Environmental Issues: Biodiversity and Sustainability

Dr. Rajesh Trehan

Dr. Jahid Ali Malik

Environmental Issues: Biodiversity and Sustainability

EMPYREAL PUBLISHING HOUSE

India | UAE | Nigeria | Uzbekistan | Montenegro

Environmental Issues: Biodiversity and Sustainability

By:

Dr. Rajesh Trehan
Associate Professor and Head
Department of Chemistry, SGGSJ Govt. College, Paonta Sahib (H.P.)

Dr. Jahid Ali Malik
Assistant Professor
Department of Botany, SGGSJ Govt. College, Paonta Sahib (H.P.)

First Impression: June 2022

Environmental Issues: Biodiversity and Sustainability

ISBN : 978-93-93810-06-9

Rs. 650/- ($18)

Published by:
Empyreal Publishing House

PREFACE

Biodiversity is the term applied to the variety of organisms that occupy a given region in a particular time frame. It's that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locality, in a region, in the country and the world, and various types of ecosystems, both terrestrial and aquatic, within a defined area. It includes geosphere, biosphere, sociosphere and socio-cultural environment. The biodiversity found on Earth today is the result of approximately 3.5 billion years of evolution. Until the emergence of humans, the earth supported more biodiversity than any other period in geological history. However, since the dominance of humans, biodiversity has begun a rapid decline, with one species after another suffering extinction.

It's marred by ill effects of social mobility; food shortage; problems of overpopulation; air, water, soil and noise pollution; problems associated with waste disposal; poverty, malnutrition, sanitation and diseases; deleterious effects related to pesticides and insecticides; adverse effects of intensive agriculture and animal husbandry practices. Situation has been deteriorated by industrialization, urbanization, modernization, modern warfare including large scale weapon tests and changing life styles and its impact on environment.

The enormous value of biodiversity due to their genetic, commercial, medical, aesthetic, ecological and optional importance emphasizes the need to conserve biodiversity. It's 'the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations' and includes the protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water. There are two approaches of biodiversity conservation: In situ conservation (within habitat): This is achieved by protection of wild flora and fauna in nature itself, e.g., Biosphere Reserves, National Parks, Sanctuaries, Reserve Forests etc. Ex situ conservation (outside habitats): This is done by establishment of gene banks, seed banks, zoos, botanical gardens, culture collections etc.

The role of biodiversity is to be a mirror of our relationships with the other living species, an ethical view with rights, duties, and education. If humans consider species have a right to exist, they cannot cause voluntarily their extinction. Besides, biodiversity is also part of many cultures' spiritual heritage. The maintenance of biodiversity is important for the ecological stability, economic benefits, tourism & recreation and

ethical reasons. High biodiversity makes an ecosystem more sustainable because the food web is stronger and organisms perform a wide variety of functions.

India has one of the richest ecosystem diversities, ranging from deserts, plains, hills, mangroves, rainforests, rivers, lakes, costal line to cold Himalayas. Out of the 18 hot spots of biodiversity recognized in the world, India has two of them, viz. Eastern Himalaya and The Western Ghats. Eastern Himalayas is recognized as the “Cradle of Speciation” due to rich diversity of primitive flowering plants. Throughout Indian history, people have related the very existence of human race to biodiversity through cultural, spiritual and religious beliefs. Many plants, animals, forest, landscapes and rivers are considered as sacred and worshiped by the people. Today these have become cultural heritage. These beliefs have played an effective role in conservation of many species of plants and animals especially preservation of many endemic and rare species. We have sacred species, sacred grooves, sacred landscapes, sacred rivers and water bodies, sacred hills etc. from time immemorial where we have protected our rich and endangered biodiversity.

Nature has sustained itself for billions of years by using solar energy, biodiversity, population regulation, and nutrient cycling-lessons from nature that we can apply to our lifestyles and economies. Sustainable development can be achieved only if the environment is conserved and improved. The key principle of sustainable development is the integration of environmental, social, and economic concerns into all aspects of decision making. So, biodiversity gets used as a measure of the health of biological systems, and to see if there is a danger that too many species become extinct. The United Nations designated 2011–2020 as the "United Nations decade on biodiversity". Biodiversity is essential for sustainable development and human well-being. It underpins the provision of food, fibre and water; it mitigates and provides resilience to climate change; it supports human health, and provides jobs in agriculture, fisheries, forestry and many other sectors. Without effective measures to conserve biodiversity and use its components in a sustainable manner, the 2030 Agenda of United Nations for Sustainable Development will not be achievable.

Let us all be proud of our biodiversity and try all possible ways to preserve it.

Dr. Rajesh Trehan

Dr. Jahid Ali Malik

ACKNOWLEDGEMENT

We express our sincere thanks and gratitude to respected Dr. Garima Gupta, Scientist F, Programme Officer, Star College Scheme, HRD Division, Department of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi for writing the foreword for this book as her endorsements. We are also very grateful to Sh. Sukh Ram Chaudhary, MPP and Power Minister, Government of Himachal Pradesh and Sh. Satish Goel, President, HCCI, Paonta Sahib (H.P.) for their blessings and writing the good wishes messages for the book. We appreciate Dr. Veena Rathore, Principal, SGGSJ Government College, Paonta Sahib for her inspiration, guidance and all administrative helps. We would like to thank all the scholars, faculty members and researchers for writing their research papers/articles. We pay heartfelt gratitude to all the associates and kindred people who have directly and indirectly helped to form the proposed idea in a book form. We remember our friends Dr. Sunil Kumar, Dr. Pooja Bhati and Sudesh Sharma for the assistance and motivation for the present work. Financial assistance from the Department of Biotechnology, New Delhi under the Star College Scheme is gratefully acknowledged. We convey our thanks to Empyreal Publication House for converting these ideas expressed by different contributors about given topic in the form of book. Lastly, we convey our special thanks to our families for their wholehearted support.

Dr. Rajesh Trehan

Dr. Jahid Ali Malik

EDITORIAL

Biodiversity has been one of the most important bases of human life. We have been using the varied natural resources in different ways to satisfy our needs. For its well-being, human dependency on biodiversity and ecosystems has been increasing day by day. However, these resources are not infinitely available for human use. Our efforts to protect biodiversity are very inadequate. Not only non-renewable but also renewable resources are limited. The 2019 Global Assessment of Biodiversity and Ecosystems Services underscored that most of nature's contribu-tions to people are not fully replaceable, and some are irreplaceable. Besides, the rate of global biodiver-sity degradation during the past 50 years is getting unprecedented in human history. Haphazard industrialization, efforts to satisfy the need of growing population worldwide despite technological advances has also resulted in various problems which need to be solved in order to help us to use the resources on sustainable basis and to make this Earth worth living. Unscientific exploitation of resource has also resulted in degradation and destruction of natural resources. In present situation, investment in biodiversity protection is very necessary for sustainable development, healthy life, clean environment and poverty alleviation. Biodiversity is the foun-dation of healthy and sustainable food systems. Therefore, to protect our present and future, we need to increase investment in the current biodiversity to have a sustainable approach for development.

The volume entitled Environmental Issues: Biodiversity and Sustainability provides a comprehensive survey of the major topics in the field of Biodiversity and Sustainable Development. This book explores the three main pillars of sustainable development, namely economy, environment and society, and their interlinkages at the regional and the global level. The book comprises 21 articles, written by experts in their respective disciplines and provides state of the art information. The selected articles are most sought after by both researchers and students at the graduate and post-graduate level. Each article provides succinct information on central developments in the field and end with summaries and perspectives for the future.

The volume starts with an article by Aarti Trehan and Rajesh Trehan in which they have discussed the aspect of awareness and attitude among undergraduate students towards environmental sustainability. The current discussion entails that it is necessary to educate and inform students so that they acquire a positive attitude towards the environment and can promote environmental consciousness to the general public since they have the ability to raise awareness in society about the importance of improving environmental circumstances. Article 2 discusses bamboo biodiversity in Indian context (Ajay Thakur and Anugrah Tripathi). The discussion is relevant since only few species of bamboo are being cultivated in India and others are in wild and located in small patches. There is need of conservation of these bamboos. Amita Joshi, Anju Aggarwal and Saloni Sood depicted a true picture of sustainable development through a case study of a small village of district Solan in Himachal Pradesh. The inhabitants have been following sustainable practices and preserving their natural surroundings for future generations including the natural water resources and forests. Traditional knowledge plays a key

role in the preservation and sustainability of diversity and many activities based on it are important sources of income, food and healthcare for the indigenous people. In article 4 Amita Joshi and Rajesh Trehan have elaborated the importance of traditional knowledge in preserving the biodiversity for achieving sustainable development. The articles by Kamlesh Kumar and Dev Raj Sharma documented the importance of environment, biodiversity and sustainable development to protect it for future generations. The problem of indoor air pollution is increasing day by day which is very serious and dangerous to human health. In India air pollution is a very serious problem. The indoor plants can help in reducing the indoor air pollutants by 75 % in different conditions. These plants can provide efficient, low cost, sustainable bioremediation system for reducing indoor air pollution and improving indoor air quality which can further result in improving human health and productivity. Dhanmanti Kandasi enlisted some common indoor plants which can help in sustainable improvement of indoor air quality. Forests are important source of subsistence, employment, revenue earnings, and raw materials to a number of industries and also play vital role in ecological balance, environmental stability, biodiversity conservation, food security and sustainable development of a region. Jagdish Chand in his study assessed the extent and trends of forest cover in Renuka Forest Division using geospatial techniques for the periods 1972, 1989, 2001, and 2011 and also provides an overview on the main causes of forest cover change. Jagdish Chauhan in his article has attempted to address the issue of sustainable development in the developing countries in light of rising corporatization and intense inclination towards market. The contamination of the environment by heavy metals is currently a major global environmental problem threatening the health of vegetation, wildlife, and humans. Arsenic (As), a naturally occurring element in earth's crust is present in different background levels. Its concentration is increasing in the environment due to anthropogenic activities of various kinds. Jahid Ali Malik has discussed the physiological implication of Arsenic in reference to contrasting chickpea varieties. In recent years, there has been amazing curiosity in the medicinal plants especially those used in Ayurveda and other traditional system. Indigenous health care system is more acceptable because of its easy availability, cost–effectiveness and proven efficacy since ancient time. Jaswant Singh Saini revealed the importance of several plants which are used to treat skin diseases by the local residents around the villages of Colonel Sher Jung National Park, Simbalbara, Paonta Sahib, Sirmour, Himachal Pradesh, India. Since time immemorial the preservation of natural forests and biodiversity has been an integral part of our extensive culture and beliefs related to customs, reflects relationship of nature and human beings. Many communities around the globe are giving their bit to conserve nature and its vital biodiversity. Sacred groves are a part of this protection initiative. Monika Panchani reviews this aspect of biodiversity conservation in reference to sacred groves of Kullu District of Himachal Pradesh to aware the people about importance of sacred groves in biodiversity conservation. Poonam Siwatch discussed the recent advances in synthesis, properties and applications of Graphene quantum dots along with its future prospects. Graphene has a huge potential for being a highly sustainable material and improving the sustainability of different industries. In recent years, it has emerged that graphene can be integrated into different materials to make them more environment friendly. Pradeep Tomar has elaborated the issues and challenges of sustainable

development in reference to India. The pollution hazards that can be created by the aerosols as air pollutants in a small region or globally have been described by Rajesh Trehan, Sudesh Kumar and Sunil Kumar with the help of parameters like sources of aerosols and their formation, their size and number distribution, mass concentration, chemical composition and optical activities etc. In this article, these parameters and related aerosol effects along with various measures to control the aerosol assisted pollutions have been discussed. In the article "Sustainable Consumption: Another Aspect of Sustainable Development" by Rinku Aggarwal, the author assesses the significance of sustainable consumption in making the Indian economy 'self-reliant, self-sufficient and sustainable'. Ritu Pant in her article documented the diatom flora of Siwalik stream of Markanda basin in Himachal Pradesh. The distribution and biodiversity of diatoms can provide an insight of sustainable development of aquatic ecosystem as the distribution of diatoms may be affected by the land use and water pollution. Review article by Shivali Sharma and Harinder Singh Banyal deals with morphology and characteristics of hill streams including estimation of impact of stream ecology on fish assemblage pattern. They suggested that long-term proper management policies are required for the sustenance of indigenous fish faunal diversity in the hill streams of Himachal Pradesh. The last two articles of the book elaborate environmental and green auditing in academic institutes. They discuss the relationship between educational institutes and the environment within which they operate; the environmental problems faced by them; public awareness; sustainable development; and environmental management. A brief history and necessity of these audits is provided along with the analysis of their objectives and benefits. In the last part of these articles the processes of environmental and green audits are elaborated with the case studies of SGGSJ Government College, Paonta Sahib, Himachal Pradesh.

The complete bibliography is given at the end of each article. The editors are grateful to all the learned contributors for their cooperation and support in compiling very useful information on various facets of biodiversity and sustainable development. We are sure that the information compiled in this volume will prove helpful in persevering biodiversity and to ensure the use of ecosystems sustainably for survival of our own species. This book will serve as an excellent reference material for academicians, researchers, industrialists and students in the field of biodiversity, biotechnology, microbiology, ecology, environment, economics etc.

Contributors are fully responsible for the authenticity of their work and the concepts/views presented by them through this book and the editors has no role or claim or any responsibility in this regard. We apologize unreservedly for any mistakes, omissions or failure to fully acknowledge any source. Any suggestions for improvement in this book are also welcome.

Dr. Rajesh Trehan

Dr. Jahid Ali Malik

Dr. Garima Gupta
Scientist F, Programme Officer
Star College Scheme, HRD Division, Dept of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi
Email: garima.g@nic.in

Foreword

Biodiversity is the collective term for the full variety of life on earth or can also be explained as the total number of species, but it is essentially more complex than that. It is about the genetic diversity within species, the diversity of habitats, and the large biological units known as biomes. Even though we are often oblivious to it, this diversity of life is what provides clean water, oxygen, and all other things that end up being part of our diet, as well as clothing and shelter.

The biggest threats **to biodiversity** are habitat destruction and fragmentation, direct harvest, various forms of pollution, and climate change. Biological diversity encompasses all environmental factors, so there are things that are direct threats, like habitat fragmentation. There are also indirect things like the distortion of the nitrogen cycle and the proliferation of dead zones in estuaries and coastal waters around the world. Basically, we cannot dream of solving the biodiversity problem if we don't try to address all those problems as well.

There needs to be a major shift in perception from thinking of nature as something with a fence around it in the middle of an expansive, human-dominated landscape as opposed to thinking about embedding our aspirations in nature. It means restoring vegetation along watercourses and putting natural connections back into the landscape, so when species begin to move and respond to climate change, there is actually a way for them to do it.

Sustainable development is defined as an approach to developing or growing by using resources in a way that allows for them to renew or continue to exist for others. **Using recycled materials or renewable resources when building** is an example of sustainable development. The Sustainable Development Goals, also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to **action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity**.

For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social inclusion and environmental protection. These elements are interconnected and all are crucial for the well-being of individuals and societies.

Eradicating poverty in all its forms and dimensions is an indispensable requirement for sustainable development. To this end, there must be promotion of sustainable, inclusive and equitable economic growth, creating greater opportunities for all, reducing inequalities, raising

basic standards of living, fostering equitable social development and inclusion, and promoting integrated and sustainable management of natural resources and ecosystems.

Sustainable development should help in ensuring a better life for present and future generations; lowering the impact on the environmental pollution and in achieving long term economic growth.

In this context, the present book **"Environmental Issues: Biodiversity and Sustainability"**, being published will be a valuable source of information for all those who are associated in the conservation of biodiversity and sustainability. I congratulate the editors **Dr. Rajesh Trehan** and **Dr. Jahid Ali Malik** and authors for this fruitful effort and strongly hope that the book would be an important source of information and referral document for conservation scientists, researchers and academicians working in the areas of biodiversity conservation and sustainability as well as the scientific community and entire humanity.

Garima Gupta

Sukh Ram Chaudhary
MPP & Power Minister
Government of Himachal Pradesh

Message

I am pleased to know that **Dr. Rajesh Trehan** and **Dr. Jahid Ali Malik** of **Shri Guru Gobind Singh Ji Government College, Paonta Sahib** are publishing the book entitled, **"Environmental Issues: Biodiversity and Sustainability"** describing various environmental issues, in particular biodiversity and sustainable development.

Biodiversity, environment and human health are connected together and the protection of biological species in the biosphere is in the interest of humanity. Healthy biodiversity provide healthy life and we need to learn to live in harmony with nature. Every species in this biosphere has the right to live on this beautiful Earth. The genetic and ecosystem diversity need to be preserved for the future generation.

I hope that this volume will make good contribution in analyzing and understanding important issues challenging the progress of environmental education in 21st century Bharat in global context and it will be a useful reading for all the stakeholders and researchers interested in the contemporary issues pertaining to biodiversity and sustainable development in the current context.

My good wishes to the authors and contributors for the success of this important academic activity.

Sukh Ram Chaudhary

Sh. Satish Goel
President
HCCI
Paonta Sahib (H.P.)

Message

It gives me immense pleasure to write a message on the publication of book, **"Environmental Issues: Biodiversity and Sustainability"** by **Dr. Rajesh Trehan** and **Dr. Jahid Ali Malik** of **Shri Guru Gobind Singh Ji Government College, Paonta Sahib**. Biodiversity is a vital asset in global and local economies. The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide.

The theme of the book is chosen very appropriately as most of the sustainable development goals and their targets can be achieved, if we focus on better resource management and biodiversity conservation. Thus, resource management and biodiversity conservation are two major and critical pre-requisites to achieve sustainable development goals. Environmental issues are considered in the production and consumption analysis in economics. Environmental policy becomes an important part of economic policy. All economic activities either affect or are affected by natural and environmental resources.

I have gone through the work and pleased to see its rich qualitative content. I congratulate both the editors for their dedication in bringing out this book and wish their beautiful work a great success. The book is very relevant in the present scenario. I hope this book will be beneficial for the students of higher education and policy planners. I appreciate the contributors for their scholarly contribution in giving the shape to this book.

Satish Goel

Dr. Veena Rathore
Principal
SGGSJ Government College, Paonta Sahib, District Sirmour (H.P.) 173025.
Email: gcpaontasahib@gmail.com
Website: www.gcp.ac.in

Message

I am feeling immense pleasure in congratulating **Dr. Rajesh Trehan** and **Dr. Jahid Ali Malik** for publishing the book entitled, **"Environmental Issues: Biodiversity and Sustainability"** on the vital and multi-disciplinary subject. It is my pleasure to congratulate the editors and contributors of this book for spending their valuable time and energy to make this project a success.

The Living Planet Report estimates that by the year 2030, we will need an entire other planet to support the human population if we continue to live with current consumption patterns. It is an urgent need of the hour to change our definitions of development. Biodiversity is a direct indicator of environmental health and plays a vital role in economic sectors that drive development including agriculture, farming, fisheries and tourism. On close observation, it becomes evident that ecosystems are the basis of all kinds of economies. Biodiversity is not just the diversity of life on earth. It includes variability among all living organisms including within the same species, between different species and of various ecosystems. It includes millions of different species and genetic variations within the species. We must preserve this biodiversity if we want to ensure the survival of our own species.

There are many ways to define sustainable development. The one that makes the present scenario crystal clear is "improving the quality of human life while living within the carrying capacity of supporting ecosystems". It means we must meet our needs without influencing the needs of our future generations. This sensitive equilibrium can only be maintained by making the next generation aware of this grim situation.

I am very sure that this book will succeed on the idea to achieve the goals of sustainable development by the year 2030. I extend my greetings and good wishes for this commendable work of its own kind and confident that it would be quite useful to researchers, administrators and policy makers.

Veena Rathore

CONTRIBUTORS

Dr. Aarti Trehan, Associate Professor, Department of Chemistry, Arya Kanya Mahavidyalaya, Shahabad (M), Kurukshetra-136135, India.

Dr. Rajesh Trehan, Associate Professor, Department of Chemistry, SGGSJ Govt. College, Paonta Sahib (H.P.)-173025, India.

Dr. Ajay Thakur, Head of Division, Genetics and Tree Improvement, Forest Research Institute, Dehradun-248006, India,

Dr. Anugrah Tripathi, Research Assistant, Genetics and Tree Improvement, Forest Research Institute, Dehradun-248006, India.

Amita Joshi, Assistant Professor, Department of Chemistry, Dr. Y. S. Parmar, Govt. P. G. College, Nahan, District Sirmaur (H.P.)-173001, India.

Anju Aggarwal, Associate Professor, Department of Chemistry, Dr. Y. S. Parmar, Govt. P. G. College, Nahan, District Sirmaur (H.P.)-173001, India.

Saloni Sood, Assistant Professor, Department of Chemistry, Dr. Y. S. Parmar, Govt. P. G. College, Nahan, District Sirmaur (H.P.)-173001, India.

Dr. Dev Raj Sharma, Associate Professor, Department of Music, Government College Sangrah, District Sirmour, H.P.-173023, India.

Dhanmanti Kandasi, Assistant Professor, Department of Botany, SGGSJ Government College, Paonta Sahib, District Sirmour, H.P.-173025, India.

Dr. Jagdish Chand, Assistant Professor, Department of Geography, Government College Sangrah, District Sirmour, H.P.-173023, India.

Dr. Jagdish Chauhan, Associate Professor, Department of Economics, Government College Bharli, District Sirmour H.P. 173025, India.

Dr. Jaswant Singh Saini, Associate Professor, Department of Botany, Swami Vivekanand Government College Ghumarwin, District Bilaspur, Himachal Pradesh- 174021, India.

Dr. S.K. Sood, Former Chairman, Department of Biosciences, Himachal Pradesh University, Shimla-171005

Dr. Jahid Ali Malik, Assistant Professor, Department of Botany, SGGSJ Government College, Paonta Sahib (H.P.)-173025, India,

Kamlesh Kumar, Assistant Professor, Department of Geography, SGGSJ Govt. College Paonta Sahib-173025, H.P., India

Dr. Monika Panchani, Associate Professor, Department of Zoology, SVPC University, Mandi, H.P.-175001

Dr. Poonam Siwatch, Assistant Professor, Department of Physics, Arya Kanya Mahavidyalaya, Shahabad (M), Haryana-136135, India

Dr. Pradeep Singh Tomar, Assistant Professor, Department of Economics, Dr. Y.S. Parmar P.G. College, Nahan, Distt Sirmour, H.P.-173001, India.

Sudesh Kumar, Assistant Professor, Department of Physics, Dr. Y. S. Parmar, Govt. P. G. College, Nahan, District Sirmaur (H.P.)-173001, India.

Dr. Sunil Kumar, Assistant Professor, SGGSJ Govt. College Paonta Sahib, District Sirmour, Himachal Pradesh-173025 India.

Dr. Ravi Kant Sharma, Assistant Professor, Department of Economics, SGGSJ Govt. College, Paonta Sahib (H.P.)-173025, India.

Rinku Aggarwal, Assistant Professor, Department of Commerce, SGGSJ Government College, Paonta Sahib (H.P.)-173025, India,

Dr. Ritu Pant, Associate Professor, Department of Zoology, SGGSJ Government College, Paonta Sahib-173025 (H.P), India.

Dr. Prakash Nautiyal, Professor and Head, Department of Zoology & Biotechnology, H.N.B. Garhwal Central University, Srinagar-246174, Uttarakhand, India.

Shivali Sharma, Research scholar, Department of Biosciences, Himachal Pradesh University, Summer Hill, Shimla-171005, India.

Dr. Harinder Singh Banyal, Associate Professor, Department of Biosciences, Himachal Pradesh University, Summer Hill, Shimla – 171005, India.

Table of Contents

ANALYTICAL STUDY ON ASPECT OF AWARENESS AND ATTITUDE TOWARDS ENVIRONMENTAL SUSTAINABILITY

Aarti Trehan[1] and Rajesh Trehan[2]
[1]Associate Professor, Department of Chemistry, Arya Kanya Mahavidyalaya, Shahabad (M), Kurukshetra-136135, India
[2]Associate Professor, Department of Chemistry, SGGSJ Govt. College, Paonta Sahib (H.P.)-173025, India
[1]aartitrehan218@gmail.com and [2]trehanr@hotmail.com

ABSTRACT
Deterioration of the environment is of great concern all over the world since indiscriminate exploitation of natural resources is still unabated and is threatening the very existence of living beings. There is a dire need to create consciousness with respect to the environment in all sections of society. Major efforts are required so that each one in society can play an active role in conservation efforts. Environmental values, situational characteristics and psychological factors all play a significant role in sustainability. Prime factor for conservation and protection of the environment is to create awareness and develop an attitude in this direction among the society. The minds of human beings need to be kindled towards the environment to accelerate efforts for its sustainability and moreover, the knowledge and skill of such minds can be applied to find solutions to environmental problems also. We will have to try to acquaint each one with a set of values, attitudes and skills to address environmental concerns. Imparting environmental education to an individual can help him know the environment and develop due attitude towards it. This study discusses the aspect of awareness and attitude among undergraduate students of colleges in Kurukshetra districts of Haryana. It stresses that it is necessary to educate and inform students so that they acquire a positive attitude toward the environment and can promote environmental consciousness to the general public since they have the ability to raise awareness in society about the importance of improving environmental circumstances. Each and everyone in the society must be motivated and educated to act in an environmentally conscious manner for the judicious use of natural resources for sustainable development in social, economic and ecological areas in the present scenario.

Keywords: *Environment, Sustainability, Environmental Awareness, Environmental Attitude, Natural Resources.*

INTRODUCTION
The relentless degradation of the environment, which is becoming all-pervasive, is causing tremendous alarm all around the world. The unrestrained depletion of natural resources has put living beings' survival in jeopardy, since many floras and fauna are on the edge of extinction. This environmental degradation is due to the fact that ecological aspects are not taken into account in industrial and related operations. Increasing population, industrialization, and poverty are all putting pressure on natural resources and causing the environment to deteriorate. Changing climate trends, global warming, and the loss of valuable species, ozone layer depletion, and an increase in pollution levels are all signs that disaster is approaching. As man is responsible for the preservation of the world and this delicate universe, therefore, there is a critical need to raise awareness in order to develop attitude to properly solve environmental issues, which must be addressed through a variety of legal, scientific, technical, economic, and educational approaches. Environmental awareness and attitude foster a sense of connection to the natural world, promotes its conservation, and aids in the understanding of its fragility. Environmental awareness is extremely important in today's world, because without it, a nation's biggest challenges will be lack of public engagement, attitudes, and conduct. It instils a sense of

belonging to the natural world and promotes its preservation. The most important component in environmental conservation and protection is to raise awareness and foster a positive attitude in society. One of the most effective ways to achieve this goal is to educate the younger generation about environmental issues in order to enroot a positive attitude toward environmental stewardship in them.

LITERATURE REVIEW

The various research studies related to environmental awareness are depicted as:

Environmental concern has been treated as an evaluation of, or an attitude towards facts, one's own behaviour, or others behaviour with consequences for the environment (Weigel, 1983). Hines, Hungerford & Tomera (1987) have argued that environmental concern has direct relationship with pro-environmental behaviour. Filegenschnee (1998) said that females usually have a less extensive environmental knowledge than man but as they are more emotionally engaged, therefore, show more interest, concern and willingness to change the environment. However, Owens (2000) stated that knowledge and awareness of the environment did not lead to pro-environmental behaviour. Dhillon and Sindhu (2005) found that the level of environmental awareness among the school teachers belonging to rural and urban areas is significantly different, but they did not find any significant difference among male and female teachers. Choudhary (2005) explained that the girls have obtained higher level of awareness than the boys. Ernesto (2010) found that the relationship of environmental awareness between secondary school male and female students was not found significant, but in case of rural area and urban area it was found significant. Abdo (2010) exhibited that the males have more knowledge about environmental issues than the females. Thakur (2012) has examined a study on environmental awareness among senior secondary school students of Chandigarh. The result showed that the science students possessed high degree of environmental awareness than the students of humanities. Aminrad (2013) observed that the level of education and increase in age also increases the level of environmental awareness among the students. The study also revealed that there was no significant difference for it on the basis of gender.

OBJECTIVE OF STUDY

India possesses a large percentage of young people who can be stewards in the conservation of environment. Present study discusses and compares level of awareness and attitude for environment among undergraduate students of colleges of Kurukshetra district with respect to gender, and stream.

IMPORTANCE OF STUDY

Since environmental issues are becoming more and more complex, the need to take actions becomes more urgent. One of the best efforts in this direction can be to equip the young generation with environmental awareness to develop a positive attitude in them to be environment conscious. Once people acquire and exchange knowledge, values and skills, they will be able to act individually or collectively to solve various environmental problems. Environmental awareness requires special focus with reference to gender, area, stream, communities, cultures etc. As a result, the primary goal of this research is to examine undergraduates' awareness and attitude regarding the environment of male and female undergraduate students studying different streams like arts, commerce and science from several perspectives. The following research questions should be addressed in this regard:

1) To determine whether there is a gender gap in environmental awareness and attitude among undergraduate students.
2) To examine the awareness and attitude of undergraduate students in the arts, commerce, and sciences toward environmental issues.

METHODOLOGY

The current study included undergraduate students from the arts, science, and commerce streams of aided and self-finance degree colleges in Haryana's district Kurukshetra. Kurukshetra District has 11 aided and self-financing degree colleges. With the use of random sampling, a sample of 274 undergraduate students in their third year for the academic year (2019-2020) was selected.

Tools Used

Dr. Parveen Jha (1998) developed environmental awareness ability assessments that are being employed in the study. The Environmental Attitude Scale (TEAS), developed by Dr. Haseen (2001), was used to demonstrate undergraduate students' attitudes toward the environment. There are 51 items on the scale and five factors. After thorough review and discussion with specialists, 46 statements were chosen. The five variables are: "1) Health and Hygiene 2) Wild Life 3) Forests 4) Polluters 5) Environmental Concerns". For the construction of an appropriate research measure, the reliability and validity tests were also used.

ANALYSIS AND INTERPRETATION

Population and Sample

The Table (1) represents the total sample size of 274 respondents comprises 80 (29.2%) male undergraduate students and 194 (70.8%) female undergraduate students. It exhibits from the table that majority of respondents are female due to a greater number of girls aided and self-finance colleges in Kurukshetra district.

Out of 274 respondents, 93 (33.9%) are from Arts Stream, 82 (29.9%) from science stream and 99 (36.1%) from Commerce Stream. The table depicted that there are not many differences of percentages among Arts, Science, and Commerce stream.

Table 1: Sample profile of respondents

	Variables	**Frequency**	**Percentage**
1. Gender			
	a) Male	80	29.2
	b) Female	194	70.8
	Total	**274**	**100.0**
2. Stream			
	a) Arts	93	33.9
	b) Science	82	29.9
	c) Commerce	99	36.1
	Total	**274**	**100.0**

(***Source:*** Primary Data)

Gender and Stream Wise Comparisons of Components of Environmental Awareness

Because society is inextricably related to the environment and has a considerable impact on it, environmental awareness in society is critical in order to conserve the environment. Environmental awareness and practice at educational institutions should have a social dimension in this regard. The comparison of components of environmental awareness for five variables was studied on the basis of gender and stream in the current study to see how gender and stream influenced the results. (Table 2). The observations from table (2) show that the variable 'Causes of Pollution' has accorded highest mean score (0.9098) in case of male undergraduate students and on the variable 'Conservation of Human Health' the highest mean score (0.8093) has been obtained in case of female undergraduate students. The mean scores accorded by male undergraduate students are higher than the female undergraduate students. It shows that the level of environmental awareness is higher in case of male undergraduate

students than the female undergraduate students. The same level of agreement has been found on the two variables i.e., Conservation of Soil, Forests and Conservation of Human Health in case of male and female undergraduate students. When stream wise data was analysed, it is clear from table (2) that the highest mean score of 0.8003 and 0.7778 have obtained in the variable 'Causes of Pollution' by the arts and commerce stream undergraduate students. Whereas, the students of science stream have exhibited the highest mean score on the variable 'Conservation of Wildlife and Animal Husbandry, conservation of soil & forests and conservation of human health. As a result, the Science stream undergraduate students have higher level of awareness regarding the environmental protection. But, the students of all streams have same level of awareness regarding the variable 'Energy Conservation' with the mean scores of (0.7885), (0.7602) and (0.7273).

Table 2: Comparisons of components of environmental awareness

Dimensions	Male	Female	Arts	Science	Commerce
	Mean Score (Standard Deviation)	**Mean Score (Standard Deviation)**	**Mean Score (Standard Deviation)**	**Mean Score (Standard Deviation)**	**Mean Score (Standard Deviation)**
1. Causes of Pollution	0.9098 (0.6699)	0.7894 (0.1675)	0.8003 (0.1667)	0.9085 (0.0892)	0.7778 (0.1609)
2. Conservation of Soil, Forests	0.7625 (0.2512)	0.8093 (0.2874)	0.7370 (0.1582)	0.7905 (0.0791)	0.7190 (0.1492)
3. Energy Conservation	0.9875 (0.0515)	0.6632 (0.1978)	0.7885 (0.2803)	0.7602 (0.1483)	0.7273 (0.2148)
4. Conservation of Human Health	0.7625 (0.2512)	0.8093 (0.2874)	0.7673 (0.1614)	0.8232 (0.0795)	0.7547 (0.1475)
5. Conservation of Wildlife and Animal Husbandry	0.8589 (0.0196)	0.7467 (0.1532)	0.6935 (0.2951)	0.9390 (0.1646)	0.7727 (0.2881)

Source: Primary Data

Figures in parentheses indicate the Standard Deviation.

* Significant at 1% level of significance

Gender and Stream Wise Comparisons of Components of Environmental Attitude

Pelstring (1997) defined Environmental Attitude as the "learned tendencies in the form of consistent behaviors against environment as positive or negative". Students have a strong sense of responsibility for the environment and environmental issues and this concern in their attitude is a positive aspect to protect environment. Hence, environmental attitude becomes the key area to study among students. Table (3) reveals the dimensions of Environmental Attitude for undergraduate students.

On the basis of gender, it is found that highest mean score (3.662) is found on the dimension 'Wild Life' and lowest mean score (2.535) is obtained on the variable 'Environmental Concerns' in case

Table 3: Comparisons of components of environmental attitude

Dimensions	Male Mean Score (Standard Deviation)	Female Mean Score (Standard Deviation)	Arts Mean Score (Standard Deviation)	Science Mean Score (Standard Deviation)	Commerce Mean Score (Standard Deviation)
1. Health and Hygiene	2.680 (.523)	3.053 (.563)	2.653 (.504)	3.087 (.554)	3.099 (.559)
2. Wildlife	3.662	2.817	3.290	2.812	3.060

	(1.276)	(.532)	(1.08)	(.741)	(.791)
3. Forests	2.654 (.559)	3.190 (.645)	2.720 (.558)	3.170 (.716)	3.215 (.615)
4. Polluters	2.563 (.346)	2.814 (.368)	2.512 (.325)	2.929 (.297)	2.801 (.381)
5. Environmental concerns	2.535 (.586)	2.939 (.517)	2.478 (.556)	3.180 (.371)	2.845 (.523)

Source: Primary Data

Figures in parentheses indicate the Standard Deviation.

* Significant at 1% level of significance.

of male undergraduate students. While, in the case of female students, the highest mean score (3.190) is accorded on variable 'Forest' and lowest mean score (2.814) is obtained on the variable 'Polluters'. In stream wise comparison for environmental attitude the highest mean score in case of the variables i.e., 'Health and Hygiene' (3.099) and 'Forests' (3.215) is accorded by the Commerce stream undergraduate students. In case of the variables 'Polluters' and 'Environmental Concerns' the highest mean scores of 2.929 and 3.180 have exhibited by the Science stream undergraduate students. Whereas, the lowest mean score of 2.653, 2.720, 2.512, and 2.478 have obtained by Arts Stream undergraduate students for the four variables (Health and Hygiene, Forests, Polluters and Environmental Concerns) of environmental attitude.

DISCUSSION AND CONCLUSION

In the current circumstances, it is vital to raise environmental consciousness in humans in order to provide a good quality of life for all living species. Therefore, environmental awareness has become a critical need for all human beings, resulting in a favorable attitude toward the environment and students are an effective tool for this aim. We should educate the younger generation about environmental issues in order to inculcate in them a favorable attitude toward environmental stewardship. The purpose of this study is to assess the level of undergraduate students' environmental awareness and attitudes. The findings revealed that there was a substantial difference in environmental knowledge and attitude between male and female students. The results also showed that science undergraduate students have a higher level of environmental awareness and attitude than arts and commerce undergraduate students. As a result, it is necessary to educate and inform students so that they acquire a positive attitude toward the environment and can promote environmental consciousness to the general public. They have the ability to raise awareness in society about the importance of improving environmental circumstances. Conferences, seminars, courses, extension lectures, and competitions can also be held to improve students' environmental understanding. The findings of this study shed light on the gender gap and stream differences among undergraduate students in terms of environmental knowledge and attitudes. More efforts are needed to raise awareness among undergraduate students, with a particular focus on females and students in the arts and commerce streams, according to the findings. In order to give future generations with a clean environment full of natural resources in good shape and achieve sustainable progress, there must not only be a balance between environment and development, but also a moral commitment on the part of all human beings.

REFERENCES

1. Abdo, S.A.W. (2010). The effect of demographic factors on the environmental awareness of Omani citizens, Human and Ecological Risk assessment, **16**, 380-401.

2. Aminard, S. (2013). Knowledge of Environmental Issue where pupil acquire information and how it affects their attitude, opinion and laboratory behavior. Journal of Psychology, **4**(1).

3. Choudhary, R. (2005). Ecology and Environment and Pollution, definitions, history and scholarships. Agrobios, Jodhpur, India, pp 1-10.http://jcmc.ind.

4. Dhillon, J. S. & Sandhu, V. (2005). Environmental Education Awareness among Elementary School Teachers. Dissertation. Abstract International, **61**(4).

5. Ernesto, A. (2010). Environmental Education course Development for Pre service Secondary School Science Teacher in the Republic of Korea. The Journal of Environmental Education, **31** (4), 11-18.

6. Fliegenschnee, M. & Schelakovsky, M. (1998). Umweltpsychologie und Umweltbildung: eine Einfuhrung aus humanokologischer Sicht (Wien, Facultas Universitats Verlag).

7. Hines, J., Hungerford, H. & Tomera, A. (1987). Analysis and Synthesis of Research on Environmental Behavior: A Meta Analysis. Journal of Environmental Education, **18**(2), 1-8.

8. Owens, M. A. (2000). The Environmental Literacy of Urban Middle School Teachers. Dissertation. Abstract International, **61**(4).

9. Pelstring, L. (1997). Measuring Environmental Attitudes: The New Environmental Paradigm. www.docstoc.com/docs/20845968/Environmental-Attitude

10. Thakur, K. (2012). A Study of Environmental awareness among Senior Secondary School Students of Chandigarh. International Indexed and Referred Research Journal, ISSN0975-3486. RNI RAJBIL. Ⅳ (**38**).

11. Weigel, R.H. (1983). Environmental Attitudes and Prediction of Behavior. In N.R Feimer & E. S Geller, (Eds.), Environmental Psychology: Directions and Perspectives. New York; Praeger, 257.

BAMBOO BIODIVERSITY IN INDIAN CONTEXT

Ajay Thakur[1] and Anugrah Tripathi[2]
[1]Head of Division and [2]Research Assistant, Genetics and Tree Improvement, Forest Research Institute, Dehradun-248006, India
mithoojorhat@yahoo.co.in[1] and anugrah@icfre.org[2]

ABSTRACT
Bamboo is perennial woody grass from family Poaceae and distributed across temperate to tropical countries of the world. Across the globe more than 1600 species are reported. Asian bamboo forests are spread over 6.3 million km^2, most dense are reported from the north-east Indian state followed by Myanmar, South China, Sumatra and Borneo. India has largest bamboo bearing area with 1.6 lakh km^2 (ISFR, 2019) and third largest genetic diversity of woody bamboo resources with 136 species (125 indigenous and 11 exotic) after China and Brazil. Bamboos grow naturally in every state of India except Kashmir valley, hot and cold desert of India. State-wise bamboo species richness reported for Meghalaya (46-50 spp.), Arunachal Pradesh (47 spp.), Manipur (40 spp. + 1 var.), Assam (38 spp. + 2var.) Mizoram (33 spp.), Sikkim (29-30 spp.), West Bengal (32 spp.), Nagaland (32 spp.), Kerala (22 spp.+ 2var.), Andaman (22 spp.+ 2var.), Tripura (19 spp.+ 1var.), Bihar (19 spp.), Odisha (12 spp.+ 1var.), Jharkhand (10 spp.+ 1var.), Karnataka (10 spp.), Chhattisgarh (9 spp.), Himachal Pradesh (8 spp.), Madhya Pradesh (8 spp.), Maharashtra (7 spp.+ 1 var.). The States and Union territories with low number of bamboo species are: Punjab (4 spp.), Jammu and Kashmir (2 spp.), Rajasthan (2 spp.), Gujarat (2 spp.), Haryana (2 spp.), and Goa (2 spp.). In India, 16 bamboo species are being cultivated but others are in wild and located in small patches. There is need of conservation of these bamboos.

Keywords: *Bamboo conservation, Biodiversity, Bamboo species, Bamboo rearing areas in India.*

INTRODUCTION
Bamboo is an extraordinary and unique plant that are sustainable, productive, and versatile in nature. The physical and environmental properties as well as fast growing nature of bamboo makes it an exceptional economic resource for a wide range of socio-economic values. Bamboo growing stock is a major indicator of the extent of bamboo resources. Information on the growing stock is also needed to estimate bamboo biomass and carbon content. Bamboo possesses two type of growth forms *viz.* sympodial (clump forming bamboo and monopodial (non-clumping bamboos). There are some instances of amphipodial growth in *Melocanna baccifera* (Thakur and Tripathi, 2021). Growing stock is normally measured in culms (for monopodial species), clumps (for sympodial species) and weight (for both types of species). Coefficients exist the different species to convert number of culms and clumps to fresh and dry weight. Commercial growing stock is calculated from the number of commercial species, the quantity of each and their physical and economic accessibility. Unit of clump is known as culm which is divided into nodes and internodes. Each culm is covered by leafy and scaly structure known as culm sheath which becomes an important key for the identification of bamboos in the field conditions. Buds and branching morphology were first observed and described by Usui (1957) which was then continued by McClure (1966) stating that the mature bamboo branch complement is often more complex to be elucidated accurately.

Bamboos are usually distributed naturally in the forest areas; however, farmers and villagers maintain bamboo clumps in their home garden or farm boundary to fulfil various cultural, ecological and economic requirements. Bamboos are often divided into cultivated or village bamboos and native or forest bamboos (McNeely, 1995). Bamboo seems to have followed many

ancient maritime spice routes between China, Indonesia, Sri Lanka and India, sometimes making it difficult to establish the centre of origin for some species (Soderstrom and Calderon, 1979).

Uses of Bamboo

Bamboos are known for its multiple uses. These are used for manufacturing a wide range of items like furniture, trays, baskets, winnows, lampshades, fishnets, flutes, fans, mats, hats, flooring, lanterns, decoration items, pulp, plywood, activated charcoal, etc. More than 1,500 products exist, which are known to be made of bamboo. According to INBAR estimates, around 2.7 billion people i.e., 38% of the world's population rely on solid biomass for cooking. Bamboo which is a fast-growing renewable energy resource with recurring growth of culms, play a major role in mitigating the issues of slow growth of various forest genetic resources (Van der Lugt *et al.,* 2009). Bamboo is utilized across the world for a multitude of applications like food, furniture, clothing, artistic crafts, and paper products (Goyal *et al*., 2010; Gulabrao *et al.,* 2012). In many developing countries, bamboo is traditionally considered to be as poor man's material. This is obviously due to the abundance of bamboo forests and the relatively less machinery and expertise required for obtaining a useable building material in its natural form.

Bamboos are integral not only to the culture of India but that of the entire Southeast Asia. The wide range of their uses qualifies this group of species to be the one foremost associated with the mainstay of rural life and culture in our country. Its versatility has led to the coinage of such terms as "bamboo culture", "green gold", "poor man's timber", "friend of the people" and "cradle to coffin timber". In fact, bamboo can be used as a substitute of timber in many respects.

The Confederation of Indian Industries (CII) prepared a report in 2007, which classified various bamboo applications into following types (Khan *et al*., 2007).

a. Wood substitutes and composites including bamboo-based panels, bamboo flooring, bamboo furniture, incense sticks and bamboo blinds
b. Food products- mainly bamboo shoots
c. Construction and structural applications including traditional houses, bamboo frames with plaster and pre-fabricated houses
d. Bamboo-based fibres and fabrics
e. Bamboo charcoal
f. Bamboo for paper and pulp (Khan *et al*., 2007).

Growth and Morphology

Bamboos possess several factors of growth *viz*. clump height, diameter of clump, internode diameter and number of culms/clumps etc. The clump height of bamboos varies from a few centimetres to 35 m with large, medium sized to thick, sometimes thin-walled culms. Depending on the growth form, bamboos may be classified into four main types, i.e., tree form, reed form, shrub form and straggler form (Table 1).

Table 1: Details of various forms of bamboo with examples (Vishwanath *et al*., 2017)

Bamboo Forms	Examples
Tree	Bambusa bambos, Dendro calamusstrictus, B. balcooa, B. nutans, B. tulda
Reed	Ochlandra travancorica, O. scriptoria, O. rheedi
Shrub	Arundinaria racemosa, Sinoarundinaria falcata
Straggler	Dinochloa andamanica,

Most bamboos in India are of tree form category. The reed forms are small- to medium-sized bamboos with long internodes. They are found growing gregariously alongside streams or rivers

as reed brakes. The shrub forms are short and erect with very thin culms, up to 5 m in height and are usually found at higher elevations in the Himalaya near snow line and also in higher reaches of the Western Ghats. The straggler bamboos, also called climber bamboos, are not common in India. The productivity of bamboos in well- managed stands is much higher due to better silvicultural practices. Bamboos also produce highest biomass when managed by cultivation, selection and regular harvesting of mature culms. If harvested culms are turned into durable products, a managed bamboo forest sequesters more carbon than fast growing tree species (Kuehl and Yiping, 2012).

Bamboo Biodiversity in India

Approximately, across the world, 1650 bamboo species have been documented in World Atlas of Bamboos and Rattans (Vorontsova *et al.,* 2016). India stands at third position after China and Brazil in bamboo genetic resources (Greco *et al*., 2015); however, there are varying reports on the number of bamboo species existing in the country, viz. 123 species under 23 genera (Seethalakshmi and Kumar, 1998), 102 species (Ohrnberger, 1999) and 115 species under 20 genera (Naithani, 2008). But the recent assessment of Indian bamboo by Sharma and Nirmala (2015) revealed 148 species under 29 genera. Forests and rural areas of North-eastern and Eastern India comprising the political territories of the States of West Bengal, Sikkim, Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Mizoram, Tripura have over 50% of the bamboo species of the Indian floristic region. Himalayan region consisting political boundaries of the States of Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh (Himalayan part), Sikkim, North Bengal and Arunachal Pradesh is also rich with high altitude elements occurring under different eco-physiological conditions.

Bamboo possesses wide matrix of distribution across India. They are found in almost all the states of the country, from the tropical to the temperate regions and the alluvial plains to the high mountains, the only exception where they do not occur naturally is Kashmir. The principal bamboo genera occurring in India are *Arundinaria, Bambusa, Chimonobambusa, Dendrocalamus, Dinochloa, Gigantochloa, Indocalamus, Ochlandra, Drepanostachyum, Phyllostachys, Pleioblastus, Pseudoxytenanthera, Schizostachyum,* and *Thamnocalamus.*

The FSI (2021) inventory results indicate that bamboo bearing area across the country 1,49,443 km^2 (approximately 15 million ha) which is 10,594 km^2 less than 2019 estimation of FSI (Table 2), although there is a substantial increase in the total number of culms across India. Total number of bamboo culms across country are 53,336 million which is net increase of 13882 million culms from FSI estimation of 2019 (Table 3).

Table 2: Bamboo bearing area in India (ISFR, 2021):

Sl. No.	State/UT	Bamboo Bearing area (ISFR, 2021) (sq km)
1	Andhra Pradesh	6,104
2	Arunachal Pradesh	15,739
3	Assam	10,659
4	Bihar	1,103
5	Chhattisgarh	10,467
6	Goa	288
7	Gujarat	3,547
8	Haryana	39
9	Himachal Pradesh	1,027
10	Jharkhand	3,717
11	Karnataka	8,624
12	Kerala	2,404
13	Madhya Pradesh	18,394

14	Maharashtra	13,526
15	Manipur	8,377
16	Meghalaya	5,007
17	Mizoram	4,561
18	Nagaland	3,947
19	Odisha	11,199
20	Punjab	280
21	Rajasthan	1,555
22	Sikkim	994
23	Tamil Nadu	4,001
24	Telangana	4,535
25	Tripura	4,201
26	Uttar Pradesh	1,832
27	Uttarakhand	1,201
28	West Bengal	702
29	Andaman and Nicobar Islands	1,413
Total		**1,49,443**

Table 3: Total number of culm resources of bamboo in India (ISFR, 2021)

Details of culms (In Million)	Green sound culms	Dry sound culms	Decayed culms	Total no. of culms (ISFR,2021)	Total no. of culms (ISFR,2019)	Change w.r.t. ISFR,2019
Total	39,150	9,352	4,834	53,336	39,454	13,882

The maximum number of green sound culms are found in Arunachal Pradesh (7,455 million) followed by Assam (4,813 million), Madhya Pradesh (3,108 million), Odisha (2,785 million) and Maharashtra (2,767 million). Dry culms were found maximum in Madhya Pradesh (1005 million) followed by Maharashtra (932 million) and Chhattisgarh (860 million). As compared to the estimation of ISFR, 2019, maximum number of increases in number of culms by soundness has been observed in Arunachal Pradesh (3055 million) followed by Assam (1827 million) and Odisha (1682 million).

DISCUSSION

Bamboo has great potential to address the societal and environmental concerns. Although India consists the largest bamboo bearing area across the world, still productivity level of bamboo forest is lower (Singh, 2008). There are substantial knowledge gaps on bamboos under cultivation. There is a need for developing a network of bamboo growing Gardens and Arboreta of the region and outside with a view to gather latest information on introduction, phenology, reproductive biology, propagation, exchange of germplasm, conservation status etc. There is a need for the introduction of other species of ethnobiological significance. It is noteworthy to mention here that most of the bamboo gardens and bambusetum do not possess up-to-date information on ecological and growth parameters, morphological variabilities, threat and conservation value and methods for multiplication, characterization with a view to widening the genetic base.

A National Bamboo Policy may be formulated as the first step towards developing the bamboo sector. Regional Bamboo Policies be implemented through a three-tier structure with a National Bamboo Board and State Bamboo Boards for every state or a group of states and District Bamboo Boards for every district or group of districts. Such a policy would serve to outline the fundamental principles that would guide the State interventions in the bamboo sector, particularly in terms of balancing industry.

In 2017, Government of India, by amending Indian Forest Act 1927, has exempted bamboo grown in non-forest areas from the requirement of felling/transit permit to increase cultivation of bamboo. It is a crucial shift towards the commercialization of bamboo as an enterprise at farmer's and grower's level. It will surely generate opportunities for the communities, farmers dwelling in the rural areas and fringes of the forests as well as bamboo utilizing industries for the bamboo.

REFERENCES

1. FSI. 2021. India state of forest report (ISFR). Forest Survey of India, Dehradun.
2. Goyal, A.K., Middha, S.K., Usha, T., Chatterjee, S., Bothra, A.K., Nagaveni, M.B. and Sen, A. 2010. Bamboo-Infoline: A database for north Bengal Bamboo's. Bioinformatics, **5,**184–185.
3. Greco T.M., Pinto M.M., Tombolato A.F.C., Xia N. 2015. Diversity of bamboo in Brazil. J Trop Subtrop Bot.,**23**(1),1–16.
4. Gulabrao, A. Y., Kaushal, R., Tewari, K.S., Tomar, S.M.J. and Chaturvedi, P.O. 2012. Seasonal effect on rooting behaviour of important bamboo species by culm cuttings. Journal of Forest Research, **23**, 441–445.
5. Khan, Amir Ullah; Hazra, A., 2007. Industrialisation of the Bamboo Sector: Challenges and Opportunities. India Development Foundation, Publication 15. Published by Confederation of Indian Industry (CII), New Delhi.
6. Kuehl, Y. and Yiping, L., 2012. Carbon offsetting with Bamboo; International Network for Bamboo and Rattan (INBAR) Working Paper 71.
7. McClure, F.A. 1966. The bamboos: A fresh perspective. London: Harvard University Press
8. McNeely A.J. 1995. Bamboo, Biodiversity and conservation in Asia. Bamboo, people and the environment. In: Proceedings of Vth International bamboo workshop and the IV international bamboo congress, Ubud, Bali, Indonesia.
9. Naithani H.B. 2008. Diversity of Indian bamboos with special reference to North-east India. Indian Forester, **134**(6),765–788.
10. Ohrnberger D. 1999. The bamboos of the world: annotated nomenclature and literature of the species and the higher and lower taxa. Amsterdam: Elsevier, pp. 526.
11. Seethalakshmi K.K., Kumar M. 1998. Bamboos of India—a compendium. New Delhi: Kerala Forest Research Institute, Peechi and International Network for Bamboo and Rattan.
12. Sharma M.L., Nirmala C. 2015. Bamboo diversity of India: an update. In: Proceedings of the 10th world bamboo congress, Damyang, Korea, 17–22 September 2015, pp 516–528.
13. Singh, O. 2008. Bamboo for sustainable livelihood in India. Indian Forester, **134,** 1193-1198.
14. Soderstorm, T.R. and Calderon, C.E. 1979. A commentary on bamboos (Poaceae: Bambusoideae). Biotropica, **11,**161–172.
15. Thakur, A. and Tripathi, A. 2021. Overview of bamboo resources. In Bamboo Propagation, Management and Utilization: Practical Manual, VOLUME – I (Eds. Ajay Thakur, Anugrah Tripathi and Y C Tripathi).
16. Usui, H. 1957. Morphological studies on the prophyll of Japanese bamboos. Botanical Magazine Tokyo, **70,** 223-227.

17. Van der Lugt, P., Vogtlander, J. and Brezet, H. 2009. Bamboo, a sustainable solution for Western Europe-design cases, LCAs and land-use. INBAR technical report 30. Beijing: INBAR.

18. Viswanath, S., Sharma, R. and Kumar, D. 2017 Silviculture and Management; In Bamboo: Conservation, Management and Utilization in India, A Status Report. pp 35-46.

19. Vorontsova M.S., Clark L.G., Dransfield J., Govaerts R., Wilkinson T., Baker W.J. 2016.World atlas of bamboos and rattan. Kew: International Network of Bamboo and Rattan & Royal Botanic Gardens.

TOWARDS SUSTAINABLE DEVELOPMENT: A CASE STUDY OF A VILLAGE IN SOLAN DISTRICT OF HIMACHAL PRADESH

Amita Joshi, Anju Aggarwal and Saloni Sood
Dr. Y. S. Parmar Govt. P. G. College, Nahan, Dist. Sirmaur (H.P.) India-173001
[1]anonyjy@gmail.com, [2]aggarwal.anju17@gmail.com and [3]salonisood85@gmail.com

ABSTRACT
Sustainable development has been a buzzword for the last one decade. It is a very broad term which carries different meanings for different people. The term gained momentum after the adoption of 2030 Agenda for Sustainable Development by the United Nations in 2015. The seventeen sustainable development goals mentioned in the agenda are especially important for developing countries like India, where about 65% of the total population lives in rural areas. The rural population of India though still in the developing or underdeveloped stage has a natural psyche for preserving their culture and traditions and this goes a long way in sustainable development. The present study of a small village located in District Solan of Himachal Pradesh depicts a true picture of sustainable development which is a way of living for these people. Without being much aware of this buzzword sustainable development they have been following sustainable practices and preserving their natural surroundings for future generations including the natural water resources and forests. The study concludes that if some initiatives are taken for making improvements in the practical education of the youth, then it could enhance their socio-economic standard and help them to make their village a Sustainable Model Village.

Keywords: *Sustainable development, Natural surroundings, Water resources, Socio-economic standard.*

INTRODUCTION
India is a land of people who mostly have a rural base and they prefer to live in villages. Even the people who are living in cities have a basic connect from one or the other village and so deep down their hearts they are connected with village life "The soul of India lives in its villages", is a true statement given by M.K. Gandhi in the 20th century. Almost 68% of the total population lives in rural areas. The villages have flourished in India due to their closeness to nature and their psyche to follow and preserve their culture and ancient traditions. Though, the word sustainable development has gained momentum in recent years after the adoption of 2030 Agenda for Sustainable Development by the United Nation in 2015, yet the daily lifestyle of the villagers in India has been unconsciously revolving around sustainable development for the last many centuries. The agenda 2030 lays stress on 5 P's i.e People, Planet, Peace, Prosperity and Partnership (UN General Assembly, 2015). The villages of India have been following a lifestyle which takes care of these 5 P's for the last many centuries. They are well aware of how to sustain and preserve their resources while making the best and judicial use of the resources provided and available to them in their surroundings. The present case study of a village in District *Solan* of Himachal Pradesh has been done with the purpose of studying the innate psyche of the villagers which motivates them to live a sustainable life in harmony with nature.

OBJECTIVES OF THE STUDY
The main objective of this study has been to analyze the sustainable lifestyle of inhabitants of a small village in District Solan of Himachal Pradesh and to find how the inhabitants have sub-consciously adopted practices that help them to maintain their natural resources. Hence, the main objectives of the study are:

1. To study the psyche of the villagers which has helped them to sustain their natural resources for the last 100 years.
2. To know about the developmental changes and changes in the environment they have seen in the past one decade.
3. To know their views on sustainable development.
4. To know their opinion on how their natural water bodies, found in the nearby forests can be protected and rejuvenated.

METHODOLOGY

The information from the villagers has been collected by various methods like individual and group interviews in unstructured form. The group interview helped a lot in getting the detailed information of the village life as used earlier by other research groups for case studies (Kapoor and Baghel 2016, Wirmark, 2009). Some villagers were able to fill the structured questionnaire but most of the elderly people actively participated in the group interviews. Daily trekking in different seasons to their grasslands (*ghaasni* in local language) and natural water reservoirs, stepwells (*bowar*i in local language) helped a lot in gaining an insight into the knowledge of the village folk about the vast medicinal plants which are judiciously used by them for themselves as well as for their cattle herd. Besides this the photography done by the villagers during trekking and some photography by the researcher as well as by other sources helped to broaden the understanding of the sustainable village life. Visits and revisits to the village with close interaction with the inhabitants increased the possibility of making keen observations and this helped a lot in this case study. A close relationship with the inhabitants of the village also helped the researchers to go deep into the psyche of the inhabitants.

About the Village Chawal

The village under study is located in the Happy valley of District *Solan* of Himachal Pradesh in India (@2022 VillageInfo.in). Happy Valley is known for its rich biodiversity, scenic beauty, a deep silence in the pine forests and the fresh vegetables of all types grown by the localites. The village is situated 12 kms away from district headquarter *Solan*. The total geographical area of the village is 32 hectares according to the census of 2011 and the village code is 021851. *Subathu* is the nearest town for the villagers and from where they procure their daily requirements. This town is famous as the Headquarter of 14 GTC Cantonment and it is 8 km from the village. The village is not connected with the road and the nearest roadhead station is *Matando* on the *Solan-Subathu-Dharampur* road. From *Matando*, a 20-minute uphill walk amidst the pine trees takes one to this small village.

RESULTS AND DISCUSSION

Keeping in mind the objectives of the study the following points have been covered:

1. Population

The population as per census 2011 was 59 with 31 males and 28 females. As per this study the population of this village is 50 out of which 23 are female and 27 are male. The number of youths in the age group of 18-35 is 18 out of which 12 are male and 6 are female. There are 3 males and 4 females in the age group 4-17, 12 male and 12 female in the age group of 36-80. There is only one female in the age group of 80 plus (Figure 1). The population of the village has not increased in the past decade which shows that the villagers are conscious about the growth of population and how it can affect the use of available natural resources and hence their living standards also. The youth of the village when interviewed were of the opinion of improving their standard of life before entering the family life. Their main attention was development and improvement in the agricultural practices and building good *pucca* houses with modern amenities for themselves and their elders.

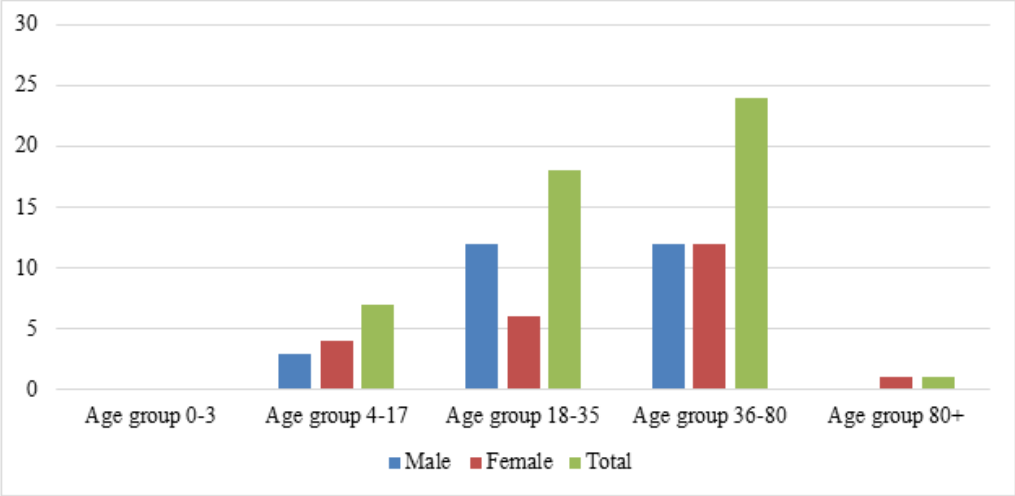


Figure 1: Population of the village *Chawal* at the time of study

2. Occupation

98% of the villagers pursue agriculture as the main occupation. Being a part of the happy valley, it gives them an extra edge to grow the seasonal vegetables as cash crops. Out of the twelve men in the age group of 18-35 only one has opted for a job in defense services, six pursue agriculture with part time skilled jobs in the nearby factories/industries, one has opted for higher education on a regular basis and four exclusively do farming (Figure 2).

Majority of the boys in their youth either opt for some technical course or part time private jobs in nearby industries/factories. Their main focus is in growing cash crops like capsicum, tomato, ginger, garlic, colocasia, which they grow and sell in nearby markets. They prefer to work in nearby factories/industries only when the agricultural work in their fields is less. Out of the six women in the age group 18-35 only one has opted for regular higher education and the remaining five are pursuing agriculture just like their men counterparts.

Out of 12 men in the age group of 36-80 only one is doing a government job. The other eleven are pursuing agriculture as the main occupation and part time jobs in nearby factories in the off-season time for economic sustainability. Out of twelve women in the age group of 36-80, only one is in government sector and rest of the women are doing farming and this feature of equal participation of women in farming in all age groups shows gender equality (Figure 4) in the village which is an important goal in sustainable development as prescribed in UN AGENDA 2030 for sustainable development (UN General Assembly, 2015, PIB, Government of India, 2021).

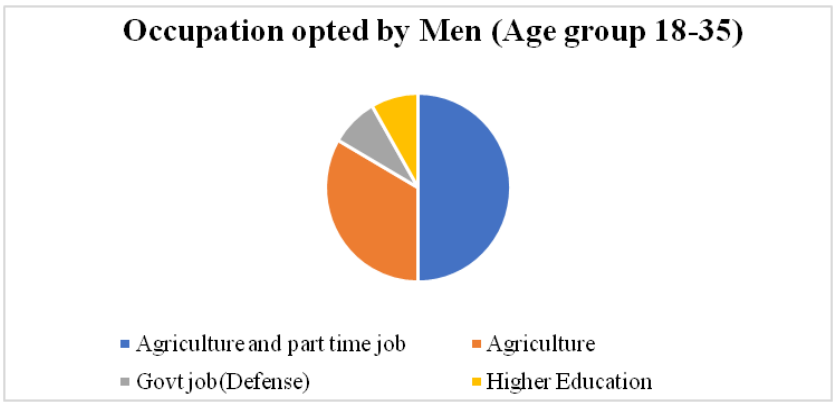


Figure 2: Occupation opted by men (Age group 18-35)

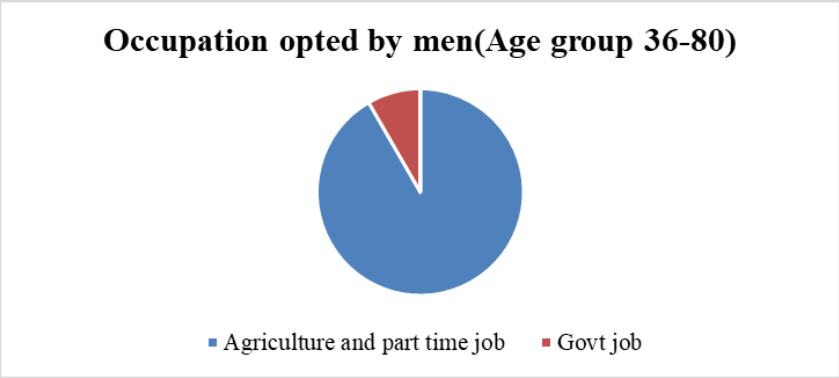


Figure 3: Occupation opted by men (age group 36-80)

Figure 4: Gender equality

3. Houses in the Villages

As per the 2011 survey there were 10 houses in the village which were built mainly by the stones available in the village and mud. At present there are 13 *pucca* houses with all modern amenities. The youth of the village have either inherited or learnt the skills of carpentry, masonry, stone carving from their ancestors or they have acquired skill-based education from the nearby institutes in different traits. They have put in their technical skills to enhance their living standards by building modern houses with all amenities and without any external technical support. This finding clearly showed how the youth of the village still upholds the culture of working with the community and meeting their needs sustainably without harming their

Figure 5A. Pucca house with retaining wall made of local stone.

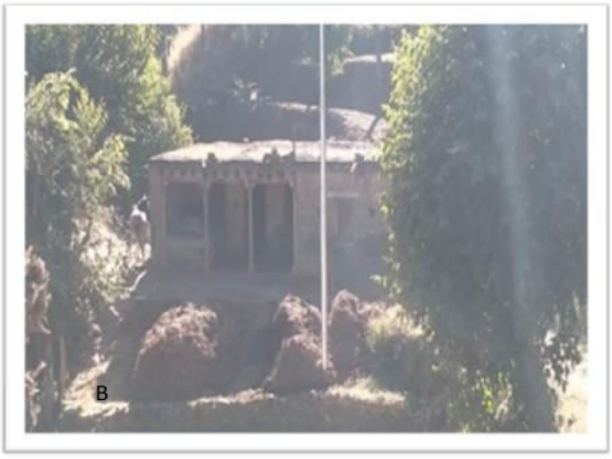


Figure 5B. Cow shed made of local stone and mud.

Environment. They have a complete knowledge of the stone used for building purposes found in their area. They locally call it *Neela Pathar*. They are also conscious of the government schemes and have utilized it for building retaining walls outside their house which is necessary for the protection of the house on hilly terraced land (Figure 5 A). Separate cowsheds have been made by the villagers using local stone and mud for their livestock which includes cows, bulls and oxen (Figure 5B).

4. Sustainable Agriculture Practices

Agriculture is the key occupation of the villagers for the last four generations. As per the findings of this study, the villagers have been practicing sustainable farming for the last three generations. They use the cow dung manure in their fields and also have the knowledge of how to maintain and improve their soil fertility. They know and follow the principles of sustainable agriculture and very judiciously manage their food requirements. They grow the basic millets, maize, wheat, beans of all varieties and common spices like chilies, turmeric and coriander to meet their daily needs. Not only this, they also grow cash crops like capsicum, tomato, ginger, garlic, colocasia, pea and sell them in nearby markets for economic sustainability. As told in an exclusive interview with the oldest woman of the village, the villagers also used to practice rearing of sheep and weaving of sheep yarn to make blankets which are used by them in winters. The youth of the village who willingly filled the questionnaire clearly mentioned that they are aware of the new high yielding variety of seeds, about the pesticides and insecticides and have incorporated their knowledge in practicing sustainable agriculture. Besides this they also use ash as a fertilizer in their garlic fields and are aware of the fact that it contains essential minerals required for maintaining the fertility of soil. They still cultivate the terraced fields with traditional methods. Birds and animals like peacock, rabbit, pig, wild rooster which frequently visit the fields and destroy their harvests are also dealt with sensibly by the villagers. They do not kill the animals for their needs and greed. The villagers, especially the youth and old folk (approximately 80% of the population) regularly feed the birds and cows in the morning and attach religious importance to this daily practice, which they have learnt from their ancestors and which they gladly carry forward to their next generations.

5. Technology in Harmony with Nature

There is complete electrification in the houses of the village but they use it judiciously and 100% of the villagers are conscious about the use of power and they have LED bulbs as well as solar lights in their houses. The group interview with women folk was very engrossing and full of healthy discussions. 100% of the women had the basic knowledge of health, and were happy about the facilities they had developed in their washrooms and kitchens. They showed their newly built *choolha* (hearth) which are specially designed (Figure 6A), however the use of *choolha* (hearth) along with LPG facility is found in almost 90% of the houses as found by the researchers after visiting every house (Figure 6B). The water circulating around the walls of the *choolha* (hearth) gets heated up simultaneously while cooking is being done. Proper water connections to their washbasins and sinks helps them to get continuous supply of hot water for washing utensils after they complete their cooking in the *choolha* (hearth). All the 12 young men in the age group of 18-35 knew the skill to build these *choolhas* (hearths).

Cautious use of natural products like the fallen pine cones as fuel, dry pine needles for making brush locally called *koochi* (Figure 6C and 6D), the local dry grass called s*aran* for making brooms (Figure 6E) and using the fallen twigs and wood for *choolha* by 100% of the inhabitants shows that the villagers are eco-friendly and environment conscious. They have a complete knowledge of the flora in their surroundings and use the wide variety of medicinal plants in their common ailments. In the group interviews with the men folk in the age group of 36- 80, several discussions related to the medicinal plants and their use were held.

The men showed great interest in talking about the use of plants like *shatavar* (*Asparagus* species) (Figure 6F) for immunity and strength, *Hadjod* (*Monstera* species) (Figure 6G) for arthritis and bone problems, *Timur* (*Zanthoxylum* species) (Figure 6H) for tooth and gum problems and use of *giloy* (*Tinospora*) for fever, and they take good care of the naturally growing medicinal plants and 20% of the men have inherited the art of making ayurvedic decoction or leaf paste from these medicinal plants. One of the villagers was of the opinion that this rare art of using the medicinal plants for various ailments can be further enhanced if the villagers get proper support from some government organization or NGO.

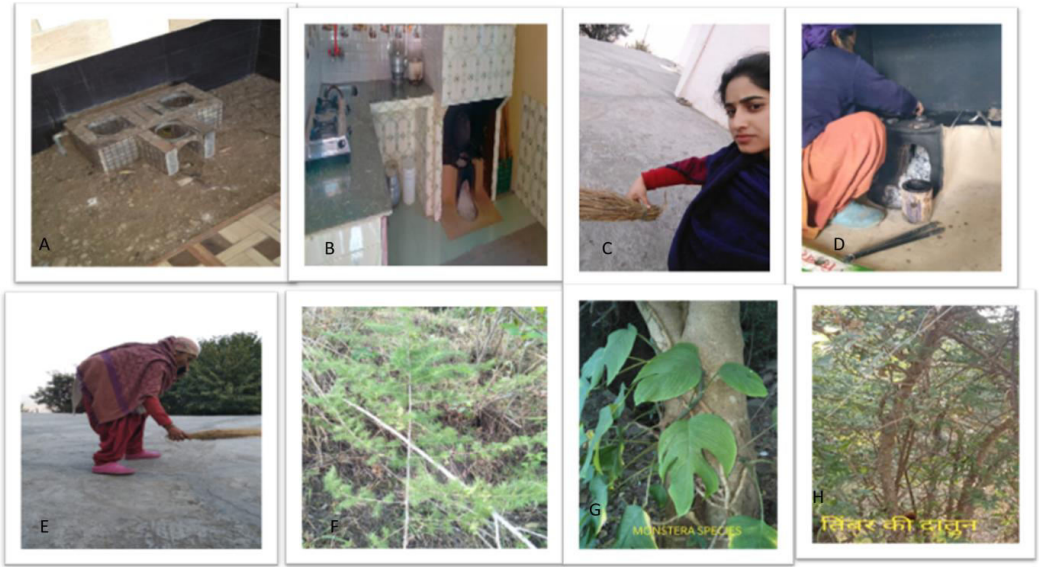


Figure 6A. New improved *Choolha* with water pipeline being made by localities in the kitchen, **Figure 6B**. LPG connection and stove in kitchen along with improved *Choolha*, **Figure 6C**. Brush, locally called *Koochi* made of dry pine needles, is being made and used by a young village girl, **Figure 6D**. Brush (*Koochi*) being used by a village woman for disinfecting the *Choolha* with cow urine, **Figure 6E**. Broom made of locally available grass called *Saran*, **Figure 6F**. Asparagus, a medicinal plant, growing wild in the village commonly called *shatavari* by villagers, **Figure 6G**. *Monstera* species commonly called *Hadjod* by villagers, **Figure 6H**. *Pahari neem* commonly called *Timbar* by villagers.

6. Well Managed and Maintained Water Resources

The village has been well connected with the government water supply and 100% of the houses have taps and water connection. But the villagers have the insight to conserve water resources and utilize it wisely. As told by the women of the village they use water from the nearby natural *bowaris* (step wells) for drinking and cooking purposes and maintain them. As told by the oldest women (80+) of the village, bowaris hold a sacred place in their lives and every newly wed girl has to go to the bowari to do the *pooja* and to bring a bucketful of water from there. The old woman very enthusiastically showed these pictures from the photo album. A few photographs of recent times could be luckily clicked by the researchers. The men folk of the village were of the view that there were many such *bowaris* in the nearby forest areas but now only few are maintained (Figure 7A, 7B, 7C and 7D) and if some scheme can be started for the rejuvenation and restoration of other old *bowaris*, then they would be more than happy to work for it. The researcher visited the newly constructed rain water harvesting tank (Figure 7E) which has been built about 7 years back in the village by the villagers with the support of government schemes and they find it useful for irrigating their fields, for their cattle and don't waste even a drop of water (Figure 7F).

Figure 7A. Water from natural springs, **figure 7B.** Well maintained natural water source in the village, **Figure 7C**. 100 years old *bowari* (step well) considered sacred by villagers, **Figure 7D**. A village woman fetching water from *bowari* for drinking purpose, **Figure 7E.** Rain water harvesting tank built in 2015 under govt. scheme, **Figure 7F.** Waste water being collected for irrigation.

7. Understanding of the Term Sustainable Development

There are a number of ways in which the term sustainable development (SD) has been explained and interpreted by the people. For this study the most common definition of SD has been taken up. The most well-known definition of sustainable development was given in 1987 by the world commission on environment development. "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition was published in the "Brundtland Report" by the commission's chairwoman Go Harem Brundtland (Keeble, 1988)

Only seven villagers out of a total fifty are aware of the term sustainable development as defined in the Brundtland report. For all the villagers who are practicing sustainable development in the real sense sustainability is associated with each and every work that they do whether it is using a twig of *Timbar* tree for brushing their teeth or bringing a bucketful of water from *bowari* for drinking or using the handmade blanket made by their ancestors from sheep wool. According to the villagers worshiping their natural surroundings like the *Peepal* tree, the water bodies, feeding the small house martins, and using the skills to improve their living standards is what all they understand by sustainable development.

CONCLUSION AND SUGGESTIONS

As Himachal Pradesh has been ranked second in the achievement of sustainable development goals as mentioned in the *Niti Aayog* report 2020-21(PIB, Government of India, 2021), so a little effort in this direction and a little guidance to the villagers in this direction with some support can make this village a model village and many other villages can follow this pattern. We conclude that this small village *Chawal* in *Solan* district of Himachal Pradesh can develop into a real smart village (Adamowicz, M. & Zwolińska-Ligaj, M., 2020) (Ramachandra, T.V. *et.al*., 2015) if the suggestions given below are implemented in a practical manner where local people are involved in the development and there is cooperation between the government and non-government organizations. Most of the suggestions have been given by the villagers who have been following sustainable practices and have an innate psyche to develop their village into a modern sustainable smart village.

- The youth of the village need to be trained in some skills which can help them adopt modern technologies in a better way and can improve their socio-economic status.
- Some measures can be adopted to promote higher education in this village.
- Some measures to save and develop the natural sources of water should be taken up by local administration. The old traditional ponds in the hills can be rejuvenated and renovated.
- Road connectivity to the village is essential so that the villagers stay in the village and maintain the environment for the coming generations.
- As told by the localites in interview, there is a great scope of nurturing the medicinal plants used by localites for various ailments.
- The youth can be motivated and supported through various schemes to start vermicompost units, homestays for tourists with trekking facilities. They can expand their agriculture by growing stone fruits and so can become entrepreneurs (El Ebrashi, 2003).
- Just by identifying the potential of the village's natural resources, the self-sustainability of the village can go a long way in future.

REFERENCES

1. Adamowicz, M., & Zwolińska-Ligaj, M. (2020). The "Smart Village" as a way to achieve sustainable development in rural areas of Poland. Sustainability, 12(16), 6503.
2. El Ebrashi, R. (2013), "Social Entrepreneurship Theory and Sustainable Social Impact", Social Responsibility Journal, 9(2),209. https://doi.org/10.1108/SRJ-07-2011-0013
3. Indian Village Dictionary, Https://Villageinfo.In/Himachal-Pradesh/ Solan/ Solan/ Chawal. Html
4. Kapoor, S. And Baghel, S.S. (2016, July 15-16), Sustainable Development of Villages: A case Example of Village in Mathura District. IEEE 2016: Technological Innovations in ICT for Agriculture and Rural Development (TIAR), Chennai, India, 10.1109/ TIAR.2016.7801227
5. Keeble, B. R. (1988). The Brundtland Report: 'Our common future'. Medicine and war, 4(1), 17-25. https://doi.org/10.1080/07488008808408783
6. PIB, Government of India (2021, June 3) NITI Aayog Releases SDG India Index and Dashboard 2020–21 [Press Release] https:// pib.gov. in/ Press Release Iframe Page. aspx?PRID=1723952
7. Ramachandra, T. V., Hegde, G., Subhash Chandran, M. D., Kumar, T. A., Swamiji, V. (2015). Smart Village Framework (ENVIS Technical Report: 90 April, 2015) Energy & Wetlands Research Group [EWRG] Centre for Ecological Sciences, Indian Institute of Science http:// wgbis. ces. iisc. ernet.in/ biodiversity/ pubs/ ETR/ ETR90/ETR90.pdf
8. Transforming Our World: The 2030 Agenda for Sustainable Development, New York, NY, USA: UN Gen. Assembly, 2015. https://sdgs.un.org/2030agenda
9. Wirmark, A. (2009). Towards Sustainable Development in Kallankuthal, A Small Village in Southern India. https://stud.epsilon.slu.se/581/1/wirmark_a_091029.pdf

TRADITIONAL KNOWDGE AND SUSTAINABLE DEVELOPMENT

Amita Joshi[1] and Rajesh Trehan[2]
[1] Assistant Professor, Department of Chemistry, Dr. Y. S. Parmar Govt. P. G. College, Nahan, District Sirmaur (H.P.)-173001, India
[2]Associate Professor, Department of Chemistry, SGGSJ Govt. College, Paonta Sahib (H.P.)-173025, India
[1]anonyjy@gmail.com and [2]trehanr@hotmail.com

ABSTRACT
Traditional Knowledge (TK) is the knowledge that derives from, or is rooted in the traditional way of life of aboriginal people and is the accumulated knowledge and understanding of the human place in relation to the universe. In the globalized world, TK somehow gained special importance in the past few years which have seen an outburst in the demand for herbal medicines, as the herbal and the traditional methods for making these medicines are taking an important part of human health. The developing countries like India are very rich in traditional type of Biological Variety known as "Biodiversity" and new products have been discovered through research based on "Biological Recourses" named "Bioprospecting". As the commercial development is increasing, technologically advanced countries are using those biological resources and biological components without taking permission or providing any fair compensation to those indigenous people and these biological recourses are used in this unlawful way, it amounts to a theft called "Biopiracy". TK constitutes the ancient knowledge of humanity, the deepest layer on which our science and culture have developed, the local solutions that have allowed the creation and management of ecosystems and cultural landscapes on the entire surface of the planet. It enables the development of solutions with a low energy and resource use that are able to adapt to environmental variability and to react to emergencies and catastrophes in flexible and multifunctional ways. TK plays a key role in the preservation and sustainability of diversity and many activities based on it are important sources of income, food and healthcare for the indigenous people. The long-term economic development of many indigenous and local communities, depend on their ability to harness their traditional knowledge for commercial benefits. TK is being rapidly lost as local ecosystems are degraded and traditional communities are integrated into the wider society. Protection of Traditional Knowledge. TK can be protected by way of enacting laws, rules and regulations, access and benefit sharing provisions, royalties etc. and steps taken to prevent acquisition of intellectual property rights over traditional knowledge. People's attitude is very important and unless they are made to feel through awareness campaigns that their tradition and skills are worth conserving, sustainable management cannot be materialised in its true sense.

Keywords: *Traditional knowledge, sustainability, biodiversity, bioprospecting, biopiracy, sacred grove, traditional medicine.*

INTRODUCTION
Traditional knowledge refers to the knowledge, innovations and practices of the local people of an area which have been handed down from one generation to the next generation in the form of stories, songs values, beliefs, rituals, community laws etc. The traditional knowledge differs from one community to another and is also called community knowledge and is an integral part of the community in which it operates. Different communities perceive traditional knowledge differently. For some, this knowledge is essential for survival and for others it carries spiritual meaning and for some it can be a way of leading sustainable life. Traditional knowledge for these communities provides basis for many aspects of everyday life and occupations. The range of different fields where traditional knowledge is being used are hunting, fishing and gathering,

agriculture, animal husbandry, health related issues, astronomy, astrology, textile, building, clean air and water, adaptation to environment etc.

Defining Traditional Knowledge

According to UNESCO, "Local and indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural and indigenous people, local knowledge informs decision making about fundamental aspects of day-to-day life. This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource use practices, social interactions, ritual and spirituality. These unique ways of knowing are important facets of the world's cultural diversity and provide a foundation for locally appropriate sustainable development."

A report of the International Council for Science Study Group on science and traditional knowledge characterizes traditional knowledge as: "Traditional knowledge is a cumulative body of knowledge, know-how, practices and representations maintained and developed by people with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, rituals, spirituality and world view."

According to World Intellectual Property Office (WIPO) the definition of traditional knowledge includes indigenous knowledge relating to categories such as agricultural knowledge, medicinal knowledge, biodiversity related knowledge and expressions of folklore in the form of music, dance, song, handicraft, designs, stories and artwork.

Relation between Sustainable Development and Traditional Knowledge

Sustainable development refers to the process of development which judiciously utilizes the natural resources in the present while keeping the needs of the future generations in mind. The most common definition of Sustainable development given by Brundtland Commission of the United Nations in 1987 "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Sustainable development has become a buzzword these days as most of the countries in the world are racing hard and fast for technology, development and making maximum profitable use of the natural resources without being concerned for the future generations. By the year 2050 our global population will almost reach a mark of 9 billion and the inefficient way in which we are using earth's natural resources, the consequences are far more than dangerous. Problems in the field of agriculture, health, climate, forest resources, availability of fresh water, clean air etc. have started cropping up and it is these problems which have once again forced the human beings to think of ways to develop sustainably. Sustainability has become a broad term which can be applied to all the needs of the people living in villages, towns, cities and metro cities. The sustainable ways mainly focus on a strategy which uses the resources efficiently keeping in mind the long-term benefits of earth and human beings. These sustainable development strategies are closely related to the various indigenous ways which some of the communities in the world have been following in all walks of life. The traditional indigenous knowledge possessed by these communities can go a long way in reviving the sustainable living patterns followed by these communities in day-to-day life.

India's intellectual resources are not limited to (though they are limited by) its 'Indi-Genius' doubting intellectual elite. Today, there are Indian economists, social developers, and scholars who are working hard to revitalize many Traditional Knowledge Systems (TKS). Resources for research and teaching of India's TKS should be made available for the following reasons:

- India has amongst the best cases for successful revival of TKS: It has a rich heritage still intact in this area. It has the largest documented ancient literature relevant to TKS. It has the intellectual resources to appreciate this and to implement this revival, provided the Macaulayite mental blocks could be shaken up through re-education of its governing elite. It has dire needs to diversify beyond dependence solely upon the new panacea of globalization and westernization.
- India's scientific heritage, besides its philosophical and cultural legacy, needs to be properly understood. The aim is not inspired by chauvinism, but to understand the genius of Indian civilization better. This would overhaul the current assessment of India's potential.
- To correct the portrayal of the History of Science, the History of Ideas, mainstream accounts of World History, anthropology and culture. This entails emphasizing to scholars and educators that TKS should be included, especially India's achievements and contributions to world science that have been very significant but unappreciated.
- To include Traditional Knowledge Systems in economic planning, because they are eco-friendly, sustainable, labour rather than capital intensive, and more available to the masses. This should be done in parallel with the top down 'modern' scientific development using westernized 'globalization', as the two should co-exist and each should be used based on its merits.

Traditional Knowledge (TK) Through the Ages

Traditional knowledge has contributed a lot in the survival of indigenous communities through ages. These communities have been able to cope up with all the problems related to food, clothing, shelter, health, environment, climate with the help of this traditional knowledge and their undoubted faith in what they learnt from their ancestors. Around 80% of the people living in rural areas of the world depend on the TK for health and medicines and this knowledge is not static but dynamic as it keeps evolving with each passing generation when people face challenges in the environment. The people who practice traditional knowledge understand and consider the connectivity that exists between animals, plants, human beings, air, water, land, soil and other elements of the universe and therefore this knowledge provides a sustainable basis for every sphere of life like agriculture, health, clothing, construction, navigation, ecological balance, climate etc.

Agriculture and Forestry: Indigenous knowledge in agriculture is vast and people have accumulated it over centuries in different fields like soil management, cultivation methods, irrigation systems, harvesting and storage of crops. The knowledge has been successfully used in a sustainable manner by the local people in different parts of the world.

Indigenous rain water management is done by farmers who use a self-made rain gauge of stone to find the amount of rain so that the farmers can carry the agricultural operations at right time under right conditions. Terracing, trenching and mulching as techniques for preserving soil moisture are all indigenous techniques followed by people living in hilly areas. Spreading ash in the snowy areas of Himalayan region is another indigenous method to melt the snow fast in the fields. This helps to prolong the crop growing season in the snow bound areas. Indigenous methods are also used in the control of pests, insects and diseases in fields. These methods mostly use plants for the control and this helps in maintaining the soil quality and prevents soil pollution. *Neem* seed extract, garlic leaves extract, *parsa* leaves, *sandha* water are most commonly used in rice fields for pest control in different parts of India. These are not only cost effective but also ecofriendly methods. Besides these many herbal formulations like *Vitex nigunda* leaves extract, cow urine, *neem* leaves powder, asafetida powder is also used for controlling pests and insects in fields. Locally made indigenous agricultural implements like *guddelli* for harvesting ginger, *patella* for levelling of land, are used in many areas. Indian

farmers still follow the indigenous methods of storing seeds and grains safely like mustard oil treated green gram, use of *neem* leaves, sealing the container with mud, use of finger millet heads (*ragi*), use of cloves for protecting sugar from ants.

Sacred Groves: These are distinct patches of forests which have been left untouched by the local people and are protected by the people who associate religious and social reasons with the biodiversity found in these forests. Since sacred groves protect all levels of biodiversity in their natural environments so they are a very good example of in-situ conservation of biodiversity. The degree of sanctity accorded to the sacred groves varies from one area to another. In some forests, even the dry foliage and fallen fruits are not touched. Sacred groves are a tract of virgin forest that is protected traditionally by the local communities as a whole and a harbour rich in biodiversity. They are important repositories of flora and fauna diversity that have been conserved by local communities in a sustainable manner and help in the protection of a number of rare, endangered, and endemic species. They are often associated with ponds, streams or springs, which support the water requirements of the local people. Thus, the vegetative cover of sacred groves helps in recharging the aquifers.

In India the sacred groves that have been reported so far are around 14000 and most of them are associated with some Hindu God. People believe that the local deities in sacred groves have the power to protect them. Some groves of Buddhist and Islamic origin also exist in India. They are often associated with temples, monasteries, shrines or with burial grounds. Ancient Indian texts have many references to sacred groves, for example, Kalidasa's *Vikramorvasiyam*. These groves are called by different names in different regions as *Deva Bani* in Rajasthan, *Dev Van* in Himachal Pradesh, *Umang Lai* in Manipur*, Kovil Kadu* in Tamil Nadu and *Kavu* in Kerela. The size of a sacred grove can vary from a few trees to a large forest where the growth and conservation of trees is considered crucial and people are afraid of incurring any harm to flora and fauna present in the grove. Sacred groves in the hills of Garhwal and Kumaon are mentioned in old Hindu scriptures like the *Puranas*. Among the largest sacred groves of India are the ones in Hariyali, near Gaucher in Chamoli District of Uttarakhand. Himachal Pradesh in North India and Kerela in South India are specifically known for their sacred groves.

Sacred groves in North Kerela are mainly associated with goddesses (*Amma, Durga, Ayiravalli*), while in South Kerala these are generally associated with snake worship. *Sarpa Kavu* or *Naga Banna* is a holy snake grove found in Kerala mainly associated with snake worship.

In Himachal Pradesh the sacred groves are called *dev van* or *devata ka jungle* and mostly temples are situated in these sacred groves and no one is allowed to cut trees in these groves. All the groves are rich source of flora, fauna and natural water bodies. Some examples are *Talai van* in Shimla and *Shipin* which is believed to be the largest deodar grove and has trees which are thousands of years old.

Sacred groves exist in other parts of the world too. In *The Golden Bough*, author James Frazer says that people have worshipped forests right from the Palaeolithic age, thereby preserving them. In ancient Greece and Rome stone walls usually enclosed these forests. Initially these forests began as open-air temples but even after huge temples were built, they continued to be protected. Many of them contained streams and lakes that were also considered sacred, and no one was allowed to fish in them or pollute them. Such groves exist in countries such as Ghana, Syria, and Turkey.

Threats to Sacred Groves and Ways to Protect Them: In recent times due to developmental activities certain sacred groves have been reduced in terms of area covered and in some places fruit orchards have replaced the trees in sacred groves. The disappearance of the traditional belief systems (as are now considered mere superstition) but were fundamental to the concept of

sacred forests and transformation of the primitive forms of nature worship into formal temple worship are the threats to these sacred groves. So, the need of the hour is to create public awareness about the importance of these groves, to enact special laws in each state to protect these groves and to pay special attention to the endangered and threatened flora and fauna which are found in these groves. The introduction of Wildlife Protection (Amendment) Act, 2002, provides government protection to these lands, but the role of the local community and NGO's remains important in saving these sacred groves and the indigenous knowledge about the flora and fauna of these groves which is crucial for maintaining the ecological balance. The survival of these groves depends entirely on the control of the community over the forest and the people.

Medicine and Health: The earliest literature of traditional knowledge about health and medicines is *Charak Samhita* which gives a detailed account of natural medicines for various health problems, *Sushruta Samhita* which provides knowledge of surgery and *Ashtanga Hridaya Samhita* about *Ayurveda*. These texts give a detailed account of various healing options available naturally for the cure of common ailments as well as the methods to wisely and judiciously use the natural resources for preparing medicines. The modern allopathic system of medicine has its roots in the traditional knowledge only. In the ancient times healers used various herbs for curing different ailments. The knowledge of medicinal properties of any particular herb was handed down from one generation to the next by the local people of that area where the particular medicinal plant grew. The knowledgeable person referred to as the *Vaidya* was held in high esteem by the village people. Today also, this tradition is being followed in many areas of the world. Traditional knowledge provides for a high percentage nearly 60-70% of the primary health care needs of the people around the world. With the advancement of medical science and study of chemistry of the active compounds found in these herbs, synthesis of these compounds also started in the laboratory. This gave rise to a new field of study called **Bioprospecting.** It is the exploration, extraction and screening of biological diversity and indigenous knowledge for commercially valuable genetic and biochemical resources. For bioprospecting, plants, insects, algae and even microorganisms have been explored. Many important drugs like atropine from *Atropa belladonna,* ephedrine from *Ephedra vulgaris,* morphine from *Papaver somniferum* have been developed by the chemists. The convention on Biological Diversity (CBD) 1992, clearly states that there will be control of the local agency over the biological resource which is being used by pharmaceutical industry for bioprospecting.

Biopiracy: Closely associated with the term bioprospecting is the term biopiracy. Biopiracy is defined as the use of indigenous knowledge of natural resources for commercial applications without the consent and with little and no compensation or recognition to the community from which it originates.

Traditional Technologies: The technology which has been handed over from one generation to next generation by the local people and which uses the materials available locally is traditional technology. In almost all the villages' artisans have been using this technology since ancient times and they have learnt it from their ancestors. The skill of pottery, carpet weaving, metal work, leather work, wood work has been a part and parcel of village life and with each passing generation there has been a greater perfection in the work. The technology used by these people has all the sustainability features. The raw materials used by them are locally available, the methodology and technique utilize mostly hand work, the resources are renewable and all this requires low capital input.

The Indus-Sarasvati Civilization was the world's first to build planned towns, with underground drainage, civil sanitation, hydraulic engineering, and air-cooling architecture. Oven baked bricks were invented in India in approximately 4,000 BC. From complex Harappan towns to Delhi's Qutub Minar and other large projects, India's indigenous technologies were very sophisticated in

design, planning, water supply, traffic flow, natural air conditioning, complex stone work, and construction engineering. Beside civil engineering Indians were pioneer in metallurgy and metal work, textiles, shipping and ship building, water harvesting, forest management, farming techniques, medicines, mathematics, astronomy, logic and philosophy, language and linguistics etc. due to their strong traditional knowledge and technologies.

Protection of Traditional Knowledge

Traditional knowledge is a living knowledge as most of it has been passed orally from one generation to another and has a cultural and spiritual factor associated with it. Very less traditional knowledge is available in documented form. So, the protection of this knowledge is a difficult task.

WIPO (World Intellectual Property Organization): WIPO is a specialized agency of the United Nations whose mission is to develop a balanced and accessible international intellectual property system which rewards creativity, stimulates innovation and contributes to economic development while safeguarding the public interest. WIPO has done remarkable work in the protection of traditional knowledge. Three aspects of traditional knowledge are taken into consideration under WIPO:

1. Traditional knowledge which includes technical knowledge, skills and innovations related to biodiversity, agriculture and health.
2. Traditional cultural expressions like music, art, symbols.
3. Genetic material of actual or potential value found in plants, animals and microorganisms.

Two Types of Intellectual Property Protection are Also Being Considered by WIPO:

1. Defensive protection which aims to stop people outside the community from acquiring intellectual property rights over traditional knowledge.
2. Positive protection which grants rights that empower communities to promote their traditional knowledge, control its uses and benefit from its exploitation.

Convention on Biological Diversity (CBD) and Traditional Knowledge

The Convention on Biological Diversity is an international legally binding treaty which works for conservation of biodiversity, sustainable use of biodiversity and fair and equitable sharing of benefits arising from the use of genetic resources. In its preamble several articles consider the important role of traditional knowledge of indigenous people in sustainable development.

Article 8(j) of CBD states that "Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices."

Article 10(c) "Each contracting party shall, as far as possible and as appropriate shall protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements".

Besides WIPO and CBD, United Nations Permanent Forum on Indigenous Issues (UNPFII), an advisory body to Economic and Social Council (ECOSOC) looks into indigenous issues related to economic and social development, culture, environment, education, health and human rights.

Traditional Knowledge Digital Library (**TKDL**): TKDL is an institutional mechanism set up in India to protect the traditional knowledge. It is a database containing 34 million pages of formatted information on some 22,60,000 medical formulations in multiple languages. It is a

unique deposit of India's traditional knowledge and is serving as a powerful tool in the country's fight against erroneous patents also called biopiracy.

Importance of TKDL: The local communities carry forward their traditional knowledge either orally or in some other form but still no method has been adopted to keep the traditional knowledge in documented form like the scientific knowledge. So, preservation and nurturance of traditional knowledge is a big issue specially in countries like India where there is diversity in people, their culture and beliefs and also there is rich biodiversity. The formation of TKDL became necessary when United States Patent and Trademark Office (USPTO) granted patent on the wound healing properties of turmeric and the European Patent Office (EPO) granted patent on antifungal properties of *neem* and great effort was made by India to revoke these patents. In the beginning of 21st century TKDL found that around 2000 patents relating to Indian medical systems were being erroneously granted by patent offices around the world. Another important role played by TKDL has been to bridge the gap of languages. Most of the TK is in languages like Sanskrit, Arabic, Persian, Urdu and Tamil which could not be understood by the patent examiners and TKDL has converted and structured ancient texts into 34 million A4 sized pages which have been translated into French, English, German, Japanese and Spanish.

The TKDL is available to all patent offices that have signed TKDL Access Agreements with the EPO and patent offices of Australia, Canada, Germany, United Kingdom and United States As per this agreement, patent examiners may use the TKDL for search and examination purposes only and its content may be revealed only to the third parties for the purpose of citation.

Scientific Development and Traditional Knowledge

Most of the activities followed by the indigenous communities had a scientific base though it was not in a documented form. Today with the development of science and technology, by combining the traditional knowledge with scientific knowledge viable solutions can be found for sustainable development. By keeping in mind, the requirements of the local communities, new innovative strategies can be devised to enhance and harness the indigenous knowledge of these communities in such a way that traditional values are not hurt and the communities are also benefitted. A symbiotic relationship needs to be established between the indigenous communities and the scientific communities for sustainable development. So, cooperation and partnership between the old traditional knowledge of the indigenous communities and new scientific knowledge of scientists are most essential for sustainable development. The National Innovation Foundation (NIF) is an autonomous body of Department of Science and Technology set up in the year 2000 at Ahmedabad, Gujarat to strengthen the grassroot level intellectual and traditional knowledge and to ensure sharing of wealth between the knowledge owner and the innovator.

Certain Principles must be followed by the scientific community to ensure the collaboration of the indigenous people in the modern research work and planning for sustainable development.

1. The traditional knowledge holders should be an integral part of all policies and planning that are being made for sustainable development.
2. The social and cultural values of these indigenous people should be acknowledged and taken on priority basis.
3. The scientific research work must be holistic and interdisciplinary in nature with due regard to the old traditions and the community knowledge.
4. Due credit in terms of intellect and monetary benefit should be given to the indigenous knowledge holders.

5. The traditional knowledge holders should be fully informed about the partnership and their role in the scientific research.
6. The problems of the traditional knowledge holders should be identified and solved scientifically for the benefit of the society at large.
7. Intergovernmental organizations and NGOs should play a prominent role in developing collaborative partnerships between the scientific community and the local traditional knowledge holders.
8. Efforts for generating employment for the local and indigenous people can be made to improve the socio-economic status of the people.
9. Provision for training of indigenous and local people can be made to carry out research on traditional knowledge.
10. The indigenous technologies like rainwater harvesting, biogas generation from waste, organic farming should be given due recognition in the local areas.

CONCLUSION

The preservation and protection of traditional people and their knowledge has been recognized as a means to achieving sustainable development. However, much still needs to be done at the policy and development programming levels to enable genuine and sustainable participatory processes of engagement of a multiplicity of knowledge systems. Traditional knowledge is widely being abandoned by the elite in India who resort to alien and "modern" but unsustainable development values and practices. There is therefore an urgent need to nurture it to form the backbone of sustainable development in India. Governments and development agencies in the country need to revitalize and re-engineer development policies/programmes, legal and institutional frameworks at the central and local government levels, and traditional institutions to support a vigorous promotion and development of TKS and SD. These measures should be backed by appropriate research to document pertinent information and define effective educational programmes to increase awareness and understanding on the subject. This process must be participatory and involve all stakeholders.

REFERENCES

1. Nirmal Sengupta, Traditional Knowledge in Modern India: Preservation, Promotion, Ethical Access and Benefit Sharing Mechanisms; Springer; 1st ed., 2019.
2. Amit Jha, Traditional Knowledge System in India; Atlantic Publishers and Distributors Pvt Ltd, 2009.
3. Robin Wall Kimmerer, Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants; Milkweed Editions, 2013.
4. Paul Kuruk, Traditional Knowledge, Genetic Resources, Customary Law and Intellectual Property: A Global Primer; Edward Elgar Publishing Ltd (2020).
5. Apte, T., A Simple Guide to Intellectual Property Rights, Biodiversity and Traditional Knowledge. Kalpavriksh, GRAIN, and IIED, Pune/Delhi (2006).
6. ICSU Science, Traditional Knowledge and Sustainable Development, ICSU Series on Science for Sustainable Development No. 4. International Council for Science, Paris, (2002).
7. Singh Nijar, G. (1998) Community intellectual rights protect indigenous knowledge. Biotechnology and Development Monitor, No. 36, pp 11-12.

8. Twarog, S. and Kapoor, P. (Eds.), (2004) Protecting and Promoting Traditional Knowledge: Systems, National Experiences and International Dimensions. United Nations Conference on Trade and Development. Document No, United Nations, Geneva. UNCTAD/DITC/TED/10.
9. World Commission on Environment and Development, Our Common Future, Oxford University Press, Oxford (1987).
10. Pareek A, Trivedi P.C. (2011), Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India, Indian Journal of Traditional Knowledge, Vol. 10(1), 2011, pp 183-189.
11. Sarma Jayanta Kumar (2016), Traditional Practices of livestock management in Northeast India, https://www.nezine.com/info/WkFtZDJjTWkraVZwMndubHdENVJFQT09/traditional-practices-of-livestock-management-in-northeast-india.html
12. Bodeker, Gerald, Traditional Health Knowledge and Public Policy, Nature and Resources 30(2) (1994), 5-16.
13. Linden, Eugene, Lost Tribes, Lost Knowledge, Time, 138 (12) (1991), 46-56.
14. Swamy, P.S., M. Kumar and S.M. Sundarapandian, Spirituality and Ecology of Sacred Groves in Tamil Nadu, India, *Unaslyva* 213, Vol. 54, 2003.
15. https://www.researchgate.net/publication/259151641_Sacred_groves_around_the_earth_an_overview
16. https://www.dsource.in/resource/sacred-groves-manav-sangrahalay/downloads
17. https://nif.org.in/hindi
18. https://www.cbd.int/traditional/intro.shtml
19. https://www.wipo.int/tk/en/tk/
20. https://egyankosh.ac.in/handle/123456789/3907

ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

Dev Raj Sharma
Associate Professor, Department of Music, Government College Sangrah, Distt. Sirmour, H.P.-173023
devrajnahan@gmail.com

ABSTRACT
Environment is a challenging issue in the whole world today. No doubt we have made tremendous achievement in every sector but along with this, in one way or other it has affected environment badly. The economic development that we have achieved so far has come at a very heavy price at the cost of environment.

Keywords: *Environment, Sustainable development, Economic development.*

INTRODUCTION
Environment is defined as all those conditions and their effects which influence life. It includes: biotic components, viz., plants and animals and abiotic components, viz., water and air. According to the Environment Protection Act 1986, "Environment includes water, air and land the interrelationship which exists among and between water, air and land and human being and other creatures, plants, microorganisms and property." Environment includes living elements or biotic elements (birds, plants, animals, forests and fisheries) as well as non-living elements or abiotic elements (air, water, land, soil, minerals resources) which make up our surroundings and impact our existence and the quality of our life. Environment includes two types of resources: (1) Renewable (2) Non-renewable resources.

Renewable resources are those which can be replenished and are not likely to be exhausted or depleted on use, for example wood, sea, and animal. Nonrenewable resources are those which are likely to be exhausted or depleted on use. The rate at which those resources re-emerge is so far short of the rate at which these resources are being exploited for example- fossilfuel. Environment crises occurs when carrying capacity of the environment is challenged (or exceeded) through excessive exploitation of natural resources or when generation of waste exceeds the absorptive capacity of environment.

Factors Affecting the Environment
There are several factors which have affected environment to a great extent:

Poverty: A large section of Indian populations cut trees for fuel wood they use for self and sell to earn their livelihood. This causes soil erosion which leads to crises.

Increasing Population: Increasing population is the main cause of environment crises. Pressure of population on land has tremendously increased, consequently land has been ruthlessly exploited. Population explosion has caused fragmentation of holdings and conversion of forest land for individual and residential purposes.

Urbanization: Migration from villages to urban areas is a big threat to environment. It has resulted in increasing demand for land and excessive exploitation of other natural resources.

Use of Insecticides, Pesticides, and Chemical Fertilizers: In order to increase the production of crops the use of insecticides, pesticides and chemical fertilizers has added to environment pollution.

Rapid Industrialization: Rapid Industrialization is one of the main causes of environment pollution. Chemical waste coming from the industries pollute the river water which the people use for drinking hence it deteriorates the health of people. Smoke of factory adds to air pollution.

Global Warming: Global warming is a gradual increase in the average temperature of the earth's lower atmosphere as a result of the increase in greenhouse gases since the industrial revolution. Much of the recent observed and projected global warming is human induced. It is caused by man-made increase in carbon dioxide and other greenhouse gases through the burning of fossil fuels and deforestation. Adding carbon dioxide, methane and such other gases to the atmosphere with no other changes will make our planet's surface warmer. During the past century the atmospheric temperature has risen by 1.1˚F (0.6˚C) and sea level has risen several inches. Due to global warming ice of mountains is melting continuously with a resulting rise in sea level and coastal floodings. Scarcity of drinking water is another cause of melting ice.

Ozone Depletion: Ozone depletion refers to the phenomenon of reduction in the amount of ozone in the atmosphere. Ozone depletion problem is caused by high levels of chlorine and bromine compounds and chlorofluorocarbons (CFC), used in fire extinguishers. As a result of depletion of the ozone layer, more ultraviolet (UV) radiation comes to earth and causes damage to living organisms. UV radiation seems responsible for skin cancer in humans.

Multiplicity of Transport Vehicles: Multiplicity of transport vehicles has substantially increased noise and air pollution.

Environment pollution is the consequence of increasing urbanization and industrialization, besides man's disregard to the civic norms. Air pollution, water pollution and sound pollution are peaking up to the alarming limits. It needs urgent redressal at the national and international level. Besides this some are the principal issues of environmental degradation in India such as degradation of land, water pollution and management of fresh water, loss of biodiversity and solid waste management etc.

Sustainable Development

Sustainable development is the need of the hour not only for the survival of mankind but also for its future protection. Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability can be described as a state in which humankind is living within the carrying capacity of the earth. Humankind is nowadays facing the fact that, with the intensive industrial activities, pollution and resources exploitation has exceeded the earth's carrying capacity. This means we must make strong and concentrated shift of development in direction where earth can sustain humankind needs. This concentrated and integrated action and change of direction can be referred to as sustainable development. Sustainable development is basically an action plan which help us to achieve sustainability in any activity which makes use of resources. Most organized definition of sustainable development by the **Brundtland Commission in 1987** is "Sustainable Development is development that meets the needs of the present generation without impairing/ reducing the ability of future generation to meet their own needs."

In the recent past the process of economic growth has accelerated in complete disregard to the resource endowment and environment. The competitive process of growth and development has led to environment degradation and environment pollution to an alarming extent. Diverse crops are grown on land led to fall in soil fertility. Excess mining of iron, coal, gold, silver, and extraction of crude oil has led to the depletion of their stock. Smoke and other injurious emissions from factories led to environment pollution.

Sustainable development does not suggest delimiting or curtailing the process of growth and development but suggest a judicious or optimum utilization of resources in a manner such that the pace of growth is sustained without challenging the ability of the future generation to grow and prosper.

Strategies for Sustainable Development

Here are some strategies for sustainable development:

LPG, Gobar Gas in Rural Areas: In rural areas most of the people use wood, dung cake or other biomass as fuel which cause deforestation, reduction in green cover and air pollution. Now the subsidized LPG is being provided by the government and Gobar gas plants are being provided through easy loans. It reduces household pollution to a large extent.

Wind Power: In areas where speed of wind is high, wind mills can provide electricity without any adverse impact on environment.

CNG in Urban Areas: In big cities CNG is being provided by the government to minimize the air pollution due to transport system.

Solar Power through Photovoltaic Cell: India is endowed with abundant sunlight which is a rich source of energy. Solar energy and its conversion into electricity is an effective answer not only to the problem of economic growth but also to solve the various environmental problems leading to sustainable development.

Mini Hydel Plants: Mini hydel plants are an environment friendly way to generate electricity, especially in the mountain regions.

Biocomposting: In India most of the farmers use chemical fertilizers to increase production which resulted in degradation of land and water pollution. The government is serious about to promote organic method of farming under the National Mission and Sustainable Agriculture. The use of bio fertilizers is being promoted as a part of the scheme.

Biopest Control: Efforts are being made to introduce biopest control. The chemical pesticides contaminate food products, soil, water bodies and even ground water. Pest controlling chemicals have been extracted from *Neem* and their use being encouraged.

CONCLUSION

Economic development, which aimed at increasing the production of goods and services to meet the needs of a rising population, puts greater pressure on the environment. Now the world is faced with increased demand for environmental resources but their supply is limited due to overuse and misuse. Sustainable development aims at promoting the kind of development that minimizes environmental problems and meets the needs of the present generation without compromising the ability of the future generation to meet their own needs. Sustainable development has become a catch phrase today. It is indeed a paradigm shift in development thinking. Sustainable development aims at decreasing poverty of the poor by providing lasting and secure livelihood that minimize resources depletion, environment degradation, cultural disruption and social instability.

REFERENCES

1. Text and reference books on environment
2. Newspapers and magazines
3. Wikipedia
4. Britannica encyclopedia

INDOOR AIR POLLUTION AND PLANTS

Dhanmanti Kandasi
Assistant Professor, Department of Botany, SGGSJ Government College, Paonta Sahib, Distt.Sirmour, H.P.-173025
dhanmanti4botany@gmail.com

ABSTRACT
Indoor air pollution is the physical, chemical and biological contamination of indoor air. Indoor air pollution is ubiquitous and it is of many forms ranging from smoke emitted from solid fuel combustion, especially in households of developing countries to complex mixtures of volatile and semi-volatile organic compounds present in modern buildings. In developing countries, the indoor air pollution has more health impact on people than in outdoor air pollution. Indoor air pollution is very serious and dangerous to the human health. People living in urban areas spend most of the time indoor. The concentration of contaminants in indoor air is generally 5 to 7 times that of outdoor air (Garg et. al., 2021). The indoor plants can help in reducing the indoor air pollutants by 75 % in different conditions. They can help in reducing the air borne contaminants such as volatile organic compounds, nitrogen oxides and dust. These plants can provide efficient, low cost, sustainable bioremediation system for reducing indoor air pollution and improving indoor air quality which can further result in improving human health and productivity. This paper has main focusing on the types of indoor air pollutants and uses of some important plants for reducing indoor air pollution.

Keywords: *Indoor plants, Sustainable, Bioremediation, Air quality, Indoor air pollutants.*

INTRODUCTION
There are many types of air pollution but indoor air pollution is very serious and dangerous to human health. In India air pollution is a very serious problem. The principal sources of indoor air pollution are combustion, building material and bioaerosols. While radon, asbestos, pesticides, heavy metals, volatile organic matter, and environmental tobacco smoke are considered major indoor pollutants in developed countries, the combustion products of biomass fuels contribute most to indoor air pollution in developing nations. In India out of 0.2 billion people using fuel for cooking; 49% use firewood; 8.9% cow dung cake; 1.5% coal, lignite, or charcoal; 2.9%kerosene; 28.6% Liquefied Petroleum Gas (LPG); 0.1% electricity; 0.4% biogas; and 0.5% any other means (Kankaria *et. al.*, 2014). The incomplete combustion products of biomass fuels include suspended particulate matter, carbon monoxide, polyaromatic hydrocarbons, poly organic matter, formaldehyde, etc., which have adverse effects on health. The combustion of coal results in production of oxides of sulphur, arsenic and fluorine. Resins, waxes, polishing materials, cosmetics and binders produce pollutants such as aldehydes, volatile and semi volatile organic compounds. Mattresses, carpets, humidifiers and stagnant water produces the biological pollutants like dust mites, molds, pollen, and other infectious agents. The indoor air can contain 5 to 7 times more concentrations of contaminates than outdoor air. Some harmful contaminants in indoor air are also the components of “sick building syndrome” with symptoms of nausea, sore eyes, headache, dizziness, sore throat and loss of concentration. Plants represent nature and exposure to nature is considered beneficial to both physical and mental health and general wellbeing (Chauhan *et. al*., 2017; Garg *et. al*.,2021; Hess-Kosa, 2002). A number of studies have shown that indoor plants can contribute to the sustainable improvement of indoor air quality and can reduce indoor air pollution. Growing some indoor potted plants can help in reducing the indoor air pollution.

OBJECTIVE

The main objective of this study is to enlist some common indoor plants which can help in sustainable improvement of indoor air quality. The details on botanical names and common names along with the type of pollutants removed by them is also provided in this study.

Some Traditional Air Purification Methods

There are many methods which are used traditionally for improving indoor air quality. Some of these methods are:

Mopping: It is one of the old methods for cleaning dust particles that settled down on the floor surface. In mopping all the dust get stick to mobs' fibre and provide the clean surface (Davis, J. 2009).

Ban on Smoking: Burning tobacco during smoking produces carbon monoxide, volatile organic compounds and particulate matter. These are harmful to both active and passive smokers. Many carcinogenic diseases can be prevented by avoiding smoking in houses (consumer reports, 2010).

HEPA Filter: They are commonly known as air purifiers and they help in removing all the accumulated particles like dust and lead particles. They are useful for allergic people as they can remove large amount of biological and chemical allergens (Davis, J.2009).

Bees Wax Candles: These candles produce the ions which combine with free floating chemical ions making them heavier and fall off to ground so these candles can neutralize toxic compounds and other contaminants (Natural living ideas, 2011).

Salt Lamps: These are made of Himalayan Pink Salt and they can neutralize the toxins from the air. They work on principle of hygroscopy as they can attract water molecules with toxins. Water is evaporated back into the air when the lamp is lit up and it leaves behind the particles (Natural living ideas, 2014).

Activated Charcoal or Carbon Filters: They work on principle of adsorption. When air passes through filters the carbon adsorbs the contaminants and air get purified (Natural living Ideas, 2014).

These methods mentioned above are very old and traditional but effective methods. But due to industrialization and urbanization the level of indoor air pollution is very high and some very effective, inexpensive, natural and low maintenance methods are needed. One of the natural methods for this is bioremediation that uses organisms to remove or neutralize pollutants from contaminated sites. In this method the biological, chemical or physical activities of green plants is used for removal of pollutants. The use of Plant-based systems to lower the concentration or change the bioavailability of pollutants in soil or water is known as phytoremediation (Evans, *et. al.* 2010). Very few studies have done in phytoremediation of indoor air (Evans, *et.al.*2010& Garima, T. 2014). There are many varieties of plants that can remove different pollutants from the air. Some of these plants are listed below:

Table 1: Various indoor plants and the pollutants eradicated by them

S.No.	Name of plant	Ammonia	Hydrocarbons	Benzene	Ozone	Toluene and xylene	Formal-dehyde	Trichloro-ethylene	References
1.	Aloe vera (Aloe vera)	No	No	Yes	No	No	Yes	No	Wolverton, *et. al.* & Pottorff, L., 2019

2.	Chrysanthemum morifolium (Florist's Chrysanthemum)	Yes	No	Yes	No	Yes	Yes	Yes	Wolverton, *et. al.,* 1993
3.	Chlorophytum comosum (Spider plant)	No	Yes	No	Yes	Yes	Yes	Yes	Corneio, J. *et.al.,* 1999 & Papinchak *et. al.,*2009
4.	Dracaena fragrans (Cornstalk Dracaena)	No	No	Yes	No	No	Yes	Yes	Wolverton *et. al.,*1993
5.	Dracaena marginata (Red-edged Dracaena)	No	No	Yes	No	Yes	Yes	Yes	Wolverton, *et. al.,*1993 & Pottorff, L., 2010
6.	Ficus Benjamina (Weeping Fig)	No	Yes	No	Yes	Yes	No	No	Wolverton, *et. al*., 1993
7.	Ficus elastica (Rubber plant)	No	No	No	No	No	Yes	No	Corneio, J.J.*et. al*.,1999
8.	Hedera helix (English ivy)	Yes	Yes	Yes	No	Yes	Yes	No	Mung Yoo, *et. al.,* 2006
9.	Nephrolepis exaltata (Boston fern)	No	No	No	No	Yes	Yes	No	Wolverton, *et. al.,* 1993
10.	Sansevieria trifasciata (Variegated snake plant, mother in law's tongue)	No	No	Yes	Yes	Yes	Yes	Yes	Pappinchak, *et.al.,*2009 & Wolverton, *et. al.*,1993

CONCLUSIONS

Indoor air pollution causes ill health effects among people. The development of new energy technologieshas a role to play in solving this problem. One of the challengesis to increase the access of poor households to cleaner and more efficient household energy systems. The use of plants in phytoremediation of indoor air pollution can result in an efficient, low cost and natural eco-friendly method for purifying indoor air.

FUTURE ASPECTS

With the increase in population and improved standards of living suggest that air pollution will be an increasing problem until and unless the population is controlled. Air pollutionhas many ill effects on both health of people and on environment. It is now very necessary to do something for present and future generations. Controlling air pollution should be a topic of research in the countries with very high populations such as: China, India and America. Some new transgenic indoor plants can be developed which can remove indoor pollutants more efficiently. There is also need to create and implement effective guidelines for prevention of indoor air pollution in developing countries so that hospitals, schools, offices and residential buildings can be kept free from indoor pollution.

REFERENCES

1. Chauhan, P., Rawat, M.S., Gauba, S. (2014) Indoor air pollution in India: Implications on health and its control. Indian Journal of Community Medicines, **39**(4), 203-207.
2. Corneio, J.J., Munoz, F.G., Ma, C.Y., & Stewart, A.J. (1998) Studies on the decontamination of air by Plants. Ecotoxicology, **8**(4), 311-320.
3. Consumer reports (2010) 7 easy ways to reduce indoor air pollution. http:// www. consumerreorts.org/cro/news/2010/08/7-easy-ways-to-reduce-indoor-air-pollution/index.htm.
4. Davis, J.L. (2009) Breathe Easy. 5 ways to improve indoor air quality. http;// www.webmed.com/lung/features/12-ways-to-improve-indoor-air-quality.
5. Evans., Gareth, M., Furlong, J.C., (2010) Phytotechnology and photosynthesis, John Wiley and Sons Ltd. 145-174.
6. Gay, K. S., Jain, K., Pal, M. (2021) Some indoor plants and their role in reducing indoor pollution. Journal of Global Biosciences, **10**(3), 8430-8439.
7. Hess-Kosa, Kathleen., (2002) Indoor air quality-sampling methodologies, Lewis Publications.
8. Kankari, A., Nongkynrich, B., & Gupta, S. (2014) Indoor air pollution in India: Implications on health and its control. Indian Journal of Community Medicines, **39**(4), 203-207.
9. Mung H.Y., Youn J. K.& Ki-Cheol S. (2006) Efficacy of indoor plants for the removal of single and mixed volatile organic pollutants and physiological effects of the volatiles on the plants. Journal of the American Society for Horticultural Sciences, **131**(4),452-458.
10. Natural Living Ideas. (2014) 8 ways to purify home air naturally so your family can breathe the healthiest, cleanest air possible. http://www.naturallivingideas.com/8-ways-to-purify-home-air-naturally/.
11. Papinchak, H.L., Holcomb, E.J., Best, T.O., and Decoteau, D.R. (2009) Effectiveness of houseplants in reducing the indoor air pollutant Ozone. HortTechnology, **19**(21), 286-290.
12. Pottorff, L. (2010) Clean air inside our homes. Colorado State University & Denver Country Extension Master Gardener.
13. Tiwari, G. (2014) Applications of bioremediation on solid waste management: Review Journal of Bioremediation and Biodegradation. **5**(6).
14. Wolverton, B. C., Wolverton, J.D. (1993) Plants and soil microorganisms: Removal of Formaldehyde, Xylene and Ammonia from the indoor environment. Journal of Mississippi Academy of Sciences, **38**(2), 11-15.

FOREST COVER AND LAND USE MAPPING IN RENUKA FOREST DIVISION USING GEOSPATIAL TECHNOLOGY

Jagdish Chand
Assistant Professor, Department of Geography, Government College Sangrah, District Sirmour. H.P.-173023 India
jagdishgeo@gmail.com

ABSTRACT
Forests are important source of subsistence, employment, revenue earnings, and raw materials to a number of industries and also play vital role in ecological balance, environmental stability, biodiversity conservation, food security and sustainable development of a region. Forests are the world's air conditioners and the earth's blanket; without them world would be a bleak and inhospitable place. Forests are renewable resource and nature's gift to mankind. The forest eco-system consisting of a variety of flora and fauna representing remarkable bio-diversity is essential for environmental stability and food security. They provide numerous goods and services and maintain life support systems essential for life on earth. The forest resource is under tremendous pressure. Intensified shifting cultivation, indiscriminate removal of timber, fuel wood, fodders and other forest produce, forest fire and encroachment has led to forest degradation and deforestation. The loss and degradation of forest results in soil erosion, loss of biological, damage to wild life habitats and degradation of watershed areas and deterioration of the quality of life. The present study assesses the extent and trends of forest cover in Renuka Forest Division using geospatial techniques for the periods 1972, 1989, 2001, and 2011 and also provides an overview on the main causes of forest cover change.

Keywords: *Forest, Ecological balance, Biodiversity conservation, Food security, Sustainable development, Environment, Forest cover change.*

INTRODUCTION
Forests are the green blankets that are naturally protecting the hill environment and preserving the natural resources. The recent researches show that the overwhelming population pressure, practicing of unscientific agricultural methods and the lack of awareness about the importance of forests among the populace in general are the prime causes for deforestation and degradation of forests. The rates of depletion, reason for the deterioration and remedial measures to restore it are the essential factors to assess the forest cover in any terrain. The inventory of forest resources and forest cover assessment and change detection in the rugged topography or hill sector is not an easy task and it is a time-consuming process. This can be made easier only through the high spectral, spatial and temporal resolution qualities of remote sensing techniques. Indeed, the precise database pertaining to forest cover information is an imperative input of formulating various management plans and also remote sensing technology can be effectively utilized for change detection and monitoring activities (Jessica *et al.,* 2001). According to Macleod and Congalton (1998), in general, remote sensing considers following four aspects of change detection (a) detect the changes, (b) identify the nature of change, (c) measure the aerial extent of change and (d) assess the spatial pattern of change. Earlier, many researchers have carried out the change analysis through visual or digital interpretation. Forest cover change detection has been done, through visual interpretation of satellite data by Unni *et al.* (1985), Roy *et al.* (1991a,b), Sukumar (1991), Porwal and Pant (1989), Kushwaha (1990). However, the following researchers Jessica *et al.* (2001), Pradhan and Awang (2008), Sakthive *et al*. (2010) Bharti *et al.* (2011), Hansen (2013) and Stibig *et al.* (2014) have done the forest cover change detection through computer assisted digital image processing (DIP) techniques. The basic principle of change detection through remote sensing is that the changes in spectral signatures

commensurate with the change in land cover. The detailed procedure is to superimpose two period maps to find the change (Jessica *et al.,* 2001). Moreover, the process of change detection is premised on the ability to measure temporal impacts (Sabins, 1987). According to Singh (1989), change detection is the process of identifying differences in the state of an object or phenomenon by observing it in different times (multi-temporal variations). It is evident that change detection can be precisely calculated using GIS technology and because of its high volume spatial and a spatial data handling capability. It enables to do overlay process with two or multi vector layers under single umbrella (Bhaduri *et al.,* 2009). Some of the researchers have identified that the increase in vegetation cover has resulted in increased rainfall (Sharma, 2001; Dengiz *et al.,* 2009) and decrease in forest cover has direct relationship with socioeconomic status and marginal worker force (Murali *et al.,* 2002). Forests are a dynamic feature on the land surface. As true for other covers, forests too change in time and space. The changes may be positive i.e., re-growth, plantations etc., or negative such as degradation and depletion of forests due to population pressure other unscientific practices etc.

The study area, Renuka Forest Division situated in Sirmour district **(Fig 1)**. It lies between 77º17´34´´ and 77º47´38´´ east longitudes and 30º31´11´´ and 30º52´16´´north latitudes. It is bounded on the North by Chopal and Rajgarh Forest Divisions; on the East by Chakrata Forest Division of Uttarakhand; on the West by Nahan Forest Division and on the South by Paonta Sahib Forest Division. The geographical area of the division is 987 sq. km. and forest area of 549 sq. km. There are five forest ranges in Renuka division namely Renuka, Sangrah, Nohra, Shillai and Kafota. The entire tract is mountainous and varies in elevation from 620m to 3647m msl. The entire region of Renuka Forest Division falls within the catchments of Giri, Sainj and Tons rivers.

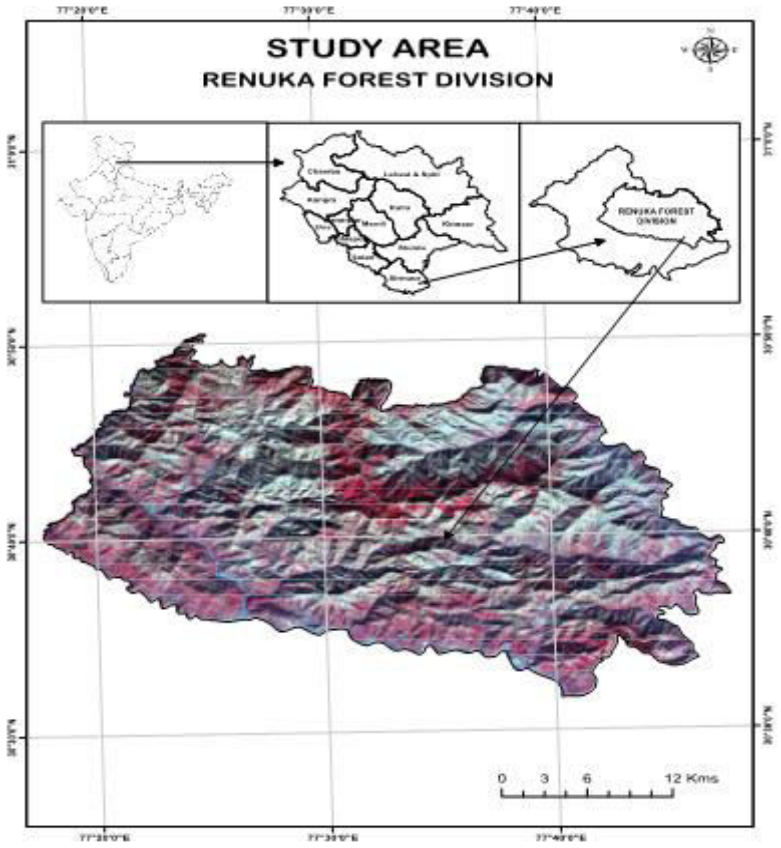


Fig 1

METHODOLOGY

In the present study, for assessing the temporal changes in the forest cover, the Landsat TM, Landsat ETM+ and Indian Remote Sensing Satellites (IRS) RESOURCESAT-2 were used. Moreover, the forest working plan reports and administrative maps were also taken into account. Digital image processing software Erdas Imagine 10 and ArcGIS 10 were used for the processing, analysis and integration of spatial data to reach the objectives of the study. The final maps which represent the forest cover changes during 1972, 1989, 2001 and 2011 were also generated.

Forest Cover of the Renuka Forest Division

The assessment of changes in forest cover, between 1972 and 2011 has been analysed with the help of remote sensing and geographic information system (GIS) (**Table 1**), in the Renuka forest division of Sirmour district. The trend of forest cover changes over the time span of 39 years has been examined.

Table: 1 Forest Cover of the Renuka Forest Division from 1972-2011

	Forest Cover 1972		**Forest Cover 1989**		**Forest Cover 2001**		**Forest Cover 2011**	
Forest Cover	Area in Sq.km.	% age	Area in Sq.km.	% age	Area in Sq.km.	% age	Area in Sq.km.	% age
Forest	610	61.80	634	64.24	558	56.53	549	55.62
Agriculture	178	18.03	115	11.65	102	10.33	190	19.25
Open Land/Grass Land/Shrub Land	190	19.25	230	23.30	320	32.42	242	24.52
Water Body	9	0.91	8	0.81	7	0.71	6	0.61
Total Area in Sq. km.	987	100.00	987	100.00	987	100.00	987	100.00

Source: Data calculated by author from satellite imageries of Landsat MSS, TM, ETM+ and RESOURCESAT-2

Forest Cover Changes of the Study Area from 1972-2011

In the study area **(Fig 2)**, forests, which were occupying 610 sq.km in 1972, is found to occupy 634 sq.km in 1989. The forests, which occupied cover in 61 percent for the study area in 1972 increased to 64 percent in 1989. All these observations clearly prove that during the period 1972-1989 forests have increased intensively due to efforts taken to restore and rehabilitate degraded areas by bringing them under massive afforestation, social forestry and fuelwood/fodder development programs.

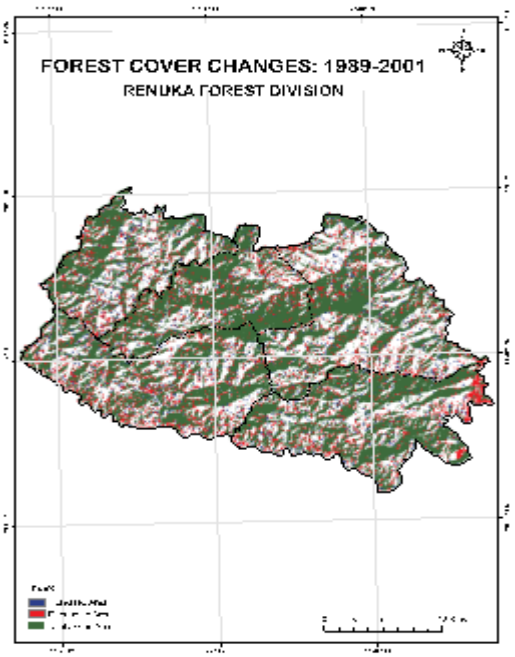


Fig 2

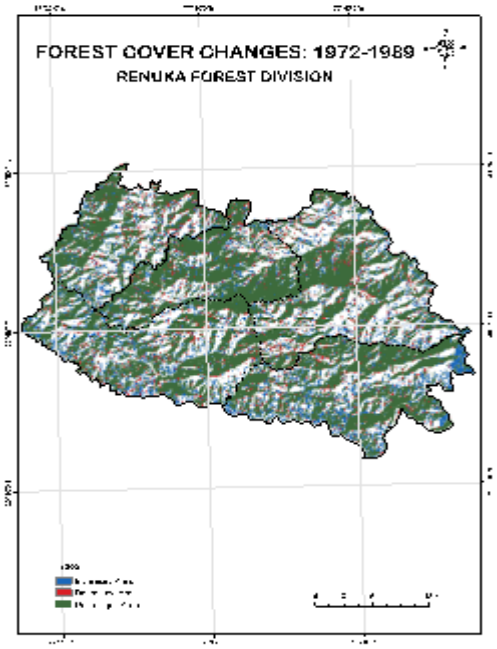


Fig 3

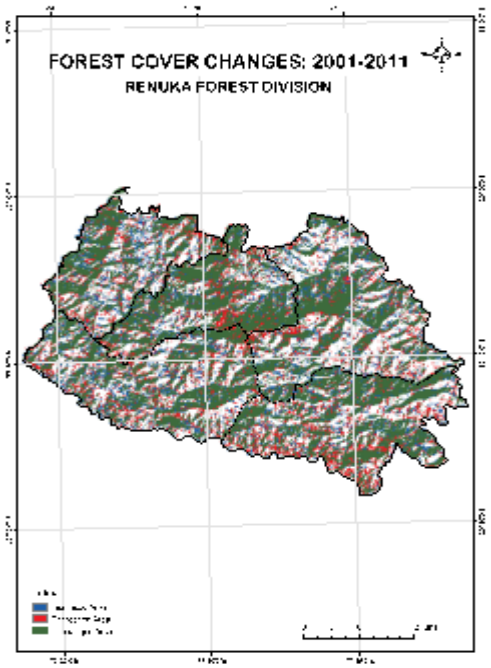


Fig 4

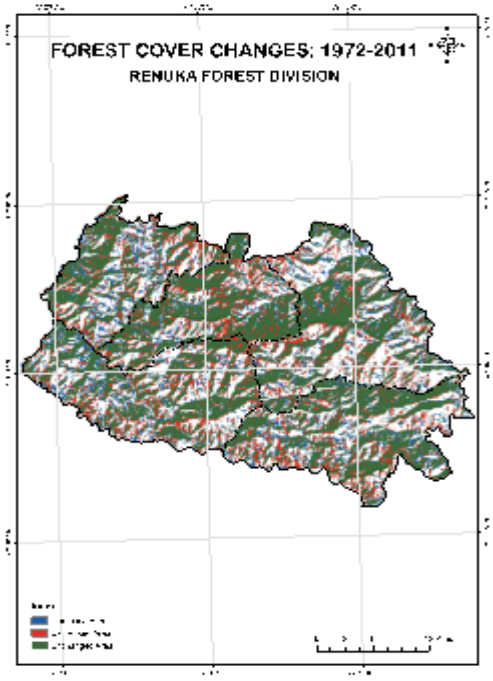


Fig 5

It also increased due to afforestation programme carried out by forest department mainly in Renuka range (Ghataun), Kafota range (Tatiyana), Shillai Range (Shri Kyari, Chyali, Bhatnaul, Kota Pab, Khatva, Milla, Jaswi, Lani, Baror, Dabar, Jarwa, Jakandon, Naipanjor, Tatwa Beyong), Sangrah Range (Daskana, Taikri, Panjah, Bhaltar, Lajwa, Arat, Ranphuwa, Uncha Tikkar) and Nohra Range (Manal, Chokar, Pipli, Bandal, Shilli, Bhangar, Bhangari, Nohra, Bhog, Charna, Ghandoori, Chunvi and Sail). In these forest ranges Deodar and Kail were planted. However, the natural growth in tree cover has been also noticed during the field survey.

In the study area, open land/grass land/shrub land, which occupied 190 sq.km. during 1972 got increased to 230 sq.km in 1989. In terms of percentage, open land/grass land/shrub land, which occupied 19 percent of the study area in 1972, got increased to 23 percent in 1989. Thus, it is clear that during the period 1972-1989, open land/grass land/shrub land have increased. This indicates that there was no human interference in the hill ecosystem during this period.

In the year 1989, the forests occupied 634 sq.km, which is about 64 percent of the study area and the open land/grass land/shrub land was 230 sq.km, which makes about 23 percent of the area **(Fig 3)**. The forests have been decreased to 558 sq.km, 56 percent in 2001. This shows the massive loss of forests as about 76 sq.km area of forests declined during the period 1989-2001. During the period 1989-2001 forests have decreased due to illegal encroachments by villagers and the forest cover in certain region has depleted at a faster rate as a result of over exploitation for meeting the daily human needs of fuel fodder and fibre. The decline in the forest cover has been the result of lopping and chopping for fuel wood and other purposes and growth of roads and other infrastructural facilities.

However, in 2001, open land/grass land/shrub land occupied 320 sq. km, covering about 32 percent of the study area about 90 sq. km area is occupied by open land/grass land/shrub land during the period 1989-2001. The analysis shows that during the period 1989-2001, open land/grass land/shrub lands have increased.

The forests, which were occupying 558 sq. km in 2001, is found to occupy 549 sq. km in 2011**(Fig 4)**, registering a decline of about one percent to total forest cover. The study reveals that this decline in forest cover may be attributed to intensive agriculture activities emerging due to growing human pressure. The field survey revealed that some of the areas have witnessed large-scale depletion and degradation of forest cover. The mention may be made of Charag, Ganu, Cho Boghar forests in Renuka Range, Khajuri, Jamna Pabar forests in Kafota Range, Balokothi, Koti Bonch, Kharkhan, Loja, Manal, Bandauli forests in Shillai Range and Jamal Nihog, Bhajond forests in Nohra Range. The open land/grass land/shrub land, has registered a sharp decline from 320 sq. km (32 percent) to 242 sq. km (24 percent) during 2001 to 2011.

It is also inferred that forests cover in the study area has also been notably changed from 1972 to 2011 **(Fig 5)**. It also indicates that the area under agriculture and human habitation has substantially increased. Extensive damage to forests has been also caused by open grazing of cattle by local people and nomadism; Gujjars coming from lower Shivalik of Sirmour district and shepherd coming from Kinnaur. These cattle not only damage the new saplings but also make the soil under their hoof compact and prevent new sprouting. Nomadic people practicing transhumance cause widespread damage to hill forests. The construction activities in the form of buildings, means of transport and communication, dams, installed hydropower projects and reservoirs and mining and quarrying have adverse impact on the forest lands. Commercial activities like resin extraction, oil extraction, fruit guarding and plantation also lead to massive deforestation. The massive encroachment has reduced the forest to few relict pockets. Due to excessive biotic pressure, heavy exploitation for the purpose of timber, fuelwood extraction, grazing and other local uses, the forest cover has been reduced and many areas are degraded. The forest cover in the region incurred major losses during last decade due to increase in population.

CONCLUSION

The present study is an integrated approach of remote sensing, GIS and analysis of socio-economic data used for forest cover changes. This study has showed the utility of satellite images and GIS to monitor changes in the forest cover of the study area. The result shows that most of the forest cover has been under the human pressure depleting and degrading its originality over the years. The forest cover changes study is of fundamental significance, as the

land resources play a strategic role in the determination of man's economic, social and cultural progress. In fact, the land use of a region is always characterized by the spatial variations and is profoundly influenced by physio-socio-economic factors. The study of forest cover changes in land use is important in the field of geography.

REFERENCES

1. Bharti, R.R., Ishwar, D.R., Adhikar, B.S. and Rawat, G.S. (2011) Timberline Change Detection Using Topographic Map and Satellite Imagery: A Critique, Tropical Ecology, **52**(1), pp 133-137.
2. Dwivedi, A.P. (1993) Forests, the Ecological Ramifications, Natraj Publishers, Dehradun, pp 14-15.
3. EOSAT (1992) Landsat TM Classification International Georgia Wetlands in EOSAT Data User Notes, EOSAT Company, Lanham, MD, (7) 1.
4. EOSAT (1994) EOSAT's State-wide Purchase Plan Keeps South Carolina Residents in the Know, in EOSAT Notes, EOSAT Company Lanham, MD, **9**(1).
5. Hansen, et al. (2013) High-Resolution Global Maps of 21st Century Forest Cover Change Science Magazine, **342** (6160), pp 850-853.
6. Hansen, M.J., Franklin, S.E., Woudsma, C. and Peterson, M. (2001) Forest Structure Classification in the North Columbia Mountains Using the Landsat TM Tasselled Cap Wetness Component, Canadian Journal of Remote Sensing, **27**(1) pp 20-32.
7. Jessica, P.K. et al. (2001) Forest Change Detection in Kalarani Round, Vadodara, Gujarat a Remote Sensing and GIS Approach, Journal of the Indian Society of Remote Sensing, **29,** pp 129-135.
8. Kennedy, R.E., Cohen, W.B. and Schroeder, T.A. (2007) Trajectory Based Change Detection for Automated Characterization of Forest Disturbance Dynamics, Remote Sensing of Environment, **110,** pp 370-386.
9. Khullar, D.R. (2010) India: A Comprehensive Geography, Kalyani Publishers, New Delhi.
10. Kushwaha, S.P.S. (1985) Environmental Monitoring and Cyclone Impact Assessment on Sriharikota Island, India, Project Report, National Remote Sensing Agency, Hyderabad.
11. Kushwaha, S.P.S. (1990) Forest Type Mapping and Change Detection from Satellite Imagery, ISPRS Journal of Photogrammetry and Remote Sensing, **45,** pp 175-181.
12. Kushwaha, S.P.S., Kuntz, S. and Oesten, G. (1994) Applications of Images Texture in Forest Classification, International Journal of Remote Sensing, **15**(11) pp 2273-2284.
13. Macleod, R.D. and Congalton, R.G. (1998) A Quantitative Comparison of Change Detection Algorithms for Monitoring Eelgrass from Remotely Sensed Data, Photogrammetric Engineering and Remote Sensing, **64**(3), pp 207-216.
14. Opeyem, A.Z. (2006) Change Detection in Land Use and Land Cover Using Remote Sensing Data and GIS: A Case Study of Ilorin and its Environs in Kwara State, M.Sc. Thesis, Department of Geography of Ibadan, Ibadan.
15. Ota, T. et al. (2011) Influence of Using Texture Information in Remote Sensed Data on the Accuracy of Forest Type Classification at Different Levels of Spatial Resolution, Journal of Forest Research, **16**(6), pp 432-437.
16. Pandey, A.C. and Nathawat, M.S. (2006) Land Use and Land Cover Mapping through Digital Image Processing of Satellite Data- A Case Study from Panchkula, Ambala and Yamuna Nagar Districts, Haryana State, India.

17. Pandian, M. et al. (2014) Land Use and Land Cover Change Detection Using Remote Sensing and GIS in Parts of Coimbatore and Tirupur Districts, Tamil Nadu, India, International Journal of Remote Sensing and Geoscience, **3**(1) pp 15-20.

18. Panigrahy, S.D. et al. (2010) Timberline Change Detection Using Topographic Map and Satellite Imagery, Tropical Ecology, **51,** pp 87-91.

19. Phong, L.T. (2004) Analysis of Forest Cover Dynamics and Their Driving Forces in Bach Ma National Park and Buffer Zone Using Remote Sensing and GIS, M.Sc. Thesis, ITC, Enschede, the Netherland.

20. Phung, T.T. et al. (2014) Impacts of Changes in Mangrove Forest Management Practices on Forest Accessibility and Livelihood: A Case Study in Mangrove- Shrimp Farming System in Ca Mau Province, Mekong Delta, Vietnam, Science Direct, **36**, pp 89-101.

21. Porwal, M.C. and Pant, D.N. (1989) Forest Cover Type and Land Use Mapping Using Landsat Thematic Mapper-A Case Study for Chakrata in Western Himalayas, Uttar Pradesh, Journal of the Indian Society of Remote Sensing,**17**, pp 33-40.

22. Pradhan, B. and Awang, M.A.B. (2007): Forest Fire Susceptibility and Risk Mapping Using Remote Sensing and Geographical Information Systems (GIS), Disaster Prevention and Management, 16(3): PP 344-352.

23. Roy, P.S and Giriraj, A. (2008) Land Use and Land Cover Analysis in Indian Context, Journal of Applied Sciences, **8**(8), pp 1346-1335.

24. Roy, P.S. (1991a) Tropical Forest Type Mapping and Monitoring, International Journal of Remote Sensing, **129**, pp 2205-2225.

25. Roy, P.S. (1991b) Forest Cover and Land Use Mapping in Karbi Analog and North Cachar Hills Districts of Assam Using Landsat MSS Data, Journal of the Indian Society of Remote Sensing, **19**, pp 113-123.

26. Sakthive. R, Manivel, J.R., Pugalanthi, R. and Vijay, A. (2010) Remote Sensing and GIS Based Forest Cover Change Detection Study in Kalrayan Hills, Tamil Nadu, Journal of Environmental Biology, **31**(5), pp 737-747.

27. Stibig, H.J. et al. (2014) Change in Tropical Forest Cover of Southeast Asia from 1990 to 2010, Biogeosciences, **11**, pp 247-258.

28. Sukumar, R. (1991) Long Term Monitoring of Vegetation in a Tropical Deciduous Forest in Mudumalai, South India, Current Science, **62**, pp 608-616.

29. Tansley, A.G. (1920) The Classification of Vegetation and the Concept of Development, Journal Ecology, **8**, pp 118-149.

30. Tansley, A.G. (1947) British Ecology during the Past Quarter Century: The Plant Community and the Ecosystem, Journal Ecology, **27**, pp 513-534.

31. Tiwari, M.K. and Saxena, A. (2011) Change Detection of Land Use/ Land Cover Pattern in an Around Mandideep and Obedullaganj Area, Using Remote Sensing and GIS, International Journal of Technology and Engineering System, **2**(3).

32. Unni, N.V.M. et al. (1985) Evolution of Landsat and Airborne Multispectral Data and Aerial Photographs for Mapping Forest Features and Phenomenon in a Part of Godavari Basin, International Journal of Remote Sensing, **6**, pp 419-431.

ISSUES OF SUSTAINABILITY AND MARKET EXTERNALITIES IN THIRD WORLD COUNTRIES

Jagdish Chauhan
Associate Professor, Department of Economics, Government College Bharli, District Sirmour H.P. 173025
chauhanjc@rediffmail.com

ABSTRACT

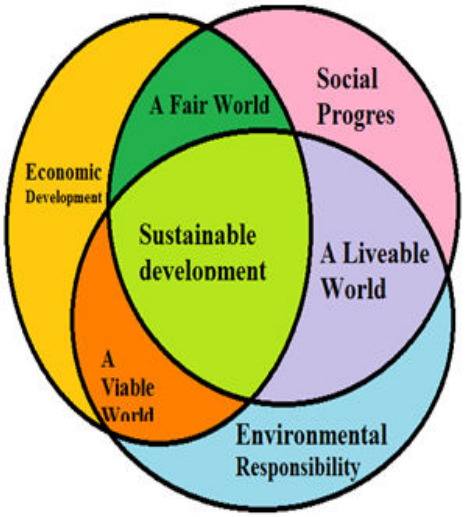
Sustainability envelops the fundamental canons of acquiring from the planet earth only what it can provide indefinitely thereby leaving future generations no less then what we have access to over selves. But in the wake of increasing marketization, the goal of sustainable development appears to be unattainable especially in the context of third world developing countries like India because of inherent failure of businesses to address and subside the large-scale negative externalities particularly in production. The present paper attempts to address the issue of sustainable development in the third world developing countries in the light of rising corporatization and intense inclination towards market. Forming a close linkage between sustainability, market failure and externalities, the paper asserts that India like developing countries may not perform well in addressing the issue of sustainable development primitively because market, due to its implicit profit orientation, cannot grapple with the detrimental environmental threats of business processes, and thus their negative by-products (CO_2 emission, fossil fuels; deforestation; water, air, sound pollution etc.) are over produced than the socially optimum level. Further, there is a trade-off between the objective of Economic Development and Sustainable Development in these countries since speedy economic development cannot be compromised in view of high incidence of poverty, hunger and unemployment. Also, the irresponsible human behavior consistent with low education, lack of awareness and rising population has posed a threat to sustainability in these countries. Lastly, some suggestions have been floated to ensure sustainability such as environmental taxation, financial penalties, enforcement of legislations regarding environmental standards, caps and trading schemes to limit carbon emission etc.

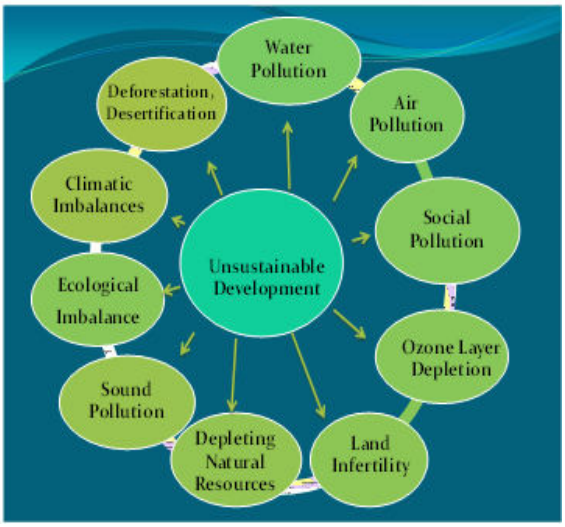
Keywords: Economic sustainability, Sustainable development, Carbon emission, Environment, Pollution.

INTRODUCTION

Sustainability envelops the fundamental canons of acquiring from the planet earth only what it can provide indefinitely thereby leaving future generations no less then what we have access to over selves. It implies the balance between environment, equity and economy. It is defined as: "the integration of environmental health, social equity and economic vitality in order to create thriving, healthy, diverse and resilient communities for this generation and generations to come. The practice of sustainability recognizes how these issues are interconnected and requires a systems approach and an acknowledgement of complexity." It is a state of living that is able to continue for long and thus looks to protect our natural environment, human and ecological health, while driving innovation and not compromising our way of life.

Sustainable development is all about ensuring the sustainability with development i.e., the development that sustains our natural resources, ecological and climatic balance. It is thus the development strategy that ensures the sustainability of a fair, livable and viable world with socio-economic progress having environmental responsibility thereby leaving the planet and its resources for the use of future generations.





Basically, the concept of Sustainable Development was first described by the 1987 Brundtland Commission, a UN Sub Organization, and formerly World Commission on Environment, that aimed to unite countries in pursuit of sustainable development, and to find the ways to reconcile economic development with environmental protection. The Brundtland Commission Report defines sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1] In the recent past, in October 2015, the UN General Assembly adopted a Resolution thereby launching a 2030 Agenda of Sustainable Development Goals (SDGs) as a set of 17 interlinked global goals and associated 169 integrated targets designed to be a "blueprint to achieve a better and more sustainable future for all."[2]

This Agenda, which is to be implemented by all countries and stake holders, is a holistic plan of action for humanity, planet and prosperity, and is intended to be achieved by the year 2030. The SDGs are in fact a call for action by all countries – poor, rich and middle income- to promote prosperity while protecting the planet. These SDGs include: No Poverty; Zero Hunger; Well Being; Inclusive Quality Education; Gender Equality; Clean Water & Sanitation; Clean & Affordable Energy; Inclusive Growth with Decent Work; Inclusive Industrialization with Resilient Infrastructure and innovation; Reducing Inequalities; Resilient Cities & Communities; Sustainable Consumption and Production Pattern; Climatic Security; Conservation of Life Below Water; Conservation of Ecosystem and Biodiversity; Peace, Justice and Inclusive Institutions; and Global Partnership for SDGs.[3]

Objectives and Importance of Study

Now the question arises- how a developing third world country like India will perform in view of these global SDGs since there is an intense drive for compulsive privatization to push the

[1] https://en.unesco.org/themes/education-sustainable-development/what-is-esd/sd

[2] UN General Assembly Resolution retrieved at https://en.m.wikipedia.org/wiki/Sustainable_Development_Goals

[3] United Nations, A/RES/70/1Transforming our world: the 2030 Agenda for Sustainable Development, 2015 at https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf

growth rate through market forces. Proponents of privatization are welcoming this move to promote the case for greater private sector participation, particularly in the global south. The recent proposal of the Govt of India to privatize the state-owned companies in the coming year is seen as an important step by the Government to achieve long term sustainable growth of the companies. This move needs to be taken a serious look at the history of the private sector leaving behind the most marginalized and vulnerable. This is particularly silent in the global context where investment treaties increasingly limit the ability of states to uphold human rights commitments when they are deemed to interfere with profits. It becomes therefore important to address the issue of sustainability in view of the large-scale externalities created on account of the market failure in these countries. The paper thus focuses on the under mentioned objectives:

1. To study the threats for Sustainable Development in the Developing World in the light of increasing drive towards privatization and External Diseconomies caused by the market failure.
2. Whether there exists a trade-off between Growth, Sustainability and Conservation?
3. To suggest a few policy measures that developing countries can resort to deliver for the Sustainable Development Goals.

Sustainability, Externalities and Market Failure

Externalities, also called the Neighborhood Effects, are the external effects of any business process which may be beneficial and detrimental. The positive external effects are called as External Economies or positive externality, and harmful external effects of such processes are termed as external diseconomies or Negative Externalities. "When the action of an economic decision-maker creates benefits for others, for which he is not paid, there occurs an external economy for others (and the economy as a whole). When the action of an individual agents creates costs for others for which he does not pay, there occurs an external diseconomy for the other (and the society as a whole)".[4]

Since there has been unplanned and unregulated exploitation of the world's natural resources, the threat to sustainability is inevitable. Further in view of the shift towards increased reliance on businesses and market forces, the issues of achieving SDGs have become more challenging. The market regulated economies are governed by the fundamental principle of profit motive, competition. self-interest, private property with limited or no government intervention. The basic intent remains confined to profit and productivity with intense cut-throat competition without addressing the socio-economic objectives of public policy along with welfare and sustainability issues of the country. Competition wipes out the disadvantaged (older aged, children and physically challenged) having inherent competitive disadvantage. Market driven economy hardly cares for the vulnerable and deprived since it reflects the values for winners only. "A market economy may produce private jets for some people while others have no food or place to call home"[5]

In the absence of imperative government intervention, when externalities exist, market prices do not reflect the full costs or benefits in the production or consumption of a good. Basically, market efficiency and social optima in production is ensured if production costs of negative by-products include both private costs and the social costs as well. The inclusion of social or marginal external cost raises the production costs thereby restraining these products from getting overproduced and over consumed. Also, the products are made available for society at

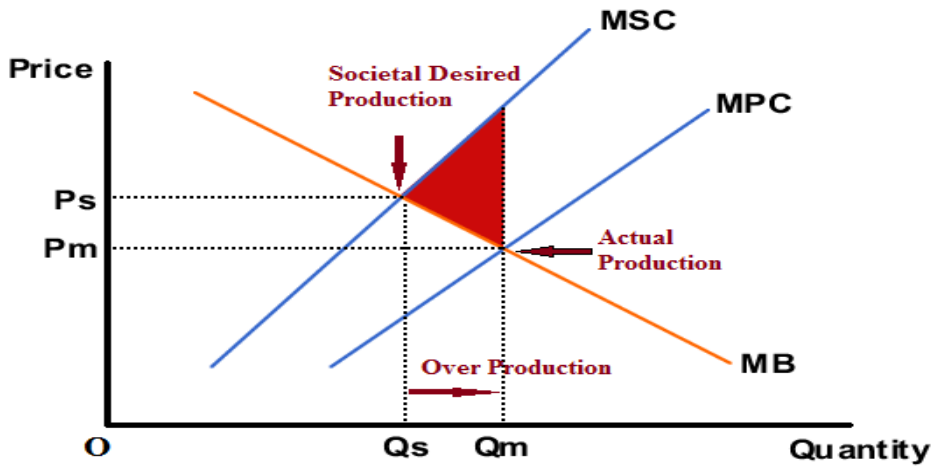
[4] Koutsoyiannis, A., Modern Microeconomics, Macmillan, London (1979), p 541.

[5] Amadeo, Kimberly, "What is the Market Economy? At https://www.thebalance.com/market-economy-characteristics-examples-pros-cons-3305586#toc-cons-explained

higher prices. But due to the structure of markets, it may be impossible for them to be perfect. Reasons for market failure include: positive and negative externalities, environmental concerns, lack of public goods, under-provision of merit goods, overprovision of demerit goods, and abuse of monopoly power. Externalities thus lead to market failure because a product or service's price equilibrium does not accurately reflect the true costs and benefits of that product or service.

Negative Externalities especially in production causes divergence between Private Costs and Social Costs. Due to the profit –oriented production processes, the private enterprise determines the price of products on the basis of their private marginal costs and thus excludes the marginal environmental/social costs in terms of negative by-products e.g., noise, air and water pollution; excessive emission of greenhouse gases etc. Since private enterprises do not include this external social and environment costs, the products creating the threats to sustainability are over produced and are made available at low price thereby resulting in overconsumption. Thus, the whole external environmental costs are borne by and shifted to the society and the future generations.

In the case of external costs, such as pollution, producers may not bear all the societal costs of production, and this would translate to lower prices to consumers than they should pay. A company causing pollution as a by-product could profit by not paying the true cost of managing its waste, and others (the broader public) would be burdened by the costs—including loss of natural resources, loss of pleasure from the environment because of environmental degradation, and public health problems caused by the pollution. Oil and oil sales and consumption can have high external costs to society beyond the price charged by the oil company. The pollution from oil use has external costs and oil use can increase dependency on foreign resources, including on foreign countries with repressive governments. The over-production and overuse of fossil fuels raises environmental as well as economic concerns, since coal, petroleum, and natural gas contain high percentages of carbon, the burning of which generates greenhouse gasses (GHGs) such as Carbon Dioxide contributing to the process of global warming.



Market Failure and Over Production of Negative Externalities

For market efficiency, consumers should pay the full costs, private and social as well, of the products and services they consume. If an individual or business does not pay the full (private and social) costs of goods and services they consume, this would cause a good to be overproduced and over consumed while pushing additional costs on to individuals not involved in the transaction. "Negative externalities usually come at the cost of individuals, while positive externalities generally have a benefit. For example, a crematorium releases toxic gases

such as mercury and carbon dioxide into the air. This has a negative impact on people who may live in the area, causing them harm. Pollution is another commonly known negative externality. Corporations and industries may try to curb their costs by putting in production measures that may have a detrimental effect on the environment. While this may decrease the cost of production and increase revenues, it also has a cost to the environment as well as society".[6]

Presence of negative externalities in the production processes caused by the market failure leads to the over production of the product causing external harms since producers to minimize cost and price, don't pay the social cost of such negative byproducts, may be air pollution, noise pollution, water pollution, soil infertility on account of excessive use of chemicals, water scarcity, deforestation, biodiversity loss and CO_2 emissions etc. So, in view of the increasing marketization of the developing economies, these negative by-products which are a serious threat for the sustainability, are further likely to be over-produced and over consumed than desired by the planet.

Dilemma of Sustainable Development in Third World Countries

The threat for the Sustainable Development has largely been posed by the Developed Countries mainly because of the excessive emission of Green House Gases especially CO_2, but developing countries are mandatorily required to deliver for the issues of sustainability through appropriate policy measures. But the principal challenge for Sustainable Development is the dilemma of developing nations who seek a faster economic growth for the elimination of poverty, hunger, inequality, unemployment and social injustice without further impacting the global environment. Therefore, the issues of sustainable development in the developing country like India needs to be addressed in the light of the existing socio-economic ills e.g., abject poverty, mass unemployment, social injustice and high population growth.

High incidence of Poverty and open unemployment in the developing world are major threats to the sustainable development since poor and unemployed persons are overexploiting the natural resources to earn livelihood e.g., over exploitation of land and water resources. The depletion and degradation of natural resources are posing serious challenges not only to produce enough food and other agricultural products to sustain local livelihoods, but also to meet the needs of urban populations which rely on this supply. So there appears to be a trade-off between Economic Development and Sustainable Development in these countries since Sustainable Development cannot be achieved by compromising economic development and without reducing poverty, unemployment, hunger, malnutrition, inequalities and social injustice.

These socio-economic ills, which themselves are creating negative externalities for Sustainability, if addressed through rapid growth and productivity i.e., through conventional model of growth and development, will further take away these countries from achieving the goal of Sustainable Development. Also, there is a Conflict between Economic Development and Conservation. As rapid economic development goes on, more and more natural habitats will be depleted and will ultimately limit or even inhibit economic development. Further, human population has been growing exponentially in the developing countries. Increased population growth has put increased pressure on food production, land masses, water body, transportation and biodiversity losses etc. Meeting the needs of the global population initiates all the subsequent problems. "Understandably, all the demands resulted from the increased population lead to the stress on the existing resource, depletion of the non-renewable resources and

[6] Rathburn Pete, "How Do Externalities Affect Equilibrium and Creates Market Failure? At https://www.investopedia.com/ask/answers/051515/how-do-externalities-affect-equilibrium-and-create-market-failure.asp

imbalance of the natural integrity".[7] Therefore, the global population needs to be proportionate with the natural resources.

Now the dilemma is, "What should be the priority in LDCs?". Should it be development and economic growth targeting not only the faster productivity along with effectively addressing the socio-economic ills such as poverty, hunger and social injustice? or, should it be a reduction of CO_2 emissions for protecting humanity from the destructive consequences of climate change? We are living in a critical time. We stand today at a crossroad. While the developed nations are responsible for this situation, developing nations have been left to act responsibly and find solutions to come out of this dilemma of sustainable development.

Strategy and Suggestions for Sustainable Development

Sustainable Development is, a historic opportunity for the world communities- both developed and developing) to deliver inclusive growth, eliminate poverty and reduce the risk of climate change by changing perspectives and approaches to economic development. It entails everyone to participate in making efforts to achieve sustainable development. The following are some of the suggestions and strategies that developing countries can pursue to deliver for the issues of sustainability: -

1. Issues of Economic Development i.e., poverty, unemployment and high population growth etc. needs to be addressed at the priority basis by the national governments of developing countries. Because of their continuously high fertility rates, the developing countries like India will continue to see the number of youth and adolescents rising. A growing share of young and productive population presents opportunities for reaping a demographic dividend. However, this dividend will pay out only if these countries can create employment opportunities, which will be a major challenge for least developed countries in the decades ahead.

2. There is also a strong scientific consensus that global warming is induced by human behaviour, predominantly by fossil fuel use and, to a smaller extent, by changes in land use and deforestation. Climate change poses numerous and stark challenges for sustainable development. Degree of vulnerability will vary even more, with developing countries and the poor, which have contributed the least to global warming, likely to suffer the most. The increased concentration of greenhouse gases in the atmosphere—most importantly, CO_2—is leading to a warming of the planet. National governments can respond to negative externalities of production and to resource depletion and CO_2 pollution using a number of mechanisms designed to reduce emissions of global greenhouse gases and promote sustainability. These include: environmental taxation, such as carbon taxes, to recover the external costs of pollution; legislation setting environmental standards and banning firms which fail to meet these standards. Taxation and financial penalties increase the market price of carbon. This provides strong incentives to reduce carbon emissions by sending signals to **consumers** about what goods and services produce high carbon emissions and which should be used more sparingly; to **producers** about which inputs emit more carbon, and which emit less, so encouraging them to move to lower-carbon technologies; and to **inventors and innovators** to develop and introduce lower-carbon products and processes.

3. Caps and Trade Scheme needs to be introduced effectively to reduce the emission of greenhouse gases. A cap (upper limit) and trade scheme is a market-based approach to reducing carbon emissions through financial incentives. It's a system designed program to limit, or cap, the total level of emissions of certain chemicals, particularly carbon dioxide, as

[7] Patwary, Sarif, "Environment Sustainability and Current Threats", at https:// www.linkedin.com/pulse/environmental-sustainability-current-threats-sarif-ullah-patwary

a result of industrial activity. The government issues a set number of permits to companies that comprise a cap on allowed carbon dioxide emissions. Companies that surpass the cap are taxed, while companies that cut their emissions may sell or trade unused credits to those who already have reached the emission limits. The total limit (or cap) on pollution credits declines over time, giving corporations an incentive to find cheaper alternatives. Further, the government lowers the number of permits each year, thereby lowering the total emissions cap. This makes the permits more expensive. Over time, companies have an incentive to invest in clean technology as it becomes cheaper than buying permits.

4. Promoting Clean and Green Technologies e.g., recycling, renewable energies (wind and solar power, biomass and biofuels and hydropower), green transportation, waste water recycling and energy efficient lighting, homes, buildings, electric motors and commercial and domestic appliances. Further, nations should increasingly resort to the Green Growth Strategy of inclusive sustainable development- a sustainable growth strategy that incorporates environmental issues such as efficient and appropriate use of land, energy, water and other resources, conservation of significant habitats, endangered species along with our archeological treasure. "Green growth is necessary, efficient, and affordable. It is the only way to reconcile the rapid growth required to bring developing countries to the level of prosperity to which they aspire with the needs of the more than 1 billion people still living in poverty and the imperative of a better managed environment".[8]

Shift towards Market Economy and Big Businesses are, however, an increasing Global Phenomenon, even the developing countries should not follow the LPG model blindly. Further, Business, as usual, will not help us to get the future we want. It is therefore critical for companies to change the purpose of doing business which expects them to make profits with a greater social and environmental responsibility than ever before. So, while well-thought-out policies by developing countries will make growth and climate objectives mutually reinforcing in the short and long term, businesses will be required to make investments in the drive to low carbon economy. And, we as individuals also have to grow into responsible consumers by committing to a changed lifestyle. If we do not act now, we will be delayed to reverse the impact.

CONCLUSION

In essence, in can be concluded that in the wake of increasing marketisation, the goal of sustainable development appears to be unattainable especially in the context of developing countries like India because of inherent failure of businesses to address and subside the large-scale negative externalities particularly in production. The paper has attempted to address the issue of sustainable development in the developing countries in the light of rising corporatization and intense inclination towards market. Forming a close linkage between sustainability, market failure and externalities, it is argued that India like developing countries may not perform well in addressing the issue of sustainable development primitively because market, due to its implicit profit orientation, cannot grapple with the detrimental environmental threats of business processes, and thus their negative by-products (CO_2 emission, fossil fuels; deforestation; water, air, sound pollution etc.) are over produced than the socially optimum level. Further, there is dilemma of Economic Development and Sustainable Development in these countries since speedy economic development cannot be compromised in view of high incidence of poverty, hunger and unemployment and social injustice. Also, the irresponsible human behavior consistent with low education, lack of awareness and rising population has posed a threat to sustainability in these countries. Therefore, to deliver for global goal of

[8] World Bank (2012), Inclusive Green Growth: The Pathway to Sustainable Development, World Bank Publications, Washington DC (2012) p xii.

sustainability it is suggested that assertive governments should enforce some measures such as environmental taxation, financial penalties, enforcement of legislations regarding environmental standards, caps and trading schemes to limit carbon emission and adoption of green growth strategies etc. accompanied by major steps to address the threats of poverty, unemployment and high population growth.

REFERENCES

1. Amadeo, Kimberly (2021), "What is the Market Economy? at https:// www. The balance. com/market-economy-characteristics-examples-pros-cons-3305586#toc-cons-explained
2. Koutsoyiannis, A. (1979), Modern Microeconomics, Macmillan, London.
3. Patwary, Sarif (2016), "Environment Sustainability and Current Threats", at https:// www.linkedin.com/pulse/environmental-sustainability-current-threats-sarif-ullah-patwary
4. Peet, John (2021), "Sustainability-A Scientific Dilemma", at https:// www. cambridge. org/core/books/abs/sustainable-development-asiapacific-perspectives/sustainability-a-scientific-dilemma/61BA14F808416117F5929DACAB067CB1
5. Rathburn, Pete (2021), "How Do Externalities Affect Equilibrium and Creates Market Failure? at https://www.investopedia.com/ask/answers/051515/how-do-externalities-affect-equilibrium-and-create-market-failure.asp
6. Stiglitz, Joseph E (2002), Globalization and Its Discontents, W.W. Norton & Company, New York.
7. Sustainable Development, at https://en.unesco.org/themes/education-sustainable-development/what-is-esd/sd
8. Sustainable Development Goals, at https:// en.m. wikipedia. org/ wiki/ Sustainable_ Development_Goals
9. Todaro, Michael P. (1989), Economic Development in Third World, Longman, New York.
10. United Nations (2015), A/RES/70/1Transforming our world: the 2030 Agenda for Sustainable Development, at https:// www. un.org/ en/ development/ desa/ population/ migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf
11. What is Sustainability? at https://www.sustain.ucla.edu/what-is-sustainability/
12. World Bank (2012), Inclusive Green Growth: The Pathway to Sustainable Development, World Bank Publications, Washington DC.

PLANTS USED TO TREAT SKIN AILMENTS BY ETHNIC PEOPLE OF PAONTA SAHIB, DISTRICT-SIRMOUR, HIMACHAL PRADESH, INDIA

Jaswant Singh Saini[1] and S.K. Sood[2]
[1]Associate Professor, Department of Botany, Swami Vivekanand Government College Ghumarwin, District Bilaspur, Himachal Pradesh- 174021, India
[2]Former Chairman, Department of Biosciences, Himachal Pradesh University, Shimla-171005
[1]jssainibot@gmail.com

ABSTRACT
Skin is the outermost defense organ of our body. It protects us from harmful diseases. Pathogen favourable environmental conditions and weak immune system can lead to infection which may not cause death but if overlooked, it interferes with healthy lifestyle. The present study undertaken is to reveal the importance of several plants which are used to treat skin diseases by the local residents around the villages of Colonel Sher Jung National Park, Simbalbara, Paonta Sahib, Sirmour, Himachal Pradesh, India.

The study revealed that 53 genera and 62 species belonging to 36 families for the treatment of skin ailments were recorded, and dominant life form utilized was shrub while the preferred method of utilization was poultice, along with leaf as the most used plant part. The highest family importance value was recorded for the family Zingiberaceae and relative frequency citation values range from 0.04 to 0.48% and fidelity level value ranges from 5.37% to 100%. Plants with high use value can be considered for further scientific analysis and to create awareness among locals for the preservation and bring more of these plants in agro-cultivation practices.

***Keywords**: Ethnomedicine, Paonta Sahib, skin ailment, medicinal plant, National Park.*

INTRODUCTION
Adornment and using beauty care products to protect the skin is natural instinct of every individual on the planetas beauty boosts an individual's self-confidence, makes one proud and fills the life with joy. According to citation by world health organization (2020), if tropical diseases of skin areneglected, one's fragile health system can lead to psychological problems, stigmatization, exclusion and distress. Our ancient Indianliterature emphasizes the use of herbal treatment along with physical exercise for balancing the bodily system. Whereas in China the earliest records of skincare in the Far East come from the Shang Dynasty. They are known to use facial massages, a diet of black beans, sesame (*Sesasum*) seeds, and Chinese yams, and cleansers made from seaweed and jellyfish. Similarly, the ancient Romans, Greeks, and Egyptians are also found to use many common plants in combination such as a mixture of Aloe, Myrrh, and frankincense to cure skin blemishes and acne, and purifying facial mask made from honey and milk. They also used to prepare moisturizingcream by mixing castor (*Ricinus*), sesame, and Moringa oils, and soapy paste with clay and olive oil as a facial cleanser and makeup remover; and exfoliant by adding sea salt.

The term **cosmetology** is used for the study and application of beauty treatment in Unani system, which has its traditional root in Indian system since long and it is in practice in South Asian, African and Arabian countries. The **cosmetology** is the study or art of cosmetics and their uses or the science of practice of beautifying the skin, face, hairs and nails etc. The word cosmetics means any single substance or compound product intended for local application on external parts of human body or teeth and mucosal membrane of oral cavity for the purpose of beautification. It helps in presenting and enhancing the beauty and personality aspect of human being. Raymound Reed (a member of U.S. Society of Cosmetic Chemist) first uses the word

'**cosmeceutical**' to address the substances having scientific cosmetic property in 19th century. This term was popularized by Dr. Albert Kligman. The term '**cosemtics'** (Greek – 'kosmeticos') pertains to beautifying substance or 'kosmein' means 'decoration' which is related to the preservation, restoration or bestowing the bodily beauty and the surgical correction of disfigured physical defect. The definition of **cosmetics** according to encyclopedia Britannica is 'any preparation that are applied to human body for beautifying, preserving, or altering the appearance or for cleansing, colouring, conditioning, or protecting the skin, hair, nails, lips, eyes or teeth'.

The Unani literature emphasizes the use of heena (*Lawsonia*), turmeric (*Curcuma*), sandal surkh (*Pterocarpus*), elwa (*Aloe*), agaru (*Aquilaria*), etc. Numbers of evidence prevails of extremely superior ideas of self-beautification and a greatrange of varied cosmetic usages by both genders, in ancient India (Patkar, 2008) in which many plants directly or indirectly satisfy the basic requirement for the skin care needs. The Himalayas are naturally having a vast repository of unique plants and traditional knowledge associated with them. Dermatological important plant species have been reported in different parts of Himachal Pradesh(Lahaul-Spiti: Lal & Singh, 2008;Kangra: Kaushal *et al.*, 2016;Pacchad (Sirmaur): Sharma & Rana, 2016; Mandi: Sidhu & Thakur, 2017 and Verma & Kanwar, 2019).Similar attempt has been done from other parts of India and World (Upadhyay *et al.,* 1998; Dilara & Nath, 2000; Saikia *et al.*, 2006; Korpenwar, 2012; Kumar *et al.*,2012; Mutyala Naidu *et.al.*, 2015; Mowobi *et al.*,2016;Panda and Mishra, 2016; Saini and Sood, 2017; Mahato *et al.,* 2018; Kianifar, 2019; Malik *et al.*, 2019;Ghalme, 2020; Mudang *et al.*, 2020 and Singhal *et al.*, 2020). Sood *et al*. 2011 has compiled very useful information on 831 species of Indian Herbs belonging to 559 genera and 161 families for perfumery and beauty care.

Indigenous health care system was more acceptable because of its easy availability, cost–effectiveness and proven efficacy over ancient time. In recent years, there has been amazing curiosity in the medicinal plants especially those used in Ayurveda and other traditional system. In some parts of Himachal Pradesh, the indiscriminate use and over exploitation of some medicinal plants put undue pressure on many species that are on the verge of extinction (Goutam, 2022). There is an urgent need to document the ethno biological knowledge presently existing among the diverse communities before it's lost completely (Rao, 1996). Thus, the effort of present study related to the first quantitative ethnobotanical study of remedial plants by interviewing the natives of Paonta Sahib, Sirmour for various skin ailments has been made.

MATERIAL AND METHODOLOGY

Study Area

The present investigation was undertaken in and around Colonel Sher Jung National Park (CSJNP) Simbalbara which is located in Paonta valley of district Sirmour, Himachal Pradesh within Geographical coordinates North - 30028'13''N & 77028'43''E, East - 30024'15''N & 77033'55''E, South - 30023'31''N & 77033'44''E and West - 30027'26''N & 77027'40''E, having an area of 27.88 sq km with an altitudinal range of 350-700m above mean sea level (Figures 1 & 2). The national park is located at the junction of the four states viz. Uttarakhand, Uttar Pradesh, Haryana and Himachal Pradesh, at the confluence of plains and the main Shivalik range in Western Himalaya in India, and it shares boundaries with three protected areas of two different states namely Kalesar National Park of Haryana towards the South and Rajaji National Park of Uttarakhand towards the East (Figure 3). The temperature of area ranges from 4°C - 48°C and receives a mean annual rainfall of about 1260 mm while the relative humidity varies from 100% during monsoon to 26% in summer. The hills are composed of unconsolidated siltstone, sandstone and conglomerate that are more susceptible to erosion. The area is also traversed by two perennial streams which join at Simbalbara to form Nimbuwala khol. Beside there are as many as 32 small annual streams that contribute to the drainage system of the

national park. The protected area was notified as a game sanctuary for the first time on February 8, 1958. Thereafter, it has been declared as Simbalbara wildlife sanctuary (WLS) on March 27, 1974 comprising an area of 19.00 sq km. Later on, state Government keeping in view the purpose of protecting, propagating and developing wildlife and its environment, upgraded the existing WLS into National Park Simbalbara by adding 8.88 sq km on June 07, 2013. After rationalization presently the total protected area of CSJNP is 27.88 sq km (Figure 3). The vegetation of the national park is mainly composed of thick Sal (*Shorea*) forests, and other deciduous species of tropical and sub-tropical origin like *Diospyros melanoxylon, Eucalyptus tereticornis, Mallotus philippinensis, Syzygium cumini, Terminalia tomentosa*, providing food and shelter to microbes, non-chordates and the chordates. Eco-sensitive zone outside the national park with thick forest cover serves as an additional protective corridor for the wildlife.

People and Landuse

Trans-nomadic Gujjars are the foremost people residing around the park with their massive livestock and they migrate from the lowland plains in the winters to the upper hills of Himachal Pradesh during the summer season. Their economy depends mainly on selling milk and dairy foodstuffs. They speak 'Gojri' and have distinctive ethnicity, arts and crafts and food habits. Besides, there are as many as 50 small villages on its fringe. People residing in the vicinity of the study region belong to a diverse caste, creed and religion. The major activities of local populace are agricultural practices and pastoralism for which they predominantly depend upon the forest wealth particularly on fodder, fuel wood and for their primary healthcare needs.

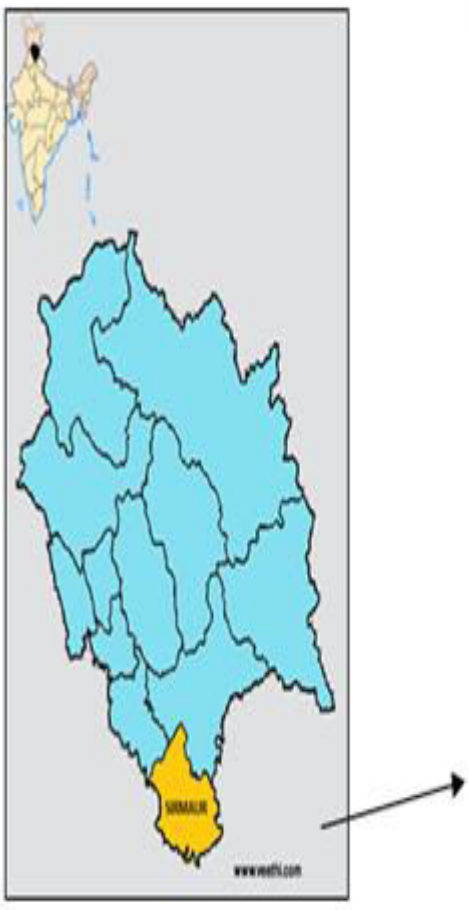


Figure 1: Location map of Himachal

Figure 2: Map of Sirmour District Pradesh in India

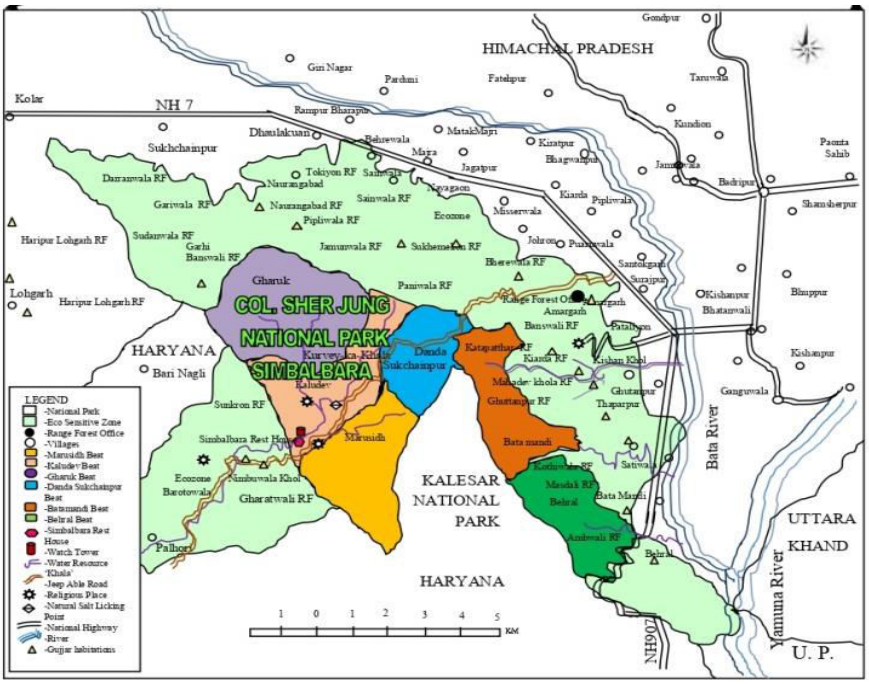


Figure 3: Detail map of Col. Sher Jung National Park Simbalbara, Paonts Sahib, Distrit Sirmour (H.P.)

Field Exploration and Datacollection

In order to collect data, field tours to these areas were made as per the procedure delineated by Schultes (1962) and Jain (1967, 1989). The duration of each visit in different seasons was of 2-3 months. A firsthand account of ethno botanically interesting species either in flowering or fruiting stage was taken. Local informants were contacted for getting a better understanding of skin care plant species through a semi-structured questionnaire, interview and group discussions. Photographs of the plants were clicked in the natural habitat. The data collected was verified and cross-checked by showing herbarium specimens/photographs to various informants and even to the same informants on different occasions. The species was identified with the help of treatises on Indian flora and carefully matched with authentic specimens housed in the herbarium of Northern Circle of Botanical Survey of India and F.R.I., Dehradun. The vernacular (local) name(s) and the name of the families have also been provided along with the valid botanical names that were confirmed from Chaudhary & Wadhwa (1984), Kaur & Sharma (2004). For further authentication IPNI (The International Plant Name Index- http://www.ipni.org) and the plant list (www.theplantlist.org) were also consulted.

Quantitative Dataanalysis

The collected data was analyzed with quantitative tools viz. Fidelity Level (FL), Family Importance Value (FIV), Use Value (UV) and Relative Frequency Citation (RFC).

Fidelity level signify the comparative importance over another species, it is calculated by the percentage of informants reporting the usage of particular plant in relation to particular disorder. Friedman *et al.,* 1986 given the formula [FL (%) = $N_P/N * 100$] in which Np represents the number of informants that declare the usage of species for particular diseases, and N is the total participants that use plants as medicines for the treatment of any given ailment.

The **Use Value (UV)** was calculated by using the formula UV = (ΣU/n), where U represents the total number of use reports per species and 'n' represents the total number of participants interviewed for a given plant (Phillips *et al.*, 1994). Value ranges in between 1 to 0. High UV indicates that specific plant species have high preference over other species in the region.

According to Vitalini *et al.,*2013, the **Relative Frequency Citation (RFC)** signifies the local importance of each species in a study region andcalculated by the formulae: RFC=FC/N (0<RFC<1). This index is determined by dividing the number of informants citing a useful species (FC) by total number of informants in the survey (N).

RESULTS

Total 205 individuals that is 55 females and 150 males of different age groups (from 25 to 50, 50 to 75, and above 75) were willing to share the information for skincare needs from the study area. The data recorded revealed the usage pattern of 62 plant species (02 monocots, 60 dicots) belonging to 53 genera (02 monocots, 51 dicots) under 36 families (02 monocots, 34 dicots) against 10 types of prevailing skin ailments (abscesses, acne, boils, blisters, skin irritation, cracks, eczema, itches, pimples, sun burn). The dominant life form utilized is shrubs (25 species) followed by trees (22 species) and herbs (15 species). Leaves formed the plant part which was extensively used preferably as poultice but also used as powder and paste on the affected skin. All plants were used in crude form, generally from fresh raw material. From usage perspective, the utilitarian families are represented by Euphorbiaceae and Fabaceae, (5 species each), Solanaceae (4 species), Malvaceae, Moraceae, Rutaceae (3 species each), Apocynaceae, Asclepiadacae, Asteraceae, Chenopodiaceae, Combretaceae, Lamiaceae, Meliaceae Menispermaceae, and Rubiaceae (2 species each) and Acanthaceae, Adoxaceae, Amaranthaceae, Annonaceae, Bixaceae, Brassicaceae Cactaceae, Convolulaceae, Crassulaceae, Dipterocarpaceae, Lytharaceae, Martyniaceae, Oxalidaceae, Papaveraceae, Rosaceae, Salicaeae, Sapotaceae, Urticaceae, Verbenaceae, Xanthorrhoeaceae and Zingiberaceae (1 species each).

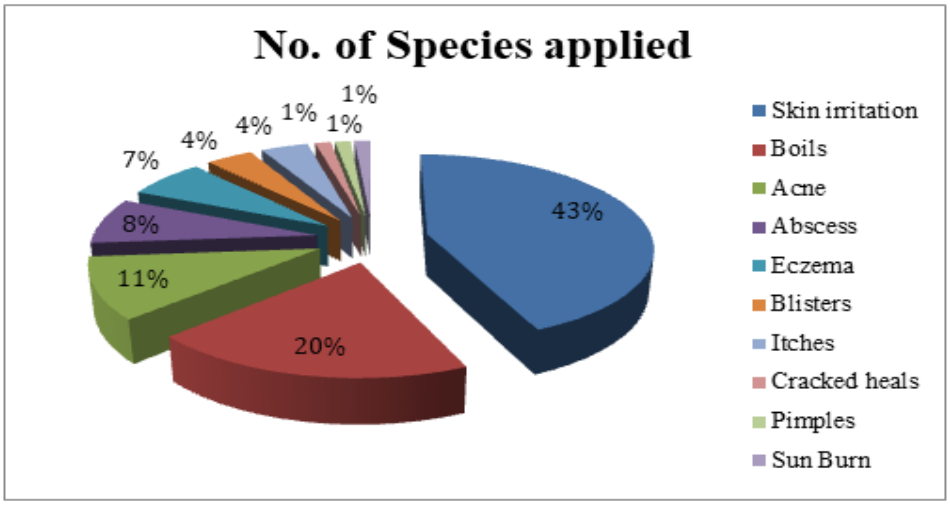


Figure 4: Percentage of species used for the cure of various skin ailments

The information gathered from all the respondents (Table 1), showed that the most prevalent skin ailment among them isgeneralskin irritationfollowed by boils, acne, abscesses, eczema, blisters, itches, cracks, pimples, sun burn for the cure of which 53 genera, 62 species were used. Maximum 33 species i.e. 43% (*Achyranthes aspera, Argemone Mexicana, Azadirachta indica, Brassica rapa, Butea monosperma, Calotropis gigantea, C. procera, Cereus hildmannianus, Chenopidium album, C. murale, Cissampelos pareira, Clerodendrum infortunatum, Cyanthillium cinereum, Euphorbia hirta, E. pulcherrima, E. royleana, Ficus carica, Ipomea carnea, Jatropha curcus, Justicia adhatoda, Kydia calycina, Lawsonia inermis, Nerium oleander, Senna obtusifolia, S. occidentalis, Shorea robusta, Spilanthes acmella, Terminalia bellirica, Tinospora sinensis, Toona ciliate, Vitex negundo, Withania somnifera, Zanthoxylum armatum*) are utilized for general skin infection, followed by boils 20%,15 species (*Aloe vera, Annona squamosa, Bryophyllum pinnatum, Datura metel, D. stramonium, Hibiscus rosa-sinensis, Holarrhena pubescens, Oxalis corniculata, Populus deltoids, Prosopis juliflora,*

Ricinus communis, Sida acuta, Solanum anguivi, Terminalia arjuna, Wendlandia heynei), Acne 11%, 8 Species (*Aloe vera, Annona squamosa, Azadirachta indica, Citrus aurantiifolia, C. aurantium, Curcuma longa, Dalbergia sissoo, Rosa indica*), Abscess 8%, 6 species (*Artocarpus heterophyllus, Calotropis procera, Catunarega, spinosa, Duranta erecta, Kydia Calycina, Martynia annua*), Eczema 7%, 5 species (*Boehmeria macrophylla, Calotropis gigantea, Euphorbia pulcherrima, E. royleana, Ipomea carnea*), Blister (*Aloe vera, Azadirachta indica, Bixa orellana*) and Itches 4%, 3 species (*Lawsonia inermis, Madhuca longifolia, Solanum anguivi*) each, and one species each for Cracked heals (*Ficus religiosa*), Pimples (*Azadirachta indica*), and sun burn (*Sambucus nigra*).

Table 1: Plants used for skin diseases in fringe villages of Colonel Sher Jung National Park, Simbalbara, Paonta Sahib (H.P.)

Disease	Botanical Name	Vernacular Name	Family	Habit	PU	U	FL	UV	RFC
Abscess	*Artocarpus heterophyllus* Lam.	Kathal	Moraceae	T	Lx	AD*	21.95	0.107	0.11
	Calotropis procera (Aiton) W.T. Aiton	Ak, Akada	Asclepiadaceae	Sh	Lx	AD	32.68	0.161	0.26
	Catunaregam spinosa (Thunb.) Tirveng.	Mainphal	Rubiaceae	Sh	Lf	LP*	21.95	0.098	0.11
	Duranta erecta L.	Doranta	Verbenaceae	Sh	S, Lf	P*	16.59	0.073	0.09
	Kydia calycina Roxb.	Pula, Pulia	Malvaceae	T	Lf	LP	11.22	0.059	0.07
	Martynia annua L.	Bichu	Martyniaceae	Hb	Ft	P	21.95	0.073	0.09
Acne	*Aloe vera* (L.) Burm.f.	Ghee-Kwaanar	Xanthorrhoeaceae	Hb	Lf	LP	91.71	0.166	0.22
	Annona squamosa L.	Sitaphal	Annonaceae	T	Lf	P	16.59	0.102	0.22
	Azadirachta indica A. Jussieu	Neem	Meliaceae	T	Lf	P	100.00	0.371	0.37
	Citrus aurantiifolia (Christm.) Swingle	Nimbu	Rutaceae	T	R	P	22.44	0.156	0.16
	Citrus aurantium L.	Santara	Rutaceae	T	R	P	21.46	0.102	0.27
	Curcuma longa L.	Haldi	Zingiberaceae	Hb	Rh	P	100.00	0.22	0.48
	Dalbergia sissoo DC.	Shisham, Tahli	Fabaceae	T	Lf	LP	16.59	0.102	0.22
	Rosa indica Hook. f.	Gulab	Rosaceae	Sh	Fl	P	11.71	0.112	0.42
Blisters	*Aloe vera* (L.) Burm.f.	Ghee-Kwaanar	Xanthorrhoeaceae	Hb	Lf	P	21.95	0.127	0.33
	Azadirachta indica A. Jussieu	Neem	Meliaceae	T	Lf	P	31.71	0.141	0.17
	Bixa orellana L.	Sindoori	Bixaceae	T	Lf	P	21.95	0.029	0.17
Boils	*Aloe vera* (L.) Burm.f.	Ghee-Kwaanar	Xanthorrhoeaceae	Hb	Lf	P	38.05	0.166	0.21

	Annona squamosa L.	Sitaphal	Annonaceae	T	Lf	P	28.78	0.059	0.19
	Bryophyllum pinnatum (Lam.) Oken	Pattharchat	Crassulaceae	Hb	Lf	P	23.41	0.054	0.16
	Datura metel L.	Kala Dhatura	Solanaceae	Sh	Lf	P	21.95	0.068	0.21
	Datura stramonium L.	Dhatura	Solanaceae	Hb	Lf	P	11.22	0.063	0.10
	Hibiscus rosa-sinensis L.	Gudhal	Malvaceae	T	Lf	P	5.37	0.112	0.06
	Holarrhena pubescens Wall. *ex* G. Don.	Karu, Ramjau	Apocynaceae	T	Lf	P	13.17	0.093	0.08
	Oxalis corniculata L.	Changeri	Oxalidaceae	Hb	Lf	P	60.00	0.083	0.26
	Populus deltoids Bartram *ex* Marshall	Poplar	Salicaceae	T	B	P	9.27	0.059	0.11
	Prosopis juliflora (Sw.) DC.	Vilayati Kikar	Fabaceae	T	Lf	P	13.66	0.093	0.08
	Ricinus communis L.	Arand	Euphorbiaceae	Sh	Lf	P	23.90	0.122	0.21
	Sida acuta Burm.f.	Bala, Khareti	Malvaceae	Sh	Lf	P	21.95	0.093	0.08
	Solanum anguivi Lam.	Banta-maku, Brihati	Solanaceae	Hb	Sd	P	27.32	0.102	0.42
	Terminalia arjuna (Roxb. *ex* DC.) Wight. & Arn.	Arjun	Combretaceae	T	B	P	16.59	0.19	0.25
	Wendlandia heynei (Schult.) Santapau & Merchant	Bathua, Pansara	Rubiaceae	T	B	P	96.59	0.054	0.42
Cracked heals	*Ficus religiosa* L.	Peepal	Moraceae	T	Lx	AD	92.20	0.068	0.38
Eczema	*Boehmeria macrophylla* Hornem.	Samrala	Urticaceae	Sh	Lf	P	59.02	0.044	0.12
	Calotropis gigantea (L.) Dryand.	Safed Ak	Asclepiadaceae	Sh	Lx	AD	70.73	0.068	0.20
	Euphorbia pulcherrima Willd. *ex* Klotzsch	Lal Patti	Euphorbiaceae	Sh	Lx	AD	65.37	0.107	0.17
	Euphorbia royleana Boiss.	Danda Thor	Euphorbiaceae	Sh	Lx	AD	49.27	0.088	0.12
	Ipomoea carnea Jacq.	Besharam, Panphul	Convolvulaceae	Sh	Lx	AD	33.66	0.063	0.12
Itches	*Lawsonia inermis* L.	Mehndi	Lythraceae	Sh	Lf	P	31.22	0.112	0.10
	Madhuca longifolia var. *latifolia* (Roxb.) A.	Mahuwa	Sapotaceae	T	Lf	P	27.32	0.054	0.14

	Chev.								
	Solanum anguivi Lam.	Banta-maku, Brihati	Solanaceae	Hb	Sd	P	20.98	0.049	0.13
Pimples	*Azadirachta indica* A. Jussieu	Neem	Meliaceae	T	Lf	P	26.83	0.141	0.12
Skin irritation	*Achyranthes aspera* L.	Chitra, Puthkanda	Amaranthaceae	Hb	S	P	59.02	0.112	0.18
	Argemone Mexicana L.	Bharbhara, Pili Kanteli	Papaveraceae	Hb	S	P	70.73	0.107	0.18
	Azadirachta indica A. Jussieu	Neem	Meliaceae	T	Lf	P	79.51	0.21	0.17
	Brassica rapa L.	Sarson	Brassicaceae	Hb	Sd	P	47.80	0.112	0.16
	Butea monosperma (Lam.) Taub.	Dhak, Palas	Fabaceae	T	Sd	P	69.76	0.102	0.12
	Calotropis gigantea (L.) Dryand.	Safed Ak	Asclepiadaceae	Sh	Lx	AD	72.20	0.137	0.16
	Calotropis procera (Aiton) W.T. Aiton	Ak, Akada	Asclepiadaceae	Sh	Lf	P	44.39	0.127	0.27
	Cereus hildmannianus K. Schum.	Kantila	Cactaceae	Sh	Lx	AD	25.85	0.093	0.04
	Chenopodium album L.	Batho, Gahnau	Chenopodiaceae	Hb	Sd	P	76.10	0.088	0.16
	Chenopodium murale L.	Kharatua Bathu	Chenopodiaceae	Hb	Lf	P	81.46	0.073	0.10
	Cissampelos pareira L.	Harjori, Patindu	Menispermaceae	Sh	Lf	P	65.37	0.044	0.09
	Clerodendrum infortunatum L.	Bhant, Karu	Lamiaceae	Sh	Lf, Rt	P, J*	67.80	0.063	0.07
	Cyanthillium cinereum (L.) H. Rob.	Sahadevi	Asteraceae	Hb	Lf	P	15.61	0.059	0.21
	Euphorbia hirta L.	Lal Dudhi	Euphorbiaceae	Hb	P	P	28.29	0.102	0.10
	Euphorbia pulcherrima Willd. *ex* Klotzsch	Lal Patti	Euphorbiaceae	Sh	Lx	AD	32.68	0.073	0.21
	Euphorbia royleana Boiss.	Danda Thor	Euphorbiaceae	Sh	Lx	AD	37.56	0.127	0.05
	Ficus carica L.	Anjeer	Moraceae	Sh	Lf	P	14.15	0.049	0.08
	Ipomoea carnea Jacq.	Besharam	Convolvulaceae	Sh	Lf	P	63.90	0.088	0.22
	Jatropha curcas L.	Ratanjot, Safed Arand	Euphorbiaceae	Sh	Lx	AD	70.73	0.063	0.09
	Justicia adhatoda L.	Arusa, Bansa, Basaka	Acanthaceae	Sh	P	P	43.41	0.122	0.10
	Kydia calycina Roxb.	Pula, Pulia	Malvaceae	T	Lf	P	23.90	0.024	0.06
	Lawsonia inermis L.	Mehndi	Lythraceae	Sh	Lf	P	97.07	0.093	0.37
	Nerium oleander L.	Kaner	Apocynaceae	T	Lx	AD	65.85	0.063	0.25

	Senna obtusifolia (L.) H.S. Irwin & Barneby	Panwar	Fabaceae	Sh	Lf	P	43.41	0.054	0.09
	Senna occidentalis (L.) Link	Chakunda, Kasmarda	Fabaceae	Sh	Lf, Sd	P	65.37	0.039	0.15
	Shorea robusta C. F. Gaertn.	Sal, Shal	Dipterocarpaceae	T	Sd, B, Lf	P	40.98	0.049	0.07
	Spilanthes acmella Murray	Akarkara	Asteraceae	Hb	Lf	P	65.37	0.078	0.19
	Terminalia bellirica (Gaertn.) Roxb.	Bahera	Combretaceae	T	Ft	P	81.46	0.088	0.16
	Tinospora sinensis (Lour.) Merr.	Giloe, Gurch, Gulja	Menispermaceae	Sh	S	P	85.85	0.029	0.21
	Toona ciliata M. Roem.	Tun, Toona	Meliaceae	T	B	P	65.85	0.044	0.09
	Vitex negundo L.	Bano, Malaha	Lamiaceae	Sh	Lf	P	44.39	0.063	0.16
	Withania somnifera (L.) Dunal	Ashwagandha	Solanaceae	Sh	Sh	P	92.20	0.039	0.26
	Zanthoxylum armatum DC.	Tirmir, Tumbar	Rutaceae	T	Lf	P	98.54	0.073	0.37
Sun burn	*Sambucus nigra* L.	Khaman	Adoxaceae	Sh	Fl	P	59.02	0.054	0.06

Habit: Hb-Herb, Sh- Shrub, T-Tree.

Part Used (PU): B-Bark, Fl- Flower, Ft-Fruit, Lf-Leaf, Lx-Latex, P-Plant, R-Rind, Rh-Rhizome, Rt-Root, S-Stem, Sd-Seed, Sh-Shoot.

Utilization (U): AD*-Applied directly, J*- Juice, LP*-Leaf paste, P*- Poultice.

FL- Fidelity Level, **RFC-**Relative Frequency Citation**, UV-** Use Value**.**

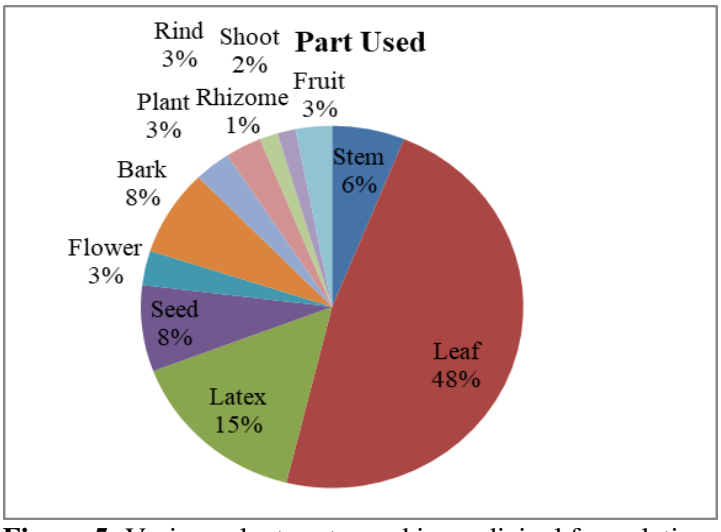


Figure 5: Various plant parts used in medicinal formulations

The quantitative methods including use value (UV), family importance value (FIV), and fidelity level (FL) were applied. The highest use-value of*Azadirachta indica* is the reason of its maximum availability in the region, followed by*Curcuma longa* which is given prominence in agricultural practices. The highest family importance value (FIV) has been recorded for the family Zingiberaceae.

The RFC values ranges from 0.04 to 0.48% with *Curcuma longa* (0.48) and *Rosaindica* (0.42) having the high relative frequency citation (RFC) which represents high prospective therapeutic plant species for future research in anti-skin diseases drug expansion.

The fidelity level (FL) value ranges from 5.37% to 100%. The high value of FL indicates the choice of participants to treat the specific disease. Species havingfidelity percentage greater than 80% are found to have greater significance over others. The above listed plants should be further analyzed for phytochemical compounds, to identify their active chemical components for drug discovery.

DISCUSSION

The documentation of indigenous knowledge offers for an adaptive management that can propose prediction for potential development in an area. Most of the people inherit traditional knowledge from their elders that passed through generation to generation (Jain, 1989; Rao, 1996). The data recorded for skincare needs from the fringe villages of Colonel Sher Jung National Park Simbalbara, Tehsil Paonta Sahib of District Sirmour in Himachal Pradesh reveals the usage pattern of 62 plant species (02 monocots, 60 dicots) belonging to 53 genera (02 monocots, 51 dicots) under 36 families (02 monocots, 34 dicots) against 10 types of prevailing skin ailments (abscesses, acne, boils, blisters, skin irritation, cracks, eczema, itches, pimples, sun burn). The dominant life form utilized were shrubs while the favored method of utilization has poultice. Leaves were used most frequently (48%) then latex (15%), bark and seeds (8% each), stem (6%), rind/flower/whole plant (3%), etc. (Figure 5). The leaves weremain used plant part which was similar to the earlier findings of Kaushal *et al*., 2016; Sidhu & Thakur, 2017; Verma & Kanwar, 2019;Mahato *et al.,* 2018. The highest family importance value (FIV) was recorded for the family Zingiberaceae and relative frequency citation (RFC) values range from 0.04 to 0.48% and fidelity level (FL) value ranges from 5.37% to 100%. Fidelity percentage greater than 80% found be having greater significance over others. The RFC indices symbolize high potential healing plant species for future investigation of anti-skin diseases medication in this region. Findings on ethnomedicinal plants forcure of dermatological problems were similar to earlier workers like Kumar *et al.* (2012), Mutyala Naidu *et.al.* (2015), Malik *et al.* (2019) and Singhal *et al.* (2020). The present studysuggested that ethnomedicinal plant species still play a vital role in primary health care need and these species from this region need further evaluation of their therapeutic efficacy, side effects, and toxicity.

SUMMARY

A total of 63 plant species have been recorded for the treatment of various skin ailments. The information so gathered from respondents indicates that they were aware about the medicinal plants and their uses. This information was innate from their ancestors but vanishing gradually and requires immediate attention; most of the plants used were shrubs, so the locals can be encouraged for bringing them in cultivation. Furthermore, this preliminary data can be used for novel drug discovery after complete pharmacological and phytochemical analysis.

REFERENCES

1. Chaudhary HJ and Wadhwa BM. 1984. Flora of Himachal Pradesh. Botanical Survey of India, Howrah, West Bengal.

2. Dilara Begum and Nath SC. 2000. Ethnobotanical review of medicinal plants used for skin diseases and related problems in Northeastern India. J. Herbs Spices Med. Plants. **7**(3), 55-93.

3. Friedman J, Yaniv Z, Dafni A and Palewitch D. 1986. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethno pharmacological field survey among Bedouins in the Negev desert, Israel. J Ethnopharmacol.**16**(2-3), 275-87.

4. Ghalme R. 2020. Ethno - medicinal plants for skin diseases and wounds from Dapoli Tehsil of RatnagiriDistrict, Maharashtra (India). Flora and Fauna, **26**(1).

5. Goutam Pal, I., 2022. Medicinal Plants: Himachal Pradesh Forest Department. [online] Hpforest.nic.in. Available at: <https://hpforest.nic.in> [Accessed 07 January 2022].

6. Kaur H and Sharma M. 2004. Flora of Sirmaur, Himachal Pradesh. B.S.M.P.S., Dehradun.

7. Jain SK. 1967. Ethnobotany: its scope and study. Indian Mus. Bull. **2**, 39-43.

8. Jain SK. 1989. Methods and Approaches in Ethnobotany. Deep Publ., New Delhi, India.

9. Kaushal, P., Seth, M. and Lata, S., 2016. Medicinal Plants Used for Skin Diseases in Kangra District of Himachal Pradesh. IJSR, **5**(9), pp 286-287.

10. Kianifar J, Azadbakht M, Azadbakht M and Davoodi A. 2019. Ethnobotanical study of medicinal plants used in skin diseases in the area Alamut-Qazvin, Iran. J. Med. Plants. **18** (72),121-132.

11. Korpenwar AN. 2012. Ethnomedicinal plants used to cure skin diseses in Ambabarwa Wild Life Sanctuary area of Buldhana district, Maharashtra, India. Int. J. of Recent Trends in Sci. and Tech.**2**(3), 36-39.

12. Kumar Sanjeet, Jena PK, Sabnam S, Kumari M and Tripathy PK. 2012. Study of plants used against the skin diseases with special reference to Cassia fistula L. among the king (Dongaria Kandha) of Niyamgiri: A primitive tribe of Odisha, India. Int. J. Drug Dev. & Res.**4**(2), 256-264.

13. Lal, B. and Singh, K., 2008. Indigenous herbal remedies used to cure skin disorders by the natives of Lahaul-Spiti in Himachal Pradesh. Indian Journal of Traditional Knowledge, **7**(2), pp 237-241.

14. Mahato G, Hansda B and Banerjee N. 2018. Ethnobotanical used for the treatment of skin diseases with special emphasis on carbuncle diseases from Purulia district of West Bengal in India. Pharmacogn. J.**11**(4), 745-753.

15. Malik K, Ahmad M, Zafar M, Ullah R, Mahmood HM, Parveen B, Rashid N, Sultana S, Shah SN and Lubna. 2019. An ethnobotanical study of medicinal plants used to treat skin diseases in northern Pakistan. BMC Complement Altern. Med. **19**, 210

16. Mowobi G, Abubakar S, Osuji C, Etim VN, Ogechi N and Egya JJ. 2016. Ethnobotanical survey of medicinal plants used for the treatment of skin diseases in Keffi, Nigeria. American J. of Phytomed. and Clin. Therap.**4**(02), 073-090.

17. Mudang, J., George, AE. and Varghese, SA., 2020. Major contributions to dermatology from India. Journal of Skin and Sexually Transmitted Diseases, **2**(2), pp79-85.

18. Mutyala Naidu, Kumar OA, Mallikarjuna K, Raju PR, and Rao MK. 2015. Ethnobotanical studies for skin diseases by tribes of Papikondalu forest, Andhra Pradesh, India. Int. J. Adv. Res. Sci. Technol.**4**(4), 416-420.

19. Panda, T. and Mishra, N., 2016. Folk Knowledge on Medicinal Plants Used for the Treatment of Skin Diseases in Bhadrak District of Odisha, India. Medicinal & Aromatic Plants, **5**(4).

20. Patkar KB. 2008. Herbal cosmetics in ancient India. Indian J Plast Surg. **41**(Suppl), S134-S137.

21. Phillips O, Gentry AH, Reynel C, Wilkin P and Galvez-Durand BC. 1994. Quantitative ethno botany and Amazonian conservation. Conserv. Biol.**8**(1), 225-48.

22. Rao, RR., 1996. Traditional knowledge and sustainable development: Key role of ethnobiologist. Ethnobotany,**8,** 14-24.

23. Saikia, A., Ryakala, V., Sharma, P., Goswami, P. and Bora, U., 2006. Ethnobotany of medicinal plants used by Assamese people for various skin ailments and cosmetics. Journal of Ethnopharmacology, **106**(2), pp149-157.

24. Saini, JS. and Sood, SK., 2017. An Ethnomedicinal Plant Study in Fringe Villages of Col. Sher Jung National Park Simbalbara, Sirmour, H.P. India. CPUH-Research Journal, **2**(2), pp 1-16.

25. Schultes RE. 1962. Tapping our heritage of ethnobotanical lore. Econ. Bot. **8**, 224- 227.

26. Sharma, S. and Rana, M., 2016. Commonly used Medicinal Plants in Tehsil Pachhad, District Sirmour, Himachal Pradesh. PharmaTutor, **4**(3), pp34-38.

27. Sidhu, MC. and Thakur, S. 2017. Medicinal plant remedies for dermatological problems. Current Botany, 8, pp 23-33.

28. Singhal RR, Talati KN, Gandhi BP, Shinde MK, Nair PA and Phatak AG. 2020. Prevalence and pattern of skin diseases in tribal villages of Gujarat: A tele dermatology approach. Indian J. Community Med. **45**,199-203.

29. Sood, S., Sharma, S., Lakhanpal, T. and Kumar, S., 2011. Indian herbs for perfumery and beauty care. Delhi: Daya Pub. House.

30. Upadhyay OP, Kaushal Kumar and Tiwari RK. 1998. Ethnobotanical study of skin treatment uses of Medicinal Plants of Bihar, Pharm. Biol. **36**(3),167-172.

31. Verma, S. and Kanwar, S., 2020. Medicinal plants used for the treatment of skin diseases in Sarkaghat tehsil of Mandi District, Himachal Pradesh, India. JBES, [online] **15**(4), pp108-117. Available at: <http://www.innspub.net> [Accessed 12 January, 2022].

32. Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A and Fico G. 2013. Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)-An alpine ethnobotanical study. J. of Ethnopharm.**145**, 517-529.

33. Who.int. 2020. Skin NTDs: prioritizing integrated approaches to reduce suffering, psychosocial impact and stigmatization. [online] Available at: <https:// www. who. int/ news/item/29-10-2020-skin-ntds-prioritizing-integrated-approaches-to-reduce-suffering-psychosocial-impact-and-stigmatization> [Accessed 02 January, 2022].

EFFECT OF ARSENIC TOXICITY ON REPRODUCTIVE BIOLOGY OF CONTRASTING CHICKPEA (CICER ARIETINUM L.) GENOTYPES

Jahid Ali Malik
Assistant Professor, Department of Botany, SGGSJ Government College, Paonta Sahib (H.P.)-173025, India
jahidmalik@gmail.com

ABSTRACT
The contamination of the environment by heavy metals is currently a major global environmental problem threatening the health of vegetation, wildlife, and humans. Arsenic (As), a naturally occurring element in earth's crust is present in different background levels. Its concentration is increasing in the environment due to anthropogenic activities of various kinds. Arsenic toxicity and consequent health risks to all forms of life, has generated interests among researchers to study various aspects of arsenic toxicity. This paper, presents effects of As on reproductive growth, yield and flower functioning in contrasting chickpea (Cicer arietinum L.) genotypes.

Keywords: *Environment, Arsenic, Flower functioning, reproductive growth, toxicity*

INTRODUCTION
Arsenic is a natural element present in the atmosphere as well as in the aquatic and terrestrial environment. Natural background levels of arsenic are 5-6 mg/Kg dry soil. However natural anomalies and anthropogenic activities of various kinds such as pesticide use, mining or irrigation by contaminated ground water results in strong enrichment of the area (Bleeker *et al.,* 2002). Water supplies, soils and sediments contaminated with As are the major sources of drinking water and food-chain contamination in numerous countries. This has caused a global epidemic of As poisoning, with many people having developed skin lesions, cancers and other symptoms (Tripathi *et al.*, 2007). Long term exposure to arsenic in drinking water has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver and prostate. Exposures to low levels of arsenic can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage of blood vessels (Schmoger *et al.,* 2000). Meharg and Rahman (2003) reported high levels of arsenic in soils irrigated with arsenic contaminated water. Rice grain collected in districts of Bangladesh with high arsenic levels in paddy soils had 10-fold higher than the normal level of 0.2mg/kg arsenic (Meharg and Rahman, 2003). Studies of Xie and Huang (1998) and Abedin *et al.* (2002) have shown that arsenic levels in the grain increase with increasing arsenic in irrigation water/soil. Elevation of arsenic levels in the soil causes considerable concern with respect to plant uptake and subsequent entry into the wildlife and human food chains. Arsenic has no role to play in plant metabolic activities and thus is altogether non-essential. Inhibition of various physiological and biochemical processes by the As result in consequent reduction in morphological characters and economic yield of agricultural and horticultural crops. Major characters affected are tillers (in cereals), plant height, leaf number and area, pod number and length (in legumes), and dry matter production (Bhowmik and Sharma, 1999). In chickpea, no information is available on the reproductive biology of contrasting chickpea genotypes treated with As. Hence, in the present study, we compared the reproductive growth, yield and flower functioning, in *Desi* (GPF2) and *Kabuli* (L550) chickpea genotypes under As treatment.

MATERIAL AND METHODS

Chickpea (*Cicer arietinum* L.) genotypes *Desi* (GPF2) and *Kabuli* (L550) were procured from Punjab Agricultural University, Ludhiana. Healthy seeds were inoculated with *Rhizobium ciceri* bacterial strain The plants were raised in earthen pots (12 cm diameter) having mixture of dry soil and sand in ratio of 2:1 (v/v). The plants were irrigated as and when required. After 30 days Arsenic (Sodium Arsenate) was added to the pots in solution form at the rate of 10mg/kg of soil. Effects of Arsenic (As) on reproductive growth yield and flower biology was assessed.

(A) Flowering Response

Nine plants per treatment were tagged for following observations:

(I) Total Number of Flowers Produced

Plants were marked and flowers produced were counted.

(II) Flower Retention Percentage

It was calculated by dividing number of flowers retained by total number of flowers produced multiplied by one hundred.

(B) Podding Response

(I) Pod Set Percentage

It was calculated by dividing number of pods set by total number of retained flowers multiplied by one hundred.

(II) Pod Retention Percentage

It was calculated by dividing number of pods retained by total number of pods produced multiplied by one hundred.

(C) Yield Parameters

(I) Total Pod Number per Plant

(II) Total Pod Weight per Plant

(III) Total Seed Number per Plant

(IV) Total Seed Weight per Plant

(D) Floral Biology

The functioning of the flowers was assessed using following parameters:

(I) Pollen Viability

Pollen viability (%) was tested on pollen grains with 0.5% acetocarmine or Alexander triple stain (ATS) solution (Alexander, 1969).

(II) Pollen Load

The number of flowers with fully dehiscent anthers and pollens on stigma were counted and pollen-load on stigma was scored on 1-5 scale (1-low and 5-high) (Srinivasan *et. al.,* 1999).

(III) Pollen Germination Percentage (In Vitro)

Pollen germination was assessed (Brewbaker and Kwack, 1963) after incubating pollens in a medium (pH 6.5) containing.

(a) 10% Sucrose (b) 100 ppm Boric acid (c) 300 ppm Calcium nitrate (d) 200 ppm Magnesium sulphate and (e) 100 ppm Potassium nitrate

Incubation was done at 25±2°C for overnight (dark) in medium. The *in vitro* germination process was stopped after incubation by adding a drop of acetocarmine to

the medium pollen was counted as germinated when pollen tubes were at least to the diameter of the pollen grain. The percentage germination was determined on the basis of at least 100 pollen grains per replicate.

(IV) Pollen Germination (In Vivo) and Fate of Pollen Tube Growth

Fluorescence microscopy was done to assess the pollen germination on stigma and to trace the pollen tube path in style and ovary. Flowers were collected at one to three days after anthesis and fixed in acetic alcohol (1:3) for 24 hr. and then transferred to 8N NaOH for 6 hr at 60°C for clearing purpose. Complete gynoecium part was transferred to aniline blue (0.1%) and kept overnight. Finally, they are mounted on a slide in a 1:1 (aniline blue: 10% glycerin) solution. The stained gynoecia were then observed under fluorescence photomicrograph microscope (Nikon, Japan) (Dumas and Knox, 1983).

Scanning electron microscopy was carried out to observe any structural changes on pollen. On the day of anthesis, fresh flowers were collected early in the morning from control and metal treated plants. Anthers were collected and teased on a metallic stub. Remaining extra debris was removed and these stubs were gold plated and scanned under scanning electron microscope (Postek *et. al.,* 1980).

(V) Stigma Receptivity Test

Esterase test using □-naphthyl acetate as substrate in the azo-coupling reaction with fast blue B as modified by Mattson *et al.* (1974) was used for detecting stigma receptivity. Stigmas were removed one day before flower opening, immersed in the working solution, at 37°C for 15 min. A positive test was indicated with purple red to brown colour. Staining intensity was scored on a 1-5 scale.

Working Solution

(a) α-naphthyl acetate	-	1 mL
(b) Phosphate buffer 0.1 M, pH 7.0	-	99 mL
(c) Sucrose (as osmoticum)	-	10-15%
(d) Fast Blue B	-	100 mg

Control: Working solution without substrate (□-naphthyl acetate)

(VI) POLLEN MORPHOLOGY

Scanning electron microscopy was carried out to observe any structural changes on pollen. On the day of anthesis, fresh flowers were collected early in the morning from control and metal treated plants. Anthers were collected and teased on a metallic stub. Remaining extra debris was removed and these stubs were gold plated and scanned under scanning electron microscope (Postek *et. al.,* 1980).

The results were statistically analyzed for LSD values.

RESULTS

Flowering Response

(I) Total Number of Flowers Produced

In Both the genotypes, maximum number of flowers was recorded in control plants. A significant reduction in total number of flowers was observed with Astreatment over control. In *Desi* genotype reduction was 43.2% while in *Kabuli* genotype reduction was observed to be 43.1% (Fig.1).

(II) Flower Retention (%)

In *Desi* genotype, the control plants showed 70.5% flower retention. With As treatment, a decrease in flower retention percentage was observed. Plants treated with As showed 61.1% flower retention. In *Kabuli* genotype, the control plants showed 51.3% flower retention. Compared to control plants, the As-treated plants showed a decrease in flower retention percentage (44.4%). Percentage decrease in flower retention over control was higher in *Kabuli* genotype compared to *Desi* (Fig 2).

Podding Response

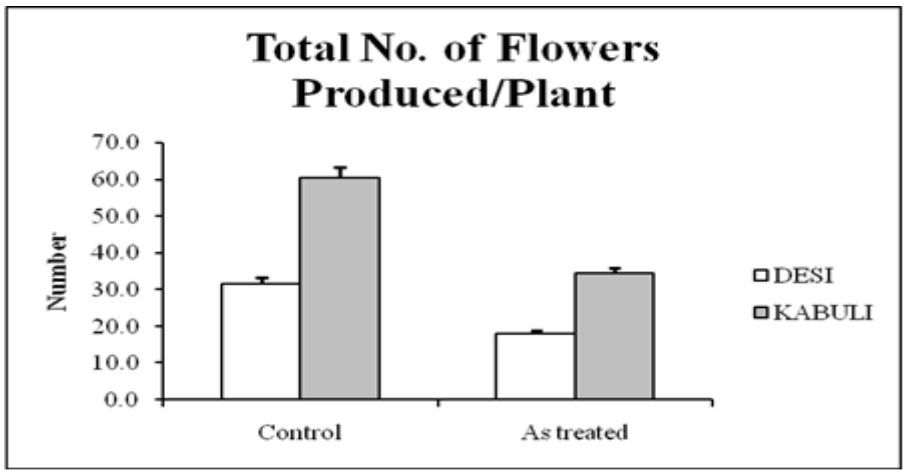


Fig. 1: Effect of Arsenic on total number of flowers produced in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes - 6.5, Treatments – 6.5, Genotypes × Treatments - 9.2. Bars represent standard error at 5% level (n = 3).

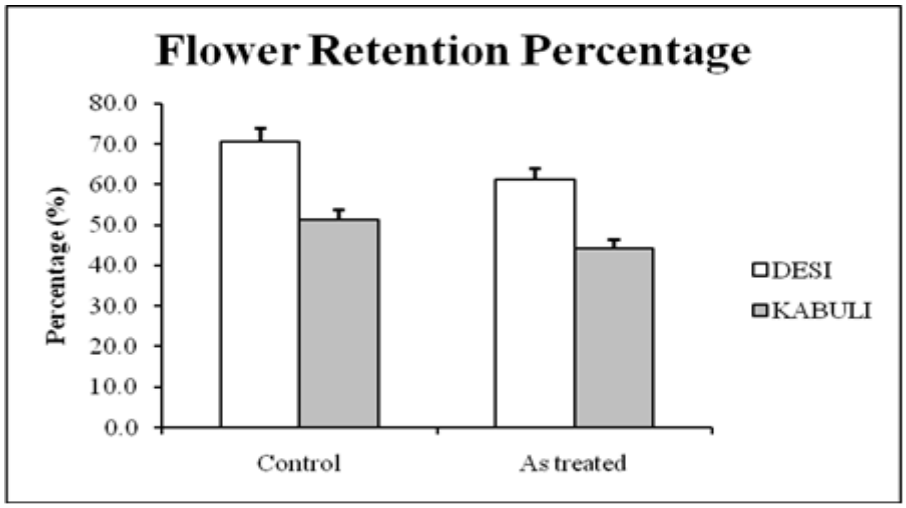


Fig. 2: Effect of Arsenic on flowers retention percentage in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes - 8.2, Treatments - 8.2, Genotypes × Treatments - 11.6. Bars represent standard error at 5% level (n = 3).

(I) Pod Set Percentage

The pod set in control plants of *Desi* genotype was recorded to be 75.8%. The decrease in pod set percentage was recorded with metal treatments. In case of As treated plants, pod set was 68.7%. In *Kabuli* genotype, the pod set in control plants was recorded to be the maximum (81.1%). In case of As treated plants, pod set percentage was 69.4 (Fig 3).

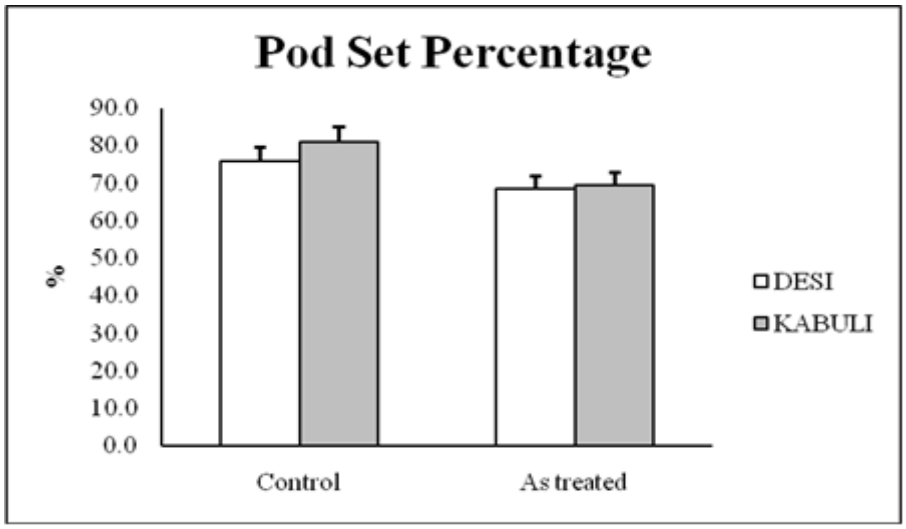


Fig. 3: Effect of Arsenic on pod set percentage in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 9.5, Treatments – 9.5, Genotypes × Treatments – 13.5. Bars represent standard error at 5% level (n = 3).

(II) Pod Retention Percentage

In *Desi* genotype, the pod retention in controls was observed to be 96.4%. Arsenic treated plants showed 85.8% pod retention. In *Kabuli* genotype, the pod retention was affected to a larger extent. In this genotype, the pod retention percentage was found to be 86.4 in control plants. As treated plants showed 77.9% pod retention (Fig 4).

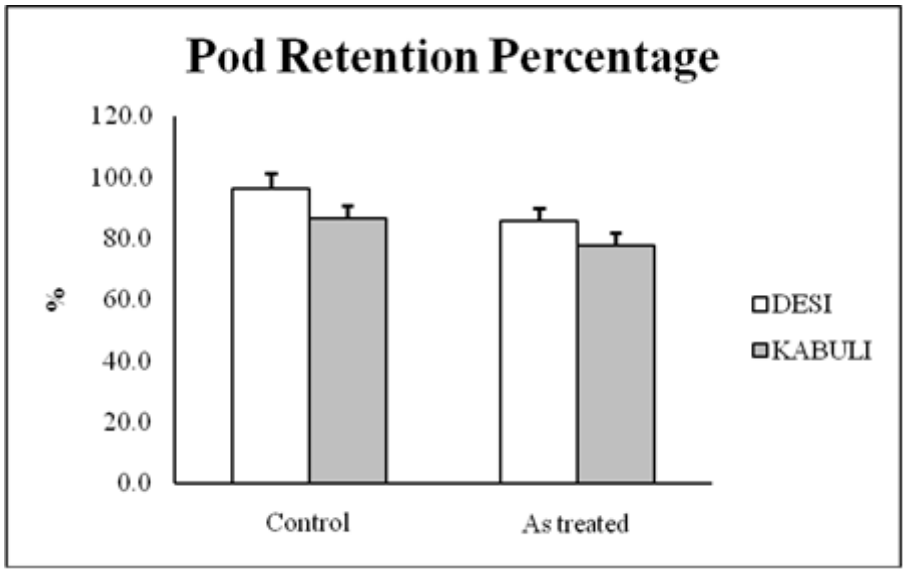


Fig. 4: Effect of Arsenic on pod retention percentage in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotype – 4.3, Treatment – 4.3, Genotypes × Treatments - 6.0. Bars represent standard error at 5% level (n = 3).

Yield Parameters

(I) Total Pod Number per Plant

The total pod number in control plants of *Desi* genotype was found to as 16.3. When the plants were treated with As the pod number per plant was observed to be 6.7. In *Kabuli* genotype, maximum pod number was found in control plants (22). Pod number was quite low in case of plants treated with As and the value was 8.7 (Fig 5).

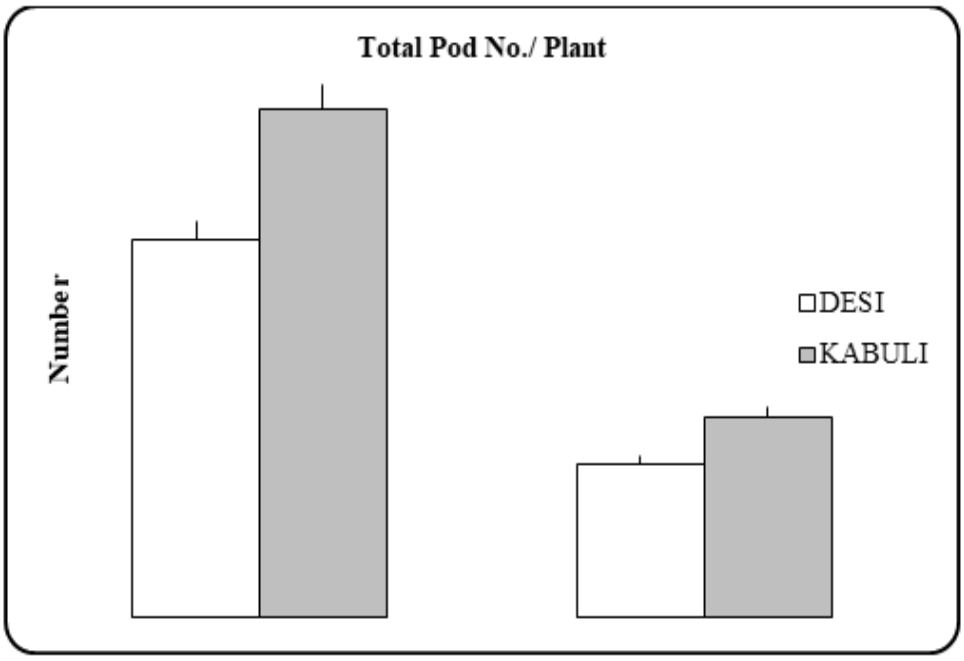


Fig. 5: Effect of Arsenic on total pod number per plant in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 5.1, Treatments – 5.1, Genotypes × Treatments – 7.3. Bars represent standard error at 5% level (n = 3).

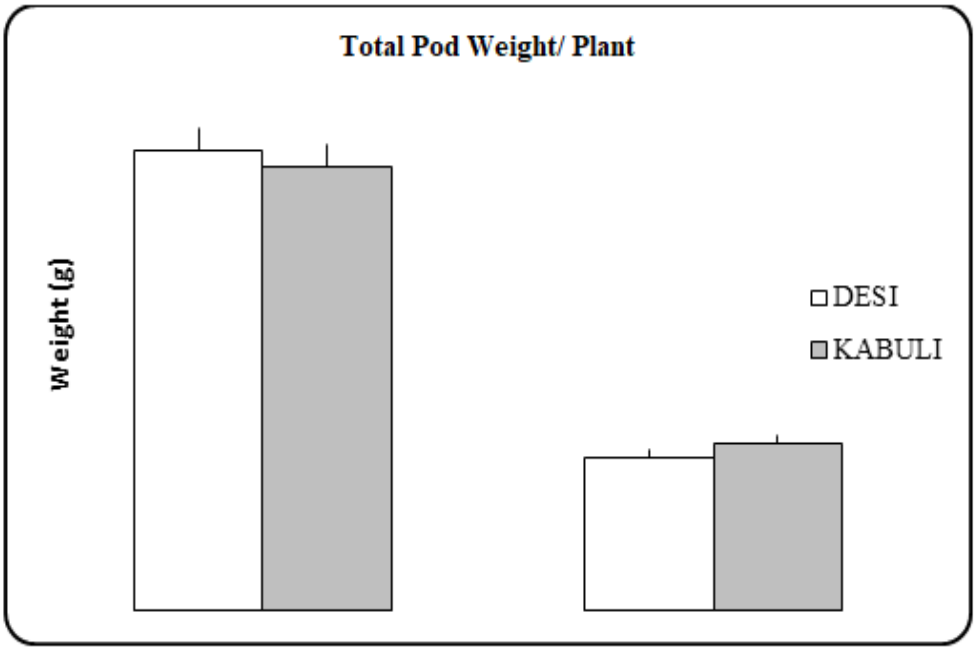


Fig. 6: Effect of Arsenic on total pod weight per plant in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 0.6, Treatments – 0.6, Genotypes × Treatments – 0.9. Bars represent standard error at 5% level (n = 3).

(II) Total Pod Weight per Plant

The control plants possessed 4.82g pod weight per plant. Pod weight in metal-treated plants decreased significantly. As treatment showed 1.60g pod weight per plant. In *Kabuli* genotype also, the maximum pod weight per plant was observed in control plants (4.65g). With As treatment, pod weight was found to be 1.75g (Fig 6).

(III) Total Seed Number per Plant

In *Desi* genotype, maximum seed number per plant was recorded in control plants (20.3). Least seed number per plant (6.3) was observed in plants treated with As.In control plants of *Kabuli* genotype, the seed number per plant was found to be 21. Seed number per plant was recorded to be 5.7 in As treated plants (Fig 7).

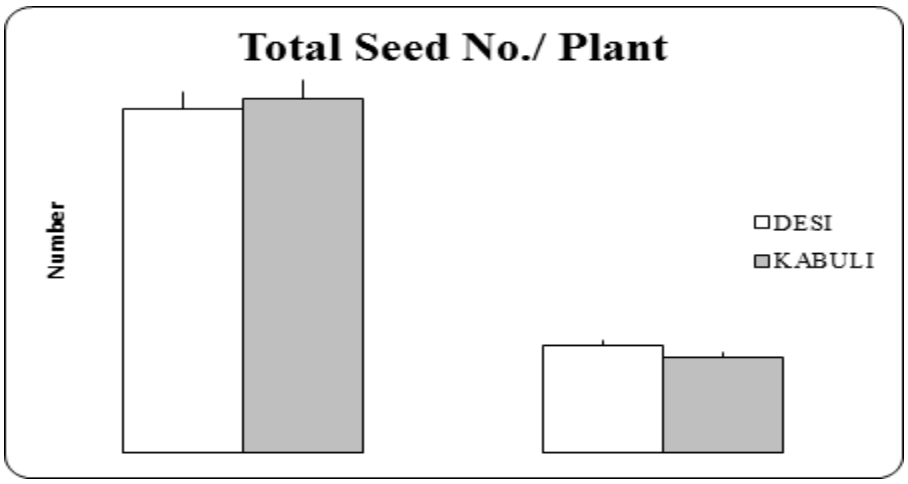


Fig. 7: Effect of Arsenic on total seed number per plant in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 5.2, Treatments – 5.2, Genotypes × Treatments – 7.4. Bars represent standard error at 5% level (n = 3).

(IV) Total Seed Weight per Plant

In control plants of *Desi* genotype, the total seed weight was found to be maximum (2.33g). In case of As treated plants, total seed weight/plant was found to be 0.72g. In *Kabuli* genotype, maximum seed weight per plant was found in control plants (4.03g). With As treatment seed weight was recorded to be 1.02g (Fig. 8).

FLORAL BIOLOGY

(I) Stigma Receptivity

A significant decrease in stigma receptivity was noticed with As treatment. Decrease in stigma receptivity was higher in genotype (Fig. 9, Plate 1).

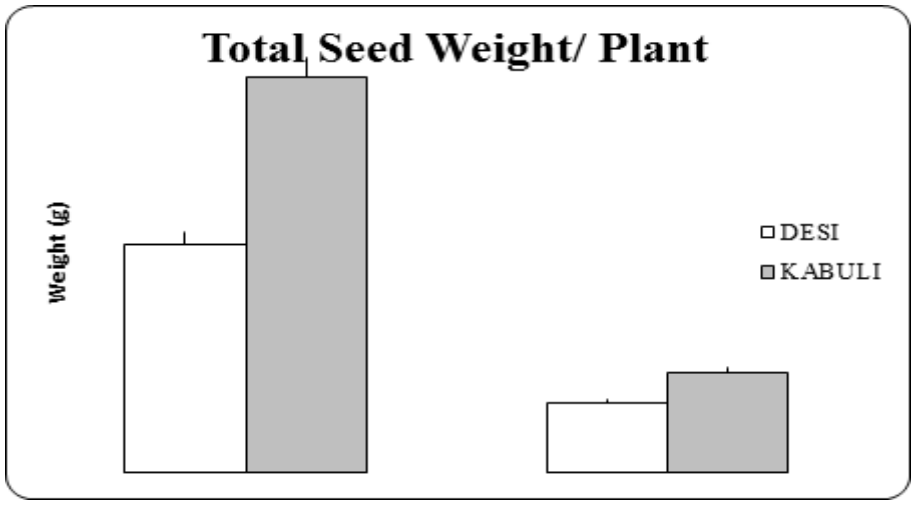


Fig. 8: Effect of Arsenic on total seed weight per plant in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 0.6, Treatments – 0.6, Genotypes × Treatments – 0.8. Bars represent standard error at 5% level (n = 3).

 ISBN: 978-93-93810-06-9

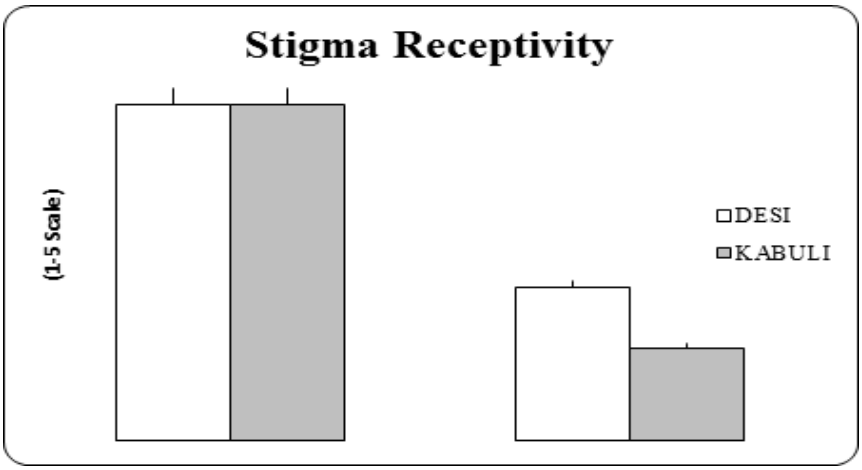
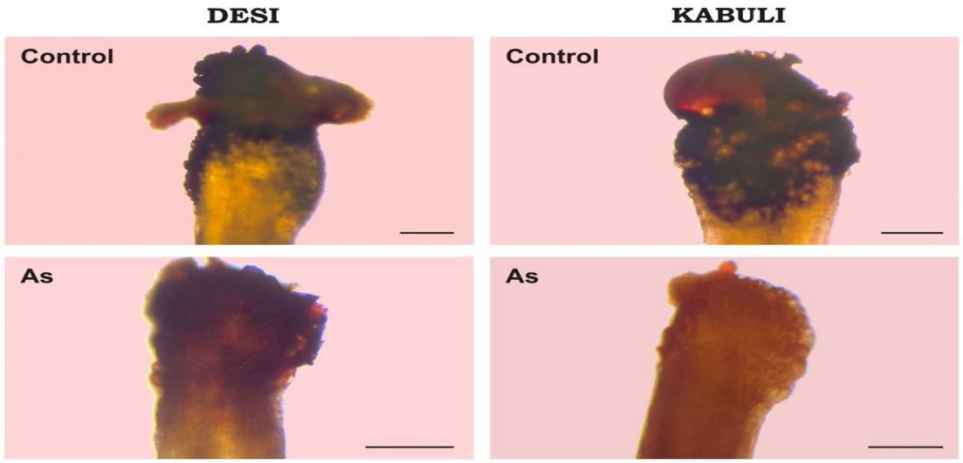
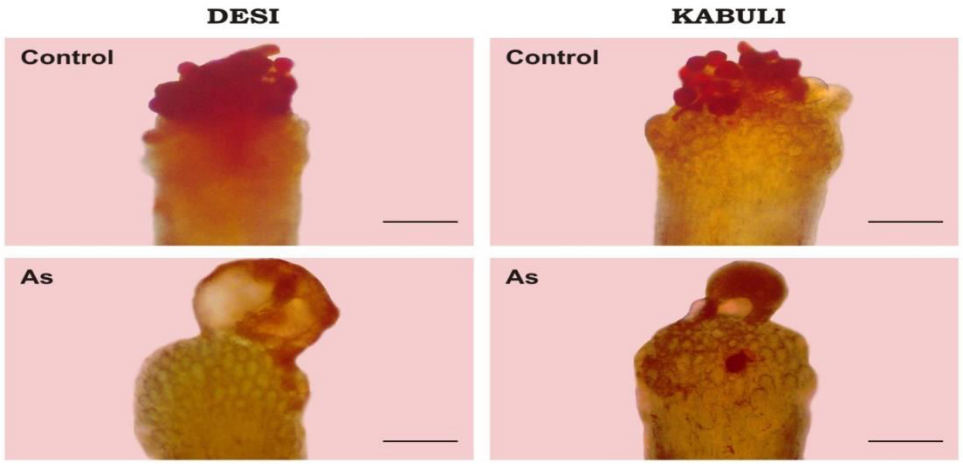


Fig. 9: Effect of Arsenic on stigma receptivity in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 0.7, Treatments – 0.7, Genotypes × Treatments – 1.0. Bars represent standard errors at 5% level (n = 3).

Plate 1



Effect of arsenic on stigma receptivity in Desi and Kabuli chickpea genotypes. Scale bar - 100µm



Effect of arsenic on stigma pollen load in Desi and Kabuli chickpea genotypes. Scale bar - 100µm.

(II) Pollen Load

Metal stressed plants showed a significant decrease in pollen load in both the genotypes, compared to controls. Decrease was observed to be higher in genotype (Fig 10, Plate 1).

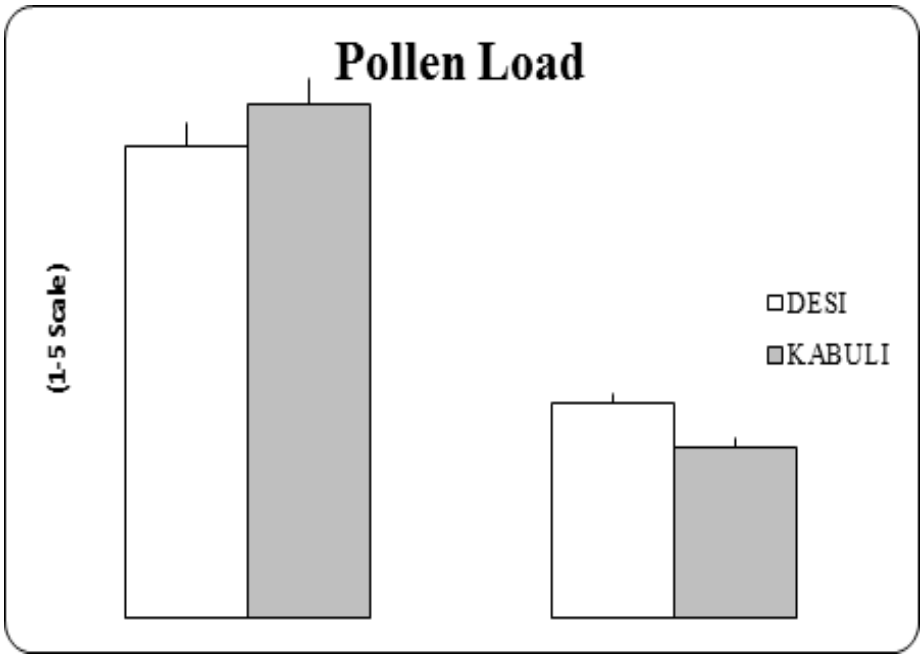


Fig. 10: Effect of Arsenic on pollen load in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 0.8, Treatments – 0.8, Genotypes × Treatments – 1.1. Bars represent standard errors at 5% level (n = 3).

(III) Pollen Viability

Normal pollen grains showed dense cytoplasmic content with uniformity in shape and size while non-viable pollen grains (unstained) show yellow colour. Significant reduction over control was observed in pollen viability with As, treatment in both the genotypes (Fig 11).

(IV) Pollen Morphology Using Scanning Electron Microscopy (SEM)

SEM studies of pollen grains showed a great difference in morphology of pollen architecture between control and stressed plants in both the genotypes. Pollens of healthy plants were observed to be in good shape and were healthy in look. Pollens of As treated plants were highly distorted (Plate 2).

(V) In Vitro Pollen Germination

Pollen grains were collected one day before anthesis and kept in the germination medium at 25°C for 24 hrs. and observed later for *in vitro* pollen germination. The germination percentage was calculated.

Significant reduction in pollen germination percentage over control was observed with As treatment. Level of inhibition was higher in *Kabuli* genotype compared to *Desi* genotype (Fig 12, Plate 3).

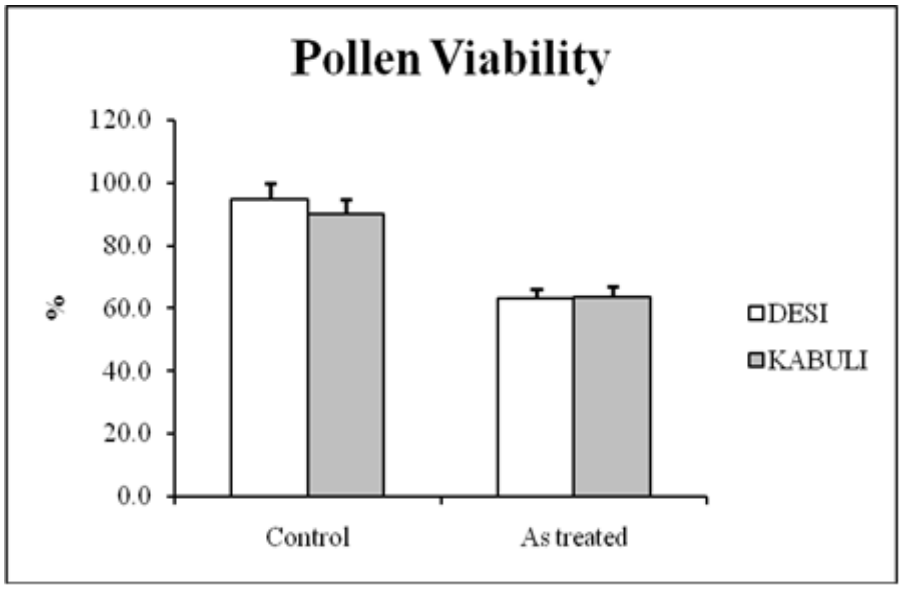


Fig. 11: Effect of Arsenic on pollen viability in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 3.1, Treatments – 3.1, Genotypes × Treatments – 4.4. Bars represent standard errors at 5% level (n = 3).

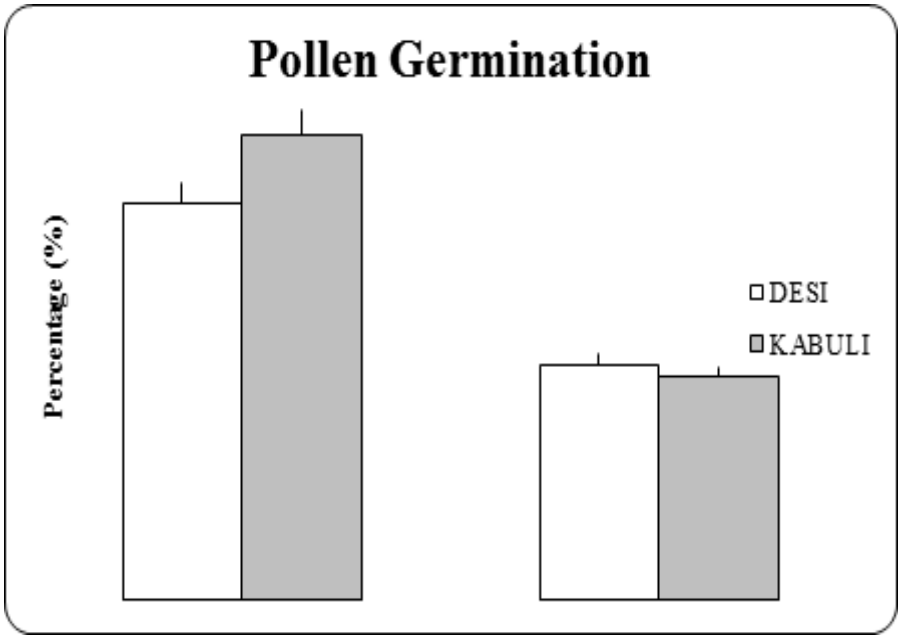


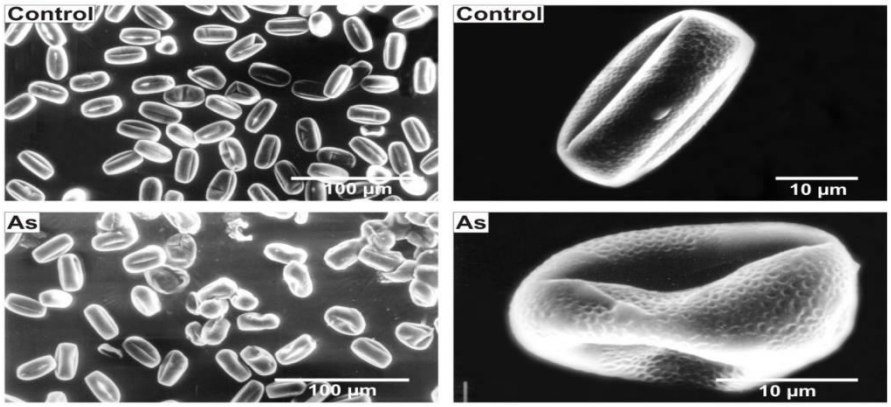
Fig. 12: Effect of Arsenic on in vitro pollen germination in *Desi* and *Kabuli* chickpea plants. LSD at 5%: Genotypes – 2.9, Treatments – 2.9, Genotypes × Treatments – 4.1. Bars represent standard errors at 5% level (n = 3).

(VI) In Vivo Pollen Tube Growth

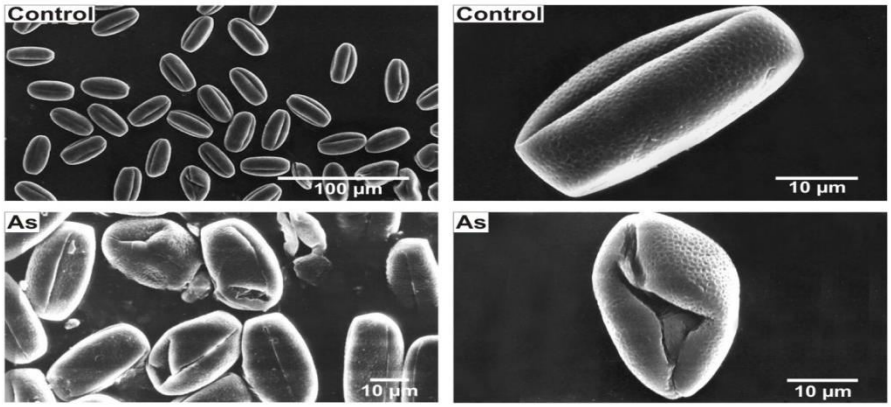
Fluorescence microscopy (FM) was done to see, the pathway of the pollen tube and whether it was able to reach the ovule for fertilization in case of stressed plants (untreated as well as treated). In As treated plants in both the genotypes, unlike control plants, the pollen tubes were not able to reach the ovule, they stopped growing after reaching the middle of the stylar tissue. Among both the genotypes inhibition to pollen tube growth was higher in *Kabuli* genotype (Plate 4,5).

 ISBN: 978-93-93810-06-9

Plate 2

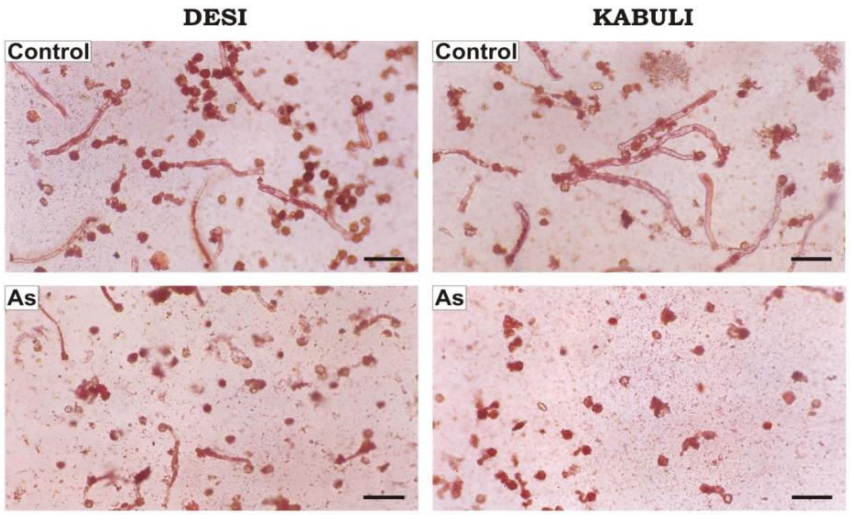


Effect of arsenic on pollen morphology of Desi genotype studied by Scanning Electron Micrograph.



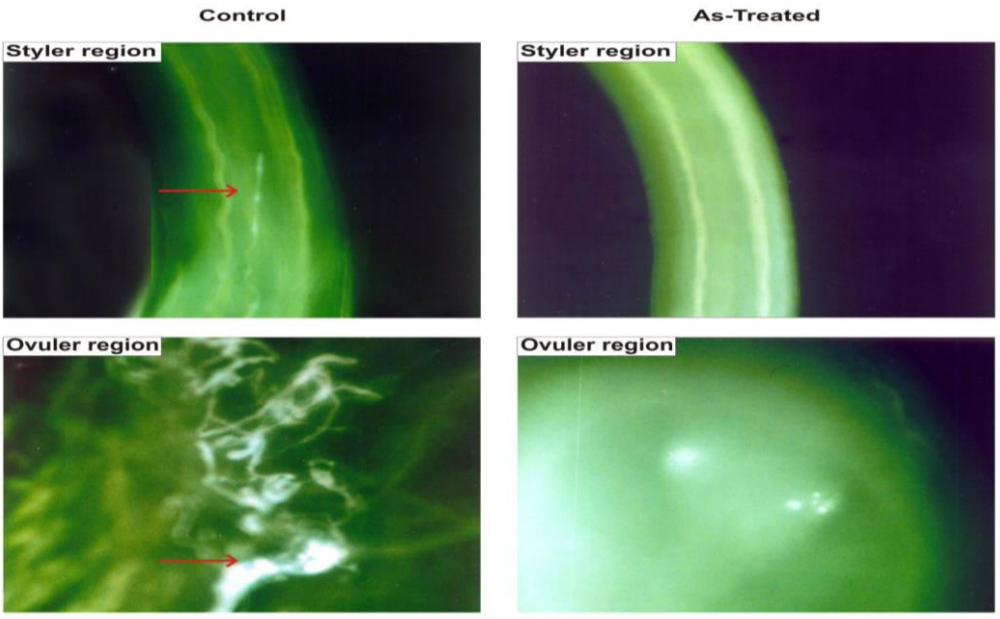
Effect of arsenic on pollen morphology of Kabuli genotype studied by Scanning Electron Micrograph.

Plate 3



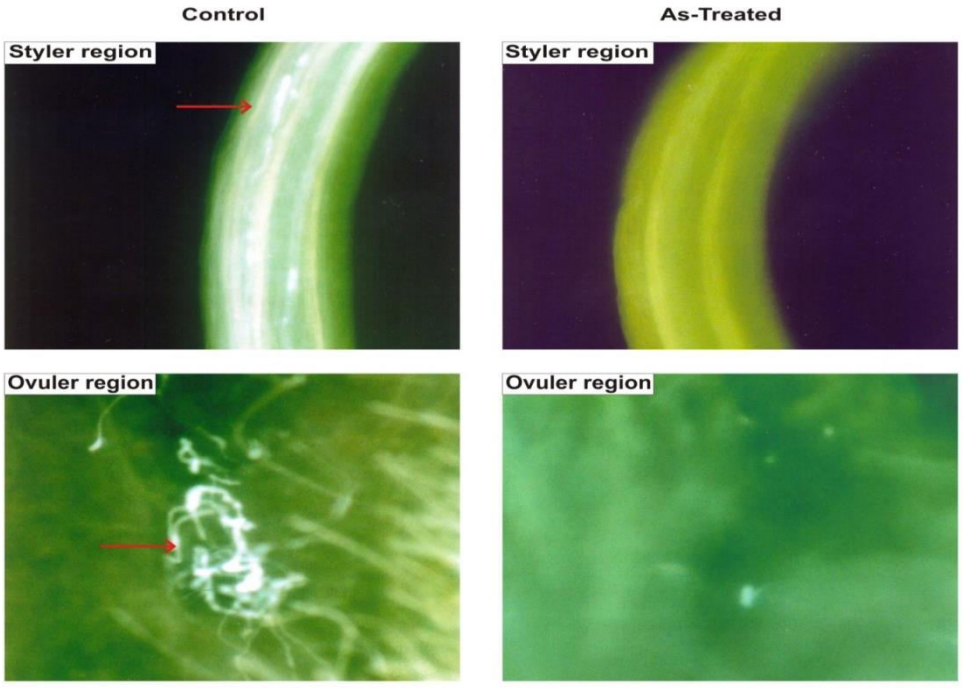
***In vitro* germination of pollens collected from plants treated with arsenic in Desi and Kabuli chickpea genotypes.**

Plate 4



Fluorescence micrograph shows pollen tube in styler and ovuler region of gynoecium in Desi genotype under arsenic treatment.

Plate 5



Fluorescence micrograph shows pollen tube in styler and ovuler region of gynoecium in Kabuli genotype under arsenic treatment.

DISCUSSION

A reduction in flower production was observed due to As treatment, with greater reduction in *Kabuli* genotype. Flower retention was also decreased with metal treatments. Pod set and pod retention percentage was also affected negatively with As.

Relatively, there are few reports on effects of heavy metals on flowering and podding response, as most of studies are restricted on seedling growth and yield. In a previous study, cadmium application was found to induce the reduction in the number of flowers in *mungbean* genotypes (Kumar and Dhingra, 2005). Chaudhry and Khan (2006) found a decrease in number of flowers with Hg application in *Lagenaria siceraria* (Mol.) Standl. and *Luffa cylindrica* L. In some cucurbits, Pb and Hg resulted in reduction in flowering potential (Chaudhry and Khan, 2006). Cd application was found to reduce the number of flowers in several crop species (Gupta *et. al.,*2007). In bean, Zeid (2001) observed reduction in pod number with application of heavy metals. The decrease in pod number in Chickpea with Cadmium treatment was also reported earlier by Hasan *et al.* (2008). In soybean, Cadmium treatment reduced the number of seeds per pod and mature seed mass (Malan and Farrant, 1998).

As a consequence of As-metal stress, a decrease in yield was recorded in both the genotypes. Yield loss due to As was higher in *Kabuli* genotype. Dewan and Dhingra (2003) reported decrease in seed and pod number in Cd-applied plants. Jalloh *et al*. (2008) reported reduction in rice grain yield under the influence of Cd. Singh and Aggarwal (2005) worked on effects of various heavy metals on several crop species. These authors reported reduction in yield and biomass of crops like radish, spinach, chickpea and pea with application of Cu, Zn, Pb and Cd. Siddhu *et al*. (2008) reported reduction in growth and yield of egg plant with Cd application. Wani *et al*. (2008) observed reduction growth and yield of pea plants growing in the presence of Cd, Cr and Cu. Sharma and Agarwal (2008) in mustard observed that the higher concentration (50 mg/kg soil) of Zn, Ni and Cd caused maximum reduction in growth and yield, the reduction was more pronounced with cadmium. Wani *et al*. (2007) investigated the phytotoxic effects of heavy metals on chickpea, grown in unsterilized soils. Cadmium at 5.75 and 11.5 mg/kg soil decreased the seed yield by 14 and 19%, respectively, compared with the control. In contrast, lead at 97.5 and 195 mg/kg soil increased the seed yield by 12.3 and 8.8%, respectively, above the control. Flowering in chickpea plants was delayed following metal application. The degree of toxicity of heavy metals on the measured parameters decreased in the following order: Cd, Zn, Ni, Cu, Cr and Pb. Accumulation of heavy metals was higher in the roots relative to the shoots of chickpea and was significantly correlated with the concentration of the metals added to the soil.

In rice, the reduction of grains per panicle is the main cause of grain yield loss under soil Cd stress (Liu *et al.,* 2007b). In another study on rice,the arsenic application as 10, 20, 30, 60, 90 mg of As kg^{-1} soil decreased the Chl. a and b contents (Rahman *et al.,* 2007). Well correlations were observed between chlorophyll content and rice growth and yield suggesting that arsenic toxicity affects the photosynthesis which ultimately results in the reduction of rice growth and yield. In wheat, the studies revealed that application of heavy metals in soil before sowing caused varying extent of reduction in yields of wheat. Mercury caused maximum reduction in biological as well as economic yields followed by Cu, Pb and Cd, while Zn did not affect the growth and grain yield of wheat markedly. The number of spikes/pot and grains/spike were reduced, while 1000 grain weight increased significantly by the application of copper, lead and cadmium in soil (Singh and Aggarwal, 2005).

Flower functioning was also affected negatively. Our results showed decrease in stigma receptivity and stigma pollen load due to As treatment. No reports are available on effects of heavy metals on stigma receptivity and pollen load. In this context our findings provide some new leads about damage to reproductive function by metals.

However, the effects of drought and salt on stigma receptivity and pollen load have been reported. Bassetti and Westgate (1993) noticed decrease in stigma receptivity in drought-stressed maize silks. Khan and Zaibunnisa (2003), reported decrease in stigma receptivity in salt stressed rice. Ravikumar *et al.* (2003), reported decrease in pollen load in drought stressed sorghum.

A reduction in pollen viability and subsequent damage to pollen architecture, germination and pollen tube growth was observed due to As-metal stress in both the genotypes. The decrease in pollen viability, change in its shape and size with Hg exposures has been also observed by Regis and Lagunzad (2002) in in four species of weed. Pollen grain abortion was manifested by reduced size and staining deficiency. All the four mercury exposed species showed higher pollen abortion rate compared to unexposed cohorts. Aborted pollen grains lack protoplasm, which may be due to physiological damage (Micieta and Murin, 1996).

Earlier studies on pollen germination and pollen tube growth also showed that heavy metals led to a decrease in pollen germination and pollen tube growth in various crop plants. Gür and Topdemir (2008) demonstrated heavy metals (Cd, Cu, Hg and Pb) led to a significant decrease pollen germination and tube growth of apricot and cherry. Reduction in pollen germination and tube elongation was higher with increased metal concentrations. They observed Cu to be most toxic followed by Hg, Cd while Pb had the least effect. Tuna *et al*. (2002) also observed similar effects of heavy metals (Ni, Fe, Pb, Co, Cd, Hg, Al, Zn and Cu) on pollen germination and pollen tube length in the tobacco plant (*Nicotiana tabacum* L.). The decrease in pollen germination and tube growth due to Cd in *Lilium longiflorum*and *Nicotiana tabacum* has been also observed (Sawidis, 2008). The presence of Cd reduces cell wall plastic extensibility and impairs normal cell elongation in growing pollen tubes, causing morphological and structural alterations (Sawidis, 2008).

Distortion in pollen morphology due to heat and drought stress has been also reported. Earlier such observations were also reported in *Phaseolus vulgaris*, where SEM was used to examine the morphology of anther and pollen wall architecture after heat stress (Porch and Jahn, 2001). Saini *et al.* (1984) also observed abnormalities in shape of the pollens of wheat plants stressed due to water or temperature.

These structural and functional abnormalities in male and female components caused by the metals possible contribute towards decrease in flower retention, pod retention and hence seed and pod yields. The damage to *Kabuli* genotype was found to be higher due to greater impact of metals in causing impairment in flower functions.

REFERENCES

1. Abedin, M.J., Cresser, M.S., Meharg, A.A., Feldmann, J. and Cotter-Howells, J. 2002. Arsenic accumulation and metabolism in rice (Oryza sativa L.). Environ. Sci. Technol., **36**: 962-968.

2. Bassetti, P. and Westgate, M.E. 1993. Water deficit affects receptivity of maize silks. Crop Sci.,**33**: 279-282.

3. Bhowmik, N. and Sharma, A. 1999. Effect of inorganic lead on growth and development of Hordeum vulgare L. pp. 1144-1145. In: Proceedings of the Fifth International Conference on the Biogeochemistry of Trace Elements (W.W. Wenzel, D.C. Adriano, B. Alloway, H.E. Doner, C. Keller, N.W. Lepp, M. Mench, R. Naidu and G.M. Pierzynski, eds.), vol. 2. Technical University, Vienna, Austria, 11-15 July 1999, International Society for Trace Element Research, Vienna.

4. Bleeker, P.M., Schat, H., Voojis, R., Verkleij, J.A.C. and Earnst, W.H.O. 2002. Mechanisms of arsenate tolerance in Cytisus striatus. New Phytol., **157**: 33-38.

5. Chaudhry, N.Y. and Khan, A.S. 2006. Improvement of pistillate flowers yield with GA_3 in heavy metals treated plants. Plant Growth Regul., **50**: 211-217.

6. Dewan, M. and Dhingra, H.R. 2003. Effect of cadmium on reproductive functions and yield in two varieties of pea (Pisum sativum) and their hybrid. Indian J. Agr. Sci., **73**: 221-224.

7. Dumas, R.S. and Knox, R.B. 1983. Callose and determination of pistil viability and incompatibility. Theor. App. Genet., **67**:1-10.

8. Gupta, S., Thakur, R. and Sahu, M. 2007. Cadmium as a pollutant in environment and agriculture. J. Ind. Pollut. Cont., **23**: 351-356.

9. Hasan, S.A., Hayat, S., Ali, B. and Ahmad, A. 2008. Homobrassinolide protects chickpea (Cicer arietinum) from cadmium toxicity by stimulating antioxidants. Environ. Pollut., **151**: 60-66.

10. Jalloh, M.A., Chen, J., Zhen, F. and Zhang, G. 2008. Effect of different N fertilizer forms on antioxidant capacity and grain yield of rice growing under Cd stress.J. Hazard. Mater., **162**: 1081-1085.

11. Khan, M.A. and Zaibunnisa, A. 2003. Reproductive physiology of two wheat cultivars differing in salinity tolerance under dense saline-sodic soil. Food Agric. Environ., **1**:185-189.

12. Kumar, S. and Dhingra, H.R. 2005. Sexual reproduction and cadmium partitioning in two mungbean genotypes raised in soils contaminated with cadmium. Indian J. Plant Physiol., **10**: 151-157.

13. Malan, H.L. and Farrant, J.M. 1998. Effects of the metal pollutants cadmium and nickel on soybean seed development. Seed Sci. Res., **8**: 445-453

14. Mattson, O., Knox, R.B., Heslop-Harrison, J. and Heslop-Harrison, Y. 1974. Protein pellicle of stigmatic papillae as a probable recognition site in incompatibility reactions. Nature, **247**:298-300.

15. Meharg, A.A. and Rahman, M.M. 2003. Arsenic contamination of Bangladesh paddy field soils: Implications for rice contribution to arsenic consumption. Environ. Sci. Technol., **37**: 229-234.

16. Micieta, K. and Murin, G. 1996. Microspore analysis for genotoxicity of a polluted environment. Environ. Exp. Bot., **36**: 21-27.

17. Porch, T.G. and Jahn, M. 2001. Effects of high-temperature stress on microsporogenesis in heat-sensitive and heat-tolerant genotypes of Phaseolus vulgaris. Plant cell & Environ., **24:** 723-731

18. Postek, M.T., Haward, K.S., Johnson, A.H. and McMichael, K.L. 1980. Scanning ElectronMicroscopy – A Students Handbook. Ladd Research Industries Inc., Williston, USA.

19. Rahman, M.A., Hasegawa, H., Rahman, M.M., Islam, M.N., Miah, M.A.M. and Tasmen, A. 2007. Effect of arsenic on photosynthesis, growth and yield of five widely cultivated rice (Oryza sativa L.) varieties in Bangladesh. Chemosphere, **67**: 1072-1079.

20. Ravikumar, R.L., Patil, B.S. and Salimath, P.M. 2003. Effect of gamete selection on segregation of wilt susceptibility. Euphytica, **133**: 371-376

21. Regis, E.G. and Lagunzad, D.A. 2002. Comparison of Pollen Grain Abortiveness in Four Weed Species Treated with Mercuric Chloride. Science Diliman, **14**: 21-27.

22. Saini, H.S., Sedgley, M. and Aspinall, D. 1984. Developmental anatomy in wheat of male sterility induced by heat stress, water deficit or abscisic acid. Aust. J. Plant Physiol., **11**: 243-253.

23. Sawidis, T. 2008. Effect of cadmium on pollen germination and tube growth in Lilium longiflorum and Nicotiana tabacum. Protoplasma, **233**: 95–106

24. Schmöger, M.E.V., Oven, M. and Grill, E. 2000. Detoxification of arsenic by phytochelatins in plants. Plant Physiol.,**122**: 793-802.

25. Sharma, S. and Agarwal, A. 2008. Effect of heavy metals (zinc, nickel and cadmium) on seed germination, total chlorophyll content and grain yield of mustard (Brassica juncea). Ecol. Environ. Conserv., **14**: 111-114.Siddhu et al. 2008

26. Singh, S. and Aggarwal, P.K. 2005. Effect of heavy metal fertilization on growth, yield and metal distribution in wheat. Indian J. Plant Physiol., **10**: 302-305.Tripathi et. al., 2007

27. Wani, P.A., Khan, M.S. and Zaidi, A. 2007. Impact of heavy metal toxicity on plant growth, symbiosis, seed yield and nitrogen and metal uptake in chickpea. Aus. J. Exp. Agric. **47**: 712-720.

28. Wani, P.A., Khan, M.S. and Zaidi, A. 2008. Effects of heavy metal toxicity on growth, symbiosis, seed yield and metal uptake in pea grown in metal amended soil. Bull. Environ. Contam. Toxicol., **81**: 152-158.

29. Xie, Z.M. and Huang, C.Y. 1998. Control of arsenic toxicity in rice plants grown on an arsenic-polluted paddy soil. Communications in Soil Science and Plant Analysis,**29**: 2471-2477.

30. Zeid, I.M. 2001. Responses of Phaseolus vulgaris to chromium and cobalt treatments. Biol. Plant., **44**: 111-115.

BIODIVERSITY AND SUSTAINABLE DEVELOPMENT

Kamlesh Kumar
Assistant Professor, Department of Geography, SGGSJ Govt. College Paonta Sahib-173025, H.P., India
kamleshsharma.ks657@gmail.com

ABSTRACT
In the present scenario the world around us is changing very rapidly in context of biodiversity. Biodiversity constitutes the living natural resources that are found inhabiting aquatic (including marine and fresh water) and terrestrial (including major biomes like forests) ecological systems. Biodiversity contributes to numerous ecosystem processes that support ecological, economic and social wellbeing. Biodiversity supports food security by providing raw genetic material for improved crop and livestock varieties. The biological wealth of our planet Earth has been declining rapidly due to global warming, deforestation, pollution, industrialisation, urbanisation and climatic change. There are many species of plants, animals, and birds which are endangered on our planet Earth. The developing countries which are rich in biodiversity but almost poor and struggling the global level challenges are under pressure to preserve it. Therefore, it is a big challenge before us to conserve the biodiversity, because the humans are participating in the race for more development, especially developed countries to gain more benefits, thus destroying the surrounding biodiversity. Generally, loss of biodiversity leads to decline the plant production which disturbs the life cycles of whole biotic organisms. At the first Rio-Janeiro Earth summit in 1992, the legal binding agreement was opened for signature as Convention on Biological Diversity (CBD). Recently, United Nation's Climate Change Conference was held in Glasgow (UK) from 31 October to 12 November 2021 and a new global agreement was ready. Although this agreement not legally binding, will set the global agenda on climate change for the next decade. It aims to reduce the worst impacts of climate change. The concept of sustainable development, comes from the Brundtland Report 1987. Sustainable development concept draws a road map that how we complete our needs of the present without compromising the ability of future generation to meet their own needs. Thus, sustainable development is necessary to conserve the biodiversity. This paper highlights the importance of biodiversity and requirement of sustainable development to conserve it.

***Keywords**: Biodiversity, Ecosystem, Planet, CBD, Sustainable development.*

INTRODUCTION
Biodiversity is the diversity of life on the Earth. Under this various species of flora and faunas are included. On the other hand, biodiversity includes not only various species on the earth but also consists of the specific genetic variations and traits within species as well as the various types of different ecosystems, marine and terrestrial, in which human being live and depend, such as coastal areas, forests, wetlands, grasslands, mountains, plains and deserts. In present scenario the world around us is changing very rapidly in context of biodiversity. There are various species of plants, animals and birds that's depend upon each other for food. There are many types of plants which are the habitats of various animals and birds. All the animals and birds depend upon the plants directly and indirectly for their food. Various species of flora and fauna work together to survive and maintain the balance of their surrounding ecosystem. For example, the grass eaten by cattle and cattle then produce manure that returns nutrients to the soil, which helps to grow more grass. This manure can also be used as organic fertilizer in fields to produce healthy and more productive crops. Thus, the species are interdepended upon each other and we have to preserve them from extinction for the balance of ecosystem.

In ancient time there were many varieties of birds and animals inhabiting the forest area and animals & birds were living without fear near/in the villages. Sometimes, men encroached the habitats of animals & birds to fulfil their ambition and needs. But after industrial revolution humans were more ambitious and they destroyed the natural habitats of many animals and birds rapidly by cutting the forests for various purposes. Therefore, many species of flora & fauna are on the verge of extinction and needs to be conserved.

Some regions of the world found more biodiversity than the others, such as Himalayan region, southeast Asia's region, Australian eastern coastal area, New Land's archipelago area, South Africa, Madagascar, Brazil, Mexico, Andes Mountain region, southwestern United States. Finding the variety of species shows that a particular place is rich in biodiversity and there is more ecological balance. If there is loss of biodiversity it indicates the imbalance of ecosystem. Biodiversity hot spots refers to the areas that are both rich for life and high risk for destruction. Biodiversity hot spots cover about less than 3 percent of Earth's land surface (According to National Geographic). There are various biodiversity hot spots recognized in the world (Fig. 1).

Fig. 1: Major Biodiversity hot spots of the world

In Asian continent the Himalayan region is the newest mountain in the world. This region inhabitants' various animals which are not found in other areas, such as giant panda, water buffalo and black necked crane. The area of south-eastern Asia is also full with variety of flora and fauna. The New Land archipelago is also important biodiversity hotspot as there are many species of insects and plants. The Andes Mountain is the world's most diverse hotspot with various species of plants in this region. The forests of Brazil are also full of flora and fauna and various species of plants, animals and birds are found there.

In India, two major biodiversity hot spots are identified i.e., (i) Eastern Himalayan Region, (ii) Western Ghats (Fig. 2). In India, 5% biodiversity is found whereas it occupies 2.5 % of total land of the world. There are various species of natural vegetation, animals, and birds in India. On behalf of biodiversity, India is one of the richest countries in the world. Although, there are many laws and acts are implemented in the country to protect the wild animals, birds, forests etc. and many national parks and sanctuaries are existing to conserve and preserve the biodiversity of India; yet due to over population, destruction of natural habitats, industrialisation, pollution, continuous decrease of density and area of forest, mining and hunting, global warming, the biodiversity in India is declining.

Most plants in a biodiversity hot spot are endemic forever on the earth. Yet, biodiversity hotspots are losing its original natural vegetation due to human activities. Today, much of the Earth's biodiversity has reached near to extinction and also even destroyed the ecosystems. Therefore, many species of animals and birds are in dangerous position and are fighting for their survival. There are many causes responsible for the loss of biodiversity such as:

Habitat Destruction: Due to human activities and encroaching in the area of animals, birds and others biotic organisms, their habitats have been destroyed. Deforestation, industrialisation, mining, cattle ranching, commercial fishing, agriculture, manufacturing and construction of dams destroys their natural habitats.

Deforestation: Deforestation refers to loss of forests. Expansion of agricultural area, shifting cultivation, cattle grazing, collection of forest wood and timber, road construction, fire in forests, are causes for deforestation and ultimately loss all biotic organism that's depended upon the forests.

Pollution: Pollution refers to decrease in the quality of natural environment and creates the imbalance of surrounding environment. There are many reasons for environment pollution such as - industries, transport services, thermal plants, oil refineries, factories, pesticides etc. All are polluting the soil, water and air, which are the bases of life for all biotic organism.

Population Explosion: In present time rapid growth of population in the developing and under developed countries from Asia, Africa, South America continents have reached the population explosion stage. Population explosion means an uncontrol in population numbers within specific time period. So, over population is a situation in which the resources are insufficient for overgrowing need of the people. The world population was estimated to 7.9 billion people as of November 2021 (According to Wikipedia). Therefore, over population is the main threat to the planet Earth. Meanwhile, industrial development in developed countries from North America and Europe continents is the main reason for environment pollution. Ultimately, the various species of flora and fauna are on the verge of extinction.

Fig. 2: Major Biodiversity hot spots in India

Global Warming: Gradually increase in the Earth's temperature caused by high levels of greenhouse gases in the atmosphere results in global warming. Various Human activities increase the level of many such gases - CO_2 (carbon dioxide), CFC (chloro-fluro carbon), CH_4 (methane), NO (nitrogen oxides) and depletion of Ozone layer. Effects of global warming are: increase in the sea level, many islands to be submerged into sea, increase in the natural hazards, loss of soil fertility, danger to coral life, shrink the sources of river, danger for biodiversity. Ultimately, it causes climatic changes which is responsible for destroying the biodiversity.

Sustainable Development: "Sustainable Development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." - Our Common Future/ Brundtland Report 1987.

In the ancient period the relation of human and its environment was quite harmonious. Invention of new things, greed of humans and over population are the threats to the planet because these factors are responsible for the environment degradation which in turn destroys the biodiversity. Humans used their environment indiscriminately to become more prosperous physically and to fulfil their greed. In present scenario humans become much ambitious and used their environment without thinking. He cuts the forests rapidly, increases industrial's area, constructs more dams and roads and utilises the natural resources rapidly without think and hesitation. So, there is a great concern for the environmental conservation. After destructive impact of industrial revolution in western countries, the various issues related to environment were raised in 1960 resulting into the protests against the government policy. Meanwhile, United Nations Conference on the human environment was held in Stockholm, the capital of Sweden, in 1972 with focus on international environmental issues, which reflected a growing interest in its conservation worldwide. This conference also laid the foundation for global environment governance.

In the concern surrounding ozone depletion, global warming and other environmental problems, the United Nations formed the World Commission on Environment and Development (WCED) under the chairmanship of Gro Harlem Brundtland (former Norwegian prime minister) which is also known as Brundtland Commission. It published the report "**Our Common Future**" also known as the "Brundtland Report", in 1987. The Brundtland Report included the sustainable development, economy, population, species, and ecosystem. Although UN organised many conferences on sustainable development and identified the Sustainable Development Goals (SDGs) and Millennium Development Goals (MDGs) and gave target to all member countries to achieve these Goals between 2015 and 2030, but most countries did not achieve there SDGs and MDGs within the time frame. Sustainable development takes cares about the ecological, social and economical aspects of development during the present scenario and conserve the resources to enable the future generations to use them. It takes into account the development of whole mankind which have common future.

CONCLUSION

Today we are great concerned about various environment related issues which are responsible for destroying the biodiversity. The main cause for this is human being. Therefore, sustainable development concept arises to save the planet for future life and in this connection many numbers of international conferences and summits related to environmental issues have been organised by UN. Recently, United Nations Climate Change Conference was held in Glasgow (UK) from 31 October to 12 November 2021 and a new global agreement was ready. Although, agreement formed was not legally binding, will set the global agenda on climate change for the next decade. Through this paper an analytical attempt has been made to relate biodiversity, its causes and conservation through the sustainable development. As humans are responsible for destroying the biodiversity therefore, steps to be taken to control the over population by implementing the effective population control policy. It is the need of the hour to spread the

awareness programmes related to environment protection and to conserve the biodiversity through sustainable development for achieving the millennium development goal.

REFERENCES

1. National Geographic
2. Wikipedia
3. Britannica
4. NCERT books
5. Dr. P. K. Salaria's textbooks: Resources and Environment, Environmental Geography.

CONTRIBUTION OF SACRED GROVES IN BIODIVERSITY CONSERVATION

Monika Panchani
Associate Professor, Department of Zoology, SVPC University, Mandi, H.P.-175001
monaharipanchani@gmail.com

ABSTRACT
Sacred Groves are considered as "Sacred Natural Sites" as per the definition of International Union for Conservation of Nature (IUCN). Sacred groves are the patches of forest that are left untouched by the local inhabitants which harbour rich biodiversity. Several plants including medicinal plants, animals and many threatened species are conserved in the sacred groves. These are protected by the local people due to their cultural and religious beliefs and taboos. The importance of sacred grove in nature conservation has been increased manifold after the declaration of Convention on Biological Diversity (CBD). One of the prime agendas for CBD is community-based conservation initiatives in which villagers participate. But with the passage of time there is degradation of sacred groves due to change in religious beliefs, taboos and peoples' perception towards them. Changing social structure is leading to declination of sacred grove system. Due to modernization the traditional worship places have been replaced by modern temples/solid structures. Encroachment in various sacred groves for agricultural practices and heavy influx of tourism and pilgrimage also leads to destruction of biodiversity. More over there is gap between these traditional knowledge and scientific understanding in new generation. We need to combine traditional knowledge with scientific reasons for the conservation of sacred groves for the sake of biodiversity conservation. This paper briefly reviews the studies on sacred groves in Himachal Pradesh particularly in Kullu District that could provide knowledge and aware the people about the importance of sacred grove in biodiversity conservation.

Keywords: *Sacred groves, Biodiversity, Traditional knowledge, Religious beliefs and taboos.*

INTRODUCTION
Sacred groves are the patches of forest that are left untouched by the local inhabitants which harbour rich biodiversity. These are considered as "Sacred Natural Sites" as per the definition of IUCN. Several plants including medicinal plants, animals and many threatened species are conserved in the sacred groves. These are protected by the local people due to their cultural and religious beliefs and taboos. Sacred groves are recognized as a system that informally forces traditional communities to protect natural resources in sustainable manner (Purthi and Burch, 2009). These groves possess a great heritage of diverse gene pool of many forest species which are ecologically and genetically important.

There are many protected areas and various *in-situ* and *ex-situ* conservation practices. Many laws governing the biodiversity conservation have also been enacted such as "The Biological Diversity Act 2002" by the Government of India. Besides these formal laws, there are many traditional conservation practices of indigenous communities in many parts of the world, which have contributed to the conservation and protection of biodiversity. The importance of sacred grove in nature conservation has been increased manifold after the declaration of Convention on Biological Diversity (CBD). One of the prime agendas for CBD is community-based conservation initiatives in which villagers participate. Traditional societies have co-evolved with their environment, maintaining it in a sustainable way based on their socio-cultural practices and religious beliefs (Gadgil and Berkes, 1991; Ramakrishnan, 1998). In Indian tradition the importance of nature is recognised, celebrated and valued. In the cultural history of India nature has been admitted, respected, feared and loved both for its instrumental and for its intrinsic value (James, 2000). These age-old institutions are still surviving all over the world and

help in conserving natural resources (Godbole and Samaik, 2004). The sacred groves are important reservoirs of biodiversity and play a major role in the environmental protection such as clean environment i.e., air, soil and water conservation, flora and fauna conservation, temperature control and conservation of traditional knowledge. This paper briefly reviews the studies on sacred groves in Himachal Pradesh particularly in Kullu District that could provide knowledge and aware the people about the importance of sacred grove in biodiversity conservation.

AIM

The main aims of the present study are:

- To document the sacred groves in Himachal Pradesh particularly in Kullu District and to study their importance in local and global context.
- To aware the people about the importance of sacred grove in biodiversity conservation.

METHODOLOGY

For the present study, literature survey was performed on the topic and articles related with the work were searched and thoroughly analyzed. Although, primary information with respect to sacred grove of local area and awareness about conservation of biodiversity has been collected from local people through interviews and observations.

DISCUSSION

Sacred groves are the repository of endemic species and can be regarded as the remnant of the primary forest left untouched (Anthwal, *et al.,* 2006). Sacred groves are not only the sacred ecosystems but also a product of socio-ecological philosophy (Anubhav, *et al.,* 2010). These are the home of local flora, fauna, gene pool and mini biosphere reserve (Deepamol and Khaleel, 2009). The sacred groves represent climax vegetation of rare and endangered species of plants (Singh et al., 2010). They possess rich diversity of medicinal plant and provide suitable habitat for their sustainable natural generation (Khumbongmayum, *et al.*, 2005).

Sacred Groves in Himachal Pradesh

Himachal Pradesh is known as the abode of Gods, the land of snow. State can be called the land of deities and sacred groves. It is situated in the northwest corner of India, in the lap of the Himalaya ranges, bordered by Jammu & Kashmir on the north, Punjab on the west and south-west, Haryana on the south, Uttaranchal on the southeast and by Tibet on the east. The Location – latitudes 30° 22' 40" N to 33° 12' 40" N and longitudes 75° 45' 55" E to 79° 04' 20" E. It has geographical area of 55,673 km^2 and constitutes 1.69% of India's area and 10.54% of Himalayas (Fig.1). In Himachal Pradesh, the local myths and legends associated with sacred groves go a long way in preserving the forests from destruction. There are several groves named *Dev Van* or *Devta Ka Jungle* where one is not allowed to cut trees or even carry dry leaves outside the area. According to WWF report (2016) about 329 sacred groves have been documented in Kullu and Shimla district in the state (Table 1). The thick forests provide a good habitat for leopards, barking deer, *ghorals*, black bears, hares, wolves and many more animals. Deodar, Kail and Oak, with occasional Spruce and Silver fir are among the most commonly found plant species in the sacred groves. Pheasants like *Khaleej, Monal*, and *Cheer* etc. are also found in the sacred groves. Other bird species like Red Vented Bulbul, Himalayan Bulbul, Yellow Billed Blue Magpie, Tree Creepers, Parakeets, Himalayan Thrush, Woodpeckers, Babbles, Warblers and Swifts are also found (WWF report, 2016).

About 109 sacred groves have been documented in the area Ani, Banjar, Kullu, Nirmand and Naggar in Kullu district. Sacred grove reported at highest altitude is Jagtham Rishi (Bagishadi, Banjar block) 3194m altitude and at lowest altitude is Devta Chambu (Dharopa, Nirmand Block) 900m (Fig 2). Sacred grove having largest area reported is Gautam Rishi (Manihar,

Kullu) 250 bigha and with smallest area is Renuka Mata (Tosh, Kullu Block) 1.5 Biswa (Fig 3). (WWF report, 2016).

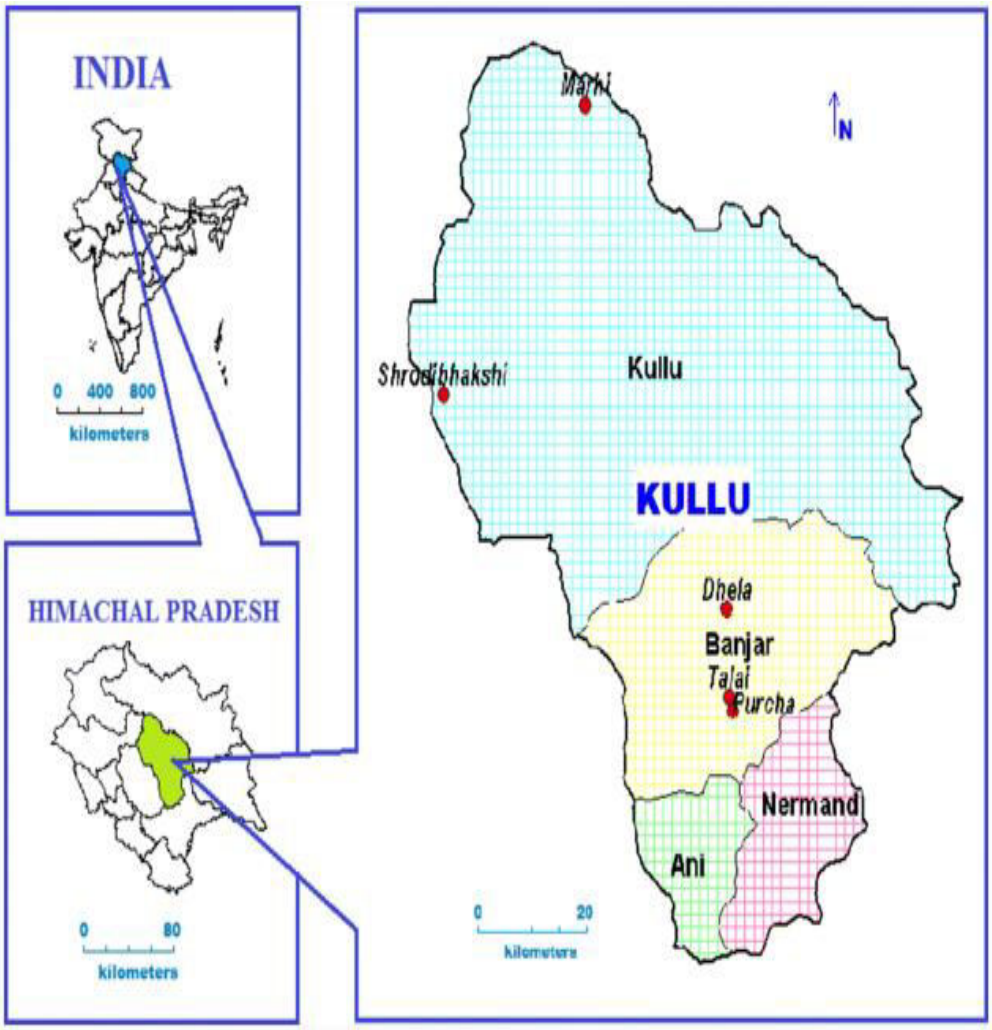
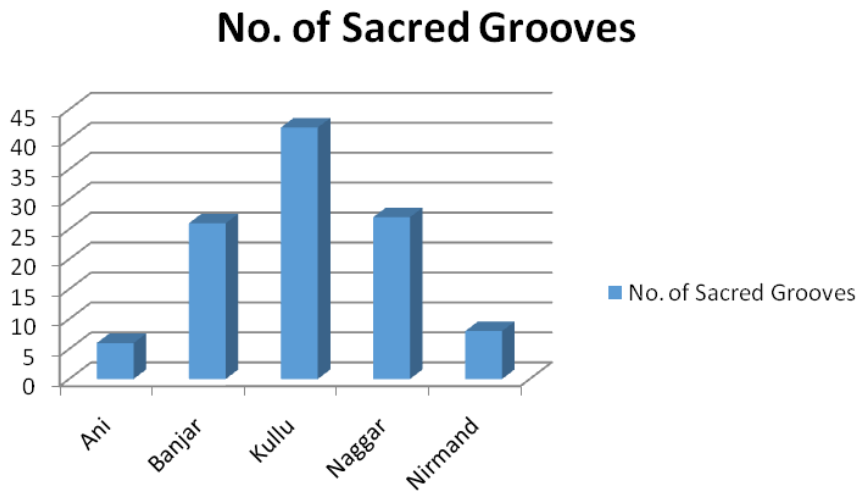


Fig: 1 Himachal Pradesh Map

Table 1: List of Sacred Groves in Kullu and Shimla regions of Himachal Pradesh

S.No	No. of Sacred Groves	Name of the Sacred grove	Location
1	1	Dev Kothi	Shimla
2	1	Devban	Kullu valley
3	300	Devta	Kullu valley
4	1	Lakyntang	Khasi and Jantia
5	1	Bakhu Devban	Up Tukka
6	1	Banaugi devta	Ringarishi
7	1	Hallan	Kullu
8	1	Railla	Kullu
9	1	Ringu Nag	Railla
10	13	Not Known	Theog sub- Division
11	8	Not Known	Rohru sub- division
Total	**329 groves**		

Source: Sacred Groves of Himachal Pradesh, Down to Earth, 31 December, 2003



S.NO	BLOCK	NUMBER
1	Ani	06
2	Banjar	26
3	Kullu	42
4	Naggar	27
5	Nirmand	08

Fig 2: Total sacred groves of District Kullu -109

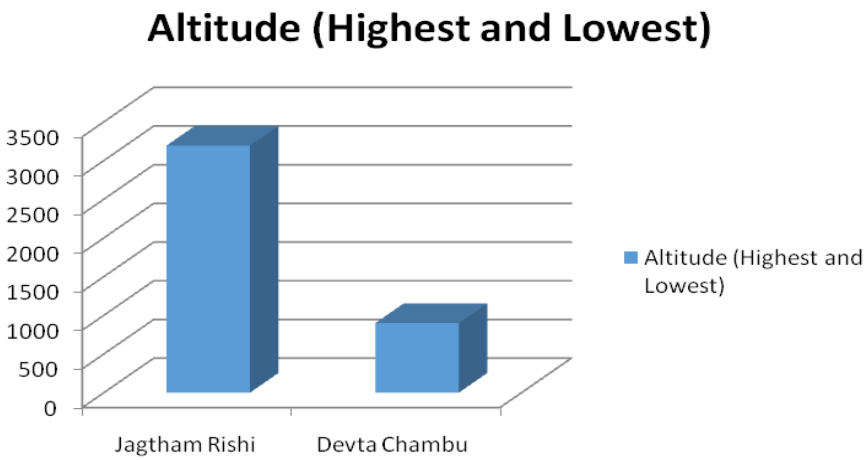


Fig 3: Highest Altitude: Jagtham Rishi (Bagishadi, Banjar bock) 3194 m altitude Devta Chambu 900m altitude Sacred Grove

Lowest Altitude: Devta Chambu (Dharopa, Nirmand Block) 900m

Largest Area: Gautam Rishi (Manihar, Kullu) 250 bigha

Smallest Area: Renuka Mata (Tosh, Kullu Block) 1.5 Biswa

Village Deities as Sacred Grove

Almost every village has a temple where they congregate for common worship (Mian 1999; Thakur, 1998). The institution of village Gods is the major custodian of the activities in a village society and the village God is the symbol of village culture. The village deities in Himachal

Pradesh are not simply objects of worship rather they govern all social, cultural, moral, economic, religious and political life of the village folk. They also play an important role in water conservation and other natural resources. Many problems related to environmental degradation have been solved by obeying the rules of local deity which are environment friendly. This spiritual knowledge and beliefs of villagers develops the environmental attitudes and values and contributes in environment conservation (Panchani, M., 2016).

There are about 10,000 temples in the State with well-defined management committees and *Biradari Panchayats* (caste councils). Almost all the major deities in the state have their own groves and hence the state can be called as land of deities and sacred groves (Sharma, 2005). It is estimated that there are over 300 *devta*s in the Kullu valley. Naturistic and animistic forms such as *Nag* (snakes), *Vanshiras* (forest guardians), and Jognies (fairies) as well as various Gods of the Hindu pantheon are worshipped as *devta*. Temples are usually located inside the sacred grove and are surrounded by thick forests, in some cases temples are either in the village or outside the sacred grove. Temples like *Hadimba mata, Nag devta* and *Jogini mata* surrounded by rich forest in Manali are examples of sacred grove (Fig 4). Most of the groves are managed by the temple committees. The temple committee comprises of *Kardar*, *Pujari, Bhandari* and *Gur*. The *Kardar* manages affairs, *Pujari* performs *Puja* and other rituals, *Gur* is the spokesperson of the deity and *Bhandari* looks after the store. The people have a firm, almost a blind belief in the village deities, rather the deity is a divinity, called *deo* or *devta.* There are many incidents of intervention in the decisions of policy making and day to day activities in the village by the local deity. These interventions of local deity directly or indirectly help in conserving environment and biodiversity (Panchani, M., 2016).

Fig 4: Village Deity Hadimba Mata Temple in Dungri Manali as Sacred Grove

Dev Van as Sacred Groves

Sacred groves in Himachal Pradesh are called *dev-van* or *Devta ka Jungle* are dedicated to a particular deity (Fig 5). The *dev van* of Kullu valley in Himachal Pradesh are an integral part of the *devta* system, a unique socio-cultural religious institution of this region. No one is allowed to cut the trees or even extract dry leaves from the area, there are many groves in which human entry is also restricted. The wood from the sacred grove is mainly used for maintenance of the temple or as fuel for cooking community feast. Kullu *dev van* are generally Himalayan moist temperate forests typical in this region between 1600 and 3000 m altitude. The main trees found are deodar (*Cedrus deodara*), kail (*Pinus excelsa*), and oak (*Quercus incana, Q. dilatata, Q. semicarpifolia*) with occasional spruce (*Picea smithiana*) and silver fir (*Abies pindrow*). The upper reaches of Sainj and Tirthan valleys in Kullu were declared the Great Himalayan National Park in 1982. The Park authorities instituted a number of Eco-Development Committees in villages along the park boundary. Many local NGOs have also built their activities around

programmes of conservation and sustainable use. In *Bakhu dev van* opportunities are provided to educated village youth to create networks with conservationists, documentary film makers, non-governmental organisations and researchers to record and highlight traditional/ indigenous/ community conservation successes (Vassan & Kumar, 2006).

Fig.5: *Dev van as* Sacred Grove

Importance of Dev Van in Biodiversity Conservation

There are rules restricting the access to resources and forbidding them through religious belief, ritual, and social convention which in fact help biodiversity conservation. Trees have long been protected or conserved through religious taboo, values, and practices (Pandey, 2003). There are a number of plants, animals, forests and lakes that are regarded as sacred and no exploitation is carried out there. People are not allowed to enter the forest area for human activities. Sacred groves or sacred trees serve as a home for birds and mammals, and hence, they indirectly help in the conservation of living organisms (Islam *et al.* 1998). People Believe in trees to be the abode of gods and ancestral spirits; rules and customs are framed to endure their protection. These rules varied from grove to grove but often prohibited the felling of trees, collection of any material from the forest floor, and killing of animals. Hunting and logging are usually strictly prohibited within these patches. Other forms of forest usage like honey collection and deadwood collection are sometimes allowed on a sustainable basis. Sacred groves did not enjoy protection via federal legislation in India. However, the introduction of the protected area category community reserves under the Wild Life (Protection) Amendment Act, 2002 has introduced legislation for providing government protection to community held lands, which could include sacred groves. Conservation of sacred groves contribute in the maintenance of local and regional biodiversity and preservation of the sociocultural integrity of local communities (Anthwal *et al,* 2010; Bhagwat *et al,* 2008). The sacred groves act as small less disturbed islands of vegetation supporting endemic and endangered plant and animal species (Chatterjee *et al.,* 2000).

Causes of Degradation of Sacred Groves

With the passage of time there is degradation of sacred groves due to change in religious beliefs, taboos and peoples' perception towards them. Lack of awareness towards long term future benefits has resulted in the destruction of sacred groves. Traditional ways of resource management are becoming nonfunctional due to direct conflict between ever increasing human population and limited natural resources. In the modern educational system, younger generations are not being sensitized, for local traditions and beliefs, and the cultural importance of sacred groves. Many now view the practices of the past as old and outdated. Some of the main causes and threats are given below:

- Human impact on sacred groves like rapid urbanization, developmental activities.
- Increase in population pressures leads to habitat degradation.

- Exploitation of resources, Forest fragmentation.
- Encroachment in various sacred groves for agricultural practices and heavy influx of tourism and pilgrimage also leads to destruction of biodiversity.
- Changes in people's attitudes and socio-cultural practices.
- Erosion of religious beliefs and traditional values. Due to modernization the traditional worship places have been replaced by modern temples/solid structures.

Strategies to Conserve the Groves

We can adopt some methods for the conservation of biodiversity and sacred grove by developing and managing ICCAs (Indigenous Community Conserved Areas), or creating Biodiversity Management Committees (BMC). Local people can be encouraged to maintain the record in People's Biodiversity Registers (PBR) as registries of local biodiversity knowledge. Awareness programme for conservation management of resources within the sacred groves can be organised at panchayat level. For sustainable management of the groves specific groups of local people like *Yuwa mandal*, *Mahila mandal* with forest department can work together along with panchayat and local deity system. Moreover, we need to focus on maintaining the following:

- Ecological balance
- Gene bank for indigenous species
- Conservation of biodiversity
- Managing the natural resources
- Ecodevelopment CCA (Community Conserved Areas)

CONCLUSION

The sacred groves play an important role in ecosystem services such as clean environment i.e., air, soil and water conservation, flora and fauna conservation, temperature control and conservation of traditional knowledge. The sacred groves improve the soil stability of the area thus preventing erosion. Further these habitats maintain microclimate, enhance nutrient cycling and maintain in situ conservation. The *dev van* of Kullu valley in Himachal Pradesh which are an integral part of the *devta* system, a unique socio-cultural religious institution are well known examples of sacred groves. The village deities in Himachal Pradesh are not simply objects of worship rather they govern all social, cultural, moral, economic, religious and political life of the village folk. They also play an important role in the conservation of biodiversity and other natural resources. Therefore, culture has a role to play in developing sustainable management practices as an asset because shared values may generate higher levels of co-operation, commitment, communication and the participatory decision making essential for the conservation of sacred groves. But now a days, there is gap between these traditional knowledge and scientific understanding in new generation. For sustainable development we need to combine traditional knowledge with scientific reasons for the conservation of sacred groves to protect the biodiversity.

REFERENCES

1. Anthwal, A., Sharma, R.C and Sharma, A. (2006). Sacred Groves: Traditional way of Conserving Plant Diversity in Garhwal Himalaya, Uttaranchal. The Journal of American Science **2** (2), 35- 43.
2. Anthwal, A., Gupta, N., Sharma, A., Anthwal, S. and Kim, K.H. (2010). "Conserving biodiversity through traditional beliefs in sacred groves in Uttarakhand Himalaya, India," Resources, Conservation and Recycling, **54**(11), pp 962–971.

3. Anubhav. Singh, K., Rastogi, A and Singh, V. (2010). Sacred Groves in India: Celebrating Sanctity of Life through Biodiversity Conservation.

4. Bhagwat, S. A., Cheppudira, G., Kushalappa, Paul, H. W. & Brown, N.C. (2005). A landscape Approach to Biodiversity Conservation of Scared groves in the Western Ghats of India. Conservation Biology **19** (6),1853- 1862.

5. Bhagwat, S., Kushalappa, C., Williams, P. and Brown N. C. (2008). "The role of informal protected areas in maintaining biodiversity in the Western Ghats of India," Ecology and Society, **10**(1), article 8.

6. Chatterjee, S., Sastry, A. R. K., Roy, B. N and Lahon, R. (2000). "Sacred groves of Sikkim and Arunachal Pradesh," in Abstract, National Workshop on Community Strategies on the Management of Natural Resources, Bhopal, India.

7. Chhatra, A., Lothiyal, T. and Sharma, V. (1998). Nature in Retreat: Development and Conservation in Himachal Pradesh. Mimeo, WWF India, New Delhi.

8. Deepamol, P.S. & Khaleel, K.M. (2009). Comparison of Floral Diversity in Fresh water and salt water wetlands Sacred Groves of Kannur District. Journal of Phytology **1**(5), 299-301.

9. Gadgil, M. and Vartak V.D. (1976). The sacred groves of Western Ghats in India. Economic Botany **30**, 152–160

10. Gadgil, M. and V.D. Vartak. (1981a). Sacred Groves of Maharashtra: An Inventory. In: Glimpses of Indian Ethno-Botany (ed. S.K. Jain). Oxford and IBH, New Delhi.

11. Gadgil, M. and V.D. Vartak (1981b). Studies on Sacred Groves along the Western Ghats from Maharashtra to Goa: Role of Beliefs and Folklore. In: Glimpses of Indian Ethno-Botany (ed. S.K. Jain). Oxford and IBH, New Delhi.

12. Gadgil, M. and Vartak, V.D. (1975). Sacred Groves of India: A Plea for Continued Conservation. Journal of Bombay Natural History Society **72**(2): 313-320.

13. Godbole, A. and Sarnaik, J. (2004). Tradition of sacred groves and contribution in their communities. Applied Environment Research Foundation, Pune.

14. Islam, M. A. and Hoque, A.E. (1998). Species composition of sacred groves, their diversity and conservation in Bangladesh. pp 163-165.

15. James, 2000 James, G. A. (2000). Environment ethics and biodiversity prioritization in India.in Setting Biodiversity conservation priorities for India. Edited by Shekhar Singh et al. WWF-India. Vol. II, pp 672-679.

16. Kala, C.P. (2011). Traditional ecological knowledge, sacred groves and conservation of Biodiversity in the Pachmarhi biosphere Reserve of India. Journal of Environment Protection **(2)**, 967-973.

17. Kalam, M.A. (1996). Sacred Grove in Kodagu District of Karnataka (South India); a socio Historical Study, Institute Francais de Pondichery, Pondicherry.

18. Khumbongmayum, A.D., Khan, M. L & Tripathi, R.S. (2005). Ethnomedicinal plants in the sacred groves of Manipur. Indian Journal of traditional knowledge **4**(1), 21-32.

19. Mian Goverdhan Singh 1999. Wooden temples of Himachal Pradesh. Indus Publishing company, New Delhi 151 pp.

20. Panchani, M. (2016). Rural People of H. P. and Role of Local Deities Assisting in Environmental Conservation. Voyager: Vol. VII, 1-8.

21. Pandey, 2003 Pandey, A. and Rao, P.V. 2002. Impact of globalization on culture of sacred groves: A revival of common, but decay of the tradition institution. Paper submitted for the Ninth Biennial conference of IASCP 17- 21 June 2002.

22. Pruthi, I. Burch Jr. W. (2009). A Socio- Ecological Study of Sacred Groves and memorial parks: Cases from USA and India. International Journal of Environmental Science and Engineering **1**(1), 7-14.

23. Sharma, B. R (2005). Socio-religious role of the institutions of village gods in the western Himalayan Society-Institute of Integrated Himalayan studies, H.P. University Shimla. pp 1-23.

24. Singh, H., Husain, T & Agnihotri, P. (2010). Haat Kali sacred grove, Central Himalaya, Uttarakhand. Current Science **98** (3): 290.

25. Thakur, M.R. 1997. Myths, rituals and beliefs in Himachal Pradesh. Indus Publishing New Delhi. 188 pp.

26. Unnikrishnan, E. (1990). Part played by the sacred groves in local Environments, Centre for science and Environment, New Delhi.

27. Vasan, S. (2006). Living with Diversity. Forestry Institutions in the Western Himalaya. Indian Institute of Advanced Study, Shimla.

28. Vasan, S. (2002). Community Forest Management: Historical Legacy of Himachal Pradesh in Where mortals and mountain gods met; Society and culture in Himachal Pradesh Ed. L. Thakur. IIAS, Shimla. pp 30-48.

29. Vasan, S. and Kumar, S. (2006). Situating Conserving Communities in their Place: Political Economy of Kullu Devban. Conservation and Society, **4**(2), 325-346

30. World Wide Fund for Nature (2016). Progress Report on Sacred Groves of Kullu and Shimla Ref. letter No.: SCSTE/SBB-6242 Dated 22-11-2016.

31. WWF (World Wildlife Fund) (1996). Sacred and Protected Groves of Andhra Pradesh. WWF, New Delhi.

GRAPHENE QUANTUM DOTS: PROSPECTS AND APPLICATIONS

Poonam Siwatch
Assistant Professor, Department of Physics, Arya Kanya Mahavidyalaya, Shahabad (M), Haryana, 136135, India
siwatchpoonam@gmail.com

ABSTRACT
Graphene, a two-dimensional inorganic compound, is gaining importance in recent years due to its certain features such as high mechanical strength, excellent electrical conductivity and availability. It can be used as nanofiller for synthesis of polymer nanocomposites. In graphene family, Graphene quantum dots (GQDs) are the youngest and emerging superstars. GQDs have unique opto-electrical properties. Also, non-zero bandgap, very good dispersibility, tunable properties, and biocompatibility make them suitable for various applications. GQDs have found numerous applications in various fields such as catalysis, energy devices, sensing, drug delivery, and bio-imaging. Ideal GQDs consist of only one atomic layer of carbon atoms. However, the synthesized GQDs possess multiple atomic layers (size less than 10 nm) and also contain functional groups like oxygen, hydrogen etc. Due to its small size, GQD has a good prospect in biomedical applications in comparison to graphene or graphene oxide (GO). But, before using GQDs for practical applications, their biocompatibility and toxicity are still the main issues. Several studies reveal that GQDs have good biocompatibility and lesser bio-toxicity. Due to this rapidly evolving field, there is an urgent need to identify the emerging challenges of GQDs in recent advances. This study provides a discussion of recent advances in synthesis, properties and applications of GQDs. Also, current challenges and future prospects of GQDs are highlighted.

Keywords: *Graphene, Quantum dots, Prospects, Energy devices; Biotoxicity.*

INTRODUCTION
Graphene is a new type of nanomaterial with excellent mechanical, electrical, thermal, and optical properties gaining importance nowadays. Graphene can be synthesized by many methods, such as micromechanical stripping [Novoselov, 2004], chemical vapour deposition (CVD) [Kim, 2017], SiC epitaxial growth [Heer, 2007], and graphene oxide (GO) reduction [Obata, (2017)]. Owing to large plane conjugate structure of graphene, the π electrons have a delocalization effect and hence graphene possesses a zero-band gap limiting its application in the optoelectronic devices and semiconductors. Graphene quantum dots (GQDs) have a single atomic layer and contain carbon only. But in actual practice, most of the synthesized GQDs also contain oxygen and hydrogen, and have multiple atomic layers (sizes < 10 nm). The band gap of the GQDs can be controlled within 0 to 6 eV by changing the size or surface chemical properties, due to the quantum confinement effect and the edge effect [Zhu, 2015]. GQDs have the hexagonally symmetrical crystalline structure with the in-plane lattice spacing of 0.24 nm, exactly the same as that of graphene [Chen, 2012]. The GQDs possess stable fluorescence properties, low toxicity and good water solubility [Zhu, 2017]. The photoluminescence mechanism of GQDs is due to the quantum confinement effect of conjugated π-domains, the surface/edge state in GQDs. GQDs have found numerous applications in various fields such as catalysis, energy devices, sensing, drug delivery, bio-imaging and solar cells. Also, GQDs have a better potential application in biological medicine than graphene or graphene oxide due to the smaller size. Few researches also suggest that GQDs have relatively good biocompatibility and low biological toxicity. Till date, there had been many reviews on GQDs. Li *et al.* [Li, 2017] used acid oxidation and solvothermal reactions, for the synthesis of GQDs. Li *et al.* [Li, 2013] used the top-down strategies, which have the benefits of abundant raw materials, mass

production, and simple operations. Here, the latest research progresses on the preparation and applications along with current challenges and future prospects of GQDs are reviewed.

Synthesis Methods of GQDs

GQDs can be generally synthesized by both the processes- top-down and bottom-up approaches. The bottom-up synthesis techniques of GQDs need complex reaction steps and specific organic materials, making it difficult to optimize the conditions. So, top-down approach is generally used, in which large blocks of carbon materials are cut into small pieces. Moreover, the raw material (carbon materials) needed is cheap and easy to obtain. For synthesis of GQDs by top-down approach, several methods have been used in literature, such as oxidative cleavage, hydrothermal method, electrochemical oxidation, ultrasonic assisted process, chemical vapour deposition etc. The methods using bottom-up approach includes microwave method, molecular carbonization and electron beam irradiation (EBI) methods

Chemical Oxidation Method, also known as oxidative cleavage method, is a very frequently used technique, in which carbon bonds of graphene, graphene oxide or carbon nanotubes are usually destroyed by H_2SO_4, HNO_3 or other oxidants [Gu, 2018]. Owing to strong oxidants use such as H_2SO_4 and HNO_3, the oxidative cleavage method is not very safe, and the generated chemical waste pollutes the environment also.

Hydrothermal or Solvothermal Method is a simple and fast method for synthesis of GQDs. The underlying principle is to break the bonds between carbon materials to form GQDs by application of high temperature and high pressure. Tian *et al.* [Tian, 2016] synthesized GQDs using H_2O_2 in N, N-dimethylformamide (DMF) environment by this method. In this preparation, the use of concentrated H_2SO_4 and HNO_3 to treat raw materials was eliminated completely. The photoluminescence signal showed a good stability under different pH conditions, suggesting its broad application prospects in different environments. This method has the advantage of having low cost, high yield, no requirement for purification and simple experimental setup.

In Electrochemical Oxidation Method, carbon–carbon bonds of graphite, graphene, or carbon nanotubes are oxidized and decomposed into GQDs at high redox voltage (1.5 V - 3 V). For controllable and efficient preparation of crystalline GQDs in aqueous systems, a weak electrolyte (e.g., ammonia solution) electrochemical method has been developed to enhance the oxidation and cutting process, thus achieving high yield of GQDs. Chen *et al.* synthesized boron-doped graphene quantum dots (BGQDs) by potentiostatic electrolysis [Chen, 2017]. The GQDs prepared by this method has high stability, but the pre-treatment of raw materials and the purification of GQDs products is time consuming, and the quantum yield is also low.

Chemical Vapour Deposition is a widely used technique to make 2D nanomaterials and thin films. In this process, the precursors, gas or vapour, can react or decompose on the preselected substrate at high temperature and vacuum in a chamber. Lee *et al.* [Lee, 2012] prepared the uniform GQDs using self-assembled polystyrene-b-polydimethylsiloxane (PS-PDMS) block copolymers (BCPs) as an etch mask on graphene films grown by chemical vapor deposition (CVD).

Ultrasound Assisted Method is also a common method for material synthesis. Under the action of ultrasound, thousands of small bubbles will be formed in the liquid, and the mechanical force thus produced can destroy the carbon–carbon bonds cutting into GQDs. Gao *et al.* [Gao, 2017] synthesized three kinds of GQDs- pristine graphene quantum dots (PGQDs), expanded graphene quantum dots (EGQDs) and graphene oxide quantum dots (GOQDs)- using natural graphite, expanded graphite, and oxide graphite as the base materials in a supercritical CO_2/H_2O system assisted by ultrasound. This method is also an environmentally friendly, low-cost, fast and mass-scale synthesis method of GQDs.

Microwave Method has become a fast-heating synthesis method as the hydrothermal method takes a long reaction time. It has not only shortened the reaction time, but also increased the yield. Zhang *et al.* [Zhang, 2016] by using aspartic acid and NH_4HCO_3 as the raw materials and deionized water as the solvent, purified GQDs by microwave irradiation (for 10 min). This method shortens the time for synthesizing GQDs, and can be doped with various elements.

Molecular Carbonization method is an environment friendly and simple method which uses suitable organic molecules or polymers for dehydration and further carbonization. Bayat *et al.* [Bayat, 2017] synthesized low cost and high yield green single-layer graphene quantum dots (SLGQDs) using DI water as solvent and glucose as precursor. The synthesized SLGQDs (~8 nm) were uniformly dispersed without any aggregation. Also, Teymourinia *et al.* [Teymourinia, 2017] prepared GQDs (20-30 nm) with corn flour as green precursor.

Electron Beam Irradiation (EBI) Method requires expensive equipment and has the risk of being injured by radiation, so it has not been widely used. Wang *et al.* [Wang, 2017] synthesized single crystal fluorescent GQDs by EBI at room temperature.

Applications of GQDs

Sensors

As the interaction between GQDs and certain substances can cause fluorescent intensity of the GQDs to be reduced, so a variety of chemical and biological sensors can be designed to detect heavy metal ions, small organic or inorganic molecules, biological molecules etc. Wang *et al.* [Wang, 2012] made use of GQDs to detect Fe^{3+} ions. Fan *et al.* [Fan, 2012] investigated the detection of trinitrotoluene (TNT) in solution, based on the fluorescent quenching of GQDs by TNT. It suggests that TNT is adsorbed on the surface of the GQDs by a π-π interaction, and fluorescence resonance energy transfer is caused by molecular dipole-dipole interaction, reducing the fluorescence intensity of GQDs. Li *et al.* [Li, 2012] designed electrochemical fluorescent sensors to test Cd^{2+} ions, using the electrochemical fluorescence emission properties of the GQDs. Also, GQDs have high electrical conductivity, good dispersibility, and a large specific surface area and is useful for the biological molecules to load on its surface. So, Shehabab *et al.* [Shehabab, 2017] prepared GQDs via glucose carbonization for a non-enzymatic glucose sensor. Ju *et al.* [Ju, 2014] synthesized blue luminescent nitrogen-doped graphene quantum dots (N-GQDs) by hydrothermal treatment of citric acid and dicyandiamide which can be used as efficient fluorescent probes for the detection of glutathione.

Bio-Imaging

GQDs play important role in the field of bio-imaging owing to their excellent fluorescence properties and the low cytotoxicity. Dong *et al.* [Dong, 2012] used GQDs in cell imaging of human breast cancer cell line MCF-7. This work depicts that the cell membrane, cytoplasm, and nucleus can be marked with fluorescence by GQDs. As we know, there had been no direct effective technology for imaging of stem cells for a long time, due to the particularity of the stem cells. GQDs were used in imaging of stem cells by Zhang *et al.* [Zhang, 2012]. Three different kinds of stem cells were cultivated, and the results suggested that GQDs can smoothly enter into the stem cells. Moreover, GQDs were not observed in the nucleus, showing that it will not cause genetic disruption of the stem cells and hence less toxic. Ge *et al.* [Ge, 2014] suggested a photodynamic therapy (PDT) agent based on GQDs which can produce singlet oxygen by a multistate sensitization process, resulting in highest quantum yield of PDT agents.

Solar Cells

Due to size-dependent band gap tuning properties, better dispersion, high chemical stability, and low toxicity of GQDs, these have benefits for applications in solar cells compared with other materials such as silicon and perovskite. Moreover, GQDs have the quantum confinement effect and edge effect, which suits well to solar cells. To date, many kinds of GQD-based solar cells

have been reported, such as the use of hole transport layer material, silicon/GQD hetero-junction solar cell and conductive polymer-doped GQD solar cell. Researchers have focused on the use of GQDs as an electron-hole transfer material and as a tuner of the band gap. Li *et al.* [Li, 2013] prepared GQDs with a uniform size distribution through solution chemistry. The introduction of these GQDs into a bulk hetero-junction polymer solar cell (PSC) results in a significant enhancement of the power conversion efficiency (5.24%). Kundu *et al.* [Kundu, 2017] reported efficiency of $11.7\% \pm 0.2$ and a fill factor of 71% for dye-sensitized solar cells after modifying the TiO_2 photoanode with N,F,S-co-doped GQDs. An upward shift in the Fermi level has been detected, probably responsible for the improved performance along with the possibility of preventing the back electron transfer from TiO_2.

Drug Delivery

Graphene or graphene-based nanomaterials have been reported for drug delivery and release in order to improve delivery efficiency and enhance therapeutic effects. In comparison to graphene, GQDs have improved water solubility, lesser cytotoxicity, larger surface area and massive capabilities of surface functionalization. All these properties make GQDs more effective as drug molecular loading cores. GQDs also provide more bonding sites for chemotherapeutic conjugation and improved cell uptake ability. Moreover, the π-orbitals in the sp^2-hybridized GQD lattice can be used to bond drugs containing an aromatic ring structure through π–π stacking, without covalent conjugation, allowing wide applications of GQDs for drug delivery. GQDs were proved to be able to cross the blood–brain barrier (BBB) and prevent α-synucleinopathy in Parkinson's disease without surface functionalization. Although considerable progress has been made in targeting drug delivery systems to deliver anticancer drugs to specific sites of interest, new nanomaterials are often developed and explored for better drug delivery efficiency [Zhao, 2020].

Other Applications

GQDs can be used to prepare photoelectric detectors and light emitting diode devices because of their strong size dependent optical properties [Sofia, 2016]. Using density functional theory, it has been found that the band gap of GQDs can reach about 7.4 eV. So, GQDs can be added as a conductive material to the electrode in supercapacitors due to their good conductivity, large specific surface area and ease of doping and modification. The luminescent properties of GQDs promote their biological applications such as bio-imaging, biosensors, and cell isolation techniques. Also, the chemical groups and dopants provide GQDs intrinsic catalytic properties through band gap alignment, synergistic cooperation and promotion of charge transfer [Li, 2015]. Also, the development of GQDs for energy conversion and storage has been reported by Liu *et al.* [Liu, 2020].

CONCLUSIONS

In this review paper, the superior qualities of GQDs over other materials have been discussed. Then basic methods of synthesis of GQDs have been explained. The basic method for making GQDs is cleavage of carbonaceous materials by repeated oxidation and reduction (i.e., top-down approach). Also, other ways including controllable synthesis and carbonization have been discussed. In GQDs preparation methods, hydrothermal methods are generally combined with chemical oxidation methods for breaking down larger molecules such as graphite, fullerene, carbon nanotubes, crop biomass. The microwave method has the advantages of short reaction time, simple operation, cheap equipment, and no pre-treatment of raw materials. Nowadays, the hydrothermal process is the environmentally friendly approach, but strong-acidic treatment of graphite is the method by which mass production can be achieved. Then probable applications of GQDs in various fields have been explored. However, the research on the GQDs is still in its infancy, compared to graphene. There is still a long way to go and a wide space is available for exploration to researchers. There are still many challenges waiting to be settled. It is a challenge

to find scaled but easy preparation method for the production of high quality GQDs. Also, elaborative and convincing explanation of the PL mechanism of GQDs is not there and it is still not known the effect of size, doping, crystallinity, and surface functionalization, on the optical properties. An in-depth experimental verification and theoretical calculations are needed. Also, it is also vital to find the defects/sites, most appropriate for tuning the interactions and the reaction mechanism. The use of GQDs should be explored more in potential applications. For instance, in bio-imaging, long-wavelength emission is more suitable for biological window, but quantum yield of GQDs is less by long wavelength excitation. So, new methods for mass production of GQDs with long emission wavelengths are desired. Also, the size and surface molecules are required to be fine-tuned for efficient devices preparation. All these issues should be taken into consideration for further development.

REFERENCES

1. Bayat, A., Saievar-Iranizad, E. (2017). Synthesis of green-photoluminescent single layer graphene quantum dots: determination of HOMO and LUMO energy states. Journal of Luminescence **192**, 180–3.
2. Chen, L., Wu, C., Du, P., Feng, X., Wu, P., Cai, C. (2017). Electrolyzing synthesis of boron-doped graphene quantum dots for fluorescence determination of Fe^{3+} ions in water samples. Talanta **164**, 100-9.
3. Chen, S., Liu, J.W., Chen, M.L. (2012). Unusual emission transformation of graphene quantum dots induced by self-assembled aggregation. Journal of Chemical Communications **48,** 7637-7639.
4. Dong, Y., Chen, C., Zheng, X. (2012). One-step and high yield simultaneous preparation of single-and multi-layer graphene quantum dots from CX-72 carbon black. Journal of Materials Chemistry **22**, 8764-8766.
5. Fan, L., Hu, Y., Wang, X. (2012). Fluorescence resonance energy transfer quenching at the surface of graphene quantum dots for ultrasensitive detection of TNT. Talanta **101**, 192-197.
6. Gao, H., Xue, C., Hu, G., Zhu, K. (2017). Production of graphene quantum dots by ultrasound-assisted exfoliation in supercritical CO_2/H_2O medium. Ultrasonics Sonochemistry **37,** 120-7.
7. Ge, J.C., Lan, M.H., Zhou, B.J., Liu, W.M., Guo, L., Wang, H. (2014). A graphene quantum dot photodynamic therapy agent with high singlet oxygen generation. Nature Communications **5**, 4596.
8. Gu, S., Hsieh, C.-T., Chiang, Y.-M., Tzou, D.-Y., Chen, Y.-F., Gandomi, Y.A. (2018). Optimization of graphene quantum dots by chemical exfoliation from graphite powders and carbon nanotubes. Materials Chemistry and Physics **215**, 104-111.
9. Heer, W.A., Berger, C., Wu, X. (2007). Epitaxial graphene. Solid State Communications **143**, 92-100.
10. Ju, J., Zhang, R.Z., He, S.J., Chen, W. (2014). Nitrogen-doped graphene quantum dots-based fluorescent probe for the sensitive turn on detection of glutathione and its cellular imaging. RSC Advances **4**, 52583-52589.
11. Kim, K.S., Weman, H., Sang, W.L., Hwang, J.Y., Lee, W.K., Nam, S., Dong, H.S. (2017). Chemical vapour deposition of graphene on platinum: growth and substrate interaction. Carbon **111**, 733-740.

12. Kundu, S., Sarojinijeeva, P., Karthick, R. (2017). Enhancing the Efficiency of DSSCs by the modification of TiO_2 photoanodes using N, F and S, co-doped graphene quantum dots. Electrochimica Acta **242**, 337-343.

13. Lee, J.S., Kim, K., Park, I.K. (2012). Uniform graphene quantum dots patterned from self-assembled silica nanodots. Nano Letters **12**, 6078-6083.

14. Li, F., Kou, L., Chen, W. (2013). Enhancing the short-circuit current and power conversion efficiency of polymer solar cells with graphene quantum dots derived from double-walled carbon nanotubes. NPG Asia Materials **5**, e60.

15. Li, K.H., Liu, W., Ni, Y. (2017). Technical synthesis and biomedical applications of graphene quantum dots. Journal of Materials Chemistry B **5**, 4811-4826.

16. Li, L.L., Ji, J., Fei, R. (2012). A facile microwave avenue to electro chemiluminescent two-colour graphene quantum dots. Advanced Functional Materials **22**, 2971-2979.

17. Li, L.L., Wu, G.H., Yang, G.H. (2013). Focusing on luminescent graphene quantum dots: Current status and future perspectives. Nanoscale **5**, 4015-4039.

18. Li, X.M., Rui, M.C., Song, J.Z. (2015). Carbon and graphene quantum dots for optoelectronic and energy devices: a review. Advanced Functional Materials **25**, 4929-4947.

19. Liu, Q., Sun, J., Gao, K., Chen, N., Sun, X., Ti, D., Bai, C., Cui, R., Qu, L. (2020). Graphene quantum dots for energy storage and conversion: from fabrication to applications. Materials Chemistry Frontiers **4**, 421.

20. Novoselov, K.S., Geim, A.K., Morozov, S.V. (2004). Electric field effect in atomically thin carbon films. Science **306**, 666-669.

21. Obata, S. (2017). High crystallinity graphene synthesis from graphene oxide. Carbon **114**, 750.

22. Shehabab, M., Ebrahima, S., Solimana, M. (2017). Graphene quantum dots prepared from glucose as optical sensor for glucose. Journal of Luminescence **184**, 110-116.

23. Sofia, P., Emilio, P., Eugenia, M.F. (2016). Graphene and carbon quantum dot-based materials in photovoltaic devices: from synthesis to applications. Nanomaterials **6**, 1-20.

24. Teymourinia, H., Salavati-Niasari, M., Amiri, O., Safardoust-Hojaghan, H. (2017). Synthesis of graphene quantum dots from corn powder and their application in reduce charge recombination and increase free charge carriers. Journal of Molecular Liquids **242**,447-55.

25. Tian, R., Zhong, S., Wu, J., Jiang, W., Shen, Y., Jiang, W., Wang, T. (2016). Solvothermal method to prepare graphene quantum dots by hydrogen peroxide. Optical Materials Express **60**, 204-8.

26. Wang, D., Wang, L., Dong, X. (2012). Chemically tailoring graphene oxides into fluorescent nanosheets for Fe^{3+} ion detection. Carbon **50**, 2147-2154.

27. Wang, L., Li, W., Wu, B., Li, Z., Pan, D., Wu, M. (2017). Room-temperature synthesis of graphene quantum dots via electron-beam irradiation and their application in cell imaging. Chemical Engineering Journal **309**, 374-80.

28. Zhang, C., Cui, Y., Song, L., Liu, X., Hu, Z. (2016). Microwave assisted one-pot synthesis of graphene quantum dots as highly sensitive fluorescent probes for detection of iron ions and pH value. Talanta **150**, 54-60.

29. Zhang, M., Bai, L., Shang, W. (2012). Facile synthesis of water-soluble, highly fluorescent graphene quantum dots as a robust biological label for stem cells. Journal of Materials Chemistry **22**, 74610-7467.

30. Zhao, C., Song, X., Liu, Y., Fu, Y., Ye, L., Wang, N., Wang, F., Li, L., Mohammadniaei, M., Zhang, M., Zhang, Q., Liu, J. (2020). Synthesis of graphene quantum dots and their applications in drug delivery, Journal of Nanobiotechnology **18**, 142.

31. Zhu, C., Yang, S.W., Wang, G., Mo, R.W. (2015). Negative induction effect of graphite N on graphene quantum dots: tunable band gap photoluminescence. Journal of Materials Chemistry **C 3**, 8810-8816.

32. Zhu, S.J., Song, Y.B., Wang, J. (2017). Photoluminescence mechanism in graphene quantum dots: quantum confinement effect and surface/edge state. Nano Today **13**, 10-14.

SUSTAINABLE DEVELOPMENT: ISSUES AND CHALLENGES IN INDIA

Pradeep Singh Tomar
Assistant Professor, Department of Economics, Dr. Y.S. Parmar P.G. College, Nahan, Distt Sirmour, H.P.-173001
tomarpradeep1976@gmail.com

ABSTRACT
The term sustainability literally means "a capacity to maintain some entity, outcome or process overtime" and carrying out activities that do not exhaust the resources on which that capacity depends. Development is a process whose output aims to improve the quality of life and increase the self-sufficient capacity of economies that are technically more complex and depend on global integration. Fundamental purpose of this process is a creation of stimulating environment in which people will enjoy and have long and creative life. Development and sustainability are two fundamental elements of the concept of sustainable development.

Keywords: *Sustainable development, Stimulating environment, Creative life*

INTRODUCTION
The term sustainable development was first coined in 1972 at the United Nations conference on human environment at Stockholm. It is improving the quality of life of the present generation without excessive use of natural resources so that they can be preserved for the future generations. Sustainable development is often referred as the marriage between economy and ecology i.e., to attain economic development without compromising the ecological balance. Sustainable development means different things to different people.

Sustainable Development: Meaning &Features
"Sustainable Development is the development that meets the needs of the present generation without compromising with the needs of future generations." This definition was put forward by the Brundtland Commission in its report "Our Common Future" in 1987. It calls for a concerted effort to build an inclusive, sustainable, and resilient ecosystem for the people and the planet.

The Main Features of Sustainable Development Include
1. Increase in per capita income
2. Judicious use of natural resources
3. Preserving the resources for future generations

The concept of sustainable development is based on the concept of development (socio-economic development in line with ecological constraints), the concept of needs(redistribution of resources to ensure the quality of life for all) and the concept of future generations (the possibility of long run usage of resources to ensure the necessary quality of life for future generations).

The essence of the concept of sustainable development derives from the triple bottom lines which implies the balance between three pillars of sustainabilitynamely: social, economic and environmental.Environmental sustainability focus on maintaining the quality of life of people;social sustainabilityensures human rights and equality, preservation of cultural identity, respect for cultural diversity, race and religion and economic sustainability is necessary to maintain the natural, social and human capital required from income and living standards. Complete sustainable development achieved through a balance between all these three pillars.

Three Aims of Sustainable Development

Economics to attain balance growth i.e., Growth, efficiency and the optimum use of resources.

Ecological to preserve the ecosystem and environment.

Social to provide equal access to resources to all human beings i.e., equity, empowerment and social cohesion.

Sustainable development involves the development of better future for the society, economy and environment. In simple words sustainable development means linking the economy with society and environment and to save the resources and environment for the future generations.

Sustainable Development Index (SDI):

SDI is an efficiency metric, designed to assess the ecological efficiency of nations in delivering human development.

$$SDI = \frac{Development\ Index}{Ecological\ Impact\ Index}$$

Development index follows the base formula of the Human Development Index (HD1), with a sufficiency threshold on income.

Development Index = (Life expectancy index & Education index) x (Income index).

Goals of Sustainable Development

The main goals of sustainable development are to ensure sustainable development particularly for financial resources; maintaining peace and security in the world, protecting the human rights and fundamental freedom, promoting the international law, eradicating poverty and unemployment, reduction of inequality and promoting the mutual tolerance and cooperation, provide basic human needs to all people (home, food, water, and clothing etc.). Rational and controlled use of resources focused on renewal and long-term usage, protection and conservation of nature, raising ecological awareness, stopping population growth using industry and technology in line with environmental requirement.

In the agenda 2030, adapted by most of the counties of the world focus on the following 17 main goals of sustainable development:

1. No poverty
2. Zero hunger
3. Good health and well being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Clean energy
8. Decent work and sustainable economic growth
9. Industry innovation and infrastructure
10. Reduction in inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action

14.Life below water

15.Life on land

16.Peace, justice and strong institutions

17.Partnerships to achieve the goals

Overall development of humanity over the last decades has led to the increasingly unfavorable climate change, natural disasters, socio-economic and political instabilities through their action. Human have negatively impacted the environment endangering the survival on the earth and the future generation. These conditions have indicated changes in the behaviour aiming towards more rational and efficient management of all resources that will allow less pressures and environmental impact. Such responsible behaviour that ensures the long-term exploitation of resources without jeopardizing future generations is considered within the concept of sustainable development. Any country's environmental problems are related to the levels of its economic development, the availability of natural resources and the lifestyle of its population.

In India, rapid growth of population, poverty, unemployment, inequality, urbanization, industrialization and several related factors are responsible for the rapid degradation of the environment. Environment problems have become serious in many parts of the country. The main environment problems in India are related to air and water pollution particularly in metropolitan cities and industrial zones; degradation of common property resources which effect the poor adversely as they depend on them for their lively hood; threat to biodiversity and inadequate system of solid waste disposal and sanitation with consequent adverse effect on health, infant mortality and fertility rate. In India efforts are being made on the environmental management in a sustainable manner.

Key Issues of Sustainable Development in India

Key issues of sustainable development in India are as follows:

1. Explosive increase in population and human resources:

a) World population may reach the 8 billion marks by 2025 and projected to increase around 2 billion by 2050

b) The most rapid population growth is in Asia, Africa and Latin America

2. Food security

3. Continuing problem of pollution

4. Loss of forests and biodiversity

5. Solid waste disposal

6. Degradation of environment

7. Global warming and climate change

8. Clean and safe drinking water

9. Productive land

10.Good quality food stuff

11.Growing water scarcity

12.Loss of waste management

13.Urbanization in the Himalayas

14. Depletion of resources (land, air and water)
15. Degrading air quality index

In case of income inequality, India is the second most unequal country in the world after Russia asin November 2016. The richest 1% of Indians own 58.4% of wealth. Again, unemployment is a major social issue in India and approximately 31 million people are jobless as on September-2018 (Ministry of labor and employment, Government of India).

Main Challenges in Achieving the Goals of Sustainable Development in India:
The main challenges to sustainable development in India which are also global in character includes poverty exclusion, unemployment, climate change, conflict and humanitarian aid, building peaceful and inclusive societies, building strong institution of governance for supporting the rule of law. The main challenges which India faces to achieve the goal of sustainable development are as bellow:

1. Ending poverty and hunger, achieving food security and improved nutrition and promote sustainable agriculture by 2030.
2. Control population and improve the standard of living of their people so as tomaximize the social and economic welfare of their people.
3. Ensuring inclusive and equitable quality education and promoting life-long learning opportunities for all by 2030.
4. Ensuring availability and sustainable management of water and sanitation for all by 2030.
5. Promoting sustainable, inclusive and economic growth, full and productivity employment and decent work for all.
6. Sustainable per capita economic growth in accordance with national circumstances and in particular attained at least 7% per annum GDP.
7. Promote inclusive and sustainable industrialization.
8. Encouraging innovation by developing quality infrastructure.
9. Reducing inequality within and among countries by 2030.
10. Making cities and human settlement inclusive, safe and sustainable by 2030.
11. Ensuring sustainable consumption and production patterns.
12. Taking urgent action to store and mitigate climate change.
13. Providing access to justice and peace for all and promote effective, accountableand inclusive institution at all levels.

The pandemic has challenged the health infrastructure adversely, impacted livelihoods and exacerbated the inequality in the food and nutritional availability in the country.

Priority Areas for Achieving Sustainable Development
Following are the priority areas for achieving sustainable development:

1. **Slow Down Population Growth:** This is essential for addressing all the other priority areas.
2. **Reduce Poverty, Inequality and Third World Debt:** Improving health, longevity and literacy, increasing employment etc. This is important for curbing the loss of species, the extent of land degradation and water pollution.

3. **Make Agriculture Sustainable:** This includes reducing soil erosion anddecreasing the use of harmful agricultural practices. This is important forcurbing the loss of biodiversity, land degradation and pollution.
4. **Protect Forests and Other Habitats:** This includes reforestation and afforestation of wastelands, protection of other living resources, control greenhouse gases and ozone layer depletion. This is important for reducing air pollution, land degradation, depletion of energy and minerals.
5. **Make Water and Energy Usesustainable:** This includes improvedenergy efficiency, conserving energy and developing renewable energyresources. This is important for reducing air pollution, land degradation, depletion of energy and minerals.
6. **Make Wateruse Sustainable:** This includes improving the efficiency of water use and protecting water quality. This is important for curbing water pollution and its depletion and land degradation.
7. **Reduce Waste Generation:** This includes improving production processes, waste treatment and recycling processes. This is important for reducing air and water pollution and energy, mineral and water depletion.

Measures Taken by India to Implement Sustainable Development

Since 2015 [when the United Nations, along with other countries, adopted the Sustainable Development Goals (SDGs)] the Indian government has launched several flagship programs that are at the heart of SDGs. Some of these include *Swachh Bharat* Mission, Skill India, Make in India, Digital India, etc.

Agenda 2030 and Sustainable Development in India

Our national development target must be an image to SDGs implementing agenda 2030 in a fast-track mode. Government has released a draft of three years action agenda covering years 2017-18, 2018-19 and 2019-20. Reflecting India's commitment to SDGs, agenda at the highest level of the government, Indian parliament organized several forums including South Asia speaker's summit in February 2017. These forums have central focus on poverty, no hunger, gender equality, climate change and resource mobilization for SDGs. Implementing SDGs agenda, government has initiated series of national programmes such as "*Pradhan Mantri Jan Dhan Yojana*" which is one of the largest programs of financial inclusion globally. Government has been working effectively on strengthening decentralization which has brought an ecosystem of cooperative and competitive federal governance.

Initiatives Taken By the Governmentof India to Achieveagenda 2030

- India's commitment to Paris climate agreement is one of the bold documents to act on sustainable development goals of climate action.
- India has set a voluntary target to reduce carbon emission by33-35% of the GDP by 2030 (from 2005 level), should be seen as a prospective of advance implementation of agenda 2030.
- Government's firm commitment of proposing a total greenhousegas emissionsby 2.5 to 3.0 billion tonesby 2030, through additional forest cover, taping renewal energy etc. could be seen as a step forward to implement climate action agenda properly.
- Sustainable development goals provide one the armaments for fighting poverty, ways to generate employment, household purchasing, to access services, clothing, education and help government finance spending. India has continued its economic reforms to achieve sustained accelerated growth.

- In the area of education, there is a national mission for quality primary education as "the right to education" which entitles a framework for all children (6-14years) to access free compulsory education without any discrimination.
- India is committed to ensure affordable housing facility to the urban poor by 2022 (*Pradhan Mantri Awas Yojna*). Again, *Pradhan Mantri Ujjwala Yojana,* launched in 2016 is providing the rural marginalized households access to LPG connections for cooking. So far, 8 crore eco-friendly cooking LPG connections have been dispersed to the poor.

Air pollution has emerged as a serious issue in India. Government has launched national yearwise program to address country's issue of air pollution in comprehensive manner. To measure the progress regarding the attainment of sustainable development in India *NITI Aayog* has been set up with single measurable index to track the progress of states and UTs across the goals of sustainable development. This index helps states and UTs, which aggregate towards each sustainable development goals. Kerala and Himachal Pradesh are front runners among the states of India and Tamil Nadu is also progressing very fast.

Sustainable consumption and production are also a priority of government of India and is reflected in various policies/programs like Make in India, Zero Effect Zero Defect, Smart Cities, *Swatch Bharat*, Ganga Rejuvenation Mission etc. Resource efficiency has emerged as one of the key strategies towards the 2030 agenda of achieving sustainable development goals. India has been actively promoting clean energy and clean technology as well as continuing the flagship schemes on combating climate change in both adoption and mitigation fronts.

TERMINOLOGY

1. Development: A stage of advancement
2. Sustainability: A process which can be continued indefinitely without depleting the resources base on which it depends.
3. Environment: Biotic (living) and abiotic (non-living) components.
4. Biodiversity: The diversity of and in livingnature.
5. Global warming: Increase in the global temperature.
6. Climate change: Change of climate which is attributed directly or indirectly tohuman activity that alters the composition of the global atmosphere.
7. Sustainable developmentindex
8. Development index
9. Ecological impact index

REFERENCES

1. Todaro Michael P & Stephen C Smith, "Economic development: The Environment and development, 2008, pp 463-464.
2. Kapila Uma, Indian Economy: Performance & Politics, 2006, pp 46-52.
3. Economic survey: 2018-19&2019-20, Vol-l & II, Government of India, Ministry of Finance, New Delhi.
4. OECD (2007), Institutionalizing sustainable development, OECD sustainable developmentstudies, OECDpublishing, Paris.
5. UNDP (2007), Human development report 2007-2008, Fighting climate change: Human solidarity in a divided world, Palgrave Macmillan, New York.

6. Strange Tracey & Anne Bayley, Sustainable Development, Linking Economy, Societyand Environment, OECD, 2008.
7. UNDP, Sustainable development Goals, 2015.
8. Ramakrishna B.M. &Jayasheela, Environmental problems and sustainable development withspecial reference to India: issues and challenges. Journal of Global Economy, ResearchCentre for Social Science, Mumbai, Vol 6(2), 2010.
9. Bharucha, E., Textbook of Environmental Studies for Undergraduate Courses, Universities Press (India) Private Limited, Hyderabad, 2005.
10. Botkin, D. B. & Keler, E. A., Environmental Science: Earth as a Living Planet, New Delhi, Wiley India Pvt. Ltd., 8th Ed., 2011.
11. Kaushik, A., Environmental Studies, New Age International (P) Limited, 2nd Ed., New Delhi, 2004.
12. Rajagopalan, R., Environmental Studies, Oxford University Press, 3rd Ed., New Delhi, 2015.
13. Reddy, M. A., Text Book of Environmental Science and Technology, BS Publications, Hyderabad, 2007.
14. Wright, R. T., Environmental Science: Towards a Sustainable Future, PHL Learning Private Ltd., New Delhi, 2008.

IMPORTANCE OF AEROSOLS IN THE STRATOSPHERE

Rajesh Trehan[1], Sudesh Kumar[2] and Sunil Kumar[3]
[1]Associate Professor and [3]Assistant Professor, SGGSJ Govt. College Paonta Sahib, Distt. Sirmour, Himachal Pradesh-173025, India
[2]Assistant Professor (Physics), Dr. Y. S. Parmar Govt. P. G. College, Nahan (H.P.)-173001, India
[1]trehanr@hotmail.com

ABSTRACT
Poor air quality is globally the largest environmental health risk. The human health and uncertainty in climate change can be attributed to aerosols to some extent. The size and chemical composition of aerosol particles vary widely, as well as regionally and both are important in governing their effects on climate and human health. For climate effects, the number of intermediate size particles are more important than the mass whereas the ecological effects are solely influenced by the mass concentration. Aerosols affect the climate directly by scattering and absorbing the solar radiation and indirectly by modifying the properties of clouds. All aerosols except black carbon cause cooling. Aerosols have short lifetime of few days or weeks in comparison to the long lifetime of greenhouse gases. Therefore, aerosol effects are more regional and less persistent into the future than those of green house gases. As a consequence of reductions in aerosol concentrations there will be a more pronounced warming due to greenhouse effect. Aerosols also contribute to acid rain and affects visibility in the troposphere by forming fog, mist, smog and haze etc. Aerosols also affect human health. The health impact of aerosols consists of both short-term acute symptoms, like asthma and bronchitis, and long-term chronic irritation and inflammation of the respiratory tract, which can potentially lead to cancer. Thus, aerosols have adverse effects on climate and human health.

***Keywords**: Aerosols, Climate change, Global warming, Aerosol optical depth, Health issues.*

INTRODUCTION
An aerosol is defined in its simplest form as solid or liquid particles suspended in a gas, and it includes a wide range of phenomena such as dust, fume, smoke, mist, fog, haze, and smog. Impact of aerosols on climate change and health-related issues has drawn considerable attention[1-9] worldwide in last few decades. Aerosols (natural or anthropogenic), an aero-solution; clouds of microscopic particles in air, are suspensions of fine solid particles or liquid droplets within air or in gases. Aerosols are natural as well as anthropogenic and cause reduction in thevisibility by forming fog, mist and brown clouds etc. The absorption and scattering of solar radiation by aerosols influence Earth's radiation budget and hence lead to climate change. The absorption (scattering) of the solar radiation by aerosols results in warming (cooling) of the atmosphere thereby causing global warming (cooling). In addition to their role in climate change, aerosols are also of interest because they contribute to acid rain, are cause of poor visibility and can affect human health as well. Numerous international studies have looked at the relationship between aerosols and increased mortality. According to a recent international Commonwealth Science Council conference, aerosol pollution kills thousands of people every day worldwide. The health impact of aerosols consists of short-term acute symptoms, like asthma and bronchitis, and long-term chronic irritation and inflammation of the respiratory tract, which can potentially lead to cancer.

These pollution problems not only cause local problems, but also lead to the degradation of regional air quality. In concern to this, the pollution hazards that can be created by the aerosols as air pollutants in a small region or globally can be studied with the help of parameters like

sources of aerosols and their formation, their size number distribution, mass concentration, chemical composition and optical activities etc. In this paper, we discuss few of these parameters and related aerosol effects along with various measures to control the aerosol assisted pollutions.

METHODOLOGY

The effects of aerosols on the environment, in particular on the climate change and human health, can be studied in terms of experimental survey done on various parameters like sources of aerosols, their classification in terms of size, mass concentration, chemical composition, optical activity etc. Few of the parameters are discussed below:

Sources of Aerosols

Aerosols have both natural and anthropogenic sources [1-9]. Natural sources of aerosols are wind-blown desert dust and sea salt and anthropogenic aerosols are combustion by-products in the form of sulfates and nitrates. The aerosols can be categorized as primary and secondary aerosols. The primary aerosols are emitted directly whereas secondary aerosols are produced from gas phase reactions of sulfur dioxide (SO_2) and NO_x. Thus, spatial distribution of both types of aerosols is equally important. Aerosols are also produced from coal burning, which is, by far, the most important fuel. SO_2 and particulate matter are responsible for serious damage to the environment. The air pollution arising from the burning of the coal worldwide has not been controlled effectively, and other sources of emissions have also become important, owing to the recent rapid economic development and urbanization. A sharp increase in concentrations of NO_x, particulate matter, volatile organic compounds and ozone has been observed due to fast growth of the number of vehicles, especially in mega-cities and economically developed regions. Emissions due to the use of coal and traffic together lead to serious pollution, characterized by enhanced aerosol concentration in the form of photochemical smog, high concentration of fine particles, and poor visibility.

Formation of Aerosols

New particle formation takes place when different vapor molecules collide together to form a new particle through nucleation process. In general, the most abundant trace gases in the atmosphere are very volatile and do not nucleate new aerosols nor even condense on existing ones. They first go oxidation process in sunlight to produce a compound with a lower vapor pressure e.g., oxidation of SO_2 into sulfuric acid, H_2SO_4. The H_2SO_4 vapor can then condense together with water molecules to form a stable cluster of molecules of typically 0.001 to 0.002 μm in diameter. Besides sulfuric acid, organic compounds and ammonia are considered to be potentially important in the nucleation process. The majority of small particles with diameters less than 0.1 μm are created in the atmosphere by nucleation. Favorable conditions for nucleation to occur include a strong source of condensable vapor; high solar radiation intensity; low pre-existing aerosol concentration; high relative humidity; low temperature; presence of ions; and atmospheric mixing processes. A freshly nucleated particle grows larger by condensation of organic and inorganic vapors. Aerosol particles can also collide together in a process called coagulation which is particularly efficient after nucleation. Only a small fraction of the small particles reaches large enough sizes to influence climate. In the atmosphere, particles are also subject to transformation processes e.g., oxidation, polymerization, evaporation, condensation, coagulation and they will not persist in their original state for very long. For example, a black carbon or soot particle will start to be oxidized at the edges, after which more water retaining species condense on its surface. Thus, it will become a liquid mixed particle with traces of black carbon, inorganic compounds and organic species. On the basis of size, aerosol particles reside in the atmosphere for several days to weeks before being deposited to the ground. Particles of intermediate size of order of 0.1 μm have the longest atmospheric lifetime.

Size Number Distribution

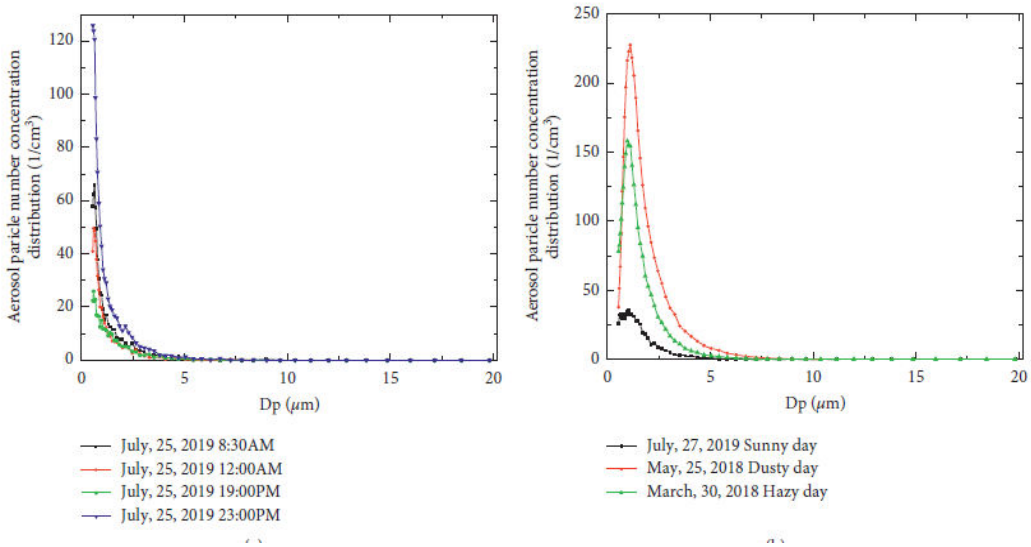


Figure 1: (a) aerosol PSD on July 25, 2019 and (b) at the same moment under different weather conditions.

Almost all of the aerosol properties, and thus effects, are size dependent. The particle size governs the rate at which they deposit to the ground and thus decides their atmospheric lifetime, their interaction with radiation, their impact on clouds, and their health effects. Their size can range from a few nanometers to tens of micrometers. However, cloud droplets and raindrops can grow even larger which are usually classified separately. All the aerosol particles are not spherical in shape, but are usually characterized according to their equivalent spherical diameter[10] (Figure 1). The tropospheric number concentration of aerosol particles ranges from several tens or hundreds per cubic centimeter of air in remote locations to more than hundred thousand or a million per cubic centimeter in polluted environments or after a strong nucleation event.

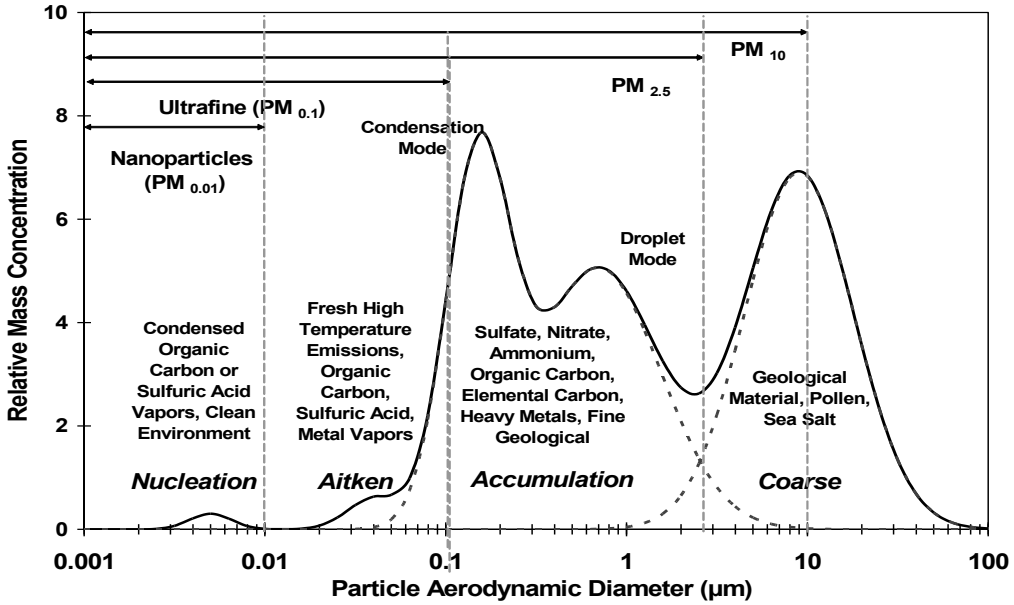


Figure 2: Particle size distribution

The number or volume concentration as a function of particle size is described by a size distribution. The number of particles is generally dominated by the smaller aerosols, whereas the volume (mass) is dominated by the larger ones. The exact shape of the size distribution depends on the environment, as it reflects the sources, sinks, and transformations of the particles. Besides the total number and mass of particles, the effects of an aerosol population also depend on the shape of the size distribution and are often dominated by a certain size range, depending on the effect of interest. For the measurement of mass of some pollutant that is being transported through the air for biogeochemical cycles, the mean diameter of the particles with the mass or volume is calculated i.e., what size particles carry the most mass? For visibility, the diameter of the particles must have the largest cross section or surface area, so what size particles cover the largest surface area is of more interest. In case of cloud formation or microphysics, the range of diameters with the largest number of particles is important. Here, the size of the most abundant particles is required. For human health, both the mass and number of the particles are required to be calculated, because only a certain size particle can enter the lungs. Penetration into human lungs and its potential effects depends on the size of the aerosols, thereby, sampling of particles as a function of size is required to be done (Figure 2).

An aerosol with an aerodynamic diameter of typically 100 μm or less is classified as classical suspended particulate. The particles with a diameter of less than 10 μm are termed as PM-10, which can enter the human air tract. Particles with size smaller than 2.5 μm (PM-2.5) can even penetrate into human lungs.

Chemical Composition

The bimodal nature of the size-number distribution of atmospheric particles suggests at least two distinct mechanisms of formation, and the chemical composition of the particles reflects their origins[11] (Figure 3). Fine particles have a diameter smaller than about 2.5 mm, and are produced by the condensation of vapors, accumulation, and coagulation. They have a chemical composition that reflects the condensable trace gases in the atmosphere: SO_2, NH_3, HNO_3, VOCs, and H_2O. The chemical composition is water with SO_4^{-2}, NO_3^-, NH_4^+, Pb, Cl^-, Br^-, C(soot), and organic matter; where biomass burning is prevalent. Coarse Particles have a diameter greater than about 2.5 mm, are produced by mechanical weathering of surface materials. Their lifetimes, controlled by fallout and washout, are generally short. The composition of particles in this size range reflects that of the earth's surface - silicate (SiO_2), iron and aluminum oxides, $CaCO_3$ and $MgCO_3$; over the oceans, NaCl.

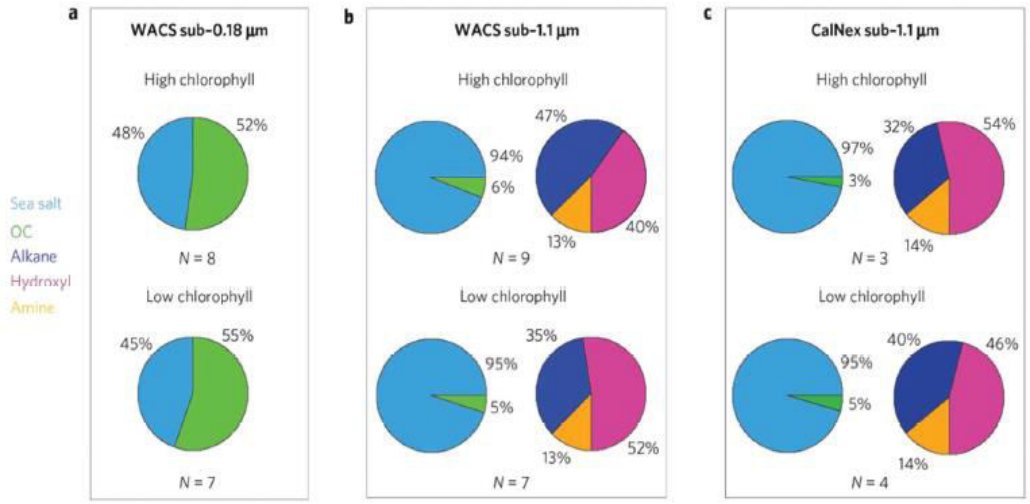


Figure 3: Average mass fractions of organic carbon (OC) and sea salt in nascent sea spray aerosol generated at sea.

Various instruments in use for the parameterization of the aerosolsare; Aerosol mass spectrometer (AMS), Differential mobility analyzer (DMA), Electrical aerosol spectrometer (EAS), Aerodynamic particle sizer (APS), Aerodynamic aerosol classifier (AAC), Wide range particle spectrometer (WPS), Micro-Orifice Uniform Deposit Impactor(MOUDI), Condensation particle counter (CPC), Epiphaniometer Electrical low pressure impactor (ELPI), Aerosol particle mass-analyzer (APM),Centrifugal Particle Mass Analyzer (CPMA), in remote sensing approaches Sun photometer, Lidar, and Imaging spectroscopy.

Aerosol Effects

Effects of aerosols[1-9] are mainly; effects on atmospheric properties, visibility reduction, fog formation and precipitation, solar radiation reduction, temperature and wind distribution alteration e.g., climate change, effects on materials, effects on vegetation and health.

Climate Change

Several types of atmospheric aerosol have a significant effect on Earth's climate: volcanic, desert dust, sea-salt, that originating from biogenic sources and human-made. Volcanic eruptions release large amounts of sulphuric acid, hydrogen sulfide and hydrochloric acid into the atmosphere. These gases represent aerosols and eventually return to earth as acid rain, having a number of adverse effects on the environment and human life. Volcanic aerosols are formed in the stratosphere after an eruption as droplets of sulfuric acid that can prevail for years and reflect sunlight. Desert dust, mineral particles blown to high altitudes, absorbs heat and may be responsible for inhibiting storm cloud formation. Human-made sulfate aerosols, primarily from burning oil and coal, affect the behavior of clouds. Aerosols interact with the Earth's energy budget in two ways, directly and indirectly. e.g., a direct effect is that aerosols scatter and absorb incoming solar radiation. This will mainly lead to a cooling of the surface due to backscattering of solar radiation but may also contribute to a warming of the surface due to absorption of incoming solar energy by black carbon. Intermediate sized aerosols, 0.1 to 2 μm diameter, are the most effective at backscattering of solar radiation. In order to model the climate effect of aerosols it is necessary to know the spatial distribution of aerosols. While the sign of the total aerosol forcing is uncertain, it is clear that the radiative forcing associated with sulfate and nitrate aerosols is negative. Thus, these aerosols produce a cooling that can potentially offset some of the warming due to increasing concentrations of greenhouse gases. This will be an additional element to the greenhouse effect and therefore contributing to the global climate change.

Cloud Formation

Aerosols play a significant role in the cloud formation by acting as cloud condensation nuclei (CCN) around which cloud droplets can form, an indirect effect that results from the aerosols interfering with formations that interact directly with radiation[12] (Figure 4). The larger the aerosol particle, the more effective is it to be a CCN. If more aerosol particles (CCN) are available, more cloud droplets will be formed. Since the available water has to be divided over more droplets, their average size will be smaller. However, the total surface area of all the droplets together is larger, and the resulting cloud is more reflective. Such cloud, existing of more but smaller droplets, will not rain out as quickly. As a result, the cloud persists longer. The particle chemical composition also affects the CCN activity, though to a lesser extent than the particle size. The primary parameter influencing the strength of the indirect effect is the number concentration of particles with a size larger than ~0.1 μm. A small subset of particles can also act as ice nuclei (IN), on which ice crystals can form. The formation of an ice crystal usually occurs via freezing of a liquid droplet, and is called ice nucleation. Mineral dust is typically regarded as a good ice nucleus.

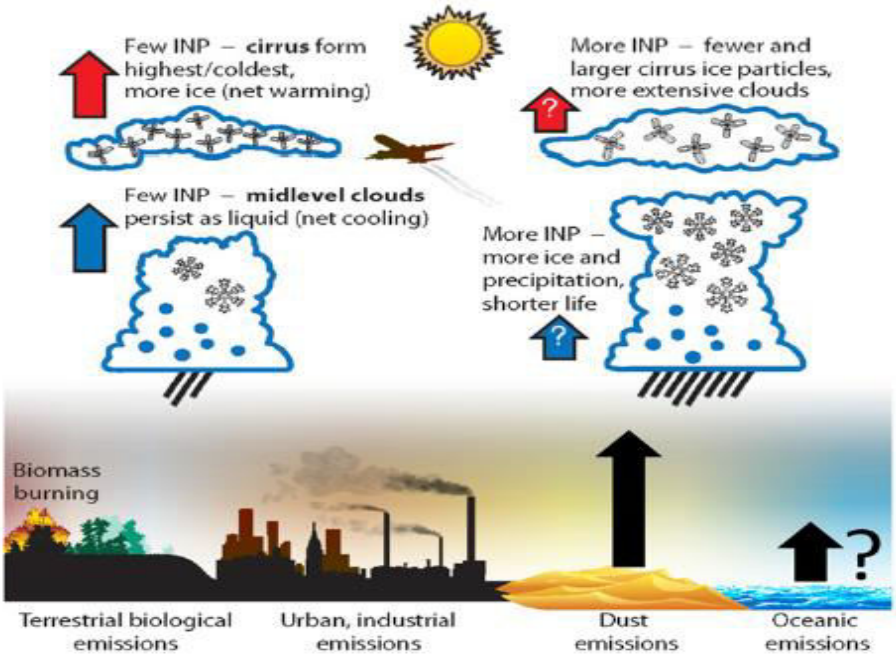


Figure 4: Climate relevance of ice nucleation by atmospheric aerosols via altered cloud radiative properties and precipitation

The exact effect of having more CCN in the atmosphere depends on a lot of factors: Seen from below, clouds absorb and re-emit infrared radiation back to the surface, much as greenhouse gases do, and so exert a warming effect. Seen from above, clouds reflect sunlight and emit infrared radiation to space, and so exert a cooling effect. The global net effect is a cooling, but dependent on conditions, this can vary with location and time. Clouds at low heights generally cool surface, though clouds at large heights generally warm the surface. This is due to high cirrus clouds usually being optically thin, so reflecting only a small portion of the incoming solar radiation. In addition, due to their low temperature, they re-emit radiation of low energy content, so less energy is lost to space and more remains in the atmosphere. At night time clouds cause warming, since there is no solar radiation to reflect, but there is infrared radiation from the surface to absorb and re-emit. During the day cooling generally dominates and depends on altitude.

Poor Visibility

Another most noticeable effect of aerosol pollution is reduction in atmospheric visibility. Pollutants (particles and some gases) scatter and absorb light in the air and cause poor visibility. Those particles, referred to as fine particles, are in general smaller than 2.5 μm in aerodynamic diameter. Although all hydrometeors, solid and liquid, can be described as aerosols, a distinction is commonly made between such dispersions (i.e., clouds) containing activated drops and crystals, and aerosol particles.

The atmosphere of Earth contains aerosols of various types and concentrations, including quantities of natural inorganic materials; fine dust, sea salt, or water droplets, natural organic materials; smoke, pollen, spores, or bacteria anthropogenic products of combustion such as; smoke, ashes or dusts. Aerosols can be found in urban ecosystems in various forms, for example, dust, smoke, mist from aerosol spray cans, soot or fumes in car exhaust. When aerosols absorb pollutants, it facilitates the deposition of pollutants to the surface of the earth as well as to bodies of water. This has the potential to damage both the environment and human health.

Health Effects

Aerosol particles with an effective diameter smaller than 10 μm can enter the bronchi, while the ones with an effective diameter smaller than 2.5 μm can enter as far as the gas exchange region in the lungs, which can be hazardous to human health[13] (Figure 5). In general, inhalation of airborne particles contributes to excess mortality and morbidity, not all adverse effects result in death. Specific health points include: declines in lung function, increased respiratory symptoms such as cough, shortness of breath, wheezing and asthma attacks, chronic obstructive pulmonary disease, cardiovascular diseases, lung cancer etc.

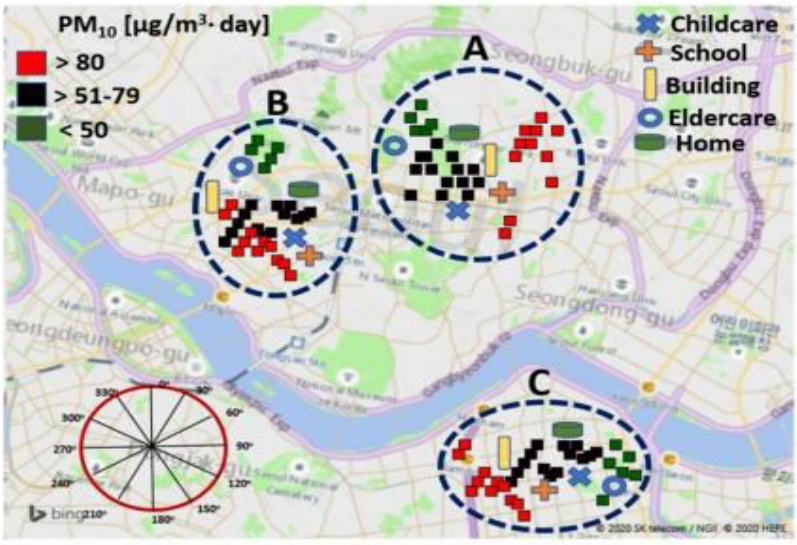


Figure 5: Sampling locations with the plots of outdoor using R statistical software and Microsoft 3D maps

A series of epidemiologic studies has clearly shown the causative interconnection between particles and health effects; frequency rates of chronic obstructive respiratory diseases seem to be increasing. Many studies have generally accepted that the ability for particles to cause health effects is dependent on their size. In spite of the fact that particles up to 100 μm enter the body through breathing, only very small particles, below 5 μm aerodynamic diameter can reach deep into the lung and these very small particles have the main potential for causing health effects. The current focus of health-related sampling of particulate matter is on particles with aerodynamic diameter less than 10 μm (PM10) but recent research pointed out the great health effect of fine particles PM2.5, and even PM0.1. The importance of chemical composition of fine particles is also outstanding.

Measures to Control Aerosols

Activated carbon is one of the most popular forms of air pollution control. This type of control involves the use of a pollution filter, carbon, to reduce the amount of pollutants that are allowed to escape into the air. When in use, these filters absorb pollutants helping to cleanse the air of any possible toxins.

Bio-Filtration

It is another effective type of air pollution control. It uses microorganisms, often bacteria and fungi, to dissolve pollutants. Industries that employ bio-filtration systems include food andwaste plants, pharmaceutical companies, and wastewater management facilities. While this method of air pollution control works rather well, a large space is required in order to operate a bio-filtration system. Many industries do not have this amount of available space, so this method is often disregarded.

Changes in Fuel

This technique involves the use of less polluting fuel to reduce air pollution. Use of low sulfur fuel instead of high sulfur fuel by electric utilities is an example of this method. The other choice for an electric utility can be the use of natural gas as a fuel. Introduction of compressed natural gas, propane, ethanol and oxygenated fuels for automobiles have helped in the reduction of air pollutants. Nuclear power plants are relatively pollution free when compared to the coal fired power plants. However, they have been subjects of controversy in their overall environmental impact.

Improve Dispersion

This approach is based on the concept that dilution of air contaminants before they reachground will lower the concentrations to which the population is exposed. The use of this approach for industry is discouraged by the U.S. Environmental Protection Agency (US EPA). The emissions from the plant are passed through a control device before releasing to atmosphere. The pollutants are removed, destroyed or transformed in the control device before discharging into ambient air. The scrubbing or Flue Gas Desulphurization (FGD) processes can be classified as (i) throwaway or regenerative processes or (ii) wet or dry processes.

CONCLUSIONS

Aerosols have both natural and anthropogenic sources consisting of a mixture of components: sulfates, nitrates, ammonium, organic carbon, black carbon, sea salt, mineral dust, trace metals and water. Aerosol concentrations are highly variable in space and time due to their short lifetime. This variability is an important factor in the relatively large uncertainty surrounding aerosol effects on climate. The global warming caused by greenhouse gases is masked to some extent by the aerosol. Over the longer term i.e., decades to centuries, CO_2 will be the main driver of climate change because of its very long presence in the atmosphere. The strong increase in man-made aerosols during the middle of the 20th century has counteracted the increase in greenhouse gases during that same period, causing the global temperature to remain relatively steady. After the late 1970's however, greenhouse forcing became dominant, and the globe warmed again. Aerosol concentrations are expected to be reduced globally, but at a different pace in different regions. Reductions are achieved first in developed countries, whereas in developing countries the aerosol burden may first increase before it starts to decline at a later stage. As a consequence of reductions in aerosol concentrations there will be a more pronounced warming due to greenhouse effect. Trends in aerosol concentrations continue to have an important influence on the climate, especially regionally. The health impact of aerosols consists of both short-term acute symptoms, like asthma and bronchitis, and long-term chronic irritation and inflammation of the respiratory tract, which can potentially lead to cancer. Thus, aerosols involve spate of pollutants which creates a lot of chronic and acute diseases in human being so we have to put the foreign particles within the constraint of standard limit. This shows that aerosols have reverse effects on climate and human health. Therefore, in devising policies to curb health effects, simultaneous climate impacts should also be considered, and vice versa as both the issues are intricately linked with one another.

REFERENCES

1. Y.J. Kaufman et. al. (2002) Nature, **419**, 215-223.
2. S. Menon (2002) Science, **297**, 2250-2253.
3. J. Schneider (2013) Physics & Chemistry of Aerosols, 1-41.
4. T. Takemura (2010) Nobel Carbon Resources Science Newsletter, 15-17.
5. J. Jung et. al. (2009) Journal of Environmental management, **90**, 3231-3244.
6. M. Kulmale et. al. (2011) Atmos. Chem. Phy., **11**, 13061-13143.

7. Abdul Razzak et. al. (2000) J. Geophys. Res., **105**, 6837-6844.
8. A. K. Yadav et. al. (2003) Journal of the Air & Waste Management, **53**, 946-56.
9. D. Vashi et al. (2015) Adv. Appl. Sci. Res., **6**(5), 118-121.
10. Y. Ren et al. (2020) Advances in Meteorology, 1-11.
11. T. H. et al. (2018) Chem. Soc. Rev., **47**, 2374-2400.
12. J.H. Seinfeld et al. (2016) PNAS, **113**(21) 5781–5790.
13. H.J. Oh et al. (2020) Int. J. Environ. Res. Public Health, **17**, 1923.

ECONOMIC SUSTAINABILITY: A THEORETICAL PERSPECTIVE

Ravi Kant Sharma
Assistant Professor, Department of Economics, SGGSJ Govt. College, Paonta Sahib (H.P.)-173025, India
ravikant9787@gmail.com

ABSTRACT
The crisis generated by the pandemic is one of the most serious in the history of modern society. Considering the extent of the economic damages, it is necessary to identify a strategy able to guarantee positive results both in the short and long term. The strategy, however, can't be disconnected from the concept of ***sustainable development****, both for economic and environmental reasons. For this reason, in order to make possible a development model compatible with the environmental issue, it's necessary to undertake not only an energy transition process, but also interventions in all the most polluting sectors to make human activities less impactful and economically convenient. Sustainable development is the overarching paradigm of the United Nations. The concept of sustainable development was described by the 1987 Brundtland Commission Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

Keywords: *Economic sustainably, Environment, Sustainable development, Energy, Pollution.*

INTRODUCTION
There are four dimensions to sustainable development – society, environment, culture and economy – which are intertwined, not separate. Sustainability is a paradigm for thinking about the future in which environmental, societal and economic considerations are balanced in the pursuit of an improved quality of life. For example, a prosperous society relies on a healthy environment to provide food and resources, safe drinking water and clean air for its citizens. One might ask, what is the difference between sustainable development and sustainability? Sustainability is often thought of as a long-term goal (i.e., a more sustainable world), while sustainable development refers to the many processes and pathways to achieve it (e.g., sustainable agriculture and forestry, sustainable production and consumption, good government, research and technology transfer, education and training, etc.

Economic sustainability can refer either to the continued success of an economy over time or more recently to the way an economy operates in a sustainable manner, protecting social and environmental sentiments. Economic sustainability refers to practices that support the long-term economic development of a company or nation while also protecting environmental, social, and cultural elements. Today, economic sustainability is a goal that very few organizations achieve, despite a fairly universal understanding of what types of business practices (e.g., burning of fossil fuels, creating food waste, leveraging harmful manufacturing methods) contribute to climate change.

Definitions
According to the University of Mary Washington, *Economic Sustainability is described as: "Economic sustainability refers to practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community."*

The Thwing Center defines economic sustainability in some other way which is more traditional in sense as: "The ability of an economy to support a defined level of economic production indefinitely."

The first definition brings environmental and social factors into the mix for sustained economic production. This definition takes more of a green view on economic sustainability. The second definition can be applied on a larger scale.

Economic Sustainability and Minimum Living Standards

We can determine how far the world is from becoming economically sustainable. To do this, we need to consider the percentage of people below the minimum living standards. This data differs per country, but some data from the Central Intelligence Agency (CIA) Fact Book is shown below. The minimum is defined by "The International Poverty Line" when referring to developing economies, equivalent to anything less than $2 per day. The UK and US set their own targets.

- The United States: 15% of people living below the minimum standard of living
- The United Kingdom: 14% of people living below the minimum standard of living
- India: 76% of people living below the minimum standard of living
- China: 36% of people living below the minimum standard of living

Based on the above percentages, we can infer that the world is seemingly far beyond reaching economic sustainability, as per our current working definition.

You see, it may be impossible for developing countries like India and China, to catch up with developed countries in terms of average GDP per person. This sometimes poses a question mark on the achievability of economic sustainably.

Barriers to Economic Sustainability

When it comes to environmental harm, the global business community is one of the worst offenders. By not prioritizing economic sustainability, businesses around the world continue to have an enormous negative impact on the environment.

In most cases, the products that are the cheapest to manufacture and purchase have the worst economic impact. (Think fast fashion and single-use plastic.) Why? As Harvard Business Review pointed out a decade ago, "Higher cost to the planet does not translate to higher prices for customers. Of course, this is because businesses are rarely obliged to pay for the full toll their operations take on the world." Another barrier to economic sustainability is the expectation, from both businesses and nations that economic growth will flow naturally from population growth. After all, if more consumers exist on Earth, more people will buy products. The problem with this premise, as the "Post Carbon Institute" explains, is "a bigger economy uses more stuff than a smaller one, and we happen to live on a finite planet. So, an end to growth is inevitable."

Solutions to Economic Sustainability Problems

The issue with economic sustainability, and why it seems unachievable, is due to unresolved root causes. Economic sustainability is not possible with our current practices used to deliver a minimum living standard. To achieve economic sustainability our economy and our current way of life have to adapt. We need to be more efficient in our use of available resources, find new ways to harness currently underused resources and reduce our consumption in the process. Across the world, there are a multitude of social movements and grassroots projects underway, exemplifying what our next, leave-things-better economy could look like.

Examples of some projects to illustrate unresolved root causes of Economic Sustainability Problems have been discussed in detail.

Energy Crisis and Economic Sustainability

In 1971, the geologist Earl Cook discovered that each then-modern city dweller required 230,000 kilocalories per day. Compare this to our hunter-gatherer relatives, who survived on 5000 Kcal per day. You can see, there is a gap between simple and complex lifestyles, which has widened even further since 1971. Factoring in all systems, networks, and gadgets that fulfil our modern-day demands means that each New York City dweller needs 60 times more energy and resources than their hunter-gatherer ancestors did. To grant the high energy demands of individuals living at and above the required minimum standard, our energy industry burns its way through easy-to-access fossil fuels. However, being a finite resource, fossil fuel extraction is becoming harder and more expensive every year. To make matters worse, as our modern-day human system becomes more complicated, we demand more and more energy to keep the system going. We have an energy crisis.

In short, how we obtain energy from our environment currently cannot continue to supply our energy demands. This renders economic sustainability an unachievable myth under these circumstances. We have to look at the root causes of our energy crises, to resolve this roadblock and achieve economic sustainability.

Conserve Energy Future have Outlined the Following Root Causes:

1. Overconsumption
2. Overpopulation
3. Poor infrastructure
4. Unexplored renewable energy options
5. Delay in commissioning power plants
6. Wastage of energy
7. Poor distribution systems

One way we can switch up our economic system is by tackling the above root causes of our energy crises. Let's take a look at how alternative renewable energy options are being explored today. One exciting project is the Space Solar Power Project. As the name suggests, this project is essentially building a solar power plant in space. As Ali Hajimiri puts it:

"Above the Earth, there's no day and night cycle and no clouds or weather or anything else that might obstruct the sun's ray, so a constant power source is available."

It sounds and feels like I have jumped into the 22nd century. Surely this level of technology, innovation, and engineering is not possible yet (were my initial, albeit pessimistic, thoughts). Despite my doubts, the project is well and truly gaining traction. The team at Caltech has successfully tested and proved that the concept works on the ground. The next step is to perform scale-down experiments in space. The research into solar power systems in space is ongoing. Scientists are comparing the amount of energy it would take to implement these solar power systems against the energy obtainable from these systems. The removal of atmospheric effects means space solar-power can generate around 2,000 gigawatts of energy, compared to 1.8 gigawatts generated from the largest land solar farm. The potential is there, but further research and cost-benefit analyses are needed. Renewable energy sources offer alternative solutions. However, retrofitting these renewable energy systems on a large enough scale, to meet present and future energy demands, would require vast investments of material, organizational effort, and ironically, energy. As blogger Gail Tverberg says:

"A lack of cash flow for investment and infrastructure will eventually bring the system down."

It seems that more investment, infrastructure, and support are needed in favour of renewable sources of energy for them to become an actionable alternative. Also, renewable sources tackle only one of the seven outlined root causes of our energy crises. All causes must be considered and acted on to produce viable solutions.

Water Crisis and Economic Sustainability

Las Vegas, a city built from the desert, inhabits the biggest consumers of water in the world. 800-1000 litres of water are consumed per person per day. It is estimated that water shortages could impact nearly 2 billion people in 2025. An estimated trend that represents yet another issue blockading our ability to reach economic sustainability. So, what can we do about it? Focusing on a solution, we are brought to Mexico City. Mexico City was once a grounding of interconnected lakes and more than sixty rivers. Looking around, it is now a dusty megalopolis covered by sandy roads, concrete skyscrapers, and shopping malls. Rivers and lakes were treated as a problem to be overcome. Hard engineering channelled the waterways, built over them and covered them. Luckily though, past water systems were not completely out of mind for some.

A large team of ecologists and architects worked to replace the busy roads with a ring of water and parks around the city. This restored at least three rivers in the process. Since, these rivers have become home to a myriad of plants, aquatic wildlife, and birds. Mexico's rivers are reborn. We are seeing equal changes across cities elsewhere. For example, the city of Seoul in South Korea removed a major freeway to make way for the Cheonggyecheon River. These examples represent a shift in thinking. A knowledge that, at the heart of economic sustainability, there is a need for improved environmental health.

Food Crisis and Economic Sustainability

One in nine people on earth, or 796 million people, do not have enough food to lead a healthy lifestyle. According to the Food and Agriculture Organization of the United Nations:

- Roughly one-third of human consumable food production in the world is lost or wasted every year. That is, 1.3 billion tonnes of food are cast aside, unused.
- The food losses and waste amount to roughly $680 billion in industrialized countries, and $310 billion in developing countries.
- Consumers of developed countries waste almost as much food (222 million tonnes) as the entire food production of sub-Saharan Africa (230 million tonnes).

We have a food wastage issue that needs to be addressed for economic sustainability to be obtainable. The 'Food Commons' team is an ambitious group trying to do just that. Community gardens and urban farming are propagating throughout cities, in addition to constructing widespread projects connecting schools to farmers. Top-down connections are being made too, at a policy level. For example, in 2014 the U.S. Department of Agriculture announced a $78 billion investment in local and regional food systems. This included food hubs, farmers markets, distribution hubs, and other local business enterprises. This connectedness inspires social innovation and support to transform the agricultural system, to make it more localized and less wasteful. With less waste, we are one step closer to providing enough food to meet human need, and thus closer to achieving economic sustainability.

Benefits of Economic Sustainability

This paper provides examples of both top-down and bottom-up ideas or initiatives which can help us toward our conception of economic sustainability. We need to have day-to-day actions aligned with policy in order to achieve our outcomes. According to 'The Fiscal and Economic Benefits of Sustainability', a 2014 report from the Institute for Local Government, policymakers on a local level can gain the following direct benefits of investing in, and legislating for, sustainable outcomes:

1. Increased Investment

Change is constant in life, and, in the business world, this is no exception. We are beginning to see that rather than one bottom line, consideration of a triple bottom line is gaining more and more traction. Green bonds are on the rise, and there is a growing interest in sustainable developments. There is increasing investor interest in environmental, social and governance, and ESG strategies, prompting growth in sustainability-related fixed-income products. By becoming sustainable, investors recognize the improvements, this will have in terms of the economic sustainability of your business, meaning you gain increased investor interest.

2. Budget Saving

To achieve a triple bottom line, cost savings are obtained through the reduction of environmentally costly activities, such as reducing water or energy consumption. If you want to know how you can reduce your own agency costs, see our 'Environmental Accounting Internal Audit' checklist. These savings also act to reduce long-term liabilities via cost savings and lower operating costs.

3. Boost in Tax and Free Revenues

Economic sustainability is all about increasing the average GDP per person. This will create a positive feedback loop, increasing local economic activity. With increased economic activity come boosted tax and fee revenues.

4. Improved Fiscal Stability

Economic sustainability creates a stable economy, one that is resilient to uncertainty such as potential rises in energy and water costs. In terms of your business, economic sustainability safeguards your profession, so that your operations are buoyant and strong in the face of change.

5. Targeted Investment

Increased savings and economic activity spur targeted investments and additional savings, revenues and economic development, which all benefit you at a business level. Several key ideas make up the economic angle of sustainability such as smart growth, long-range planning, cost savings, research and development spending and cost of living.

However, sustainability does not come until social and environmental interactions are considered. That is, economic sustainability cannot be achieved until you have acquired a sustainable business. Economic sustainability is not about continual growth in wealth. It is multidisciplinary, with huge social and environmental factors. It is about the regeneration of life on Earth by meeting social and environmental needs. The core value of our emerging sustainable economy is about stewardship, rather than extraction – the positive of which feeds on the positive. By finding alternative ways that work in partnership with living processes, the easier it will become to reach economic sustainability. And by reconnecting with our wild side, we can reduce our ecological footprint, achieve economic sustainability, and meet the needs of people and our planet.

Purpose of Economic Sustainability

Economic sustainability is an integrated part of sustainability and means that we must use safeguard and sustain resources (human and material) to create long-term sustainable values by optimal use, recovery and recycling. The benefits of Sustainable Economic Development impact more than just those in poverty. For example, reducing energy use and expanding public transit options leads to less air pollution, which can improve asthma and heart conditions. Efficient homes and businesses will be more comfortable and safer.

Sustainability promotes a better economy where there is little waste and pollution, fewer emissions, more jobs, and a better distribution of wealth. This means that the public sector in particular will provide support to occupations and sectors that create a better environment and a better sense of well-being. Examples could be organic farming, green and socio-economic enterprises, etc. Sustainable economic development entails the ability of the present human beings to meet their needs with the available resources without trashing the ability of the future generations from doing the same. It also involves integrating all environmental issues with the purpose of ensuring economic development that can meet the immediate needs of both the present and future generations. Sustainable economic development encompasses cultural, natural, social, and economic environments whose inclusive development is vital to the welfare of society. Notably, sustainability in terms of interdependence and fairness ought to be between countries in the world and individuals within a country. For instance, South Africa that has abundant gold and platinum lacks adequate water for its population. The rich population possesses most of these natural resources since the distribution processes do not follow fairness and equity but the purchasing power of an individual. Clearly, such an economy encourages disparities among the population with a small population having the potential to consume a large portion of the world's natural resources. Thus, country can reduce poverty levels by enhancing pro-poor development mechanisms. Economic Development program is focused on recovery from these related crises. Sustainable Economic Development is a national initiative built on local economies' unique assets to address their individual challenges and provide quantifiable real-world benefits. It is a practical, implementable toolkit that tailors' strategies to work for local people, businesses, and institutions. Elements of an anti-poverty program may be common from place-to-place, but solutions must be grounded in the political, social, and economic reality of a location if they are to create real change. The Sustainable Economic Development framework identifies a city's specific needs and untapped opportunities, using these to lift people out of poverty and bolster economic and environmental resilience. These solutions are designed to raise incomes and decrease household costs by increasing resource efficiencies, improving access to jobs and services, and creating new employment opportunities.

Economic Sustainability Examples

Thankfully, a variety of economic sustainability examples are taking hold around the world. In some cases, businesses and governmental agencies are improving their sustainability practices to reduce their carbon footprint. Meanwhile, enterprising companies are manufacturing products or technology that actually benefits the planet in some way. Some have even embraced tenets of economic sustainability at the expense of some degree of growth. Although globally, we still have a long way to go to achieve true economic sustainability, these examples of economic sustainability can help inspire change in businesses of all sizes and among individuals.

1. Air to Water Innovations

One of the most exciting examples is emerging technology that can extract water from the air. Several companies have developed or are working on these types of innovations. For example, 'Zero Mass Water's system', which is powered by solar panels, captures air with a fan, filters out dust and pollutants, and separates out the water. It has been installed in more than 40 countries. These types of systems are economic sustainability in action: a compelling,

innovative product offers economic benefits to the manufacturer while also providing enormous environmental benefits, such as reliable access to safe water (which 2.2 billion people lack worldwide) and reduced use of plastic.

2. Growth of Recycling

Recycling is still one of the best ways to reduce your carbon footprint. Today, a variety of companies have made a business out of recycling or its counterparts: upcycling, downcycling, e-cycling, and precycling. These include local recycling centers, websites like eBay, Vintage and pre-owned clothing shops, and apps such as 'letgo'. In this vein, some communities have committed to economic sustainability. For example, Kamikatsu, Japan, started working toward a zero-waste goal more than 20 years ago. Today, residents can separate their household waste into an incredible 45 categories. They compost food waste, reuse as many things as possible and wash things like plastic bags and bottles so they can easily be recycled. Although unanticipated challenges have kept Kamikatsu from achieving zero waste, they recycled 81% of their waste in 2016. Considering the national average in Japan is just 20%, this is a significant achievement and a model for any community that hopes to reduce its landfill waste.

3. Micro-Farming

Micro-farming, also known as urban farming, is farming on residential or commercial property of less than five acres. Micro-farming is a relatively easy way for a community to improve the food security of its residents and boost local economic growth while benefiting the environment. Each micro-farm offers benefits such as reduced carbon emissions (because food doesn't have to be transported), less use of pesticides and herbicides, and better public health. When a micro-farm replaces a grass yard, the farmer also ensures he or she is using less water and providing an enticing area for pollinating insects. Micro-farming organizations have popped around the globe in the last several years. One example is "Fleet Farming in Orlando", an organization that encourages homeowners to transform their lawn space into "edible landscapes" to make healthy, affordable food more convenient and to educate the community about sustainable food growth. The group offers professional landscape consultation and installation, then uses part of those profits for community outreach and education.

4. Solar Energy Expansion for Low-Income Families

California's Solar Initiative (CSI) is a state-run program that gives low-income families the opportunity to add solar panels to their homes, with the goals of decreasing overall energy usage, helping families enjoy lower energy bills, and reducing the cost of solar energy. CSI has been a huge success. The program's original goal was to install 1,940 megawatts of solar capacity at customer sites. As of the end of 2019, it had surpassed 9,600 megawatts of capacity, with solar panels installed at more than 1 million customer locations throughout the state.

5. Sustainable Fish Farming

Overfishing is wreaking havoc on our oceans, and today nearly one-third of the world's fisheries are on the brink of collapse. Many see fish farming as a solution to overfishing, but this approach has its own problems—for example, fish farmers have to continue fishing in the oceans to feed farmed fish, and farmed fish tend to be significantly less healthy than ocean fish. The good news is that fish farming techniques are gradually improving, which is allowing fish farmers to pivot toward a more economically sustainable approach. For example, one new farming technique involves treating fish waste and then using it as high-quality fertilizer, and filtering and reusing wastewater. Another involves farming kelp, scallops, mussels, and oysters in addition to fish, and rotating pens to create a healthier, more natural growing environment. Although these techniques typically require greater investment of time and money, the health of the farmed fish is greatly improved and the overall environmental impact is significantly reduced.

Economic Sustainability in Action

These economic sustainability examples are proof that some organizations truly do care about the health and future of our environment. There are still very important and difficult questions related to the "energy returned on energy invested" of these, and similar, examples—but they are a step in the right direction. Today, businesses must no longer rely on exponential population growth and harmful environmental practices to deliver ongoing economic growth; this mindset is already wreaking havoc on our planet. We need to embrace a new way of doing business—one that prioritizes the health of the environment and people—to ever stand a chance of achieving environmental sustainability. At Population Media Center (PMC), we understand the role of economic sustainability in protecting our environment, and we know that population is part of the broader solution to combat climate change. Our work has economic sustainability at its heart, as we work to empower women and girls and address key issues such as biodiversity and habitat conservation, biodiversity mainstreaming, forest management, water conservation, farming practices, and climate change adaptation.

CONCLUSION

In this paper, following points were concluded to achieve economic sustainability:

- Attempted to redefine what economic sustainability is. We have considered what it means for each individual of the 7.7 billion that occupy our planet today.
- Learned about projects bringing this new, sustainable economy to the forefront of economic development.
- Considered the benefits economic sustainability can bring in a business sense.
- Given actionable resources to help show how you can create a business that is more sustainable so that you can start working to achieve economic sustainability today.

An effort has been made through this paper to persuade that there is a profound change underway. Across our world, we are starting to see advancements aimed to reduce our ecological footprint, to create a world that can reach an economically sustainable level. That is, by reducing our ecological footprint, more people can live at a minimum living standard.

REFERENCES

1. Agras, J. and Chapman, D. (1999) 'A dynamic approach to the environmental Kuznets hypothesis', Ecological Economics, Vol. 28, No. 2, pp.267–278.
2. Alber, J. (2002) 'Besser als sein Ruf–Der Sozialstaat als erfolgreiches Modell', WZB-Mitteilungen, Vol. 2002, No. 98, pp.24–28.
3. Bossel, H. (1996) 20/20 Vision. Exploratios of Sustainable Futures, Center for Environmental Systems Research, Kassel.
4. Daly, H.E. (1991) Steady-State Economics, Second Edition with New Essays, Island Press, Covelo/Washington DC.
5. Ecological Economics (2000) 'Special issue on the human actor in ecological-economic models', Ecological Economics, Vol. 35, No. 3, pp.307–412.
6. ICSU International Council for Science, (Ed.) (2002) Science and Technology for Sustainable Development, Science for Sustainable Development, ICSU, Paris.
7. James, A.N. (1999) 'Agricultural land use and economic growth: environmental implications of the Kuznets curve', Int. J. Sustainable Development, Vol. 2, No. 4, pp.530–553.

8. Pearce, D.W. and Barbier, E.B. (2000) Blueprint for a Sustainable Economy, Earthscan, London.

9. Rammel, C. and van den Bergh, J.C.J.M. (2003) 'Evolutionary policies for sustainable development: adaptive flexibility and risk minimising', Ecological Economics, Vol. 47, No. 2, pp.121–133.

10. Spangenberg, J.H. (2005) Die ökonomische Nachhaltigkeit der Wirtschaft, edition sigma, Berlin.

11. Tol, R. (2003) 'Integrated assessment models and sustainability', Measuring Sustainability, in Edler, D. and Blazejczak, J. (Eds.): DIW Research Notes 31, DIW, Berlin, pp.35–38.

SUSTAINABLE CONSUMPTION: ANOTHER ASPECT OF SUSTAINABLE DEVELOPMENT

Rinku Aggarwal
Assistant Professor, Department of Commerce, SGGSJ Government College, Paonta Sahib (H.P.)-173025, India
rinkuaggarwal2007@gmail.com

ABSTRACT
This study applies the theory of consumption value perceptions to adjudicate the influence of such values on sustainable consumption decisions which is gradually becoming an indispensable measure for creation of a sustainable economy. The study aims to ascertain the urgency of green consumerism towards deployment of green management practice, an indispensable tool to make sustainable economy. The damaging impact of unsustainable consumption on environment has been a matter of careful concern and to supersede such predicament the need to assess the impact of economic variables assessing the role of consumption on environment needs contemplation. The study thus tries to adopt a modelling framework to assess the impact of consumption value perceptions as major predictor variables on adoption of sustainable consumption practices which shall eventually lead to the transition of sustainable lifestyle practices in an emerging economy.

Keywords: *Sustainable development, Sustainable consumption, Green consumerism, Lifestyle.*

INTRODUCTION
Sustainable development can be achieved through the conjoint efforts of sustainable production and sustainable consumption. Concerns on environmental corrosion have captured thoughtfulness of the world community since 1980s. India as an emerging economy has been experiencing fast economic growth with rise in per capita income which is enhancing consumption and leading to environmental predicament in the form of over and unsustainable consumption leaving a severe impact on the environment. Environmental deterioration is elicited by unsustainable consumption behaviour and unplanned resource exploitation by the community. Enhanced awareness about the implications of global warming, harmful impact of pollutants etc. is instigating consumers, manufacturers, government and marketers to switch to environment friendly substitutes. Studies have shown that environmental impact is higher in the emerging economies struggling to raise their per capita GDP than in the developed economies. For an emerging economy like India with high rate of growth in population and consumer base and which is aiming to become self-sustained and self-reliant, adoption of sustainable consumption practices would be an indispensable leveraging factor in achieving its goal. Sustainable consumption practices include adoption of healthy lifestyle practices, green living practices, green consumption and more. Consumption of products which are produced without hazardous substances or are recyclable, reusable, bio-degradable and have low detrimental environmental impact at all stages of its life-cycle and engaging in lifestyle management practices such as optimum resource usage, waste recycling with the long-term goal of preservation of the environment, can be defined as sustainable consumption practices. Researches on consumption behaviour have identified consumers' perceived value from product or service consumption, peer opinion, social pressure, influence of promotional activities, product incentives and subsidies, evaluation of alternatives, want of knowledge, zeal to exhibit protective role towards the environment have substantial impact in prognosticating sustainable consumption practices (Biswas and Roy, 2015a; Biswas and Roy, 2015b, Biswas, 2017). This paper tries to depict the consumption values governing sustainable consumption practices and their variation with regard to different product categories thrusting upon the need to switch to

sustainable lifestyle practices for consumers of an emerging economy like India which is witnessing unprecedented growth in consumption and urbanization. This paper also tries to assess the significance of sustainable consumption in making the Indian economy 'self-reliant and self-sufficient and sustainable'.

Theoretical Background

The theoretical framework of the study is based on the integrated model of the theory of consumption values that explains consumption behaviour as a function of multiple consumption values (Laroche *et al.*, 2001; Lin & Huang, 2012; Biswas and Roy, 2015a; Biswas and Roy, 2015b, Biswas, 2017). Different studies have assessed consumption behaviour from the perspective of different consumption values. Consumption value refers to the degree of net consumer gratification from consumption of a particular product or service after comparing the gains from consumption with the gives to avail the benefit of such consumption (Biswas and Roy, 2015a; Biswas and Roy, 2015b, Biswas, 2017). Consumption values have been applied to assess the gap in perceived and expected values. Variation in perceived consumption values with consumers' level of household income needs further contemplation in the context of the Indian economy which is having huge consumer base, high rate of urbanization and which is witnessing a paradigm shift in its policy decisions. The significance of these values in leveraging sustainable consumption practices in the Indian economy and its subsequent role in making India achieve the '3S concept - Self-reliant, Self-sufficient and Sustainable' has been the focus of this study. Consumption value perceptions assessing sustainable consumption practices – four consumption value perspectives have been studied to assess their influence in leveraging sustainable consumption practices as detailed:

Operational Value

Operational value is measured by consumers' perceived value about the product performance concerning its functionality, durability, permanence, efficacy, dependability, price and quality. It has been assessed as a major driver instigating green purchase decisions (Sheth *et. al,* 1991; Bei & Simpson, 1995; Biswas and Roy, 2015a).

Convivial Value

Convivial value or social value encompassing social responsibility, peer pressure and subjective norm entails its influence in purchase decision (Lin & Huang, 2012).

Psychological Value

Psychological value is characterized by consumers' conscience, intellect, want of knowledge, moral obligations and sense of responsibility (Lin &Huang, 2012; Biswas and Roy, 2015a; Biswas and Roy, 2015b).

Contingent Value

'Contingent value' denotes utility derived in a specific situation affected by situational variables or circumstances which can either accentuate or understate specific consumption decisions (Lin & Huang, 2012; Biswas and Roy, 2015a).

Analysis

The items of the four-dimensional consumption values scales and sustainable consumption were adapted from Lin & Huang, 2012; Biswas and Roy, 2015a; Biswas and Roy, 2015b. The responses were measured across Likert Scale. One way ANOVA with Post-Hoc tests and multiple linear regression were applied for hypothesis testing and analysis. (Biswas and Malakar, 2022)

Transcendence towards sustainable consumption by the Indian consumers is strongly influenced by the price, quality, durability, product-life and performance of the green products. They prefer products with enhanced disclosures, eco-labelling on products. Consumers are guided by peer

opinion, norms, word-of-mouth and associated group values while exhibiting their green preferences. On the contrary consumers' green product preference seems to be inversely related to contingent value. Thus, contingent factors like discounts or subsidies have a strong inverse impact in framing consumers' green preferences. (Biswas and Malakar, 2022)

Consumers were thus divided into three segments based on their income category. Consumers with high income are significantly less than the low- or moderate-income segment. Consumers with financial strength exhibit greater faith in green products regarding operational attributes and product disclosures than their less environmentally responsive counterparts. The impact of peer opinion and social pressure is highest on the moderate-income segment. Thus, they rely more on word of mouth regarding green purchase decisions. Discounts, promotions or subsidies generate similar excitement among those at the higher ends of the society; however, the low-income segments seemed to be indifferent or ignorant about offers on green products mostly due to their lack of concern about environment and society or too much engrossment in the day-to-day affairs. Thus, based on income, consumption values differ substantially among different consumer segments (Biswas and Malakar, 2022).

CONCLUSION

As the operational, convivial and psychological values impact consumers' green product preferences; these values should be identified and targeted by the marketers for market positioning and segmenting. Sustainable consumption practices can further be propagated by active participation of Government, Corporate houses and NGOs in undertaking environmental campaigns, advertisements highlighting products' environmental impact, eco-labelling and spread of knowledge through social media about environmental degradation. Tax incentives can be provided by the Government to companies undertaking green initiatives in production mechanism or supply chain. This will provide them with a competitive edge to undertake and enhance the market share which in turn will lead to sustainable consumption habits.

The impact of consumer-driven variables is often high on environmental impact and such strong adversarial impact will inevitably endanger the growth of any economy which signifies the urgency to adopt sustainable consumerism endeavor to prevent the environmental jeopardy. India's economy with policy initiatives such as make in India, import substitution and export promotion, advancement of traditional industries, upgradation of Ministry of Micro, Small & Medium Enterprises (MSMEs), better industry-academia linkages, enhanced research and consultancy, memorandum of understanding with foreign industrial, professional and academic bodies, sharing of intellectual property, sustained innovation and invention in every aspect of human need and endeavor, improved financial markets, retail investments and more is expected to grow in future speeding up the growth rate in urbanization, affluence and per capita consumption expenditure and technology usage.

The growing impact of change in lifestyle and consumption practices on environment can be managed by substituting household consumption habits towards environment friendly alternatives such as products containing zero pollutants, generating low after-life waste, easy to recycle and emits low carbon or toxic effluents, thus resorting to sustainable consumption. Thus, the dual objective of environmental protection and economic prosperity can be attained simultaneously though sustainable consumption.

REFERENCES

1. Bei, L., & Simpson, E (1995) The determinants of consumers' purchase decisions for recycled products: an application of acquisition-transaction utility theory. Advances in Consumer Research, **22** (1), 257-261.

2. Biswas A, Roy M (2015a) Green products: An exploratory study on the consumer behaviour in emerging economies of the east. J Clean Prod, **87**, 463–468 http://dx.doi. org/10.1016/j.jclepro.2014.09.075

3. Biswas A, Roy M (2015b) Leveraging factors for sustained green consumption behavior based on consumption value perceptions: Testing the structural model. J Clean Prod, **95,** 332–340 https://doi.org/10.1016/J. JCLEPRO.2015.02.042.

4. Biswas A (2017) A consumption value-gap analysis for sustainable consumption. Environ Sci Pollut Res, **24**(8)7714–7725. https://link. springer.com/article/10.1007/ s11356-016-8355-9.

5. Lin, P.C., Huang, Y.H., (2012) The influence factors on choice behaviour regarding green products based on the theory of consumption values. J Clean Prod, **22**, 11-18.

6. Laroche, M., Bergeron, J., & Barbaro-Forleo, G (2001) Targeting consumers who are willing to pay more for environmentally friendly products. Journal of Consumer Marketing, **18** (6), 503-520.

7. Sheth, J., Newman, B., Gross, B., (1991) Why we buy what we buy: a theory of consumption values. J Bus Res, **22** (2), 159-170.

8. Biswas A, Malakar (2022) Sustainable consumption practices- A leveraging factor of Atmnirbhar Bharat, The Management Accountant, **57** (2), 68-71.

DISTRIBUTION OF DIATOM FLORA OF SPRING FED STREAM "MARKANDA"

Ritu Pant[1] and Prakash Nautiyal[2]
[1]Associate Professor, Department of Zoology, SGGSJ Government College, Paonta Sahib-173025 (H.P.), India
[2]Professor and Head, Department of Zoology & Biotechnology, H.N.B. Garhwal Central University, Srinagar-246174, Uttarakhand, India
[1]pantdr69@gmail.com and [2]pn.mahseer@gmail.com

ABSTRACT
The study was undertaken to investigate the diatom flora of Siwalik stream of Markanda basin in Himachal Pradesh. The samples were collected seasonally from seven locations by scraping the cobble surface and mounted on Naphrax after acid treatment. In this study, 190 diatom taxa were identified in total. The identified flora comprised of one centric and six pennate families: Thalassiosiraceae, Fragilariaceae, Eunotiaceae, Achnanthaceae, Naviculaceae, Bacillariaceae and Surirellaceae. However, the share of Naviculaceae was found to be highest followed by Achnanthaceae. Naviculaceae contained 25 to 69 taxa (mostly above 40 taxa at most of the locations). Achnanthaceae contained 17 to 30 taxa at different locations. The distribution and biodiversity of diatoms can provide an insight of sustainable development of aquatic ecosystem as the distribution of diatoms may be affected by the land use and water pollution. Hence, distribution of diatom flora may be an important indicator of water health.

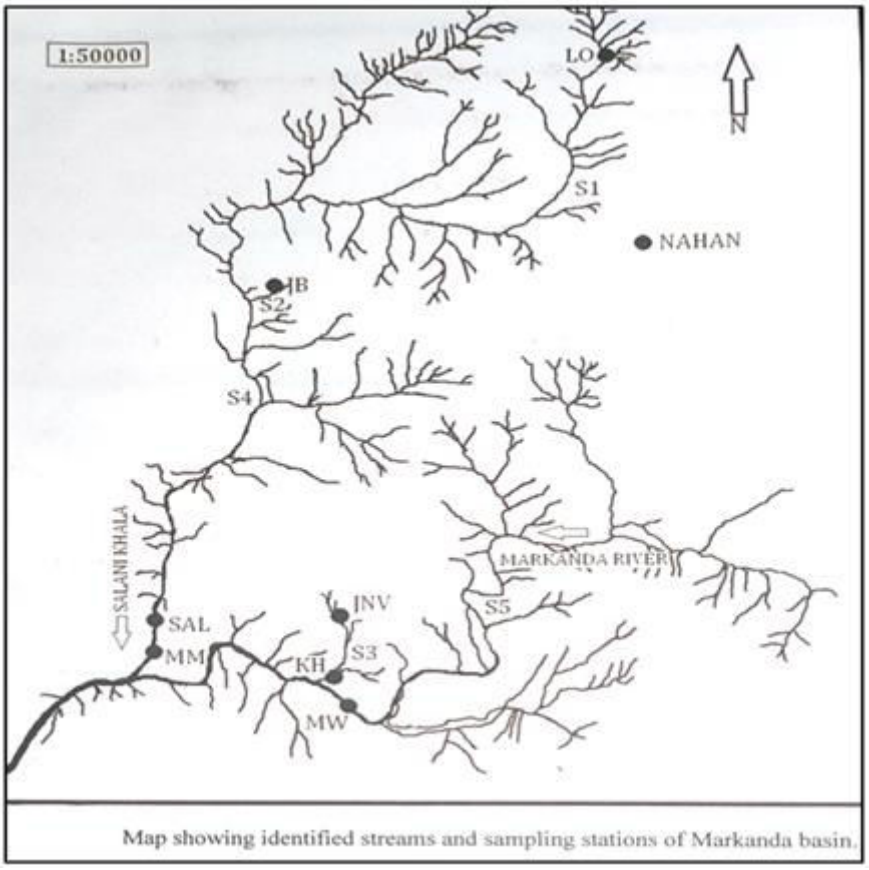
***Keywords**: Siwalik, Diatom, Biodiversity, Pennate, Centrales.*

INTRODUCTION
Diatoms are primary producers of the aquatic ecosystem. In Indian subcontinent, the diatom study was mainly undertaken by Gonzalves and Gandhi (1952), Prasad and Srivastava 1992 and Gandhi 1998. However, in Himalayan region, little is known about diatom distribution in aquatic ecosystems (Dickie, 1882; Carter, 1926; Rao,1963; Suxena *et al.,* 1968, 1970, 1972; Rout and Gaur 1994; Ormerod *et al.,*1997; Jüttner *et al.,* 2001; Nautiyal *et al.,* 2004 a, b, 2013, 2014 a, b; Dwivedi and Misra, 2015; Verma *et al.*, 2016. Hence, the present study aims to investigate the floral composition of spring fed Siwalik stream, the Markanda (Himachal Pradesh).

STUDY AREA
The Markanda stream is located in the Siwalik hills of Himachal Pradesh adjacent to Doon valley in the West Himalaya. The total catchment area of this rivulet in Himachal Pradesh extends between latitude 30° 31″ to 30° 31″ and longitude 77°15″ to 77°17″; measuring around 376.50 square kilometers in area. Most of its basin is composed of dry riverbed (commonly known as *Khalas),* having water only during rainy season. This Siwalik area is surrounded by climax type mixed dry deciduous forest with *Sal* as dominant species. The climatic conditions are subtropical. Five streams were identified for the study. The streams except Markanda bear no name and therefore for identification purpose have been described as S1, S2, S3, S4 and S5. S5 is the main rivulet of the basin. Streams S3 and S4 are tributaries of Markanda.

MATERIALS AND METHODS
The seasonal intensive sampling was undertaken. The sampling was carried out seasonally during winter (December), summer (May), and post monsoon (September) months.The sampling was performed across the width of stream. Diatom samples were collected by scraping the cobble surface with razor and brush from an area of 3×3 cm. After Acid treatment, the permanent mounts were prepared in Naphrax for examining the flora. Identification of diatom species were made according to standard literature (Husted, 1985; Krammer and Lange-

Bertalot, 1986-1991,1991a&b,2004; Sims, 1996; Lange-Bertalot, 2001; Metzeltin and Lange-Bertalot, 2002, 2005; Krammer 2002,2003; Lange-Bertalot *et al.,* 2003. In addition to these, Sarode and Kamat (1984), Prasad and Srivastava (1992) and Gandhi (1998) were also consulted for subcontinent flora. The permanent mount has been adequately stored at the Aquatic Biodiversity Lab, Department of Zoology, H.N.B. Garhwal University (where the work was undertaken).



Map showing identified streams and sampling stations of Markanda basin.

RESULTS

A total number of 190 taxa were observed from seven stations of the Siwalik streams. The flora consisted of coscinid, araphid, pseudoraphid, monoraphid and biraphid elements. The flora consisted of very few cocinid and araphid elements and a high share of biraphid. The monoraphids constituted 21-25% at most of the locations and biraphids accounted for 61 to 69% at most stations. Consequently, flora was dominated by pennate elements. The identified flora comprised of one centric and six pennate families: Thalassiosiraceae, Fragilariaceae, Eunotiaceae, Achnanthaceae, Naviculaceae, Bacillariaceae and Surirellaceae. However, the share of Naviculaceae was found to be highest followed by Achnanthaceae. Naviculaceae contained 25 to 69 taxa (mostly above 40 taxa at most of the locations). Achnanthaceae contained 17 to 30 taxa at different locations. The epilithic diatom flora in Siwalik stream of Markanda Basin was distributed in a highly fragmented fashion (Table 1).

Table 1: Distribution of diatom flora in the Markanda basin.

		LO	SAL	MM	JB	JNV	K	MW
	GENERA							
	CENTRALES							
	COSCINODISCINEAE							

	THALASSIOSIRACEAE							
1.	*Cyclotella delicatissima n. sp*				+	+		
2.	*Cyclotella kutziangiana Thw.*				+	+		
3.	*C. meneghiana Kutzing*			+	+	+		
4.	*Cyclotella stelligeroides Hust.*		+	+	+	+		
5.	*Melosira dickiei (Thwaites)Kutzing*			+	+	+	+	
6.	*Melosira numuloids (O.F.Muller) Agardh*			+				
	PENNALES							
	ARAPHIDINEAE							
	FRAGILARIACEAE							
7.	*Diatoma anceps (Ehrenberg) Kirchner*				+	+	+	
8.	*D. hymale (Roth) Heiberg*		+	+	+	+	+	
9.	*D. hymale quadratum (Kutzing) R. Ross*		+	+	+			
10.	*D. moniliforma*	+		+	+		+	
11.	*D. tenue elongatum Lyngbye*			+	+			
12.	*D. vulgare breve Bory*			+				
13.	*Fragilaria bidensHeigerg*				+			
14.	*F. vaucheriae deformedvalve Kutzing*			+	+	+		
15.	*Fragilaria alpestris Krasske*				+			
16.	*Fragilaria inflate* (Heiden) Hustedt			+				
17.	*Synedra amphicephala* var. *austriaca* Grunow	+			+			
18.	*S. ulna* (Nitzsch) Ehrenberg	+	+	+	+	+	+	+
19.	*S. ulna contracta* Ostrup			+			+	
20.	*S. ulna spathulifera* Grunow		+	+			+	
21.	*S. ulna var. oxyrhynchus*(Kutzing) Van Heurck			+	+	+	+	+
	EUNOTIACEAE							
22.	*E. sudetica*			+			+	
23.	*Euontia biggiba Kutzing*			+				
24.	*Euontiaexigua (Brebission ex Kutzing) Rabenhorst*			+	+	+	+	
	ACHNANTHACEAE							
25.	*A. affinis* Grunow	+	+		+			
26.	*A. austriaca helvetica Hustedt*				+	+		
27.	*A. biasolettian Grunow in Cleve et Grunow*	+	+	+	+	+	+	+
28.	*A. bicapitata* Hustedt	+	+		+	+	+	+
29.	*A. boyei* Ostrup						+	
30.	*A. breviceps intermedia (Kutzing) Cleve*			+				
31.	*A. clevie Grunow*						+	
32.	*A. delicatissima* Krasske		+	+	+	+	+	
33.	*A. didyma* Hustedt	+	+	+	+	+		
34.	*A. exigua Grunow in Cleve et* Grunow		+					
35.	*A. expressa* J.R. Carter	+	+		+		+	+
36.	*A. flexella*var. *alpestsis*(Kutzing) Grunow	+		+	+		+	
37.	*A. grimmei* Krasske	+	+	+	+		+	+
38.	*A. hauckiana* Grunow		+	+			+	
39.	*A. hungarica* Grunow	+	+	+	+	+	+	+
40.	*A. kolbei* Hustedt						+	
41.	*A. kryophilia* Petersen	+	+		+	+	+	+

42.	*A. lanceolata* (Brebison in Kutz.) Grunow	+		+	+		+	+
43.	*A. lanceolata capitata* Muller	+		+	+	+		+
44.	*A. lanceolata elliptica Cleve*	+	+		+	+		
45.	*A. lanceolata rostera (*Ostrup*)Hustedt*		+	+				
46.	*A. lanceolata v. expressa*				+	+		
47.	*A. lapponica* Grunow	+		+	+		+	
48.	*A. laterostrata* Hustedt	+		+	+	+	+	+
49.	*A. lemmermanni* Hustedt	+		+	+	+	+	+
50.	*A. linearis/ pusilla Krasske*			+	+	+		
51.	*A. linkei*						+	
52.	*A. lutheri*Hustedt			+	+		+	
53.	*A. minutissima cryptocephala* (Kutzing) Grunow	+	+	+	+			+
54.	*A. minutissima* Kutzing	+	+	+	+	+	+	+
55.	*A. orientalis* Hustedt						+	+
56.	*A. pussila*			+				
57.	*A. saxonica Krasske*	+			+			
58.	*A. spitzbergensis*						+	
59.	*A. thumensis* (A.Mayer) A.Cleve-Euler	+		+	+			+
60.	*A. triggiba* Hustedt	+	+	+	+			
61.	*Cocconeis disculus (S*chuman*n) Cl*				+	+		
62.	*C. pediculus* Ehrenberg	+		+	+	+	+	
63.	*Cocconeis placentula* Ehrenberg	+	+	+	+	+	+	
64.	*C. plancetula euglypta (*Ehrenberg)Grunow	+		+	+	+	+	+
65.	*C. plancetula lineata Ehrenberg*	+		+	+	+		+
66.	*Rhoicosphenia vanheucki Grunow*							+
	NAVICULACEAE							
67.	*Amphora coffeaeformis* Agardh	+			+			
68.	*A. ovalis* Kutzing			+	+	+	+	
69.	*A. ovalis pediculus* Kutzing	+		+	+	+	+	
70.	*Caloneis bacillum lancetulla (Schultz) Hustedt*			+				
71.	*Caloneis bacillaris (Gregory)Cleve*			+			+	
72.	*C. borealis J.R. Carter*			+				
73.	*Cymbella affinis* Kutzing	+	+	+	+	+	+	+
74.	*C. aequalis W. Smith*		+	+	+			+
75.	*C.aspera (*Ehr.) Cleve		+				+	
76.	*C. bernesis* Meister		+	+	+	+	+	
77.	*C. brehmii* Hustedt	+	+	+	+		+	+
78.	*C. caespitosa (*kutzing)Brun							+
79.	*C. cymbiformis* Agardh	+	+	+	+	+	+	+
80.	*C. cymbiformis nonpuncta* Fontell		+	+	+		+	+
81.	*C. elegensis* Krammer		+	+			+	+
82.	*C. gaeumannii* Meister			+	+	+	+	
83.	*C. halvetica* Kutzing	+	+	+	+		+	
84.	*C. hebridica* (Gregory) Grunow	+	+	+	+		+	+
85.	*C. hustedi* Krasske	+	+	+	+	+	+	
86.	*C. hybridiformis* Hustedt				+			
87.	*C. kutzingiana* Thw.				+	+		

88.	*C. lacustris (*Agardh)Cleve		+	+	+	+	+	
89.	*C. laevis Negali in* Kutzing	+	+	+	+		+	
90.	*C. lanceolata (*Her)VanHeurck	+	+	+	+		+	
91.	*C. lapponica* Grunow ex Cleve			+				
92.	*C. latens*		+		+			
93.	*C. lepidula* (Grunow in Van Heurck) Cleve		+		+			
94.	*C. macedonia*		+					
95.	*C. microcephala* fo Grunow in Van Heurck	+	+	+	+		+	
96.	*C. minutafo lateens (*Krasske)Reimer			+			+	+
97.	*C. minuta* Hilse Rabenhorst	+			+	+	+	
98.	*C. naviculiformis* Auerswald	+			+		+	+
99.	*C. norvegica* Grunow in A. Schmidt		+	+				
100.	*C. parva (*W.Smith) Cleve		+					
101.	*C. perpusilla* (Berkeley)Cleve		+	+	+	+	+	
102.	*C. prostrata* (Berkeley)Cleve	+	+	+	+	+		
103.	*C.pusilla* Grunow ex Schmidt			+				
104.	*C. rupicola* Grunow		+	+	+			+
105.	*C. silesiacum* Bleischin Rabenhorst						+	
106.	*C. sinuatafo. ovata* Hust,	+		+	+		+	
107.	*C. sinuata* Gregory/Reimeriasinuata		+	+	+	+		+
108.	*C. tumida* (Brebisson) Van Heurck	+	+	+	+	+	+	
109.	*C. tumidula* Grunow	+	+	+	+	+		
110.	*C. turgidula* Grunow	+	+	+	+	+	+	+
111.	*C. ventricosa* Kutzing	+		+	+		+	+
112.	*Gomphocymbella ancyli (*Cleve) Hust.		+	+	+	+		
113.	*Gomphonem abbrevatum* Agadh Kutz.		+		+	+	+	
114.	*G. angustatum* (Kutz) Rabh			+	+	+	+	
115.	*G. apicatum* Ehrenberg		+	+	+	+	+	+
116.	*G. augur* Ehrenberg	+	+	+	+		+	
117.	*G. bohemicum* Ehrenberg	+		+	+			
118.	*G. clavatum* Reichelt &Fricke		+		+	+	+	
119.	*G. constrictum capitata* Ehrenberg		+	+			+	
120.	*G. exigum* Kutzing				+		+	+
121.	*G. gracile* Ehrenberg			+	+	+		
122.	*G. grovei* M. Schmidt	+	+	+	+	+	+	
123.	*G. helveticum* Brun		+	+			+	
124.	*G. intricatum pumila* Grunow				+	+	+	
125.	*G. lanceolatum (Lyngbye) Kutz*	+	+	+	+	+	+	+
126.	*G. lanceolatum* var. *insignis* Gregory	+						
127.	*G. longiceps*var. *subclavata* Grunow	+				+		+
128.	*G. minutum (*Agardh*)*						+	
129.	*G. olivaceum.calcarea* Cleve				+	+		
130.	*G. olivaceum (*Kutzing*)*	+	+	+	+	+	+	+
131.	*G. olivaceum minutissima* Hustedt	+		+	+	+	+	
132.	*G. parvulum*	+	+	+	+	+	+	
133.	*G. parvulum subelliptica*	+	+	+	+			+
134.	*G. pseudotenellum* Lange-Bertalot		+	+	+		+	
135.	*G. rhombicumfo.*						+	
136.	*G. sphareophorum* Ehrenberg	+	+		+	+	+	

137.	*G. subtile* Ehrenberg		+				+	
138.	*G. tergesteum* Gregory			+	+	+	+	
139.	*G. ventricosum* O. Muller		+	+				
140.	*G. wansbeckii* (Donkin)Cleve				+	+		
141.	*Gyrosigma acuminatum* (Kutzing) Rabenhorst		+	+	+	+		
142.	*G. acuminatum* Ehrenberg			+				
143.	*G. scalproides* (Rabenhorst)Cleve		+					
144.	*N cryptocephala* Kutzing						+	
145.	*N. cari* Ehrenberg	+			+			
146.	*N. cincta* (Ehrenberg)Ralf in Pritchard	+	+		+			+
147.	*N. citrus* Krasske			+	+	+		
148.	*N. contenta*			+				
149.	*N. cryptotenella* Lange-Bertalot	+			+	+	+	
150.	*N. disjuncta* Hustedt			+				
151.	*N. fluens Hustedt*						+	
152.	*N. gandersheimiensis* Rabh.			+				
153.	*N. gibbula* Cleve			+				+
154.	*N. palustris* Hustedt	+			+			
155.	*N. protracta* Grun. In Cleve et grun.		+	+			+	
156.	*N. pseudolanceolata* Hustedt						+	
157.	*N. pseudonglica* (Lange-Bertalot)E.Jcox						+	
158.	*N. pseudoventralis* Hustedt						+	
159.	*N. pupula* Kutzing	+	+	+	+		+	+
160.	*N. radiosa* Kutzing				+	+		
161.	*N. rhynchocephala* Kutzing	+	+	+	+	+	+	+
162.	*N. romana* Grunow	+			+			
163.	*N. scirpus* J.R. Carter						+	
164.	*N. simplex* Krasske	+		+	+		+	
165.	*N. subrhyncocephala* Hustedt		+	+	+		+	+
166.	*N. tentellerideslange*-Bertalot				+	+	+	
167.	*N. variostriata* Krasske				+	+		
168.	*Pinnularia brandelii* Cleve	+			+	+		
169.	*P. braunii* Grunow ex Schmidt		+					
170.	*Pinnulari asinuata* Gregory						+	
171.	*P. subcapitata* Gregory		+	+	+	+		
172.	*Stauroneis prominula* (Grun) Hustedt						+	
	BACILLARIACEAE							
173.	*N. amphibia* Grunow	+	+	+	+	+	+	+
174.	*N. capitata* Ehrn.	+	+		+		+	+
175.	*N. fonticola* Grunow	+	+	+	+	+	+	
176.	*N. fonticola subsalina* Hust.			+				
177.	*N. frustulum (Kutz)* Grunow			+			+	
178.	*N. hanztschiana* Kutzing		+	+	+	+	+	
179.	*N. heufleriana* Grunow	+			+			
180.	*N. kutziangiana* Hilse		+	+				
181.	*N. linearis*			+				
182.	*N. palea* Grunow	+		+	+	+		
183.	*N. paleacea* Grunow	+	+	+	+		+	+
184.	*N. sinuatata bellaria* Grunow	+					+	+

	SURIRELLACEAE							
185.	*Surirella ovalis* Breb.			+			+	
186.	*S. ovalis* Ehrenberg						+	
187.	*S. ovata* Kutzing		+				+	
188.	*S. robusta* Wm. Sm.		+		+	+		
189.	*Surriela subnodosa* Berb						+	
190.	*S.(stenopterobia)* Lewis			+				
		73	82	118	124	77	107	48

DISCUSSION

Biodiversity in freshwater ecosystem is relatively discontinuous as compared to marine or terrestrial ecosystem. The land barriers separate river drainage into discreate units and fresh water small stream harbor unique and locally evolved form of life.

In the Siwalik streams, *Navicula (*38) and *Achnanthes (*33) were most species rich taxa whereas *Navicula* s.l. (50) and *Achnanthes* s.I. (49) were recorded by Nautiyal *et al.* (2004 b) in Alaknanda-Ganga.But in lesser Himalyan stream *Achnanthes*26 taxa, *Navicula*73 taxa (Verma *et al.,* 2009). Monoraphids were more in the Himalyan than in Plateau region (Verma and Nautiyal, 2011). In unregulated water of Yamuna, Navicula 7, and Achnanthes 5, 4 for Navicula, 1Achnanthes in Tons River ((Sharma *et al.*, 2018). Whereas in spring fed spring of Doon valley the share of A. minutissimum is13.25% (Rajbeer *et al.,* 2018a). In Markanda Basin, monoraphids accounted for 5.8% of the total flora. However, investigations of Nautiyal and Nautiyal (1999), Nautiyal *et al.,* (2004 a, b), Nautiyal (2010) found that Himalayan rivers are richer in araphid flora. Khan (2002) found only 7.4% of araphid in Kashmir; whereas in Siwalik streams, only 9% araphids were observed. Biraphids were the major elements among the pennales, centric being very few.

The biodiversity of Siwalik streams is different from other part of Himalya and is under the influence of a number of factors. The ecology of running water can be judged using the distributional pattern (Nautiyal et al 2015, Rajbeer et al 2018) and the pattern can provide a look into conservation and sustainable development of Siwalik aquatic ecosystems.

CONCLUSION

The Markandais a spring fed rivulet present in Lower Shiwalik hills of Himalaya and the out of total 190 texa only 10 taxa called as widely distributed. *Navicula* s.l. and *Achnanthes* s.l. werethe most species rich genera. The Siwalik streams appear to be centers of biodiversity in the midst of vast mountain chain. Thus, the biodiversity of diatom flora can help to fathom health of aquatic ecosystems.

ACKNOWLEDGEMENT

The academic support by the Department of Zoology, H.N.B. Garhwal Central University is highly acknowledged.

REFERENCES

1. Carter, N. (1926) Freshwater algae from India.Records of Bot Sur Ind,**9**, 263-302.
2. Dickie G. (1882) Notes on algae from Himalaya. Journal of Linnean Society, Botany,**19**, 230-232.
3. Dwivedi R.K. and Mishra P.K. (2015) Fresh water Diatoms from Himalayan state Himachal Pradesh, India. Phykos,**45**(1),30-39.
4. Gandhi, H.P. (1998) Fresh water Diatoms of Central Gujarat (with a review andsome others). Bishen Pal Singh, Mahendra Pal Singh, Dehradun.

5. Gonzalves, E.A. and Gandhi, H.P. (1952) A systematic account of the Diatoms ofBombay and Salsette, part I. J Ind Bot Soc, **31**,117-151.

6. Hustedt, F. (1931-1959) Die Kieselalgen Deutschlands Oesterrichs und derSchweiz Bd. 7, Teil 2, Translated by N. G. Jensen as The Pennate Diatoms 1985. pp 918. Koenigstein: Koeltz Scientific Books.

7. Jüttner, I. and Cox, E.J. (2001) Diatom communities in streams from the Kumaon Himalaya, north-west India. pp 237-248. In: A. Economou - Amilli (ed.) Proceeding of 16th International Diatom Symposium. Athens and Aegean Islands. Amvrosiou Press, University of Athens, Greece.

8. Khan, M.A. (2002) Phycological studies in Kashmir: Algal biodiversity. In: Ethology of Aquatic Biota. PHA Publication Corporation, New Delhi.

9. Krammer, K. and Lange-Bertalot, H. (1986-1991). Bacillariophyceae. DieSüsswasserflora von Mitteleuropa. Vol. **2/1**Naviculaceae, pp1-876 mit 206 pl. Vol. **2/2** Bacillariaceae, Epithemiaceae, Surirellaceae, pp 1- 596 (1988). Vol **2/3**Centrales, Fragilariaceae, Eunotiaceae, pp 1-576 (1991). Vol. 2/4 Achnanthaceae, Kritische Erganzungen zu Navicula (Lineolatae) und Gomphonema. pp 1-437 (1991). Vol.**5** English and Frenchtranslations of the keys and Supplements (2000). Stuttgartand Heidelberg.

10. Krammer, K. and Lange-Bertalot, H. (1991a) Suffwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/3, **3**. Teil: Centrales, Fragilariaceae. Stuttgart: Gustav Fischer Verlag.

11. Krammer, K. and Lange-Bertalot, H. (1991b) Suffwasserflora von Mitteleuropa, Bacillariophyceae, Band 2/4, **4**. Teil: Achnanthaceae, Kritische Erg. nzungenzu Navicula (Lineolatae) und Gomphonema Gesamtliteraturverzeichnis. Stuttgart: Gustav Fischer Verlag.

12. Krammer, K. and Lange-Bertalot, H. (2004) Süsswasser Flora von Mitteleuropa. Bacillariophyceae Band 2/4, **4**. Teil: Achnanthaceae. 68. Berlin: Spektrum Akademischer Verlag, Heidelberg.

13. Krammer, K. (2003) Diatoms of Europe: Diatoms of European Inland Watersand Comparable Habitats.Cymbopleura, Delicata, Navicymbula, Gomphocymbellopsis Afrocymbella, pp 530. Ruggell: A. R. G. Gantner, K. G. Verlag.

14. Lange-Bertalot, H. (2001). Diatoms of Europe, Vol **2**, The genus Navicula sensustricto 10 Genera Separated from Navicula sensu lato Frustulia. A.R.G. Gantner Verlag KG, pp 526, pl140.

15. Metzeltin, D. and Lange-Bertalot, H. (2002): Diatoms from the Island Continent Madagascar. Annotated Diatom Micrographs (H. Lange-Bertalot ed.). IonographiaDiatomologica,**11**. A. R. G. Gantner Verlag K. G.

16. Metzeltin, D., Lange-Bertalot, H. and Garcia-Rodriguez, F. (2005) Diatoms of Uruguay. Taxonomy-Biogeography-Diversity (Annotated Diatom Micrographs (H. Lange Bertalot ed.). Iconographia Diatomologica**15**, A.R.G. Gantner Verlag KG, pp 726, pl 240.

17. Nautiyal, P. (2002) Ecology of mountain streams and rivers in Garhwal Himalaya. 393-417. In: Kumar, A. (ed.) Ecology and Conservation of Lakes, Reservoirs and Rivers. A.B.D. Publishers, Jaipur.

18. Nautiyal, P.& Nautiyal, R. (2002) Altitudinal variationsin the relative abundance of epilithic diatoms in some glacier andspringfed Himalayantributaries of the Ganga River system intheGarhwal region, pp 141-151. In: John, J.(ed.) Proceedings of the 15th International Diatom Symposium. A.R.G. Gantner Verlag KG., Ruggell.

19. Nautiyal, P., Kala, K. & Nautiyal, R. (2004a). A preliminarystudy of the diversityof diatoms instreams of Mandakini basin (Garhwal), pp235-269. In: Poulin, M. (ed.) Proceedings of 17th International Diatom Symposium, 2002 Ottawa. Biopress Ltd, Bristol.

20. Nautiyal, P., Nautiyal, R., Kala, K. and Verma, J. (2004b): Taxonomic richness in the diatom flora of Himalayan streams (Garhwal, India). Diatom, **20**, pp123- 132.

21. Nautiyal, R. & Nautiyal, P. (1996) Pennate diatom flora of a cold-watermountainriver, the Alaknanda: suborder Raphidioideae andMonoraphideae.Journal of the Indian Botanical Society,**5**, pp 99-101.

22. Nautiyal, R. & Nautiyal, P. (1999) Altitudinal variations in the pennate diatomflora of the Alaknanda-Ganga River system in the Himalayan stretch of Garhwalregion, pp 91-105. In: Mayama, S., Idei, M., & Koizumi, (eds) Proceedings of 14th International Diatom Symposium, Tokyo, Koeltz Scientific Books, Koenigstein.

23. Nautiyal, R., Nautiyal, P. & Singh, H.R. (1995). Pennate diatoms of Alaknanda, a cold-water mountain river: suborder Biraphidae. Phykos,**34**, 91-96.

24. Nautiyal, R., Nautiyal, P. & Singh, H.R. (1996a). Impact of sewage on the diatom communitiesof river Alaknanda (Srinagar, Garhwal). InternationalJournal of Ecology and Environmental Sciences, **22**, 289-296.

25. Nautiyal, R., Nautiyal, P. & Singh, H.R. (1996b). Pennate diatom flora of a cold-watermountain river, the Alaknanda: II suborder Araphideae.Phykos, **35**, 57-63.

26. Nautiyal, P., Nautiyal, R., Semval V.P., Verma J., Uniyal D.P., Uniyal M., SinghK., R (2013) Ecosystem health indicators in the Ganga basin (Uttarakhand India) Biodiversity and spatial Patterns in Structure and Distribution of benthic diatoms, macro invertebrates and ichthyo fauna. Aquat. Ecosystem Health Mgmt.,**16**(4), 362-373.

27. Nautiyal, P., Verma J., Mishra A.S. (2014a) Distribution of Major Floral and Faunal Diversity in the Mountain and Upper Gangetic Plains Zone of the Ganga Diatoms, Macroinvertebrates and Fish.In: R Sanghi (ed.) Our National River Ganga Lifeline of Millions, Springer International Publishing, Switzerland.

28. Nautiyal, P., Nautiyal, R. Verma J., (2014b) Distribution of Diatom flora in thePlateau and mountain chains of Indian subcontinent and its Island. In: L. Jose (ed.) Proc. National Sem.on Taxonomy and Ecology of fresh water Algae, Department of Botany, St. Albert College Ernakulum pp39-44.

29. Nautiyal, P., Mishra A.S., Verma J. (2015) The health of benthic diatomassemblage in lower stretch of a lesser Himalayan glacier fed river, Mandakini. J Earth Syst. Sci.,**124**(2), 383-394.

30. Ormerod, S.J., Baral, H.S., Brewin, PA., Buckton, S.T., Juttner, I., Rothfritz, H., & Suren, AM. (1997) River Habitat Surveys and Biodiversity in the Nepal Himalaya, pp 241-250. In: Boon P.J. & Howell, D.L. (eds) Freshwater Quality: Defining the Indefinable, HMSO, Edinburgh.

31. Prasad, B. N. and Srivastava, M. N. (1992) Fresh water algal flora of Andaman and Nicobar Islands Vol. **I**, B. Singh and M. P, Singh Publ.Dehradun, India, pp369.

32. Rao, R.S. (1963) A botanical tour in the Sikkim state, Eastern Himalayas. Bulletinof Botanical Survey of India,**5**, 165-205.

33. Singh, R., Nautiyal, P. and Nautiyal, R. (2018) Evaluation of the ecological state of the major streams located in Doon valley using diatoms as indicators, Journal of Applied and Natural Science,**10** (1),500-506.

34. Rout, J. and Gaur, J.P. (1994) Composition of dynamics of epilithic algae in a forest stream at Shillong (India). Hydrobiologia, **291**,61-74.

35. Sarode, P.T. & Kamat, N.D. (1984) Freshwater Diatoms of Maharashtra. pp 338, SaikripaPrakashan, Aurangabad.

36. Sharma, S., Nautiyal, R. and Nautiyal, P. (2018) Diatom Florain Natural and Regulated Stretch of River Tons and Yamuna: Determining the Impacts of Hydropower Projects on the River Ecosystem.

37. Singh, H.R., Nautiyal, P., Dobriyal, A.K., Pokhriya1, R. C., Negi, M., Baduni, V., Nautiyal, R., Agrawal, N.K. & Gautam, A. (1994) Waterquality of river Ganga (Garhwal Himalaya). Acta Hydrobiologica,**36** (1), 3-15.

38. Singh R., Nautiyal P. and Nautiyal R.(2017a) Variability in diatom assemblages of spring habitatsin Doonvalley, J. Mountain Res,**12**, 59-65.

39. Singh R., Nautiyal, P. and Nautiyal, R. (2018b) Evaluation of the ecological state of the major streams located in Doon valley using diatoms as indicators. Journal of Applied and Natural Science,**10** (1), 500-506.

40. Sims, P.A. (ed.). 1996. An Atlas of British Diatoms, pp 601. Biopress Limited, Bristol.

41. Suxena, M. R. & Venkateswarlu, V. (1968) Algae of the Cho-Oyu (E. Himalaya) Expedition - I. Bacilariophyceae. Hydrobiologia,**32**, 1-26.

42. Suxena, M.R.& Venkatesuwarlu, V. (1970) Diatoms of the hot springs of Badrinath Himalayas. (Diatomaceae II). Nova Hedwigia,**31**, 633 -652.

43. Suxena, M.R., Venkateswarlu, V. & Rao, V.S. (1972) Algae of the Cho-Oyu (E. Himalaya) Expedition- II. Bacilariophyceae. Nova Hedwigia **23**, 415-426.

44. Verma, J. and Nautiyal P., (2009) Longitudinal Patterns of Distribution of Epilithic Diatoms in a Lesser Himalayan Stream, Journal of Hill Research,**22** (2),105-109.

45. Verma, J., Gopesh, A. and Nautiyal, P. (2016) Biogeography and distribution of bacillariophyceae in the highland rivers of India. International Journal of Applied Research. **2**(4), 356-359.

A PERSPECTIVE ON FISH FAUNAL DIVERSITY OF THE HILL STREAMS OF HIMACHAL PRADESH VIS-A-VIS STREAM MORPHOLOGY

Shivali Sharma[1] and Harinder Singh Banyal[2]
[1]Research Scholar and [2]Associate Professor, Department of Biosciences, Himachal Pradesh University, Summer Hill, Shimla-171005, India
[1]shivali20597@gmail.com

ABSTRACT
Running waters are integral component of the planet earth. Life from viruses to human depends on water. The study of life in running water disclose the history of entire continent and also predicts its ability to support life in the future. In India standard hill streams are found in the Himalayan belt. The hill streams are an essential and important part of mountainous ecosystem of Himalaya. High water velocity, cold water with more dissolved oxygen and typical indigenous fauna characterizes these streams. These hill streams provide the feeding and breeding grounds for most of the hill stream fishes, which in turn have an impact on the reservoir fisheries. Hill streams are also valued for recreation, wildlife habitats, drainage habitation, industrial and agricultural uses. It has been marked those streams in high altitude have steep gradient and boulder dominated substrate with rapids as main habitat type. As we go down steepness decreases, pools and riffles increase and there is cobble dominated substrate. The fish faunal diversity increases from upland to lowland streams in the Himachal Pradesh of Himalayan region. The present review deals with morphology and characteristics of hill streams including estimation of impact of stream ecology on fish assemblage pattern. The ecology of fishes and in turn their diversity in hill streams of Himachal Pradesh is very closely related to landscape phenomena like inputs or accessibility of nutrients, sources or quality of water, geology, availability of food, water withdrawals, land use and interference of natural stream flow by impoundments. Long-term proper management policies are required for the sustenance of indigenous fish faunal diversity in the hill streams of Himachal Pradesh.

Keywords: *Diversity, Hill streams, Morphology, Running water, Fish fauna.*

INTRODUCTION
Western Himalaya lie mainly in the Northern Indian subcontinent. The Western Himalaya expand southeast for some 560 km from the curve of the Indus River (northwest) to the Sutlej River (southeast). All five tributaries of the Indus River system (Jhelum, Chenab, Ravi, Beas, Sutlej) arise from the Western Himalaya (Anonymous, 2016).

Himachal Pradesh is a state in northern part of India, located in Western Himalaya, situated between 30°22′N and 33°12′N latitude and 75°47′E and 79°04′E longitude. The drainage system of Himachal consists of both rivers and glaciers. It provides water to the Indus and

Source: https://i0.wp.com/www.himbuds.com/wp-content/uploads/2017/09/River-System-of-Himachal.jpg

Ganges River basins. The drainage system of the region encompasses the Chenab, the Ravi, the Beas, the Sutlej, and the Yamuna. These rivers are perennial and fed by snow and rainfall. Each river is fed by many tributaries or streams (Anonymous, 2006).

Stream is a natural water body containing flowing water, at least for a part of the year, along with suspended and dissolved materials, and supporting plants and animals' community within the stream channel and riparian zone (Armantrout, 1999). Stream channel morphology is very important aspect in stream ecology, because, with stream hydrology, it also determines the nature and amount of stream and riparian habitat (Colley, 1997). In the river continuum concept, (Vannote *et al*., 1980) hypothesized that there is continuous gradient of physical conditions and biological communities within a stream.

Hill streams play a very important role in maintaining the ecological health of rivers and reservoirs located in mountain regions of India (Sugunan, 1995). The 'ideal' stream lies in constant geological terrain, it is most erosive in its head waters where rocks and boulders create uneven and turbulent flow. As the slope is gradually reduced stream's ability to erode its bed lessens. The stream becomes horizontal when it meets the sea. The size and depth of the channel increases downstream as more water is ejected from an increasing catchment area (Moss,1988). Each stream has distant anatomy because each is composed of series of riffles, pools and runs. Riffles are characterized by shallow depth and turbulent water flow. Pools are deep with slow current. Runs are characterized by moderate current and depth greater than riffles (Hauer and Lamberti, 2007).

LITERATURE REVIEW

First attempt for the classification of streams is by Davis (1899), based on relative stage of development i.e., young, mature, and old age. Melton (1936) first presented qualitative and descriptive account of stream classification. Stehr and Branson (1938) and Neel (1951) documented the physical and chemical factors of the stream, and their work is still a landmark in descriptive studies of lotic system. Leopold and Wolman (1957) described straight and meandering braided channel pattern on the basis of slope and discharge of water. Some of the landmark studies of physical and chemical parameters, turbidity, light as well as longitudinal distribution, variation in algae and aquatic invertebrates and fishes include those of Minckley (1963). Various other classifications have also been put forward in the past, based on geomorphology (Schumm,1963), depositional feature, vegetation, braiding pattern, sinuosity, meander scroll, bank height and flood plain types (Culbertson et al.,1967), stream morphology (Montgomery and Buffington,1993) and hydrology of streams (Poff and Ward,1989). Worldwide the work on stream ecology has been reviewed by Hynes (1970). Rosgen 1994 noted the occurrence of nine types of streams based on common patterns of channel morphology.

STREAM CLASSIFICATION

According to Rosgen (1994) streams are classified as:

Type “A” streams are isolated thread channels, deep and narrow, flows through steep V-shaped valleys. A stream type with slope greater than 10% are categorized as “Aa+”.

Type “B” streams are wider than A stream type with broader valley but less developed floodplain. They are often rapid dominated with high width/depth ratios.

Type “C” streams are riffle-pool streams with meanders and well develop floodplains. The channel aggradation, degradation and lateral extension processes are primarily active in these types of streams.

Type “D” streams found in alluvial valleys and are multichannel streams which are characterized by moderate to high bank erosion rate, depositional features, and frequent shift in bed forms.

Type “DA” streams are stable braided streams with low width/depth ratio. This stream type is often found in deltas consisting of abundance of wetlands and numerous interconnected channels.

Type “E” stream illustrates developmental endpoint of channel stability and exhibit very low width/depth ratio with high meanders. These streams consist of highest number of pools per unit distance of channel as compared to other stream types.

The “F” stream types are often meandering streams, with high width/depth ratio. They evolve into “C” and then “E” stream types by creating new floodplain at lower elevation.

The “G” or gully stream type exhibits moderate to steep channel slopes and low width/depth ratio. They have high bank erosion and have high sediment supply.

The hill streams are considered as one of ecological system of running water, but in real practice they have totally distinct ecology (Gorman and Karr,1978; Horwitz, 1978; Rahel and Hubert, 1991; Aadland,1993; Armantrout,1995). Nautiyal and Nautiyal (1995) found powerful interrelationship between SC-WT, WT-T & WC-T and negative for WC-DO, and T-DO after working on riverine systems in Garhwal region of the Himalaya. Water temperature, turbidity, water current and dissolved oxygen are important physico-chemical factors which affect the biotic communities of the water body. Water temperature, water current and turbidity influence the amount of dissolved oxygen in these water bodies (Dobriyal and Singh, 1988).

Pioneer work related to stream classification, morphology and ecology in India is done mainly by Sehgal (1983), Nautiyal et al. (1993), Arunanchalam and Soronam (1997). Sehgal (1983) classified streams based on fish fauna inhabiting the stream as snow trout, trout and mahseer streams. Nautiyal et al. (1993) classified hill streams based on temperature ranges as glacial and non-glacial streams or torrential stenothermal and placid eurythermal streams. The stream ecology of Western Ghats has been worked out by Arunanchalam and Soronam (1997).

In this context streams of H.P. are classified from ecological studies perspective by Johal *et al.,* (2001) and Johal and Rawal (2005). Johal and Rawal (2005) classified hill streams as high mountain, mountain, and foothill streams. Johal (2006) documented that hill streams shows altitudinal pattern of A, B, C, F and G.

Fish Fauna of Himachal Pradesh

Johal (2002) reported 133 fish species (excluding exotic and commercial fishes and some culturable native carps) belonging to mainly 2 orders and 31 genera from hill streams of Himachal Pradesh and Garhwal Himalaya. Mehta and Uniyal (2005) reported 104 species of fish from the state of Himachal Pradesh whereas, Sharma & Sidhu (2016) has given an account of 81 fish species belonging to 49 genera, 18 families and 6 orders from the state. In Himachal Pradesh there are two major man-made reservoirs i.e., Govind Sagar and Pong reservoir, which are fed by many tributaries or streams of Beas and Sutlej rivers. These streams are breeding grounds of most of the commercial fishes found in these reservoirs (Johal & Rawal, 2005). The fish fauna of Indian hill streams was also documented by Jayaram (1999). The hill streams in upper Himalayan region are good source of *Salmo trutta fario* & *Onchorhynchus mykiss* (exotic trouts). Middle Himalayan regions are occupied by *Tor putitora*, *Crossocheilus lattius diplocheilus*, *Schizothorax richardsonii*. In lower Himalayan regions, streams are good source of Indian major carps (*Catla catla, Cirrhinus mrigala, Labeo rohita, Labeo dero*), the exotic carps (*Cyprinus carpio*) and *Tor putitora* and various catfishes such as *Wallago attu, Bagarius bagarius*. The streams of Himachal Pradesh support a diverse group of fish fauna, out of which Cypriniformes was found to be the most dominant order followed by Siluriformes. Hill stream fishes develops various morphological adaptations such as dorsoventrally flattened head, subcutaneous eyes, long caudal fin, strong caudal peduncle, fin rays modified into spines covered by skin fold, suckers for attachment to substratum so that they can withstand with high water current and varying degree of steepness of hill streams.

CONCLUSION

Perusal of literature has revealed that, the stream morphology, and various other characteristic features of hill streams of Himachal Pradesh including their ecology are governed by water current, spate of floods and composition of bed material. The removal of bed material, construction of dams and implementation of hydal projects in the drainage basin of hill stream are the potential threats which can affect ecological integrity of the hill stream, of the Himachal Pradesh. The fishery of rivers and reservoirs rely on the ecology of hill streams as these hill streams are the major feeding and breeding grounds for these fishes. Hence, utmost care and attention is required to design proper conservation strategies for the sustenance of the biota in these water bodies including fish faunal diversity for the betterment of all the stakeholders.

REFERENCES

1. Aadland, L.P. (1993). Stream habitat types: their fish assemblages and relationship to flow. N. Am. J. Fish Management., 13, 790-806.
2. Anonymous (2006): www.indianmirror.com.
3. Anonymous (2016): www.britannica.com/place/western-himalayas.
4. Armantrout, N.B. (1995). Conditions of world's aquatic habitats. In: Proceedings of World Fisheries Congress (Theme 1). Ed. N.B. Armantrout. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. Pp. 170-194.

5. Armantrout, N.B. (1999). Glossary of Aquatic Habitat Inventory Terminology. American Fisheries Society, Bethesda, M.D.

6. Arunanchalam, M., & Soronam, R. (1997). Fish diversity of Chittar river of Western Ghats. Inter. J. Eco. Environ. Sci., 23, 335-342.

7. Colley, R.D. (1997). Stream channels are narrower in pasture than in forest, New Zealand Journal of marine and Freshwater research, 31(5), 599-608.

8. Culbertson, D.M., Young, L.E., & Brice, J.C. (1967). Scour and fill in alluvial channels. Open File Report. United States Geological Survey, Reston, Virginia. U.S.A.

9. Davis, W.M. (1899). The geographical cycle. Geogr. J., 14, 481-504.

10. Dobriyal, A.K., & Singh, H.R. (1988). Ecological basis for ichthyofaunal variation in two hill streams of Garhwal Himalaya. In: M.M. Joseph (Ed.). Fisheries Forum, Proceedings, Asian Fisheries Society, Indian Branch, Manglore, India, pp. 313-317.

11. Gorman, O.T., & Karr, J.R. (1978). Habitat structure and stream fish communities. Ecology, 59, 507-515.

12. Hauer, F.R., & Lamberti, G.A. (2007). Methods in Stream Ecology. Academia Press, San Diego ISBN 0-12-332905. 674p.

13. Horwitz, R.J. (1978). Temporal variability pattern and distributional patterns of stream fishes. Ecol. Monogr., 48, 307-321.

14. Hynes, H.B.N. (1970). The Ecology of Running Waters. University of Toronto Press. Toronto, Ontaria, Canada.

15. Jayaram, K.C. (1999). The freshwater fishes of Indian region. Narendra Publishing House, Delhi, India.

16. Johal, M.S. (2002). Ecology of hill streams of Himachal Pradesh and Garhwal region with special reference to fish communities. Project report. U.S. Fish & Wildlife, Washington. U.S.A.

17. Johal, M.S. (2006). On fishery potential of Western Himalayan hill streams and their eco-friendly and sustainable development., Fishing Chimes, April 2006, Vol.26 No.1.

18. Johal, M.S., & Rawal, Y.K. (2005). Key to management of the western Himalayan hill streams in relation to fish species richness and diversity. Hydrobiologia., 532, 225-232.

19. Johal, M.S., Tandon, K.K., Rawal, Y.K., Tyor, A.K., & Banyal, H.S. (2001). Species richness in relation to environmental factors. Curr. Sci., 80(4), 499-501.

20. Leopold, L.B., & Wolman, M.G. (1957). River Channel Patterns: Braided, Meandering and Straight, U.S. Geological Survey Professional Paper, 282-B.

21. Mehta, H.S., & Uniyal, D.P. (2005). Pisces, Zool. Surv. India, Fauna of Western Himalaya (Part-2), 255-268.

22. Melton, F.A. (1936). An empirical classification of flood plain streams. Geogr. Rev., 26, 593-609.

23. Minckley, W.L. (1963). The ecology of a spring stream, Doe Run, Meade Country, Kentucky. Wildlife Monographs, No. 11.

24. Montgomery, D.R., & Buffington, J.M. (1993). Channel classification, prediction of channel response and assessment of channel condition. Report TFWSHIO-93-002, Washington Department of Natural Resources, Olympia, Washington, U.S.A.

25. Moss, B. (1988). Ecology of Freshwaters. Man and Medium. (2nd edition) Blackwell Scientific Publications Oxford.

26. Nautiyal, P., Agarwal, N.K., & Singh, H.R. (1993). Certain abiotic components of the fluvial system and their interrelationships as evidenced by statistical evaluation. In: Advances in Limnology (pp. 181-186). Narendra Publishing House, New Delhi.

27. Nautiyal, P., & Nautiyal, R. (1995). Statistical evaluation of ecologically different glacier fed torrential stenothermal and spring fed-placid eurythermal riverine systems of the Himalayan Terrain (Garhwal, India). J. Aqu. Biol. Fish., 2(1-2), 1-12.

28. Neel, J.K. (1951). Interrelations of certain physical and chemical features in headwater limestone. Ecology, 32, 368-391.

29. Poff, N.L., & Ward, J.V. (1989). Implications of streamflow variability and predictability for lotic community structure: a regional analysis of stream flow patterns. Can. J.Fish.Aquat.Sci.,46, 1805-1818.

30. Rahel, F.J., & Hubert, W.A. (1991). Fish assemblages and habitat gradients in a rocky mountain- great plain streams: Biotic zonation and additive patterns of community change. Trans. Am. Fish. Soc.,53, 295-311.

31. Rosgen, D.L. (1994). A classification of natural rivers CATENA 22(3), 169-99.

32. Schumm, S.A. (1963). A tentative classification of alluvial river channel. U.S. Geological Survey Circular No.477.

33. Sehgal, K.L. (1983). Fishery resources and their management: Studies in eco-development. In: Himalayas Mountains and Men (eds. T.V. Singh and J. Kaur), pp. 225-272, Print House, Lucknow, India.

34. Sharma, I., & Sidhu, A.K. (2016). Faunal Diversity of all Vertebrates (excluding aves) of Himachal Pradesh. Biological Forum – An International Journal 8(1), 1-26.

35. Stehr, W.C., & Branson, J.W. (1938). An ecological study of an intermittent stream. Ecology, 19, 294-310.

36. Sugunan, V.V. (1995). Reservoir Fisheries of India. FAO Fish. Technical Paper No. 345, FAO, Rome. pp. 1-423.

37. Vannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R., & Cushing, C.E. (1980). The river continuum concept. Can. J. Fis. Aquat. Sci., 37, 130-137.

ENVIRONMENTAL AUDIT OF EDUCATIONAL INSTITUTES: A CASE STUDY

Rajesh Trehan
Associate Professor, Department of Chemistry, SGGSJ Govt. College, Paonta Sahib (H.P.)-173025, India
trehanr@hotmail.com

ABSTRACT
Environmental sustainability is an important component for transforming higher education for a sustainable tomorrow hence, there is a pressing need to step up initiatives for environmental sustainability. Institutes of higher education play a key role in imparting environmental awareness and in employing eco-friendly measures. While institutes have several academic and administrative audits, environmental audit is comparatively neglected. Environmental sustainability includes protecting and restoring ecological systems, optimal utilization of resources, enhancing the well-being of all people, and motivating students to take up environmental educational projects as part of their curriculum. Environmental audit involves the assessment of total environmental impact due to various activities and practices of an institute or establishment. The prevailing practices are analysed in the light of prevailing environmental laws. It involves the assessment of nature and availability of resources, patterns of their utilization and impact on different components of environment. It takes into account all activities which may impact the environment in positive or negative manner. It is an important tool for monitoring the environmental management and leads to identification of areas to improve health, safety and work quality. It ensures development along with safeguarding the environment. It also leads to adopting efficient and cost-effective methods of environmental management. The suggestions and recommendation of Environmental Audit Report are helpful for any institution to devise future plans and strategies and ensure environmental sustainability. In the present study environmental audit has been elaborated with a case study of SGGSJ Government College, Paonta Sahib, Himachal Pradesh to identify, quantify, describe and prioritize framework of Environment Sustainability in compliance with the applicable regulations, policies and standards. This report explains the importance of environmental auditing concepts and the role of educational institutes in the protection of environment.

Keywords: *Environmental audit, Environmental sustainability, Environmental awareness, Educational institutes, Eco friendly campus.*

INTRODUCTION
The environment where we live within is of utmost concern since it is directly related to the survival. Keeping it healthy is the responsibility of each and every individual. Environment is not merely atmosphere and other physical factors surrounding us but is the complex of all factors which not only effects on organism one time but all organism all the time (Korten, 1992). In a larger sense environment constitutes the various physical, mental, social, spiritual, educational, economic and intellectual aspects of whole humanity and when kept healthy and inspiring, it promotes the progress and development of mankind (Graedel, 2002). The environmental problems with which now we are concerned embrace diverse aspects ranging from economic, social and psychological problems of human settlement to the management and use of natural resources and habitats (Bowers, 1997; Capra, 1984). Since time immemorial, man has been and will always be exploiting nature without taking in to consideration of environment deterioration (UN, 1972). In fact, so called progress, in reality, is disturbing the environmental balance seriously leading to breakdown of life support system on the earth (Chatterjee, 2004). Generally, every constituent of our society is responsible for environment crises and it is the duty of each of us to strive hard for its conservation. If we start with ourselves, it will definitely

create a positive benchmark of the success in the journey of environment protection (Engel & Engel, 1990).

India is a developing country and adapting science and technology for its progression. There is improvement in the life style but on the other side it is creating exploitation of the environment (IIEE, 1994). Luxurious life style is becoming environmental risk which may render it unsuitable for future generation. However, besides having tradition of worshipping environment, we, Indian are overlooking the challenging and burning issues of environmental protection. Environmental issues remained just part of the debate and discussion but rarely any action is taken in systematic way. It is assumed by the society that the responsibility of protection of environment lies with government and its concern agencies (NEEAC, 1996). Even majority of industries in India are focusing on their production and marketing policies but not on the control of environment hazards that they are being responsible.

A nation's growth starts from its educational institutions where the ecology is thought as a prime factor of development associated with environment. A clean and healthy environment aids effective learning and provides a conducive learning environment. Educational institutions now a day are becoming more sensitive to environmental factors and more concepts are being introduced to make them eco-friendly (Wright, 2002). If Environmental Audit (EA) is enforced in an effective way in the educational institutes, then there are many advantages that could be adopted from it (Cook *et al.*, 2016). EA is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of various establishments. It aims to analyse environmental practices within and outside of the concerned sites, which will have an impact on the eco-friendly ambience (Mohandas, 1993).

BACKGROUND

The EA was first implemented in the United States in the early 1970s by some companies in commensuration with Clean Air and Clean Water Act to compensate the environmental loss (Biswas *et al.*, 1984; UNESCO, 1980). In UK, a few major companies mainly the British Petroleum introduced guidelines of environmental auditing for the first time in 1975 (Palmer, 1998). The United Nations Conference on Environment and Development (UNCED), also known as Earth Summit Rio-1992 inspired the countries on the globe to review their environmental stand to act effectively to save the earth with sustainable approach (Agarwal, 1999). This Rio spirit shows significant progress in most of the countries and they have changed and upgraded the environmental situation to the possible extent. Some of the Asian countries were also motivated from the summit and played same role within their limits (Postel, 1994). India is the first country in the world to make environmental audit compulsory (Arora, 2017). According to gazette notification [No. GSR 329 (E)] of March 13, 1992, all industries were communicated to submit the reports of the EA to their concerned State Pollution Board, giving details of water, raw materials and energy resources used and products and waste generated by them in their operations from 1992 (Aparajita, 1995). In 2006, Government of India has declared the National Environment Policy-2006 and made green audit mandatory to each industry (National Environmental Policy, 2006). It is recognized that the maintenance of the healthy environment is not the responsibility of the state alone. It is the responsibility of every citizen and thus a spirit of partnership is to be realized through the environment management of the country (Adams, 1990). By realizing the need of responsibility towards environment, The National Assessment and Accreditation Council (NAAC), an autonomous body under UGC has added the concept of environmental audit in accreditation methodologies of universities and colleges.

OBJECTIVE

The rapid urbanization and economic development at local, regional and global level has led to several environmental and ecological crises. On this background it becomes essential to adopt

the system of the Green Campus for the institutes which will lead for sustainable development (Wright & Horst, 2013) and at the same time reduce a sizable amount of atmospheric carbon dioxide from the environment. The National Assessment and Accreditation Council, (NAAC) has made it mandatory that all Higher Educational Institutions should submit an annual EA Report. Moreover, it is part of Corporate Social Responsibility of the Higher Educational Institutions to ensure that they contribute towards the reduction of global warming through Carbon Footprint reduction measures.

In recent time, the EA of an institution has been becoming a paramount important for self-assessment of the institution which reflects the role of the institution in mitigating the present environmental problems (Hajrasouliha, 2017). Many institutions undertake lot of good measures to resolve these problems but are not documented due to lack of green documentation awareness. All these non-scholastic efforts of the administrations play an important role in ensuring the green quotient of the campus is intact.

EA can be a useful tool for a college to determine how and where they are using the most energy or water resources; the college can then consider how to implement changes and make savings (Karpagam, 1991). It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan. It can create health consciousness and promote environmental awareness, values and ethics. It provides staff and students better understanding of environmental impact on campus. If self-enquiry is a natural and necessary outgrowth of a quality education, it could also be stated that institutional self-enquiry is a natural and necessary outgrowth of a quality educational institution. Thus, it is imperative that the college evaluate its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent.

To nurture environmentally friendly management in academic institutions following aims and objectives were formulated.

- To secure the environment and cut down the threats posed to human.
- To recognize the initiative taken by organization towards environment.
- To provide baseline information to enable organization to evaluate and manage environmental change, threat and risk.
- To recognize the effects of an organization and vice versa.
- To recognize, diagnose and resolve the environmental problems.
- To suggest the best protocols for sustainable development organization and environment.
- To assess environmental preference and the effectiveness of the measures to achieve the defined objectives and targets.
- To identify the different pressures on organization to improve their environmental performance.
- To ensure that the natural resources are utilized properly as per national policy of environment.
- To establish the parameters for maintaining health and welfare of the community of the organization.
- To set the procedure for disposal of all types of harmful wastes (Silvennoinen et al., 2015; Kulkarni, 2009, Kuo & Dow, 2015).

- To reduce energy consumption (Gowri & Harikrishna, 2014).
- To give preference to the most energy efficient and environmentally sound appliances.
- To minimize the consumption of water and monitor its quality (Marinho *et al.*, 2014).
- To identify the risks of hazards and implement the policies for safety of stakeholders (Jorge, 2015).
- To facilitate the stakeholders with different aspects of disaster management.
- To train all stakeholders of the organization and empower them to contribute and participate in the environmental protection.
- To make sure that rules and regulations are taken care to avoid the interruptions in environment.

To achieve the mentioned objectives EA is conducted in three stages viz. **pre-audit stage, audit stage and post-audit stage**. Each of these stages comprises a number of clearly defined objectives, with each objective to be achieved through specific actions and these actions yielding results in the form of outputs at the end of each stage. Keeping the importance of EA in view, the present study focuses on reviewing the process of environment audit and the measures to be taken by academic institutes to contribute towards environment. Pre-audit stage includes establishment of Environmental Management System (EMS); declaration of Environmental Policy (EP); planning of programmes or activities and their implementation and operations. EMS includes all stakeholders of an organization comprising top management to the functional team, which forms the EP reflecting the goals, objectives, scope and priorities of the organization related to environment sustenance. The EMS should plan, execute and evaluate all implemented programmes and processes and modify it as per the environment policy. Audit stage comprises actual auditing; checking of documents and evaluation and review of programmes or activities along with EP. In the post-audit stage, the auditor considers all the facts and observations of the audit together in concern with the EMS; evaluates the findings as per the standard procedure; prepares a brief report of the audit along with recommendations in consultation with the EMS and sends it to the auditing agency. According to the recommendations given by an auditor the EMS should chalk out the action plan and accomplish it effectively with the follow-up of the programmes or activities periodically.

The goal of EA is to reduce CO_2 emission, energy and water use; while creating atmosphere where students can learn and be healthy. Eco Campus concept mainly focuses on the efficient use of energy and water; minimize waste generation or pollution and also economic efficiency. All these indicators are assessed in process of EA of educational campus. Eco Campus focuses on the reduction of contribution to emissions, procure a cost effective and secure supply of energy, encourage and enhance energy use conservation, promotes personal action, reduce the campus's energy and water consumption and integrate environmental considerations in to all contracts and services considered to have significant environmental impacts (Iqbal,2015). Target areas included in this environmental auditing are water, energy, waste including e waste, green campus and carbon footprint.

Benefits of EA

If EA is enforced in an effective way, then there are many advantages that could be adopted from it:

- EA could help to shield the environment
- Recognize the cost saving methods through waste minimizing and managing strategies
- Point out prevailing and forthcoming complications

- Authenticate conformity with the implemented laws
- Empower the organizations to frame a better environmental performance
- It portrays a good image of an institute which helps building better relationships with the group of stakeholders
- Enhance the alertness for environmental guidelines and duties
- It is a continuous process. Once learnt about the short fall about the efforts towards environmental conservation, one can plan about some of the initiatives

CONCLUSION

Environmental sustainability measures can be easily and effectively adopted in educational institutes in a developing country for contributing toward environmental preservation. Further auditing of environmental sustainability is of vital importance in educational institutes using various environmental indicators. Once these environmental indicators are developed, the institution needs to formulate a data collection and surveillance system to know the progress made in these areas. Periodic environmental audit can then be conducted based on these parameters. Once found effective, environmental indicators and environmental audit as a process can be suggested to NAAC for inclusion as a criterion (criterion-7) for assessment, appraisal, and as part of their Annual Quality Assurance Reporting System. Though academic institutes take part in restoring the environment, still there is scope for the further action.

EA Report of SGGSJ Government College, Paonta Sahib (Case Study)

An environmental audit is a snapshot in time, in which one assesses campus performance in complying with applicable environmental laws and regulations. Though a helpful bench mark, the audit almost immediately becomes outdated unless there is some mechanism in place to continue the effort of monitoring environmental compliance. Audit criterion is environmental cognizance, waste minimization and management, biodiversity conservation, water conservation, energy conservation and environmental legislative compliance by the campus (Ghaus, 2017). This audit report of SGGSJ Government College contains observations and recommendations for improvement of environmental consciousness. The college has been putting efforts to keep our environment clean since its inception. Therefore, the purpose of the present EA is to identify, quantify, describe and prioritize framework of Environment Sustainability in compliance with the applicable regulations, policies and standards (Velazquez *et al.*, 2006; Ghaus *et al.*, 2017; Kitila, 2015). The purpose of the EA of the college is to ensure that the practices followed in the campus are in accordance with the Green Policy of the country (Asthana, 1992; GOI, 1986). The methodology includes: collection of data, physical inspection of the campus, observation and review of the documentation, data analysis and interaction and discussion with the stakeholders.

The main objectives of carrying out EA of SGGSJ Government College Paonta Sahib are: To map the Geographical Location of the college; To document the floral and faunal diversity of the college, To record the meteorological parameter of Paonta Sahib where college is situated; To document the ambient environmental condition of weather, air, water and noise of the college; To document the waste disposal system; To estimate the Energy requirements of the college; To report the expenditure on environmental initiatives during the last five years beside creating awareness and providing training on sustainability to its stakeholders.

REFERENCES

1. Adams, W.N., Green Development, Environment and sustainability in the third world countries Routledge, London and Newlook,1990.

2. Agarwal, H.O., International law and human rights, Central law publications, Allahabad, 1999, pp 562.
3. Aparajita Gogoi (1995) Environmental Audits- a Mean to Going Green, Development Alternatives (Delhi, India), **5**(4),7.
4. Arora, P. (2017) Environmental Audit – Need of the Hour, International Journal of Advanced Research in Engineering & Management (IJAREM), **3**(4), 25-31.
5. Asthana, Vandana, The politics of Environment: A profile, Ashish Publishing House, Delhi, 1992.
6. Biswas, A.K. et al., Third World and the Environment, Natural Resources and the Environment Series, Tycooly International Publishing Ltd, Dublin, 1984.
7. Bowers, John, Sustainability and Environmental Economics, Longman, Singapore 1997.
8. Capra Fritjof, The Turning Point, Flamingo Publishers, London, 1984.
9. Chatterjee, B., Human resources Management, Sterling publishers, New Delhi 2004.
10. Cook W.C., Bommel S, Turnhout E., Inside environmental auditing: effectiveness, objectivity, and transparency. Curr Opin Environ Sustain 2016 Feb; **18**, 33-39.
11. Engel J.R. and Engel J.G., The Ethics of Environment and Development, Belhaven press, London, 1990.
12. Ghaus R.M., Harun R., Hock L.K., Ponrahono Z., Are green universities producing greener future leaders? Planning Malaysia, 2017,**15**(4),1-12.
13. Government of India, The Environment Protection Act of India, No.26, Delhi, 1986.
14. Gowri, S., Harikrishnan, V. (2014) Green Computing: Analysing Power Consumption using Local Cooling, International Journal of Engineering Trends and Technology (IJETT), **15** (3), 105.
15. Graedel, T.E. (2002). Quantitative sustainability in a college or university setting, International Journal of Sustainability in Higher Education, **3**(4), 346-358.
16. Hajrasouliha A. (2017), Campus score: measuring university campus qualities. Landsc Urban Plan,**158**(1),166-176.
17. Indian Institute of Ecology and Environment, Occasional Monograph on Concepts of Ecology, New Delhi, 1994
18. Iqbal H., Ahmed F. (2015) Paperless campus: the real contribution towards a sustainable low carbon society. IOSR J Environ Sci Tox Food Tech, **9**(8),10-17.
19. Jorge M.L., Madueno J.H. Cejas M.Y., Pena F.J. (2015), An approach to the implementation of sustainability practices in Spanish universities, J Clean Prod, **106**, 34-44.
20. Karpagam M, Environmental Economics, Sterling Publishers, New Delhi 1991.
21. Kitila A.W. (2015) Electronic Waste Management in Educational Institutions of Ambo Town, Ethiopia, East Africa. International Journal of Sciences: Basic and applied Research, **24**(4), 319.
22. Korten, D.C., Getting to the 21st Century, Oxford and IBH Publishing Co, New Delhi, 1992

23. Kulkarni, P. (2009). Combined heat and power potential at the California wastewater treatment plants. California Energy Commission, http://www.energy.ca.gov/2009

24. Kuo, J. and Dow, J. (2015). Biogas production from anaerobic digestion of food waste and relevant air quality implications. Journal of the Air & Waste Management Associations, **67** (9), 1000.

25. M. Mohandas, Ecologically Sustainable Development; concepts and issues, Kerala Agricultural University; Trissur, 1993

26. Marinho M., Gonçalves Mdo S., Kiperstok A. (2014) Water conservation as a tool to support sustainable practices in a Brazilian public university. J Clean Prod, **62**, 98-106.

27. National Environmental Education Advisory Council Report, EE in U.S.- Assessing the 1996.

28. National Environmental Policy (2006), Government of India, Ministry of Environment and Forest, India.

29. Palmer Joy A., Environmental Education in the 21st Century, Routledge, London 1998.

30. Postel, Sandra, State of the world 1994, World Watch Institute Report, Horizon, India Books, Delhi, 1994.

31. Report of the United Nations, Stockholm Conference on Human Environment (1972).

32. Silvennoinen, K., Heikkilä, L., Katajajuuri, J.M., & Reinikainen, A. (2015). Food waste volume and origin: Case studies in the Finnish food service sector, Waste Management, **46**, 140.

33. UNESCO (1980), Environmental Education, Tbilisi Conference Report, Paris.

34. Velazquez L., Munguia N, Platt A, Taddei J. (2006) Sustainable university: what can be the matter? J Clean Prod, **14**(9-11), 810-819.

35. Wright T., Horst N. (2013) Exploring the ambiguity: what faculty leaders really think of sustainability in higher education. IJSHE, **14**(2),209-227.

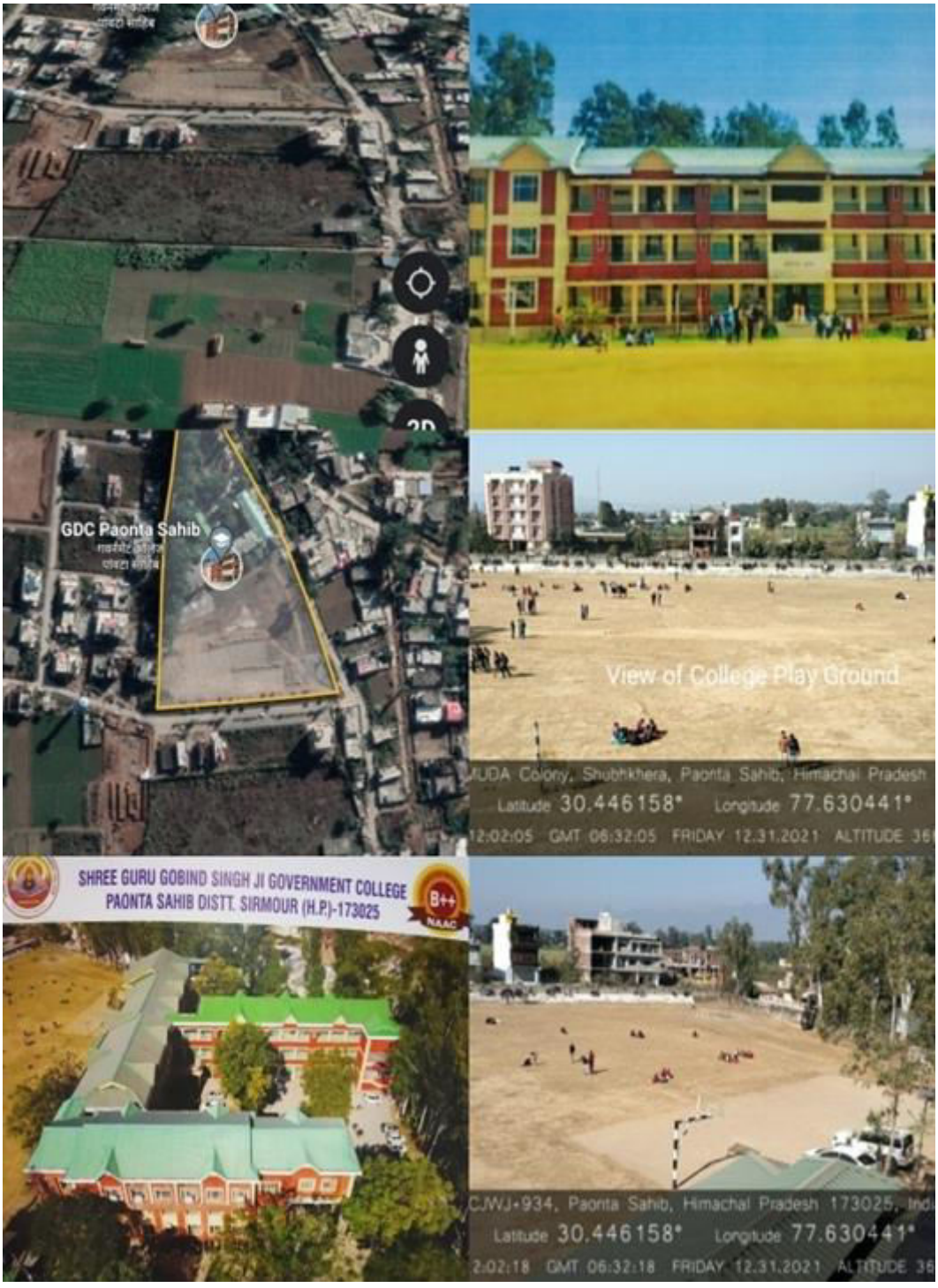
36. Wright T.S. (2002) Definitions and frameworks for environmental sustainability in higher education. Higher Edu Policy, **15**(2),105-120.

37. www.ceeindia.org

38. www.cesindia.org

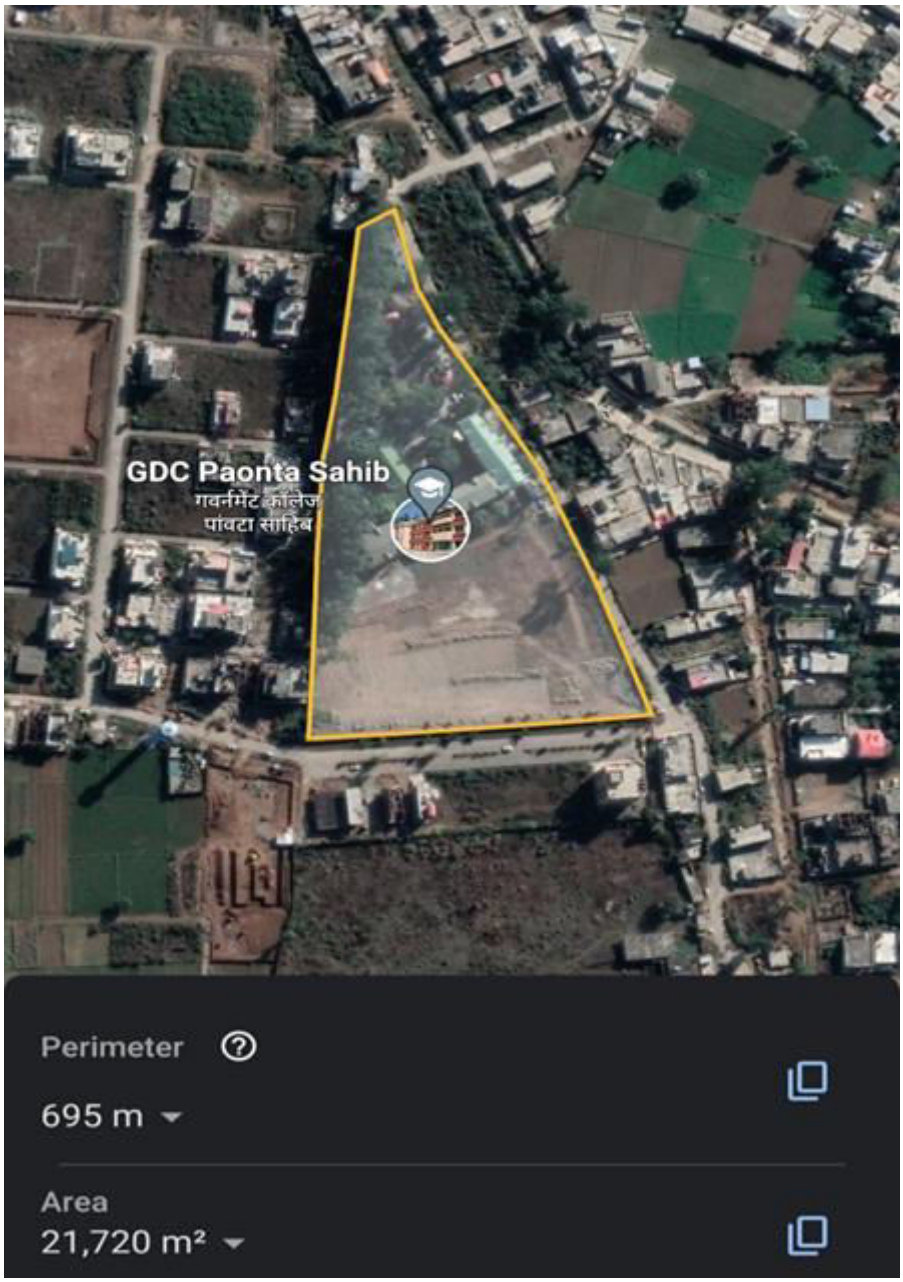
 ISBN: 978-93-93810-06-9

ENVIRONMENT AUDIT REPORT SGGSJ GOVT.COLLEGE, PAONTA SAHIB (HP) 2020-21



 ISBN: 978-93-93810-06-9

Sggsj Govt. College, Paonta Sahib (H.P.)



1.0 CONTEXT

We are committed as a component of NAAC and Social Responsibility of the Higher Educational Institutions to ascertain that they contribute towards the minimization of ecumenical warming through Carbon Footprint abbreviation measures.

SGGSJ Govt. College decided to conduct Environmental Evaluation with the assistance of Himachal Pradesh State Pollution Control Board (HPSPCB), Paonta Sahib, along with an Environmental Audit Assessment Team**.**

Environment Audit focuses on the Green Campus, Waste Management, Water Management, Air Pollution, Energy Management & Carbon Footprint etc. being implemented by the College Authorities. The concept, structure, objectives, methodology, tools of analysis, objectives of the audit are mentioned below.

2.0 CONCEPT

The term 'Environmental audit' means differently to different people. Terms like 'assessment', 'survey' and 'review' are also used to describe similar activities. Furthermore, some organizations/Institutions believe that an 'environmental audit' addresses only environmental matters, whereas others use the term to mean an audit of health, safety and environment-related matters. Although there is no universal definition of Environmental Audit, many leading institutions follow the basic philosophy and approach summarized by the broad definition adopted by the International Chambers of Commerce (ICC) in its publication of Environmental Auditing (1989).

The ICC Defines Environmental Auditing as:

"A management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organization, management and equipment are performing with the aim of safeguarding the environment and natural resources in its operations/projects." The

outcome of Environment Audit should be established with concrete evidence that the measures undertaken and facilities in the institution under environment auditing.

3.0 INTRODUCTION

A Nation's growth starts from its educational institutions, where the ecology is thought as a prime factor of development associated with environment. Educational institutions now a days are becoming more sensitive to environmental factors and more concepts are being introduced to make them eco-friendly. To preserve the environment within the campus, various viewpoints are applied by the several educational institutes to solve their environmental problems such as promotion of the energy savings, recycle of waste, water reduction, water harvesting etc. The activities pursued by colleges can also create a variety of adverse environmental impacts.

Environmental auditing is a process whereby an organization's environmental performance is tested against its environmental policies and objectives. Environmental audit is defined as an official examination of the effects a college has on the environment. As a part of such practice, internal environmental audit is conducted to evaluate the actual scenario at the campus.

Environmental audit can be a useful tool for a college to determine how and where they are using the most energy or water or resources; the college can then consider how to implement changes and make savings. It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan. Environmental auditing and the implementation of mitigation measures is a win-win situation for all the college, the learners and the planet. It can also create health consciousness and promote environmental awareness, values and ethics. It provides staff and students better understanding of Environmental impact on campus.

Environmental auditing promotes financial savings through reduction of resource use. It gives an opportunity for the development of ownership, personal and social responsibility for the students and teachers. Thus, it is imperative that the college evaluate its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent.

A clean and healthy environment aids effective learning and provides a conducive learning environment. There are various efforts around the world to address environmental education issues.

Environmental Management Systems (EMS) is very popular in the industrial sector, but the general belief is that EMS is something pertaining to industries only. Other parts of the world have started adopting compatible environmental management systems either voluntarily or for promoting standards by external certification. International environmental standards do not suit

the existing Indian educational system. Hence EHS Alliance has developed a compatible system by developing locally-applicable techniques. A very simple indigenized system has been devised to monitor the environmental performance of educational institutions. It comes with a series of questions to be answered on a regular basis. Environmental conditions may be monitored from angles that are relevant to Indian requirements, without stress on legal issues or compliance.

This innovative scheme is user-friendly and totally voluntary. The environmental monitoring system helps the institution to set environmental examples for the community and to educate young learners. It can be adapted to urban and / or rural situations.

4.0 OVERVIEW OF INSTITUTE

Established in the year 1994, Shree Guru Gobind Singh Ji Government College, Paonta Sahib has earned its name after Shree Guru Gobind Singh Ji, the 10th Sikh Guru, who commemorated the Khalsa Panth, during his sojourn in 1685-1689. The college campus is spread over 16 acres of land in village Shubh Khera of Paonta Sahib, at a walking distance of 1.5 km from the bus stand. The college is affiliated to the Himachal Pradesh University (HPU), Shimla and recognized by the University Grants Commission (UGC) of India, New Delhi. The college provides undergraduate three-year degree courses in B.A. / B.Sc. / B. Com.; professional degrees in B.C.A. / P.G.D.C.A. and postgraduate degrees in English, Economics, Political Science, Hindi & Commerce. Three departments of the college in the science faculty, namely, Botany, Chemistry & Zoology have been awarded financial support under star college scheme of the Dept. Of Biotechnology, Ministry of Science & Technology, Govt. of India.

The college has been awarded B++ grade by NAAC and is currently included among the *Utkrisht Mahavidyalayas* of Himachal Pradesh. In recent years, various national level conferences, seminars and workshops have been organized in the college under the aegis of Star College Scheme of DBT, Government of India.

The landscaped grounds of the College are widely admired for their beauty. In 2019-20 College celebrated its **silver jubilee** with great joy and pride.

The most valuable investment any educational institution can make is “Nurturing Future Leaders”. With the continuous rise in expectation of essential leadership standards, the College torch bearers have taken a responsibility for this investment to nurture the NextGen leaders with a vision to bridge the existing skill gap. With a firm step forward to attain an academic excellence, several Centres of Excellence, computer labs, and industry-academia associations have been setup at the SGGSJ Govt. College in association with the top leaders.

The College believes that its primary stakeholders are the students. All aspects of education focus on the core values of contributing to national development while fostering global

competencies among students. The College admits students from all social milieus and empowers them through intensive mentoring and counselling to face the challenges of life and become responsible and sensitized citizens of the country.

The College imparts education to *Undergraduates and postgraduates* in the following Departments:

UNDERGRADUATES

- Economics
- Botany
- Chemistry
- Physics
- Zoology
- English
- Hindi
- Sanskrit
- Music (Vocal)
- Music (Instrumental)
- History
- Mathematics

- Political Science
- Public Administration
- Geography
- Sociology
- Commerce
- Physical Education
- Computer Science

COURSES OFFERED

I. Bachelor of Commerce

II. Bachelor of Humanities

III. Bachelor of Science (Physical and Life Sciences)

IV. Bachelor of Computer Applications

V. Community College

POSTGRADUATE COURSES

- English
- Hindi
- Political Science
- Economics
- Commerce
- PGDCA
- IGNOU Centre

5.0 OBJECTIVES AND SCOPE

The broad aims/benefits of the eco-auditing system would be

- Environmental education through systematic environmental management approach
- Improving environmental standards
- Benchmarking for environmental protection initiatives
- Sustainable use of natural resource in the campus.
- Financial savings through a reduction in resource use
- Curriculum enrichment through practical experience

- Development of ownership, personal and social responsibility for the College campus and its environment
- Enhancement of College profile
- Developing an environmental ethic and value systems in young people

6.0 AUDIT PARTICIPANTS

On Behalf of Institute

Name	Position/Department	Position
Dr. Rajesh Trehan	Associate Professor Department of Chemistry	Convenor
Smt. Chinu Bansal	Assistant Professor Department of Physics	Member
Sh. Kamlesh Kumar	Assistant Professor Department of Geography	Member

On Behalf of Himachal Pradesh State Pollution Control Board (HPSPCB), Paonta Sahib:

Name	Position/Department	Position
Dr. Hitender Kumar Sharma	Senior Scientific Officer (SSO), Regional Laboratory.	Member
Er. Pawan Sharma	Assistant Environmental Engineer (AEE), Regional Office.	Member
Er. Jitender Singh	Junior Environmental Engineer (JEE), Regional Office.	Member

7.0 Executive Summary

An environmental audit is a snapshot in time, in which one assesses campus performance in complying with applicable environmental laws and regulations. Though a helpful benchmark, the audit almost immediately becomes outdated unless there is some mechanism in place to continue the effort of monitoring environmental compliance.

The College has already done internal green assessment and annual reports published for continual improvements; NAAC Programme and doing their bid towards environmental protection and environmental awareness at local and global front. Audit criterion is environmental cognizance, waste minimization and management, biodiversity conservation, water conservation, energy conservation and environmental legislative compliance by the campus. A questionnaire is used during audit. This audit report contains observations and recommendations for improvement of environmental consciousness.

8.0 AREAS OF IMPROVEMENT

Environment Policy to be adopted by the College Campus.

- Water Meter should be installed and maintain the inventory of ground water extraction resource bore well.
- Stack height of DG set should be as per DG Rules.
- Storage of chemicals like; paints, gums resins, oils, lubricants, acids etc. in designated place and safety/warning signs should be displayed.
- Internal inspection system should be developed for various aspects of environment available in campus.
- Waste Management plan should be prepared for the campus.
- Display of environment awareness posters should be there in the prominent areas of campus.

- All labs should follow the safety points for storage, use and disposal of hazardous substances.
- Chemical waste treatment plant should be as per norms. Biowastes must be treated properly before disposal.
- No vehicle day should be observed as a message to save the environment.
- Solar plant should be installed as renewable and clean source of energy.
- Star rating of electric equipment's should be considered for new purchases to save energy.
- Walking, use of bicycles, public transport and pooling of vehicles should be promoted and encouraged.

9.0 ENVIRONMENTAL AUDIT QUESTIONARE

The areas of environmental auditing to be followed/practiced by participating institution:

1 Waste Minimization and Recycling

2 Greening

3 Water Conservation

4 Clean Air

5 Noise Control

6 Environmental Awareness

Has Any Environmental Audit Been Conducted Earlier?

The college has conducted the internal Green Audit under the Eco Club of the College. The Annual reports records reviewed during the audit, Main focus of this is to bring awareness of environmental values in students and society. Now, the audit for environment is awarded to the internal committee with members from state pollution control board for a systematic way of monitoring the environmental eminence initiative, taken by college for environment protection.

What is the Total Permanent Population of the Institute?

Stake Holders	Male	Female	Total
Students	1181	1011	**2192**
Teachers	17	20	**37***
Non-Teaching Staff	10	04	**14#**
Sub Total	1208	1035	**2243**
Approximate Number of Visitors including IGNOU Students (Per day)			100
What is the total number of working days of your campus in a year?			**180**

Note: * The total population (Teaching Staff *37; Non-Teaching Staff # 14)

Which of the Following are Available in Your Institute?

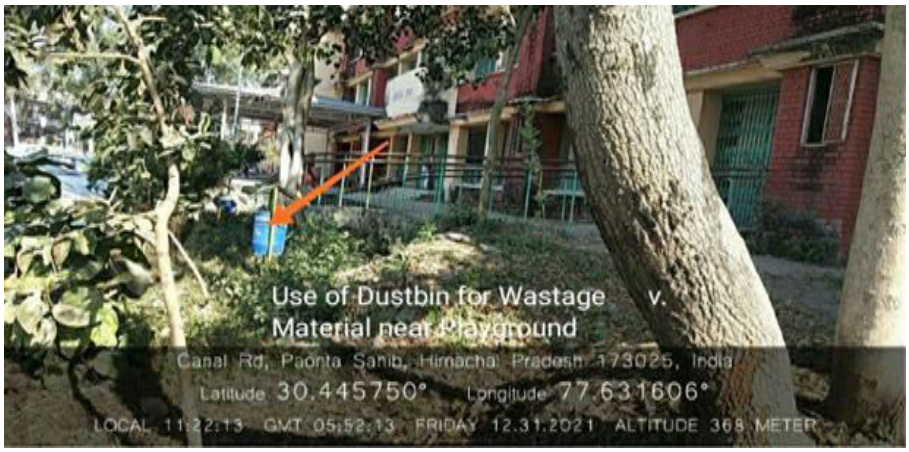
	Garden area	Available
2	Play ground	Available
3	Toilets	Available
4	Garbage Or Waste Store Yard	Available
5	Laboratory	Available
6	Canteen	Available
7	Hostel Facility	Not-Available

 ISBN: 978-93-93810-06-9

Which of the Following are Found Near Your Institute?

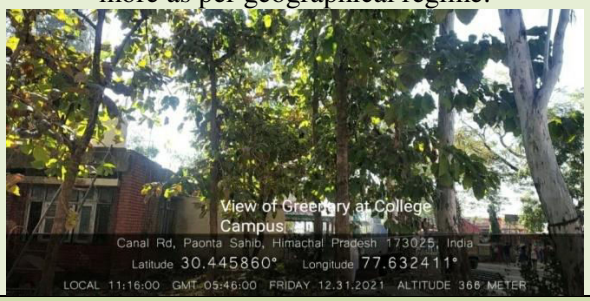
1	**Municipal dump yard**	**Not in vicinity of institute**
2	**Garbage heap**	**No Garbage heaps**
3	**Public convenience**	**Yes**
4	**Sewer line**	**4 km sewer line within campus**
5	**Stagnant water**	**No stagnant water**
6	**Open drainage**	**No**
7	**Industry – (Mention the type)**	**No**
8	**Bus / Railway station**	**Far away from campus**
9	**Public halls**	**Yes**

9.1 Waste Minimization and Recycling



1.	**Does your institute generate any waste? If so, what are they?**	**Yes, Solid waste, Canteen waste, paper waste, plastic waste, Lab waste, toiletry waste, Horticulture Waste, etc.**			
2.	What is the approximate amount of waste generated per day? (In Kilograms/month) (approx.)	Bio Degradable 40kg	Non-Biodegradable 4kg	Hazardous 1kg	others <6kg
3.	How is the waste generated in the institute managed? By: 1 Composting 2 Recycling 3 Reusing 4 Others (specify)	Composting pits are there in campus, Reuse of one side printed Paper for internal communication. Sewage water is discharged to public Sewer. Domestic Waste is given to Municipal Council. Two types of Waste bins are provided at campus for biodegradable and non-biodegradable waste. Horticulture waste is also given to Municipal Corporation and also used foe compost formation. Incinerator is used for managing sanitary waste.  			
4.	Does institute produce any chemical or bio waste? How it's dealt with?	Chemistry labs produce chemical wastes and all the waste is collected in a treatment plant before disposing off in the sink (septic tank).			
5.	Do you use recycled paper in institute?	Yes, in academic evaluation works			
6.	Do you use reused paper in institute?	Yes			
7.	How would you spread the message of recycling to others in the community? Have you taken any initiatives? If yes, please specify.	Yes, Societies and clubs of the college carried out numerous activities. Recycling campaigns, waste management, Anti plastic campaigns, Varsha Vriksharopan, cleanliness awareness rallies and sustainable goal awareness programme.			
8.	Can you achieve zero garbage in your institute? If yes, how?	Yes, as per new waste management rules all kind of waste is managed in an adequate manner without any deviation.			

9.2 GREENING THE CAMPUS

<table>
<tr><td>9.</td><td>Is there a garden in your institute?</td><td colspan="2">Yes, botanical garden, herbal garden and open Green Area.</td></tr>
<tr><td>10.</td><td>Do students spend time in the garden/ open areas?</td><td colspan="2">2-4 Hours during winters
  </td></tr>
<tr><td rowspan="4">11.</td><td rowspan="4">Total number of Plants in Campus</td><td>Plant type</td><td>Approx. number</td></tr>
<tr><td>Trees</td><td>More than 200</td></tr>
<tr><td>Shrubs</td><td>More than 100</td></tr>
<tr><td>Grass Cover</td><td>1.5 Acre</td></tr>
<tr><td>12.</td><td>Suggest plants for your campus. (Trees, vegetables, herbs, etc.)</td><td colspan="2">Ashoka, eucalyptus, mango, Bael, guava, neem, arjun, Ficus Religiosa, Sal, Bougainvillea, Aloe vera, Jamun, Amla, Khair, Azadirachta indica, parijat, thuja and many more as per geographical regime.
 
</td></tr>
<tr><td rowspan="2">13.</td><td>Is the College campus have any Horticulture Department</td><td colspan="2">No</td></tr>
<tr><td>Number of Staff working in Horticulture Department</td><td colspan="2">NA</td></tr>
<tr><td>14.</td><td>Number of Tree Plantation Drives organized by college per annum. (If Any)</td><td colspan="2">Yes, Three Tree Plantation Drives are Organized Annually. 50+ trees and 100+ shrubs planted in this financial year.</td></tr>
<tr><td rowspan="2">15.</td><td>Number of Trees Planted in Last FY.</td><td colspan="2">40</td></tr>
<tr><td>Survival Rate</td><td colspan="2">60%</td></tr>
<tr><td>16.</td><td>Plant Distribution Program for Students and Community</td><td colspan="2">Yes, Seed Bank is developed and, Saplings are distributed to Students and visitors at various Occasions.</td></tr>
</table>

17.	Plant Ownership Program	No
18.	List the animals (wild and domestic) found on the campus (dogs, cats, squirrels, birds, insects, etc.)	More than 100 Squirrels are found in the campus, approx. 4 dogs, 4 cats and others including butterflies, insects, bees, earthworms, etc. are there in campus. Monkeys and baboons are often seen in the campus.

9.3 WATER CONSERVATION

19.	List uses of water in your institute	Basic usage of water in campus are; Drinking, Gardening, Kitchen of canteen, Labs & Toilets, and Others and total consumption is approx. 450 KL/month
20.	How does your institute store water? Are there any water saving techniques followed in your institute?	Overhead Water tanks installed for storage of water. Avoid overflow of water-controlled valves are provided in water supply system.
21.	If there is water wastage, specify why and how can the wastage be prevented / stopped?	No
22.	Locate the point of entry of water and point of exit of waste water in your institute.	Entry- Water comes from borewell and MC water supply at campus Exit- From Water Drainage System to the back of campus
23.	Write down few ways that could reduce the amount of water used in your institute	By Following ways: 1. RWH, Close the taps after usage 2. Maintenance and monitoring of valves in supply system to avoid overflow, leakage and spillage 3. Water Conservation awareness for new students
24.	Does your institute harvest rain water?	Four number of Modern rain water harvesting system are available.
25.	Is there any water recycling System?	Yes, RO waste water is stored in tank and is attached to toilet supply. Drain water of ACs is used in gardening.

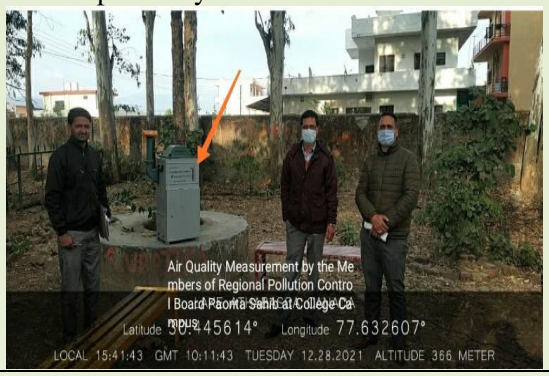
9.4 CLEAN AIR

26.	**Are the Rooms in Campus being Well Ventilated?**	**Yes**				
27.	Window Floor ratio of the Rooms	**Very Good**				
28.	Provide details of college-owned motorized vehicles?	Buses	Cars	Vans	Other	Total
	No. of vehicles	-	--	--	--	--

	No. of vehicles more than five years old	--	--	--	--	--
	No. of Air-conditioned vehicles	--	--	--	--	-
	PUC done	--	--	--	--	--
29.	Specify the type of fuel used by your college's vehicles:	Total				
	Diesel	--				
	Petrol	--				
	CNG	--				
	LPG	--				
	Electric	--				
30.	Air Quality Monitoring Program (If Any)	Yes, monitoring is being done by Himachal Pradesh State Pollution Control Board.				
31.	Students suffer from respiratory ailments? (If Any)	No				
32.	Details of Genset	 Yes, 1 Number of Genset - model, Sudhir, 100 kVA; Diesel type. Acoustic enclosure canopy and adequate stack height is under planning				

9.5 ENVIRONMENTAL LEGISLATIVE COMPLIANCE

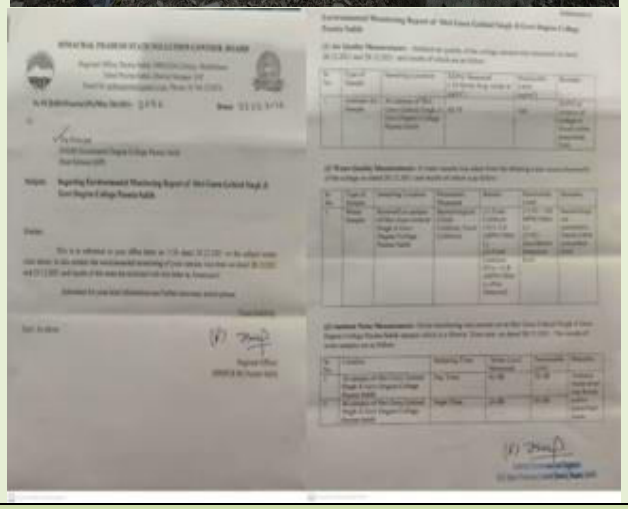
33.	Whether ambient noise measurements performed within the campus?	Yes, by Pollution Control Board and found within the limits of Silence Zone, both during day and night time.
34.	What is the permissible level of noise? Does the campus fulfil the norms?	Permissible values: Day Time 50 dB, Night Time 40 dB. Measured values in the campus: Day Time 42dB & Night Time 34 dB. Values are within the prescribed limit.
35.	Are you aware of any environmental Laws pertaining to different aspects of environmental management?	Yes
36.	Does your institute have any rules to protect the environment? List possible rules you could include.	They have banned single use plastic. Their environment policy includes awareness, and environmental conservation efforts through Eco Club, Beyond the Campus-Environmental

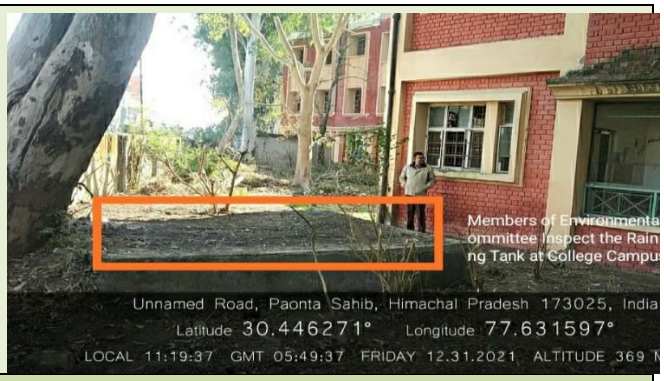
		Activity Society, NSS, Life Skills Committee and various Departments. All under graduates are studying the paper of Environmental Sciences, prescribed by UGC.
37.	Does Environmental Ambient Air Quality Monitoring conduct by the Institute?	Yes, RSPM found within the prescribed limits as reported by Pollution Control Board. 
38.	What is the prescribed limit of RSPM values in ambient air? What are the campus values?	RSPM within campus is 60.79 µg/m^3. Permissible Value: up to 100 µg/m^3.
39.	Does Water and Wastewater Quality monitoring conduct by the Institute?	Yes, drinking water quality from the borewell was monitored by Pollution Control Board and found proper.
40.	What tests were performed for drinking water? What results were found?	Bacteriological tests (total coliform and faecal coliform) were performed. TC-2.0, FC- nil were reported, they are within the prescribed limits and predicts good quality of drinking water.
41.	Does stack monitoring of DG sets conducted by the Institute?	Yes
42.	Is any warning notice, letter issued by state government bodies?	No
43.	Does any Hazardous waste generate by the Institute?	Yes, chemical waste in chemistry labs but treatment plant is there for its disposal.
44.	Does any Bio medical waste generate by the Institute? If yes explain its category and disposal method	No

9.6 GENERAL

45.	Are the stakeholders aware of different types of pollution and how to check them?	Yes, this is covered under the course of Environmental Studies, mandatory for undergraduate students.
46.	Does your institute have any societies/clubs to protect the environment?	Yes, Eco Club, Society for Beyond the Campus Environmental Promotional Activities, NSS wing, Life Skills Club etc. promote environmental awareness among the masses and work for the conservation of environment within and outside the campus.

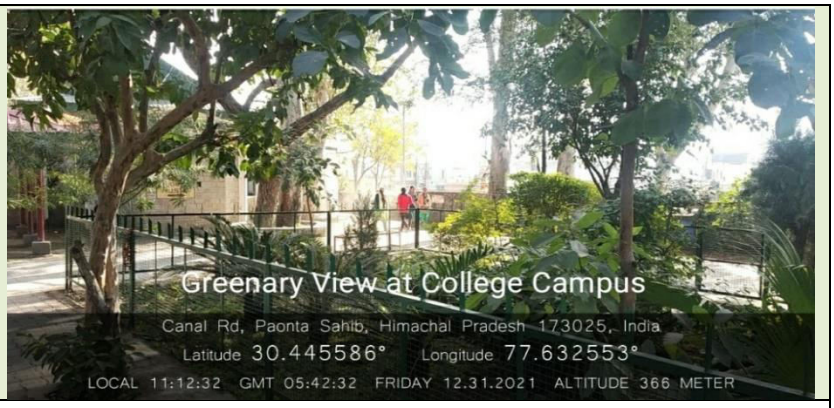
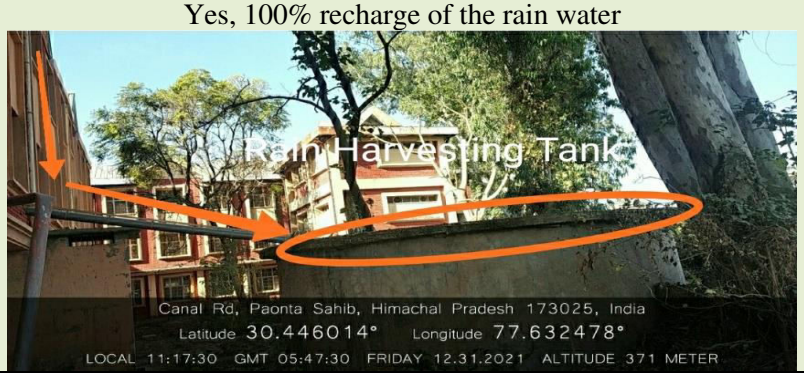
47.	Does housekeeping schedule in your campus?	Yes, Swatch Bharat movement 
48.	Are students and faculties aware of environmental cleanliness ways? If Yes Explain	Yes, periodically pollution reduction, plantation, energy conservation awareness campaigns carried out by institute. 
49.	Does Important Days Like World Environment Day, Earth Day, and Ozone Day etc. eminent in Campus?	Yes
50.	Does Institute participate in National and Local Environmental Protection Movement?	Yes, Swatch Bharat Abhiyan, Yamuna Bacchae Abhiyan by students at campus. 
51.	Does Institute have any Recognition/certification for environment friendliness?	Yes, Air quality, water quality and ambient noise were measured by the Pollution Control Board and were found within the prescribed limits.

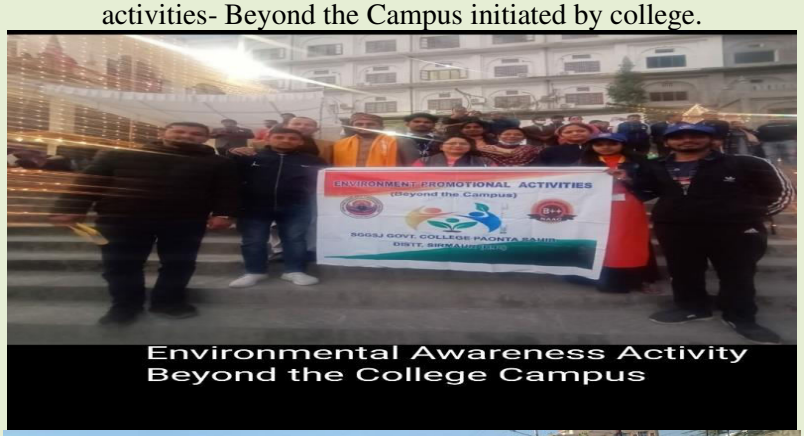
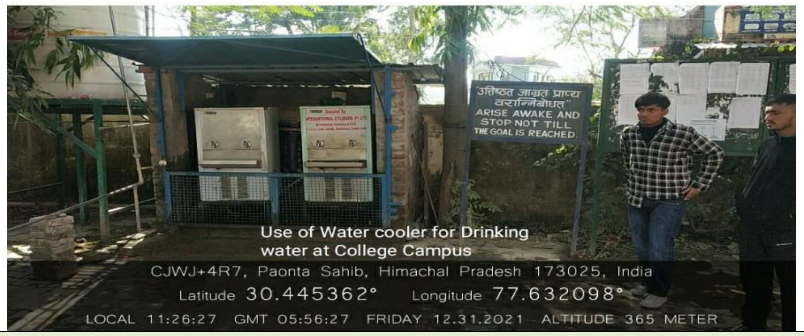
		 
52.	Does Institute use renewable energy?	Yes
53.	List few ways that you use to conserve energy in the campus.	Use of LED lights, LPG is used in chemistry labs instead of petrol-based gas plant, pressure cookers are used in the canteen, number of solar lights also installed.
54.	Are there any energy saving methods employed in your institute? If yes, please specify. If no, suggest some	Use of Natural Lights and Natural Ventilation are promoted. Solar Energy Plant will be installed in the future. Solar lights have been installed at some places. Messages will be displayed at various locations to aware the People about Energy Savings.
55.	Does your machinery (TV, AC, Computer, weighing balance, printers, etc.) run on standby modes most of the time? If yes, how many hours?	No. Rather sometimes they are run on power saving mode.
56.	Does Institution conduct a green/environmental audit of its campus?	Yes, this is first environmental audit done by the College.

		
57.	Has the institution been audited / accredited by any other agency such as NABL, NABET, TQPM, NAAC etc.?	Yes, NAAC grade B++

10.0 BEST PRACTICES/INITIATIVES FOR ENVIRONMENT

A	Renewable Energy **Solar panel installed at some places in the college. A clean source of energy is utilized at campus. Efforts towards Carbon Neutrality**	
B	**Biodiversity Conservation** Flora and fauna conservation	They have lush green campus which provides habitat to various species. Recently conducted bird count reports Indian peafowl, parakeets, Sunbird, black kite, house crow, Hume's warbler, large billed crow, wood pecker, jungle babbler, roofers treepie, common tailor bird, Eurasian collar dove, oriental magpie Robin, bulbul, Green bee eater, brown headed green barbet, Brahminy Starling, Pavo cristatus, Indian Robin. 

		
C	**Tree Plantation Drives** Two Drives Annually as well as Every Guest is honoured by Tree Plantation at Campus.	Yes, periodically the plantation drives by students and staff of campus.  
D	**Ground Water Recharge** 04 units of Rain Water Harvesting System.	Yes, 100% recharge of the rain water 
E	**Pollution Reduction** Personal Vehicles (Students) not allowed at campus	Reduction in Air Pollution through vehicular emission.

F	**E Waste Management** Collection of e-waste by staff	E-waste is sent to the authorized recyclers for adequate disposal
G	**Solid Waste Management** Lifting of garbage from campus on alternate day by Municipal Council. Yes, different mechanisms for proper disposal and recycling of e-waste, plastic waste, biodegradable waste and MSW. Lab Waste Management: Treatment plant for the disposal of chemical waste outside the chemistry labs.	
H	**Adoption of Village/society**	No, but the General Environmental awareness campaigns like Beat the Plastic, Swatch Bharat Abhiyan, Environmental Promotional activities- Beyond the Campus initiated by college.  Environmental Awareness Activity Beyond the College Campus  Cleanliness Drive Conducted in College Campus by R&R
I	**Water Conservation**	Yes, water saving push taps fitted in the drinking water zone and the toilets to avoid the wastage. They are re-using RO waste water in their washrooms.  Use of Water cooler for Drinking water at College Campus CJWJ+4R7, Paonta Sahib, Himachal Pradesh 173025, India Latitude 30.445362° Longitude 77.632098° LOCAL 11:26:27 GMT 05:56:27 FRIDAY 12.31.2021 ALTITUDE 365 METER
J	**Involvement of Students in some Environmental Projects**	Chemistry students of the institute worked on small projects on Soil Analysis, Water Analysis and Analysis of some food products and submitted their reports.

11.0 RECOMENDATIONS

○	• Formation of Environment Policy and communicate to all stake holders.
	• Environmental Monitoring i.e. (Ambient Air Quality monitoring, Stack Monitoring of DG sets, Water monitoring, Noise and soil monitoring need to be conducted by Himachal State Pollution Control Board or approved laboratory with frequency of six month.
	• Reduction in use of paper work by go digital system.
○	• Water Meter should be installed at institute for monitoring of water consumption for landscape. • Installation of Solar Plant and Wind Mill.
	• Increase in Environmental promotional activities for spreading awareness at campus.
○	• As practically feasible avoid use of personal vehicles inside the campus.

12.0 CONCLUSION

This audit involved extensive consultation with all the campus team, interactions with key personnel on wide range of issues related to Environmental aspects. The SGGSJ Govt. College, Paonta Sahib has Environmental Committee for sustainable use of resources. Overall, 60% of campus is for landscaping. The audit has identified several observations for making the campus premise more environmentally friendly. The recommendations are also mentioned with observations for college authorities to initiate actions.

The audit team opines that the overall site is maintained well from environmental perspective. There are no major observations but few things are important to initiate urgently are waste management records by monthly inventory of hazardous waste, rainwater harvesting recharge; water balance cycle and periodic inspection of buildings housekeeping and environment policy.

13.0 REFERENCES

1. The Environment [Protection] Act – 1986 (Amended 1991) & Rules-1986 (Amended 2010)
2. The Petroleum Act: 1934 – The Petroleum Rules: 2002
3. The Central Motor Vehicle Act: 1988 (Amended 2011) and The Central Motor Vehicle
4. Rules:1989 (Amended in 2005)
5. Energy Conservation Act 2010.
6. The Water [Prevention & Control of Pollution] Act – 1974 (Amended 1988) & the Water (Prevention & Control of Pollution) Rules – 1975
7. The Air [Prevention & Control of Pollution] Act – 1981 (Amended 1987) The Air (Prevention & Control of Pollution) Rules – 1982
8. The Gas Cylinders Rules – 2016 (Replaces the Gas Cylinder Rules – 1981
9. E-waste management rules 2016
10. Electrical Act 2003 (Amended 2001) / Rules 1956 (Amended 2006)
11. The Hazardous Waste (Management and Handling and Trans-boundary Movement) Rules, 2008 (Amended 2016)
12. The Noise Pollution Regulation & Control rules, 2000 (Amended 2010)
13. The Batteries (Management and Handling) rules, 2001 (Amended 2010)
14. Relevant Indian Standard Code practices
15. Internal Records of the Campus

14.0 TRANSPARENCY OF GREEN AUDIT REPORT

Green audit report is one of the useful means of demonstrating an organization/Institution's commitment to openness and transparency. If an Institute believes it has nothing to hide from its stakeholders, then it should feel confident enough to make its green audit reports freely available to those who request them. As a basic rule, environment audit reports should be made available to all stakeholders.

GREEN AUDIT OF EDUCATIONAL INSTITUTES: A CASE STUDY

Jahid Ali Malik
Assistant Professor, Department of Botany, SGGSJ Government College, Paonta Sahib (H.P.)-173025, India
jahidmalik@gmail.com

ABSTRACT
Sustainability issues in Higher Educational Institutions (HEI) have attracted increasing levels of attention from both the public and policy makers in recent decades. HEIs have been steadily progressing towards the integration of sustainable practices in their operations and curricula. Consequently, an increasing number of these institutions have recognized their responsibility and are incorporating sustainability into their operations, and practices, following a holistic approach. To analyze the environmental health within and outside the campuses and to create environmental consciousness various quality audits (viz. Green audit, Energy audit and Environmental audit) are being carried in the HEIs. Green Audit is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of various establishments. It was initiated with the motive of inspecting the work conducted within the organizations whose exercises can cause risk to the health of inhabitants and the environment. Through Green Audit, one gets a direction as how to improve the condition of environment and there are various factors that have determined the growth of carrying out Green Audit. In the present study Green audit has been elaborated with a case study of SGGSJ Government College, Paonta Sahib, Himachal Pradesh to monitor the environmental performance and ecological balance of College. The aim of green auditing is to help the institution to apply sustainable development practices and to set examples before the community and young learners.

Keywords: *Green audit, sustainability, sustainable development, educational institute, environmental quality*

INTRODUCTION
Achieving sustainable development is a challenge, and all societal components need to participate. In this regard, higher education institutions (HEIs) should play an active and fundamental role in promoting sustainability practices. According to Hesselbarth and Schaltegger (2014), they should be leaders in the search for solutions and alternatives to current environmental problems and agents of change. The sustainability movement in higher education has been rooted in the recognition of the greening university in the environmental education movement of the 1960s and 1970s (Corcoran *et al*., 2004). This movement implies that all dimensions (academic, administrative policies or facilities management) defined by Koester *et al*. (2006) comprise a "whole system approach". Green audit serve as a means to identify opportunities to sustainable development practices, enhance environmental quality, improve health, hygiene and safety, reduce liabilities and save money and achieve values of virtue. Green audits can be a highly valuable tool for college in a wide range of ways to improve their environmental and economic performance and reputation, while reducing wastages and operating costs (An Taisce, 2013). Once a baseline data is prepared after the auditing process, the data can serve as a point of departure for further action in campus greening. It will also help the college to compare its programmes and activities with other peer institutions, identify areas for improvement and prioritize the implementation of future projects. The data will also provide a basis for calculating the economic benefits of resource conservation projects by establishing the current rates of resource use and their associated costs.

Need For Green Auditing

Green auditing is the process of identifying and determining whether institutions practices are eco-friendly and sustainable. Traditionally, we were good and efficient users of natural resources, but over the period of time excess use of resources like energy, water, has made everyone habitual exorbitant, especially in common areas. Now, it is necessary to check whether our processes are consuming more than required resources? Whether we are handling resources carefully? Green audit regulates all such practices and gives an efficient way of natural resource utilization. In the era of climate change and resource depletion it is necessary to verify the processes and convert it in to green and clean one. Green audit provides an approach for it. It also increases overall consciousness among the people working in institution towards an environment.

Government of India through its National Environment Policy (2006) has made mandatory for every organization to have green audit / environmental audit in their organization. The process of environmental audit was formalized by Supreme Audit Institution (SAI) according to the guidelines given in Manual of Standard Orders (MSO) issued by Authority of the Controller and Auditor General of India 2002. University Grants Commission has mentioned "Green Campus, Clean Campus" mission mandatory for all higher educational institutes. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent. Accordingly, realizing the need of being responsible towards environment, NAAC (National Assessment and Accreditation Council), an autonomous body under UGC has also added the concept of Environmental Audit in accreditation methodologies of State and Central Universities as well as colleges (Patil *et al*., 2019).

Goals of Green Audit

Self-inquiry is a natural and expected development of quality education. Therefore, the institute must evaluate its contribution towards a sustainable future. The rapid urbanization and economic development at the regional and global levels have led to several environmental and ecological problems. In this context, it is necessary to adopt a green campus system for the institute, which will lead to sustainable development (Wright & Horst, 2013) while reducing the large amount of atmospheric carbon emissions in the environment. So green audits are conducted with following specific goals:

1. Identification and documentation of green practices followed by institute.
2. Identify strength and weakness in green practices.
3. Analyze and suggest solution for problems identified.
4. Assess facility of different types of waste management.
5. Increase environmental awareness throughout campus
6. Identify and assess environmental risk.
7. Motivates staff for optimized sustainable use of available resources.

Objectives of Green Audit

The main objective of the green audit is to promote the Environment Management and Conservation in the College Campus. The purpose of the audit is to identify, quantify, describe and prioritize framework of environment sustainability in compliance with the applicable regulations, policies and standards. The main objectives of carrying out Green Audit are:

1. To examine the current practices, which can impact on environment such as of resource utilization, waste management etc.

2. To identify and analyze significant environmental issues.

3. Setup goal, vision, and mission for green practices in campus.

4. Establish and implement Environment Management in various departments.

5. Continuous assessment for betterment in performance.

Stages of Green Audit

To achieve the goals and objectives, the green audit is conducted in 3 stages or phases:

Phase I: The Pre-Audit:

- Plan the audit
- Select the audit team
- Schedule the audit facility
- Acquire the background information
- Visit the site

Phase II: The Audit:

- Understand the scope of audit
- Analyze the strengths and weaknesses of the internal controls
- Conduct the audit
- Evaluate the observations of audit program
- Prepare a report of the observations side by side

Phase III: Post Audit

- Produce a draft report of the data collected
- Produce a final report of the observations and the inference with accuracy
- Distribute the final report to the management
- Prepare an action plan to overcome the flaws Keep a watch on the action plan

Benefits of Green Audit

There are many advantages of green audit to an educational institute:

1. It would help to protect the environment in and around the campus.

2. Recognize the cost saving methods through waste minimization and energy conservation.

3. Empower the organization to frame a better environmental performance.

4. It portrays good image of institution through its clean and green campus.

CONCLUSION

The green audit assists in the process of testing performance in the environmental arena and is fast becoming an indispensable aid to decision making in a college. The green audit reports assist in the process of attaining an eco-friendly approach to the sustainable development of the college. The green auditing report serves as a guide for educating the college community on the existing environment related practices and resource usage at the college as well as spawn new activities and innovative practices. This may lead to the prosperous future in context of green campus and thus sustainable environment and community development.

Green Audit Report of SGGSJ Government College, Paonta Sahib (Case Study)

Green auditing is a process whereby an organization's environmental performance is tested against its environmental policies and objectives. Green audit is defined as an official examination of the effects a college has on the environment. As a part of such practice, internal Green Audit is conducted to evaluate the actual scenario at the campus.

Green audit of the SGGSJ Government College Paonta Sahib was carried out with objectives:

- To prepare a checklist of flora and fauna diversity in and around the college campus.
- To suggest measures to improve biodiversity within the college campus.
- To examine the current practices, which can impact on environment such as of resource utilization, waste management etc

REFERENCES

1. An Taisce (2013) The Green-Campus Programme. Ireland: Green-Campus Office, Environmental Education Unit. Retrieved from http://www.greencampusireland.org/. Accessed 30 June, 2022
2. Corcoran, P.B., Walker, K.E., Wals, A.E. (2004) Case studies, make-your-case studies, and case stories: a critique of case-study methodology in sustainability in higher education. Environ. Educ. Res. 10 (1), 7-21.
3. Hesselbarth, C., Schaltegger, S. (2014) Educating change agents for sustainability-learnings from the first sustainability management master of business administration. J. Clean. Prod. 62, 24-36.
4. Koester, R.J., Eflin, J., Vann, J. (2006) Greening of the campus: a whole-systems approach. J. Clean. Prod. 14 (9-11), 769-779.
5. NEP (2006). National Environment Policy, Ministry of Environment, Forest and Climate Change, Govt. of India.
6. Patil S., Langi, B., Gurav, M. (2019) Green Audit in Academic Institutes. International Journal of Multidisciplinary Educational Research, 8 (6), 97-107.
7. Wright T., Horst N. (2013) Exploring the ambiguity: what faculty leaders really think of sustainability in higher education. IJSHE, 14 (2),209-227.

GREEN AUDIT REPORT

SHREE GURU GOBIND SINGH JI GOVERNMENT COLLEGE
Paonta Sahib, Distt. Sirmour (H.P.) 173025

1. INTRODUCTION

Biodiversity has been one of the most important basis of human life. We have been using the varied natural resources in different ways to satisfy our needs. Conservation of biodiversity is paramount for sustaining life on the earth. Regular inventorization and monitoring of biodiversity is essential for conservation and sustainable use of its components. Green audit serve as a means to identify opportunities to sustainable development practices, enhance environmental quality, improve health, hygiene and safety. The activities pursued by colleges' can sensitize youths, the practice of various environmental manners viz. plantation; energy conservation; waste disposal and water management etc. shall improve the environmental conditions

2. ABOUT COLLEGE

Established in the year 1994, Shree Guru Gobind Singh Ji Government College, Paonta Sahib has earned its name after Shree Guru Gobind Singh Ji, the 10th Sikh Guru, who commemorated the Khalsa Panth, during his sojourn between 1685-1689.

The college campus is spread over 27 Bighas (21,850.8 m^2) of land in village Shubh Khera of Paonta Sahib, at a walking distance of 1.5 km from the bus stand. The college is affiliated to the Himachal Pradesh University (HPU), Shimla and recognized by the University Grants Commission (UGC) under 2f and 12b of UGC Act. Three departments of the college in the science faculty, namely, Botany, Chemistry & Zoology have been awarded financial support under star college scheme of the Department of Biotechnology (DBT), Ministry of Science & Technology, Government of India.

The college has been accredited with Grade B++ by NAAC (National Assessment and Accreditation Council) in the first cycle in the year 2017 and is recently included among the Utkrisht Mahavidyalayas of Himachal Pradesh.

2.1. Vision of the Institution

The institution aspires to provide affordable quality education to the diverse strata of population including the poorest and weakest sections of the area; and create an environment conducive to the achievement of the highest standards of academic excellence along with multi-faceted development of personality of the students, transforming them into socially aware and responsible citizens of the country.

2.2. Mission of the Institution

The motto of our college fully enshrines the mission statement:

शीलवृत्फला हि विद्या (***shilvritphala hi vidya)***

—The Fruit of Learning is Good Character and Righteous Conduct.

The institution's mission is to create awareness that education is a continuous quest and develop individuals who are assets to the contemporary society.

Figure 1: Location of College (Google earth image)

Figure 2: College building and playground (Drone Camera image)

2.3. Courses Offered By The College

SI. No.	Programme Level	Name of the Programme/Course	Duration
1	Under-Graduate	B.A.	3 years
2		B.Sc.	3 years
3		B.Com.	3 years
4		B.C.A. (Self-financing)	3 years

5	Post-Graduate	M.A. English	2 years
6		M.A. Hindi	2 years
7		M.A. Political Science	2 years
8		M.A. Economics	2 years
9		M.Com.	2 years
10	PG Diploma	PGDCA (Self-financing)	1 year

2.4. The Student and Faculty Strength of the College

	Male	**Female**	**Total**
Students	1181	1011	2192
Teaching Staff	17	20	37
Non-Teaching Staff	10	04	14
Total	1208	1035	2245

2.5. Physical Infrastructure

The college campus is spread over 16 acres of land in village Shubh Khera of Paonta Sahib.

Name of Building	**Purpose**
Administrative Block	Principal Office, College Offices, Office of NSS, R&R, IQAC, IT Laboratory, Multipurpose Hall, Washrooms
Academic Block	Class rooms, laboratories, library, Washrooms
Old Science Block	Chemistry laboratories, Staff room, wash room
New Academic Block	Chemistry laboratories, Geography laboratory, class rooms
APJ Kalam Block	Music department, PG classrooms, Gymnasium
Principal Resident	IGNOU Office
Canteen	Food, tea and snacks for stakeholders

3. Objectives of Green Auditing

The major objective of green audit is to document on biodiversity and other resources; and improve resource quality and sustainable practices.

The specific objectives are:

- To prepare a checklist of flora and fauna diversity in and around the college campus.
- To suggest measures to improve biodiversity within the college campus.
- To examine the current practices, which can impact on environment such as of resource utilization, waste management etc

3.1. Biodiversity Audit

Field visits to different parts of college campus were conducted by the committee members along with students of eco club. The key focus of the visit was on assessing the status of the green cover, floral and faunal diversity of the college and its documentation.

Table 1: List of Plants in the college campus

A. Area around Community Hall			
Sr. No.	Common Name	Botanical name	No(s)
1	Jamun	Syzygiumcumini	2
2	Mango	Mangiferaindica	2
			
3	Eucalyptus	Eucalyptus globulus	14
4	Bael	Aeglemarmelos	2
5	Amla	Phyllanthusemblica	2
6	Shehtoot	Morus alba	1
7	Kachnar	Bauheniavariegata	1
8	Guava	Psidiumguajava	1
B. Area around Old Administrative Block			
1	Teak	Tectonagrandis	20
2	Shisham	Dalbergiasissoo	2
3	Safeda	Eucalyptus globulus	15
4	Bael	Aeglemarmelos	1
5	Kachnar	Bauheniavariegata	2
			
6	Bottle Brush	Callistemonsps.	1
7	Gulmohar	Delonixregia	1
8	Bougainvillea	Bougainvillea spectabilis	1
9	Guava	Psidiumguajava	1
10	Toon	Toonasinesis	1

11	Ashoka	Saraca indica	3
C. Botanical Garden			
1	Grevillea	Greville arobusta	1
2	Bougainvillea	Bougainvillea glabra	1
3	Tecoma	Tecoma stenth	1
4	Weeping fig	Ficus benjamina	1
5	Rauwolfia	Rauwolfia serpentina	1
6	Nerium	Nerium indicum	1
7	Neem	Azadirachta indica	1
8	Amla	Phyllanthus emblica	2
9	Guava	Psidiumguajava	2
10	Thuja	Thujaoccidentalis	6
11	Arucaria	Araucaria araucana	1
12	Chakotra	Citrus maxima	2
13	Chameli	Jasminum officinale	2
14	Toon	Toona sinensis	1
15	Curry leaf	Murraya koenigii	2
16	Cycas	Cycasrevoluta	5
17	China rose	Hibiscus rosa-sinensis	1
18	Tradescantia	Tradescanti apallida	1
19	Rubber plant	Ficus elastica	1
20	Dracaena	Dracaena reflexa	1
21	Behda	Terminalia bellirica	1
22	Ornamental plants viz. Dahlia, Salvia, Rose, Calendula etc.		

D. Herbal Garden			
1	Damask Rose	Rosa damascena	5
2	Podina	Mentha arvensis	2
3	Chitrak	Plumbago zeylenica	2
4	Aprajita	Clitoria ternatea	2

5	Lemon Grass	Cymbopogon citratus	5
6	Tulsi	Ocimum sanctum	5
7	Gudahal	Hibiscusrosa-sinensis	1
8	Guldaudi	Chrysanthemum indicum	10
9	Sadabahar	Chrysanthemum indicum	2
10	Stevia (Candy leaf)	Stevia rebaudiana	4
11	Bael	Aegle marmelos	4
12	Satavar	Asparagus racemosus	4
13	Kachnar	Bauhinia Variegata	10
14	Aak	Calotropis procera	4
15	Bach	Acorus calamus	5
16	Chameli	Jasminum officinale	1
17	Curry leaf	Murraya koenigii	4
18	Pathacharuti	Bryophyllum pinnatum	2
19	Parijat / Harsingar	Nyctanthes arbour-tristis	1
20	Shami tree	Prosopis cineraria	2
21	Sarpgandha	Rauvolfia serpentina	2
22	Arjun tree	Terminalia arjuna	1
23	Eucalyptus	Eucalyptus globulus	11
24	Vasaka	Adhatoda vasica	3
25	Aloe	Aloe barbedensis	7
26	Amla	Emblica officinalis	1
27	Ashawgandha	Withania somnifera	5

Vasaka: Adhatoda vasica

Ashawgandha: Withania somnifera

Kala bansa: Barleria prionitis L

Parijaat: Nyctanthes arbour-tristis

 ISBN: 978-93-93810-06-9

Aak: Calotropis sps.

Milk bush: Euphorbia tithymaloides

Chitrak: Plumbago zeylenica

Patharchat: Bryophyllum pinnatum

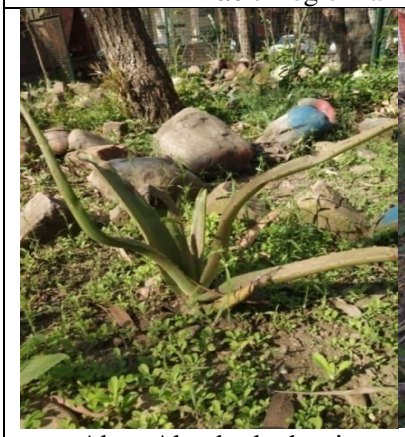
Arjuna: Terminalia arjuna

Lemon grass: Cymbopogon citratus

Bael: Aegle marmelos

Curry leaf: Murraya koenigii

Amla: Emblica officinalis



Aloe: Aloe barbedensis

Bach: Acorus calamus racemosus

Satavar: Asparagus

E. Main Gate			
1	Eucalyptus	Eucalyptus globulus	4
2	Asoka	Saraca indica	7
3	Gulmohar	Delonix regia	2
4	Neeli Gulmohar	Jacaranda mimosifolia	1
5	Toon	Toona sinesis	1
6	Mango	Mangifera indica	1
7	Guava	Psidium guajava	3
8	Shehtoot	Morus alba	1
Administrative Block			
1	Toon	Toona sinesis	5

2	Kachnar	Bauhenia variegata	2
3	Shehtoot	Morus alba	2
4	Gulmohar	Delonix regia	2
5	Ashoka	Saraca indica	5
6	Golden shower	Cassia fistula	2
G. Play Ground			
1	Eucalyptus	Eucalyptus globulus	10
2	Toon	Toona sinesis	1
3	Shehtoot	Morus alba	2
4	Kachnar	Bauhenia variegata	7
5	Amla	Phyllanthus emblica	3
6	Jamun	Syzygiumcumini	3
7	Guava	Psidiumguajava	5
8	Ashoka	Saracaindica	2
9	Thuja	Thujaoccidentalis	4
10	Peepal	Ficusreligiosa	1
11	Aak	Calotropis	1
			
H. Backside of College Campus			
1	Toon	Toona sinesis	5
2	Kachnar	Bauhenia variegata	2
3	Eucalyptus	Eucalyptus globules	13

In addition various outdoor/indoor seasonal and perennials ornamental plants are potted and placed at prominent places in the college campus.

GREEN PRACTICES: Plantation Drives

3.2 Faunal Diversity in Campus

SGGSJ Government College Paonta Sahib is located in Sirmour District of Himachal Pradesh. Paonta Sahib is an industrial town known for Pharmaceuticals, cements, and lime chemical industries. It has got extreme climates. The climatic condition of the Paonta Sahib is very suitable for a wide variedly of flora and fauna to support its rich biodiversity. The faunal Diversity of the campus has been studied and documented as below:

Table 2: List of Faunal diversity seen in the college campus

Sr. No.	Common Name	Scientific Name
1	Common Myna	Acridotheres tristis
2	House Sparrow	Passer domesticus
3	House Crow	Corvus splendens
4	Cuckoo	Cuculidae
5	Snakes (Common Krait, Russel's Viper)	
6	Yellow Wasp	Ropalidia marginata
7	Butter Fly (Golden emperor, Lime butterfly, Ringed Argus, Spotted Demon)	
8	Pied Myna	Gracupica contra
9	Parrot	Psittaciformes
10	Pigeon	Columba livia domestica
11	Red-Vented Bulbul	Pycnonotus cafer

12	Large Egret	Ardea alba
13	Garden Tiger Moth	Arctia caja
14	Owl	Athene brama
15	Oleander Moth	Syntomeida epilais
16	Slender skimmer	Orthetrum sabina
17	Beetles (Ladybugs, scarabs, Blister beetles	
18	Grasshopper	Schistocerca americana
19	Ants	Formica rufa
20	Monkey	Simiiformes catarrhini
21	Dog	C. familiaris
22	Squirrel	Sciurus

4. Solid Waste Management

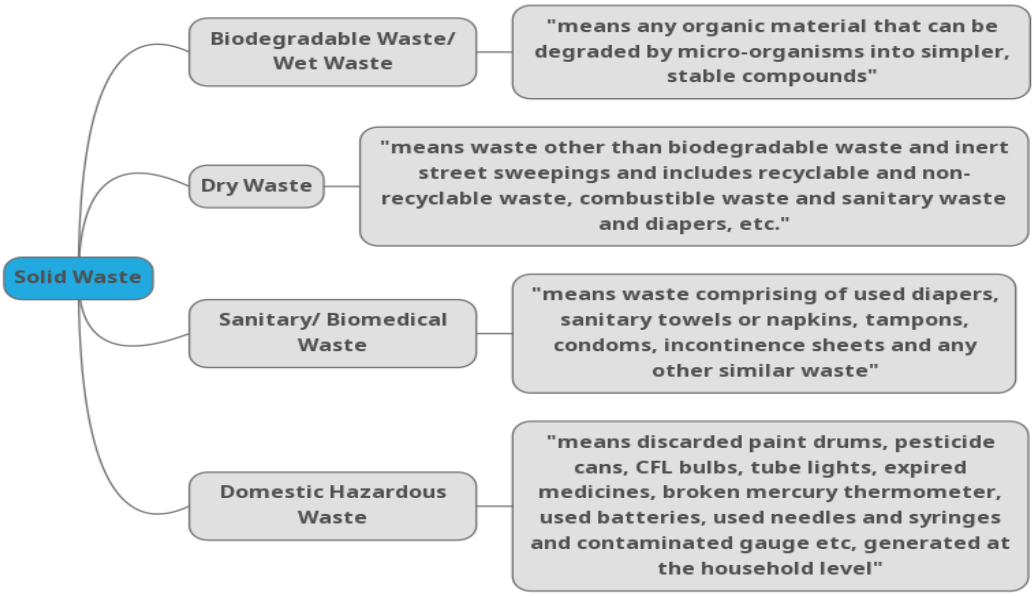
As defined in the Solid Waste Management Rules, 2016

"means and includes solid or semi solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other non residential wastes, street sweeping or silt removed from the surface drain, horticultural waste, agricultural and dairy waste, treated biomedical waste excluding industrial waste, biomedical waste and e-waste, battery waste, radio-active waste generated in the area of local authorities and other entities mentioned in rule 2"

4.1. Objective of Waste Management

The main objective of the waste management system in the campus is to promote the Environment Management and Conservation in the College Campus. The purpose of the current available system is

- To identify, quantify, describe and prioritize framework of Environment Sustainability in compliance with the applicable regulations, policies and standards.
- To introduce and aware students to real concerns of environment and its sustainability
- To secure the environment and cut down the threats posed to human health by analyzing the pattern and extent of resource use on the campus,



Source: Centre for Science and Environment

4.2. Context

- To reduce waste at institute, students and staff are educated on proper waste management practices through lectures, advertisement on notice boards, displaying slogan boards in the campus.
- Waste is collected on a daily basis from various sources and is separated as dry and wet waste.
- Two different types of bins are used for wastes. One for wet and other for solid waste.
- Biodegradable food wastes: Efforts have taken to produce compost manure from the canteen solid waste and waste from other sources. Manure is used for the purpose of garden as well or for planted tree.

- Biodegradable- Garden/Horticultural Waste: The College prohibits the burning of waste material and fallen leaves. Instead, this waste is decomposed for the preparation of manure, which is used for plants and trees in the College. A vermin-composting unit is there for the sustainable management of biodegradable waste.

- Dry waste which includes plastic bottles is used to make poly-bricks, which may be used for constructing benches etc.
- Recyclable dry waste which includes plastic, glass, metal, paper etc. are either handed over to Municipal Corporation or scrap dealer for recycling.
- Single side used papers are reused for writing and printing in all departments.
- Reports/ papers/newspapers etc. are sold out to scrap vendor after completion of their preservation period.
- Efforts have taken to produce compost manure from the canteen solid waste and waste from other sources. Manure is used for the purpose of garden as well or for planted tree.

5. **Liquid Waste Management**

- The waste water from laboratory passes through concealed pipe line into soak pit & recycled water is used for the watering trees or non-potable usage.

- Chemistry labs produce chemical wastes and all the waste is collected in a treatment plant before disposing off in the soak pit.

6. **Biomedical Waste Management:**

- Incinerator for disposal of menstrual waste, sanitary napkins is set up in girl's toilet.

7. **E-Waste Management**

- E-wastes are generated from computer laboratories, Physics Labs, Chemistry Lab, Academic and Administrative Offices.
- The E-waste collected and at stored BCA department and disposed accordingly.
- The college has made agreement with Shivalik Solid Waste Management limited, Nalagarh (H.P.) for lifting e waste generated in the college with payment to college. College also send the information as annual return of e waste to pollution control board (Annexure I).

E-waste Stored at BCA Department



8. CONCLUSION AND RECOMMENDATIONS

Green Audit is the most efficient way to identify the strength and weakness of environmentally sustainable practices and to find a way to solve problem. Even though the college does perform fairly well, the recommendations in this report highlight many ways in which the college can work to improve its actions and become a more sustainable institution.

- Landscaping of the botanical garden and college campus and development of medicinal plant nursery.
- Plant more plants in herbal garden.
- Set up water recycling unit where the recycled water can be used for gardening and other purposes in the college.
- Develop a butterfly garden that arouses appreciation towards flora and fauna diversity.

- Name all the trees and plants with its common name and scientific name to generate enthusiasm for learners.
- Organize earn while learn eco-friendly programmes.
- Ensure participation of students and teachers in local environmental issues and conduct seminars, workshops and exhibitions on environmental education.
- Display various slogans and pictures to protect environment.

ABOUT THE EDITORS

Dr. Rajesh Trehan obtained his doctorate from Panjab University, Chandigarh; master's (M.Sc., M.Phil.) from Kurukshetra University, Kurukshetra and is presently working as Associate Professor and Head of Chemistry Department at SGGSJ Govt. P. G. College, Paonta Sahib (H.P.). He has over 30 years of teaching and research experience at various premier government institutions; has more than 40 publications in national and international journals of repute and authored three books on varied topics. Dr. Trehan has organized and participated in many seminars, conferences, workshops, webinars of national and international level in various capacities and successfully completed three research projects of DST, CSIR & USAID. He was awarded fellowships of DST & CSIR (JRF, SRF open) in Chemical Sciences and is actively associated with many academic societies, clubs, associations etc. He got professional trainings on various analytical techniques from reputed institutions and performed numerous administrative and academic duties at college and university levels. He is also associated with Indira Gandhi National Open University (IGNOU) and SCERT. His current interests are material sciences, analytical chemistry, skill enhancements in chemistry and environmental sciences.

Dr. Jahid Ali Malik presently working as Assistant Professor in the Department of Botany, SGGSJ Government College, Paonta Sahib (H.P.), obtained his M. Sc. (Hons. School) and Ph.D. from Panjab University, Chandigarh, and has more than 12 years of teaching and 18 years of research experience. He was awarded fellowships of DBT and ICMR (JRF, SRF) in life sciences and has published more than 17 research papers in various national and international journals. His research interests are climate-change effects on crops, stress responses of crops and effects of toxic metals on crops and their management. Dr. Malik has organized and participated in various seminars, conferences, workshops and webinars of national and international level in various capacities. He has also attended various training programs at HIPA, Shimla and performed numerous administrative and academic duties at college level. He has successfully implemented the Community College Scheme of UGC as nodal officer and Star College Scheme of DBT as coordinator in the college.

ABOUT THE BOOK

The book aims towards conservation of biodiversity and ecosystems and their sustainable development. Public awareness is one of the main components of this work with the objective of establishing models to change behaviour of the target groups towards biodiversity conservation. Creating awareness on environmental issues and the negative impact of the loss of biodiversity will let people understand the inevitable need for biodiversity conservation. Biodiversity conservation is very important for the sustainability of our planet by preserving and protecting species, ecosystems and natural resources. If we do not act today, we can again witness the extinction of vulnerable biodiversity, which can further upset the balance of nature. This book "**Environmental Issues: Biodiversity and Sustainability**" provides an opportunity to review and reflect on all the themes of sustainable development both globally and in India. In this book, various academicians, teachers and research scholars have written through their articles on various environmental issues. A total of 21 articles/papers received from different parts of the country have been included in this book. Thus, this book is a compilation of total 21 articles on diverse topics concerning our environment.

Empyreal Publishing House

ISBN 978-93-93810-06-9

9 789393 810069