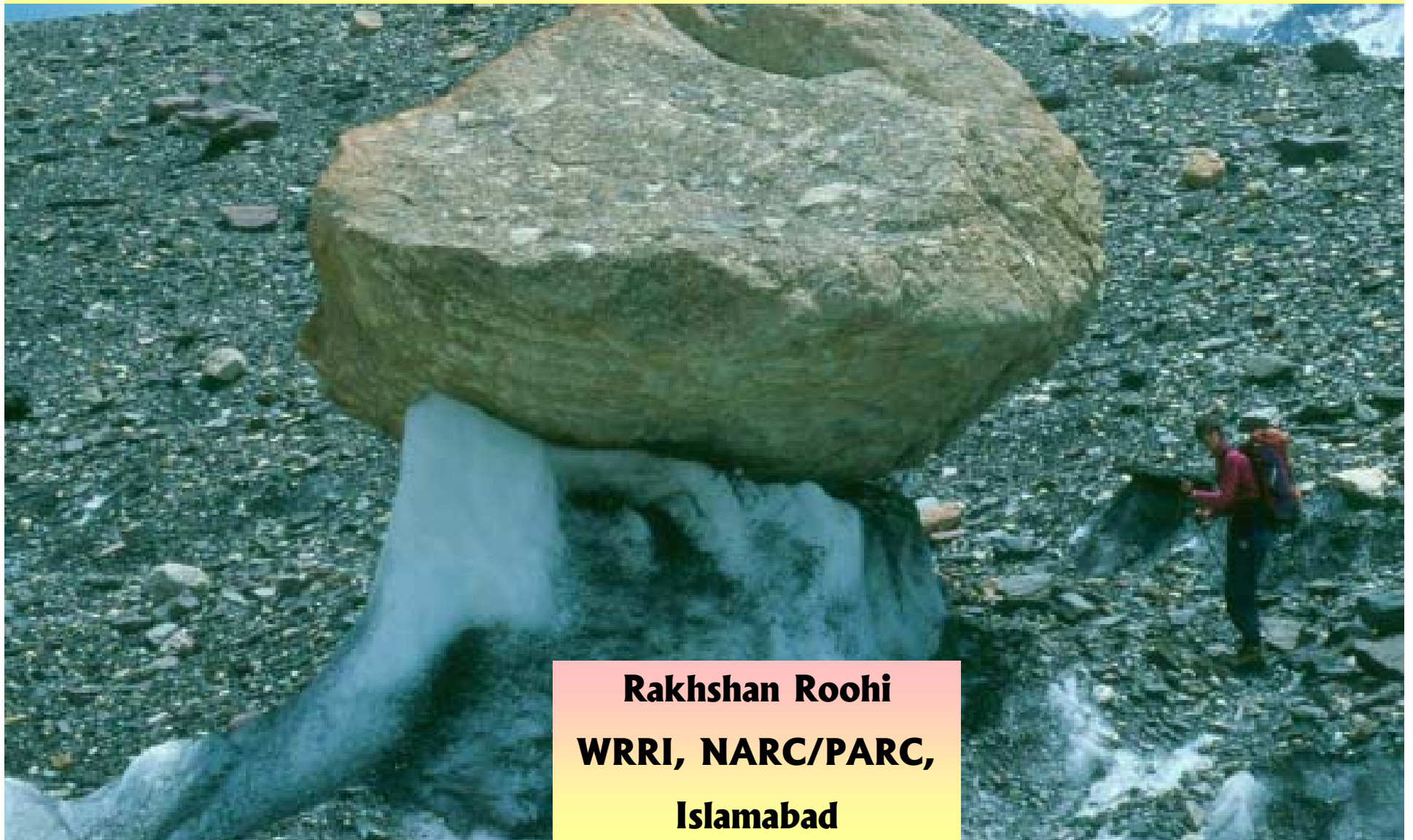
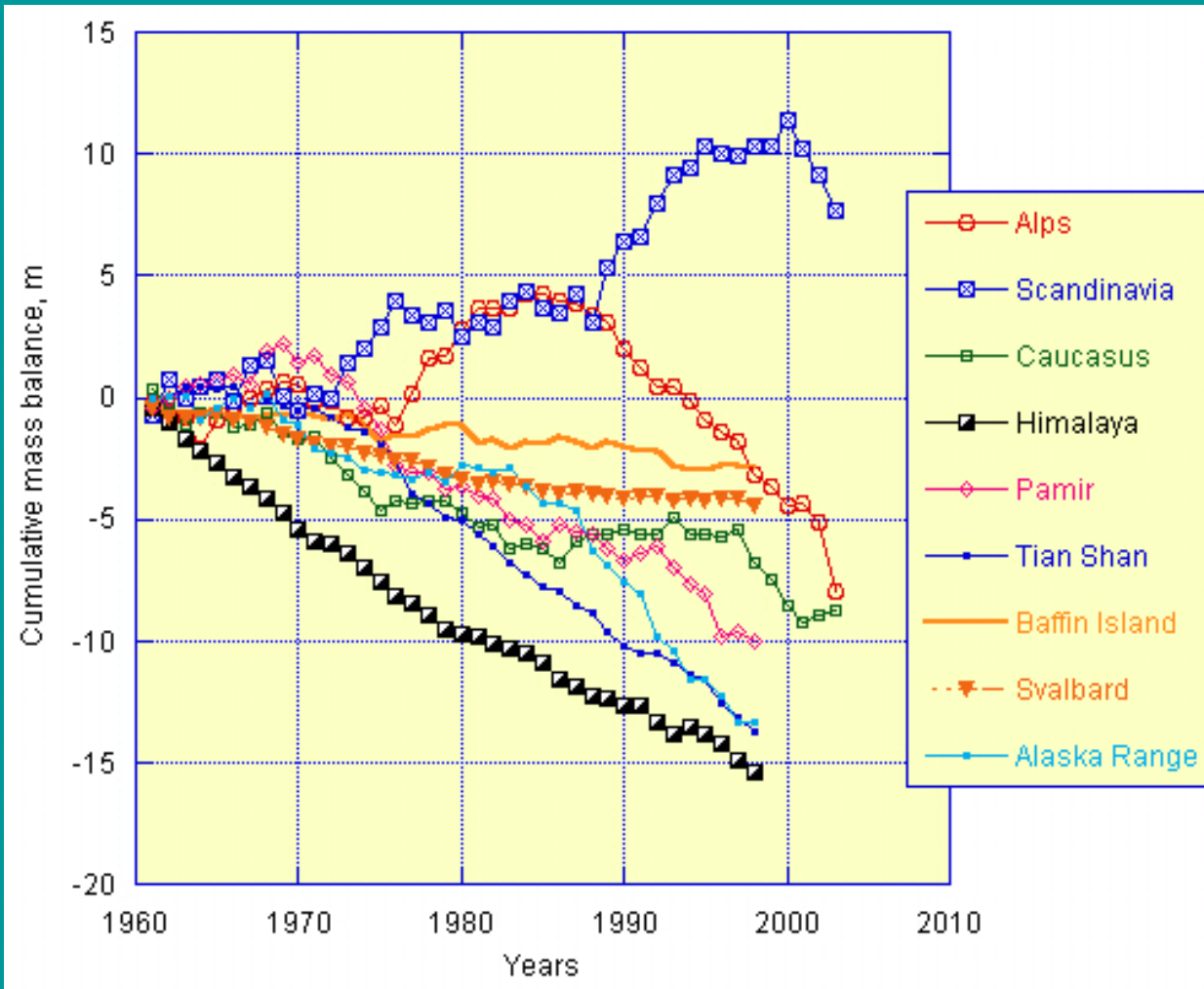


# Impacts of Decrease in Glaciers on Agriculture in Punjab



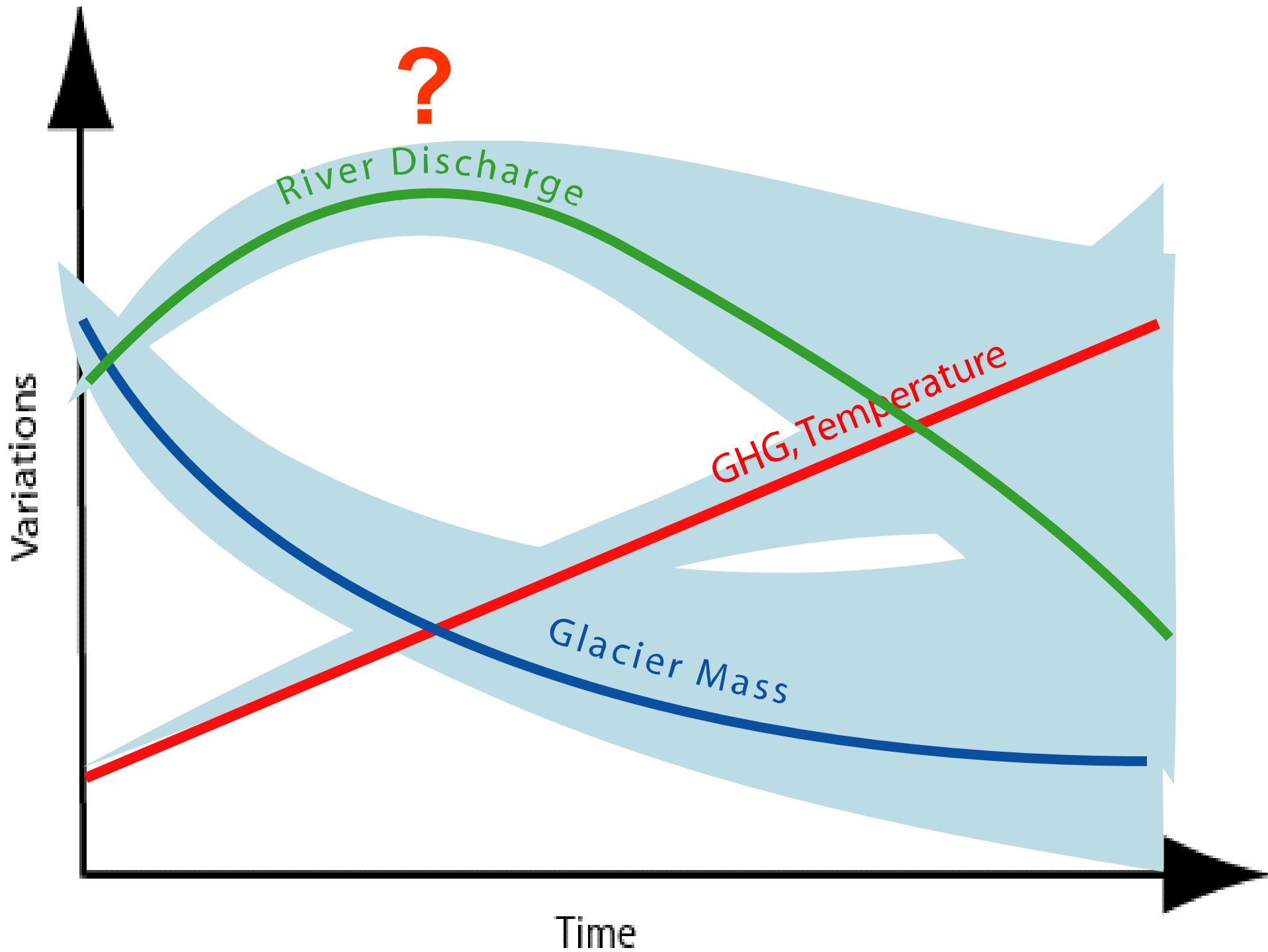
**Rakhshan Roohi**  
**WRRI, NARC/PARC,**  
**Islamabad**

# Glacier Mass Balance

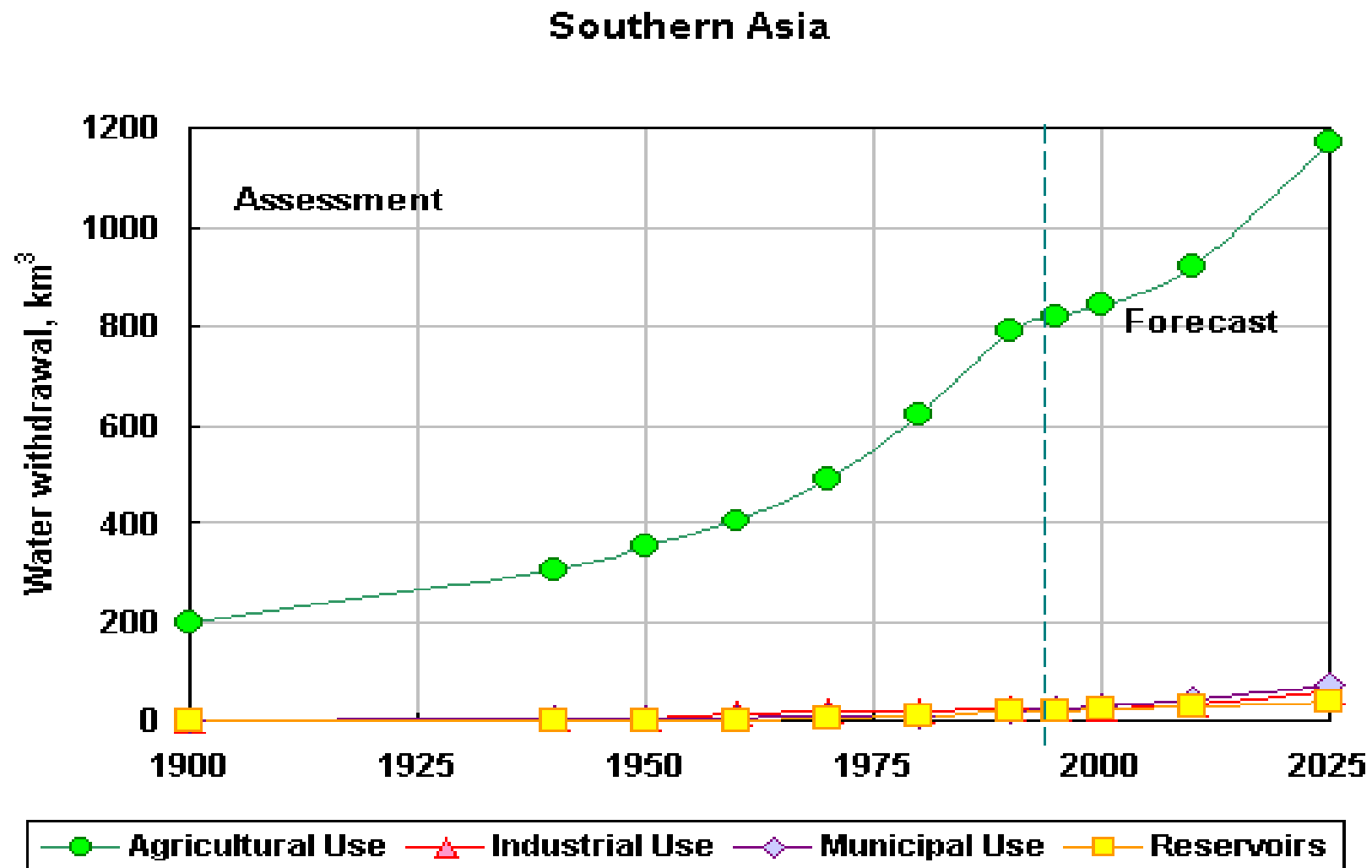


► **Himalayan glaciers are shrinking more rapidly than elsewhere**

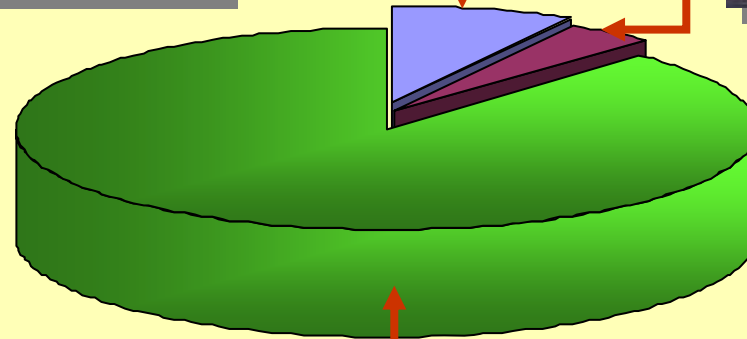
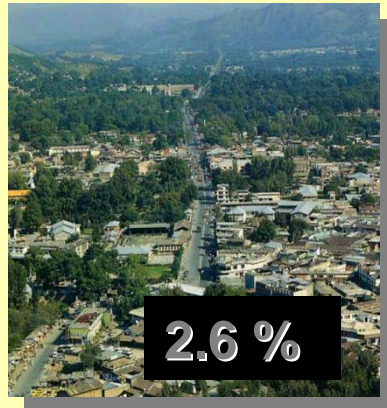
Dyurgerov and Meier, 2005



# How can upstream water (storage) meet demand for food production?



# WATER & ECONOMIC SECTORS



**Water  
Withdrawal  
in Pakistan**

**The economic  
sectors compete  
for water**



**Agriculture will be  
the loser in the  
run for water**

Source: FAO

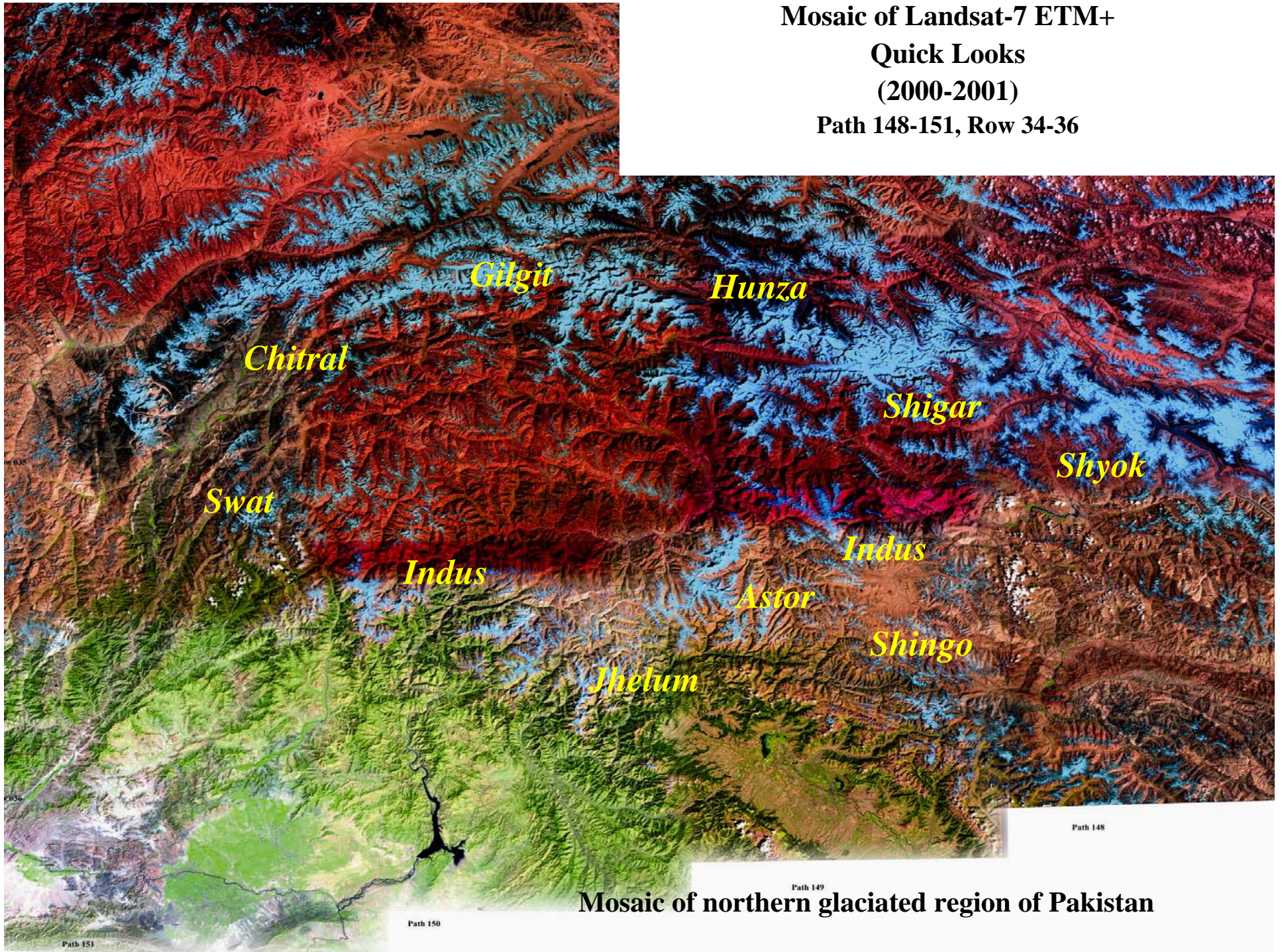
August 20, 2008

Roohi

5



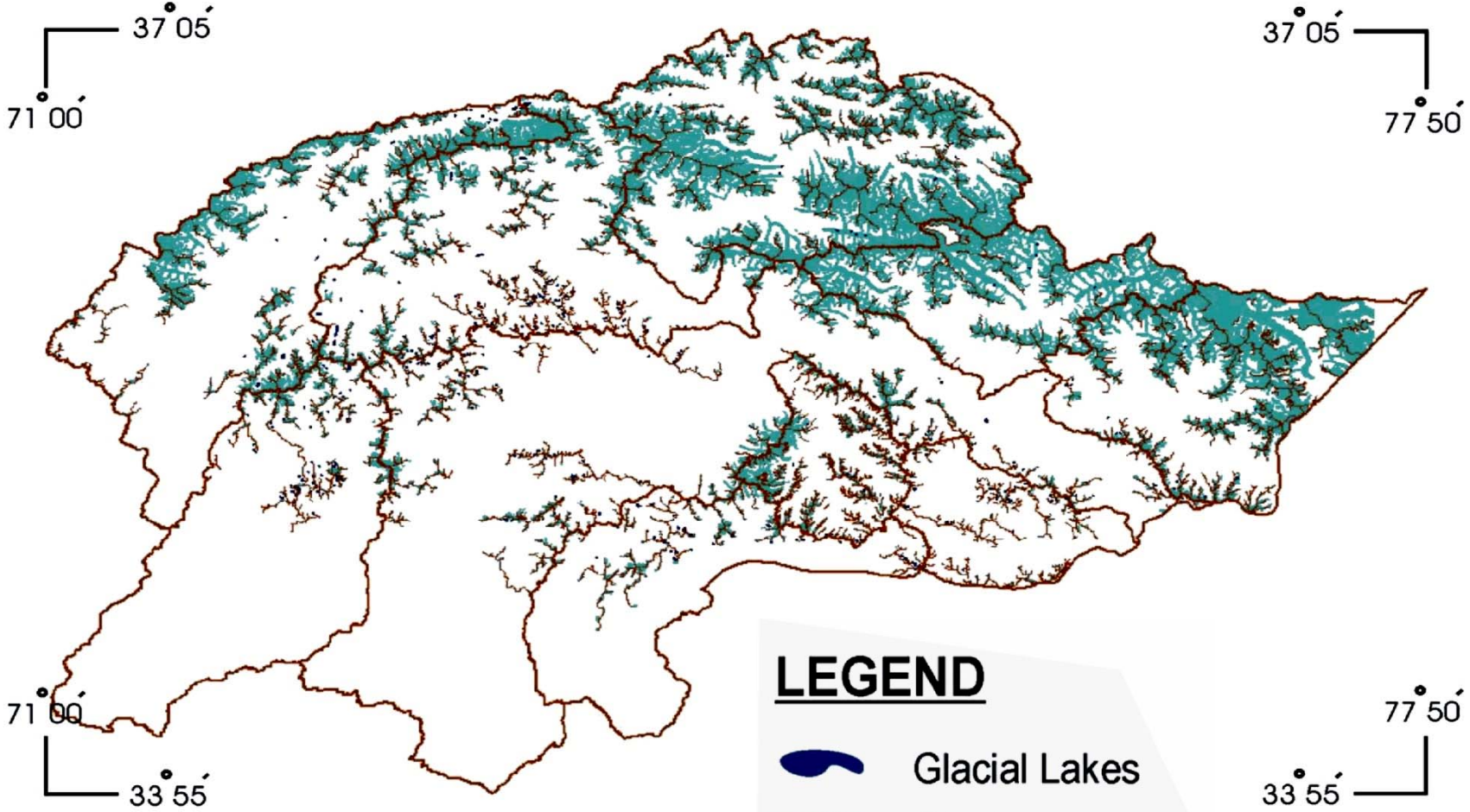
**Mosaic of Landsat-7 ETM+  
Quick Looks  
(2000-2001)  
Path 148-151, Row 34-36**



**Mosaic of northern glaciated region of Pakistan**



# Glaciers of Indus River Basin



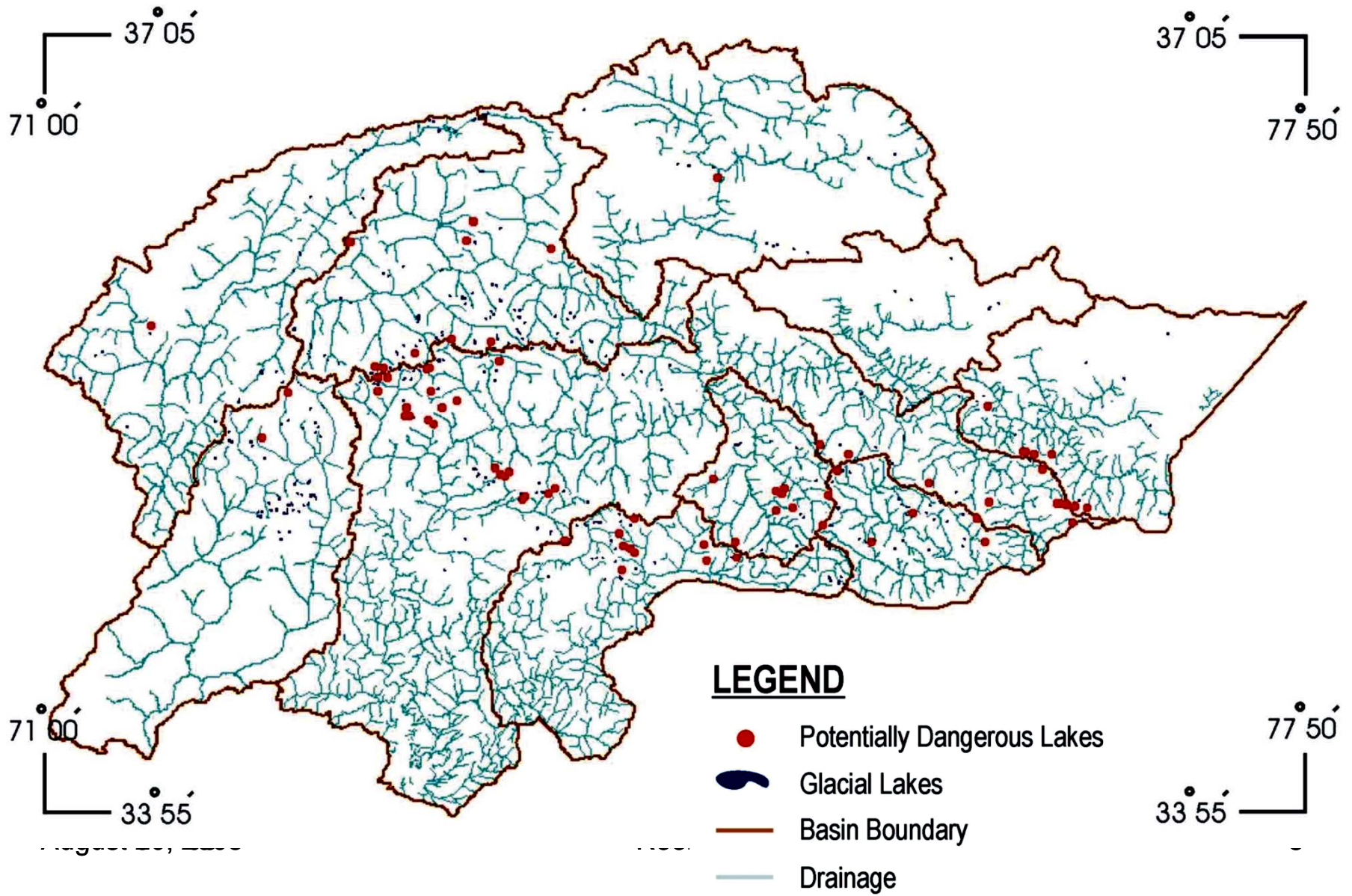
## LEGEND

-  Glacial Lakes
-  Glaciers
-  Basin Boundary
-  Ridge Lines

August 20, 2008

Rooh

# Potentially Dangerous Glacial Lakes





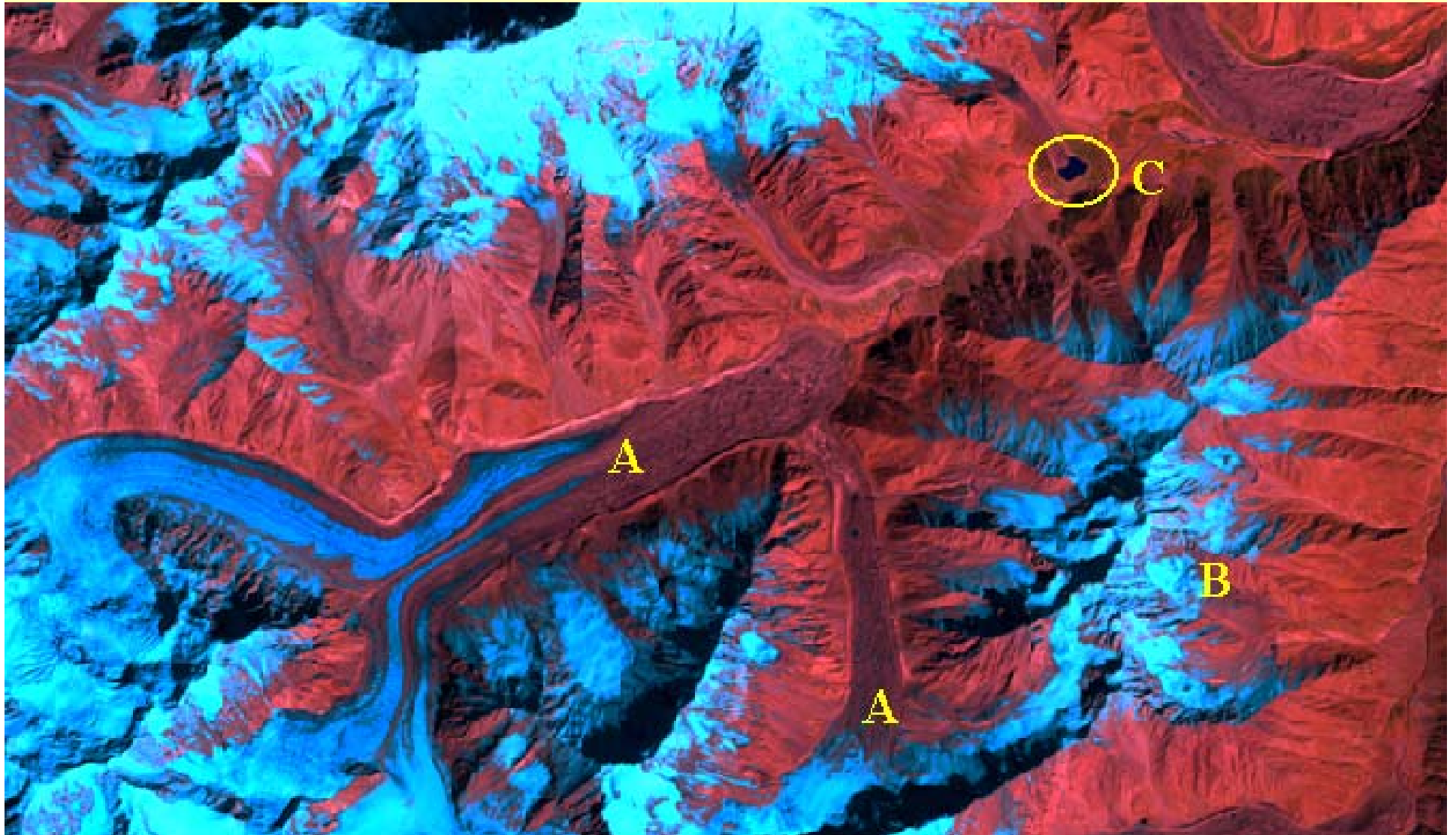
# Summary

❖ Total number of Glaciers.....	5,218
❖ Total glaciated area.....	15041 Km <sup>2</sup>
❖ Est. Ice Reserves.....	2,738 Km <sup>3</sup>
❖ Glacial Lakes.....	2,420
❖ Major Lakes.....	1,328
❖ Potentially Dangerous Lakes.....	52

# Potentially Dangerous Glacial Lakes

Basins	Cirque	End Moraine	Valley	Total
Swat	-	2	-	2
Chitral	-	1	-	1
Gilgit	-	6	2	8
Hunza	-	1	-	1
Shigar	-	-	-	-
Shyok	-	4	2	6
Indus	4	10	1	15
Shingo	2	2	1	5
Astor	5	3	1	9
Jhelum	3	2	-	5
<b>Total</b>	<b>13</b>	<b>31</b>	<b>8</b>	<b>52</b>

# Water Reserves in Glaciers of HKH Zone of Pakistan





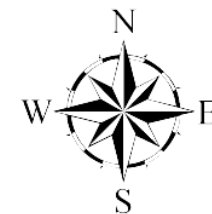
# Share of Water Resources In Glacial Reserves

Available Water Resources	Million Acre Feet (MAF)	% of total glacial water (1997 MAF)
Total surface water available at rim station in IBS (29 yr. Av.)	148.552*	7.44
Contribution of glaciers/ snow 50-85% Av. 67.5%	100.273	5.02
<b>Dam</b>	<b>Live Storage Capacity (2004)**</b>	
Mangla	4.564	0.23
Terbela	7.133	0.36
Chashma	0.435	0.02
<b>Total Large Dams</b>	<b>12.156</b>	<b>0.61</b>
<b>68 Medium &amp; Small Dams</b>	<b>5.590</b>	<b>0.28</b>
<b>Total Storage Capacity</b>	<b>17.740</b>	<b>0.89</b>

Source: \* Rana, et. Al., 2004-05, \*\* National Water policy, Volume II, 2004

# Pakistan Landcover/Landuse

0 45 90 180 270 360 Km



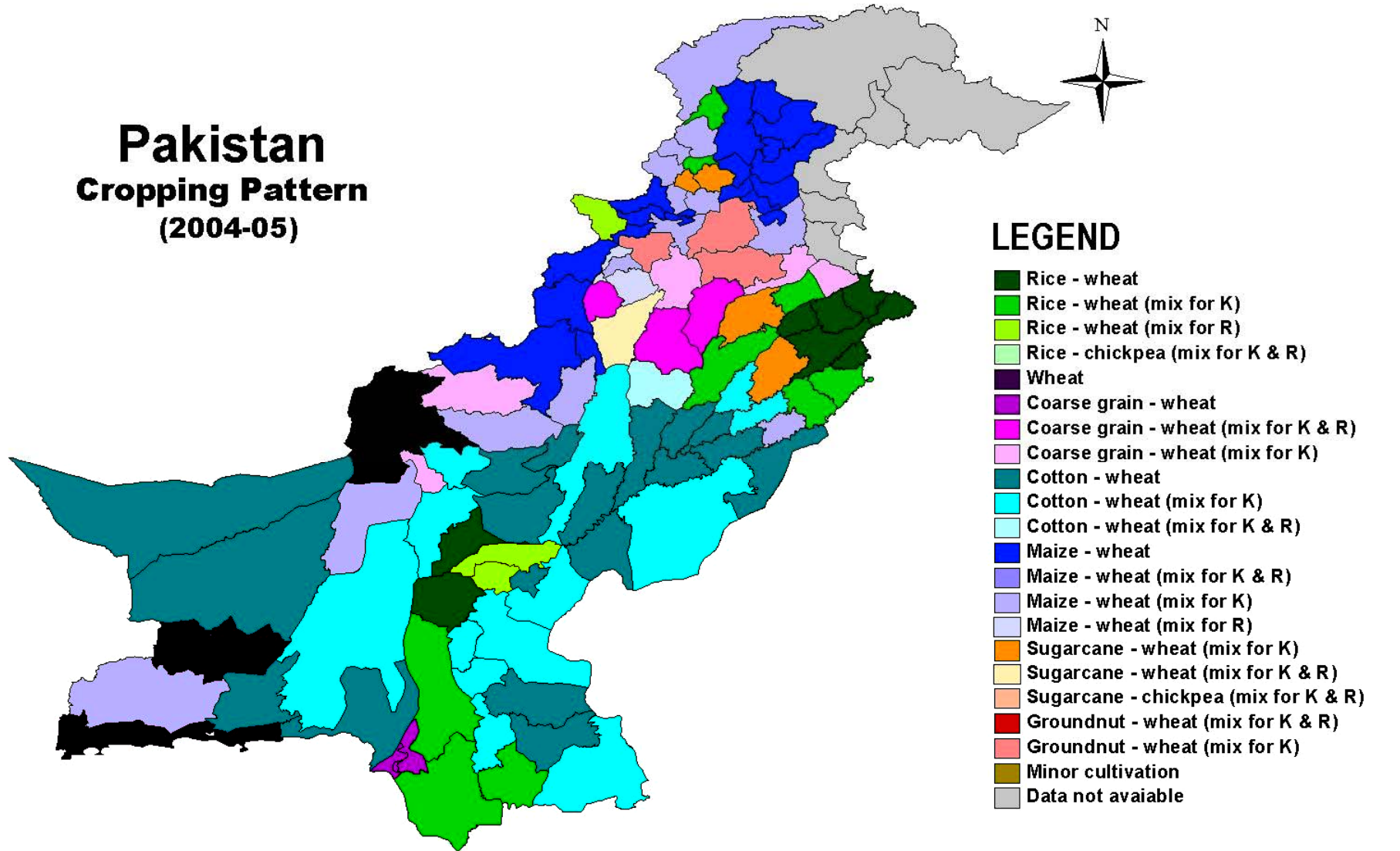
## Legend

- Conifer forest
- Broad leaf forest
- Scrub forest
- Riverine forest
- Mangroves forest
- Tree plantation
- Orchards
- Alpine pastures
- Range land
- Irrigated Agriculture
- Rainfed Agriculture
- Rodkohi Agriculture
- Open ground
- Exposed rocks
- Desert
- Built-up lands
- Waterlogged areas
- Saline areas
- Water bodies
- Snow/Glaciers Cover

Data Source: Landsat ETM+(2000-2001)

Analysed and Developed by: WRR, NARC(2008)

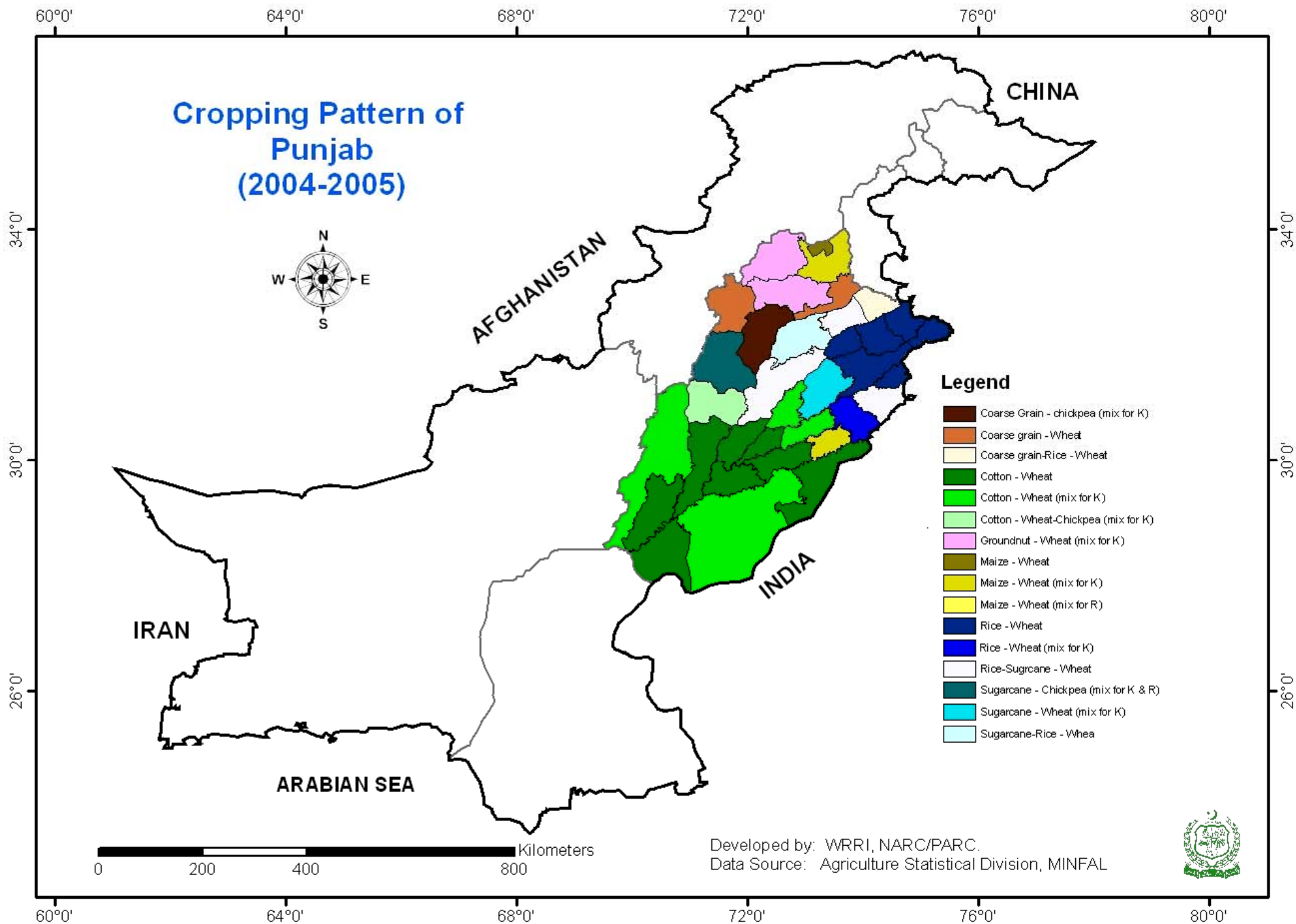
# Pakistan Cropping Pattern (2004-05)



Data Source: Agricultural Statistic of Pakistan  
 Developed by: RUP/WRRI, NARC/PARC, Islamabad, 2006

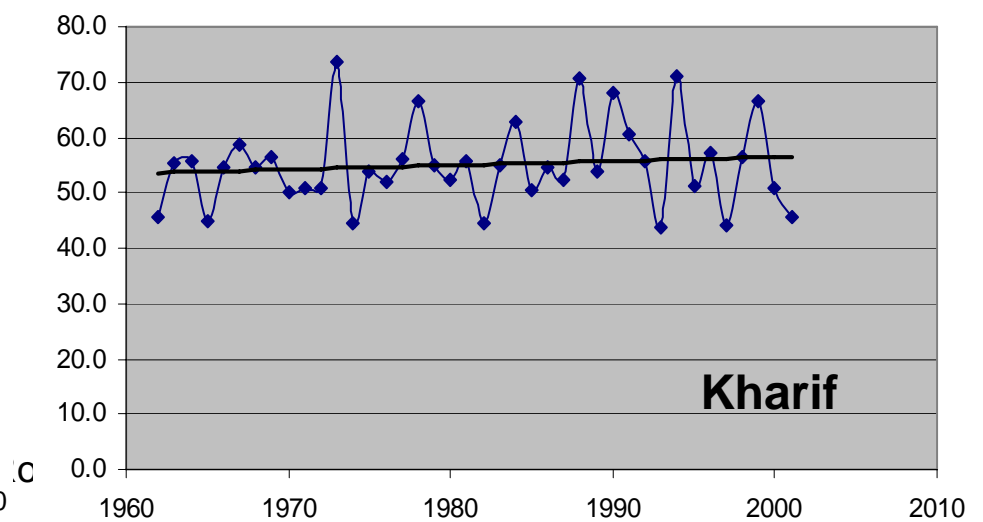
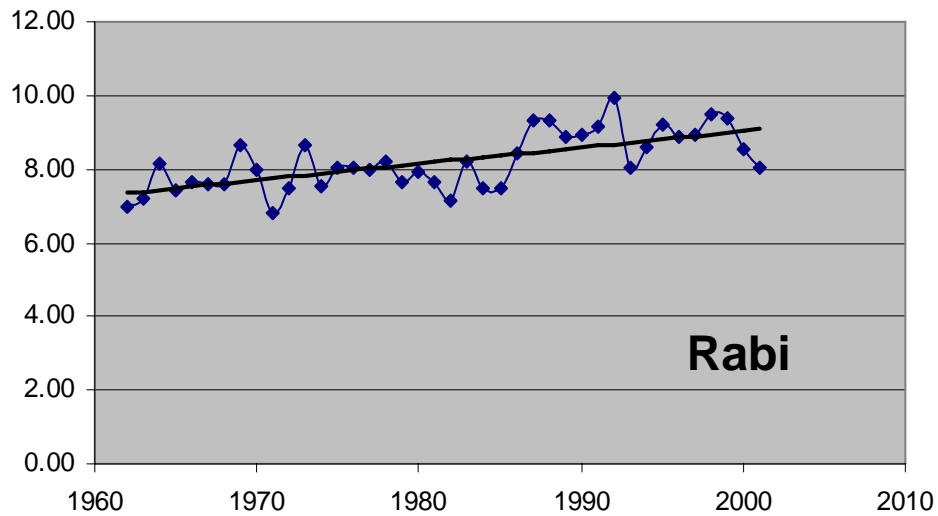
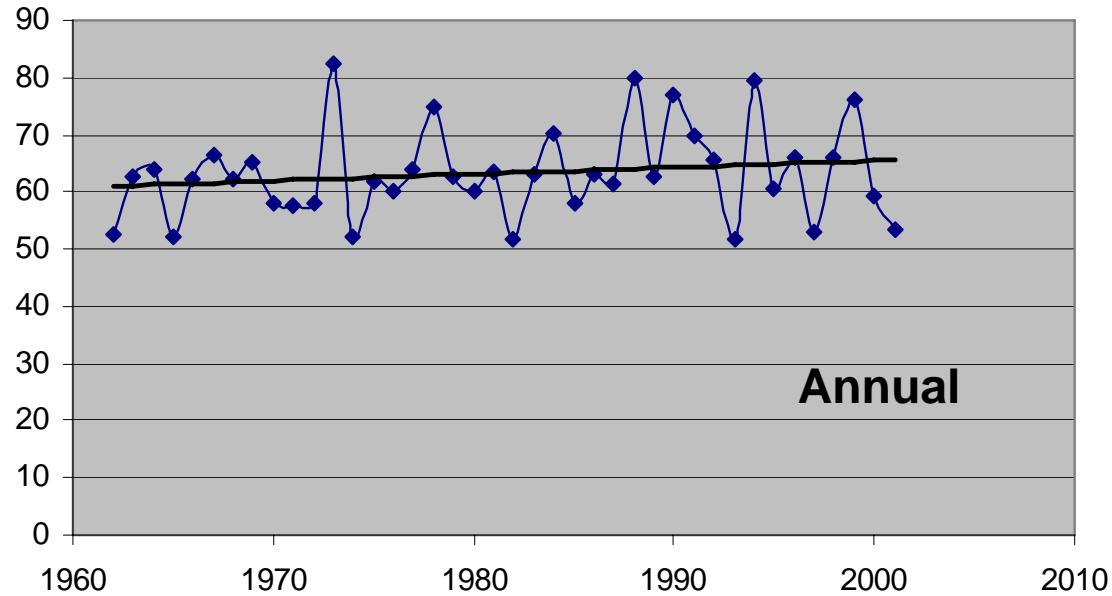






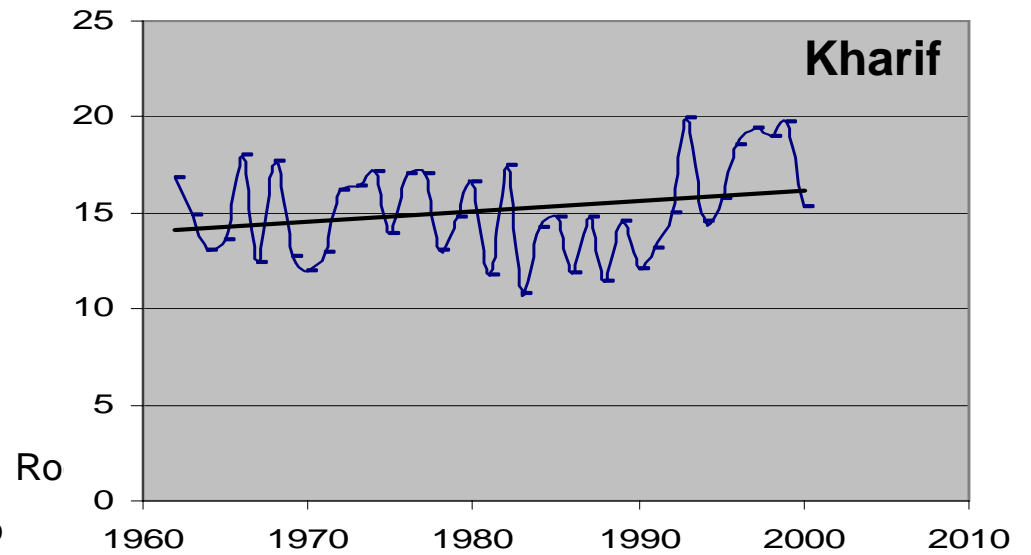
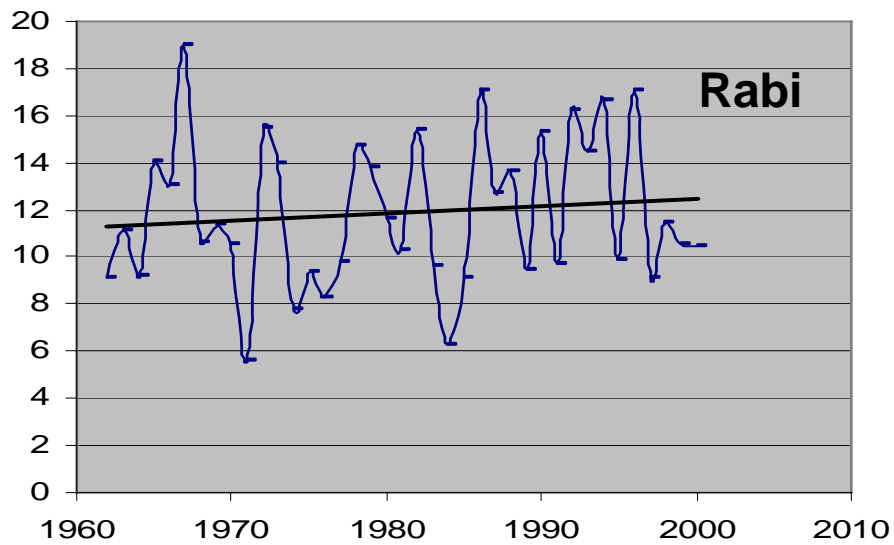
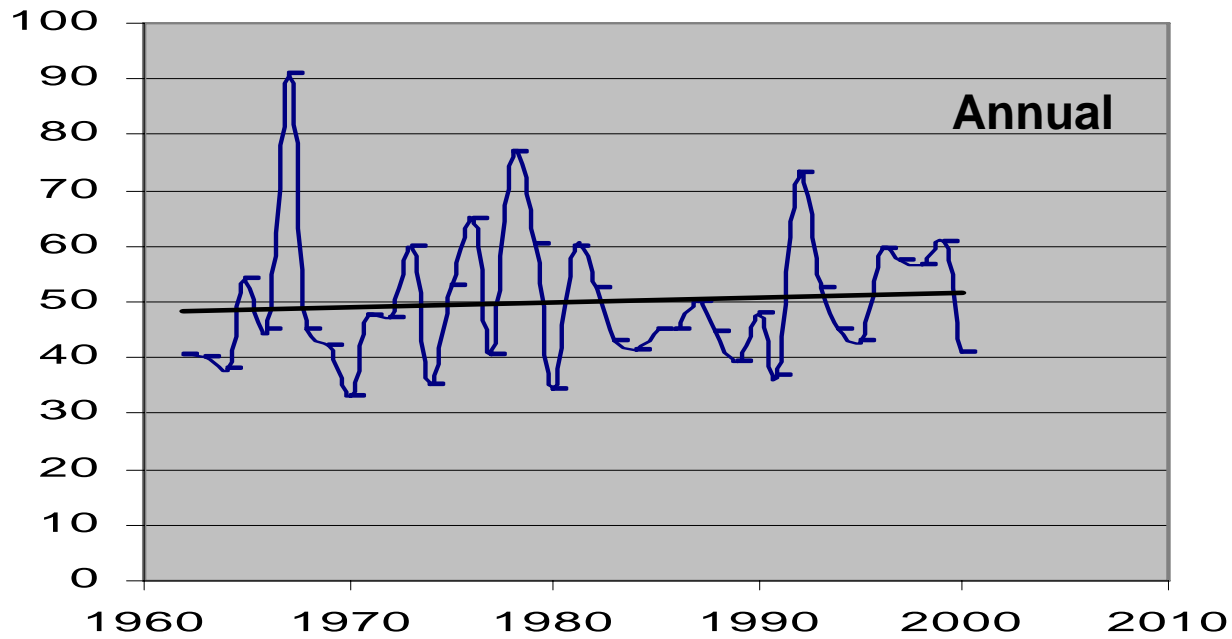
<b>Cropping Pattern</b>	<b>Kharif</b>	<b>Rabi</b>
<b>Grnt - Wheat (K)</b>	<b>189.50</b>	<b>277.20</b>
<b>Maize - Wheat (K)</b>	<b>355.50</b>	<b>285.40</b>
<b>Rice - Wheat</b>	<b>1169.40</b>	<b>1275.90</b>
<b>Rice-Scane or Scane-Rice - Wheat</b>	<b>528.20</b>	<b>883.40</b>
<b>Scane - Wheat or Chickpea (K &amp; or R)</b>	<b>137.60</b>	<b>1001.40</b>
<b>Cotton - Wheat</b>	<b>1800.50</b>	<b>1865.50</b>
<b>Cotton - Wheat (mix for K)</b>	<b>794.90</b>	<b>1233.40</b>
<b>Coarse Grain - Wheat</b>	<b>190.40</b>	<b>590.80</b>
<b>Total</b>	<b>5166.00</b>	<b>7413.00</b>
<b>%</b>	<b>35.53</b>	<b>42.64</b>

# 10 daily inflow at Terbela (MAF)





# Rainfall above Terbela



A photograph of a rocky, high-altitude landscape. The foreground shows a body of water reflecting the sky. The middle ground is dominated by dark, jagged rock formations and a path. The background features a mountain range under a cloudy sky.

# **Glacial Environment and Climate Change**

# Location of Selected Glaciers and Lakes

**Astor River basin**

Lake\_5

Lake\_4

Lake\_3

Lake\_2

Lake\_1

Gr\_5

Gr\_4

Gr\_3

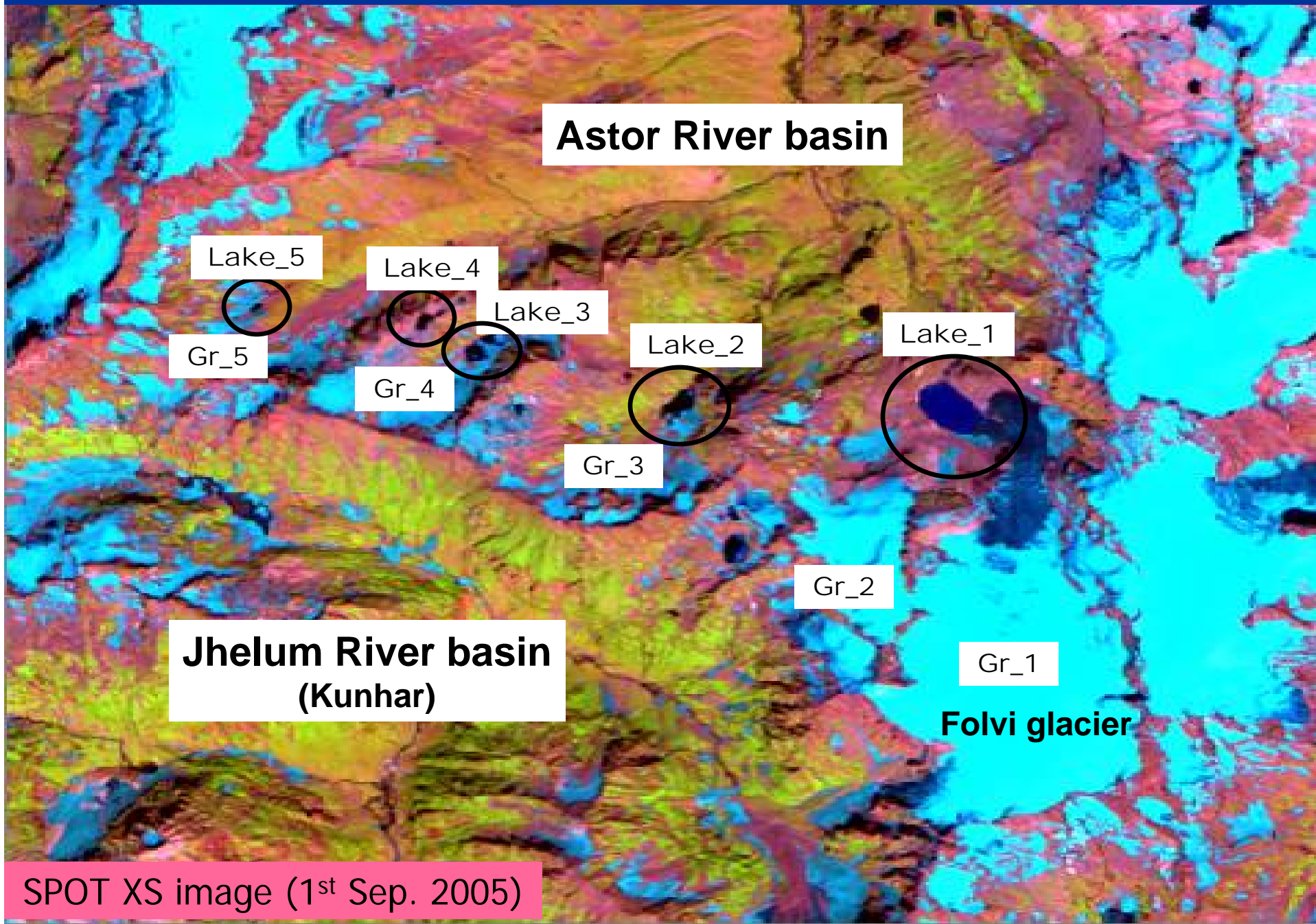
Gr\_2

Gr\_1

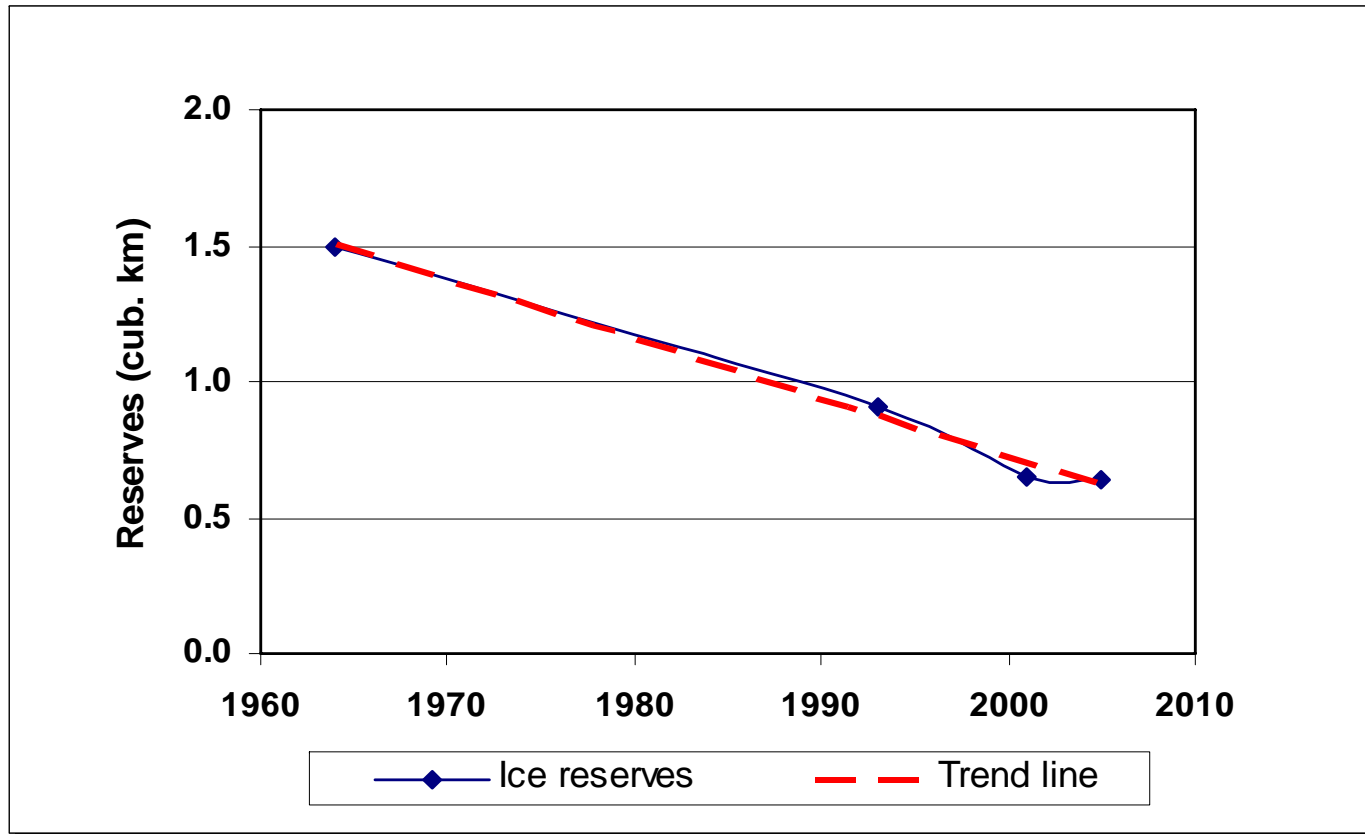
**Jhelum River basin  
(Kunhar)**

**Folvi glacier**

SPOT XS image (1<sup>st</sup> Sep. 2005)

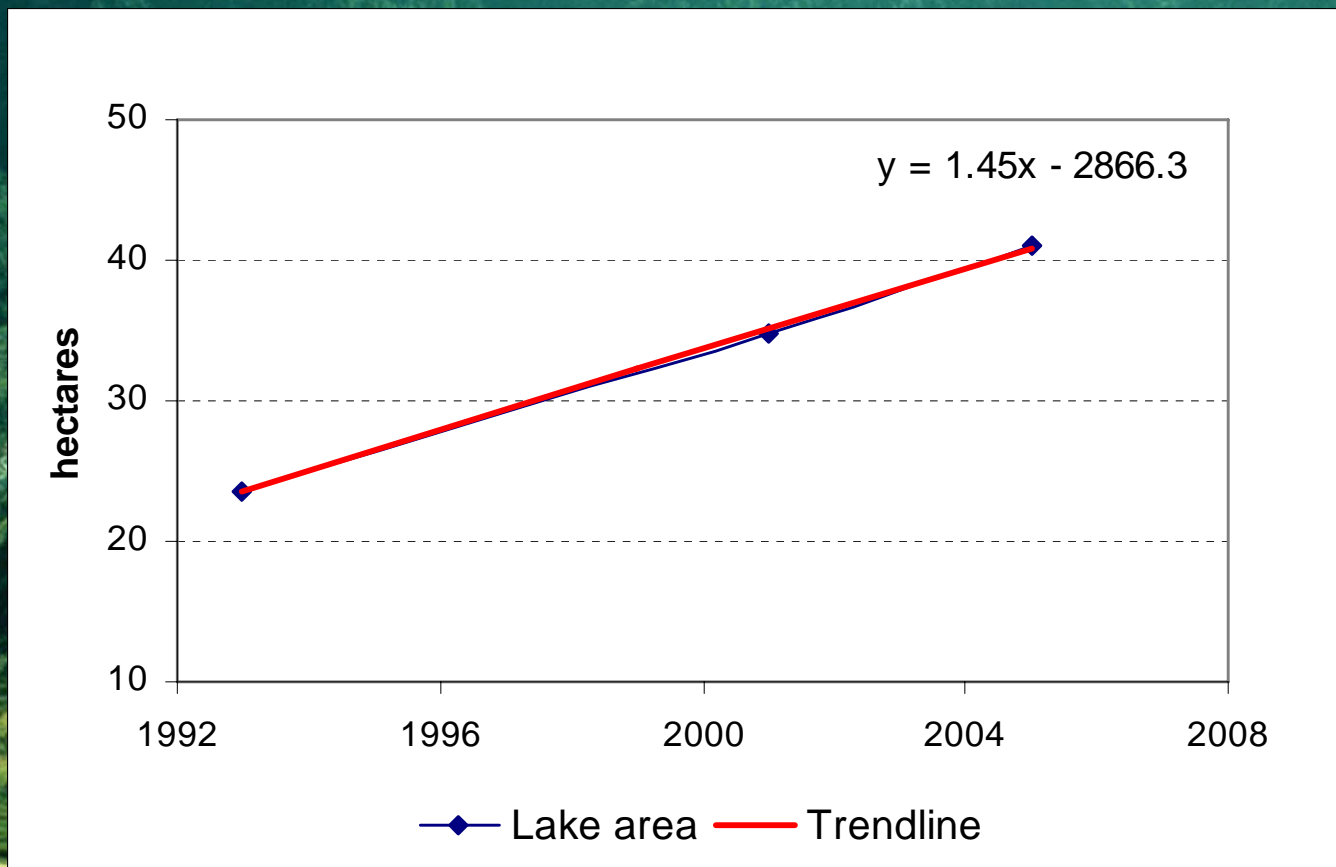


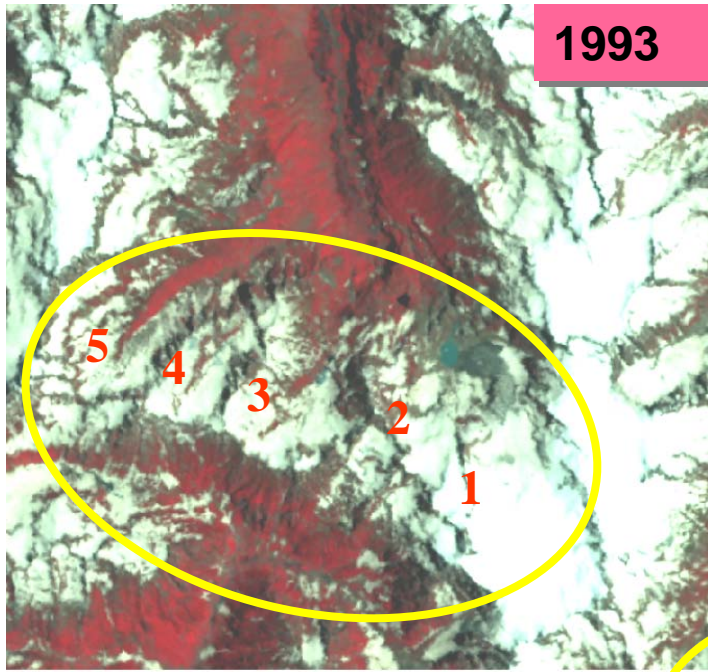
# Trend Analysis of Glacier Ice Reserves





# Temporal Variation in Lake Area



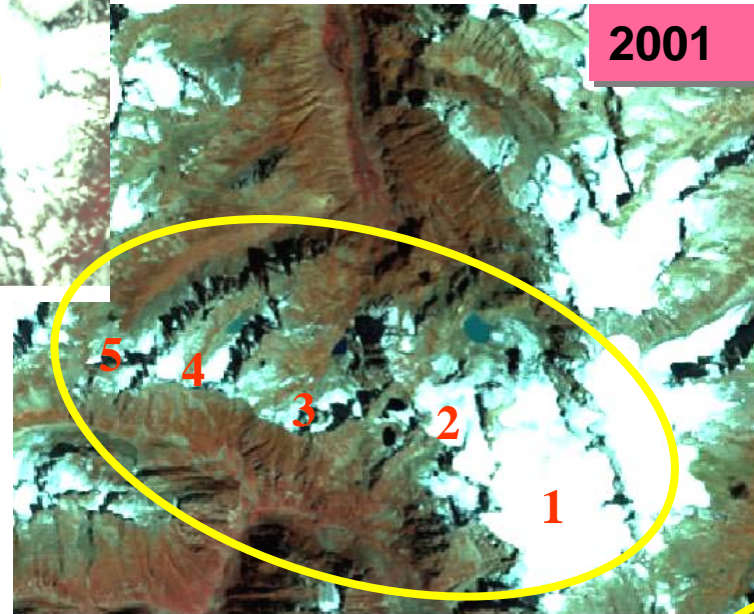


1993

Landsat-5 TM in  
14th July, 1993

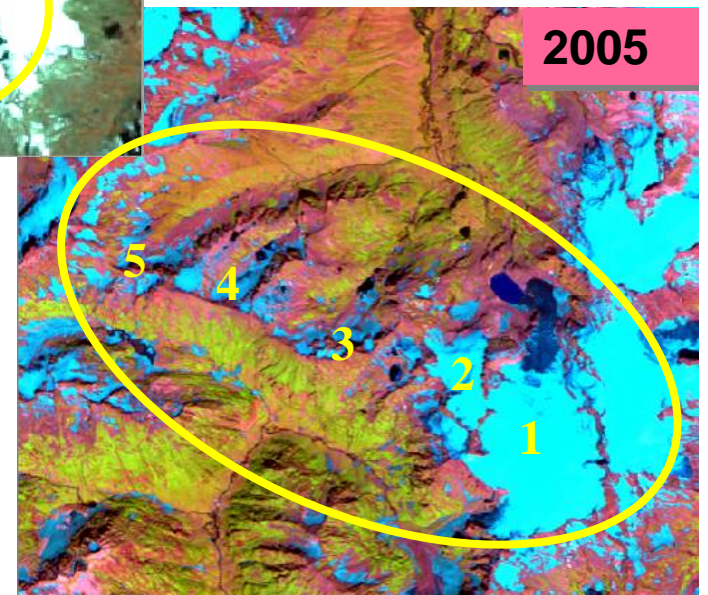
August 20, 2008

Landsat-7 ETM+  
30th Sept. 2001



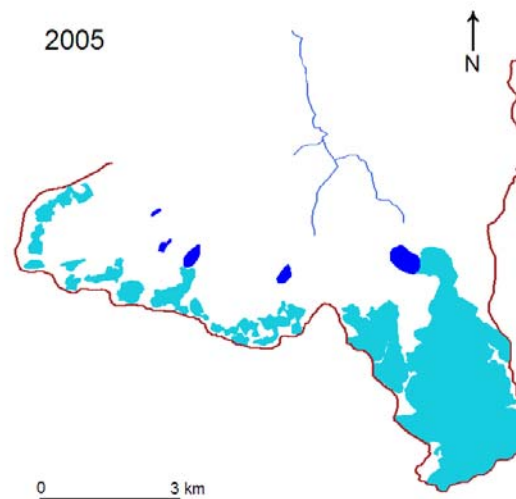
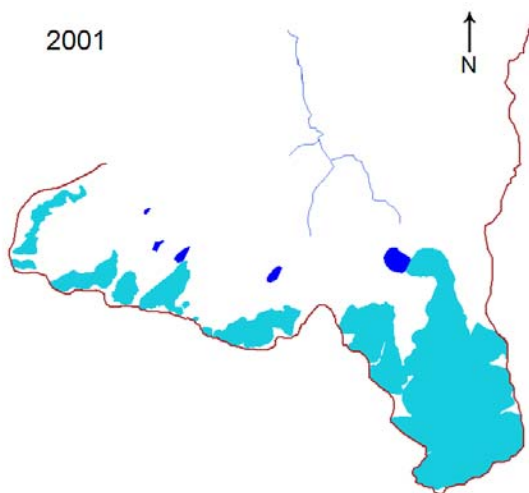
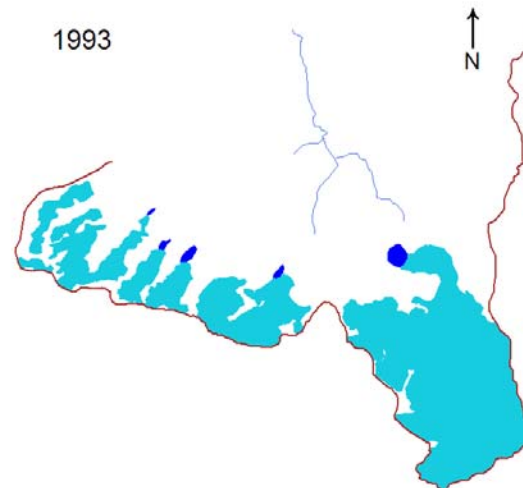
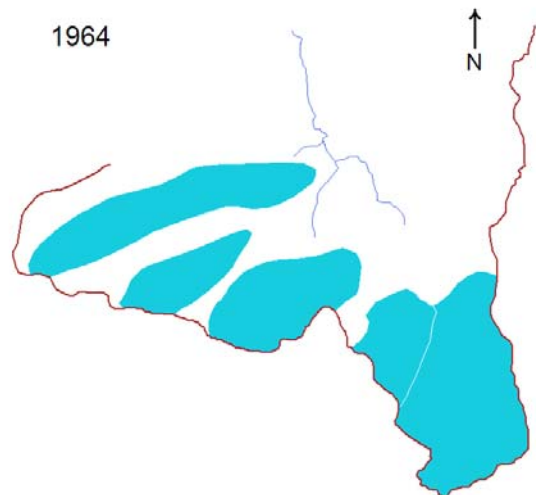
2001

SPOT- 4 XS  
1st Sept., 2005  
Roohi



2005





<b>Est. Ice Reserves (cub. Km) 2001</b>	<b>Est. Water Reserves MAF 2001</b>
<b>76</b>	<b>55.404</b>

<b>Period (1964-2005 &amp; 1993-2005)</b>	<b>Est. Ice Reserves (cub. Km,%) 2005</b>	<b>Est. Water Reserves MAF 2005</b>
<b>Maximum (0.009 cub. Km/yr)</b>	<b>72.960 (-4)</b>	<b>53.188</b>
<b>Minimum (0.001 cub. Km/yr)</b>	<b>75.696 (-0.4)</b>	<b>55.182</b>



# Conclusions

- **Increased number of more intense associated hazards i.e. GLOFs**
- **Correlation between climate change and glacier behavior???**
- **Long term process need long term monitoring/ investigation**
- **Available information!!!!!!!**
- **Need intensive investigations and field observation**
- **The more we know the more ? ? ? ? ? ? ?**

# Way Forward

- **Political commitment**
- **Institutional Collaborations... at national, regional and international level**
- **Data availability and accessibility**
- **International Collaborations and capacity building.....**
- **Long Term Commitment**

- **More storage**
- **High Efficiency Irrigation Systems**
- **On farm water management and seepage losses.....**



*Thank you*

*drroohi\_gis@yahoo.com*