Climate Change and World Heritage Sites of Pakistan

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SEQUENCE

- What changes Climate and Global Impact ?

- Cultural Heritage Sites of Pakistan

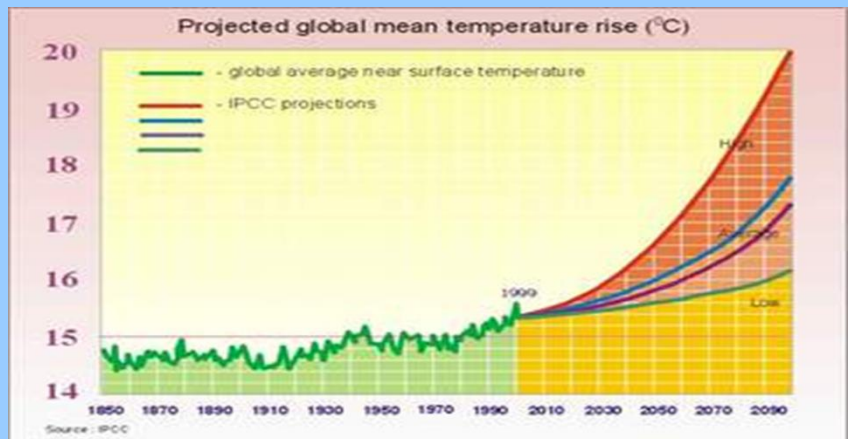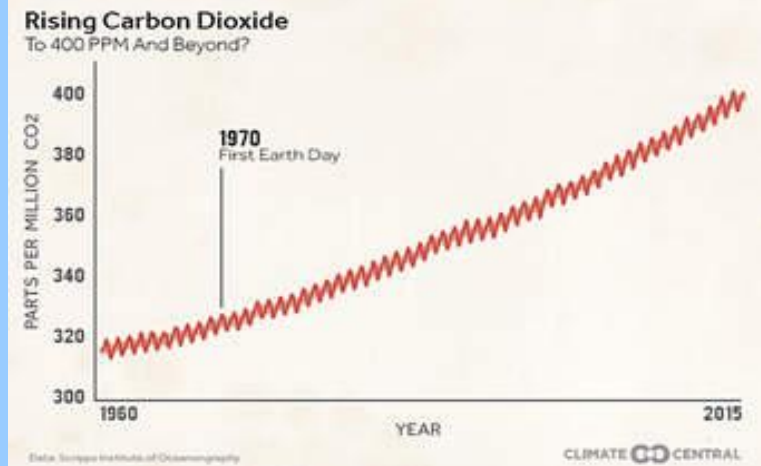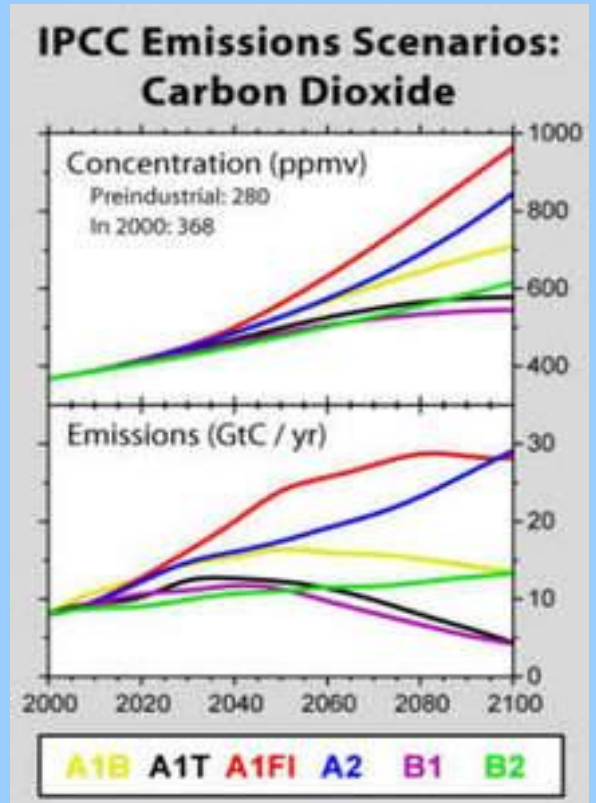- Impact of Climate Change on World Heritage of Pakista

- Micro climate

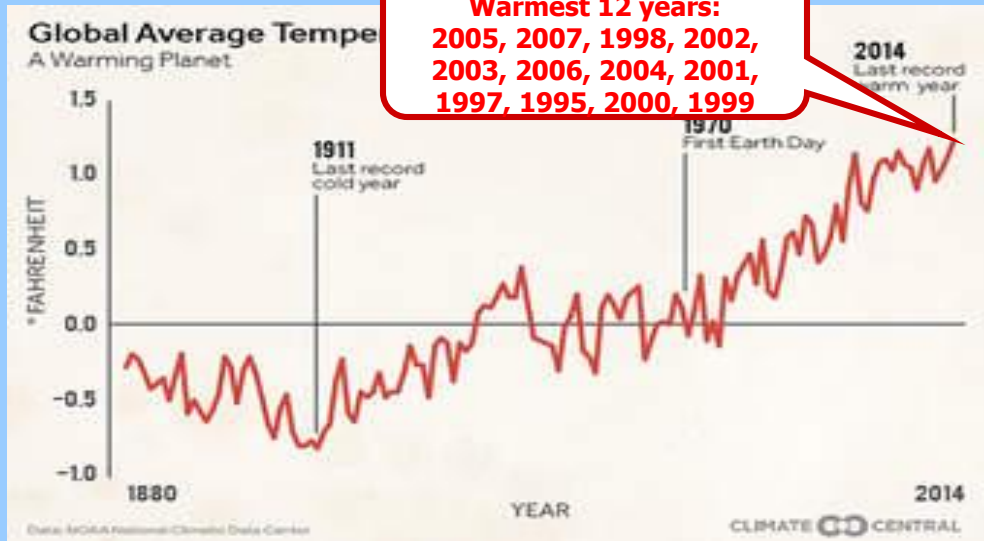…han 2 ° C rise in global temp will result
Devastating effects on climate and environment!

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…
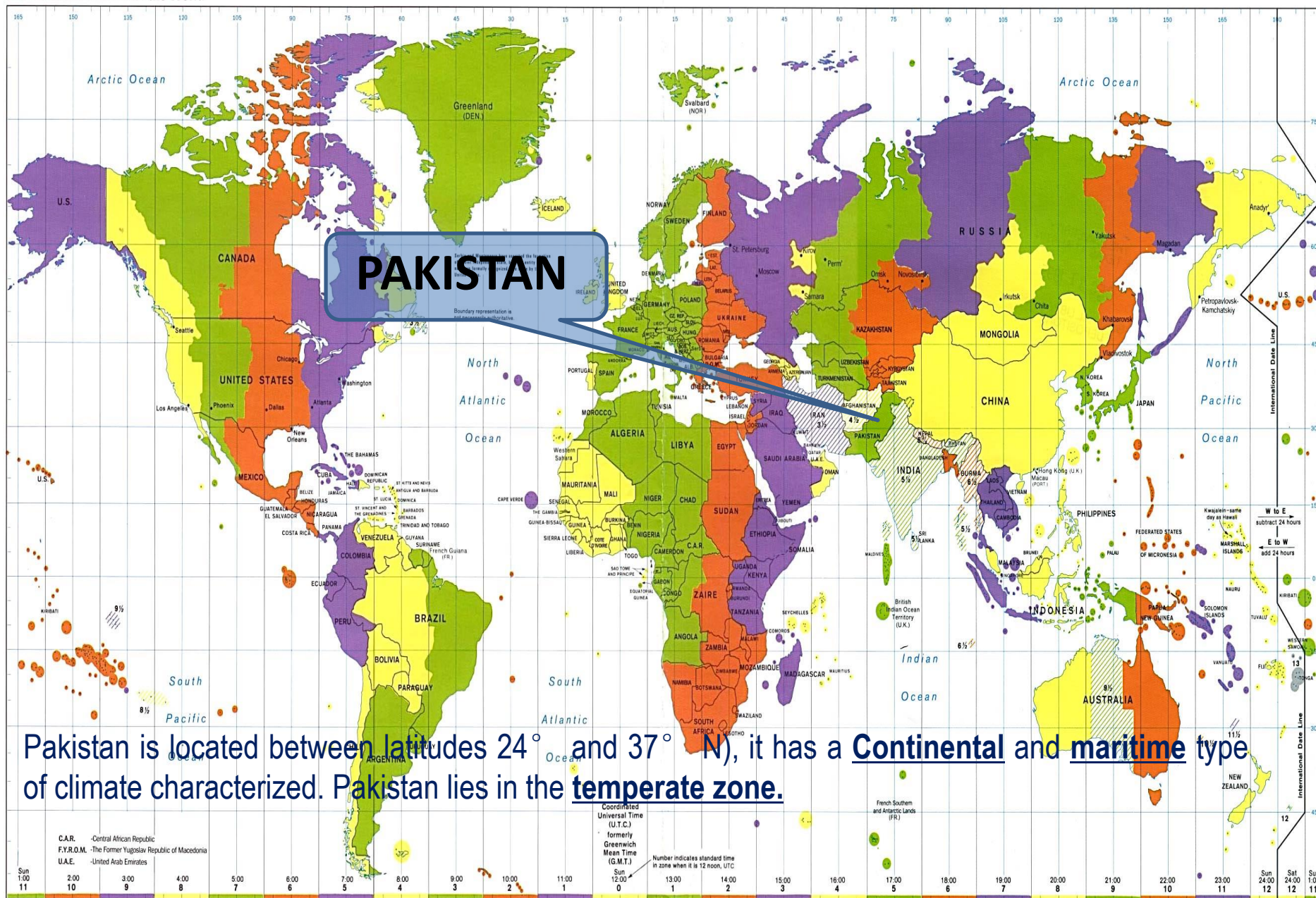
Global Average Temperature

Global Average Temperature
A Warming Planet

**Warmest 12 years:
2005, 2007, 1998, 2002,
2003, 2006, 2004, 2001,
1997, 1995, 2000, 1999**

1911
Last record
cold year

1970
First Earth Day

2014
Last record
warm year

°FAHRENHEIT

1880 — 2014
YEAR

Data: NOAA National Climatic Data Center

CLIMATE CENTRAL

IPCC Emissions Scenarios: Carbon Dioxide

Concentration (ppmv)
Preindustrial: 280
In 2000: 368

Emissions (GtC / yr)

2000 2020 2040 2060 2080 2100

A1B A1T A1FI A2 B1 B2

Rising Carbon Dioxide
To 400 PPM And Beyond?

1970
First Earth Day

PARTS PER MILLION CO2

1960 — 2015
YEAR

Data: Scripps Institute of Oceanography

CLIMATE CENTRAL

Projected global mean temperature rise (°C)

- global average near surface temperature
- IPCC projections

1850 1870 1890 1910 1930 1950 1970 1990 2010 2030 2050 2070 2090

Source: IPCC

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, CO_2 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**

9/14/2016

Source: IPCC 2013

Standard Time Zones of the World

PAKISTAN

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.**

2nd Huangshan Dialogue on UNESCO Sites and Sustainable Development

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**
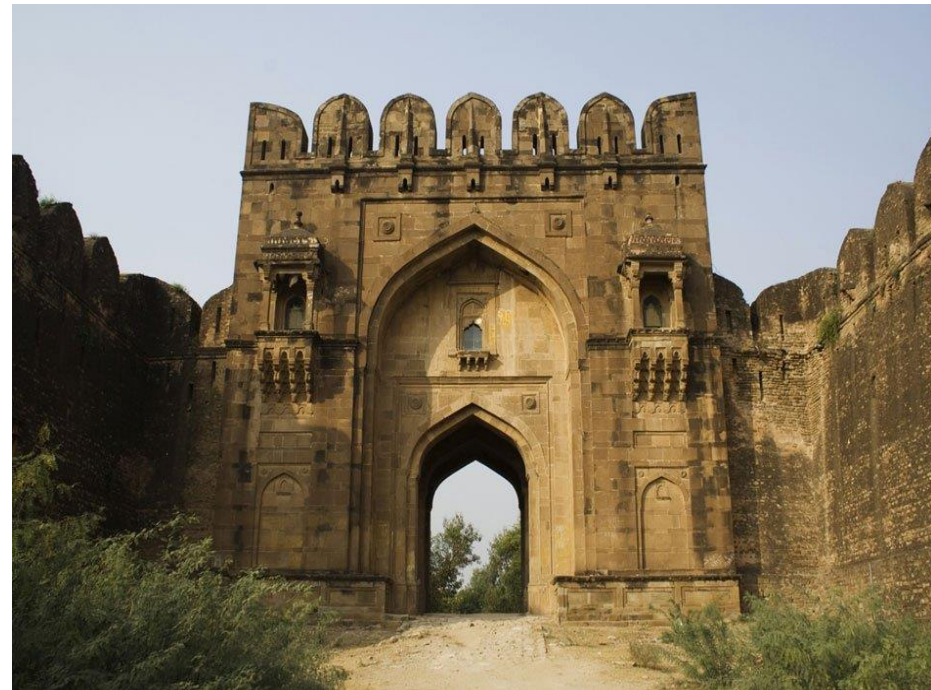
Pakistan's 6 UNESCO World heritage sites:
These sites are of national and cultural universal importance,
and attracted tourists from across borders

- 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

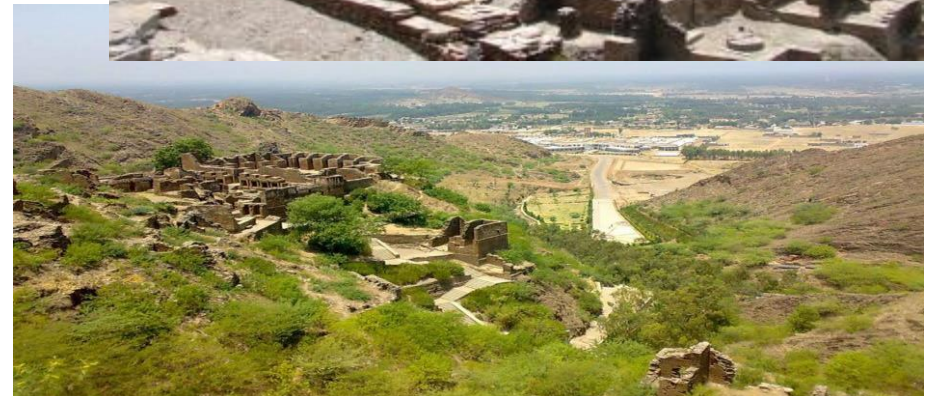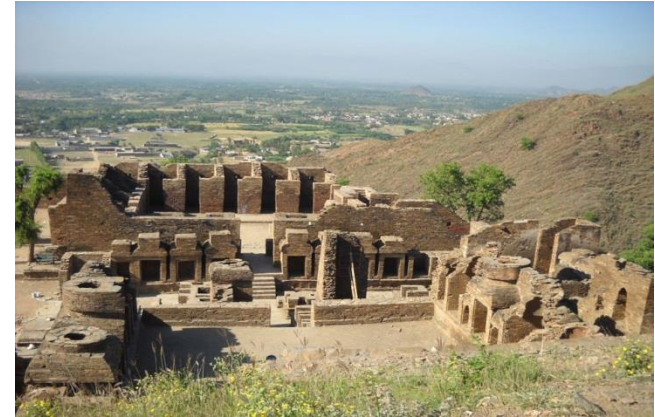# Archaeological Ruins-Moenjodaro (1980)

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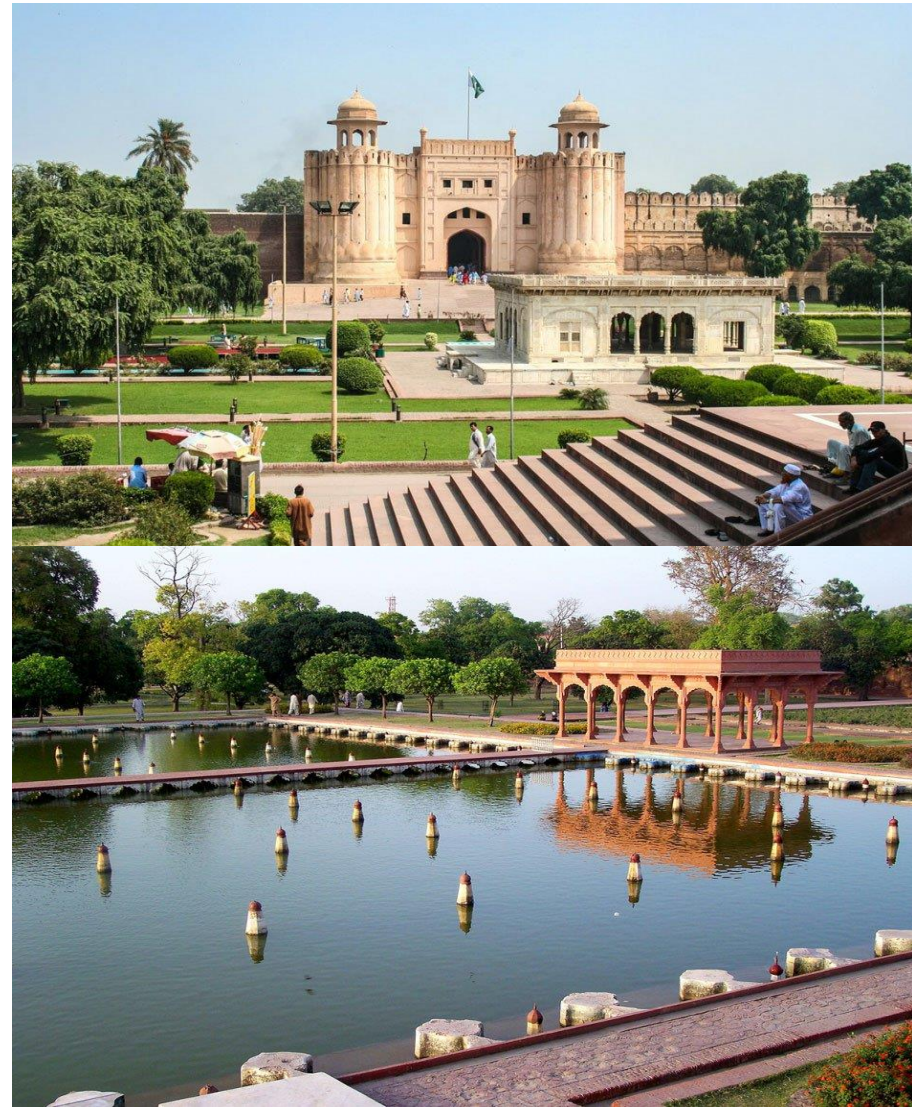
Buddhist Ruins of Takht-i-Bahi and Neighbouring City Remains at Sahr-i-Bahlol (1980)

- 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
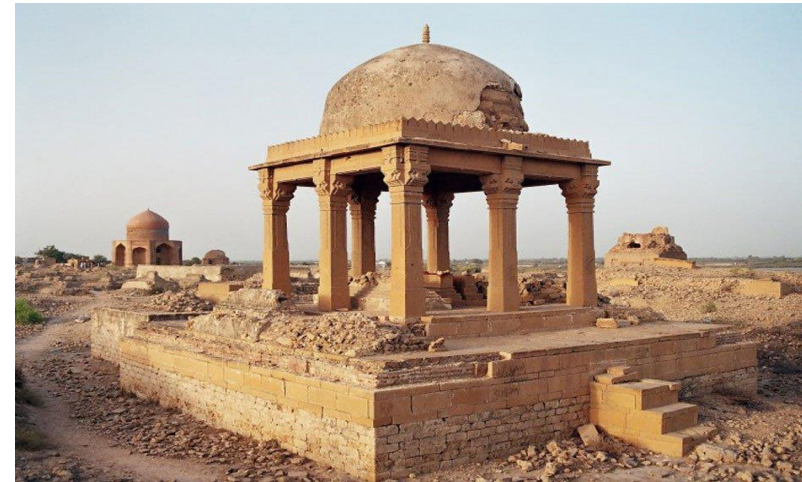
Fort and Shalimar Gardens in Lahore (1981)

- 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.
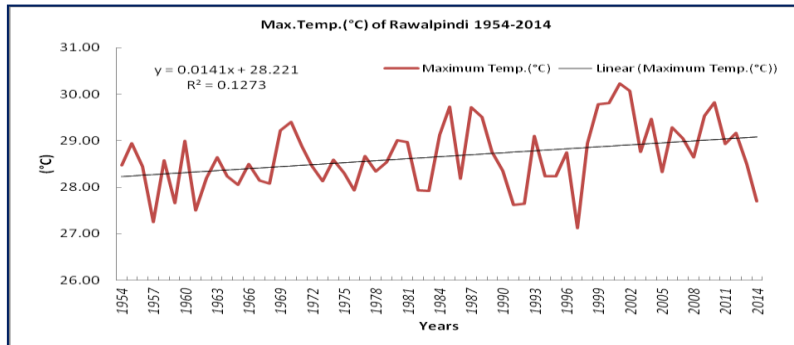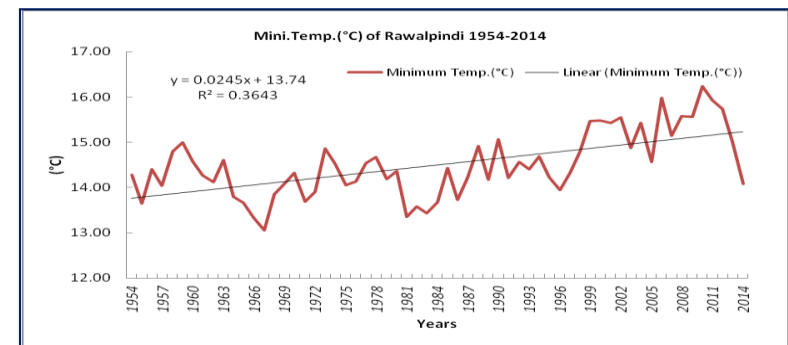
Impact of Climate Change (Sirkap and Dharmarajika)

- 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.
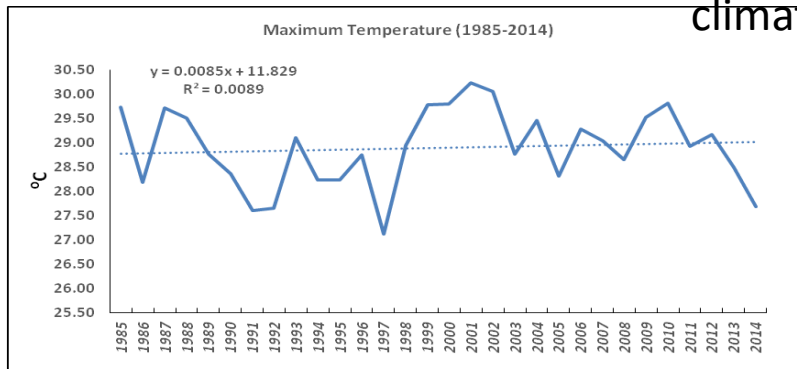
Case study of Taxila

Linear trends of T_{max} (°C) of Rawalpindi between the periods of 1954 to 2014

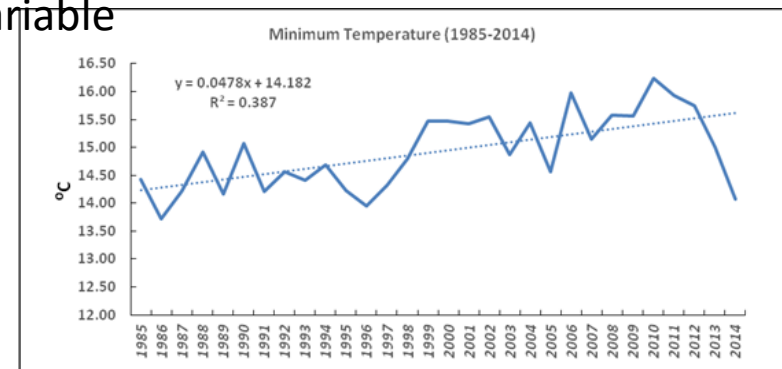Linear trends of T_{min} (°C) of Rawalpindi between the periods of 1954 to 2014

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

climatic variable

Linear trends of T_{max} (°C) of Rawalpindi between the periods of 1985 to 2014
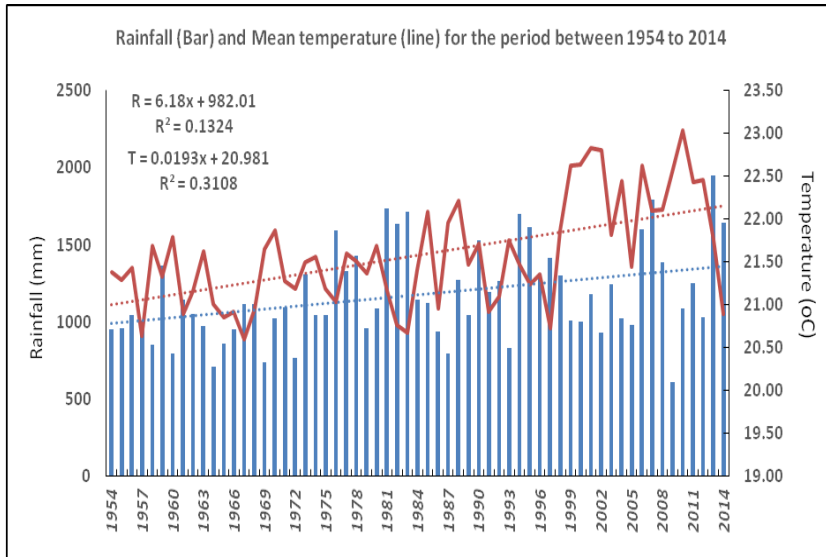

Linear trends of T_{min} (°C) of Rawalpindi between the periods of 1985 to 2014

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

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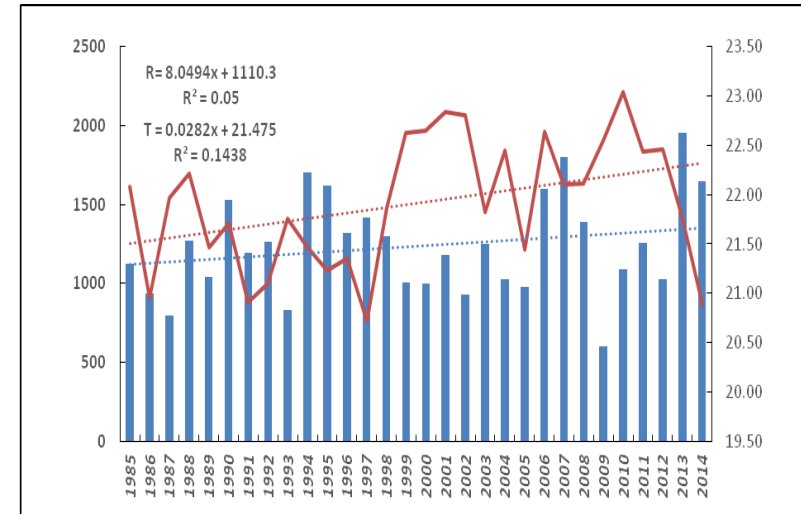
The Annual fluctuation of mean temperatures and rainfall

Rainfall (Bar) and Mean temperature (line) for the period between 1954 to 2014

$R = 6.18x + 982.01$
$R^2 = 0.1324$

$T = 0.0193x + 20.981$
$R^2 = 0.3108$

$R = 8.0494x + 1110.3$
$R^2 = 0.05$

$T = 0.0282x + 21.475$
$R^2 = 0.1438$

Linear trends of Rainfall (Bar) and T_{mean} (line) between the periods of 1954 to 2014

Linear trends of Rainfall (Bar) and T_{mean} (line) between the periods of 1985 to 2014)

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)
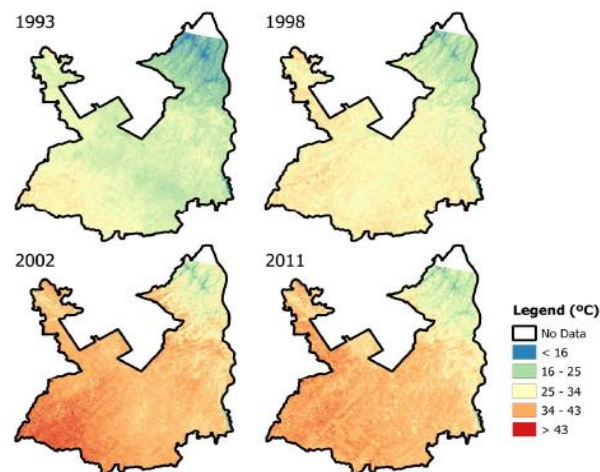

Figure 4.1 LST of district–Rawalpindi (incl. all 6 allied tehsils).
Spatial patterns of temporal trends of LST (°C) in Rawalpindi for the years 1993, 1998, 2002, and 2011. The palette was rescaled to show the temporal pattern.
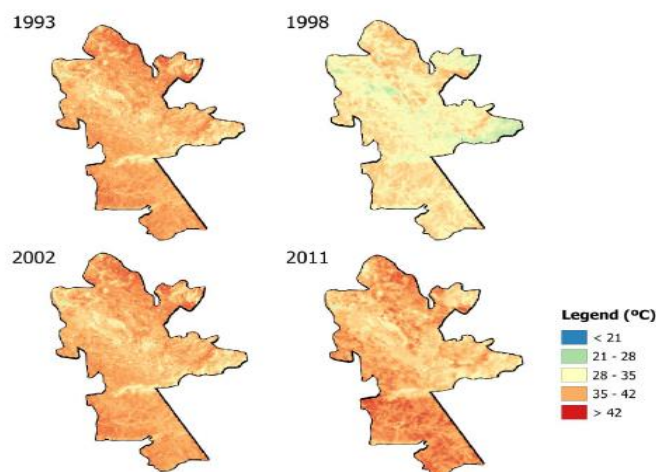

Figure 4.2 Probability distribution functions (pdf) of district–Rawalpindi.
Probability distribution functions showing spatial pattern of LST of district Rawalpindi (including all 6 allied tehsil) of years 1993, 1998, 2002, and 2011. The solid curve in each case represents the normal distribution.

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.
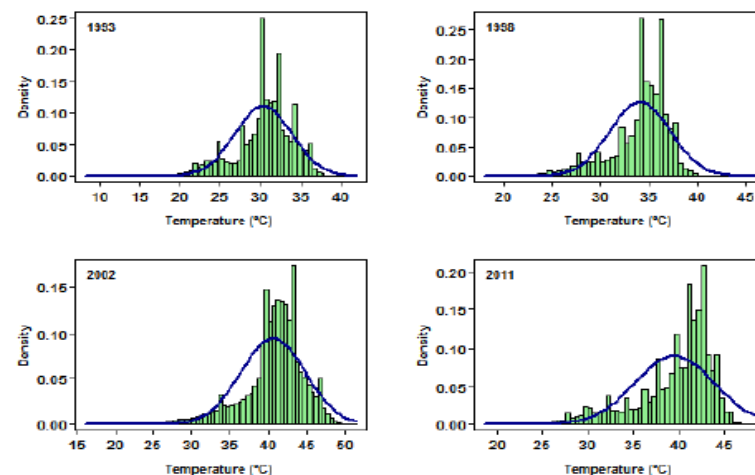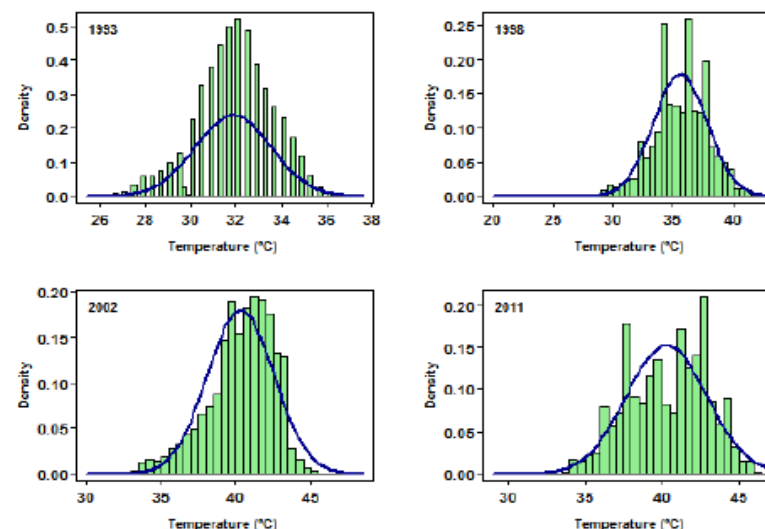

Figure 4.4 Probability distribution functions (pdf) of tehsil–Taxila.
Probability distribution functions showing spatial pattern of LST of tehsil Taxila of years 1993, 1998, 2002, and 2011. The solid curve in each case represents the normal distribution.

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

Column1		Column2	
Maximum		Minimum	
Mean	28.65088028	Mean	14.48917024
Standard Error	0.085976273	Standard Error	0.088084449
Median	28.5625	Median	14.3375
Mode	28.475	Mode	14.275
Standard Deviation	0.687810183	Standard Deviation	0.704675589
Sample Variance	0.473082847	Sample Variance	0.496567685
Kurtosis	-0.256421464	Kurtosis	-0.205465751
Skewness	0.158372499	Skewness	0.452980193
Range	3.108333333	Range	3.191666667
Minimum	27.125	Minimum	13.05
Maximum	30.23333333	Maximum	16.24166667
Sum	1833.656338	Sum	927.3068952
Count	64	Count	64
Confidence Level(95.0%)	0.171809872	Confidence Level(95.0%)	0.176022725
1954-2014			

Table 2: Descriptive statistics of variables for the period of 1954 to 2014

Column1		Column2	
Maximum		Minimum	
Mean	28.9008	Mean	14.92328539
Standard Error	0.14559	Standard Error	0.12362837
Median	28.9375	Median	14.89583333
Mode	28.7667	Mode	14.20833333
Standard Deviation	0.79744	Standard Deviation	0.677140472
Sample Variance	0.6359	Sample Variance	0.458519219
Kurtosis	-0.5616	Kurtosis	-1.046935087
Skewness	-0.3473	Skewness	0.124979358
Range	3.10833	Range	2.516666667
Minimum	27.125	Minimum	13.725
Maximum	30.2333	Maximum	16.24166667
Sum	867.023	Sum	447.6985618
Count	30	Count	30
Confidence Level(95.0%)	0.29777	Confidence Level(95.0%)	0.252848408
1985-2014			

Conclusion:

o 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.

o In addition to this, increasing of urbanization.

o The study also recommends the need of installation of automated weather stations for better investigation of micro climatic change and its impact on heritage.

Acknowledgement

The presenter would like to thank the sponsors that made attendance to @ 2nd Huangshan Dialogue on UNESCO Sites and Sustainable Development possible:

a statement on UNESCO's website says,

"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