RADIOLOGICAL RISK ASSESSMENT IN THE ENVIRONS OF MOGA AND BARNALA DISTRICTS OF PUNJAB

A

THESIS

SUBMITTED TO

MAHARAJA RANJIT SINGH
PUNJAB TECHNICAL UNIVERSITY
BATHINDA, PUNJAB (INDIA)

IN FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY
IN
FACULTY OF SCIENCES

By
Supriya Rani
(Registration No.–18406FPE01)
Department of Physics
Maharaja Ranjit Singh Punjab Technical University
Bathinda, Punjab, India
(AUGUST 2022)

CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in the thesis, entitled **"RADIOLOGICAL RISK ASSESSMENT IN THE ENVIRONS OF MOGA AND BARNALA DISRICTS OF PUNJAB"** in fulfilment of the requirements of the award of the degree of Doctor of Philosophy in Faculty of Sciences and submitted in Department of Physics, Maharaja Ranjit Singh Punjab Technical University, Bathinda, is an authentic record of my own work carried out during a period from July 2018 to August 2022 under the supervision of **Dr. Sandeep Kansal, Professor & Head, Department of Physics, MRSPTU, Bathinda and Dr. Rohit Mehra (Co-supervisor), Associate Professor, Dr. BR Ambedkar National Institute of Technology, Jalandhar.**

The matter embodied in this thesis has not been submitted by me for the award of any other degree of this or any other University/Institute.

(Supriya Rani)

Registration No. 18406FPE01

This is to certify that the above statement made by the candidate is correct to the best of our knowledge.

(Dr. Sandeep Kansal)
(Supervisor)
Department of Physics
MRSPTU, Bathinda

(Dr. Rohit Mehra)
(Co-Supervisor)
Department of Physics
Dr. BR Ambedkar NIT, Jalandhar

The Ph.D Viva-Voice examination of **Supriya Rani (18406FPE01)** Research Scholar, has been held on _____.

Sign of Supervisor **Sign of Co-Supervisor** **Sign of External Examiner**

DEDICATION

MY DEGREE OF DOCTOR OF PHILOSOPHY IS DEDICATED TO MY HUSBAND

ACKNOWLEDGEMENT

First and foremost, I would like to express heartfelt thanks to the almighty GOD for the blessing in lending me to complete this work. Immeasurable appreciation and deepest gratitude for the help and support are extended to all the persons who in one way or another have contributed towards the completion of this thesis.

I am profoundly grateful to my supervisor Prof. Sandeep Kansal, Department of Physics, MRSPTU, Bathinda, who has supported me throughout my Ph.D. work with his great motivation and immense knowledge.

Next, I would like to express my sincere gratitude to my co-supervisor Dr. Rohit Mehra, Associate Prof., Department of Physics, Dr. B. R. Ambedkar NIT, Jalandhar, for his constant support, guidance and motivation. It would never have been possible for me to take this work to completion without her incredible support and encouragement.

I thank to Prof. Buta Singh Sidhu, Vice-chancellor, MRSPTU, Bathinda for their encouragement and assistance during my research.

I am extremely grateful and highly obliged to Prof. V. K. Garg and Dr. Yogalakhshmi, Associate Prof., Department of Environmental Science and Technology, Central University of Punjab, Ghudda, Bathinda District, for providing necessary help and facilities for LED Fluorimeter for analysis of water samples.

The family of my supervisors are also to be thanked for their hospitality in putting up with me even when I bothered them at unusual hours. I am appreciative of Madam Mamta Kansal, Associate Prof. and Head, Department of Mathematics, MRSPTU, Bathinda, for making accommodations for me, and I humbly ask for forgiveness from the adorable kids Ridha and Aarush for taking away the priceless time they could have spent with their father on weekends and holidays.

From the core of my heart, I would also like to thank my loving uncle (Mama Ji) Sh. Suresh Kumar (Principal), Director Academics, PSBTE & IT, Chandigarh for their blessings, positivity and invisible help throughout the journey of my Ph.D. work.

I want to express my gratitude to the residents of the investigated area for providing a secure location collecting samples and for assisting with sample collection. It's also worth mentioning and thanking Mami ji Mrs. Neeru Rani, Mrs. Ruchi and her

family, and Manak Bansal for their assistance during field work irrespective of their busy schedule of life.

A sincere thanks to Mr. Rahul Menon, Jr. Tech. (Grade-II), Department of Physics, MRSPTU, Bathinda, for his constant support and encouragement as his younger brother. My special thanks to Mr. Jaswinder Singh, Jr. Assist., University Business School, MRSPTU, Bathinda, India for his support during my thesis work and also thanks to Dr. Vikas Duggal, Department of Physics, D.A.V. College, Bathinda for support in physiochemical parameters.

My deepest gratitude goes out to my supportive parents (Sh. Rajinder Prashad and Smt. Kamlesh Rani), sister-in-law (Rupali Jindal), and her entire family for their support and blessings during this project. And also thanks to parents (Sh. Rajesh Kumar and Smt. Suresh Rani), Brother (Gaurav Goyal) and sister (Greema Goyal) for their support during field work and encourage me. This dissertation stands as a testament to my family's unconditional love and encouragement. Thanks to all my family members for believing in me.

I owe thanks to a very special person, my husband Mr. Amit Kumar Singla for his affection, understanding and continuing support to complete this research work. I greatly value his contribution and deeply appreciate his belief in me.

It is not a fair task to acknowledge all the people who made this Ph.D. thesis possible with a few words. However, I have tried my best to extend my great appreciation to everyone who helped me scientifically and emotionally throughout this study.

Finally, my thanks go to all the people who have supported me to complete the research work directly or indirectly. Thank you very much, everyone!

Supriya Rani

LIST OF FIGURES

LIST OF TABLES

PREFACE

For the radiological risk assessment in the environs of Moga and Barnala districts of Punjab. The study has been carried out in air, water and soil for radon/thoron, their progeny and uranium concentration by using various active and passive techniques. The data has been compiled and the results are presented here. The thesis has been divided into the following six chapters:

CHAPTER 1: INTRODUCTION

This chapter deals with the introduction and literature review regarding the history of radioactivity, radiations and its types and hazardous effects of ionizing radiations. Brief description of concepts like as radiation exposure, sources of radiations, dose, units and protection are included in this chapter. The standard values are set for dose limits for radiations by various governmental/non-governmental and national/international bodies such as WHO, ICRP, UNSCEAR, USEPA, IAEA and AERB are reported in this chapter. A detailed literature review dealing with natural radiations has been discussed and the geology of the studied area and finally the objectives of the present study are reported in this chapter.

CHAPTER 2: MATERIALS, INSTRUMENTATION AND EXPERIMENTAL TECHNIQUES

This chapter deals with the various materials, instruments and experimental techniques used in the present study to assess the radiological risk in the environs of the study area. Both short term (active) as well as long term (passive) techniques have been used in the present experimental measurements.

CHAPTER 3: RADON/THORON AND THEIR PROGENY CONCENTRATION IN THE DWELLINGS

This chapter deals with the measurement of radon, thoron and their progeny concentration in the indoor environment of Barnala and Moga districts for the residents of Punjab, India. The study has been carried out throughout the year for seasonal variation using grid pattern for mapping of the whole area with time integrated passive technique using single entry pinhole dosimeters and deposition-based radon/thoron progeny sensors (DRPS/DTPS). The annual average radon/thoron and their progeny

concentration, annual effective dose and equilibrium factor in various types of dwellings has been calculated.

CHAPTER 4: RADON/THORON EXHALATION RATES IN SOIL AND ITS CORRELATION WITH THEIR CONCENTRATION IN THE DWELLINGS

This chapter deals with the measurement of radon/thoron exhalation rates in the soil samples collected from the studied area. A scintillation-based detector, Smart RnDuo has been employed for the measurement. And also, to find their correlation with indoor radon/thoron concentration levels.

CHAPTER 5: RADON CONCENTRATION IN WATER AND DOSE ESTIMATION

This chapter deals with the measurement of radon concentration in groundwater samples using Smart RnDuo. The water samples were collected from manually operated hand-pumps of privately owned or from hand-pumps established by Municipal Corporation in residential localities of studied area. The annual effective doses for ingestion and inhalation have been calculated.

CHAPTER 6: URANIUM CONCENTRATION IN WATER AND BIOKINETIC MODELLING

This chapter deals with the measurement of uranium concentration in water samples collected from different sources of water as underground and canal water. LED Fluorimeter has been used to measure the uranium concentration in water samples and also, mortality and morbidity risk have been calculated from the values of uranium concentration water to estimate the health risk to the residents of the studied area.