Climate Change and World Heritage Sites of Pakistan

Prof. Dr. Shahina Tariq
Chairperson
Department of Meteorology
COMSATS Institute of Information Technology
SEQUENCE

- What changes Climate and Global Impact?
- Cultural Heritage Sites of Pakistan
- Impact of Climate Change on World Heritage of Pakistan
- Micro climate
More than 2 °C rise in global temp will result in devastating effects on climate and environment!

Caused by anthropogenic emissions across the globe (from the burning of oil, coal, gas, deforestation, cement production)

Climate change is real, it is dangerous, and it will be catastrophic...
Global Average Temperature

Global Impacts of Climate Change:

- Temperature: higher annual mean by 2030 – between 1.7° - 2° C
  Maximum increase in coastal areas
- Rainfall: more rain and risk of floods
- Agriculture: higher temperature, CO2 concentration and precipitation will impact production
- Sea level rise: predicted to continue at rate of 1.3mm/year
- Beginning to see intensification of tropical cyclones/sea surges because of warmer temperatures

• BAD NEWS AHEAD

Source: IPCC 2013
Pakistan is located between latitudes 24° and 37° N, it has a Continental and maritime type of climate characterized. Pakistan lies in the temperate zone.
Cultural Heritage Sites In Pakistan

Pakistan’s cultural heritage includes: round about 833

• Archaeological sites
• Stupas
• Forts
• Shrines
• Tombs
• Buildings
• Residences
• Monuments and
• places of worship
Pakistan's 6 UNESCO World heritage sites:
These sites are of national and cultural universal importance, and attracted tourists from across borders

• Archaeological Ruins at Moenjodaro (1980)
• Buddhist Ruins of Takht-i-Bahi and Neighbouring City Remains at Sahr-i-Bahlol (1980)
• Fort and Shalimar Gardens in Lahore (1981)
• Historical Monuments at Makli, Thatta (1981)
• Rohtas Fort (1997)
• Taxila (1980)
Rohtas Fort (1997)

- *Rohtas Fort* is an extraordinary example of early Muslim military architecture in central and south Asia.
- Built by *Sher Shah Suri* in 1541, about 16 Km north-west of the city of Jhelum
UNESCO and the Government of Pakistan are working on the restructuring of the site management. Harappa, Mehrgarh and Rehman Dheri have been nominated as extensions of the archaeological site of Moenjodaro.

Archaeological Ruins - Moenjodaro (1980)
Buddhist Ruins of Takht-i-Bahi and Neighbouring City Remains at Sahr-i-Bahlol (1980)

• Founded in early 1st century A.D., situated on various hilltops ranging from 36.6 meters to 152.4 meters in height

• Buddhist Ruins of Takht-i-Bahi (Throne of Origins) and Neighbouring City Remains at Sahr-i-Bahlol are one of the most imposing relics of Buddhism in the Gandhara region of Pakistan
Fort and Shalimar Gardens in Lahore (1981)

- Dating back to the 17th century, both the Lahore Fort and Shalimar Gardens are outstanding examples of Mughal artistic expression at its height. The two sites were inscribed on the World Heritage List.
Historical Monuments at Makli, Thatta (1981)

- Spread over 10 kilometres and host to around half a million tombs, The vast Muslim necropolis of Makli is one of the largest in the world. Kings, queens, governors, saints, scholars, and philosophers are buried here in brick or stone monuments.
Taxila (1980)

• One of the most important complex archaeological sites developed during the Harrapan (3100-2500 BC) and Ashokan periods in Asia (Rawalpindi Pakistan).

• The ruins of Taxila depict the pattern of urban evolution on the Indian subcontinent through more than five centuries.
Impact of Climate Change (Sirkap and Dharmarajika)

- To assess the long-term climatic variable and its effect on the historical heritage, Sirkap and Dharmarajika, the maximum and minimum temperatures and rainfall data were used, which was acquired from the Pakistan Meteorology Department (PMD).

- The period of the data ranges from 1954 to 2014 (60 years). Though the in-situ observation in this area (Taxila) is not available, the LST data set for the period of 1998 to 2011 (Ali 2015, unpublished thesis) were used for the comparison and analysis.
Linear trends of $T_{\text{max}}$ ($^\circ$C) of Rawalpindi between the periods of 1954 to 2014

Linear trends of $T_{\text{min}}$ ($^\circ$C) of Rawalpindi between the periods of 1954 to 2014

Mean temperature trend in the heritage areas show increasing at the rate of 0.01 $^\circ$C/yr. Dramatic increased of temperature is found for the period of last three decades (0.03 $^\circ$C/yr) since 1985 to 2014.

Minimum temperature is rising faster (trend = 0.03 $^\circ$C/yr, $R^2$=36%), compared with the Maximum temperature (trend = 0.01$^\circ$C/yr, $R^2$ = 12%).

Significantly warming rate is observed between the periods of 1985 to 2014 for the minimum temperature (0.05 $^\circ$C/yr) compared with the maximum temperature (no change).
The Annual fluctuation of mean temperatures and rainfall

The inverse relationship is higher (R = -0.30; trend = 8.05 mm/yr) during the period of last three decades indicates that the multifarious activities of human is higher in the same period.

The inter-annual fluctuation of mean temperatures and rainfall shows negative relationship (R = -0.13), suggesting the increasing of temperature is associated with the decreasing of rainfall (trend= 6.18 mm/yr).
Land Surface Temperature (LDT) Data set for the period of 1998-2011 (Rawalpindi & Taxila)

Figure 4.1 LST of district—Rawalpindi (incl. all 6 allied tehsils).
Spatial patterns of temporal trends of LST (°C) in Rawalpindi for the years 1993, 1998, 2002, and 2011. The palette was rescaled to show the temporal pattern.

1993
1998
2002
2011

Legend (°C)
- No Data
- < 16
- 16 - 20
- 20 - 24
- 24 - 28
- 28 - 32
- 32 - 36
- 36 - 40
- > 40

Figure 4.2 Probability distribution functions (pdf) of district—Rawalpindi.
Probability distribution functions showing spatial pattern of LST of district Rawalpindi (including all 6 allied tehsil) of years 1993, 1998, 2002, and 2011. The solid curve in each case represents the normal distribution.

1993
1998
2002
2011

Legend (°C)
- < 21
- 21 - 25
- 25 - 28
- 28 - 31
- 31 - 34
- 34 - 37
- > 37

Figure 4.3 LST panel tehsil—Taxila.
Spatial patterns of temporal trends of LST (°C) in tehsil Taxila for the years 1993, 1998, 2002, and 2011. The color palette was rescaled to show the temporal patterns.

Figure 4.4 Probability distribution functions (pdf) of tehsil—Taxila.

### Table 1: Descriptive statistics of variables for the period of 1985 to 2014

<table>
<thead>
<tr>
<th>Column1</th>
<th>Column2</th>
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<tbody>
<tr>
<td><strong>Maximum</strong></td>
<td>Minimum</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>Standard Error</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>Median</strong></td>
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<tr>
<td><strong>Mode</strong></td>
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<td><strong>Kurtosis</strong></td>
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<tr>
<td><strong>Skewness</strong></td>
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<td><strong>Range</strong></td>
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<tr>
<td><strong>Minimum</strong></td>
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<tr>
<td><strong>Maximum</strong></td>
<td>30.233</td>
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<td><strong>Count</strong></td>
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<td><strong>Confidence Level(95.0%)</strong></td>
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### Table 2: Descriptive statistics of variables for the period of 1954 to 2014

<table>
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<td><strong>Range</strong></td>
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<td><strong>Minimum</strong></td>
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<td>0.29777</td>
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1954-2014
Conclusion:

- The significant of rising of minimum temperature in the study area is associated with the local anthropogenic activities, changing of land use patterns and decreasing tendency of rainfall, suggest, the possibility in declining of thermal comfort, which might be hampered the stability of foundation of cultural heritage.

- In addition to this, increasing of urbanization.

- The study also recommends the need of installation of automated weather stations for better investigation of micro climatic change and its impact on heritage.
The presenter would like to thank the sponsors that made attendance to the 2nd Huangshan Dialogue on UNESCO Sites and Sustainable Development possible.
“Heritage is our legacy from the past, what we live with today, and what we pass on to future generations. Our cultural and natural heritage are both irreplaceable sources of life and inspiration,”

Thank You

2nd Huangshan Dialogue on UNESCO Sites and Sustainable Development