

**TEMPORAL EFFECTS OF CLIMATE CHANGE ON  
THE GROWTH OF CHIR PINE (*PINUS ROXBURGHII*)  
IN TEHSIL MURREE, PUNJAB, PAKISTAN**



By

**SAJJAD HAIDER ZAIDI**

**Department of Earth and Environmental Sciences  
Bahria University, Islamabad  
2015**

**TEMPORAL EFFECTS OF CLIMATE CHANGE ON THE  
GROWTH OF CHIR PINE (*PINUS ROXBURGHII*) IN  
TEHSIL MURREE, PUNJAB, PAKISTAN**



A thesis submitted to Bahria University, Islamabad in partial fulfilment of  
the requirement for the degree of MS in Environmental Policy and  
Management

**SAJJAD HAIDER ZAIDI**

**Department of Earth and Environmental Sciences  
Bahria University, Islamabad  
2015**

## ABSTRACT

Tree rings have been used in various applications to reconstruct past climates as well as to assess the effects of climatic and environmental change on tree growth. The study focused on growth of *Pinus roxburghii* (Chir Pine) in Murree Tehsil forest. Meteorological data (maximum temperature, minimum temperature, mean annual temperature and precipitation) was analyzed during the period 1959-2015 to calibrate the effects of climate change on the growth of ring widths. The regime of maximum temperature, minimum temperature, mean annual temperature and precipitation were calculated  $17.33\pm 0.14$  °C,  $8.79\pm 0.14$  °C,  $17.32\pm 0.14$  °C and  $1648.75\pm 48.8$  mm/annum respectively. There is increase in minimum temperature (1.23 °C), maximum temperature (0.58 °C) and mean temperature (0.92 °C) (Bajwa et al., 2015) was observed during the period 1959-2015. Precipitation increased to 25% during the period 1959-2015. The mean ring-width, intra-ring early and late wood formation was 1.81 mm, 69.49 and 27.83%, respectively. The ring-width and intra-ring early wood formation decreased by 12.23% and 7.15%, respectively, while the intra-ring late wood formation increased by 11.38%. The impact of maximum temperature, mean temperature and precipitation was significant on the late wood formation. There is negative but significant correlation between ring width and temperature (minimum, maximum, mean) also ring width showed negative but significant ( $p < 0.05$ ) correlation with precipitation. The intra-ring early wood formation showed negative correlation with maximum temperature and precipitation, while intra-ring late wood formation showed positive correlation with mean temperature, maximum temperature and precipitation. Ring-width and intra-ring wood formation results revealed that climate change is effecting the growth of *Pinus roxburghii* in the Murree forest.

## **ACKNOWLEDGEMENT**

To start with, all praise to Allah Almighty who is the supreme power. I would like to show gratitude to my supervisor Mr. Muhammad Khubaib Abuzar, Senior Assistant Professor, Department of Earth and Environmental Sciences, Bahria University Islamabad for his assistance in research work, GIS and comments that greatly improved the manuscript. We are using this opportunity to express gratefulness to Prof. Dr. Tahseenullah Khan, Head of Department, Department of Earth and Environmental Sciences, Bahria University Islamabad for his aspiring support.

Last but not the least, I would like to thank my parents, wife and kids for their encouragement and constant upkeep and my beloved fellow peers with whom we have shared some of the most memorable years of our lives.

## ABBREVIATIONS

AMSL	Above Mean Sea Level
CPA	Cumulative Precipitation Anomaly
ET	Evapotranspiration
EWV	Early Wood Width
LST	Land Surface Temperature
LWW	Late Wood Width
MH	Maximum Humidity
MR	Maximum Rainfall
MT	Maximum Temperature
PMD	Pakistan Meteorological Department
SD	Standard Deviation
SPI	Standardized Precipitation Index
WMO	World Meteorological Organization
UNFCCC	United Nation Framework Convention on Climate Change
GHGs	Green House Gases
UNEP	United Nation Environment Programme
GIS	Global Information System
UNESCO	United Nations Educational, Scientific and Cultural Organization
PMD	Pakistan Meteorological Department

## CONTENTS

	Page
<b>ABSTRACT</b>	i
<b>ACKNOWLEDGEMENTS</b>	ii
<b>ABBREVIATIONS</b>	iii
<b>FIGURES</b>	Vi
<b>TABLES</b>	Viii

### CHAPTER 1

#### INTRODUCTION

1.1	Background	1
1.2	Purpose of statement	5
1.3	National Context of the research	5
1.4	Area statement	6
1.5	Management objectives	6
1.6	Forest nurseries	7
1.7	Guzara forests	7
1.8	Study plans-Definitions and concept	7
1.9	Tree ring	8
1.10	Reason for the variations in tree rings	9
1.11	Background for study plan	11
1.12	Application of tree ring study “Dendrochronology”	14
1.13	Objectives	17

### CHAPTER 2

#### MATERIALS AND METHODS

2.1	Overview of research methods	19
2.2	Data collection methods	21
2.3	Field visits	22
2.4	Selection process	22

2.4.1	Selection of research area	22
2.4.2	Selection of cluster	22
2.4.3	Target trees for data collection	22
2.4.4	Safe sample storage	22
2.5	Study area map	23

### **CHAPTER 3**

#### **RESULTS AND DISCUSSIONS**

3.1	Analysis of temperature data	24
3.2	Analysis of precipitation data	26
3.3	Ring width data analysis	27
3.3.1	Ring width	28
3.3.2	Early wood width	28
3.3.3	Late wood width	28
3.4	Correlation between ring width and annual average temperature	29
3.5	Correlation between ring width and annual average precipitation	30
3.6	Correlation between early wood width and spring precipitation	31
3.7	Correlation between late wood width and summer precipitation	31
3.8	Correlation between early wood width and spring temperature	32
3.9	Correlation between late wood width and summer temperature	33
3.10	Linear correlation between growing parameters	33

	<b>CONCLUSION</b>	34
--	-------------------	----

	<b>RECOMMENDATIONS</b>	35
--	------------------------	----

	<b>REFERENCES</b>	36
--	-------------------	----

## FIGURES

		Page
Figure 1.1.	Ring width from 1664-1795.	10
Figure 1.2.	Early and late wood rings.	10
Figure 1.3.	Dendrochronology (from Dendron, "tree limb" khronos, "time"; and logia, or tree-ring dating, is the scientific method of dating based on the analysis of patterns of tree rings, also known as growth rings. Dendrochronology can date the time at which tree rings were formed, in many types of wood, to the exact calendar year.	15
Figure 2.1.	Flowchart showing methodology adopted to complete this research.	19
Figure 2.2.	Geographical location of the study area.	23
Figure 3.1.	Annual maximum temperature over Murree Tehsil (1959-2015).	24
Figure 3.2.	Annual minimum temperature over Murree Tehsil (1959-2015).	25
Figure 3.3.	Annual mean temperature over Murree Tehsil (1959-2015).	25
Figure 3.4.	Annual precipitation over Murree Tehsil (1959-2015).	26
Figure 3.5.	Ring width over Murree Tehsil (1959-2015).	27
Figure 3.6.	Early wood width over Murree Tehsil (1959-2015).	28
Figure 3.7.	Late wood width over Murree Tehsil (1959-2015).	29
Figure 3.8.	Correlation between ring width and annual average temperature from 1959-2015.	30
Figure 3.9.	Correlation between ring width and annual average precipitation from 1959-2015	30
Figure 3.10.	Correlation between early wood width and spring precipitation.	31
Figure 3.11.	Correlation between late wood width and summer precipitation.	32
Figure 3.12.	Correlation between early wood width and spring	



	temperature.	32
Figure 3.13.	Correlation between late wood width and summer precipitation.	33

## TABLES

	Page
Table 1.1. Statistics of the study area.	06
Table 2.1. Showing aims and objectives achieved during specific time period and methodology adopted.	20
Table 3.1. Climate regimes and changes over Murree Tehsil (1959-2015).	27
Table 3.2. Statistics of ring-width of <i>Pinus Roxburghii</i> in Murree Tehsil (1959-2015).	29
Table 3.3. Correlation matrix among Chir Pine growth and climate parameter over in Murree Tehsil (1959-2015).	33