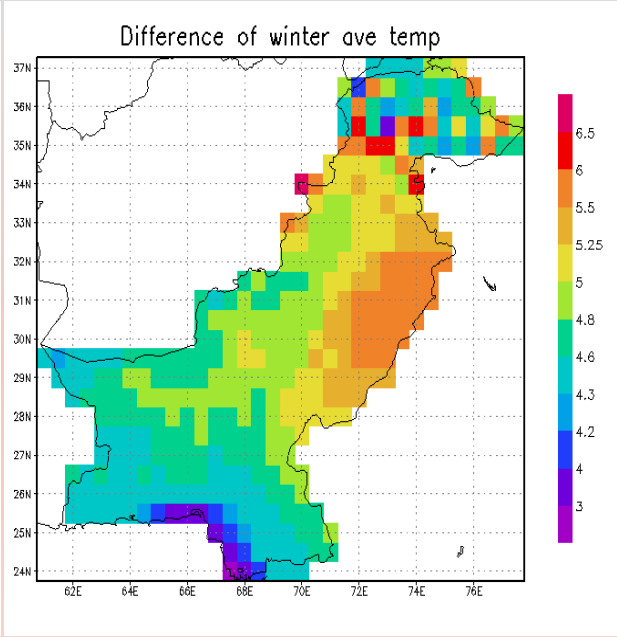
Ministry of Climate Change

Projected Temperature Change (°C) for 2080s

PRECIS (A2 Scenario)







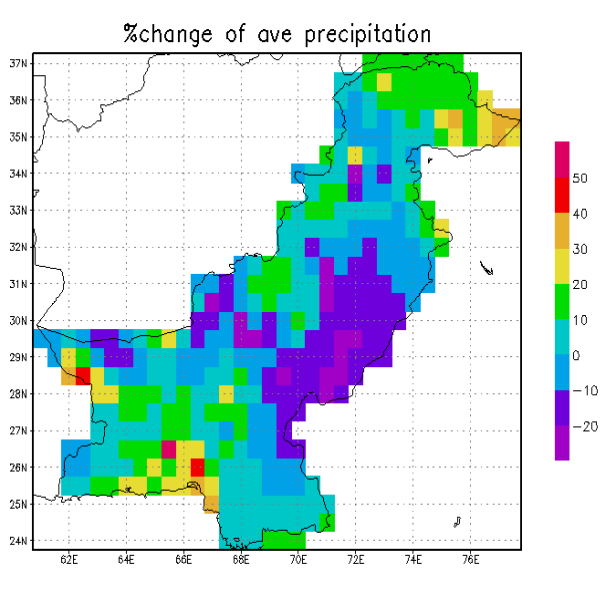
Source: GCISC, Pakistan

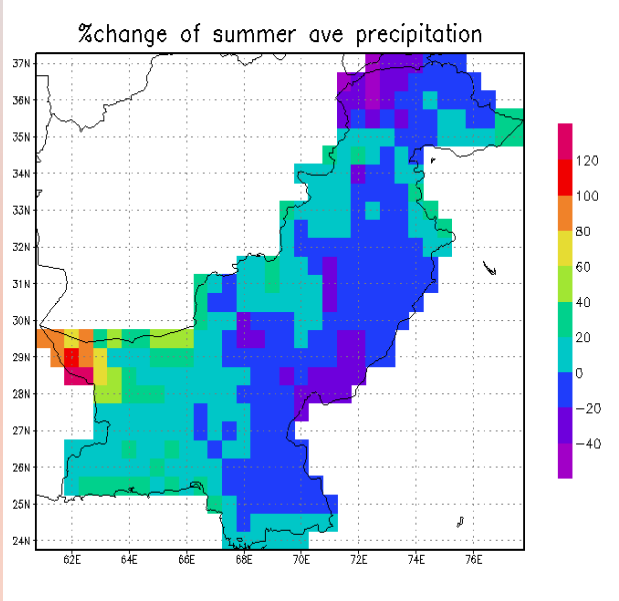
Government of Pakistan

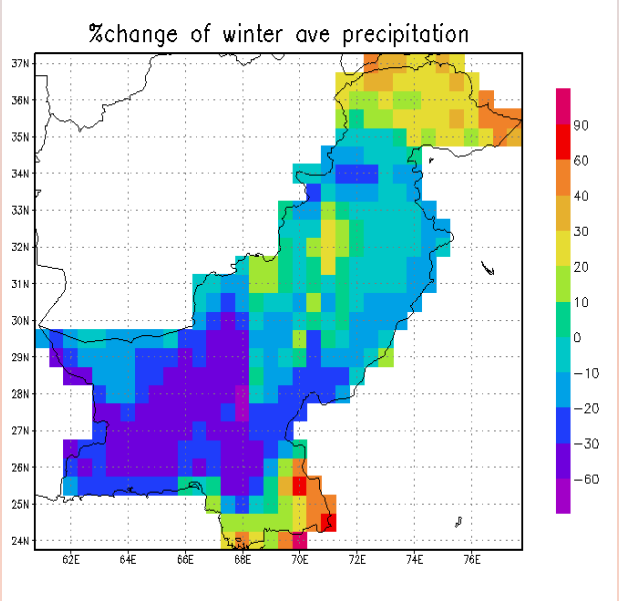
Ministry of Climate Change

Projected Precipitation Change (%) for 2080s

PRECIS (A2 Scenario)







Source: GCISC, Pakistan

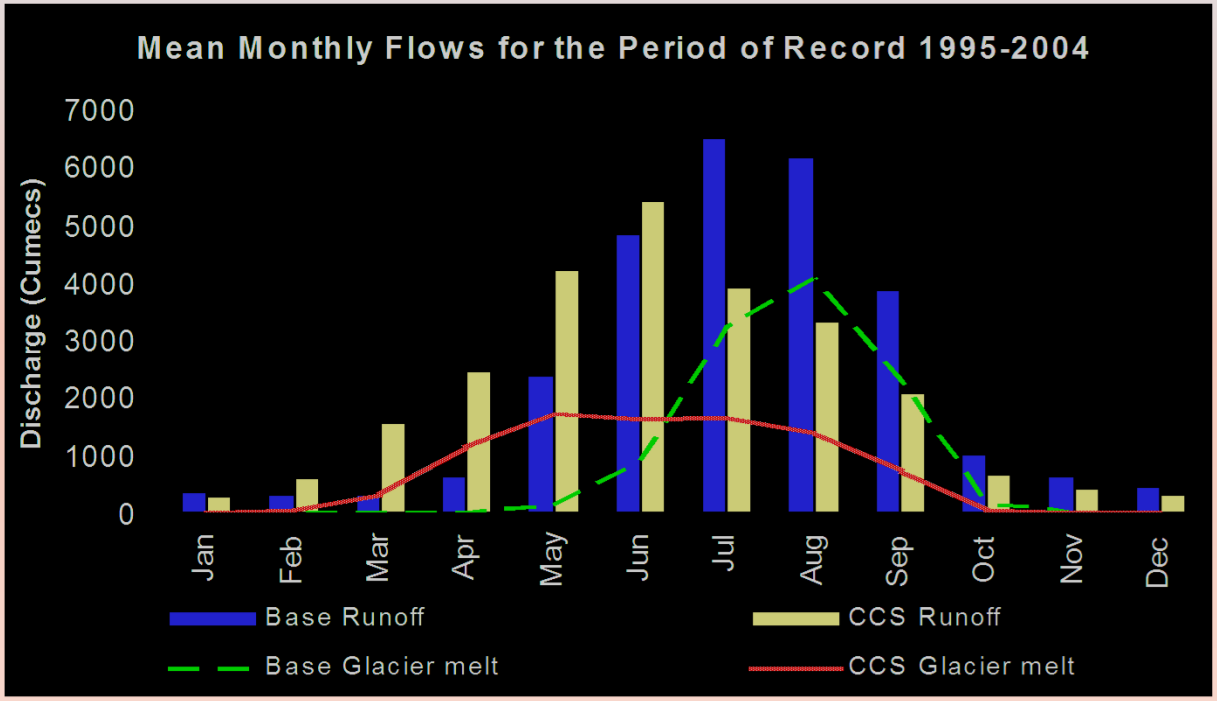
Government of Pakistan

Ministry of Climate Change

Impact of Climate Change on water resources in UIB

Assumed Climate Change Scenario (CCS):

Δ Temp: +3°C, Δ Glacier Area: - 50%



1. Annual flows reduced by 15%
2. Intra-annual flow pattern considerably changed

Government of Pakistan

Ministry of Climate Change

Change in Climate Means Vs. Climate Extremes

Climate Change

A change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer (IPCC)

Climate Extreme

Occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable (IPCC)

Government of Pakistan

Ministry of Climate Change

Climate extremes are more drastic

- Increased variability of Monsoon
- Extreme diurnal and seasonal Highs and Lows
- Extreme water variability in mountain regions
- Increased risks of floods and droughts
- Severe water-stressed conditions on slopes with low water holding capacity
- Food insecurity due to uncertain climate, poor adaptability and catastrophes

Government of Pakistan

Ministry of Climate Change

Extreme counts more than annual mean

- Chitral and Gilgit-Baltistan experiencing worst flash floods induced by torrential rains and fast-melting glaciers
- More than 300,000 families in upper and lower Chitral affected *(60,000 in Mastuj, 25,000 in Kalash valleys and the remaining in Boni, Garam Chashma and Orghoch*
- In Gilgit-Baltistan, flash floods cut off at least three valleys in Diamer and Baltistan *(inc Niat, Buner Das and Fairy Meadows*)
- Flash flood destroyed the head works of many channels in Diamer, rendering the entire population without water for drinking and irrigation

Source: The Express Tribune, 22 July 2015

Government of Pakistan

Ministry of Climate Change

A suspension bridge over the Chitral River was destroyed by flash floods. PHOTO: APP

Government of Pakistan

Ministry of Climate Change

Characteristics of Agricultural Systems in Northern Pakistan

- Limited lands, marginal lands
- Mainly in valleys with medium soil cover
- Partly on sloping, terraced fields with thin soil cover
- Single cropping system (summer crops)
- Mostly irrigated with spring water or channel irrigation
- Multiple crops with fruit culture
- Subsistence farming for families or locals
- Mechanization and crop maximization at early stages
- High exposure to climate change induced extreme events (floods, droughts, landslides)

Government of Pakistan

Ministry of Climate Change

Cultivation on marginal lands in Chitral

Dry Fruit in Hunza valley

Terraced agriculture under dry peaks of Hunza

Climate extremes threat agriculture in Swat

Government of Pakistan

Ministry of Climate Change

Some options for adapting to water variability induced by Climate Change & Climate Extremes

Government of Pakistan

Ministry of Climate Change

Maintain Crop & Fruit Diversity - 1

- GB possess a rich array of genetic crop resources
- Wild relatives of crops (barley, chickpea, millets and wheat) and fruits (grape, apple)
- Preserve wild relatives of crops and fruits as a viable adaptation measure against CC induced water variability

Common Name	Scientific Name	Distribution in GB
Wild relatives of barley	Hordeum bogdanii	Karakoram mountains
	Sorghum halepense	Common throughout GB
Wild relatives of chick pea	Cicer macranthum	Sub-alpine slopes of the Karakoram and Himalaya
	Cicer microphylum	Sub-alpine slopes of the Karakoram and Himalaya
Wild relatives of fruits	Pyrus pashia	Temperate Himalaya
	Prunus prostrate	Temperate Himalaya
Wild relatives of grape	Vitis jacquemontii	Skardu region of the Himalaya
Wild relatives of millet	Pennisetum flaccidum	Alpine slopes of the Karakoram, Hindu Kush and Himalaya
Wild relatives of wheat	Aegilops squarossus	Mountain valleys
	Aegilops triuncials	Mountain valleys
	Elymus longe aristatus	Highlands of the Hindu Kush,Himalaya and Karakoram
	Elymus russelii	Endemic to the Karakoram

Source: Nasir and Ali, 1970.

Government of Pakistan

Ministry of Climate Change

Maintain Crop & Fruit Diversity - 2

- Traditionally cultivated varieties of crops (e.g. wheat) differ in maturity, grain quality and rust resistance
- Known to be originated in Badakhshan, Ladakh and Kashgar
- Traditional varieties to promoted being more adaptable to climate extremes than varieties originated in plains
- Fruit crops now possess the genetic basis for tolerance to extreme cold, heat, frost, drought, diseases and pests

Fruit Species	Number of Varieties/ Cultivars
Almond	3
Apple	17
Apricot	28
Cherry	13
Grape	8
Mulberry	4
Olive	6
Peach	5
Pear	14
Plum	8
Walnut	15

Sources: Doolan, 1993; GB Department of Agriculture.

Government of Pakistan

Ministry of Climate Change

Improve water-use efficiency

- Natural seasonal flows likely to be disrupted with CC induced water variability
- Cascade of small reservoirs for short-term storages
- Proper floodwater management (e.g. integrated wetlands management)
- Promote fruit culture and fruit processing industry
- Promote deep rooted crops and varieties to cope with water-related extremes
- Consolidate farmlands, mitigate impacts of CC and enhance WHC by tree culture
- Piped irrigation may be advisable in water stressed areas
- Physical and biological practices to reduce evapo-transpiration and desiccation (e.g. through mulching)

Government of Pakistan

Ministry of Climate Change

Thank You

Government of Pakistan

Ministry of Climate Change

A2 Scenarios

Based on the following assumptions

- Relatively slow demographic transition and relatively slow convergence in regional fertility patterns
- Relatively slow convergence in inter-regional GDP per capita differences
- Relatively slow end-use and supply-side energy efficiency improvements (compared to other storylines)
- Delayed development of renewable energy
- No barriers to the use of nuclear energy

A1 Scenarios

Characterized by

- An affluent world, with a rapid demographic transition (declining mortality and fertility rates) and an increasing degree of international development equity
- Very high productivity and economic growth in all regions, with a considerable catch-up of developing countries
- Comparatively high energy and materials demands, moderated however by continuous structural change and the diffusion of more efficient technologies, consistent with the high productivity growth and capital turnover rates of the scenario

Go back