ECONOMIC DEVELOPMENT AND ENVIRONMENTAL IMBALANCES IN KERALA:

A STUDY ON QUARRYING WITH REFERENCE TO PALAKKAD DISTRICT

Thesis submitted to the University of Calicut
for the Award of the Degree of

Doctor of Philosophy in Economics

By

SREEJA V.

Under the supervision of

Prof. (Dr.) K.X. JOSEPH (Rtd.)

Department of Economics
University of Calicut

Department of Economics
University of Calicut
Dr. John Matthai Centre
Aranattukara, Thrissur

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CERTIFICATE

This is to certify that this thesis entitled, "**ECONOMIC DEVELOPMENT AND ENVIRONMENTAL IMBALANCES IN KERALA: A STUDY ON QUARRYING WITH REFERENCE TO PALAKKAD DISTRICT**'', submitted by **SREEJA V**., for the award of the degree of Doctor of Philosophy, to the University of Calicut, is a record of bona fide research work carried out by her under my guidance and supervision. The contents of this thesis, in full or in part, had not been submitted to any other institute or University for the award of any degree or diploma. Plagiarism is checked and found within the permitted limits.

Prof. Dr. K.X. JOSEPH
Professor (Rtd.)
Department of Economics
University of Calicut

Place: Thrissur
Date : 17.4.24

DECLARATION

I, SREEJA V., affirm that this thesis titled "**ECONOMIC DEVELOPMENT AND ENVIRONMENTAL IMBALANCES IN KERALA: A STUDY ON QUARRYING WITH REFERENCE TO PALAKKAD DISTRICT**" submitted to the University of Calicut for the award of the degree of Doctor of Philosophy in Economics is a bona fide record of research done by me under the guidance of Dr. K. X. JOSEPH, Retired Professor of Economics, University of Calicut. I declare that this thesis had not been submitted by me earlier for the award of any degree, diploma, fellowship or any other similar title or recognition of any University/Institution.

SREEJA V.
ResearchScholar
Department of Economics
University of Calicut

Place: Thrissur
Date : 17.04.2024

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Sreeja V.

CONTENT

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List of Abbreviations

Abbreviation	Description
AEQSL	Adverse Effect of Quarrying on Sustainable Life
AQ	Air Quality
AQO	Attitude of Quarry Operators
BMC	Biodiversity Management Committees
BOD	Biochemical Oxygen Demand
BRICS	Brazil, Russia, India, China, South Africa
CA	Capability Approach
CAAQMS	Continuous Ambient Air Quality Monitoring Stations
CFCs	Chloro Fluoro Carbons
DA	Damages to Amenities
DoECC	Directorate of Environment and Climate Change in Kerala
EAH	Economic Advantages to the Households
EAL	Economic Advantages to the Locality
EAQ	Economic Advantage of Quarrying
EF	Ecological Footprint
EIA	Environmental Impact Assessment
EIQ	Environmental Impact of Quarrying
EKC	Environmental Kuznet Curve
EnDQ	Environmental Damages of Quarrying
EPI	Environmental Performance Index

EPI	Environmental Performance Index
ESHDI	Environmentally centered Sustainable Human Development Index
ESZ	Ecologically Sensitive Zone
FEV1	Forced Expiratory Volume in the First Second
FVC	Forced Vital Capacity
GI	Genuine Investment
GWP	Global Warming Potential
HDI	Human Development Index
HDR	Human Development Report
HI	Health Issues
KARSAP	Kerala Anti- Microbial Resistance Strategic Action Plan
KDR	Kerala Development Report
KSBB	Kerala State Biodiversity Board
KSPCB	Kerala State Pollution Control Board
LC	Land Scape
NAMP	National Ambient Air Quality Monitoring Programme
NL	Noise Level
NSDI	National Sustainable Development Index
NWMP	National Water Quality Monitoring Programme
PBR	People's Biodiversity Register
PHDI	Planetary Pressure Adjusted Human Development Index
SAMP	State Ambient Air Quality Monitoring Programme
SDI	Sustainable Development Index

SDQ	Social Disadvantages of Quarrying
SHDI	Sustainable Human Development Index
SI	Safety Issues
SIQ	Social Impact of Quarrying
SS	Strong Sustainability
TS	Tranquility of Surroundings
ULT	Undulated Lateritic Terrain
UNDP	United Nations Development Programme
WGEEP	Western Ghats Ecological Expert Panel
WL	Water Level
WS	Weak Sustainability

Chapter 1

OUTLINE OF THE STUDY

- ***Introduction***
- ***Statement of the Problem***
- ***Objectives of the Study***
- ***Hypothesis***
- ***Data Source and Methods***
- ***Chapter Scheme***

Chapter 1
Outline of the Study

1.1 Introduction

We live in the *Anthropocene* epoch, an unofficial unit of geological time in which human activity has significantly impacted the planet's climate and ecosystems. The modifications that man made on his living planet and its impacts became a topic of relevant discussion in the current period. The available historical evidence shows that the present-day economy evolved from the nature-based human settlements of the early times. The beginning of settlement for agriculture made a difference in human life from other species. With agriculture, man started to create an economy that was different from the economy of nature. All other species similarly continued their life in tune with nature, but man changed living environment and natural infrastructure according to his needs and comforts.

Economic well-being is not the primary goal of all species except humans. In that sense, economic growth and development are purely human-centric concepts. No doubt, countries all around the globe are curious to make and execute policies for the economic expansion of their land. We cannot neglect the significance of economic prosperity, as a country's human welfare heavily depends on that country's economic growth. In the process of development, a state needs a large number of resources. Those resources may be financial, human, physical, or natural. In a closer examination, it is visible that all types of resources have some connections with natural resources. Therefore, for any development activities, man has to depend on and, to some extent, exploit the environment. This pattern of anthropogenic economic development and its outputs negatively impacts the environment.

Development has different dimensions. Like economic development, social development and human development are also essential to ensure the quality of human life. Socio-economic components constitute human development. Therefore, economic development is a part of human development. When we try to analyse these quantitative and qualitative aspects of development, the question arises of sustainability. All aspects of development and their sustainability depend on a sustainable environment. All are interlinked. Because the Earth is the only place to live, developmental activities beyond its limits cannot be justifiable, and ultimately, a matter of survival, too.

The environmental concerns related to development are now tackled more seriously than ever in arguments on development. One of the most frequently debated subjects of this kind is climate change. However, not all environmental issues receive the same amount of scrutiny. We often discuss issues that negatively impact the globe, such as climate change, while ignoring concerns that have a more localised effect. One of them is the effect of extracting non-renewable resources.

Kerala stands out for its distinctive development experience, which was the subject matter of many debates on development. Despite being relatively safe, Kerala fully acknowledged the environmental implications of its development only when the frequency and intensity of natural calamities escalated. The State has recently experienced several significant environmental disasters, including the devastating floods of 2018 and 2019 and Cyclone Ockhi in 2017. Various local environmental challenges have been responsible for worsening climate-related issues. Coastal and hilly regions have been particularly vulnerable to the adverse impacts of natural disasters. In Kerala's mountainous areas, landslides have become a common cause of significant fatalities and casualties. Research has revealed that unrestricted quarrying in ecologically sensitive regions is a critical driver of this phenomenon.

Disparities in the environment can impact a region similarly to social and economic inequality. Those marginalised or insecure within society tend to have less resilience when faced with environmental shocks, just as less affluent countries may struggle more with addressing environmental challenges than their more prosperous counterparts. Every time a natural disaster occurs, it simply requires substantial human, financial, and societal resources to survive. Environmental issues can have immediate and significant socio-economic effects and long-term impacts on sustainable survival.

Here, three questions are more relevant to answer. First, whether economic development and related resource extraction create instability in our environment; second, will those imbalances harm the human development already achieved if they create instability? Third, how can we minimise the impact of this development versus sustainable development puzzle? The present study has been developed on this background and tries to find answers to these questions.

1.2 Statement of the Problem

Development is a necessary condition for human well-being but not a sufficient condition. Kerala has a unique development experience that has been widely discussed in the academic circle and has attracted global attention. The State's achievements in social development from the beginning of her development journey and attainments in human development comparable to global standards are notable. Kerala, in the later phase, also moved forward in economic development. Geographical features, abundant natural resources, and socio-reform movements favoured the State in all aspects of development. However, as happened in many places of developing countries around the world, the environment has got less importance in the development discussions in the earlier stages. As a result, unplanned and unscientific economic development damaged the environment of the State heavily, and many of such damages are not rectifiable.

Economic development at the cost of the environment is not sustainable. It may adversely affect the sustainability of human development, too. Thus, the paradoxical situation is possible that development designed for human well-being is also threatening the achieved human development. The present study, therefore, examines the cost-and-effect relationship between economic development and environmental imbalances in the Kerala scenario. The study also tries to analyse how economic development, which aims for human prosperity, threatens the achievements in human development by creating environmental imbalances.

A sound development policy considering the environment is essential for the sustainable living of humans. Therefore, this study searches for a user-friendly, simple, sustainable Human Development Index by incorporating a convenient environmental component. Natural resource extraction is considered the primary visible link between economic development and the environment. From the sustainability point of view, the extraction of non-renewable resources has some significance. Therefore, this study focuses on quarrying-related environmental damages and their threats to human development in Kerala.

1.3 Objectives of the Study

The primary objectives of the study are following:

1. **To analyse the socio-economic and environmental impacts of quarrying.**

This study focuses on the connection between economic development and the environment. It also tries to find the threats to attained Human Development in Kerala due to environmental deterioration. Here, quarrying is selected as the economic activity for analysing the impact of development-related activities on the environment. Therefore, this objective analyses the negative and positive impacts of quarrying on society, economy, and environment in a microeconomic framework. By analysing this objective, the researcher intends to find negative and positive externalities of quarrying on society, economy and environment, the three components of sustainable development.

2. **To study threats of non-renewable resource extraction and environmental degradation to the sustainability of human development.**

The second objective examines quarrying-related environmental degradation and its impact on the sustainability of attained human development. Quarrying is selected because it is a visible, non-renewable resource extraction process for development-related activities and mainly for infrastructure development. Unlike other categories of resource usage, damages made by the quarrying activities on the environment are nonrepairable. Therefore, this objective is relevant to the study.

3. **To discuss the policy challenges and attempt to construct a sustainable human development index.**

The study searches for a methodology for constructing a user-friendly Sustainable Human Development Index (SHDI) at the state level. Also, it discusses the policies and policy challenges for sustainable human development. Presently, we have a lot of indices and methods for calculating economic and human development. However, we still need a popular measure for assessing the sustainability of Human Development as compact and straightforward as the Human Development Index, globally and regionally. Therefore, the researcher attempts to calculate a new SHDI under the framework of Human Development Index.

1.4 Hypothesis

The central hypotheses are given below:

1. Development-related resource extraction beyond a limit creates instability in the living environment of human beings.
2. Environmental imbalances are harmful to human development. It threatens the sustainability of achieved human development.

1.5 Data Source and Methods

This section describes the data sources, sampling framework and analytical framework used in this study. It includes details of various data sources, sampling techniques used for selecting the samples relevant to the study and analytical framework, including various statistical methods and the rationale behind using those methods in this study. Thus, the following sections overview the methodology used in this research.

1.5.1 Data Sources

The present study has used primary and secondary data sources to analyse the study's major objectives. The secondary data source is mainly used to examine the third objective and for background chapters. Data from the Economic Review of the State for 1960–2022, published by the State Planning Board, is used to analyse the nature and pattern of economic development in Kerala. The Census report published by the Government of India for various periods is also utilised. The data provided on the official website of the Mining and Geology Department of Kerala in various periods supplemented a significant secondary data source for this study. Secondary data from the World Data Lab and India's State-wise Environmental Performance Index were used to construct the Sustainable Human Development Index. Human Development Report published by UNDP in various years has also helped to frame the methodology to construct the Sustainable Human Development Index. Along with these sources, Study reports of various institutions, individual researchers and Government bodies, published works like articles and books, and Newspaper reports were used to support this study's data.

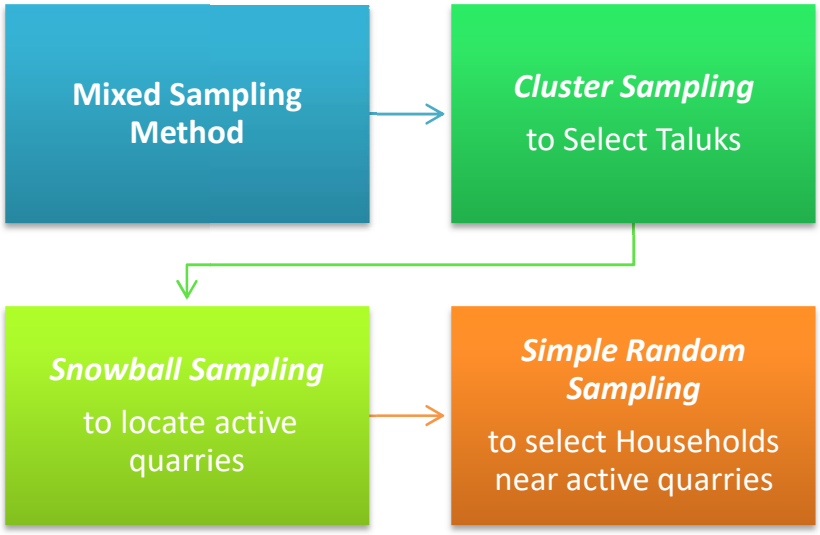
The second and third objectives of the study are mainly analysed using the primary data collected from the study area. A sample survey will be conducted from December 2021 to May

2022. To study the socio-economic and environmental impacts of the quarrying, data from households residing within a 1-kilometre area of the active quarries within ecologically sensitive zones have been collected. Samples are collected from different taluks of the Palakkad district of Kerala. According to the mapping of granite quarries in Kerala, the district of Palakkad (867) has the most granite quarries in the State (Sajeev & Alex, 2017). This study also found that, as per the number of quarries near river basins, Bharatha Puzha stands first with 940 quarries. The Palakkad district also stands second behind the Idukki district regarding the number of quarries in Ecologically Sensitive Zone –I (ESZ- I). As per the Draft Disaster Management Policy, 2016, the State, Palakkad and Idukki are the most landslip-vulnerable districts in the State. The population density of Palakkad district is much higher than that of Idukki, so vulnerability is comparatively higher for the district of Palakkad. In 2022, the Mining and Geology Department of Kerala published the statistics of active quarries in Kerala. Palakkad stands second in the number of active quarries behind the Malappuram District. Considering these factors, the Palakkad district was selected for conducting the primary survey.

1.5.2 Sampling Design

The mixed sampling method is used to select samples for the study. Cluster sampling is applied to select sample taluks from the Palakkad district. Presently, there are seven taluks in the Palakkad district. Namely Attappadi, Alathur, Chittur, Mannarkkad, Ottappalam, Palakkad and Pattambi. Five taluks in the district, namely Ottappalam, Pattambi, Mannarkkad, Chittur, and Alathur, were selected using cluster sampling. According to the Western Ghat Ecological Expert Panel (WGEEP) Report, popularly known as the Gadgil Committee Report, taluks of the district are classified under two categories: Ecologically Sensitive Zone I and Ecologically Sensitive Zone III (ESZ I & III). The taluks Attappadi, Alathur, Chittur, Mannarkkad and Palakkad are in the ESZ-1. The remaining two taluks, Pattambi and Ottappalam, are classified as ESZ-3. Considering the population density around the quarrying area, three taluks from Zone I and two from Zone III are selected for the study. Thus, Alathur, chittur and Mannarkkad were selected under cluster I, and Ottappalam and Pattambi taluks were selected under cluster II.

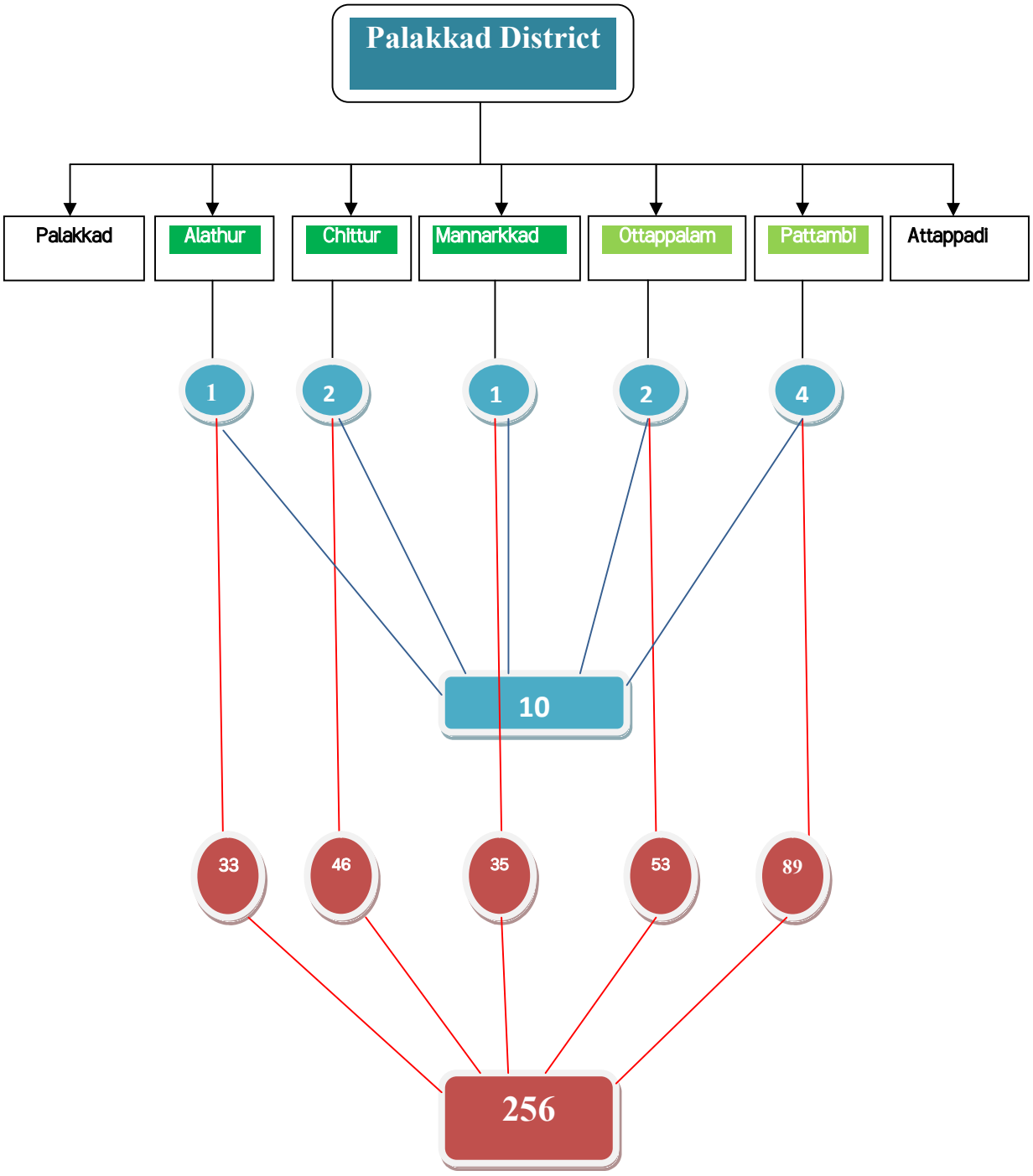
Figure 1.1: Sampling Design



Author's Compilation

As the functioning of quarries is irregular or seasonal, no one had the correct information regarding the quarries. Therefore, locating the active quarries during the survey was very difficult. Thus, snowball sampling is used to locate active quarries from selected taluks. As per the data available from the official website of the Mining and Geology department of Kerala there were 68 active quarries in the district at the beginning of the survey period. Considering a representative proportion, 15% of them were selected for sampling. Thus, ten active quarries were selected for the study. The distribution of quarries in residential areas differs; therefore, the number of quarries selected from each taluk differs. Thus, four quarries from Pattambi, two from Ottappalam and Chittur and one from Alathur and Mannarkkad, were selected. Simple Random Sampling was used to select 256 sample households from the residential areas within one Kilometer of these quarrying areas. 20% of the households were selected from each quarrying area within one kilometre of the site. Thus, 89 households from Pattambi, 53 from Ottappalam, 33 from Alathur, 46 from Chittur and 35 from Mannarkkad were selected for the sample Survey.

Figure 1.2: Sampling Framework



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1.5.3 Analytical Framework

The study has used quantitative and qualitative methods for analysis. Relevant statistical tools are used to analyse the stated objectives of the present study, along with descriptions and explanations. The significant tests used for analysis are descriptive statistics, Spearman's rank correlation, Ordinal Logistic Regression, the Mann-Whitney U test, and the Kruskal-Wallis H test. The UNDP method of HDI calculation is used to construct the Sustainable Human Development Index (SHDI). From the qualitative perspective, descriptions of the comments and views of the participants are used to explain the non-quantifiable aspects of the study.

Frequency tables, Charts and diagrams were used to present primary and secondary data in the thesis. Descriptive and summary statistics like percentages, measures of central tendency and measures of dispersion are used to know the average and spread of the data. As data is not normal, nonparametric tests were used for significant Analyses. The normality of the variables is checked using the Kolmogorov-Smirov test and Shapiro-Wilk test.

Socio-economic- environmental impacts of quarrying are measured from the level of agreement and disagreement of the households regarding the statements on a five-point Likert scale. Spearman's Rank Correlation is applied to analyse the relationship between the Adverse Effect of Quarrying on Sustainable Life and the Socio-economic and environmental impacts. An Ordinal Logistic Regression Model is employed to elicit the determinants of the adverse effect of quarrying on the sustainable life of the people.

1.6 Chapter Scheme

The study is organised into eight chapters. Chapter one is introductory, which familiarises the outline of the study. Chapter two critically reviews theoretical and empirical literature relevant to the research area. The third and fourth chapters are background chapters for the study. The third chapter gives an overview of Kerala's nature and development pattern using descriptive analysis of secondary data. A cause-and-effect analysis of Economic Development and Environmental Imbalances in Kerala is given in Chapter Four, which analyses how the economy of Kerala depends on its environment for development and the effects of this dependence. The analysis specifically focuses on infrastructure development, a construction boom, the extraction of non-renewable resources and, more precisely, the extraction of building stone and the environmental impact of quarrying.

Chapter 2

REVIEW OF THE RELEVANT LITERATURE: THEORY AND EMPIRICS

- ***Introduction***
- ***Theoretical Background***
- ***Review of Empirical Literature***
- ***Conceptual Framework***
- ***Theoretical Framework***
- ***Research Gap***

Chapter 2
Review of the Relevant Literature: Theory and Empirics

2.1 Introduction

This chapter reviews theoretical and empirical literature related to the research topic. Like the economy and society, our environment is changing globally and locally due to human interference and other reasons. As one of the primary providers of inputs to an economy, man must pay attention to the importance of his environment. The present study, therefore, critically reviews existing literature relevant to this study in different dimensions. The study tries to connect economic development, specifically infrastructure development, resource extraction for developmental activities, particularly quarrying and its impacts on society, economy and environment and overall threats on the attained Human Development of a society. The first section of this chapter details theoretical developments in economics regarding the environment, resource scarcity, allocation of resources, sustainability and socio-economic well-being.

2.2 Theoretical Background

This section highlights the theoretical background of the present study. Scarcity was a significant point of discussion in the economic literature from the beginning. Economists have different views regarding the economy and environment and natural resources capacity and economic growth. From the economic literature, it is evident that the Physiocrats of mid-18th Century France were the first school of economic thought who tried to explain the economy through natural law and considered agriculture and cultivable land as the source of net value (Scott Cato, 2021). However, with the arrival of the Mercantilist school of thought, the focus of discussion shifted from the land to the capital. Following mercantilists, classical and neo-classical ideas were developed. Increasing environmental issues resulting from environmental concerns developed new perceptions towards these issues over time. New branches of economic thought like environmental economics, ecological economics and green economics challenged the existing economic view regarding the environment.

The Industrial Revolution in the 18th Century brought widespread changes in existing social, economic, and political order, first in England, then in Europe and later in America. All these

changes influenced economists' views towards the environment (Stelguer). During the 19th and 20th centuries, the pace of resource depletion and environmental degradation increased due to rapid industrialisation. Concern about environmental issues among thinkers and economists has also increased. Significant theoretical contributions of different schools of thought relevant to the present study are discussed in the following section.

The classical economic literature had been focused on the idea that land and labour are the major factors of production. How to increase the production was their primary concern. Adam Smith, David Ricardo and J.S. Mill were significant contributors in this regard. The economic literature falls under classical tradition was written in the background of the Industrial Revolution. The industrial revolution, population growth, and growth of diversified economic activities increased pressure on natural resources along with the changes in landscape and quality of the environment. During this period, in the 18th Century, economists and others started to write about environmental issues (Kula, 1998). In The Wealth of Nations (1776), Adam Smith comprehensively discussed the mineral industries, including coal, mining, quarrying and extraction of metals in Britain. Smith lived in a period when natural resources seemed inexhaustible. Therefore, he was very optimistic regarding the availability of those natural resources in anticipation of discoveries (Kula, 1998).

However, Malthus and Ricardo, of the same tradition, kept a pessimistic view towards the unlimited availability of resources and unlimited growth. Malthus pointed out that a rapidly growing population would cut short the availability of arable land and the adequacy of food supplies in the future (Malthus, 1798). Later, David Ricardo, in his Principles of Political Economy and Taxation, observed that " economic growth would eventually peter out due to scarcity of land and its falling food production capacity, and this would stabilise the population at a subsistence level" (Kula, 1998). Like Adam Smith, Karl Marx also believes that in the natural resource–based sector, there is no tendency for decreasing returns to scale (Kula, 1998). Classical economists take both optimistic and pessimistic views regarding natural resources. Their discussions, especially of optimistic thinkers, are limited mainly in the assurance of availability and non-availability of resources. However, very little importance is given to the result of the unlimited extraction of current and new sources of resources in the future.

The neoclassical views have dominated economic thought since the 21st Century; it is considered mainstream economics, especially in the academic field (Scott Cato, 2021). Neoclassical thoughts are based on a market system where the interaction of supply and demand brings optimum outcomes for all. They favour market mechanisms to determine resource allocation. Here, economic decisions are based on utility maximisation. That means "preferences of as many economic agents as possible are fulfilled to the maximum extent possible given the limited available resources" (Scott Cato, 2021). Neoclassical economists view the market as an effective system for organising the economy. Pareto efficiency can used to convey the concept of efficiency. According to Pareto efficiency, resource distribution is efficient if anyone receiving some of it might get more without taking some of it away from somebody else.

Though they are aware of the scarcity of resources, they never think limitations in the resource availability put obstacles to unlimited growth. Thus, to neoclassical economics, natural resource constraints never limit economic growth. They argue that limitless scientific and technological advancement increases the efficiency in using natural resources, and capital, labour, and natural resources can perfectly replace one another (Romeiro, 2012). As per this view, the loss of the natural ecosystem can be replaced by capital. It is a notion of weak sustainability. Solow's famous observation summarises the neoclassical view of the environment: "The world can, in effect, get along without natural resources, so exhaustion is just an event, not a catastrophe" (Solow, 1974). The Hartwick Rule, which assures investment compensates future generations for asset losses caused by current consumption and production, is the underlying idea behind this (Romeiro, 2012).

However, changes in the environment indeed affect the economy as both are closely connected. A considerable volume of resources is required for the smooth functioning of an economy and its activities. The environment is a significant source of inputs and resources for the economy. The economy extracts resources from the environment and puts wastes and emissions of consumption and production activities on it. This environment is a resource source and disposal sink (Sengupta, n.d.). Thus, with economic growth, the environmental quality decreases. Marshall's concept of external economies gave a new analytical framework for environmental issues (Marshall, 2009). Marshall counted only the benefits of economic actions, but externalities were the key to economic analysis of environmental problems (Kula, 1998). The concept of

externalities extended to the benefits and costs of economic activities on the environment by later economists (Pigue, 1920 and Kapp, 1950). Externalities are considered market failure, and neoclassical economists deal with environmental problems under market failure. Economic activities create a network of negative externalities, which badly affect the environment and people living in it, those who were not involved in that economic transaction. Thus, environmental issues can be considered as the negative externalities of economic growth. The planet is the sole place to live for human beings and other animals; therefore, balancing economic development and environmental quality is paramount.

In the later period, different thoughts on environmental issues, from the economic standpoint, originated around the concept of market failure of neoclassical schools. Environmental economists analysed the environmental question using the theoretical framework of Neoclassical. They tried to solve the environmental issue through the market mechanism. The problems of public good, common good, negative externalities, and property rights as a solution for environmental issues were discussed under environmental economics. The nature of the ownership of resources plays a significant role in the economics of resources. The degree of exploitation depends on the accessibility and ownership of the natural resources. Natural resources like air, atmosphere, river, mineral deposits, stone, and sand are open-access resources (Ostrome, 2009). Many are considered public goods; environmental issues can be considered public bads. Non-rivalry and non-excludability features of public goods aggravate the degree of exploitation.

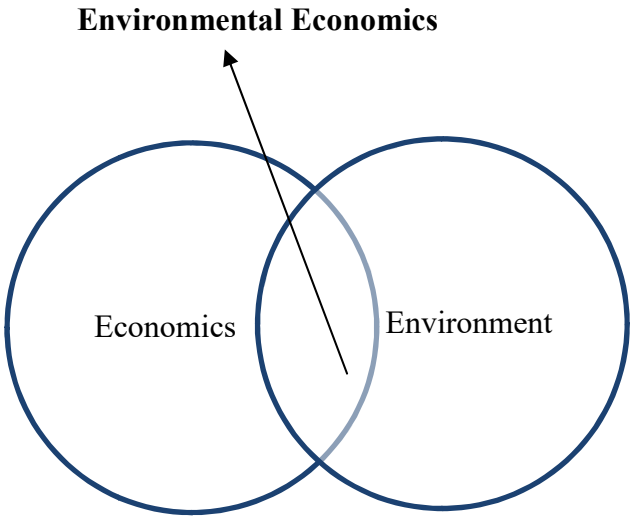
Unlike private resources, the tragedy of commons and the free-rider problem happens in the case of natural resources. These problems are significant causes of the deterioration of natural resources. Coase's theorem (1960) suggests solutions for negative externalities by internalising the harmful effects of production and consumption through the well-defined property rights system. To him, clarity in ownership helps to protect natural resources. However, in the case of natural resources, private ownership is not possible, but community ownership is feasible.

Property rights reduce the tragedy of commons and the negative externalities. Like the type of ownership, the type of natural resource is also important from the environmental point of view. All resources are not exact. Specific features of some resources increase the intensity of deterioration and damage. Natural resources are generally classified into two: renewable and

non-renewable resources. Continued extraction of non-renewable resources will result in the exhaustion of the stock of those resources. It will damage the natural environment permanently. Therefore, technology, policy and social auditing are needed for the wise use of resources.

Figure 2.1 summarises the approach of environmental economics.

Figure 2.1: Economics and Environment in Environmental Economics



Source: Sahadeven et al., 2022

By incorporating the value of natural resources into the economic model, environmental economists have made significant progress in this field. They did, however, adhere to a neoclassical framework of analysis. Ecological economics is a new school of thought in this context. Ecological Economics puts the economy as a subsystem inside the environment. They made an effort to integrate the fields of ecology and economics. Ecological economists have switched their focus from weak sustainability to strong sustainability. Under a strong sustainability view, physical capital cannot substitute for natural capital. With the International Society for Ecological Economics founding in 1987 and the publication of the Journal of

Ecological Economics in 1989, the academic subfield of ecological economics was established in the 1980s (Scott Cato, 2011).

Environment as a source of resources and as a provider of ecosystem services play a significant role in the functioning of an economy. From the viewpoint of ecological economics, the environment represents an absolute limit to economic growth. The analogy used by Boulding (1966), "cowboy economy[1]" and the "spaceship economy[2]" narrates the two different situations of resource availability. The second law of thermodynamics, the law of entropy[3], is applicable here. The theoretical premises of ecological economics are based on these laws and assumptions. Human expansion over the planet and exhaustion of resources are becoming a threat to the survival of nature and human beings. Economists like Herman Daly (1996) suggest that zero growth is the only way to prevent extinction. However, de-growth seems an extreme option, and it will not be feasible for the countries and regions of the developing stage. The discussion on the exhaustion of resources, economic progress and human sustainability were not new in the economic literature (Malthus, 1798; Javons, 1866).

Figure 2.2 depicts the view of ecological economists. To them, the economy and society are not counterparts of the environment but subcomponents. They place the economy inside the society and the society inside the environment.

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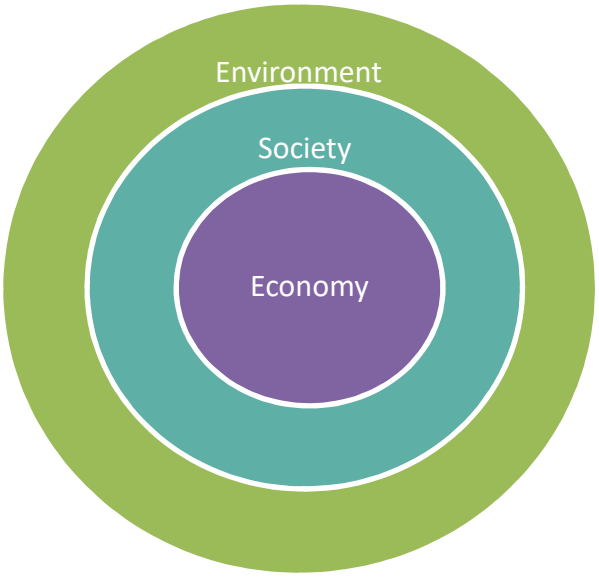
1. Cowboy economy; 2. Spaceship economy: Kenneth Boulding first proposed the idea of cowboy economy and spaceship economy in 1966. In contrast to the spaceship economy, which is closed and has limited resources, the cowboy economy is open and unlimited.

3. Law of Entropy: the absolute resource shortage imposed by the entropy law cannot be remedied by technical advancement, exploration, or substitution.

Figure 2.2: **Perspective of Ecological Economics**



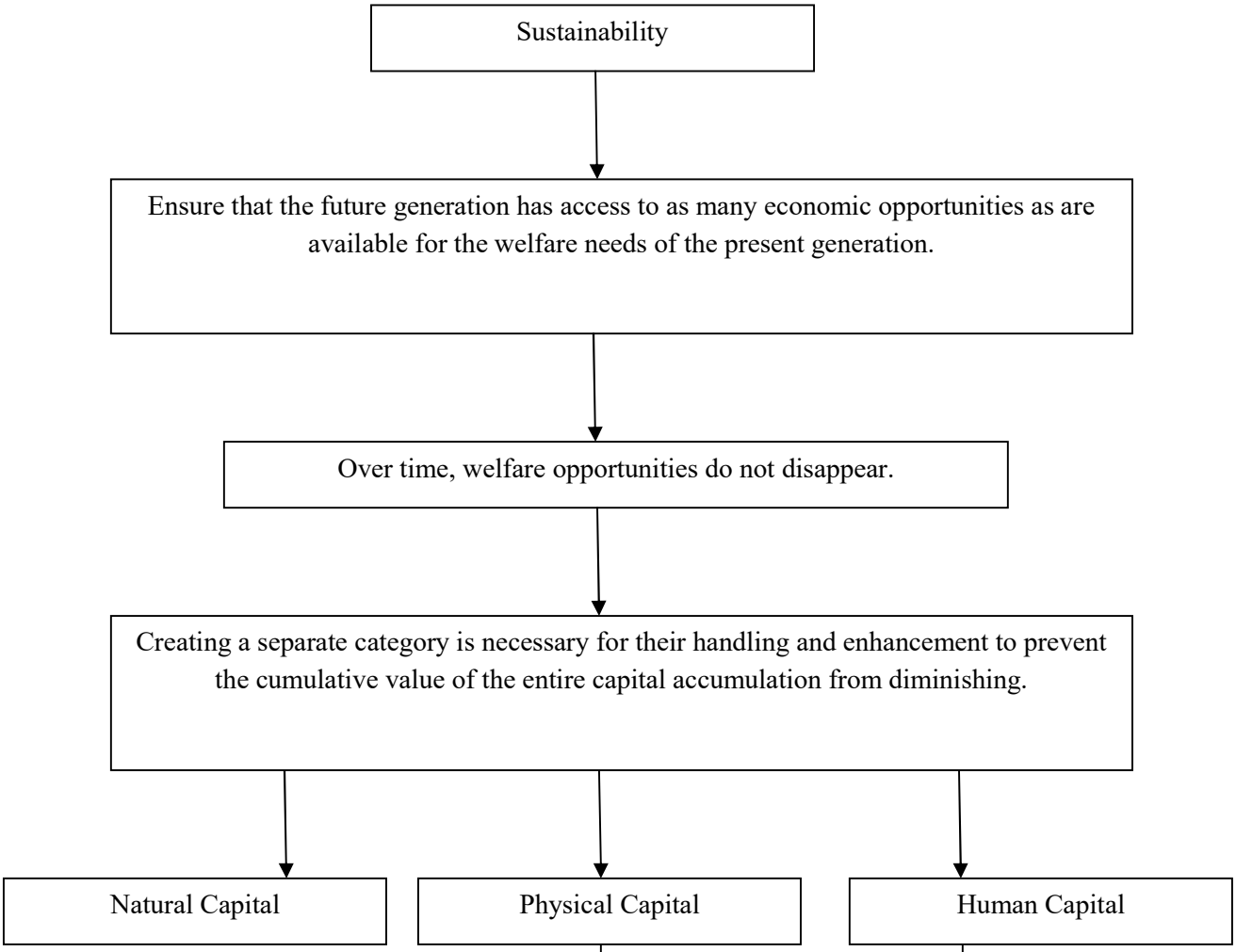
Source: Passet, 1979

When we analyse the environmental issues from a social justice purview, we can observe that developing and underdeveloped countries bear a significant share of adverse effects of environmental degradation. Countries worldwide are at different stages of development. Therefore, the intensity of development caused by environmental deterioration will differ for different countries. The Environmental Kuznets Curve (EKC) suggests that pollution and environmental damages will be higher at the early stages of economic growth, but after a specific point, it comes down. Though developed countries are significant polluters worldwide, they can minimise environmental damage in their regions by adopting sophisticated technologies. However, the global effects of environmental damage hit the low-income countries and low-income sections of people more intensively because they are more vulnerable compared to the rich people and developed countries. Thus, the problem of environmental issues becomes more complicated.

This disparity also makes discussions on sustainability more complex. Sustainability is an essential goal to achieve, and it is a necessity for the survival of humankind. Nevertheless, justice in the way to sustainability is also essential. Here, we have to analyse the intergenerational equity and intra-generational equity. Distributive justice and equity are essential for achieving intra-generational and intergenerational equity—the renowned sustainability definition of Brundtland Commission bases Intergenerational equity theory. Sen's capability approach and freedom-oriented human development are criticised (Pelenec et al., 2013). Sen holds a different view on this; "a fuller concept of sustainability has to aim at sustaining human freedom, rather than only at our ability to fulfil our felt needs" (2013). However, his views are criticised for lack of environmental concern. Achieving intergenerational equity without intra-generational equity and distributive justice is impossible. Thus, sustainability should be wide enough to incorporate these factors, too.

The different views of sustainability and their characteristics are discussed in diagram 2.3.

Figure 2.3: Natural Capital and Strong and Weak Sustainability Notions



Source: Shadevan, 2022

2.3 Review of Empirical Literature

A Critical review of empirical literature is also conducted to identify the research gap. It is conducted based on two significant themes following the objectives of the present study. These themes are the impact of economic activities on the environment, particularly the impacts of mining and quarrying and the measurement of environmental sustainability and human development. The critical review based on these themes is given below.

2.3.1 Environmental Impacts of Economic Activities

The relationship between economy and environment and different theoretical approaches towards this relationship is discussed in detail in the theoretical review. Therefore, this section only focuses on empirical studies on the environmental impacts of economic activities and available studies on quarrying. It is noticeable that studies in this area are very few.

Economic development of a region heavily depends on the environment and natural resources. Nature supports an economy as an input source and a sink for waste disposal. Sengupta (n.d.) says the entropy law of thermodynamics sets capacity limits on this source and sink, thereby putting biophysical limits on economic growth. When economic growth overshoots these limits, it results in the degradation of the environment. Environmental issues act like negative feedback on the economy. Institutional failures are the root cause of such crises. The nature of these failures differs from economy to economy. Countries face environmental problems mainly due to population pressure and the unsustainable use of resources.

The way in which "environmental degradation affects human development and sustainable economic development" is a question to be discussed in more detail. Alam (2012) analyses the long-run relationship between human resource development and environmental degradation along with other socio-economic and demographic factors, such as poverty, urbanisation, globalisation and population density in the case of Pakistan. To him, human development is a function of economic growth (EG) measured as per capita GDP, poverty (PV), the rate of Urbanisation (URB), Globalisation (GL) measured as export plus import to GDP ratio, population density (PD) & environmental degradation (ED). According to his study, economic expansion, globalisation through trade liberalisation, and urbanisation affect human resource

development favourably. The increased poverty and environmental degradation deteriorate the quality of human resource development.

Human welfare is eventually enhanced by economic prosperity. One of the critical elements of economic growth is infrastructure development. As a result, we must consider how crucial infrastructure growth is to advancing human development. The construction industry significantly influences infrastructure development, employment creation, and economic growth. Mallik and Mahalik (2008) note that the construction sector may be affecting the growth rate by expanding employment and, as a result, raising the economy's overall production. This argument is based on their analysis of impact of the construction sector on economic growth through the employment channel. Therefore, ceasing construction is not a way to conserve environment.

The following table depicts various environmental issues and their economic causes.

Table 2.1: Environmental Issues and Economic Causes

Environmental Problem	**Economic Cause**
Pollution and Climate Change	Massive expansion of productive processes that emit greenhouse gases; increasing use of fossil fuels.
Atmospheric aerosol loading	Emission of Chloro Fluorocarbons (CFCs) by manufacturers of aerosols and refrigerants.
Acidification	Emissions from fossil fuel electricity
Species extinction/ biodiversity loss	Loss of habitat caused by displacement of subsistence farmers; pressure on land caused by population increase.
Nitrogen Cycle	Intensive farming with heavy use of nitrogen fertiliser; burning of fossil fuels.
Land Degradation/ loss of soil fertility ([bio] regional, national)	Loss of traditional agriculture systems due to population displacement and movement away from subsistence agriculture.
Ozone depletion	Use of Hydrofluorocarbons (HFCs) in aerosols and refrigerants.
Freshwater Overuse	Overuse and pollution of systems from industrial processes.
Congestion (national)	Excessive material consumption.

Source: Cato, 2021

Shahabaz et al. (2015) validate the holding of the Environmental Kuznet Curve hypothesis for the Indian context. The study examines the connection between globalisation and CO_2 emission

by considering India's CO_2 emission function, energy consumption, financial development, and economic growth. They contend that unforeseen externalities, such as pollution and environmental deterioration, may happen when every economy strives to achieve a higher per capita income growth rate. Since these pollutants' emissions impact ecological imbalances and global climate change, civilisations on the Earth may suffer significant direct and indirect welfare losses. This study depicts the link between the economy and the environment. It also portrays how ecological imbalances harm the economy and thereby damage the welfare of the people in a cause-and-effect manner.

According to Mahalik et al. (2018), among numerous other socio-economic difficulties of various intensities, the two priorities for developing countries are preserving the environment and lowering income inequality. This study compares the relationships between income inequality and environmental quality for each of the BRICS economies, which is still being established in the body of literature. According to their findings, governments should consider income inequality when developing energy policies to achieve environmental sustainability, considering the importance of income inequality in environmental pollution. These studies all examine the intricate relationships between the economy and the environment.

According to Melodi (2017), an economy's private sector tends to be less concerned with the harm that mining projects cause to the environment and its inhabitants. His investigation into the environmental effects of quarry operations in Nigeria's Ogun state has shown that mining operations in the research area significantly impact land usage and cover. The number of mining operations, particularly quarry operations, is growing significantly, which lowers the standard of living and raises the cost of living for the people.

Bewiadzi et al. (2018) studied the impact of stone quarrying on workers' livelihoods and the environment. Quarrying is an alternative livelihood for many people who live in areas of economic hardship and poor agricultural yield. Environmental degradation is one of the critical environmental impacts of stone quarrying in Dalgama. This study also reveals that workers in the quarry site face many health challenges.

Quarrying resources for construction is necessary due to the ongoing development and construction projects in major urban centers worldwide. Adverse social and environmental

effects have resulted from this, which are typically disregarded in favour of economic growth. In a study, Barchok et al. (2022) evaluated the socio-economic effects of stone quarrying in Kenya's Narok North Sub-County. Quarry workers, locals, and government officials involved in environmental management were the study's intended population. According to the survey, quarrying operations have been crucial to the growth of the economy and infrastructure. However, it has resulted in detrimental societal problems such as social structure shifts, conflicts, evictions, and health problems. According to this study, there was a significant positive correlation (r) of 0.705 between the intensity of the dust exposure and the respondents' respiratory illnesses. This study also demonstrates that quarrying activities have impacted agricultural-based lifestyles while simultaneously creating employment opportunities in their community.

The primary societal impact of quarrying is health-related. A study by Nemer et al. (2020) looked into the health consequences of exposure to dust on persons who lived close to quarry sites and compared them with those who lived farther away. The 79 exposed participants, who reside fewer than 500 metres from the quarry sites, and the 79 control participants, who reside more than 500 metres away, participated in a cross-sectional comparative study. Everyone who took part completed the identical questionnaire about dust exposure at home and its consequences on health, along with a lung function test that looked at both reported and measured health effects. This study demonstrate that residents live close to the quarry sites reported experiencing dust exposure at home (98%), land degradation (85%), dust cover over the plants (97%), and difficulty in growing crops (92%). Comparing the exposed group to the control group, the exposed group reported noticeably more eye and nasal allergies (22% vs. 3%), eye discomfort (18% vs. 1%), dryness (17% vs. 3%), chest tightness (9% vs. 1%), and chronic cough (11% vs. 0%). The mean forced vital capacity (FVC) was 3.35 L vs. 3.71 L ($p = 0.001$), and the mean forced expiratory volume in the first second (FEV1) was 2.78 L vs. 3.17 L ($p = 0.001$). Lung function measures were considerably lower in the exposed group compared to the control group. Higher degrees of restricted breathing were found among the exposed group. These findings of the study demonstrate that the exposed group's lung function metrics deteriorated by living near to the quarrying site. The study emphasises the significance of defining and effectively implementing quarrying laws and regulations to avoid social unrest and protect individuals.

2.3.1.1 Environment and Economy of Kerala

Kerala's socio-economic advancement received scholarly attention when the UN study Poverty, Unemployment, and Development Policy was published in 1975. Oommen (2017) points out that Kerala is rapidly losing its reputation as a model. He views Kerala's experience with development as only a post facto generalisation of a historically evolved transformative experience in bringing social justice, universal elementary education, and broad-based healthcare to a society that was once sharply caste and class divided. A significant flaw in Kerala's growth is the inadequate discussion of the environment.

K.P. Kannan (2011) points out the environment-related challenges of the Kerala Development Model. The dominance of private interests over public interests is the root cause of many development-related issues. Kerala is, at the same time, a victim and a beneficiary of the neoliberal ideas. Gulf migration and the flow of Gulf money helped improve people's socio-economic conditions. It also boosted the expansion of the Kerala Economy.

Nevertheless, it, along with some positive effects on some sectors of the economy, has some negative impacts on the construction and consumption behaviour of the people. The exponential growth of the construction sector affected the state's land and other natural resources. Profit became the centre of economic activities, and the growth of the real estate business and construction boom changed the price and use of land resources throughout Kerala. It ultimately created the development imbibed environmental imbalance in the state.

2.3.1.2 Quarrying in Kerala

This section focuses on the studies on quarrying in Kerala. There is a considerable gap in the availability of environment-related reliable data. Developing countries face this problem more severely. In Kerala, adequate details of resource extraction are not available. The lack of data regarding mining and quarrying in Kerala is disturbing. 'There is a big information gap at the national or state level, in collecting spatial and temporal information on small scale mechanised and non-mechanised quarries' (FIMI Report, 1994). Sajeev and Alex (2017) made some relevant contributions to this field through a critical mapping initiative to map the granite quarries of Kerala. They argue that compared to the developed countries, the small-scale mining sectors of most developing countries are still in the infancy in terms of 'formalisation, use of advanced

technology, prior assessment of environmental impact, professional management and public review process'. This study attempted to map the distribution of granite quarries in Kerala using the access satellite data from 2014-2015 from WebGIS sources like Google Earth, Google Map and Bing Map. Their mapping initiative detected 5924 quarries within an area of 0.02 to 64.04 hectares in Kerala. The sectoral analysis shows that Central Kerala had the highest number and area of quarries.

The state's highlands are delicate, and excessive human activity in the form of quarries there undoubtedly exacerbates natural disasters that resemble landslides. Landslides frequently occur in the Western Ghats, especially during the monsoon, and can significantly harm people and property. Several landslides, like rock falls, rock slips, slumps, creeps, debris flows, and occasionally rotating slips, occur in the area, particularly during the monsoon season (Sajinkumar et al., 2013). According to Sajinkumar et al.'s (2013) study on risk assessment and management in a few Western Ghats hamlets prone to landslides, such occurrences are not uncommon but rather a brooding, constant reality with all its terrible implications. Given that the state has a density of more than 800 people per square kilometre, the destruction brought on by this cataclysmic phenomenon is considerably higher than one might anticipate. According to the study's findings on vulnerability, 1,321,056 persons in the human population, 2656 animals, including cattle, sheep, and chickens, and 2656 crore rupees worth of property are all at risk.

The findings from Sajinkumar et al.'s (2014) study on the impact of quarrying on the slope stability of Banasura Mala in Kerala's Wayanad district reveal that significant building stone mining in this area has contributed to the onset of landslides in this area. Through geotechnical, geophysical and environmental impact assessments (EIA), they attempted to investigate the effects of quarrying on slope stability in the Narippara area, which is nestled in the Banasuramala of the Wayanad District. They saw the beginning of a landslip, which appeared as curvilinear cracks stretching 170 metres. These fissures may reactivate at persistent rain, resulting in a landslip, and the life and livelihood of numerous families who reside on the slope may affected by this. Significant property damage may also result. The locals in this area are concerned about the extensive mining for building stones. According to geotechnical analysis, the land is stable when dry but becomes unstable when wet or saturated.

Furthermore, resistivity studies revealed that the developed cracks extend to the bedrock, and the suspected failure mechanism would be translational. EIA reveals that the possibility of land disturbances cannot be ruled out due to quarrying and mining operations during the Monsoon season. This study reveals that if a landslide happens here, it would affect many families living down slope and could result in extensive damage to life and property. The quarry and crusher unit located on one of the vulnerable slopes near Himagiri estate is one of the main reasons for the land disturbances in the area. The study suggests using controlled blasting for mining and no mining during the monsoon.

According to Vandana et al. (2020), mining and quarrying for minor minerals significantly negatively influence the local economy, ecology, and society. Their investigation of two river basins in the southern Western Ghats of India—the Nethravathi-Gurpur and Periyar-Chalakudi river basins—found that the ecology and aesthetics of the area have been negatively impacted by the transformation of many hillocks in the region into a collection of unpleasant scars. Other findings from their study include lowering the water table, altering or eliminating natural drainages, and environmental pollution. Due to the removal of the hard laterite top rock, which improves water percolation and increases the area's ability to be irrigated for agriculture, laterite quarrying has less of an impact on the environment than rock quarrying. In order to improve the overall environmental quality of the area on the one hand and meet the needs of development on the other, the study emphasises the need for environmentally acceptable quarrying alternatives with strict limits.

Mining is the most harmful human activity that impacts the environment and the land (Shobha & Krishnakumar, 2019). Resources are essential to development, and how they are used directly affects how well people can live. Therefore, meticulous planning and execution must be used while extracting and using the Earth's resources. Several environmental degradation processes go hand in hand with mining activities. Land and water degradation results from the resource extraction process, which also causes increased soil erosion, changes to the landscape, landslides, landslips, hydrological imbalances, and water contamination. The study by Sobha and Krishnakumar (2019) observed the impacts of mining and quarrying activities on the Neyyar River basin. The study concludes that the economic benefits of quarrying create social costs. At least fragile areas could get attention for comprehensive environmental conservation.

Sasikala and Chandran (2015) have studied the problems and impacts of granite quarries in Vellavada Panchayat of Thiruvananthapuram district. This panchayath is situated in a protected region. Numerous granite quarries began operating nearby without considering the region's ecological significance. That created severe adverse effects on the ecosystem and the local inhabitants. The study's main findings show that the improper operation of quarries led to issues in the study area like water scarcity, noise and dust pollution, vibration, health issues, and land degradation. All these studies indicate the severity of environmental, social, and economic damages caused by quarrying in Kerala.

2.3.2 Human Development and Environmental Sustainability

The introduction of the Human Development Index (HDI) in the 1990s was an essential step towards a more sensible development measure. However, the limitations of HDI became visible in the 21st Century due to its failure to incorporate environmental, economic and social components. Hickel (2020) proposes an alternative index, the Sustainable Development Index (SDI), to correct the drawbacks of HDI. This index puts a sufficiency threshold on per capita income. It is divided into two indicators of ecological impact: Co2 emission and material footprint calculated in per capita consumption-based terms and rendered vis-a-vis planetary boundaries. He argues that this index indicates strong sustainability that measures the nation's ecological efficiency in delivering human development.

The public, governments, and researchers are more interested in sustainability than ever before because of the growing dangers to the environment. In their 2019 study, Jain and Nagpal analysed the comparative analysis of India with the chosen developing countries between 2002 and 2016, as well as the quantitative relationships between the HDI and Environmental Performance Index (EPI) for the selected South Asian nations. In a nation that could one day threaten the Global Warming Potential (GWP), the study examines whether the degree of economic growth and standard of living has a systematic relationship with the degree of environmental degradation (existence of Kuznet Curve Hypothesis). The study also uses dynamic panel modelling on a subset of SANs, with descriptive graphical synthesis to visualise the association for India in particular. The panel analysis's results show that the HDI and EPI have a positive relationship, indicating that greater human capital accumulation reduces environmental harm and improves environmental performance. Coordinated national and local

government initiatives could contribute to integrating green technology-based infrastructure. In emerging nations, promoting a trade system could pave the way for a more sustainable and environmentally friendly future.

Neumayer's contribution to the sustainability issue of Human Development is worth mentioning here. He reviews the existing linkages between the concepts of human development and sustainability (2012). He proposes a practical way to link the measurements of Human Development and sustainability. The literature on human development and sustainable development were separate for a long time. "Without sustainability, human development is not true human development" (Neumayer, 2012). The concept of universalism is at the core of human development, and universalism requires providing the same kind of attention to future generations as to the current one (Anand & Sen, 2000). The intra-generational and inter-generational equity are equally important. Therefore, Sustainable Human Development means simply assuring the development of present and future generations. Empirical results show that countries with high human development almost invariably achieve at the price of strong unsustainability. Achieving higher levels of human development with Strong Sustainability (SS) is a significant challenge with lower levels of human development; they have to achieve higher Human Development with weak sustainability in the first place and eventually Strong Sustainability. Neumayer also argues that sustainable economic and Human Development are the same. It is also compatible with the definition of Economic Development as sustainable 'if it does not decrease the capacity to provide non-declining percapita utility for infinity' (Neumayer, 2010a).

Neumayer (2012) analyses the achievements of countries in human development and two types of sustainability by using HDI (1980-2006) for human development, GS (Genuine Investment or Adjusted Net Savings) for weak sustainability and Ecological Footprint per capita (EF) for strong sustainability (by comparing to the globally available capacity per person). The results show that countries with very high human development could be more firmly sustainable, and the same for most of the high human development countries. However, weak sustainability countries with high human development face no problems because of high investment rates into manmade and human capital. Weak and Strong Unsustainabilities are common in countries with low and medium human development. However, high human development countries dependent

on natural resource extraction often have negative GS. These results suggest that all over the globe, countries must find alternative paths to high levels of human development without exhausting natural capital.

Haque (2000) points out that mainstream theories and models are indifferent to environmental concerns. However, the environmental discourse and sustainable development models have recently gained increasing attention. His paper discusses the significant environmental challenges to development and analyses how the sustainable development models articulate the environment-development linkages in both practical and intellectual terms. The five major environmental concerns threatening sustainability are global warming, deforestation, emission of harmful chemicals, ozone layer depletion and depletion of non-renewable natural resources. These issues seriously threaten the survival of current and future generations. One of the notable features of environmental issues is worth mentioning here. These issues affect humankind often, regardless of who creates these problems. Sometimes, the vulnerable sections of society or vulnerable countries have to face the severe attack of these problems.

The discourse surrounding sustainable development has a long history highlighting environmental issues and economic advancement. Du Pisani (2006) explores the origins of sustainable development in his article. The idea first surfaced around the close of the 20th century. The progression of progress also comprises the history of Sustainable Development. The Industrial Revolution transformed the idea of material progress and economic growth. The Industrial Revolution altered peoples' perspectives. Humanity adopted maximum economic production as its motto when the natural order was broken. However, because industrialised nations receive unequal benefits, the interval between the affluent and low-income people has grown. Then, the main topic of discussion shifted to development and underdevelopment. During the latter part of the 20th century, sustainability and sustainability first appeared in the Oxford English Dictionary. Discussions about the effects of overusing environmental resources and the need for them as raw materials have existed throughout human history. Before the widespread usage of the term "sustainable development," several publications addressed sustainability-related topics. It was clear that the prior hopes for unrestricted economic expansion were no longer realistic. The Brundtland Commission Report (1987) helped to popularise and expand the

use of the new sustainable development paradigm. There is a consensus that development needs to be sustainable and should focus on environmental matters, the economy, and society.

Rauschmayer and Lessman (2013) point out those scholars should give more attention to sustainability from a capability perspective. The well-being of current and future generations is equally essential. Sustainability not means sustaining future generations' well-being by compromising the current generation's well-being. In reality, it is challenging to reconcile intragenerational and intergenerational justice to maintain a concern for people with low incomes, the environment, and future generations.

A large number of academics helped to adapt the HDI to the circumstances of today. Since the geometric mean is utilised for aggregation, the current technique of calculating the HDI has certain restrictions. Specifically, the HDI value becomes zero when the number of dimensions grows, and one or more components are approaching zero. Another disadvantage of the HDI is that many pertinent dimensions must be included in the computation. The Sustainable Human Development Index (SHDI), based on the multidimensional Synthesis of Indicators, was introduced by Biggeri and Mauro (2013). The environment and freedom are two further dimensions that SHDI incorporates. Additionally, they suggest an alternative index called the Environmentally-centered Sustainable Human Development Index (ESHDI), which centres the analysis on the environmental aspect. Thus, the authors try to integrate both environmental and freedom dimensions. Gross National Income, Education, Life expectancy, clean air (free from CO2 emission) and freedom (political and civil liberties rights) are used for the calculation.

Calculating human development and sustainability at the regional level is as crucial as calculating at global level. However, the need for more reliable data and methodological issues constrain it. Rudra and Chattopadhyay (2018) explore the trend of selected air pollutants in India and propose a Sustainable Human Development Index, which indicates the diverse picture of Indian States concerning environmental parameters. Their study analysed the association between economy and pollution under the Environmental Kuznets Curve (EKC) framework and found that CO2 and PM10 steadily increased in India. However, there is a wide disparity between the states regarding environmental issues. Unlike Bihar, Uttar Pradesh, West Bengal and Maharashtra, states like Kerala and Punjab follow the inverted U shape of the EKC. The environment fundamentally shapes the size and structure of an economy; therefore, sustainability

is vital for survival. Economic activity changes the environment through the use of resources and the generation of pollution and waste. Environmental damages ultimately reduce the life's quality. 'Activities such as extraction, processing, manufacturing, transporting, consumption and disposal change the stock of natural resources, add stress to environmental systems and introduce wastes to environmental media'.

The HDI and sustainability are linked in Neumayers's (2001) study to determine whether a nation's development is sustainable. After analysing 155 nations, he concluded that 42 countries' human development could be more sustainably achieved. They are primarily nations with low levels of human development. Not even this meagre accomplishment will hold up in the long run. The first person to create an index to gauge the seriousness of environmental problems was (Neumayer, 2001). Nevertheless, he has not tried to link it with human development. Neumayer did not prefer integrating environmental variables directly into the Human Development Index. One of the main points of his integration is that resource extraction and environmental degradation, on the one hand, and human progress, on the other, is not directly related. Instead, he recommends building a green HDI.

Social, economic, and environmental development are the three main aspects that must be addressed in the present and the future. According to Prabhu (2013), "the human development and capability approach would need to address the complexity posed by individual agency, choice, entitlements and sustainable development demands. However, conceptually, it is suited to discussing the twin challenges of equity and sustainability." Sen.'s human development and capabilities approach is a theoretical framework that can be used to address sustainability and fairness concerns. However, its application to real-world issues can be challenging due to its complexity. The author supports Sen.'s observation that processes are as crucial as consequences. Therefore, we cannot judge all things in terms of consequences alone.

Gutwald et al.(2014) link Amartya Sen's Capability Approach (CA) to analyse some aspects of intergenerational justice. Sen's suggestion to substitute 'needs' with ' capabilities' reshapes the goal of sustainable development as the protection or enhancement of substantial freedoms. Schultz et al.(2013) argued for establishing an 'integrated evaluative space' by combining CA

evaluative space (regarding humanity, the good life and its dependence upon the natural dimension) and Sustainable Development assumptions (regarding the natural dimension and the circumstances of justice). The CA structure includes feedback loops for achieving an integrated evaluative space.

All over the world, environmental problems like global warming and climate change have made us think about the drawbacks and challenges of our development models. Peeters et al. (2013) question the CA, which emphasises expanding people's capability from an environmental sustainability perspective. They advocate a threshold level for enhancing capabilities. The social goal of enhancing people's capabilities and well-being should be placed within the biophysical constraints of the ecosphere. The concept of Sustainable Human Development gained prominence after the Human Development Report of 1994. Human progress and sustainability, according to HDR 1994, are necessary for the universalism of life claims. Therefore, there is no tension between the two. HDR of 2011 observes that the past progress rates of Human Development might not continue because conditions regarding the two fundamental dimensions of environmental sustainability and equity have deteriorated (UNDP, 2011). The authors find that since people's capabilities and well-being depend on the environment, unmitigated climate change violates temporal justice.

In reaction to the UN 2030 Agenda for Sustainable Development, Jin et al. (2020) suggest creating a new National Sustainable Development Index (NSDI) based on a modified HDI. NSDI tries to improve the widely adopted HDI by incorporating more comprehensive sustainability perspectives. NSDI framework includes 12 indicators from dimensions of economy, resource environment and society and calculated the weights of the indicators using the entropy method.

Much emphasis has been paid to sustainability and the significance of intergenerational justice since the Brundtland Commission Report was released. Sen (2013) offers a freedom-oriented perspective that emphasises essential liberties that individuals should value. "He is in favour of expanding the conversation on sustainability beyond its conventional boundaries." Humans must be seen as "the agents of change who can, given the opportunity, think, assess, evaluate, resolve, inspire, agitate and through these means reshape the world" rather than just as customers or as people with wants. The resilience and power of the natural environment are always essential to the safety of human life on Earth.

Pelenc et al. (2013) point out three major shortcomings of Sen's approach regarding environmental sustainability. Firstly, Sen's approach needs to pay more specific attention to environmental issues and acknowledge the usefulness of ecosystem services. Secondly, he never accepted that humans primarily depend on nature, and, finally, he never made any explicit statements about this. Overcoming these limitations, they suggest the introduction of responsibility into three levels of human action defined by Becker (2006): responsibility of the person towards himself/ herself, responsibility towards the community and responsibility towards nature.

Sustainable development is defined by Romeiro (2012) using an ecological economics framework. According to ecological economics, the environment's subsystem is the economy. A subsystem can never be more significant than the system it is a part of, by definition. This concept is demonstrated by comparing the "Cowboy economy" to the "Spaceship economy" (Boulding, 1966). According to the study, *sustainable development* is "a process of improving human well-being based on a material/energy production that ensures the comfort deemed

appropriate, and that has been stabilised at a level consistent with the thermodynamic limits of the planet." This is how the idea is summarised from an ecological economics perspective.

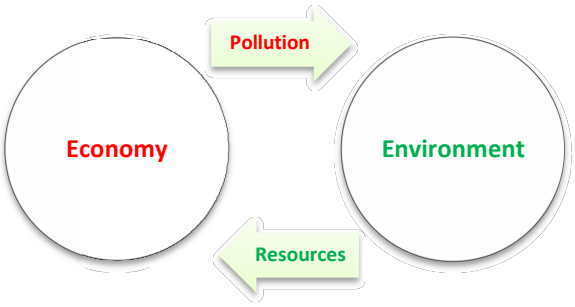
Indices cannot provide an accurate picture of anything, but they provide the right direction for policymakers and public. The Environmental Performance Index (EPI) prepared by Yale University is an excellent move towards the valuation of the environmental condition of a country. Similarly, the Planning Commission of India constructed an Environmental Performance Index for its states in 2013 and updated it with new components in 2020.

2.4 Conceptual Framework

The economy and environment are closely related. Therefore, economic activities affect the quality of the environment. The state of a nation or region's natural environment has an impact on its economic activity as well. The environment is a resource source for economic activities and a sink for its outputs like pollution. Thus, by way of resource extraction and disposal or emission, at least two-way negative externalities are facing the environment due to economic activities.

Figure 2.4 depicts the primary linkage between the economy and environment.

Figure 2.4: Economy & Environment as a 'Giver' and 'Taker'

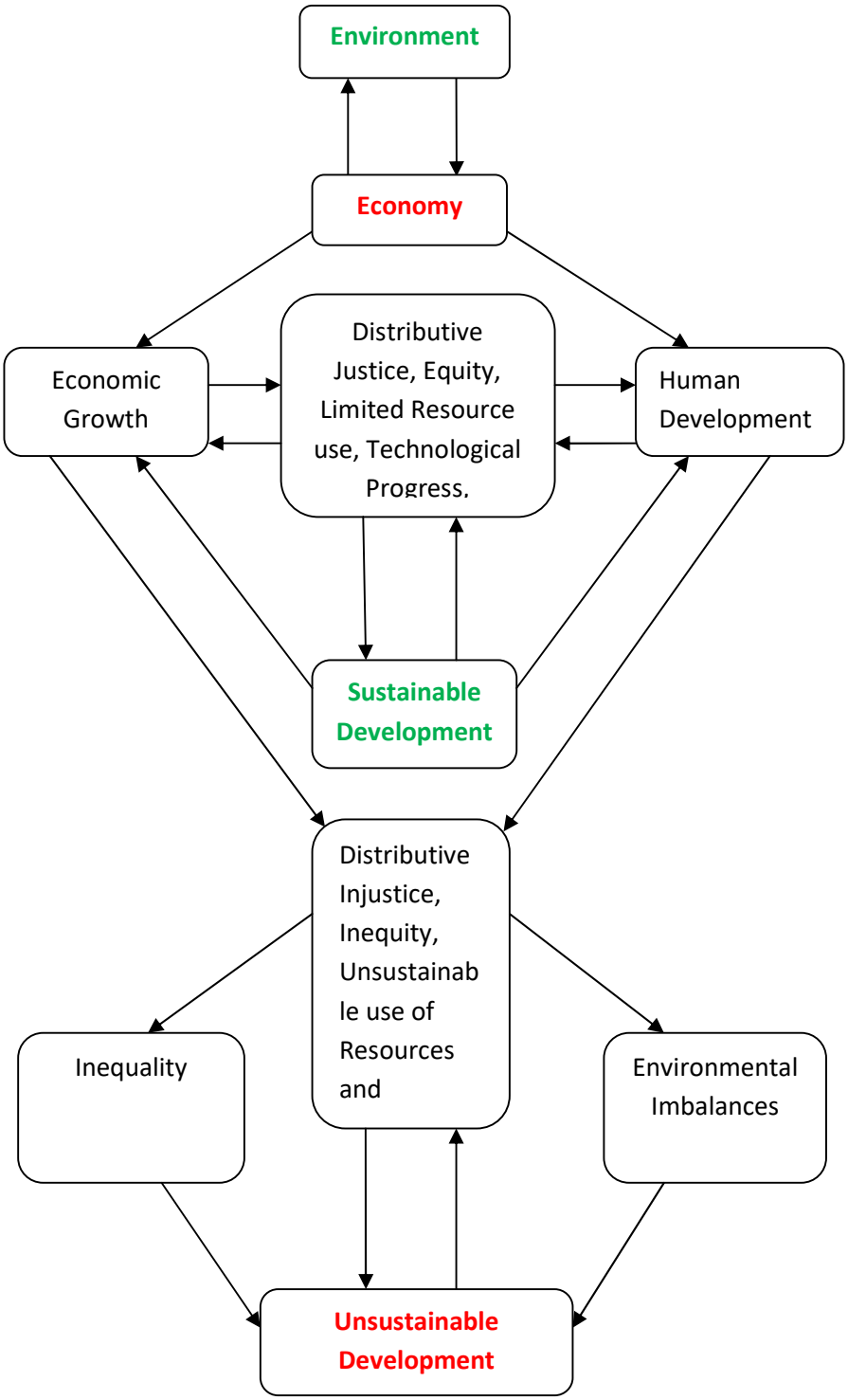


Source: *Author's compilation*

Economic Growth and Human Development are associated with the Economy and economic activities. When the economy for its expansion and human progress, exploit the environment against planetary boundaries, both economic and human well-being became unsustainable. The absence of fair distributive justice and equity aggravates the environmental loss. Technological backwardness and inefficient policies also increase the pace of environmental degradation.

To facilitate analysis, sustainability can be separated into two categories: Strong Sustainability (SS) and Weak Sustainability (WS). The foundation of WS is the belief that capital, whether natural or otherwise, is interchangeable and that, for the sake of future generations, the value of the capital stock should be preserved or, at the very least, increased. According to Neumayer (2012), strong sustainability takes into account the fact that some types of natural capital are essential and that investing in other kinds, including human and manufactured capital, cannot make up for their depletion. Here arises the question of what should be sustained and how?

Figure 2.5: Sustainability



Source: Author's Compilation

Figure 2.5 shows the link between the economy and the environment regarding how they act as a feedback system and how justice and inequality affect economic and environmental inequality and fair distribution.

2.5 Theoretical Framework

The theoretical framework of this chapter is developed mainly on market inefficiency and negative externality, game theory and inter and intra-generational equity theories. The following questions are relevant to developing a theoretical framework for this study.

1. How do economic activities cause environmental degradation?
2. Does everyone equally bear the socio-economic and environmental impacts of environmental damages?
3. Why a zero growth strategy or unlimited growth strategy unfeasible?
4. Why should we consider intra and inter-generational equity?
5. What is the feasible approach to a sustainable development strategy that balances economic development and environmental sustainability and avoids a possible extinction?

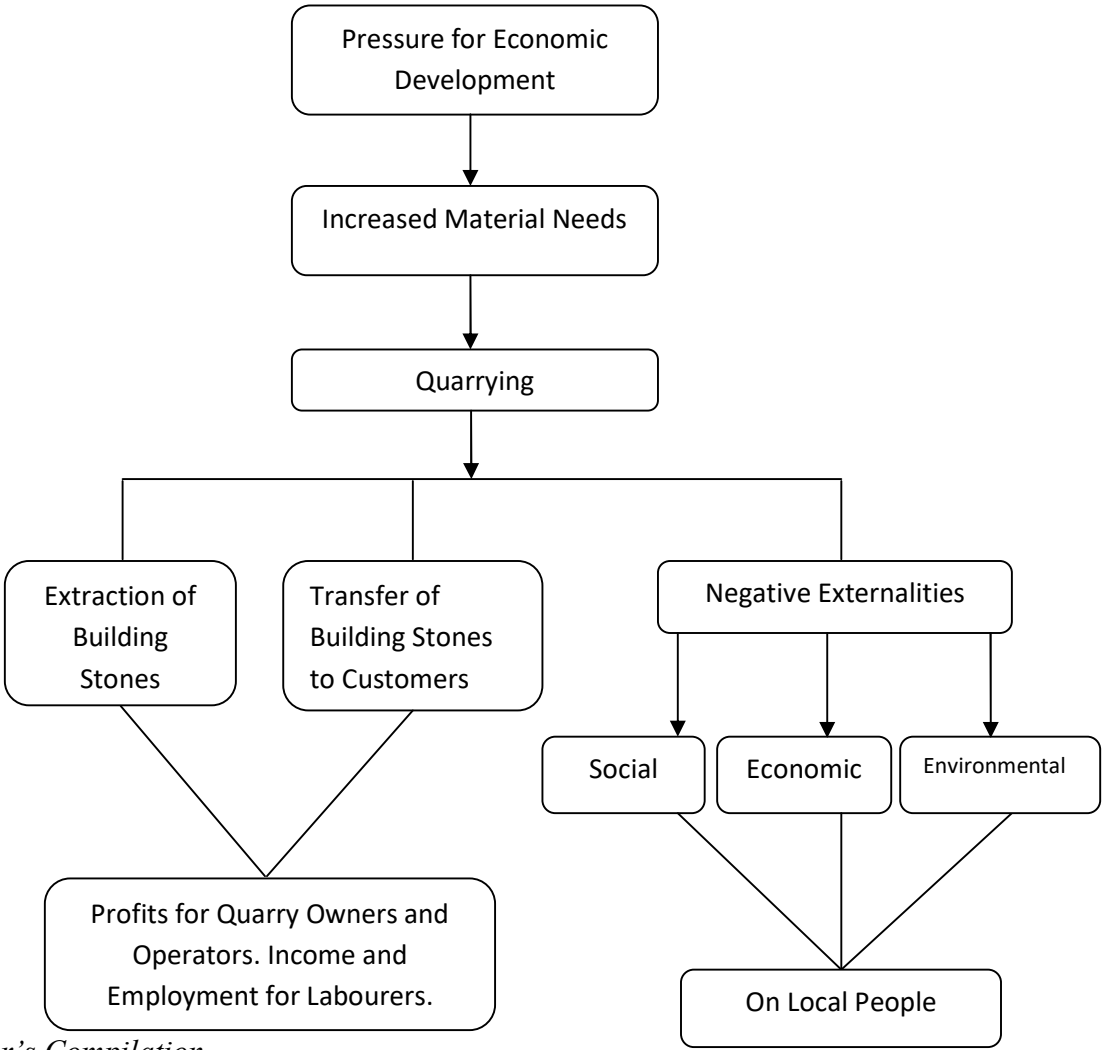
2.5.1 Environmental Issues as Negative Externalities of Economic Activities

Environmental concerns are not the only ones to which the term "externality" is applied. This idea explains situations in which one (or more) economic players' activities affect other actors' economic well-being without any trade or transaction between them. Externalities can be either favourable or adverse. When they enhance well-being, externalities are categorised as "positive"; if not, they are "negative". An example of a negative externality is pollution, whereas a positive externality is a public health campaign. Since there are neither rewards (nor benefits) for those who produce neither positive external effects nor sanctions for those who cause detrimental external effects, externalities prohibit the market from efficiently allocating resources. Because prices do not accurately reflect all relevant information when externalities are present, decisions that maximise profits are inefficient from a societal perspective. After all, societal and private expenses differ—a negative externality results from a decision with a larger social cost than a private cost. Most environmental problems result from a lack of coordination brought on by absent markets, insufficient property rights, and the incapacity of those impacted to act together.

Therefore, environmental harms might be considered as unfavourable externalities of economic activity.

In the event of quarrying, residents will not be engaged in the extraction and benefitted from these activities. The quarry owner and operator will only be able to benefit from this extraction. However, the locals living close to these extraction locations would be affected by the socio-economic and environmental effects of quarrying. Therefore, economic and environmental damages from quarrying can be considered harmful externalities to the local population. The negative externalities of quarrying work are shown in Figure 2.6.

Figure 2.6: Negative Externalities of Quarrying



Source: Author's Compilation

2.5.2 Environmental Issues: a Game theory Approach

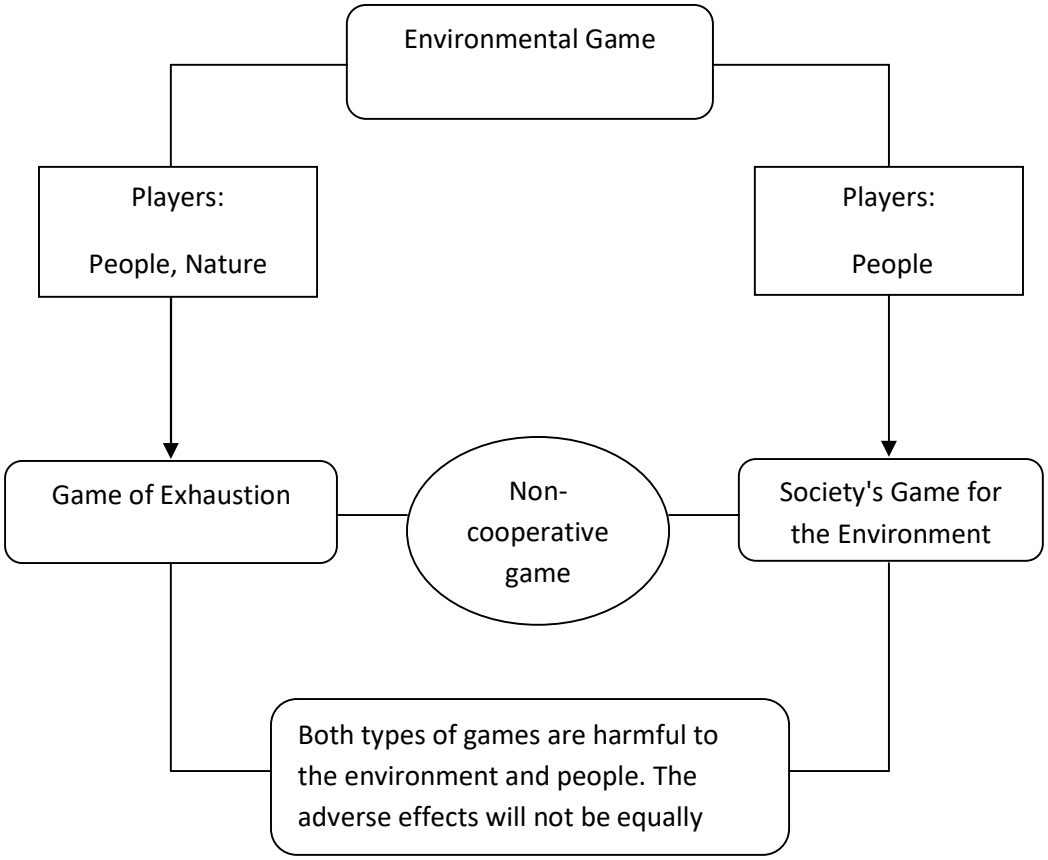
The Game theory investigates the strategic interactions, disputes, and cooperation of decision-makers (players) such as individuals, businesses, countries, and governments. This investigation is especially relevant when those activities cause harm to other players, as in the case of pollution or environmental externalities. However, it is crucial to recognise that people have a responsibility to protect the environment and have a right to coexist peacefully with it. It is evident and generally known that human beings influence not only the environmental variables, aspects, and elements through their activities but also other people's responses (Dinar, 2006).

A "game" that is played between two agents—people and the environment—is referred to by Vrieze (1995, 1996) as an "environmental game." The game shows two levels of interaction: the first is the "Game of Exhaustion," in which humans and nature compete with one another by employing various strategies, and the second is the "Society's Game for the Environment," in which various human agents influence one another by endangering the environment. By imposing some fairness principles for people and nature and looking for a socially, economically, and environmentally feasible solution, game theory attempts to settle disputes between those parties. As in the "prisoner's dilemma" or the "tragedy of the commons", non-cooperation between the players affect player payoffs and environmental quality. Cooperative outcomes are likely preferable to non-cooperative outcomes in these interactions between businesses and a public authority or between different states. Examining strategic relationships through other supportive acts (like negotiating) may be acceptable since it is frequently challenging to have enforcement methods to guarantee that agreements are kept or because the cooperative solution might not be innovative.

Local collaborations improve the chances for sustainable outcomes for people and the environment. However, other instances demonstrate how challenging it may be to achieve global collaboration to address transnational environmental issues when commercial interests are at stake. Agreements enforced by an international power make it easier for nations to cooperate internationally. However, this is not the reality (Barrett, 1994). The ability of participants to communicate with one another is of utmost importance. It is a reason for little international cooperation and little local cooperation. Inequality in the sharing of information is a significant cause of environmental issues. Without adequate information sharing between the players, a

prisoner's dilemma happens here regarding environmental issues. A cooperative environmental game is only possible where information is shared between players.

Figure 2.7: Environmental Issues in a Game Theory Perspective



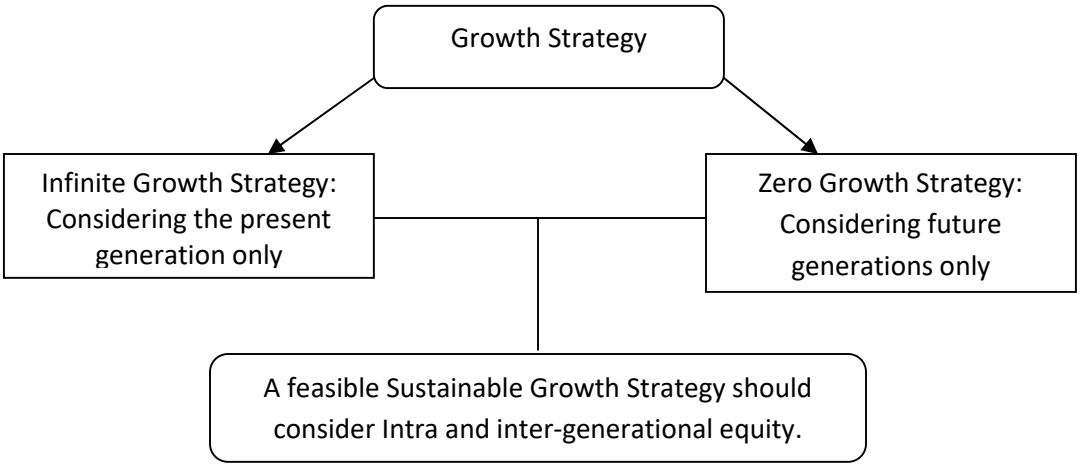
Source: Author's Compilation

2.5.3 Between Zero and infinite growth: Sustainability as a Matter of Intra and Intergenerational Equity

Finding a feasible solution for development-related environmental issues is a significant concern. It lies between zero growth and infinite growth. Neoclassical economics thinks unlimited growth with the support of technology is not practical. Likewise, a zero-growth strategy in a severe inequality and disparity world is impossible. The concept of sustainability is worth mentioning here. The Brundtland Commission Report released in 1987 popularised the term sustainable development. The report defines sustainable development as "development that meets the needs

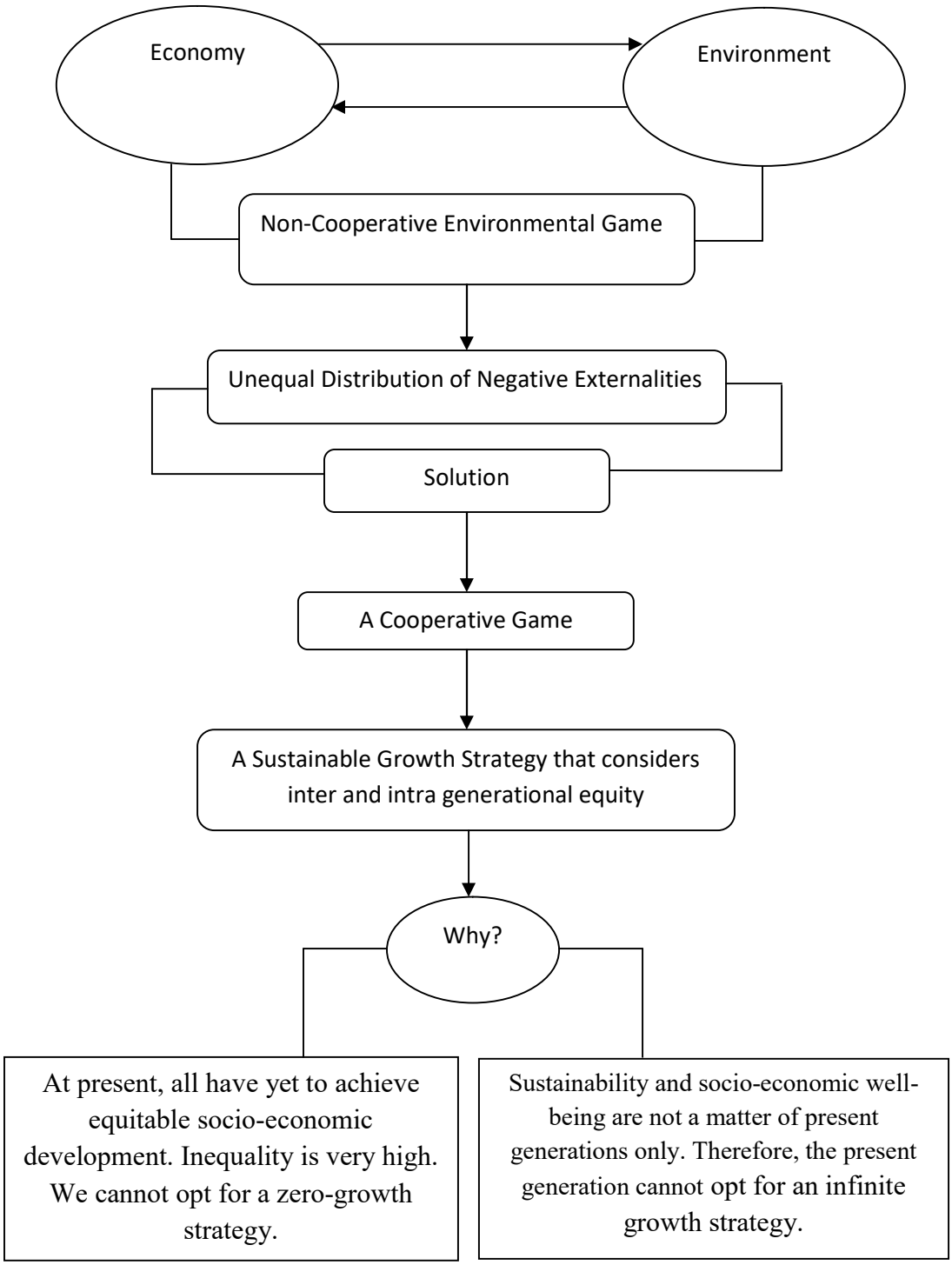
of the present without compromising the ability of future generations to meet their own needs." This definition focuses on intergenerational equity. However, in the case of sustainability, it is worth incorporating intra-generational equity, too, because the present generation has yet to achieve fuller equality in socio-economic development. Therefore, limiting development activities on the same scale worldwide would push some countries or some sections of people back in their developmental journey even without acquiring a minimum standard of living. Therefore, while finding a solution for environmental issues in terms of sustainability, one should consider intra- and inter-generational equity

Figure 2.8: Sustainable Growth Strategy



Source: Author's Compilation

Figure 2.9: Theoretical Framework of the Study



Source: Author's Compilation

Figure 2.9 summarises the Theoretical framework of this study.

2.6 Research Gap

A critical review of relevant literature summarises that uncontrolled economic activities harm the environment. As the economy depends on environment for resources and disposals, economic activities cause various environmental issues. The extraction of resources and deterioration of the environment have a significant negative impact on human life. The scope and depth of these issues increase when we concentrate on the instance of the extraction of resources that are non-renewable. Even though there have been many studies and discussions about how development affects the environment, it is still being determined whether all environmental concerns receive enough weight. There are environmental problems that can be solved and some that cannot. Some topics, like climate change, inevitably draw more attention due to their detrimental effects on a global scale. However, issues like quarrying, where the local negative impact is high, must also be taken seriously because such problems are related to non-renewable natural resources. Attempts to quantify these impacts are also rare.

Although there are studies that examine the effects of quarrying scientifically, those that address its social dimensions could be more frequent. Discussions on the sustainability of human progress and the consequences of unchecked resource extraction that is not reversible are particularly pertinent. From a social science standpoint, only a small number of researches concentrate on the local effects of environmental problems and resource extraction. Studies on the experiences of the people who live close to quarries are few and far between. That means only a few studies analyse how quarrying has affected people's social and economic lives and how it has affected their environment. Therefore, the current study makes an effort to do this. Such studies in a social science aspect are exceptional in the Kerala context. The present study attempts to analyse the socio-economic and environmental impacts of quarrying on local people and threats to attained human development. Only when studying the balance between economic development and the environment becomes essential can apt policies be formulated and sustainable solutions can be found. Consequently, this study makes an effort to analyse quarrying in that manner.

Chapter 3

THE NATURE AND PATTERN OF ECONOMIC DEVELOPMENT IN KERALA: AN OVERVIEW

- ***A Brief Introduction to the Development History of Kerala***
- ***Economic Development and Performance of Different Sectors***
- ***Social Development and Demographic Indicators***
- ***Human Development***
- ***Challenges to the Development***
- ***Conclusion***

Chapter 3

The Nature and Pattern of Economic Development in Kerala: An Overview

3.1 Introduction

Development is the ultimate goal of every state, and we practice comparing the lands with the scale of development. Kerala is one of the leading states in India in many aspects of development. Indicators show that Kerala stands first among the other Indian States in social and human development. In the economic sphere, the performance of the state is promising. The geographical location, the richness of natural resources, and the impact of socio-religious movements contributed much to the state's development journey. However, there exist some threats. Development-related environmental issues are important among them. This chapter provides an overview of the nature and pattern of economic development of Kerala since its formation. In this study, the nature of economic development is used in the sense of development features. The term pattern of development means the development's trend and model or design.

This chapter briefly introduces the development history of Kerala, an analysis of economic development and performance of different sectors of Kerala's economy, social and demographic indicators, components of human development and challenges to the development. All these variables are taken into account because an economy's development pattern and socio-economic features influence its environment and the environmental awareness of its people (Filimonova et al., 2019). Level and pattern of economic development, components of socio-human development like education, income, health and demographic features are influential in the environmental sustainability of a region (Hadler et al., 2022). Details of the environment of Kerala, development and environment retrospect and features of non-renewable resource extraction, especially quarrying in Kerala, are discussed in Chapter 4.

3.2 A Brief Introduction to the Development History of Kerala

As per the States Re-organisation Act, 1956, the Kerala state existed on November 1, 1956. The state is located at the extreme southern tip of the Indian Subcontinent. It occupies 1.18% of the total landmass of India, with an area of 38,363 square kilometers. The state enjoys diverse geographical features, with the Western Ghats towering at 500–2700 meters in the east and networked by forty-four rivers and the Arabian Sea in the west. The state has three regions: the Highlands, which slope down from the Western Ghats onto the Midlands, and the Coastal land. Geography has a vital role in the course of development. A comparatively lengthy coastal line on the west increased the state's access to the outer world's cultural diversity, knowledge, trade relations, and even social change. Due to the ease of access, diversity, and uniqueness of its natural resources, many foreigners have come to this small land. It helped the state to start its journey of modernisation earlier. The Western Ghats secured the state's climatic advantage. Many landlocked states in India fall under the underdeveloped category due to their adverse natural features and ease of access.

Kerala's development history depicts society's transformation from the medieval feudal age to the modern industrial age. Kerala had a rich tradition of foreign trade from the ancient times. The Arabian Sea acted as a gateway for cultural expansion, modernity and trade relations (Narayanan, 1972). The lengthy coastal line promoted this trade partnership along with the cultural exchange. In the 19th century, Indian reformer Swami Vivekananda called the region ‘a Madhouse of Caste (Franke & Chasin, 1984). Education was important in Kerala's transition from a rigidly caste-defined society into one of India's most egalitarian states. The contributions of Christian missionaries are significant in this regard. Communication of the state with other parts of the world through trade relations resulted in the spread of modern thought and knowledge (Varier & Gurukkal, 2012 & Ganesh, 2019).

Spread of education helped the state to overcome many social barriers. People from lower castes lived in deprived conditions because the caste system nurtured inequality. However, education trained the people to question the aristocracy rather than obey it. In the later course of the state's development journey, the school system's introduction directly challenged the hierarchy and caste-based employment structure. Thus, Kerala became the arena of strong civil activity and organisation of citizens. Kerala's social landscape favoured mass organisation methods against

social evils (Jeffry, 1992). Protests like the temple entry march became integral to Kerala's culture.

The critical feature of the development experience of Kerala has been the achievements in the quality of life of its people regardless of gender and region (Kannan, 1990). There are many historical, social, geographical and cultural factors for the state's achievements in her social development. Political participation of the people, vigilant civil society, social movements, cultural activities and print media are involved in various degrees to mould the social development of the state. Achievements in social development are reflected in the state's education, health and demographic indicators.

Kerala's socio-economic advancement received scholarly attention when the UN study Poverty, Unemployment, and Development Policy was published in 1975. The state presented a unique pattern of development experience in front of the world. It has some historical, social and ecological background. Under the traditional understanding of development, an increased GNP corresponds with more wealth and a higher individual standard of living. However, Kerala was an exception to this expectation.

3.3 Economic Development of Kerala

This section of the chapter discusses three aspects of the economic development of Kerala: phases of economic development, trends in economic development and structural composition and performance of various sectors of the economy.

3.3.1. Phases of Economic Development

The course of development of Kerala has gone through different phases from its origin as a state to the present period. Many internal and external factors influence the economic development of a region. Those factors include global economic and political conditions, central and state government developmental policies, public action, internal and external migration, and uncertainties like natural disasters or health emergencies. Considering these factors, the economic development of Kerala can be broadly divided into two (Kannan, 2022):

1. First Phase: High Human Development with Low Economic Growth and
2. Second Phase: High Human Development with High Economic Growth

The features of these phases are briefly discussed in the following Sections.

3.3.1.1 The phase of High Human Development with Low Economic Growth (1960-61 to 1986-87)

Since earlier times, Kerala's economy has benefited from the prosperity of international trade with her trading partners. The extensive coastline and availability of accessible ports served as the entry point for socio-economic and cultural interaction. Before solid economic growth, Kerala benefited historically from favourable initial conditions for achieving a higher level of socio-human development. Public participation played a significant role in its course of development. This public action was made feasible by social reform, radical politics, an active public sphere, and a social economy, which aided a substantial political need for social development.

Kerala's development experience gained comprehensive academic and public attention, nationally and internationally, after the study (1975) conducted by the Centre for Development Studies, Trivandrum, under the leadership of Dr. K.N. Raj (part of research work commissioned by the United Nations Secretariat). This study made it clear that Kerala, a provincial state in India, has provided a favourable level of welfare for its citizens within a little less than two decades of its formation in 1956, despite having a meagre per capita income by global standards. (Kannan, 2022). This study was also helpful to understand the problems underlying the development from the experiences of Kerala. Though the state's per capita income was below the national average, it was a forerunner in many social indicators. Kerala's developmental journey has experienced specific characteristics like a high level of literacy, particularly female literacy, a high proportion of children going to school, a low dropout rate and a decline in the birth rate and infant mortality. “Robin Jeffrey points out that the word Kerala Model was first used by Malcolm Adiseshiah in the book Economy Since Independence"(Oommen, 2017). Nevertheless, many scholars consider it a development experience (Sen & Dreze, 2006) or a transition backed by historically evolved socio-political factors (Jeffrey, 1992; Oommen, 2017; Kunhikannan, 2017). High socio-human development with low economic growth was the unique feature of the state's development experience.

However, the state's economic growth was poor at this phase, and its economic transformation was very slow.

3.3.1.2 The phase of High Human Development with High Economic Growth (1987- 88 to Present)

In the later stage, the state also improved its performance in economic growth. Now, the state stands in the fifth position per the State Gross Domestic Product ranking. During this phase, achievements in human development, steady remittances from migrant workers, national and state-level policies, and economic interaction through globalisation influenced the state's growth.

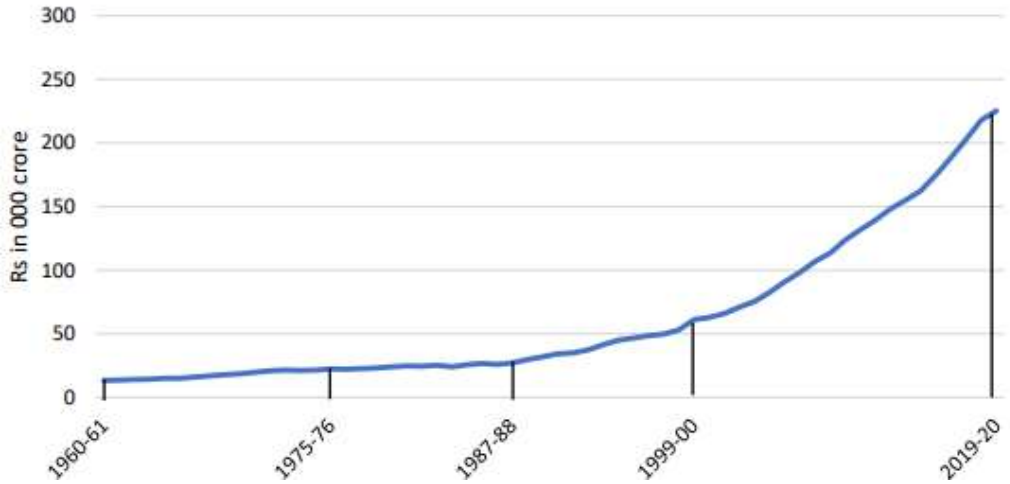
One of the main drivers of Kerala's second phase's high economic and human development was the steady and growing inflow of remittance revenue into the state's economy. It led to a considerably higher increase in per capita income and consumption than the national average. However, its multiplier impact could not help the Kerala economy break the low growth problem in the commodity-producing sectors of agriculture and industry in an extended way, as they were traded commodities and could be bought from the rest of India at competitive prices. However, given the increasing need for services like education, health, finance and trading, transport, and other non-traded activities, the multiplier effect worked well in this area. Given the need for new houses resulting from the remittance money, the construction sector is one non-service sector that witnessed continuous high growth. This increased demand for non-residential buildings coincided with the expansion of the service industry (Kannan, 2022; Prakash, 1998).

3.3.2 Trends in Economic Growth in Various Phases

In the first three decades, Kerala has experienced a slow but steady process of economic growth. However, in the subsequent decades, Kerala has registered a growth rate close to the national average. Figure 3.1 shows the trend in the State's Net State Domestic Product (NSDP) from 1960-61 to 2019- 20.

Figure 3.1

Trend in Net State Domestic Product (NSDP) in Kerala 1960-61- 2019-20 (Rs. in Thousand Crores)



Source: Kannan, 2022

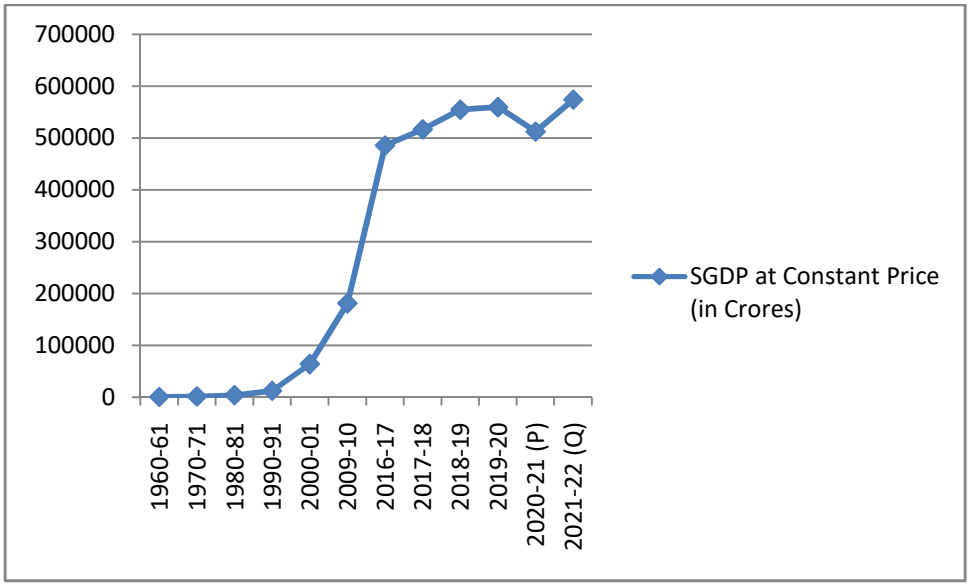
Table 3.1 shows that the state has experienced a continuous increase in its Gross Domestic Product and Percapita Income over the years.

Table 3.1: SGDP & PCI from 1960-61 to 2021-22

Year	SGDP at Constant Price (in Crores)	Percapita Income (in Rs.)
1960-61	462	276
1970-71	1255	594
1980-81	3823	1508
1990-91	12195	4207
2000-01	63715	19951
2009-10	180812	47360
2016-17	485301.54	141398
2017-18	516189.76	149650
2018-19	554228.31	159878
2019-20	559194.18	160506
2020-21 (P)	512076.08	146246
2021-22 (Q)	573591.46	162992

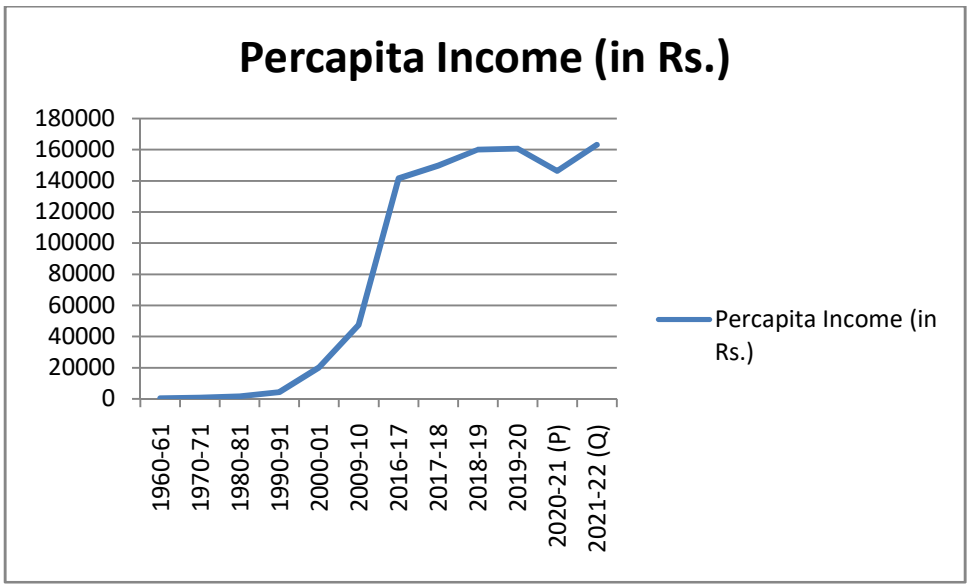
Source: Economic Review of Kerala, Various years

Figure 3.2: SGDP at Constant Price 1960-61 to 2021-22



Source: Economic Review of Kerala, Various years

Figure 3.3: Percapita Income at Constant Price from 1960-61 to 2021-22



Source: Economic Review of Kerala, Various years

Figures 3.2 and 3.3 depict trends in the growth of SGDP and PCI from 1960-61 to 2021-22. This shows that from 1990-91 to 2016-17; the state experienced a significant increase in SGDP and

PCI. After 2016-17 up to 2020-21, there was a moderate growth phase. Furthermore, again, after 2020-21, SGDP and PCI show an increasing trend.

3.3.3 Structural Composition and Performance of the Various Sectors of the Economy

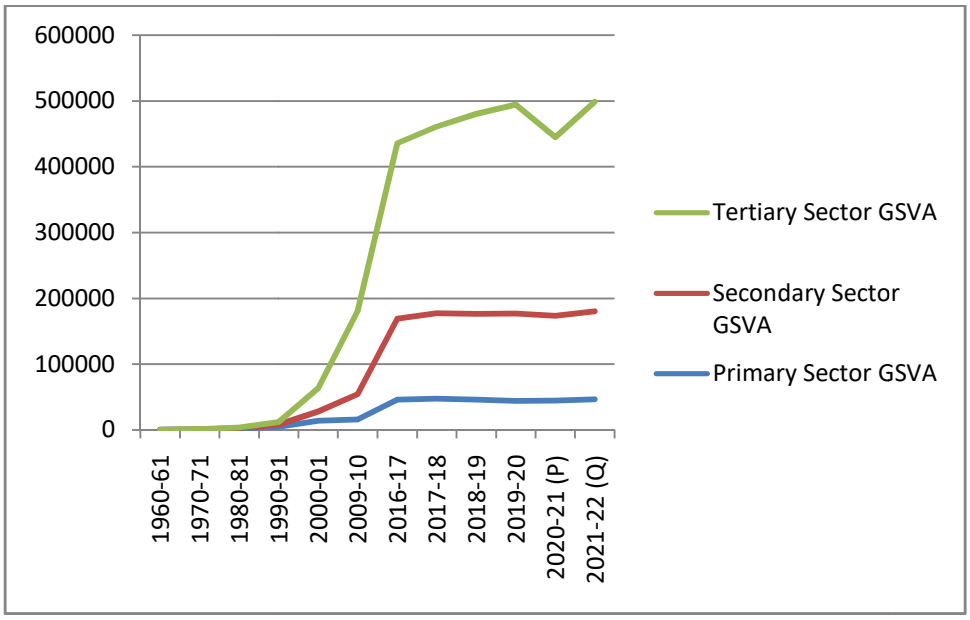
Such a growth and development trajectory, while increasing per capita income and further enhancing the human development standard, has led to a highly unbalanced economy regarding sectoral contribution to growth. Kerala is now largely service-driven, more so than the national economy. Kerala's recent economic performance compared with the Indian Economy shows that although both economies are service sector-dominated, the service sector relatively more dominates Kerala's economy than India's, and her primary or agricultural sector is much smaller. Within the service sector, three subsectors are very important: financial, real estate, and professional services, followed by trade, hotels, and restaurants, and then public administration and other services.

Table 3.2: Sectoral Contribution to GSVA from 1960-61 to 2021-22

Year	Primary Sector GSVA	Secondary Sector GSVA	Tertiary Sector GSVA
1960-61	241	68	153
1970-71	653	163	439
1980-81	1682	841	1300
1990-91	4756	3171	4268
2000-01	14017	14017	35680
2009-10	15966	38249	126597
2016-17	45936.94	123289.49	266144.63
2017-18	47619.23	129866.26	283268.51
2018-19	46114.01	130450	303661.64
2019-20	44306.26	132480.25	317187.72
2020-21 (P)	44657.68	128749.03	271393.14
2021-22 (Q)	46515.96	133735.84	318336.73

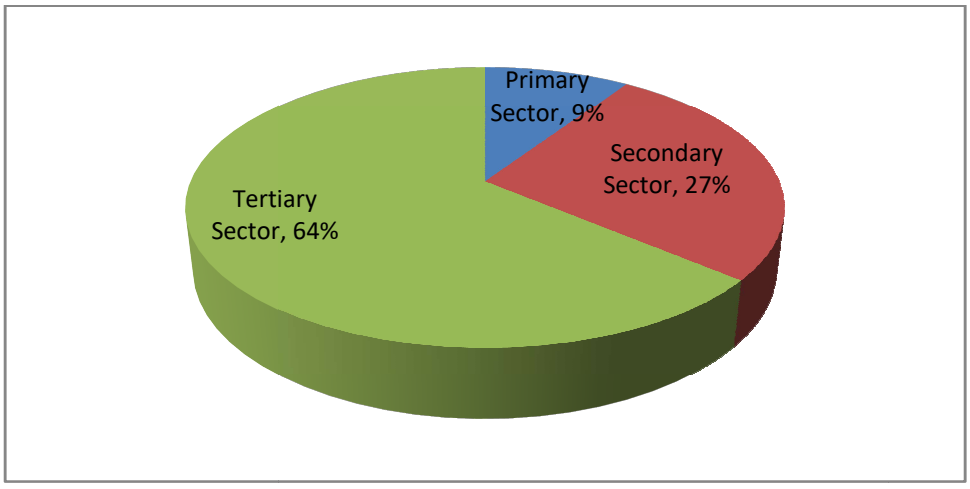
Source: Economic Review of Kerala, Various years

Figure 3.4: Trends in Sectoral Contribution to GSVA



Source: Economic Review of Kerala, Various years

Figure 3.5: Composition of Sectoral Performance



Source: Economic Review of Kerala, Various years

While examining the share of different sectors to the GSVA, it is evident that shares of the primary sector after 2017-18 indicate a diminishing trend. However, the contribution of secondary and tertiary sectors exhibits an increasing trend.

3.4 Demographic Indicators

Demographic features influence the region's resource needs and reflect social achievements. Therefore, this section of the chapter tries to analyse the essential demographic features of Kerala from 1961-2011 using Census reports published by the Government of India. The demographic transition of Kerala portrays the state's explosive population in the 1960s to the declining growth rate of the present. In 1961, Prof. M.A. Oommen wrote an article titled, *Kerala the demographic danger spot of the world*. The title itself shows the seriousness of the situation. However, from that point, central and state government activities' intervention controlled the growth rate. Now, the state stands as a place in the globe where the population is falling at an increasing rate.

3.4.1 Decadal Growth Rate of Population

As per the Census Report of India 2011, the population of Kerala was 33,406,061. It counts 2.76% of population of India. Out of which 48% are males and 52% are females. During this period, the rural population was 52.3 % and urban constitutes 47.7 %. The decadal growth rate of Kerala's population during 2001-2011 was only 4.9%. It was the lowest among the Indian States. Among the districts as per the growth rate Malappuram has the highest of 13.4 per cent, and Pathanamthitta has the lowest of -3.0 per cent. Idukki also has seen a negative rate of -1.8 per cent. Rate of population growth is lower in six southern districts, namely, Idukki, Kottayam, Alappuzha, Kollam, Pathanamthitta and Thiruvananthapuram, than in other Districts of the State. Table 3.3 shows India and Kerala's population and decadal growth rate (1961-2011).

Table 3.3: Population and Decadal Growth Rate of Population

Census Year	Population	Decadal Growth Rate(%)
1961	16903715	24.76
1971	21347375	26.29
1981	25453680	19.24
1991	29098518	14.32
2001	31841374	9.43
2011	33406061	4.91

Source: Census Report 2011

Table 3.3 shows a continuous decline in the state's decadal population growth rate.

3.4.2 Sex Ratio and Male-Female Composition in the Population

A ratio of male to female that is positive is a good measure of social development. The Sex Ratio represents the number of female population for every thousand male population in this case. Kerala's 2011 Census revealed a sex ratio of 1,084, while India's sex ratio is 943. According to the Economic Review (2019), Kerala is the sole state in India where the gender ratio has consistently been higher than unity. The fact that Kerala's districts all have favourable sex ratios is another noteworthy aspect of the state. Table 3.4 following shows the state's gender ratio.

Table 3.4: **Sex Ratio of Kerala 1961-2011**

Census Year	Sex Ratio
1961	1022
1971	1016
1981	1032
1991	1036
2001	1058
2011	1084

Source: Census Report 2011

3.4.3. Child Population and Child Sex Ratio

The declining child population and the child sex ratio are two of Kerala's demographic trends that pose a threat. It will negatively impact Kerala's future advantageous sex ratio and demographic dividend. The number of children in the state is trending downward. Kerala's child population (ages 0 to 6) represented 10.3% of the state's total population in 2011 (34, 72,955 in numerical terms), compared to 11.9% in the census results from 2001 (37, 93,146). In the same periods, the percentage of children at the national level was 13.5% and 15.9%. There is a decline in the percentage of children in every district of Kerala.

The number of females for every 1000 boys between the ages 0 and 6 is the child-sex ratio. Kerala's overall sex ratio is higher than its child sex ratio. It is only 964, according to the 2011 census. Since 1991, the state's female-to-male ratio for children ages 0 to 6 has been negatively

impacted. Three districts—Thrissur, Idukki, and Alappuzha—have a negative growth in the child sex ratio when the decadal change is analysed.

3.4.4 Population Density

The population density of the state is 860 people per square kilometre, according to the 2011 Census. It is significantly greater than the 382 national averages. Of all the districts, Trivandrum has the highest population density (1508), while Idukki has the lowest (255). High levels of natural resource exploitation are more likely in areas with dense populations. Except for Pathanamthitta (-16) and Idukki (-4), all districts saw increases in population density when compared to the statistics from the 2001 census.

Table 3.5: Population Density Comparison- India and Kerala

Census Year	Population Density			
	Kerala	**Percentage Change**	**India**	**Percentage Change (%)**
1961	435	24.6	142	**21.4**
1971	549	26.2	177	**24.6**
1981	655	19.3	216	**22**
1991	749	14.4	267	**23.6**
2001	819	9.3	325	**21.5**
2011	859	4.88	382	**17.5**

Source: Census Reports, various years, Govt. of India

3.4.5. Age Group Composition and Demographic Dividend

Two noteworthy events have occurred in the state during the demographic shift. The proportion of the population in the 0–14 age group has decreased, while the population in the old age group (60 years and above) has increased. It is noted that from 43% in 1961 to 23.4% in 2011, the percentage of the population in the 0–14 age group has decreased. From 5% in 1961 to 12.7% in 2011, the share of the population in the old age group (60 years and above) grew due to rising life expectancy and the availability of health facilities. According to the 2011 census, 29.5% of Indians are between the ages of 0 and 14, 62.5% are between 15 and 59, and 8.0% are over 60. If this pattern persists, the percentage of the population in the 0–14 age group will soon decline, leading to a fall in the number of people joining the working age group (15–59).

3.4.6. Population Projection 2011- 2036

The Technical group on population and the National Commission on Population under the Ministry of Health and Family Welfare, Government of India, formulated a report on population projections for India and its states for 2011- 2036. As per this report, India's population is expected to increase from 121.1 crore in 2011 to 151.8 crore in 2036. Population density increased from 368 people per square kilometer to 462. The important projected demographic features of Kerala are given in the table.

Table 3.6: Projected Demographic Features

Demographic Feature	Period/Year	Kerala			
Population	2011	3.34			
	2036	3.69			
Population Density	2011	860			
	2036	951			
Life Expectancy	2011-15	Male	72.19	Female	78.15
	2031-35		74.19		80.15
Infant Mortality Rate	2011-15				
	2031-35	9			
Crude Birth Rate	2011-15	14.5			
	2031-35	11.7			
Crude Death Rate	2011-15	7.0			
	2031-35	9.7			
Total Fertility Rate	2011-15	1.82			
	2031-35	1.80			
Sex Ratio	2011	1084			
	2036	1079			
Population Aged Under 15 years	2011	23.5			
	2036	17.7			
Proportion of the Middle age groups (15-59)	2011	63.9			
	2036	59.5			
The proportion of older people aged 60 years and above	2011	13			
	2036	23			

Source: Economic Review, Kerala 2020

As per the population projections, almost 5th the individual is expected to be senior citizen by 2036.

3.5 Social and Human Development

The development process of the state of Kerala can only be analysed by assessing her achievements in social and human development. The social indicators like education, health and demographic features frame the state's human development. Therefore, in this section, under the title of social and human development, the achievements of the state in two social indicators, education and health, is considered. Even in the early years of Kerala's development history, when economic growth was relatively slow, the state has been an example of high human development. Historical aspects, education, people's movement, the Renaissance, and, in later periods, government policies contributed to this achievement in human development (Kannan, 1990; Lieten, 2002). The state's achievements are impressive in contributing to the quality of life of its people. Higher levels of universal literacy combined with minimal gender and racial disparities enabled the state to properly disperse the benefits of social progress (Kannan, 1990). Many of the state's achievements were comparable to those of developed countries.

Human Development Report (1996) observes that "the record of economic growth and human development over the past 30 years shows that no country can follow a course of lopsided development for such a long time- where economic growth is not matched by advancements in human development, or vice versa". However, Kerala's development experience was against this general statement (Chakraborty, 2005). Research into the unique social development of Kerala has been around for longer than the idea of human development and the 'Paradigm shift' that goes along with it in development theory. Much before human development reports became a part of development discourse, the Centre for Development Studies (1975), with support from the Committee for Development Planning of the United Nations, embarked on a pioneering study on Kerala, which underscored the role that education had played in bringing about a variety of positive changes, including the impressive health achievements of Kerala being a relatively poor state in India.

The CDS study triggered curiosity and scholarly interest in Kerala's development experience, as it was considered to be an exemplary case that could be invoked to demonstrate the general possibility of achieving high levels of social development even with minimal economic advancement. Kerala's experience was thus held up as a model for the developing world, and the so-called 'Kerala Model' eventually became the global development discourse. However, the

sustainability of Kerala's development pattern is a question of debate every time. Education and health status of Kerala is discussed in the following sections.

3.5.1 Education

Education is one of the channels that ensure inclusiveness in any society. Education trains people to think more logically and supports them to make more accurate decisions. Regarding universal literacy, schooling, school-pupil retention, and infrastructure, Kerala's performance is outstanding compared to India. The following sections aim to make a quick assessment of the education field of Kerala. Achievements in education highlight the human development of that society.

3.5.1.1 Literacy

The most critical measure of a nation's level of human capital is literacy. Kerala has the highest literacy rate in the nation (94%), followed by Lakshadweep (91.85%) and Mizoram (91.33%), according to the 2011 Census of India. Kerala had a literacy rate of 47.18% in 1951. In 1951, there was a 22% gender disparity in literacy; by 2011, that difference had shrunk to 4.04%. The state ranks highest in terms of female literacy (92.07%), whereas Bihar has the lowest percentage (51.50%) (Census Report, 2011). Additionally, there is a slight variation in literacy levels among the districts of Kerala.

Kerala State Literacy Mission Authority (KSLMA) ensures and coordinates programmes to improve literacy and lifetime learning. The primary recipients of these programmes are those who are illiterate, neo-literate, dropouts from school, and those who are interested in completing their education (Economic Review, 2022). KSLMA programmes go beyond simple read-and-write exercises. It seeks to impart a fundamental understanding of a positive and healthy social existence. As a result, the government has also started social literacy initiatives in health, the environment, women, Kerala's Renaissance, the Indian Constitution, and online education. The table 3.7 shows the percentage of people enrolled in equivalency courses.

Table 3.7

Number of persons who enrolled in Higher Secondary and 10th equivalency courses in 2021 and 2022

Course		Female	Male	Transgender	SC	ST	Persons with disabilities	Total
Higher Secondary	2021	12,849	7,491	31	4,736	740	251	20,371
	2022	16,104	7,065	23	4,885	731	325	23,192
10th	2021	10,755	7,839	16	4,173	675	518	18,610
	2022	17,064	8,620	14	4,854	906	656	25,698

Source: KSLMA

3.5.1.2 School Education

There are 12972 schools in the state in 2021–2022. The government runs 36.2% of schools, 55.6% are aided and 8.2% are not (Economic Review, 2022). The state's 2022–2023 preliminary student enrollment ratios is 38.32 lakh, lower than the 38.68 lakh of 2021–2022 pupils. The lower primary portion shows this decline, which could be explained by the low birth rate in the state. In every sector, the number of students attending government-aided schools surpasses that of students attending government and unaided schools. Boys exceed girls in every industry and district. In 2022–2023, girls will make up 48.93% of all school pupils. In every district, there are more boys than girls. Kerala, however, has a gender discrepancy in enrollment that is relatively small.

3.5.1.2.1 Strength of SC & ST Students

Students from Scheduled Castes and Scheduled Tribes participating in schooling are a significant indication of social inclusion. As per the Economic Review of the state, in 2022–2023, there will be 9.82 per cent of students in the state who belong to the Scheduled Castes (SC). There are more SC and ST students in government schools than aided and unaided institutions. Statewide, government schools enroll 12.17% of students, government-aided schools enroll 9.40%, and private unaided schools enroll 3.67% of students.

ST students make up 1.86 per cent of all students enrolled in schools in 2022–2023. 3.34 per cent, 1.22 per cent, and 0.44 per cent of ST students attend government, government-aided, and unaided schools in 2022–2023, respectively. Just 3.25 per cent and 2.06 per cent, respectively, of

all SC and ST students in the state attend private, unaided schools. The remaining pupils are admitted to publicly funded and public schools. Of all ST pupils, 59.78% are enrolled in government schools.

3.5.1.2.2 **Dropout rate**

An increased enrollment rate indicates positive societal change. On the other hand, a higher dropout rate is not reasonable. For this reason, an analysis of the dropout rate is essential. Kerala has gained the distinction of having the lowest dropout rate among the Indian states. In Kerala, the percentage of students who dropped out of school in 2020–21 was 0.04%. 2018's Educational Statistics at a Glance report from the Ministry of Human Resource Development (MHRD) states that the average dropout rate in India is 4.13 per cent for elementary students, 4.03 per cent for upper primary students, and 17.06 per cent for secondary students. In Kerala, dropout rates in lower primary and high school classes are slightly higher than in upper primary. The highest dropout rate is among high school students.

On the other hand, from 0.22 per cent in 2017–18 to 0.05 per cent in 2021–22, the high school dropout rate has declined. This downward tendency is seen across all academic levels (Table 3.8). COVID-19 prevents access to data for 2020–21.

According to the Economic Review of the State (2022), Ernakulam (0.17%) and Idukki (0.11%) have the highest rates of lower primary dropouts. The districts of Kottayam (0.10 per cent) and Ernakulam (0.09 per cent) have the highest upper primary dropout rates. In the high school division, Idukki has the highest dropout rate (0.23 per cent), followed by Wayanad (0.18 per cent).

Over time, the percentage of dropouts among students who identify as SC or ST has significantly declined. The dropout rates for those in the SC and ST groups remain higher than those in the "others" group. However, in 2021–2022, the state's dropout rates for SC students fell to 0.04 per cent, while for ST students; they rose to 0.30 per cent.

3.5.1.3 Higher Secondary Education

In 2022, the state will have 2,077 higher secondary schools. Of these, 819 (39.4%) are government schools, 412 (19.9%) are unaided schools, and 846 (40.7%) are aided schools. In the

state, Malappuram district has the most higher secondary schools (248), followed by Thrissur (204), Ernakulam (209), and Malappuram district (209).

In 2021–2022, 83.87 per cent of students enrolled in higher secondary courses passed. 3 02,865 students were eligible for postsecondary education in 2022; 1 34,039 students were male, and 1 68,826 students were female. During that time, the pass rate for ST students was 48.92 per cent, while the pass rate for SC students was 59.11 per cent.

3.5.1.3.1 Vocational Higher Secondary Education

The state first provided vocational higher secondary education in 1983–1984. The state offers plus two vocational higher secondary education that prepare students for vertical mobility and wage, direct, or self-employment work. In 2022–2023, there will be 389 vocational upper secondary schools (VHSS) in the state, totalling 1,101 batches. Of them, the government employs 261, and nonprofit organisations employ 128. Most of the state's higher secondary vocational institutions are in districts such as Thiruvananthapuram (41) and Kollam (52). Of the students who took the VHS exam in March 2022, 81.85% were eligible for postsecondary education.

3.5.1.4 Higher Education

An essential factor in a society's progress is higher education. A valuable tool for promoting human development and advancing social, technological, and economic advancement is higher education. A society can evolve more effectively when higher-level knowledge is exchanged. A state must make higher education more accessible to everyone. Education reforms and more investment are crucial as Kerala strives to become a knowledge society.

While Kerala has consistently endeavoured to establish a broadly accessible and inclusive higher education system, it is becoming more apparent that substantial reforms are still required to enhance academic quality, equity, and inclusivity. The state's higher education system must also be modified to consider global trends and norms. Higher education institutions need to be suitably oriented in order to improve efficiency and responsiveness. Our higher education institutions must do more to help the state's economic growth as it moves towards a knowledge economy. This can be done by transferring technology, providing training, and conducting

results-driven research and development. Below is a detailed description of the higher education sector in the state.

3.5.1.4.1 Universities and Collegiate Education

Four of Kerala's 14 state universities—Kerala, Mahatma Gandhi, Calicut, and Kannur—are of a general nature. The other universities that offer specialised programmes in specific subject areas are Kerala Technological University, Kerala Agricultural University, Kerala Veterinary and Animal Science University, Kerala University of Health Sciences, Thunchath Ezhuthachan Malayalam University, Cochin University of Science and Technology, and Sree Sankaracharya University of Sanskrit.

Sree Narayana University, the first Open University in Kerala, was established in 2020 and is headquartered in Kollam. Its goal is to offer open education in various academic areas to all demographic groups. The Digital University, the nation's first university, was established in 2020 to pursue academic programmes and research in novel fields of knowledge and cutting-edge digital technology. Founded in 2005, NUALS is the sole state-run university offering legal education. Furthermore, the state is home to a central university in Kasaragod District. The state has several other notable national universities, including AIISER Trivandrum, IIM Kozhikode, and IIT Palakkad.

3.5.1.4.2 Arts & Science Colleges

The state has 229 arts and scientific colleges, comprising 163 government colleges and 66 government colleges, according to data available for 2021–2022. In addition, the state is home to many autonomous, self-financing arts and science colleges connected to universities. The districts of Ernakulam and Thiruvananthapuram have the highest concentration of arts and scientific colleges in the state, with 26, followed by Kottayam with 24. The two largest government colleges are in Kozhikode and Thiruvananthapuram (10).

3.5.1.4.3 Enrolment Details

In 2021–2022, a total of 3.48 lakh students enrolled in different courses offered by Kerala's four general universities at arts and scientific institutions (apart from independent colleges). Out of this, 2.27 lakh (or 65.4%) are female. [Table 3.8]

Table 3.8: Enrolment of Students in Arts and Science Colleges in number and per cent

Course	Total	Girls	Boys	per cent of Girls
B. A.	1,44,461	93,234	51,227	64.5
B.Sc.	1,10,552	74,970	35,582	67.8
B.Com.	47,580	29,910	17,670	62.9
Total	3,02,593	1,98,114	1,02,347	65.5
MA.	16,939	10,933	6,006	64.5
MSc.	20,919	13,241	7,678	63.3
M.Com.	7,106	4,947	2,159	69.6
Total	44,964	29,121	15,843	64.8
Grand Total	3,47,557	2,27,235	1,20,322	65.4

Source: Directorate of Collegiate Education

According to the table, of all students enrolled in degree programmes, 47.7% are enrolled in B.A. degree programmes, 36.5% in B.Sc. degree programmes, and 15.7% in B.Com. Degree programmes. Sixty-five per cent of degree course registrants are female.

There are 27 subjects available for B.A. degree programmes in terms of courses. Most students are enrolled in English, followed by Economics among them. There are 31 topics available in B.Sc. programmes, with Physics having the most student enrollment, followed by Mathematics. In 2021–2022, 23,109 students were admitted to postgraduate programmes. Girls make up as much as 65.6% of students enrolling in postgraduate programmes.

3.5.1.4.4 SC- ST Students

32,242 Scheduled Caste (SC) students were enrolled in degree and postgraduate programmes in 2021–2022, making up 9.28% of all students. In 2021–2022, 8,053 Scheduled Tribe students were admitted to graduate and undergraduate programmes in the state, making up 2.32 per cent of all enrolled students.Table 3.9 displays the percentage distribution of SC/ST students.

Table 3.9: Percentage of SC and ST students in higher education in Kerala in 2021-22

Course	Total	% of SC	% of ST	% of Others
BA	100	7.75	2.41	89.84
B.Sc	100	11.66	1.09	87.25
B.Com	100	8.41	2.13	89.46
Total	100	9.28	1.88	88.83
MA	100	9.09	6.25	84.66
M. Sc	100	8.51	3.86	87.63
M.Com	100	11.67	6.91	81.42
Total	100	9.23	5.24	85.53
Grand Total	**100**	**9.28**	**2.32**	**88.41**

Source: Directorate of Collegiate Education

3.5.2 Health

A sound healthcare system ensures a strong economy and society. A society's well-being heavily depends on its people's mental and physical well-being. Many factors support the healthcare system of a society, including the accessibility and affordability of healthcare services. Infrastructure in the medical field, awareness of the public and expenditure determine the accessibility and affordability of healthcare services. Therefore, the role of government is crucial. The features of Kerala's health sectors are analysed in the following section.

3.5.2.1 Health Sector

The main objectives of the state's public healthcare system are to provide high-quality, affordable, accessible, and equitable healthcare services. The state continues to dominate the country in these areas, according to indicators like life expectancy at birth, infant mortality, maternal mortality, and the ratio of males to females. All crucial national health metrics place Kerala at the top of the list. The NITI Aayog's State Health Index for 2019–20 shows that Kerala is the best state in the central region, with an overall score of 82.2, ahead of Tamil Nadu (72.4) and Telangana (69.96). Issues related to mental health, substance misuse, teenage health, and the pervasive problem of traffic accidents are currently receiving increased attention from state policy. The health of particular groups of people is also given special consideration under governmental programmes, such as members of Scheduled Castes and Scheduled Tribes, fishers, plantation workers, and others.

Kerala is currently facing several new health problems, including diseases brought on by environmental degradation, an increase in accidents and injuries, and the recurrence of infectious diseases. The state faces severe problems with leptospirosis, COVID-19, dengue, chikungunya, and other infectious diseases. The enormous COVID-19 pandemic epidemic has impacted the state's entire health system network. The state's general health is also at risk from other problems, such as mental health disorders, suicide, drug and alcohol abuse, adolescent health, and an increase in traffic accidents, all of which are now significant concerns. To address these issues, practical inter-sectoral cooperation and dedicated, focused efforts are required. During the 14th Five-Year Plan period, the state aims to offer the best palliative, curative, and preventive care to the general public (Economic Review of Kerala, 2022). Creating a citizen-friendly healthcare delivery system is the government's primary objective.

3.5.2.2.Indicators of Health

The following sections discuss the status of significant health indicators of the State.

3.5.2.2.1 Life Expectancy:

The life expectancy of a society's population is the most critical indicator of its quality and well-being. Out of all the Indian states, Kerala has the longest life expectancy. The state has a greater life expectancy at birth—75—than the average for the country, which is 70. Kerala still has the most excellent life expectancy rates for both sexes (71.9 for men and 78.0 for women) compared to the national averages of 68.6 for men and 71.4 for women (see Table 3.10). Women in the state can expect to live longer on average (78 years) than men (71.9 years).

Table 3.10: Demographic and health profile of Kerala as compared to India

Sl. No.	Indicators	Kerala	India
1	**Total population (in crore) (Census, 2011)**	3.34	121.06
2	**Decadal growth (per cent) (Census, 2011)**	4.90	17.7
3	**Sex Ratio (Census, 2011)**	1084	943
4	**Child Sex Ratio (Census, 2011)**	964	919
5	**Birth Rate**	13.2	19.5
6	**Death Rate**		
	(a) Children (0-4)	1.8	8
	(b) Children (5-14)	0.5	0.4
	(c) Persons (15-59)	2.7	2.9
	(d) persons (60 and above)	39.1	42.3
7	**Natural Growth Rate**	6.2	13.5
8	**Per cent of deaths receiving medical attention**		
	Government	43.3	29.9
	Private	37.4	18.9
	Qualified professional	16.0	33.2
	Untrained/others	3.4	18.0
9	**Still Birth Rate**	4	3
10	**Crude Birth Rate**	13.2	19.5
11	**Maternal Mortality Ratio**	19	97
12	**Expectancy of Life at Birth**	75	70
	Expectancy of Life at Birth– Male	71.9	68.6
	Expectancy of Life at Birth– Female	78	71.4

Source: SRS Statistical Report 2020

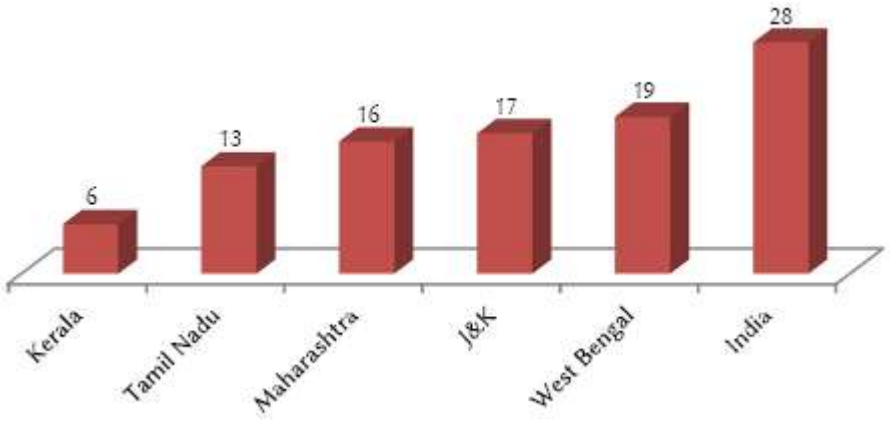
3.4.2.2.2 Maternal Healthcare

The maternal mortality ratio, or MMR, primarily determines maternal health. Table 3.10 shows that Kerala has the lowest MMR (19) out of all the states, whereas the federal MMR is 97. Southern states have similarly low MMRs. The average death rate in the nation is less than 25% and can be attributed to subpar medical care. In Kerala, the probability of a death where the deceased received medical care prior to passing away—either in a public or private hospital—is 80.7%, compared to 48.7% nationwide. Kerala continues to have a higher birth rate than the national average. This could be because Kerala, where institutional deliveries account for most births, has improved data collection. Furthermore, the country's fertility rates are lower than average. In Kerala, just 0.1 out of every 7.8 live births occur without a mother receiving medical attention from a licenced practitioner.

3.5.2.2.3 IMR

The infant mortality rate (IMR), which is 28 at the national level, is just six in Kerala. Figure 3.6 lists the top five States with low IMR.

Figure 3.6: Top 5 States with lowest IMR



Source: SRS Report May 2022

The state's Neo-Natal Mortality Rate (NNMR) is Four and a half times less than the national average (20). Out of all India's statistics, the under-five mortality rate (under five MR) stands at eight, which is also one-fourth (32). The rates for Perinatal Mortality (PNMR), Early Neo-natal Mortality (ENMR), Late Neo-natal Mortality (LNNMR), and Post Neo-natal Mortality (PNNMR) are significantly lower than those for India. 82.6 per cent of mothers in India receive medical care from trained experts at the time of delivery—a figure that stands at 99.9 per cent in Kerala—at either government or private hospitals, which is a significant contributing factor to these accomplishments. Table 3.11 provides information on the child mortality rate at various levels and the proportion of live births in Kerala, where mothers receive medical care from certified professionals.

Table 3.11

Details of child mortality rate at different levels and percentage of live births getting medical attention of qualified professionals received by mothers in Kerala

Sl. No	Indicators	Kerala	India
1	Infant Mortality Rate	6	28
	Infant Mortality Rate – Male	10	28
	Infant Mortality Rate – Female	3	28
2	Neo-Natal Mortality Rate	4	20
3	Perinatal Mortality Rate	8	18
4	Child Mortality Rate	2	8
5	Under-five mortality Rate	8	32
6	Early Neo-natal Mortality Rate	4	15
7	Late Neo-natal Mortality Rate	0	5
8	Post Neo-natal Mortality Rate	2	8
9	Crude Death Rate	7	6
10	Percentage of live births by type of medical attention received by mothers		
	Government	44.7	54.6
	Private	55.2	28
	Qualified professional	0.1	9.7
	Untrained/others	0.1	7.8

Source: SRS Statistical Report 2020

3.5.2.2.4 Fertility Rate

The National Family Health Survey 2019–20 (NFHS–5) indicates that among women in Kerala who are 25–49 years old, the median age at first marriage is 21.5 years. Six per cent of women in their 20s and 30s married before they reached the legally required age of 18. Compared to 35.9% of men in the same age range, only 10.2% of women have never married. In Kerala, the total fertility rate (TFR) expressed per woman is 1.5, but across all of India, it is two.

3.5.2.3 Financing of Health Sector

The State Budget has made substantial investments in the health sector. Over the past few years, government spending on healthcare has climbed considerably. Kerala, excluding the contribution of Local Self Governments and other line departments, spends 6.21% (1,887.13 crore in 2022-23) of its total State Plan budget (30,370 crore in 2022-23) on health care. The Sixth State Finance Commission recommended that the Local Self Government Institutions (LSGIs) receive

26.5% (₹8,048 crore) of the total State Plan outlay. A sizeable portion of Local Self Government Institutions' budget goes towards health care.

Furthermore, the government is making significant investments in this field through KIIFB and NABARD support for the construction and acquisition of expensive machinery. ₹3,31,888 lakh (BE) was allocated for programmes during the 12th Five-Year Plan. The entire amount spent during the Plan period was ₹3,00,600.50 lakh or 90.57%. The health sector was allotted ₹7,19,929 lakh for the 13th Five-Year Plan, and the reported expenditure was ₹9,10,077 lakh (126.41 per cent). Table 3.12 lists the department-by-department plan outlay and expenditure for the final four 13th Plan Annual Plan periods, as well as the total outlay and expenditure for the first 14th Plan year up to October 2022 (2022–2023).

Table 3.12

Department-wise outlay and expenditure

Department	**Annual Plan2018-19**		**Annual Plan2019-20**		**Annual Plan2020-21**		**Annual Plan2021-22**		**Annual Plan 2022-23 (Exp. upto October 31)**	
	Outlay	%Exp.	Outlay	%Exp.	Outlay	%Exp.	Outlay	%Exp.	Outlay	%Exp.
Health Services	789.21	84	783.29	82	991.40	135	991.40	206	1297.76	71
Medical Education	494.14	56	484.25	72	420.60	77	420.60	111	463.75	20
Indian Systems of Medicine	48.20	70	47.55	67	41.95	120	41.95	91	44.05	29
Ayurveda Medical Education	50.60	51	49.75	41	43.20	39	43.20	62	47.52	6
Homeopathy	27.00	100	26.60	65	23.75	85	23.75	104	25.15	21
Homeo Medical Education	10.15	100	10.00	68	8.65	170	8.65	129	8.90	31
Total	**1419.30**	**73**	**1405.94**	**76**	**1529.55**	**115**	**1529.55**	**170**	**1887.13**	**55**

Source: Economic Review of Kerala, 2022

Over the past five years, health-related spending has climbed for plans and non-plans. Revenue and capital expenditures were made in health and family welfare between 2017–18 and 2021–2022, both through plans and non-plans. Table 3.13 shows the percentage of health expenditure to total government expenditure and the percentage of health expenditure to GSDP.

Table 3.13: Investment in Health and Family Welfare (₹ in crore)

Year	Total Government Health Expenditure			Total Government Expenditure	Percentage of Health Expenditure to total Government Expenditure	GSDP in crore at constant Prices	Percentage of Health Expenditure to GSDP
	Plan	Non-Plan	Total				
2017-18 (ACC)	1862.95	4618.85	6481.79	110237.81	5.88	516189.76	1.26
2018-19 (ACC)	1862.76	5235.8	7098.56	120069.82	5.91	554228.31	1.28
2019-20 (ACC)	2246.61	5292.21	7538.81	114384.94	6.59	559194.18	1.35
2020-21(ACC)	3144.73	5657.63	8802.36	138884.49	6.34	512076.08	1.72
2021-22 (RE)	3808.37	8289.37	12097.7	164800.19	7.34	573591.46	2.11

Source: Economic Review of Kerala, 2022

3.5.2.3.1 National Health Estimates (2018-19)

The Ministry of Health and Family Welfare released a report of the National Health Accounts (NHA) Estimates for India for 2018-19. Health Accounts describe health expenditures and the flow of funds in the health system over a financial year. It included the flow of funds in the country's Government and Private sectors. The NHA estimates for 2018-19 show that there has been an increase in the share of Government health expenditure to the total GDP of the country. It has increased from 1.15 per cent in 2013-14 to 1.28 per cent in 2018-19. Total Health Expenditure (THE) constitutes current and capital expenditures incurred by Government and Private Sources, including External funds. Health account estimates of Kerala compared to India are given in Table 3.14.

Table 3.14

Health accounts estimate of Kerala compared to India 2018-19

Sl. No.	Indicator	India	Kerala
1	Population in crore	133.42	3.5
2	Gross Domestic Product (GDP)/Gross State Domestic Product (GSDP) in crore	18899668	790302
3	Government Health Expenditure (GHE) ₹ in crore	242219	8676
4	Government Health Expenditure (GHE) as % of GSDP	1.28	1.1
5	Government Health Expenditure (GHE) as % of GGE	4.81	7.4
6	Government Health Expenditure (GHE) % THE	40.6	25.1
7	Government Health Expenditure (GHE) per capita in ₹	1815	2479
8	Government General Expenditure (GGE) in crore	5040707	117747
9	Total Health Expenditure (THE) in crore	596440	34548
10	Total Health Expenditure (THE) Per capita in ₹	4470	9871
11	Total Health Expenditure (THE) % of GDP	3.16	4.4
12	Out of Pocket Expenditure (OOPE) in crore	287573	23702
13	Out of Pocket Expenditure (OOPE)% of THE	48.2	68.6
14	Out of Pocket Expenditure (OOPE) % of GSDP	1.52	3
15	Out of Pocket Expenditure (OOPE) Per capita in ₹	2155	6772

Source: National Health Estimates (2018-19)

3.5.2.4 Health Problems

The prevalence of both communicable and non-communicable diseases is rising in Kerala. The occurrence of dengue, leptospirosis, malaria, hepatitis, H1N1, scrub typhus, and COVID-19 in recent years has resulted in significant morbidity and mortality despite the state's prior success in eliminating several infectious illnesses. Numerous districts have reported cases of vector-borne illnesses like dengue, malaria, and scrub typhus. Numerous districts have also reported cases of waterborne infections, including hepatitis, typhoid, and various diarrheal illnesses.

3.5.3 Trends in Human Development

Kerala has been the top-ranked state in India for human development indices. In terms of life expectancy, infant mortality, healthcare access, and literacy rates, the state has scored highly. In both 2018 and 2019, Kerala led all Indian states in making progress towards the UN Sustainable Development Goals, according to Niti Aayog's SDG India Index. The state has also continued to dominate on many excellence indicators. Kerala experiences a high level of human development comparable to global standards. Table 3.16 shows that the disparity between the districts in the case of human development achievements is very nominal in the state.

Table 3.15: District-wise Human Development Index Distribution in Kerala

District	HDI (2017)
Thiruvananthapuram	0.773
Kollam	0.787
Pathanamthitta	0.795
Alappuzha	0.794
Kottayam	0.796
Idukki	0.754
Ernakulam	0.801
Thrissur	0.794
Palakkad	0.761
Malappuram	0.749
Kozhikode	0.781
Wayanad	0.753
Kannur	0.783
Kasaragod	0.760
Kerala	0.773
Coefficient of Variability (%)	*2.44*

Source: Chattopadhyay, 2021

3.6 Conclusion

The analysis of the nature and pattern of the development of Kerala shows that the state's achievements in various dimensions of development are remarkable. Though the state's economic growth was below the national average in the first phase, it has now advanced to one of the high-income states of the country. The composition and performance of various economic sectors show that the state's tertiary sector is more prominent than the other two sectors. While considering the state's socio and human development achievements, it is evident that the state had an excellent infrastructure to deliver services on education and health to the public. In the case of human development, the state stands first among the Indian states with attainments comparable to developed countries. However, consider the development issues of Kerala's economy. In that case, there exists a paradoxical situation where the achievements in education and social and political consciousness of the people never reflect in issues like environmental exploitation.

Chapter 4

THE ENVIRONMENT OF KERALA

- ***Features of the Environment of Kerala***
- ***Development and Environment Retrospect***
- ***Impacts of Economic Growth on the Environment***
- ***Factors Contributing to the Environmental Pressure***
- ***Mineral Resources in Kerala***
- ***Quarrying in Kerala***

Chapter 4
The Environment of Kerala

4.1 Introduction

Man and his life depend on the natural world, and so is development. In the early stages of his life, he was similar to every other animal on this planet. However, when he stopped wandering and preferred a settlement, he started to modify his environment. Initially, it accidentally happened for food and shelter, but later, this modification continued intentionally to satisfy other nonessential needs. In the different phases of human history, his materialistic needs were different. He practised four modes of resource use; "gathering, nomadic pastoralist, settled cultivation and industrial and these modes were varied in nature by technology, economy, social organisation and of ideology" (Navath, 2012). As with everywhere in the world, India's industrial mode of resource use started with colonialisation. The land use pattern and mode of resource use in Kerala can be broadly classified into the early, colonial, and modern phases (Navath, 2012). In the early phase, we followed a balanced use of resources. Whereas the colonial phase drastically changed the environmental set-up of Kerala. Consumerist mode of resource use started in the Modern Phase (Navath, 2012). Our concept of development needs an abundant supply of resources to satisfy its goals. Thus, the evolution of human settlement and the dependence on resource use have moved progressively.

To analyse the cause-and-effect relationship between development and the environment, along with the understanding of the state's economic status, an enquiry into the status of environment of Kerala is also needed. Therefore, the present chapter includes discussions on the features of state’s environment, development and environment retrospect, impacts of economic growth on the environment, significant factors contributing to the environmental pressure, minerals resources in the state, the status of quarrying in Kerala, and quarrying and natural disasters.

4.2 Features of Environment of Kerala

Kerala is among the Indian states where the relationship between development and the environment has an indispensable effect on life, society, and governance. Because of the state's distinct topography and climate, its landscapes and ecosystems are exceptional in many respects. Kerala is one of the world's and the nation's unique hotspots for biodiversity. It has all three

habitats that are most productive and rich in biodiversity: freshwater and brackish wetlands, marine coral reefs, and tropical rainforests. Due to the state's growing population density and development requirements, Kerala's environment and natural resources have been under increasing strain over time. The dire repercussions of this pressure are becoming more and more apparent. Kerala development must make sure that environmental demands are kept within the limits of the planet's capacity to support both current and future generations, making the most of ongoing scientific and technical advancements (KDR, 2021).

Kerala is distinct from its adjoining states both in its physical geography as well as human geography. As a narrow strip of land between the Arabian Sea to the West and the Western Ghats to the East, Kerala occupies parts of the Western Ghats and adjoining Coastal Plain along with the South Western corner of the Indian Peninsula. The patterns of human settlement and the social, cultural, and economic development of Kerala have been significantly influenced by its geographical features, particularly its latitudinal position, orography, and placement of the sea and mountains (Chattopadhyay, 2020).

4.2.1 Landforms Zones of Kerala

Kerala's three well-identifiable landform zones with distinct geomorphic processes are the Western Ghats, the Coastal Plain and the Intermediate Undulating Lateritic Terrain (ULT), connecting these units to the east and west.

4.2.1.1 Western Ghats

The Western Ghats occupying the eastern part of Kerala form the southern segment of the Sahyadri or the Great Indian Escarpment. Composed mainly of the Precambrian crystalline rocks and structurally controlled, this important geomorphic feature of Peninsular India overwhelmingly impacts Kerala's environment, economy, and culture. The Western Ghats, the provenance of all rivers, is a biodiversity hotspot and houses plantations of cardamom, tea, coffee, and a host of other hill products. Dense tropical evergreen and semi-ever-green forests occupy the plateau's steep scarp slopes and portions. The Western Ghats is composed of several structural blocks with varying lithology. The evolutionary process is likely not uniform throughout the Western Ghats, and therefore, the resultant landforms record variations.

4.2.1.2 Undulated Lateritic Terrain

Undulated Lateritic Terrain (ULT) connecting the Western Ghats and the Coastal Plain is a subdued terrain evolved through sedimentation, lateralisation and parallel slop retreat, valley formation, and expansion of aggradational plain. Laterite has developed as a cap on all types of rocks, including recent sediments. These lands are unsuitable for regular cultivation due to the hard crust cap. Narrow alluvial valleys indented into laterite landscapes give rise to undulated landforms, where ridges and slopes are lateritic and valleys are alluvial. The alluvial valleys have developed along the east-west, running rivers and streams, cutting the lateritic plane mostly along weaker zones like lineaments. Around 60 per cent of Kerala's landmass is lateritic. Plantation crops like cashew, rubber, coconut, other tree crops, tapioca, and pepper grow well in laterite areas.

4.2.1.2 Coastal Plain

The Malabar Plain, known as the Kerala Coastal Plain, stretches between Mangalore and Kanniyakumari. It is much broader than the plain of Karnataka and low-lying. The presence of lakes, lagoons, backwaters, spits, and other features characterises the Kerala coast. Backwaters, or kayals in the local language, are shallow sea inlets or lagoons that run parallel to the coastline. The largest of these is Vembanad Lake, which is 55 km long and has a 5-10 km spit extending for 75 km.

4.2.2 Environmental Governance in Kerala

To establish a balance between human involvement for developmental purposes and environmental sustainability, environmental governance is crucial. India passed the Environment (Protection) Act in 1986 to guarantee the improvement and protection of the environment. It grants the Central Government the power to establish organisations tasked with preventing environmental pollution in all its forms and dealing with specific environmental problems peculiar to various parts of the country. The Act was last changed in 1991. Consequently, in order to supplement and enhance the National Strategy and Policy, a State Policy Statement was mandated.

In 2009, the Kerala Environment Policy was established. In order to maximise the standard of living for everyone in the state, reduce environmental damage, and increase the state's economy, conservation and development can be accomplished simultaneously within the framework provided by this policy paper. The Haritha Kerala Mission, which the current Keralan government created explicitly to increase environmental awareness and action, has been one of its significant accomplishments. The Haritha Keralam programme, which, serves as a catch-all phrase for a wide range of regional efforts, has upped the bar for raising environmental consciousness in the nation. However, if other government departments and agencies specialised adequately in their tasks in environmental protection, the Mission's reach and environmental activity in general in the state would be significantly increased. Unfortunately, there is still much overlap, going beyond the silo-based thinking model where everyone is involved in everything. Specialisation and defining specialised roles are paramount to effective environmental action is to be taken.

4.2.3. Environmental Regulation in Kerala:

This section deals with some specific aspects of environmental regulation in the State of Kerala.

4.2.3.1 Ban on Single-Use Plastic

The state will outlaw single-use plastic starting on January 1, 2020. With the Plastic Waste Management Rules (2016), the State Government imposed stringent limitations on the usage and sale of plastic carry bags that are less than 50 microns in order to aid in the collection and recycling of such plastic. The State Government has already begun setting up the facilities needed to collect, sort, and dispose of all types of garbage, including plastic waste. However, excessive and careless use of plastic still causes risks to the environment and human health. Most plastic waste is dumped in rivers and other bodies of water, making recycling complicated. The biological system and marine ecosystem, in particular, have suffered significant damage. After the Kerala floods, the dire situation was more evident than ever. On the lakes and ocean beaches, mountains of plastic trash had washed ashore. The government established a Technical Expert Committee to compile a list of plastic products that would be outlawed and recommend alternatives. The Expert Technical Committee recommended a partial ban on some commodities,

such as PVC and flags, in its report, which was delivered to the government. It has also suggested implementing a return-and-earn programme to check use of numerous other things.

4.2.3.2 Measures to Monitor Air Quality

At 34 sites across the state, the Kerala State Pollution Control Board monitors the ambient air quality. The National Ambient Air Quality Monitoring Programme (NAMP) is responsible for 28 stations. It contains the four new stations Thiruvalla (Pathanamthitta), Kuttipadam (Ernakulam), Perinjadoor (Thrissur), and Kalpetta (Wayanad), all of which were created in 2019. Seven stations are participating in the State Ambient Air Quality Monitoring Programme (SAMP), including a new station opened in Moovattupuzha in 2019. At each of the 19 Air Quality Monitoring stations during 2018–19, a PM 2.5 sampler was deployed. In 2019–20, seventeen RDS and PM 2.5 samplers were bought to monitor ambient air quality and eight for determining microbalance. District offices in Thiruvananthapuram, Alappuzha, Ernakulam, Wayanad, Kannur, Perumbavoor, Kollam, and Thrissur have the latter installed. At Kozhikode (one station) and Ernakulam (two stations), the Kerala State Pollution Control Board developed and inaugurated Continuous Ambient Air Quality Monitoring Stations (CAAQMS). The Board established and inaugurated CAAQMs in Kollam, Thrissur, and Kannur in 2019–20. Numerous ambient air quality measures are regularly tracked and shown to the general audience.

4.2.3.3 Measures to Monitor Water Quality

Under the National Water Quality Monitoring Programme (NWMP), 128 water quality monitoring stations operate. 72 stations in 48 rivers (major, medium, and small rivers), as well as six reservoirs, three freshwater lakes, eight estuary lakes, three canals, two ponds, and 34 groundwater stations, are included in this program. The State Water Quality Monitoring Programme (SWMP) is active at 115 stations, including 23 stations in rivers and four lakes, and 23 stations. River Pamba, River Karamana, River Periyar, River Bharathapuzha, River Vamanapuram, and River Kadalundi are some rivers that have high Biochemical Oxygen Demand (BOD) values (especially during the Sabarimala festival seasons). There have been reports of highly high coliform counts at Munnattumukku in the Karamana River, Kallayi Bridge in the Kallayi River, the Pamba River, Purakatteri in the Korapuzha River, the Thodupuzha River, and the Munnar River. Periyar has the greatest BOD (higher than 2013 values) regarding

rivers. BOD levels in the Bharathapuzha and Chalakudy rivers rose from 2013 to 2014. BOD levels in Achenkovil, Kallada, and Pamba rivers are lower than in 2013.

4.2.4 Biodiversity in India and Kerala

India has performed well in raising public knowledge of biodiversity, which is the main goal of many government initiatives. India is pursuing a number of initiatives and plans in an effort to achieve equitable economic growth while protecting the integrity of its natural resources. With around 7-8% of the world's recorded species and 18% of the world's human population living on a measly 2.4% of the planet's surface area, India is a mega-diverse nation whose ability to feed its human population depends heavily on its natural capital.

India has invested much in biodiversity directly and indirectly through several state- and federally-funded development initiatives. This comes up to an annual sum of Rs. 70,000 crores instead of the approximate Rs. 1,09,000 crores needed. India is home to almost two-thirds of the world's wild tiger population. Over 520 lions, up from 177 in 1968, and 30,000 elephants, up from 12,000 in the 1970s, were counted in 2015. The 2400+ one-horned Indian rhinoceroses were at risk of extinction at the beginning of the 20th century. Furthermore, of the recorded species in India, just 0.08% are classified as highly endangered, whereas the global average is roughly 0.3%.

Most of India's destitute rural and semi-urban residents live in the desert, semi-arid, or dry sub-humid parts of the nation. Research has repeatedly shown that the rural poor, especially women, are severely impacted by environmental degradation's effects on soil fertility, water quantity and quality, air quality, forests, wildlife, and fisheries. Even though it is well understood that biodiversity must be preserved, there is still much to learn about the advantages biodiversity has for the economy and ecosystem, as well as the best ways to value and enhance it. This kind of ambiguity is common in Kerala and even India.

4.2.4.1 Biodiversity Management Committees (BMCs) in Kerala

BMCs were established in all Panchayats, Municipalities, and Corporations in 2012 by the KSSB. In 2015–16, BMCs were reconstituted following the local body elections. Block Panchayats and District Panchayats of the state's remaining upper two Panchayati Raj levels

were the first to establish BMCs during 2019–20. In December 2019, the process of the BMC constitution in 152 Blocks and 14 district Panchayats was finished. The 13th Five-Year Plan sought to improve the BMC's ability to manage local natural resources sustainably through capacity building and policy support. Twenty BMCs were chosen in 2017–18, and throughout the reporting period, 28 model BMCs were chosen (two from each district), and they were given authority and funding for specific projects.

4.2.4.2 People's Biodiversity Register (PBR)

Kerala State Biodiversity Board (KSBB) and Technical Support Group (TSG) assisted in creating The People's Biodiversity Register (PBR), a comprehensive report on biodiversity. A total of 75 PBRs have been prepared for 2019–20. All 1034 local bodies, including 941 Grama Panchayats, 87 Municipalities, and six Corporations, finished the compilation of PBRs of the locality and related traditional knowledge prepared by BMCs with technical preparation.

4.2.4.3 Impact of flood

In 2018, the KSBB used BMC to assess how flooding affected biodiversity quickly. The floods impacted around 771 landscapes, including riverine, forest, plantations, and agricultural regions. Six hundred ninety-five different species of wildlife, 1053 different types of plants, and 287 different varieties of 457 different crops were impacted. Changes in land use in wetland areas, the removal of vegetation from riverbanks, construction projects on hillside slopes, and excessive quarrying were some of the major causes of the tragedy. Following this, the areas needing care were prioritised. Twenty-eight research on the effects of landslides and floods on biodiversity and ecosystems—with a focus on riverine rejuvenation—were given to universities and R&D centres throughout Kerala. The Periyar, Pamba, Bharathapuzha, and Chalakudy river areas have been given priority for recovery strategies as a result of this study. In a few places along the Pamba River, soil erosion has been managed and controlled. Riparian vegetation regeneration has been prioritised as part of rehabilitation in areas vulnerable to landslides.

4.2.5 Major Programmes

The Indian Constitution commands the States to "take measures to safeguard the environmental quality and to protect and improve the environment." It also establishes every citizen's obligation to save the environment, including forests, lakes, rivers, and wildlife. Through initiatives like *Paristhithikam* and *Bhoomitrasena* Clubs the Directorate of Environemnt and Climate Change in Kerala (DoECC) promotes environmental education and awareness. *Paristhithikam* concentrates on running activity- and awareness-focused initiatives to fight against air pollution. 369 BMCs operate in various educational institutes around Kerala to raise environmental awareness among students.

The following were the main projects the DoECC undertook in 2019–20:

- Various water bodies, including drinking water sources in the flood-affected areas, underwent water quality assessment procedures, and chosen BMCs determined their portability and appropriateness for use.
- Under the name "Paaristhithikam", focusing on "Combating Air Pollution," environmental education and conservation programmes were carried out throughout the state.
- To encourage sustainable energy use in the automotive industry, a project called "Grid-connected solar-powered charging station for electric vehicles" was started.
- Documents on wetlands, including (i) Kavvayi, (ii) Kattampally, (iii) Kadalundy, (iv) Kottuli, (v) Pookode, (vi) Ponnani estuary/Purathur, (vii) Chetuvai Kayal, (viii) Paravur, (ix) Centre produced Vellayani for Water Resources Development and Management (CWRDM) for State Wet Land Authority Kerala.

In order to raise public knowledge of the value of biodiversity and conservation, the Kerala State Biodiversity Board opened the Biodiversity Museum at Vallakkadavu, Thiruvananthapuram. The advancement of biodiversity education and extracurricular encounters with nature and the environment is greatly aided by biodiversity clubs. Throughout the year, 150,458 new biodiversity clubs were registered. In total, Kerala has 1715 registered biodiversity clubs. The Kerala Anti-microbial Resistance Strategic Action Plan (KARSAP) is being implemented in the state due to steps taken by the Kerala State Pollution Control Board.

4.3 Development and Environment Retrospect

In the early stages of human life, materialistic requirements were limited. The difference between the needs of man and other animals on the earth was very narrow. Though he started clearing forests for settlement and expanding cultivable land in the Megalithic Period, its scale and Impact on nature initially were narrower. Population and population density were very low compared to the present time. Thus, we can observe that the conquest of nature for development significantly started in the Colonial Period. Colonialism explains the advancement of production techniques, the mismatch between the requirements of man and raw materials, especially natural resources, and the resultant search for colonies to exploit natural resources. The Industrial Revolution of the 16th Century fuelled the development related to environmental imperialism.

The new developmental goals intensified man's dependence on the environment and natural resources. In our development concept, materialistic advancement and manmade infrastructure play an important role. Colonialism and related resource mobilisation from region to region, country to country or continent to continent, whether human or natural, demanded improved transportation, communication and all other infrastructure. All new demands had forward and backward linkages to additional exploitation of natural resources—the networks of demands to exploit natural resources expanded over time. Increasing population, population density, infrastructure and increasing demands added new demands. Moreover, the balanced use of resources turned to exploiting natural resources. As the pressure of demands increased, the man began to think about the planetary limitations, the problem of planetary capacity and the problem of resource exhaustion, and whether there is any limit to growth.

4.3.1 Infrastructure Development and Impact on Environment

Infrastructure development, especially manmade infrastructure development, constitutes the more significant portion of our developmental activities. Infrastructure development is a necessary condition for the well-being of the people. At the same time, a healthy environment is essential to enjoy the developmental outputs, sustainable human well-being and ultimately for survival or to prevent a mass extinction. Balancing the manmade and natural infrastructure is not an easy task. Here, in the case of manmade infrastructure, we should clearly define what is

necessary and what is unnecessary. Every animal on the planet depends on their natural environment for food, shelter and survival. However, unlike man, they live in the natural infrastructure, so their activities never disturb or alter their environment. Men need some additional infrastructure for a better life. To build a house or flat, commercial buildings, public buildings, roads, and bridges, we need a lot of natural resources like land, sand, water, stone, minerals and metals, along with human labour and technology. Most of these resources are non-renewable or exhaustible by nature. As the demand for infrastructure development increases, pressure on natural resources also increases. Overuse or exhaustion of these resources results in an imbalance of the natural environment. Therefore, balancing the mounting developmental needs and environment is a herculean task.

4.4 Factors Increasing the Environmental Pressure in Kerala

In the early development phase, Kerala attracted academic and public enthusiasm around the globe as a unique development experience. In contrast, Social Development happened before Economic Growth, against the traditional theoretical sequences of development. One of the exciting features of this first phase of social development is that it happened without much disturbing her environment or it was a sustainable phase of development. Later, with a 'turnaround' in its performance, it became one of India's high per capita income states (Kannan, 1990). Gulf migration of the 1970s and resultant foreign remittances have made significant and sudden changes in the developmental course of the state of Kerala. B.A. Prakash observed, "the migration and the flow of remittances had resulted in unprecedented economic changes in Kerala's economy since the mid-1970s" (Prakash, 1998). The Impact of migration can be pinpointed as follows:

- The outflow of skilled and unskilled labour from the Kerala Economy.
- The labour shortage in the construction sector of Kerala has been filled by interstate migration of labourers from other states, especially from Tamil Nadu.
- Shifting of Agricultural labourers to the construction sector.
- Upliftment in the Socio-economic conditions of low-income families of migrants.
- Changes in consumption pattern.
- Reduction in unemployment and substantial poverty reduction.

- Construction boom, speculation, land price increase, real estate growth.
- Hike in the prices and demand for building materials (most of them are natural resources) and construction induced high pressure on the natural environment.

With the betterment of economic growth, the consumption pattern of Kerala households changed drastically, especially of migrant families. Along with population density, urbanisation and changes in land use patterns, some of the effects as mentioned above, namely, changes in consumption patterns, a construction boom, speculation, increase in the land price, growth of real estate and hike in the prices of and demand for natural resources, increased the construction induced high pressure on the natural environment of Kerala.

Thus, the major factors that increased the pressure on the environment of Kerala can be listed:

1. Population Density
2. Urbanisation
3. Changes in Land Use Pattern
4. Changes in Consumption Pattern
5. The construction boom and Growth of Real Estate and
6. Construction-induced hikes in the prices of and demand for natural resources

These factors are discussed in the following sections.

4.4.1. Population Density

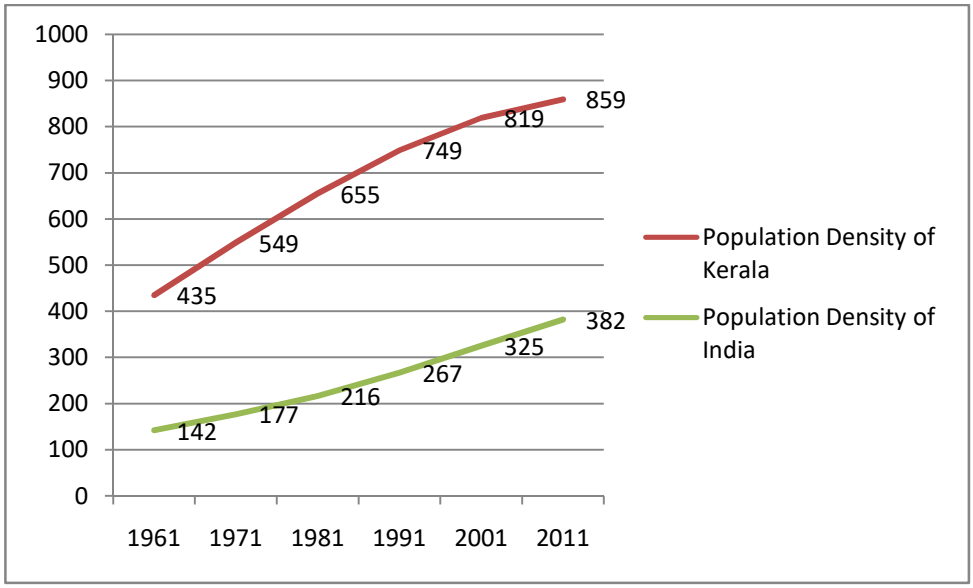
The relationship between population and environment is a significant issue due to its Impact on sustainable development, especially in developing countries (Ghanem, 2018). At least the demands of a growing population require a change in land use patterns and more natural resources. The loss of natural resources affects the quality of life of the people there. That means the high population density reduces the natural endowment per capita.

According to the available recent census data, Census of India 2011, the population of Kerala is 33 406 061, constituting 2.76% of India's population. However, it constitutes only 1.18% of India's total land area. The percentage of decadal growth rate of Kerala's population during 2001-2011 was 4.9%, the lowest among the Indian states. Among the state districts, Malappuram has the highest growth rate (13.4%), and Pathanamthitta has the lowest (- 3.0%). Idukki district also has seen a decline in population with a negative growth rate (- 1.8%). The population growth rate

is lower in six southern districts, namely Idukki, Kottayam, Alappuzha, Kollam, Pathanamthitta and Thiruvananthapuram than in other state districts.

Though the population growth rate is nominal, the state has a very high population density as a small geographical area. Kerala's population density as per 2011 Census is 860 persons per square kilometre. It is much higher than India (382). Thiruvananthapuram is the most densely populated district (1508), and Idukki is the least densely populated district. The population density has increased in all districts compared to 2001 except for Pathanamthitta and Idukki. Figure 4.1 compares the population density of India and Kerala in various years.

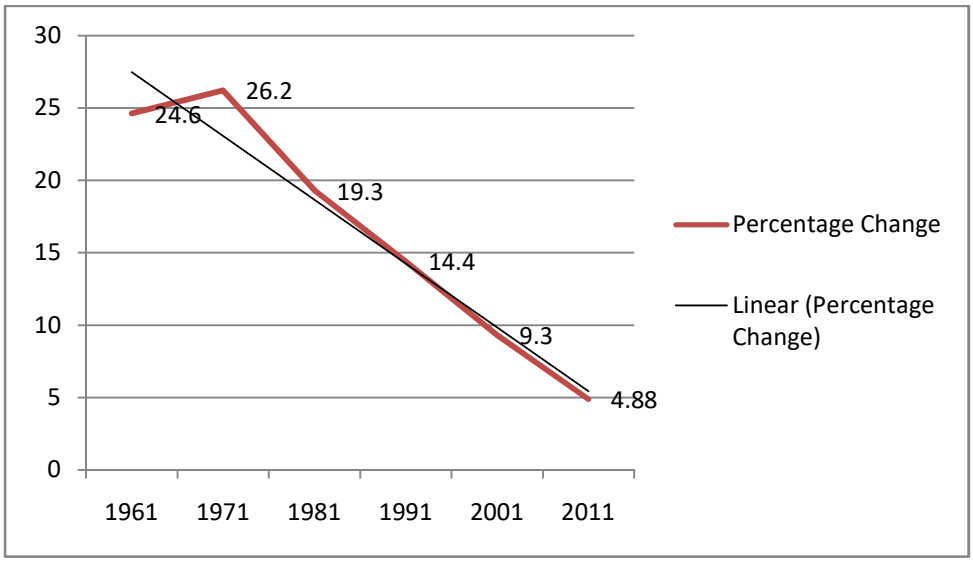
Figure 4.1: **Population Density in India and Kerala 1961- 2011**



Source: Census reports of various years, GOI

Figure 4.2 shows the percentage change in population density of Kerala between 1961- 2011.

Figure 4.2: Growth Rate of Population Density in Kerala



Source: Census reports of various years, GOI

The figure shows that though population density is high, the growth rate of population density shows a falling trend in Kerala.

Table 4.1: District-wise Population and Population Density

District/ State	Population			Population Density	
	2001	2011	Decadal Growth Rate	2001	2011
Kerala	3,18,41,374	3,34,06,061	4.9	819	860
Kasaragod	12,04,078	13,07,375	8.6	604	657
Kannur	24,08,956	25,23,003	4.7	812	852
Wayanad	7,80,619	8,17,420	4.7	366	384
Kozhikode	28,79,131	30,86,293	7.2	1228	1316
Malappuram	36,25,471	41,12,920	13.4	1021	1157
Palakkad	26,17,482	28,09,934	7.4	584	627
Thrissur	29,74,232	31,21,200	4.9	981	1031
Eranamkulam	31,05,798	32,82,388	5.7	1012	1072
Idukki	11,29,221	11,08,974	-1.8	259	255
Kottayam	19,53,646	19,74,551	1.1	885	895
Alappuzha	21,09,160	21,27,789	0.9	1492	1504
Pathanamthitta	12,34,016	11,97,412	-3	468	452
Kollam	25,85,208	26,35,375	1.9	1038	1061
Thiruvananthapuram	32,34,356	33,01,427	2.1	1476	1508

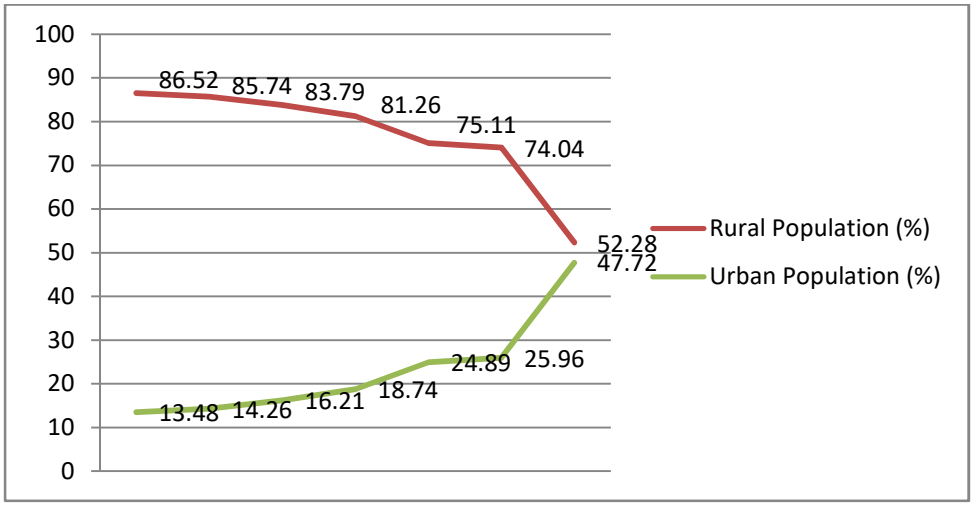
Source: Census report various years, GoI

4.4.2 Urbanisation

Urbanisation affects the physical environment through the impacts of the number of people, their activities, increased demands on resources, and reduced space. Urbanisation has negative consequences on health due to pollution and overcrowded living conditions. It can also put added pressure on food supply systems, extreme warmer and change in climate. Urbanisation contributes to environmental degradation because of the concentration of people in one geographical area, rapid use of resources, poor air and water quality, insufficient water availability, waste-disposal problems, and high energy consumption.

6.4 million People lived in Travancore, Cochin, and Malabar combined in 1901, with 5.9 million (92.2%) residing in rural areas. Merely 500,000 people, or less than 10% of the total, lived in metropolitan areas. The percentage of people living in rural areas has been falling over the past 100 years; in 2001, it comprised 74% of the overall population. Notably, the state's population was split nearly evenly between rural and urban areas in the 2011 Census. Currently, the state has 15.9 million people living in urban areas (47.7% of the total population), compared to 17.4 million living in rural areas (52.3%). Kerala's urban population grew at a decadal pace of 92.72% between 2001 and 2011. Kerala is considered the fastest-urbanising state in India and the fourth most urbanised state overall. Ernakulam (68.1%) has the highest population in cities, while Wayanad (3.8%) has the lowest.

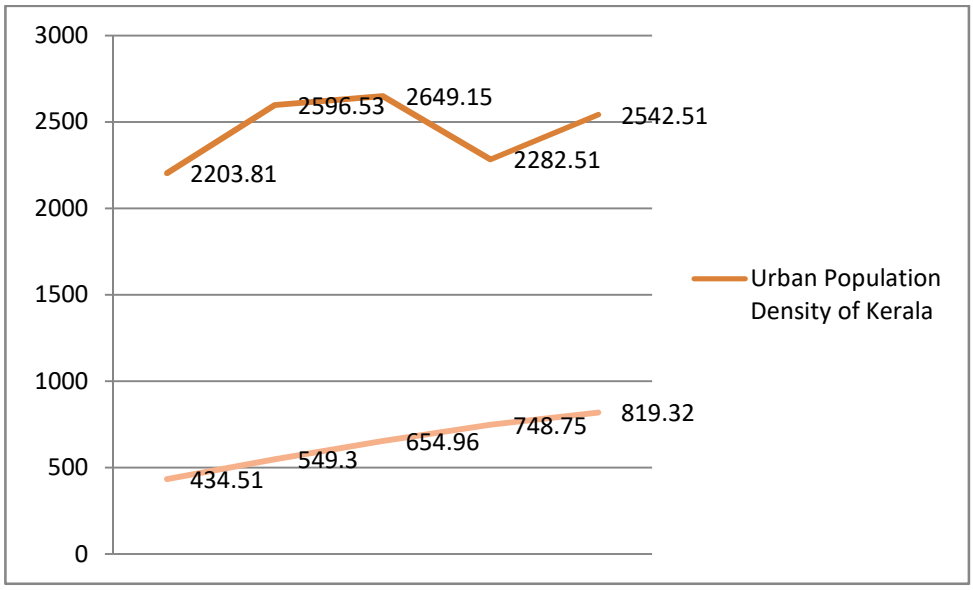
Figure 4.3: Percent Urban and Rural Population Kerala



Source: Census reports of various years, GOI

A comparison of trends in total and urban population density of Kerala is given in Figure 4.4.

Figure 4.4: Comparison of Trends in Total and Urban Population Density of Kerala



Source: Census reports of various years, GOI

The figure shows that urban population density is very high compared to the general population density in Kerala.

Kerala's growing urbanisation was demonstrated by the number of census towns in 2011. An area that does not have official town status but has achieved urban characteristics—that is, more than 5,000 people living there, a population density of at least 400 people per square kilometre, and at least 75% of working-age males employed in non-agricultural sectors—is classified as a census town. Kerala had sixty statutory towns and 99 census towns in the 2001 census. There are 461 census towns and 59 statutory towns as of the 2011 Census. This indicates that the number of census towns has increased by 366 per cent. In 2011, the districts of Wayanad and Idukki each had one statutory town but no census towns.

The rural population growth has been lowered to harmful levels due to this census town classification. Moreover, the estimated decadal population growth rate for the towns in the 2001 and 2011 Census is 3.90 per cent, less than the average decadal population growth rate for the state of 4.86 per cent. This disproves the notion that migration to towns or even natural growth is

the cause of the increasing urban population. Alternatively, the rise of census towns may be the primary cause of the urban population expansion. The state currently has 19 Urban Agglomerations. Kerala has a land scarcity. Therefore, more urbanisation comes at the expense of agricultural and ecological areas.

With 135 towns (statutory + census), Thrissur District has the most in the state and makes up almost 25% of all the towns in the state. The districts of Thrissur, Kannur, Ernakulam, and Kozhikode have almost 60% of the towns. Eight districts have more than one million people living in metropolitan areas. The top three are Ernakulam, Thrissur, Kozhikode, and Malappuram. When combined, the urban population of these four districts makes up over half of the state's entire urban population. All districts saw a positive decadal urban population increase between 2001 and 2011, except Idukki. The district with the most increase in urban population is Malappuram, followed by Thrissur, Kasaragod, and Kollam.

Regarding the state's overall population, Malappuram and Palakkad comprise about 25% of the rural population. In addition to the districts mentioned above, there are more districts where the population of rural areas surpasses that of urban areas: Kasaragod, Kottayam, Pathanamthitta, Kollam, Idukki, and Wayanad. In Wayanad and Idukki, about 95% of the population lives in rural areas.

Kerala's urban growth trends, the needs and aspirations of the growing urban population, and Policies/programmes to provide basic facilities to improve the quality of life in urban areas are becoming more and more of a challenge for the state. On the other hand, urbanisation presents a significant opportunity for economic development. Proper institutional coordination mechanisms in urban areas are essential to make the most of this.

In Kerala, 92% of people lived in rural areas in 1901, according to the Census. The percentage of people living in rural areas has been falling over time; in 2001, it accounted for 74% of all people. 52.3 per cent of the population was rural in the 2011 Census, while 47.7% lived in urban areas. In 2011, the urban population grew at a pace of 92.72% per decade. Kerala is considered the fastest-urbanising state in India and the third most urbanised state overall. Based on district-level data, Eranamkulam has the most significant percentage of urban population (68.1%). One

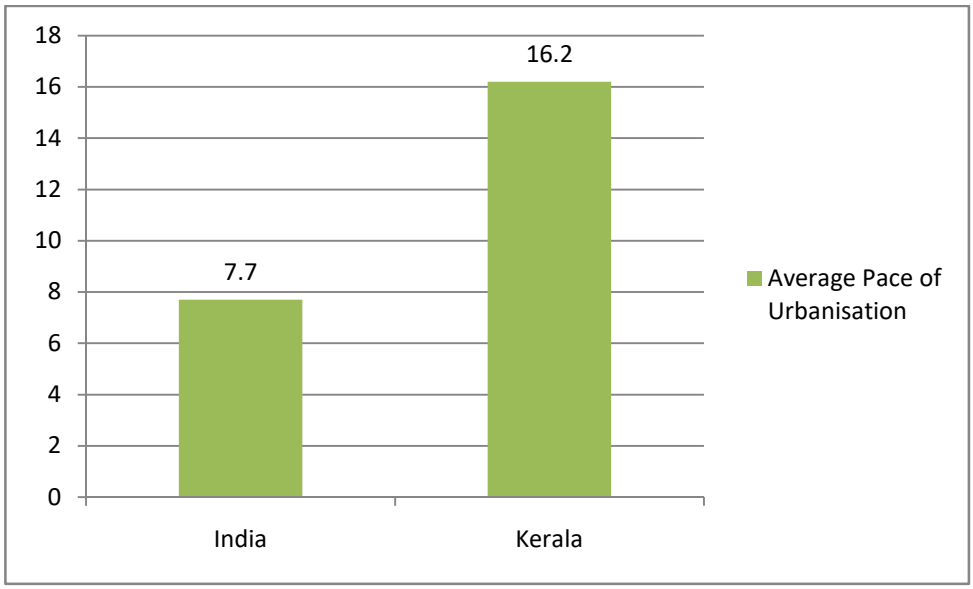
explanation is the rise of census towns. The increase of census towns in 2011 has resulted in a notable increase in the total number of towns.

Table 4.2: District-wise details of Change in Proportion of Urban Population in Kerala

District	Urban Population (Per cent)				Change in Proportion of Urban Population (Percent)		
	1981	1991	2001	2011	1981-91	1991-2001	2001-2011
Thiruvananthapuram	25.3	34	33.8	53.8	8.7	-0.2	20
Kollam	13.2	18.6	18	45.1	5.4	-0.6	27.1
Pathanamthitta		13.1	10	11	13.1	-3.1	1
Alappuzha	15.9	30.6	29.5	54.1	14.7	-1.1	24.6
Kottayam	9.5	17.6	15.4	25.6	8.1	-2.2	13.2
Idukki	4.6	4.7	5.1	4.7	0.1	0.4	-0.4
Ernakulam	39.6	48.8	47.6	68.1	9.2	-1.2	20.5
Thrissur	21.1	26.3	28.2	67.2	5.2	1.9	39
Palakkad	10.1	15.8	13.6	24.1	5.7	-2.2	10.5
Malappuram	7.4	9.1	9.8	44.2	1.7	0.7	34.4
Kozhikode	27.2	38.4	38.3	67.2	11.2	-0.1	28.9
Wayanad		3.4	3.8	3.9	3.4	0.4	0.1
Kannur	23.4	51	50.4	65.1	27.6	-0.6	14.7
Kasaragod		16.5	19.4	38.3	16.5	2.8	18.9
Kerala	18.9	26.4	26.4	47.7	7.5	-0.4	21.7

Source: Census Report Various Years, GOI

Figure 4.5: Average Pace of Urbanisation in India and Kerala



Source: Census Reports

Figure 4.5 shows the average pace of urbanisation in India and Kerala. The figure indicates that the pace of urbanisation is very high in Kerala compared to India.

4.4.3 Land Use Pattern

Changes in land utilisation reflect the link between the people and the environment. Higher population density and increased pace of urbanisation have changed the land utilisation pattern of Kerala over time. Land use change highlights the significant shifts in human interaction with the natural environment. Developmental needs of human beings and population pressure on land are the major causes of land use transformation (Jose & Padmanabhan, 2015). The table shows changes in land use patterns in Kerala from 1955-56 to 2020-21.

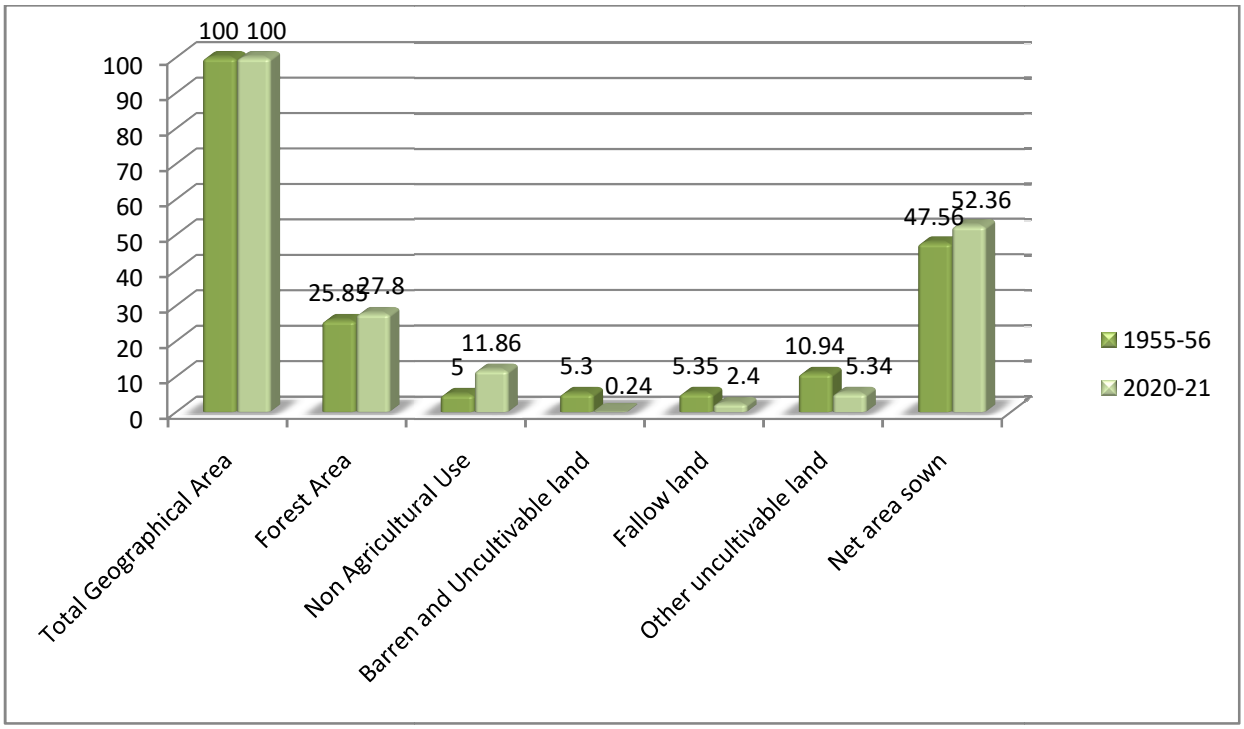
Table 4.3: Land Utilisation Pattern in Kerala

Land Type	Area		
	1955-56	**2019-20**	**2020-21**
Total Geographical Area	3808984	3886287	3886287
Forest Area	984622	1081509	1081509
Non-Agricultural Use	190611	455897	460917
Barren and Uncultivable land	201133	10619	9529
Fallow land	203966	104318	97007
Other uncultivable land	416835	207880	207880
Net area sown	1811817	2026064	2035128

Source: Economic Review of Kerala

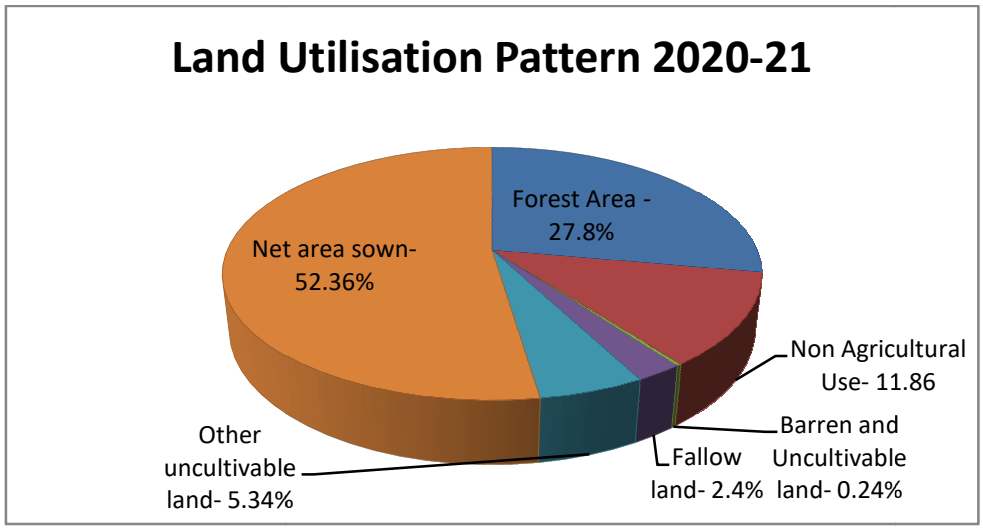
The table 4.3 and figure 4.6 show that the area used for non agriculture uses are increased significantly from 1955-56 to 2020-21.

Figure 4.6: Land Utilisation Pattern in Kerala in 1955-56 and 2020-21



Source: Economic Review of Kerala

Figure 4.7: Land Utilisation Pattern in Kerala in 2020-21



Source: Economic Review of Kerala

Figure 4.7 summarises the land utilisation pattern of Kerala during 2020-21. This figure shows that 52.34% of the state's land is in the Net area sown. 27.8% of the land is under forest area. Fallow land constitutes 2.4%, and barren and uncultivable land belongs to only 0.24%. Other uncultivable land constitute 5.34%, and land used for non-agricultural purpose is 11.86%.

4.4.4 Changes in Consumption Pattern

The increased flow of remittances stimulated a tremendous change in the consumption pattern of Keralites and thus increased the pressure on the natural resources. Instead of investing in productive business industries or even saving or depositing, people started to improve their land and houses, buy new land or houses, or construct new ones (Kannan, 1990; Prakash, 1998). Thus, industrial growth was blocked by the construction boom. Moreover, people also started to demand more health care and educational services. It ultimately increased the number of private hospitals and educational institutions. Therefore, the tertiary sector has begun to grow fast. The number of cinema theatres, hotels, bars and restaurants, printing and publishing facilities were increased (Kannan, 1990). Investments in "assets like land, buildings, gold ornaments, motor vehicles and consumer durables have been increased" (Prakash, 1998). These new trends significantly boosted trade, commerce, banking, transport and other service sector activities. Though this change started among the consumption patterns of migrant households, as a part of

the Bandwagon effect, it became the general consumption pattern of Kerala people. Ultimately, this new consumption pattern hiked the price of land and building materials. This new trend badly affected the dream of poor people to own a piece of land and build a house (Gopikuttan, 1990; Prakash, 1998).

4.4.5 Construction Boom and Growth of Real Estate

Building Statistics of Kerala reveals that during 2020-21, the number of buildings newly constructed and completed in Kerala was 355874. The highest number of buildings was constructed in Malappuram District (46964), followed by Trivandrum District (39650) and the least number in Pathanamthitta District (11786), and followed by Idukki (13262).

Table 4.4: Number of Newly Completed Buildings in 2020-21

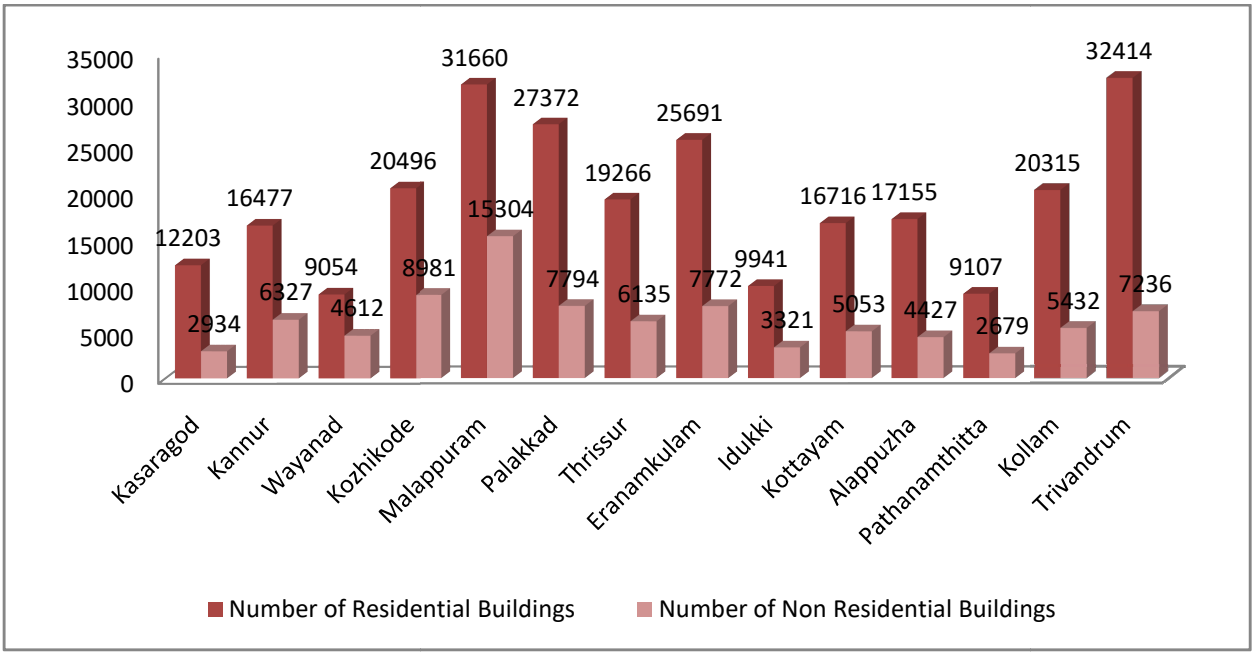
Name of the District	Total Number of Newly Completed Buildings
Kasaragod	15137
Kannur	22804
Wayanad	13666
Kozhikode	29477
Malappuram	46964
Palakkad	35166
Thrissur	25401
Ernakulam	33463
Idukki	13262
Kottayam	21769
Alappuzha	21582
Pathanamthitta	11786
Kollam	25747
Trivandrum	39650

Source: Building Statistics 2020-21, GoK

Along with the increase in the land used for non agriculture purposes the number of buildings in the state is also increasing. Table 4.4 shows the number of newly constructed building in the state during 2020-21.

Figure 4.8

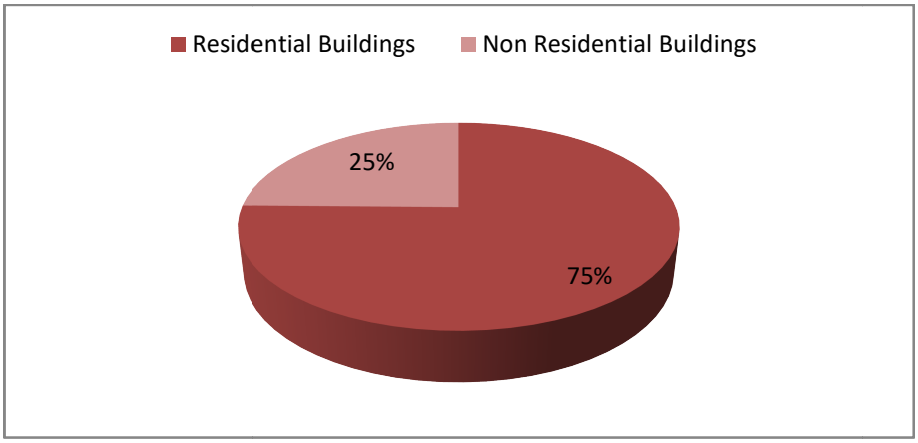
District-Wise Details of Number of Newly Completed Residential and Non-Residential Buildings in 2020-21



Source: Building Statistics 2020-21, GoK

Figure 4.9

Percentage of Newly Completed Residential and Non-Residential Buildings in Kerala in 2020-21



Source: Building Statistics 2020-21, GoK

Figure 4.8 shows that the number of newly constructed commercial buildings is considerably higher than residential buildings in every state district. Figure 4.9 depicts that 75% of the newly constructed buildings in 2020-21 are non-residential.

Table 4.5: District-wise Details of Density of Newly Constructed Buildings in Kerala 2020-21

Name of the district	**Total Number of Newly Completed Buildings**	**Area Excluding Forest**	**Density**
Kasaragod	15137	1935	8
Kannur	22804	2484	9
Wayanad	13666	1342	10
Kozhikode	29477	1933	15
Malappuram	46964	2520	19
Palakkad	35166	3113	11
Thrissur	25401	1993	13
Ernakulam	33463	2352	14
Idukki	13262	2379	6
Kottayam	21769	2123	10
Alappuzha	21582	1410	15
Pathanamthitta	11786	1100	11
Kollam	25747	1673	15
Trivandrum	39650	1689	23
Total	**355874**	**28046**	**13**

Source: Building Statistics 2020-21, GoK

Table 4.5 shows the density of the newly constructed buildings in 2020-21. Considering the density of newly constructed buildings, Trivandrum stands first, following Malappuram, Alappuzha and Kozhikode.

4.5 Mineral Resources in Kerala

The state owns mineral deposits like placers, china clay (kaolin), limestone, lime shell, silica sand, bauxite, graphite, iron ore, and granite. The principal mineral-based industries like Indian Rare Earths Ltd., Chavara, Kerala Minerals and Metals Ltd., Chavara, Malabar Cements, Walayar, Travancore Cements Ltd., Kottayam, Kundara Ceramics, Kollam, English Indian Clays Ltd. (EICL), Thiruvananthapuram, Excel Glass Industry, Alappuzha, Kerala Clays and Ceramic Products Ltd., Palayangadi, Kannur are some of the mineral based industries working in the state since several years. The resources of beautiful ornamental granites in the state are being exported to different countries.

4.5.2 Mineral Revenue

Over the years, Kerala's mining and quarrying industry's growth rate at constant prices has varied. It experienced a decrease to (-) 67.9 percent in 2015–16 from 60.8 percent in 2014–15. The mining and quarrying sector's income increased to 45.5% in 2016–17, fell to 18.9% in 2017–18, and then saw negative growth at 14.6% in 2018–19. Nine major mineral mining leases, 103 minor mineral quarrying leases, and 1289 dealer licences were awarded in 2018–19. Kerala had 169 metal crusher units registered during this time, and one prospecting licence for minor and major minerals had been issued. As of September 2018, there were 104.6 hectares in Kerala under mining leases only for granite building stones.

4.5.2.1 Mineral wise Production and Revenue Collection 2018-19

The primary source of income for the government from minerals is royalties. Major minerals provide for the remaining 5% of revenue, with minor minerals providing the other 95%. The revenue from minerals increased from ₹152 crore in 2017–18 to ₹171.3 crore (12.7%) in 2018–19. Major minerals contributed ₹5.4 crore to this total, while minor minerals contributed ₹165.9 crore. Among the principal minerals, ilmenite brought in the most money in 2018–19 ($₹2 crore), followed by zircon ($1.6 crore). The largest contribution from minor minerals in 2018–19 was made by granite building stone (119.9 crore), followed by laterite (building) (12.3 crore). Kerala produced 461.4 lakh tonnes of main and minor minerals in 2018–19. With 1.3 lakh tonnes, ilmenite topped the list of important minerals, followed by limestone (1 lakh tonnes).

Granite building stone produced the most minor minerals (353.1 lakh tonnes), followed by ordinary earth (62.8 lakh tonnes). The following lists the State's mineral production and royalties during the 2018–19 fiscal year:

Table 4.6 : Production & Royalty of Minerals in Kerala during 2018-19

Sl No	Mineral	Royalty (₹ Lakh)	Production (Tons)
Major Minerals			
1	Ilmenite	197.12	130071
2	Rutile	50.04	4969
3	Zircon	164.65	12598
4	Sillimanite	21.46	9212
5	Limeshell/Sea shell	17.65	22067
6	Lime stone	77.91	96780
7	Graphite	0.6	505
8	BR Ilmanite	6.01	1066
9	Quartz		
	Total	**535.44**	**277268**
Minor Minerals			
1	Granite Building Stone	11990.25	35305043
2	Granite Building Stone	60.26	
3	Laterite (Building)	1230.10	3007297
4	Bauxite/Laterite (Cement)	19.19	19988
5	River Sand	6.78	12000
6	Ordinary Sand	485.56	363138
7	Lime /Sea Shell	2.47	747
8	Ordinary Earth	215.44	6281735
9	Brick Clay	293.08	428815
10	China Clay	200.53	399978
11	Silica Sand	142.85	48588
Total		**14646.51**	**45867329**
Grand Total		**15181.95**	**46144597**

Source: Mining & Geology Department, Kerala

Table 4.7: Annual Mineral Revenue Collection Details

Year	Revenue Collection in Crore		
	Major Minerals	**Minor Minerals**	**Total**
2020-2021	8.38	183.75	192.13
2019-2020	8.77	151.35	160. 12
2018-2019	5.35	165.94	171.29
2016-2017	6.45	132.27	138.72
2015-2016	13.42	126.28	139.7
2014-2015	13.91	56.69	70.6
2013-2014	12.39	41.78	54,17
2012-2013	12.33	37.37	49.7
2011-2012	11. 17	33. 13	44.3
2010-2011	9.42	26.92	36.34
2009-2010	8.81	27.40	36.21
2008-2009	7.59	27.90	35.49
2007-2008	7.05	24.03	31,08
2006-2007	6.54	19.93	26.47
2005-2006	7.33	16.27	23.6

Source: Website of Mining and Geology Department, Kerala

4.6 Status of Quarrying in Kerala

Exploiting natural resources is an essential part of social and economic development. From the beginning of human history, man has depended on natural resources to satisfy the growing needs and demands of the growing population. Colonialism, urbanisation, economic liberalisation and demand for infrastructure increased the pressure on natural resources. During colonialism, resources were moved from colonial to imperialist countries and provided a resource base for the economic, social and human development of many such countries. " Though urban centres of the world cover only 2% of the total land surface, the activities within these countries consume over 75% of the global natural resource share" (Vandana et al., 2020). Likewise, in many regions of the globe, the materialistic and infrastructural needs of the people increased the quarrying activities, mainly for building stones in Kerala. As technology improved from manual extraction, extraction using explosives and machines started and sharply increased the quantity and

frequency of extraction. The quarrying and construction constitute a significant portion of Kerala's GSV. Many native and migrant workers depend on these sectors for their livelihood.

Table 4.8: Shares of different Sectors in GVA and Employment Kerala and India 2019-20

Sectors	**Shares in Gross Value Added**		**Shares in employment**	
	Kerala (GSVA)	India (GVA)	Kerala	India
Agriculture, livestock, forestry and fishing	8.4	14.83	21.89	45.56
Mining and quarrying	0.4	2.43	0.26	0.28
Primary	8.8	17.26	22.15	45.84
Manufacturing	11.1	17.10	10.59	11.15
Electricity, gas, water supply, other utility services	1.3	2.26	0.57	0.61
Construction	13.4	7.80	19.4	11.63
Secondary	25.9	27.16	30.56	23.39
Trade, repair, hotels and restaurants	18.0	15.85	18.2	13.22
Transport, storage, communication, and services related to broadcasting	7.7	4.5	8.74	5.62
Financial, real estate, and professional services	22.9	21.97	5.15	2.01
Public Administration and other services	16.8	13.25	15.2	9.92
Tertiary	65.3	55.57	47.29	30.77
	100.00	100.00	100.0	100.0

Sources:Economic Review of Kerala, 2020

Nevertheless, on the other side, in the long term, it creates many imbalances in our natural environment. Vertical and horizontal expansion of manmade infrastructure occurs through the vertical and horizontal extraction of natural resources. In more literary words, we are taking resources from the Western Ghats, levelling the wetlands and building the infrastructure. Quarrying and mining in Kerala are located mainly in and around the Western Ghats, a highly sensitive biological hotspot worldwide. It is considered a susceptible ecological area, and the population density of Kerala as a small geographical unit is very high in these regions. " The situation of mining/quarrying within the ecosystem is often alarming, and in many occasions, existing rules and regulations seem adequate to contain the ill effects of the said

activities"(Vandana et al., 2020). As Kerala is a small state geographically with a high population density, any threats to her environment without much delay adversely affect the sustained achievements in her people's socio-economic and human development.

Stone has a vital role in shaping human history. The discovery of fire and stone and the invention of the wheel stimulated the pace of human progress and modernisation. Vandana et al. study on the environmental impact of quarrying in the Nethravathi- Gurpur and Periyar- Chalakudi river basins found that quarrying caused many environmental problems, especially in "geomorphology, air quality, noise level, land use/ land cover and surface and subsurface water resources". Quarries permanently create "ugly scars, degrading ecology and aesthetic value of the region" to a considerable extent (Vanadana et al., 2020). According to the Mining and Geology Department of Kerala data, there are 643 active quarries in Kerala. Out of 643, 552 are Granite (Building Stone) Quarries. Table 4.9 and table 4.10 show the details.

Table 4.9: Types of Quarries in Kerala

Type of Quarry	**Number**
Granite (Building Stone)	**552**
Laterite (Building Stone)	46
Ordinary Earth	34
Silica Sand	6
Ordinary Clay	2
Granite(Dimension Stone)	1
Laterite	1
China Clay	1
Total	**643**

Source: Mining and Geology Department Website (23.11.2023)

Table 4.10: District-wise Quarry Count in Kerala

Sl.No	District	Number of Active Quarries
1	Malappuram	147
2	Palakkad	86
3	Kozhikode	67
4	Kannur	61
5	Ernakulam	59
6	Trivandrum	42
7	Pathanamthitta	35
8	Kottayam	34
9	Kollam	29
10	Thrissur	29
11	Kasaragod	17
12	Idukki	15
13	Wayanad	11
14	Alappuzha	11
	Total	**643**

Source: Mining and Geology Department Website (23.11.2023)

Kerala is a small state in India by the geographical area. "It has all the three maximally productive and biodiversity-rich ecosystems in the world, namely, tropical rainforests, freshwater and brackish water wetlands and the marine coral reefs" (KDR, 2021). In Kerala, there is no significant difference between rural and urban areas. In such a settlement pattern, any changes in the natural environment affect the whole. Spatial distribution in Kerala shows that housing, farming, and industries are in the same places. The quarrying activities are also conducted in the nearby places of human settlement. The state is currently experiencing frequent visits of natural calamities like floods and landslides. Activities of quarrying are indirectly intensifying the degree of landslides in Kerala.

As the geographical area is limited and population density is high, Kerala quarries are always near human settlements. Quarries have a long-term impact on the environment of a region. It also has localised short-term and long-term impacts on the environment of the locality where the quarry is located. Socio-economic and Environmental costs and benefits of quarrying activities are listed below:

Table 4.11: Socio-Economic and Environmental Costs and Benefits of Quarrying

Socio-Economic Costs	Socio-Economic Benefits	Environmental Costs	Environmental Benefits
○ *Loss of settlements* ○ *Damage of houses* ○ *Dust Emission* ○ *Sound Pollution* ○ *Over Use of Roads* ○ *Dumping of Debris*	○ *Development of Road Networks* ○ *Employment Generation*	○ *Soil Erosion* ○ *Change in Topography* ○ *Disfiguration of landscape* ○ *Cracks and landslides* ○ *Deposits of Debris* ○ *Reduction in groundwater levels*	○ *In some cases, the water level increased by recharge*

Author's Compilation

Quarrying has some localised impacts. Nature and human settlements around each quarry are different. Some quarries are located in highly populated areas. Some of them are located in highly populated areas. Some are located in forest areas and others are in isolated areas without visible human settlements. Like the location of the quarry, elevation is also essential. As elevation increases, the risk of landslides also increases.

Awareness of the people living around the quarry is also essential. Most people have an awareness of extraction and environmental issues. However, they do not know where to tell their problems. An ethical concern of the quarry operators is also important. In some quarries, operators are people-friendly. They help the natives to resist the dust problem by watering. Also, support to maintain the condition of roads. They also provide employment opportunities to the local people. They are also somewhat transparent about the quarry operations.

On the other hand, in some cases, quarry operations are not transparent, and the operators never hear the problems of the people living near the quarries. If people get any kind of social or economic benefits or issues from quarry operations minimum, people are less resistant to quarry activities. Improvement of the road network is one of the benefits almost all locals indicated. Nevertheless, in most cases, roads are highly damaged due to overuse.

Quarries are not strictly following the security cautions. The siren to indicate the explosion is only working in some places. Explosions more than allowed three times are regular in many quarries. Even in the night time, explosions and loading are there in quarries. Some people are complaining about the bribing of quarry operators. They encourage some people to suppress the resistance by giving money and other gifts. Quarry lands are private lands. Some of them were surplus land distributed during the land reforms period. Quarry operators are mainly non-natives. In almost all quarries, employers are non-Malayalis and reside in the abandoned houses of native people or temporary sheds near the quarries. They have no access to the native people. Many people are evacuated from the quarry sites. Damages to the houses are frequent. Losses of Calmness, health issues, and loss of concentration for study are frequent. Fear of home loss is frequent among the people. Minor landslides without life loss are common. Ownership of the quarry will change frequently.

4.6.1 Quarrying and natural disasters

Natural disasters have become a recurring occurrence in the Indian state of Kerala. Landslide is the central issue associated with quarrying, especially during the Monsoon period. Though landslides have happened in Kerala in the past, after the 2018-19 floods, their frequency and causality have increased substantially. According to the Institute of Land and Disaster Management report, GoK (2021), landslides in Kerala are caused by five factors.

1. Elevation of the land
2. Soil type
3. Rainfall
4. Other internal factors and
5. Manmade or external factors

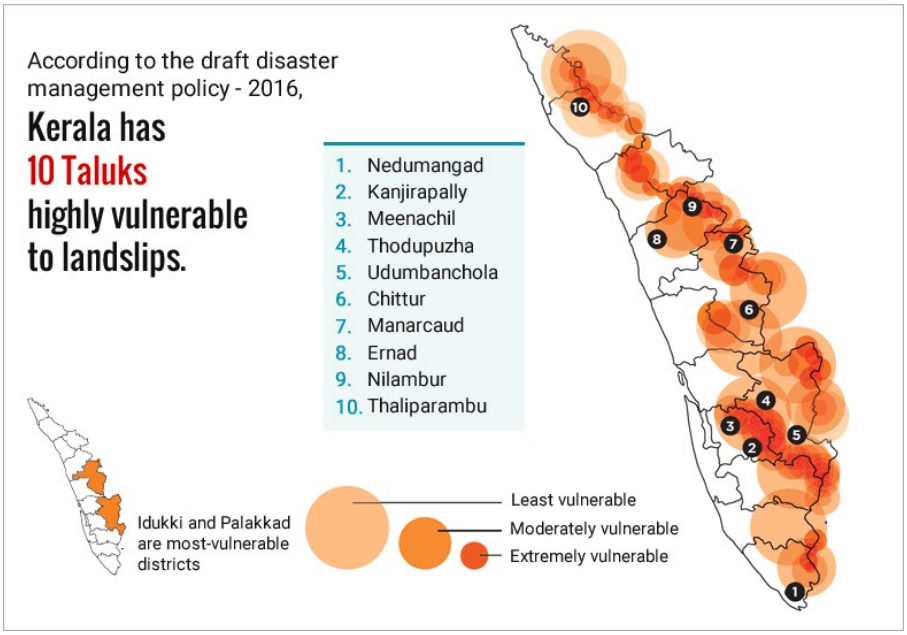
Manmade factors include:

1. Construction activities (roads, dams and buildings)
2. Density of Vehicles
3. Drainage system
4. Deforestation
5. Soil erosion and

6. Mining and quarrying

The highlands of Kerala experience several types of landslides, of which debris flows are the most common. Figure 4.10 shows the Landslip Vulnerability in the state. All districts of the state except Alappuzha are prone to landslides. As per the draft disaster management policy of 2016, ten taluks of Kerala is highly vulnerable to landslips and the districts Idukki and Palakkad are the most vulnerable districts.

Figure 4.10: Land Slip Vulnerability in Kerala



Source: Draft Disaster Management Policy 2016, GoK

Table 4.12 gives the details of distribution of landslide prone areas in the state. The table shows that the Idukki district has the highest area belong to high landslide prone following the Palakkad district.

Table 4.12 Distribution of Landslide Prone Areas in Kerala

District	Landslide prone (km2)	
	High	**Low**
Thiruvananthapuram	46	115
Kollam	76	191
Pathanamthitta	170	426
Alappuzha	NIL	NIL
Kottayam	62	191
Idukki	388	874
Ernakulam	61	229
Thrissur	108	217
Palakkad	325	367
Malappuram	198	268
Kozhikode	109	207
Wayanad	103	197
Kannur	169	273
Kasaragod	34	206
Kerala	1849	3761
Coefficient of Variability (%)		

Source: Mathai, 2009

4.7 Conclusion

The present chapter summarises the environmental status of the state in general and status of quarrying and mining and related environmental issues in particular. The analysis of the environmental status of the state conclude that the factors like population density, urbanisation, changes in land use pattern and increase in number of buildings increased the pressure on the environment and natural resources of the state. Though state possess a high civic consciousness in the matter of socio- economic development environmental matters did not get such attention. Unscientific exploitation of resources and unplanned infrastructure development is a real threat to the sustainability of achieved human development in the state.

Chapter 5

SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS OF QUARRYING

- ***Introduction***
- ***Primary Details of Selected Quarries***
- ***Details of Sample Households***
- ***Socio-Economic and Environmental Impacts of Quarrying on Local People***
- ***Conclusion***

Chapter 5

Socio-Economic and Environmental Impact of Quarrying

5.1 Introduction

The primary data analysis regarding the socio-economic and environmental impacts of quarrying and its discussion are included in this chapter. The first part of the chapter presents the primary details of the selected samples, and the second part deals with the quantitative and qualitative analyses of the primary data. The first part of the chapter discusses the features of selected quarries and provides basic information regarding the selected sample households. The basic information about the household includes the gender of the respondent, the educational qualification of the respondent, religion and social group of the respondent, type of ration card, years of residence in the current locality, nature of the house ownership, years of construction of the present house, type of roof and wall of the house, floor area of the house, average distance from the quarry, land ownership and size of land, and monthly income of the household. The second section of this chapter deals with statistical and qualitative analyses to explore the economic, social, and environmental effects of quarrying. The second objective of the present study is being met through these analyses and discussions.

5.2 Primary Details of the Selected Quarries

The study was conducted in the Palakkad District of Kerala, which stands first in terms of the number of quarries in the state as per the granite quarry mapping attempt (Sajeev & Alex, 2017) and also a recent update of the Mining and Geology Department of Kerala, Palakkad district stands second in terms of the number of active in the state. From the seven taluks of the district, five taluks were selected using cluster sampling. From these taluks, ten active quarries located in the residential area were selected for the study. Two hundred fifty-six households were selected using simple random sampling from these quarrying areas quarries (details of the sampling are given in Chapter 1). The general characteristics of the sample quarries provide a glimpse into the overall characteristics of the study area. Table 5.1 provides a general description of the selected quarries.

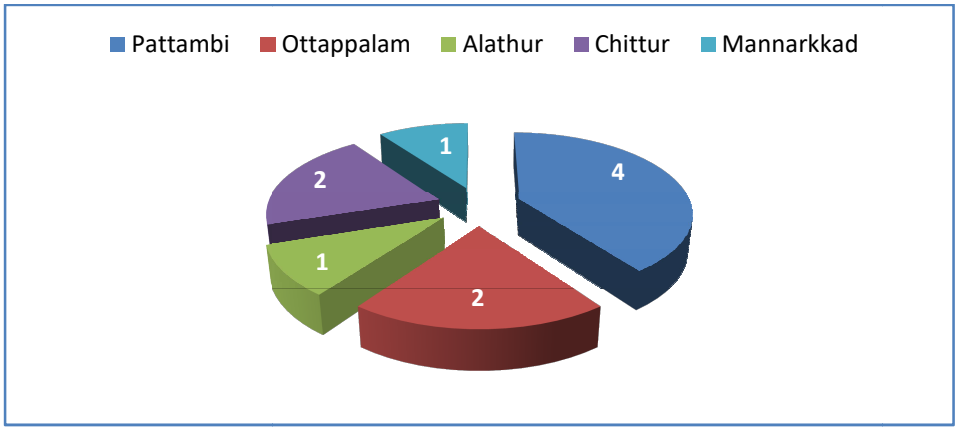
Table 5.1: Primary Details of the Selected Quarries

Sl. No	Taluk	Number of Quarries Selected	Name of the Quarry	Stone type	Samples from Quarry	Samples from Taluk
1	Pattambi	4	Super Granites	Granite-Building Stone	10	**89**
			Nechamkode Quarry, Thachanattukara	Granite-Building Stone	23	
			Royal	Granite-Building Stone	15	
			Vadanamkurussi	Granite-Building Stone	41	
2	Ottappalam	2	Blue Chips, Vaniyamkulam	Granite-Building Stone	31	**53**
			Kalpaka	Granite-Building Stone	22	
3	Alathur	1	Star	Granite-Building Stone	33	**33**
4	Chittur	2	FIvestar, Pallasana	Granite-Building Stone	20	**46**
			Thenkurussi Quarry	Granite-Building Stone	26	
5	Mannarkkad	1	Chethallur Quarry	Granite-Building Stone	35	**35**
	Total	**10**				**256**

Source: Primary data

The active quarry in densely populated residential areas is the criteria for selecting quarries. Thus, four quarries from Pattambi, two from Ottappalam and Chittur and one from Alathur and Mannarkkad were selected. All the quarries except one of the selected quarries are in rural areas. Granite building stone is the type of stone found in all of the selected quarries. Figure 5.1 shows the number of quarries selected from each Taluk.

Figure 5.1: Number of Quarries Selected



Source: Primary data

5.3 Details of Sample Households

Details of sample households provide some relevant information about the people living around the quarrying area, along with the socio-economic and geographical characteristics of the quarrying site. A total of 256 households were surveyed to get data regarding the socio-economic and environmental impact of quarrying on local people from the residential area near the selected ten active quarry sites. Table 5.2 shows the sample size and percentage of samples collected from each Taluk.

Table 5.2: The size of Samples Collected from Taluks

Taluk	**Households**	**Per cent**
Pattambi	89	34.8
Ottappalam	53	20.7
Chittur	46	18
Mannarkkad	35	13.7
Alathur	33	12.9
Total	**256**	**100.0**

Source: Primary Data

Table 5.2 shows that 34.8 % of the samples are collected from the Pattambi taluk, following Ottappalam (20.7%), Chittur (18.0%), Mannarkkad (13.7%), and Alathur (12.9%). Households are selected from the residential areas near the active quarry sites within a radius of 100 metres to 1 kilometre. While applying these criteria, the density of active quarries and the density of the population surrounding such quarries contributed to some variations in the number of quarries and the number of sample households selected from each Taluk. That is, the distribution of active quarries in residential areas and the population around such quarries are not even in taluks, which causes variations in sample size from each Taluk.

The subsequent part of the chapter sheds light on the demographic, social and economic characteristics of the surveyed households. The total number of members of 256 households is 1029. Out of these, 500 are female, and 529 are male members. Three hundred ten are aged on or above 60 years old. Two hundred ten are children on or below 15 years old. 451 of 1029 are total earning members of the sample households.

5.3.1 Gender of the Respondents

One observation made while completing the survey was that female members are generally unwilling to share their experiences about the quarry. They fear that making negative comments will be harmful to them. Conflicts between the public and quarry operators are frequent at many sites. Therefore, they hesitate to respond. They prefer male members to respond to the inquiries, even when female members are present. Table 5.3 shows the details of the gender of the respondent.

Table 5.3: Gender of the Respondents

Gender	Frequency	Per cent
Female	154	60.8
Male	102	39.8
Total	**256**	**100**

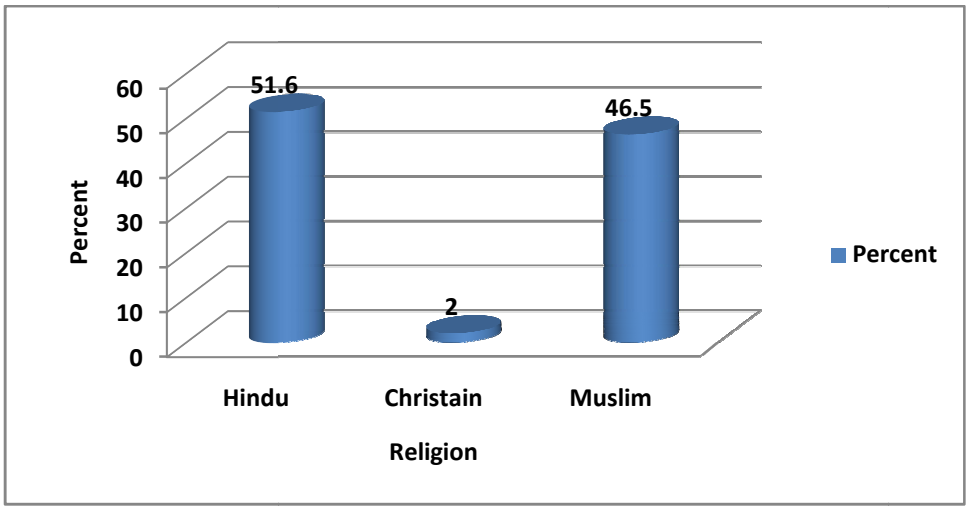
Source: Primary Data

Out of 256 respondents, 154 are males and 102 are females. That means males constitute 60.2% of the respondents, and 39.8 % are females.

5.3.2 Religion of the Respondents

Figure 5.2 shows the religion-wise distribution of the respondents. Out of a total of 256 respondents, 51.6 % are Hindus, 46.5% are Muslims, and 2% are Christians, which indicates the religious composition of the population of selected areas.

Figure 5.2: Religion of the Respondents



Source: Primary Data

5.3.3 Social group of the Respondents

The analysis of the social group of the respondent is relevant to this study. A person who lacks sufficient resources is forced to live in unfavourable and insecure conditions. Therefore, identifying social groups is crucial in analysing the vulnerability and backwardness of the people. Table 5.4 provides information about the respondents' social group.

Table 5.4: Social Group of the Respondents

Social Group	Frequency	Per cent
SC	15	5.9
OBC	188	73.4
EBC/OEC	14	5.5
General	39	15.2
Total	**256**	**100**

Source: Primary Data

73.4 % of the respondents are OBC, the highest social group in the sample. General, EBC/ OEC and SC constitute 15.2%, 5.5% and 5.9% of the sample respectively.

5.3.4 Type of Ration Card

Another evidence of the respondents' socio-economic background is the type of ration card they should use. There are four colours of ration cards for the four different categories. Yellow-cardholders are the most economically backward group and pink- cardholders belong to the priority group or are below the poverty line. Blue-card holders are in the non-priority subsidy group, and white-card holders belonging to the economically forward group are in the non-priority group. Details are given in table 5.5.

Table 5.5: Type of Ration Card

Type of Ration Card	Frequency	Per cent
White	65	25.4
Blue	106	41.4
Yellow	15	5.9
Pink	70	27.3
Total	**256**	**100**

Source: Primary Data

41.4 % of the residents have blue colour ration cards. 27.3 % of samples have pink ration cards, 25.4% of households have white ration cards, and yellow cards constitute the least, 5.9%.

5.3.5 Gender-wise Analysis of the Educational Qualification of the Respondent

The educational qualification of the respondents is significant since it influences how logically they react to the questions. Perceptions and awareness of the people are crucial, particularly when it comes to issues that affect the environment and society. So, the analysis has considered the respondent's educational background. Table 5.6 details the gender distribution of respondents' education.

Table 5.6: Gender and Educational Qualification of the Respondents Cross Tabulation

Gender	Educational qualification of the respondent							Total
	Illiterate	Primary	High School	SSLC	Pre Degree/ Plus Two	Degree	Post Graduation and Above	
Male	14	26	40	56	7	5	6	**154**
Female	11	6	24	41	11	9	0	**102**
Total	**25**	**32**	**64**	**97**	**18**	**14**	**6**	**256**

Source: Primary Data

Gender-wise distribution of educational qualification shows that 25 respondents are illiterate. Of which 14 are male and 11 are female. Thirty-two respondents have primary education. Out of that, 26 are males and 6 are females. Sixty-four respondents have a high school education. Out of them, 40 are males and 24 are females. Ninety-seven samples have SSLC qualification. Of which 56 are males and 41 are females. SSLC has the highest frequency both in the male and female category. Eighteen respondents have Pre Degree or Plus Two qualification; 7 are males, and 11 are females. Fourteen have Degree qualifications, of which 5 are males and 9 are females. Only six respondents have post-graduation and above qualifications. All of them are males. The educational qualification of the respondents reveals that only 9.8% are illiterate, and 90.2% have primary education or above qualifications.

5.3.6 Occupation of the respondents

In the present study, the occupation of the respondents is relevant in their responses related to the socio-economic and environmental impacts of quarrying in their locality. Therefore, more options were included in the types of occupation. This analysis is also interested in finding the proportion of local people engaged in quarry-related activities. Table 5.7 gives a quick look at the occupational profile of the respondents.

Table 5.7: Occupation of the Respondent

Occupation	Frequency	Per cent
Farmer	32	17
Casual Labourer (Agricultre)	12	6.4
Casual Labourer (Non Agriculture)	44	23.40
Self Employed	68	36.17
Professional	1	0.53
Salaried Employee in the Government Sector	6	3.2
Salaried Employee in the Private Sector	18	9.57
Large Scale Business	1	0.53
Quarry Worker- Mess	1	0.53
Quarry Worker- Driver	1	0.53
Quarry Worker- Others	3	1.61
Quarry Operator/ Owner	1	0.53
Total	**188**	**100.0**

Source: Primary Data

The occupational distribution of the respondents shows that 36.17 % are self-employed, which constitutes the more significant portion. Casual labourers in non-agriculture, with 23.4 %, stand as the second largest occupation, following the farmer, constituting 17 % of the sample. 6.4 % are casual labourers in the agriculture sector. 3.2 % of the respondents are salaried employees in the government sector, and 9.57 % are salaried employees in the private sector. Professionals and large-scale business operators constitute .53 % of the total sample. Quarry workers constitute only 3.2 % of the total respondents. Of which quarry worker-mess, quarry worker- driver and quarry operator constitute .53 % respectively. 1.6 % is engaged in other types of quarry works.

Out of 256 respondents, 61 respondents are unemployed. They constitute 23.8% of the total respondents. Furthermore, seven respondents are pensioners. They constitute 2.7% of the total respondents.

5.3.6.1 Gender-wise Analysis of Occupation

Table 5.8: Occupation of the Respondent- Gender Cross Tabulation

Occupation of the Respondent	Gender		Total
	Male	Female	
Farmer	32	0	32
Casual Labourer (Agricultre)	8	4	12
Casual Labourer (Non Agriculture)	35	9	44
Self –Employed	48	20	68
Professional	0	1	1
Salaried Employee in the Government Sector	6	0	6
Salaried Employee in the Private Sector	6	12	18
Large Scale Business	1	0	1
Quarry Worker- Mess	0	1	1
Quarry Worker- Driver	1	0	1
Quarry Worker- Others	3	0	3
Quarry Operator/ Owner	1	0	1
Total	**141**	**47**	**188**

Source: Primary Data

Table 5.8 gives gender wise details of respondents' occupation. Out of 188 occupied respondents 25% are females and 75% are males.

5.3.7 Years of Residence in the Locality

To analyse the socio-economic and environmental impacts of quarrying in the locality, the information regarding the years of residence of the respondents from that locality seems relevant. Table 5.9 gives the details of the period of residence. The data regarding the years of residence in the locality assure that respondents can have pre- and post-quarrying experiences in their locality.

Table 5.9: Years of Residence in the Current Locality

Years of residence	Frequency	Per cent
5-15	79	30.9
15-30	77	30.1
30-45	71	27.7
45-60	4	1.6
60-75	13	5.1
75-90	12	4.7
Total	**256**	**100.0**
Mean years of Residence		***26.45***
Standard Deviation		***17.871***

Source: Primary Data

The mean years of residence of the sample households are 26.45. The distribution shows a standard deviation of 17.871. The minimum years of residence are five, and the maximum is 85. 30.9 % of the sample belongs to 5-15 groups. 30.1 % of the families live in that locality for 15- 30 years. 30-45 years constitute 27.7 %. 45-60, 60-75 and 75-90 constitute 1.6%, 5.1 % and 4.7 % respectively.

5.3.8 Nature of House Ownership

House ownership influences the attitude of respondents regarding the damages to amenities. Details of the nature of house ownership are given in the table 5.10 below. 98% of the respondents are living in self-owned houses. Only 2% of them are living in rented houses.

Table 5.10: Nature of House Ownership

House Ownership	Frequency	Per cent
Self-owned	251	98.0
Rented	5	2.0
Total	**256**	**100.0**

Source: Primary Data

5.3.9 Years of Construction of the Present House

In this study, damages to amenities are considered a social issue of quarrying; therefore, details of the oldness of the houses are relevant. Details of years of construction show that 41% of the houses are constructed in 1-11 years. 11-21 years and 21- 31 years constitute 29.7% and 23%, respectively, which indicate that 93.8 % of houses are constructed within 30 years. Houses constructed in 31-41 years, 41-51 years, and 51-61 years constitute 2%, .8% and 3.5% of the samples, respectively.

Table 5.11: Years of Construction of the Present House

Years	**Frequency**	**Per cent**
1-11	105	41.0
11-21	76	29.7
21-31	59	23.0
31-41	5	2.0
41-51	2	.8
51-61	9	3.5
Total	**256**	**100.0**
Mean		***16. 34***
Standard Deviation		***12. 469***

Source: Primary Data

A minimum year of construction is one, and a maximum is sixty years. The given data's mean of years of construction is 16.34, with a standard deviation of 12. 469.

5.3.10 Type of Roof and Wall of the Houses

The type of roof and wall details of houses gives insight into the physical condition of houses and the economic status of the households.

Table 5.12: Type of Roof and Wall

Type of Roof	Type of Wall		Total
	Bricks/ Stone (Plastered)	Bricks/ Stone (Non Plastered)	
Sheet	1	0	1
Tile	35	29	64
Concrete (Semi)	21	7	28
Concrete (Complete)	153	10	163
Total	**210**	**46**	**256**

Source: Primary Data

All houses are made of bricks or stone. Among them, 210 houses are plastered, and 46 are non-plastered. Only one house has a sheet roof. Sixty-four houses are tile-roofed, 28 are semi-concrete, and 163 have complete concrete roofs. Table 5.12 shows the cross-tabulated details.

5.3.11 Floor Area of Houses

Total floor area is another significant variable to assess the physical condition of houses.

Table 5.13: Floor Area of Houses

Floor Area of Houses (In Sq. feet)	Frequency	Per cent
700-1000	106	41.4
1000-1300	117	45.7
1300-1600	11	4.3
1600-1900	10	3.9
1900-2200	6	2.3
2200-2500	6	2.3
Total	**256**	**100.0**
Mean floor area		***1100.98***
Standard deviation		***335. 467***

Source: Primary Data

The minimum floor area is 700, and the maximum is 2500. The mean floor area of the samples is 1100.98, with a standard deviation of 335. 467. 41.4% of the houses have a floor area between 700- 1000 Square Feet. 45.7 % of the houses have area between 1000- 1300 Square feet. That means most houses (87.1%) have a total area below 1300 Square feet. Houses having an area between 1300-1600 Square feet, 1600-1900 Square feet, 1900-2200 Square feet and 2200-2500 Square feet are 4.3%, 3.9%, 2.3% and 2.3 % respectively.

5.3.12 Average Distance of House from the Quarry

Households are selected based on the distance from the quarrying site. A pilot survey conducted in the quarrying sites revealed that the significant effect of quarrying is limited to a 1-kilometre radius of the quarrying site. Based on this inference, houses within a diameter of 100 meters to 1 kilometre are selected for the study. Therefore, the distance of houses varies from 100 meters to 1 kilometre. Table 5.14 shows the distance distribution.

Table 5.14: Distance of the house from the quarry

Distance from Quarry (In Meters)	Frequency	Per cent
100-150	6	2.3
150-200	6	2.3
200-300	40	15.6
300-500	152	59.4
500-700	38	14.8
700-800	5	2.0
800-1000	9	3.5
Total	**256**	**100.0**
Mean distance		***383.4***
Standard deviation		***157.7***

Source: Primary Data

The mean distance in meters is 383.4, with a standard deviation of 157.7. It is evident from the table that between 100- 150 meters and 150- 200 meters, there are only 2.3% of houses. 15.6 % of houses lie between 200- 300 meters. Most houses, 59.4 %, are within 300- 500 meters. 14.8%

of the houses are in 500- 700 meter distance. 5% of the sample households are living in a 700-800 meter distance, and 9% of the houses are in an 800- 1000 distance.

5.3.13 Land Ownership & Size of Land

All the 256 households have land ownership. Four cents is the smallest, and 3.5 acres is the highest landholding. 13.5 is the median of the land size. The mean size of land holdings is 18.8125, with a standard deviation of 25. Details of landholding are given below in Table 5.15.

Table 5.15: Size of Land Holding

Size of Land Holding (In Cent)	**Frequency**	**Per cent**
4-10	34	13.3
15-20	36	14.1
20-25	19	7.4
25-30	16	6.3
30-35	32	12.5
75	10	3.9
350	1	.4
Total	**256**	**100.0**
The mean size of land		***18.81***
Standard deviation		***25***

Source: Primary Data

5.3.14 Vehicle Ownership and Type of Vehicle

82% of the households own a vehicle. Tables 5.16 and 5.17 show the details of vehicle ownership. Of which 70.3 % have two-wheelers, 3.5 % own Auto Rickshaw, 18% a four-wheeler. 18% have no vehicles.

Table 5.16: Vehicle Ownership

Vehicle Ownership	Frequency	Per cent
Yes	210	82.0
No	46	18.0
Total	**256**	**100.0**

Source: Primary Data

Table 5.17: Type of Vehicle

Type of Vehicle	Frequency	Per cent
Two Wheeler	180	70.3
Auto Rickshaw	9	3.5
Four Wheeler	21	8.2
No Vehicle	46	18.0
Total	**256**	**100.0**

Source: Primary Data

5.3.15 Source of Energy

100% of the sample households use electricity as the primary energy source.

Table 5.18: Source of Energy

Source of Energy	Frequency	Per cent
Electricity	256	100.0

Source: Primary Data

5.3.16 Monthly Income of the People

The households have an average income of Rs. 34414.06. The minimum income is Rs. 5000, and the maximum is Rs. 85,000, with a Standard Deviation of 15296.047.

Table 5.19: Grouped Monthly Income

Income	Frequency	Per cent
5000-15000	24	9.4
15000-25000	35	13.7
25000-35000	76	29.7
35000-45000	43	16.8
45000-55000	54	21.1
55000-65000	20	7.8
65000-75000	3	1.2
75000-85000	1	.4
Total	**256**	**100.0**
Mean		***34414.06***
Std. Deviation		***15296.047***
Minimum		***5000***
Maximum		***85000***

Source: Primary Data

While considering the grouped monthly income of the people, 13.7% of the people have income in the range of 15000-25000. 29.7% have income between 25000- 35000. 16.8% have an income of 35000-45000. 21.1% of the households have income between Rs 45000-55000. 9.4% of the households have income between Rs 5000-15000. 7.8 % have income between 55000- 65000. 1.2 % of the people have income from 65000-75000. Only .4% has an income of Rs. 75000-85000.

5.4 Socio-Economic and Environmental Impact of Quarrying on Local People

Three components: society, economy and environment seem more relevant in analysing the threats to the sustainability of acquired human development. The average impact of quarrying on

these three components will be the total impact of quarrying activities in the locality, and that overall impact will determine whether it is a threat to sustainable life or not. The variables to analyse the socio-economic and environmental impacts of quarrying were fixed based on the literature review (Vandana et al., 2020; Sajeev & Alex, 2017).

5.4.1 Social Impact of Quarrying (SIQ)

This section discusses the social impact of quarrying by analysing the social issues generated due to the quarrying activities in the locality. Agreement of the respondents regarding the social issues entered using the point Likert scale. The level of agreement varies from Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree and Strongly Agree, with scores of 1,2,3,4 and 5, respectively. Four variables are considered for the analysis of the social impact of quarrying, namely, Health Issues (HI), Tranquility of the Surroundings (TS), Safety Issues (SI) and Damages to Amenities (DA). Each of them is discussed in detail in the following sections.

5.4.1.1 Health Issues (HI)

Health Issues (HI) consist of respiratory Diseases due to increased dust particles (HI_1), Hearing Impairment due to high volume of sound (HI_2), Mental Disturbance (HI_3), Fear and Anxiety (HI_4) and Injuries due to falling of rock particles (HI_5). Variables and statements are given in the following table.

Table 5.20: Health Variables and Statements

Variable		Statement	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Health Issues (HI)	HI_1	Respiratory Diseases due to increased dust particles					
	HI_2	Hearing Impairment due to high volume of sound					
	HI_3	Mental disturbance due to quarrying activities					
	HI_4	Fear and anxiety					
	HI_5	Injuries due to falling of stone particles or other quarrying activities					

Author's Compilation

The responses of the households are presented in Table 5.21

Table 5.21: Health Issues

Scale of Agreement	Total Responses to Statements in Percentage				
	HI_1	**HI_2**	**HI_3**	**HI_4**	**HI_5**
Strongly Disagree	1.2	.8	.8	.8	.8
Disagree	15.6	65.2	54.7	30.9	73.8
Neither Agree Nor Disagree	0	2.0	0	0	0
Agree	15.6	18.8	34.4	28.5	20.3
Strongly Agree	67.6	13.3	10.2	39.8	5.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

Table 5.21 depicts that 1.2% of the respondents strongly disagree that they are experiencing respiratory diseases due to increased dust particles (H_1) by quarry-related activities. 15.6% of the respondents disagree with the statement. However, 15.6% of the respondents agree with the statement, and 67.6% strongly agree. The percentage analysis of the agreement level shows that most respondents experience respiratory diseases due to dust. More specifically, 83.2% of the respondents agree with the statement with different agreement levels.

While considering the second variable related to health issues, which is hearing impairment due to high volume of sound (H_2), it is evident from the table that .8% of the respondents strongly disagree with the statement, and 65.2% of the respondents disagree with the statement. 2% of the respondents took an indifferent stand in this matter. 18.8% of the respondents agree that there is hearing impairment due to high volume, and 13.3 % of the respondents strongly agree on this issue. Unlike in the case of respiratory difficulties, the majority of the respondents, about 66%, deny that they experience hearing issues due to quarrying. However, a considerable % of the respondents, 32.1 %, agree or strongly agree that they have hearing impairment due to quarrying activities.

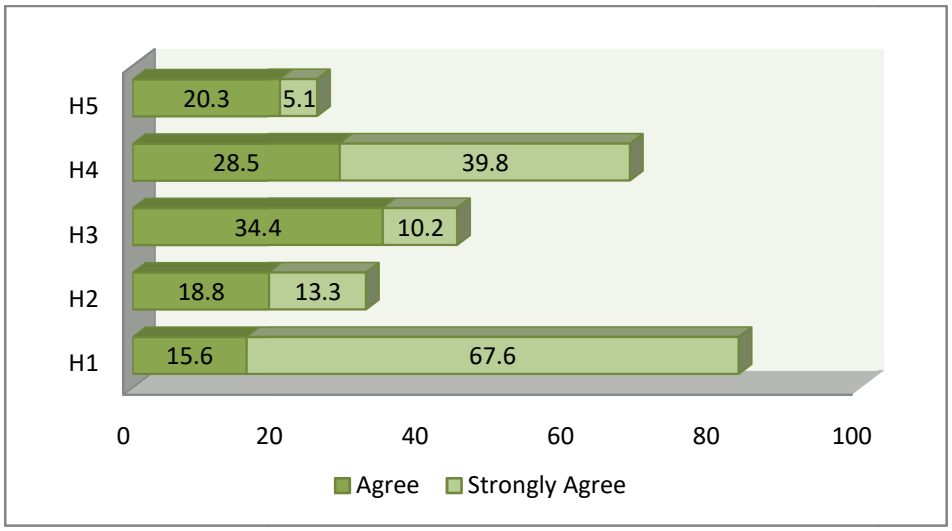
"Do you experience mental disturbance due to quarrying?" has been used to assess the third variable of health issues, HI3. 0.8% of the people strongly disagree with the statement, and

54.7% disagree. That means the majority of the respondents, about 55.5%, strongly disagree or disagree that they experience mental disturbance due to quarrying. However, about 44.6% of the respondents agree (34.4%) or strongly agree (10.2%) that they experience mental disturbance due to quarrying.

The fourth variable of health issues, HI_4, tried assessing the agreement of the local people regarding the experience of fear and anxiety due to quarrying. 0.8% of the respondents strongly disagree with that statement, and 30.9% disagree. Whereas the majority of the respondents, about 68.3%, agree (28.5%) or strongly agree (39.8%) that quarrying activities generated fear and anxiety among the locals.

Respondents are asked about the injuries that happened to the household due to falling rock particles or any other quarry-related activities, and variable HI_5 assess the agreement on that statement. Incidents of injuries, especially severe injuries, are rare. 0.8% of the respondents strongly disagree with the statement, and about 73.8% the majority disagree. However, 20.3% of the respondents agree with the statement, and 3.1% of the respondents strongly agree with the statement. Falling of small rock particles is very frequent in the houses staying near the quarrying area. An injury from such falling is rare, but some people experience such incidents.

Diagram 5.3: Agreement to Health Issues related Statements



Source: Primary Data

Health issues related to quarrying show that respiratory diseases (H1) are prevalent among people due to inhaling dust particles from the quarrying area and traffic. Fear and anxiety (H4) is the second most serious problem the local people face due to health-related issues. It is evident from Figure 5.3 that hearing impairment (H2), mental disturbances (H3) and injuries (H5) are not prominent issues related to the quarrying of the residents. If these variables are used, the percentage of people who agree or strongly agree is lower than that of respondents who disagree or strongly disagree with the statements.

5.4.1.2 Tranquility of the Surroundings (TS)

To analyse the social impact of quarrying, the locality's tranquility is considered a variable. The tranquility of the Surroundings (TS) includes Loss of calmness (TS_1), Prevalence of Uneasiness (TS_2), Loss of Concentration (TS_3) and Disturbance to students, kids, aged or patients (TS_4). Variables and statements are given in the following table.

Table 5.22: Tranquility of Surrounding; Variables and Statements

Variable		Statements	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Tranquility of Surroundings (TS)	TS_1	Loss of Calmness					
	TS_2	Prevalence of uneasiness					
	TS_3	Loss of Concentration					
	TS_4	Disturbance to kids, aged, students and patients					

Author's Compilation

The responses of the households are presented in Table 5.23

Table 5.23: Tranquility of the Surroundings

Scale of Agreement	Total Responses to Statements in Percentage			
	TS_1	TS_2	TS_3	TS_4
Strongly Disagree	.8	.8	.8	.8
Disagree	25.8	49.6	40.2	22.3
Neither Agree Nor Disagree	0	0	0	0
Agree	73.4	49.6	59.0	27.7
Strongly Agree	0	0	0	49.2
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

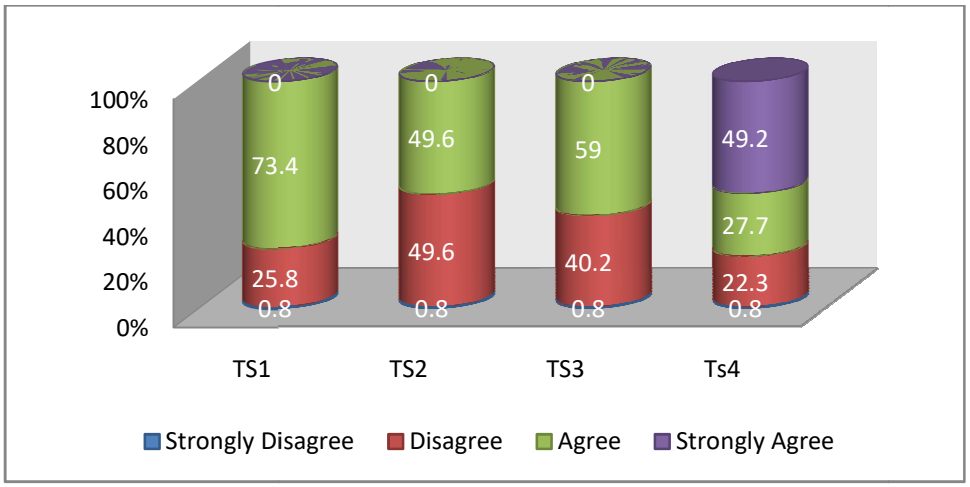
0.8% of the people strongly disagree that there is a loss of calmness (TS_1) after the functioning of the quarry. 25.8% of the total respondents disagree that there is a loss of calmness in their locality. However, the majority of the respondents, about 73.4%, experienced a loss of calmness in their locality after the functioning of the quarry. No respondent conveyed a strong agreement towards the statement.

However, in the prevalence of uneasiness (TS_2), the percentage of disagreement is slightly higher than the agreement. Here, 0.8% of the respondents strongly disagree, and 49.6% disagree with the statement that after the functioning of the quarrying, there is a prevalence of uneasiness in the locality. 49.6% of the respondents agree with the statement.

Considering the loss of concentration (TS_3), 0.8% strongly disagree that there exists the problem of loss of concentration in their area due to quarrying. 40.2 % of the respondents disagree with the statement. However, 59.0% agree that there is a loss of concentration due to quarrying-related disturbances.

Table 5.22 underlines that disturbance to students, kids, aged, and patients (TS_4) is significant in the quarrying area. Only 0.8% strongly disagrees, and 22.3% disagree with that statement. However, 27.7% of the respondents agree, and 49.2% strongly agree that quarrying disturbs students, kids, older adults and patients. Here, the agreement is considerably higher than the disagreement. Figure 5.4 visualises the agreement disagreement percentage to tranquility-related statements.

Figure 5.4: Tranquillity of the Surroundings



Source: Primary Data

The figure shows that agreement is higher than disagreement, except in the case of TS2. In TS_2, the difference between agreement and disagreement is only 0.8%. This shows that most people experience that the tranquility of the quarrying area is lost after the functioning of the quarry.

5.4.1.3 Safety Issues (SI)

The variable safety issues consist of four sub-variables, namely the Threat of cracks or feebleness of house (SI1), Fear of loss of settlement (SI2), Fear of Landslides (SI3) and Fear of Earth Quakes (SI4). Variables and statements are given in the following table.

Table 5.24: Safety Issues - Variables and Statements

Variable		Statements	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Safety Issues (SI)	SI_1	Threat of cracks or feebleness of house					
	SI_2	Fear of loss of settlement					
	SI_3	Fear of landslides					
	SI_4	Fear of earthquakes					

Author's Compilation

The people's agreement and disagreement percentages are given in Table 5.25.

Table 5.25: Safety Issues

Scale of Agreement	Total Responses to Statements in Percentage			
	SI_1	SI_2	SI_3	SI_4
Strongly Disagree	0	.8	.8	.8
Disagree	19.1	23.8	22.3	29.7
Neither Agree Nor Disagree	0	0	0	0
Agree	30.9	26.2	21.5	57.8
Strongly Agree	50.0	49.2	55.5	11.7
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

The fieldwork showed that the threat of feebleness or cracks (SI_1) on houses is significant in the residential areas near the quarries. Only 19.1 % of the respondents disagree that houses are threatened by cracks or feebleness near the quarrying area. 30.9 % of the respondents agree with the statement, and 50% of the respondents strongly agree with the statement.

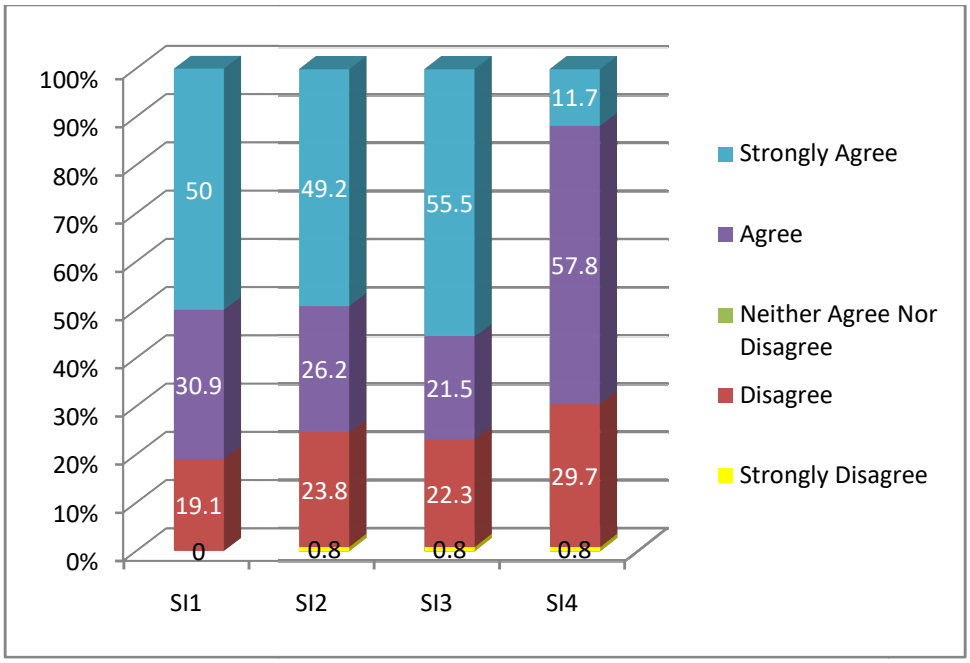
Like the SI_1, fear of loss of settlement (SI_2) is very high among the respondents. Most of them expect displacement or severe damage to their houses shortly. 0.8% strongly disagree with the statement, and 23.8% disagree. However, 26.2% of the respondents agree, and 49.2% strongly agree with the statement.

Fear of landslides (SI_3) is another security issue near the quarrying area. One of the sample quarry areas in Ottappalam taluk had already gone through a landslide during the flood of 2018. One house was damaged in that landslide, and three houses are in a precarious situation and fear landslides in the rainy season. Elevation of the locality, size of the quarry, frequency of explosion and distance from the quarrying area to the residential area are the significant factors that influence the landslide probability of a locality. Therefore, responses vary according to the features of the selected area. 0.8% of the respondents strongly disagree, and 22.3% disagree with the fear of landslides in their locality. However, 21.5% of the respondents agree that they fear landslides, especially during the rainy season, and 55.5% strongly agree.

Fear of earthquake (SI_4) is another variable used to assess the security issues of quarrying. 0.8% of the respondents strongly disagree, and 29.7% of the people disagree with the statement that there is fear of earth earthquakes in their locality after the functioning of quarrying. However, 57.8% of the respondents fear that an earthquake will affect their settlement because they are experiencing an earthquake-like situation throughout the year due to frequent blasting from quarrying sites.

Figure 5.6 below summarises the percentage of agreement and disagreement regarding the security issue-related statements.

Figure 5.5: Agreement and Disagreement towards Security Issue Statements



Source: Primary Data

Figure 5.6 shows that strong disagreement towards statements related to security issues is nominal, and the majority reveals a strong agreement or agreement towards these statements.

5.4.1.4 Damages to Amenities (DA)

Damage to amenities is considered the fourth variable to assess the security issues of quarrying. The pilot study and field experience found that cracks in houses and road damage due to overuse and less maintenance are the two main problems affecting the local people as damages to their amenities. Here, damage to the house is a personal loss, and damage to the road is a collective issue of the residents. Therefore, Damages to Amenities consist of 2 variables: Cracks on houses

(DA_1) and Damages to roads/overuse of roads (DA_2). Variables and statements are given in the following table.

Table 5.26: Damages to Amenities - Variables and Statements

Variable		Statements	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Damages to Amenities (DA)	DA_1	Cracks on house					
	DA_2	Overuse of roads					

Author's Compilation

The percentage of agreement and disagreement of the respondents towards the statement" Is there any damage to your houses and road networks in your locality due to quarrying?" is given in Table 5.27.

Table 5.27: Damages to the Amenities

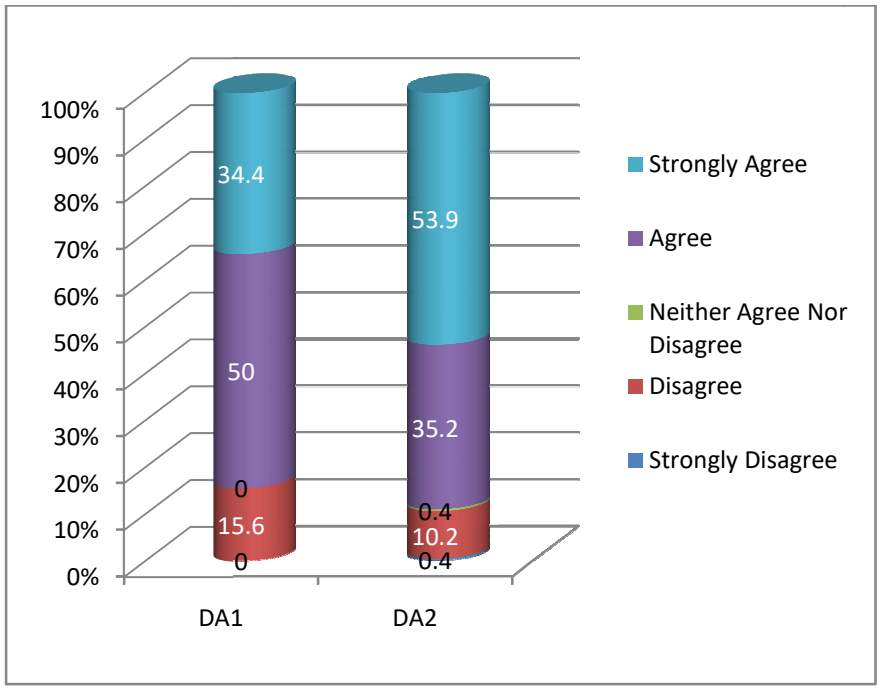
Scale of Agreement	Total Responses to Statements in Percentage	
	DA_1	DA_2
Strongly Disagree	0	.4
Disagree	15.6	10.2
Neither Agree Nor Disagree	0	.4
Agree	50.0	35.2
Strongly Agree	34.4	53.9
Total	**100**	**100.0**

Source: Primary Data

The possibility of cracks depends on the area's elevation, distance from the quarry, frequency of blasting and strength of the building. 15.6% of the respondents disagree that there are cracks in their houses (DA_1) due to blasting from the quarry. However, 50 % of the respondents agree, and 34.4% strongly agree with the statement. Cracks on houses are the major personal issue of households residing near the quarrying area. Even new houses are affected by these cracks. It is a real threat to the people residing near almost all quarrying areas.

Damages to the road facilities are another issue facing the locals as damage to their amenities. Respondents observed that road networks improved after the functioning of quarrying. However, later, it caused unrepairable damage to these roads. Overuse of roads by heavy vehicles and less maintenance is the leading cause. 0.4% of the respondents strongly disagree with the statement that quarrying-related traffic damaged the road networks in their area. 10.2% disagree with the statement. 0.4 % neither agree nor disagree with the statement. However, 35.2% agree that quarry-related traffic damaged roads in their area and 53.9% of the respondents strongly agree with that statement. During the field survey, it was observed that damage to the road is the issue raised by most people than damage to individual amenities like houses. The following figure summarises the people's responses regarding the damage to amenities.

Figure 5.6: Agreement and Disagreement Summary- Damages to Amenities



Source: Primary Data

Figure 5.7 shows that agreement levels in both cases are very high.

5.4.2 Economic Impact of Quarrying (EIQ)

This chapter section tries to analyse the economic impact of quarrying on the local people. Quarrying is an economic activity. It employs people and generates income for the economy.

The role of quarrying as a productive economic activity must be addressed. Therefore, positive or negative economic impact should be considered when assessing the total impact of quarrying on a locality. The economic impact of quarrying is assessed in two dimensions: economic impact on the household and economic impact on the locality. Data on the economic advantages of quarrying to households (EAH) and locality (EAL) are collected separately. The following sections discuss both variables and their components in detail.

5.4.2.1 Economic Advantages to the Households (EAH)

For analysing the economic advantages to the household, four variables have been taken, namely, direct and indirect employment opportunities to the household (EAH_1), increase in the market price of the property or land of the household (EAH_2), increase in the income of the household (EAH_3), and improvement in the infrastructure/ road facilities (EAH_4) using 5 points Likert scale questionnaire. Variables and statements are given in the following table.

Table 5.28
Economic Advantages to the Households- Variables and Statements

Variable		Statement	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Economic Advantage to the Household (EAH)	EAH_1	Direct and indirect employment opportunities in the household increased					
	EAH_2	The market price of the property or land of the household increased.					
	EAH_3	The income of the household increased.					
	EAH_4	Infrastructure /Road facilities near the household improved.					

Author's Compilation

Table 5.25 shows details of responses.

Table 5.29: Economic Advantages to the Households

Scale of Agreement	Total Responses to Statements in Percentage			
	EAH_1	**EAH_2**	**EAH_3**	**EAH_4**
Strongly Disagree	11.7	38.3	34.8	3.1
Disagree	73.8	48.0	47.7	59.0
Neither Agree Nor Disagree	1.6	0	1.6	0
Agree	7.8	13.7	14.5	35.5
Strongly Agree	5.1	0	1.6	2.3
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

11.7% of the households strongly disagreed with the statement that direct and indirect employment opportunities to the household (EAH_1) increased after quarrying. 73.8% of the respondents disagreed with the same. That means a majority of the respondents, 85.5%, denied that quarry activities provided any job opportunities to them. 1.6% of the respondents neither agree nor disagree with the statement, and 7.8% agree that after the functioning of the quarry, employment opportunities increased for them. 5.8% of the respondents strongly agree with that statement.

Likewise, the majority of the respondents strongly disagree (38.3%) and disagree (48.0%) that quarrying activities helped to improve the market price of their land or property (EAH_2). Only 13.7% of the respondents agree with the statement. Some households responded that the quarrying activities considerably decreased the value of their property as the damages to property were high.

34.8% of the respondents strongly disagree, and 47.7% disagree with the statement that the quarry's functioning has increased the household's income (EAH_3). 1.7% of the respondents neither agree nor disagree with the statement. However, 14.5 % of the respondents agree that quarrying helped improve the household's income. Only 1.6% strongly agree with the statement.

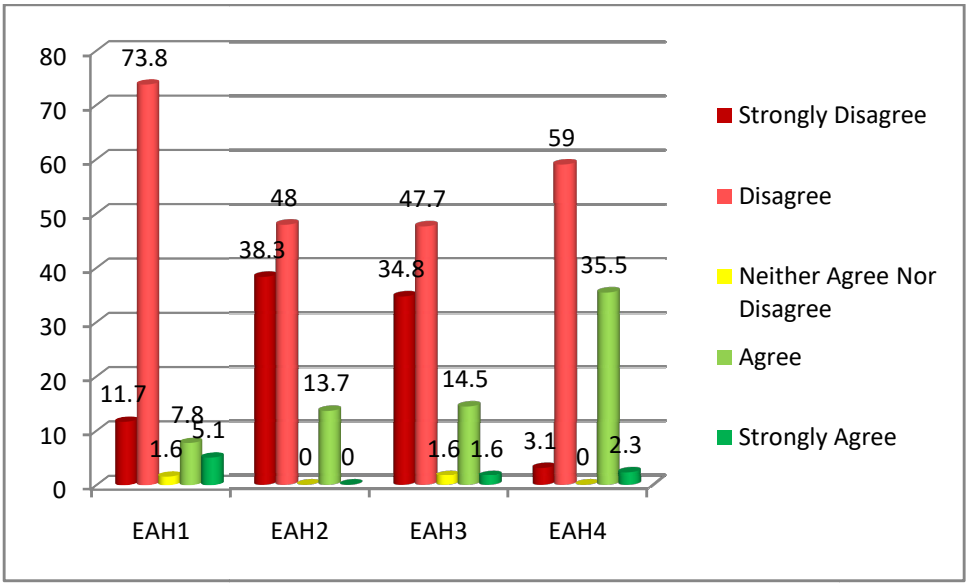
Infrastructure improvement, especially road facility (EAH_4), is another component of EAH. 3.1% of the respondents strongly disagree, and 59% disagree that infrastructure near their houses improved after the functioning of quarrying. Compared to the other three components of variable EAH, the percentage of agreement in the case of component EAH_4 is high. 35.5 % of the respondents agree, and 2.3% strongly disagree with that statement. This shows that respondents

are somewhat optimistic about the statement that infrastructure/ road facilities near the household improved. The significant economic contribution of quarries to the locality is that the road network has improved as part of its functioning. However, damages to roads due to overuse are also significant. Many respondents, however, noted that a road network to their remote location was possible with this quarry.

The following figure summarises the responses of the households.

Figure 5.7

Agreement and Disagreement Summary- Economic Advantages to Household



Source: Primary Data

Figure 5.8 summarises that though quarrying is an economic activity, benefits to local people are marginal. This is evident from the responses of the local people. 85.5% of the respondents strongly disagree or disagree that there is an increase in the household's direct and indirect employment opportunities, and 86.8% deny an increase in the market price of land or property of the household. Likewise, 82.5% strongly disagree or disagree that income increased due to quarrying and 62.1% strongly disagree or disagree that there is an improvement in the infrastructure near their houses after quarrying.

5.4.2.2 Economic Advantages to the Locality (EAL)

The economic advantage of quarrying to the locality (EAL) is considered separately during the data collection. EAL includes direct and indirect employment opportunities for the people in the

locality (EAL_1), an increase in the market price of the land (EAL_2), improvement in the infrastructure facilities of the locality (EAL_3), increase in the commercial importance of the locality (EAL_4) and increase in the income of the people (EAL_5).

Variables and statements are given in the following table.

Table 5.30: Economic Advantage to the Locality- Variables and Statements

Variable		Statement	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Economic Advantage to the Locality (EAL)	EAL_1	Direct and indirect employment opportunities for the people in the locality increased.					
	EAL_2	The market price of the land in the locality increased.					
	EAL_3	Infrastructure Facilities of the locality increased.					
	EAL_4	Market Places improved					
	EAL_5	The income of the people increased.					

Author's Compilation

Table 5.31: Economic Advantages of Quarrying to the Locality

Scale of Agreement	Total Responses to Statements in Percentage				
	EAL_1	EAL_2	EAL_3	EAL_4	EAL_5
Strongly Disagree	15.6	40.6	2.3	38.3	41.4
Disagree	62.1	44.5	56.6	45.3	23.8
Neither Agree Nor Disagree	1.6	0	0	1.6	2.3
Agree	20.7	14.8	38.3	14.1	32.0
Strongly Agree	0	0	2.3	.8	.4
Total	**100.0**	**100**	**100**	**100.0**	**100.0**

Source: Primary Data

It is evident from Table 5.26 that 15.6% of the respondents strongly disagree that there is an increase in direct and indirect employment opportunities for the people in the locality (EAL_1) after the functioning of quarrying. 62.6% disagree with this statement, and 1.6% of the

respondents neither agrees nor disagrees. However, 20.7% agree that an increase in direct and indirect employment opportunities happened after the functioning of the quarry.

The responses to EAL_2 exhibit that 40.6 % of the respondents strongly disagree that the market price of the land in their locality increases after quarrying. 44.5% of respondents disagree with this, and 14.8 % agree with the statement.

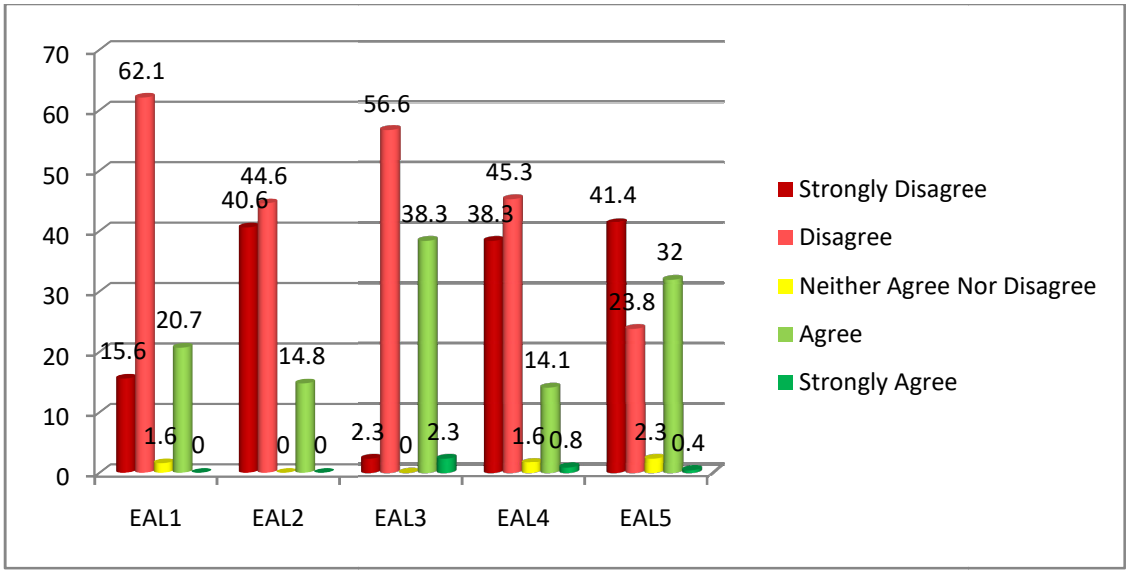
2.3% of the respondents strongly disagree that there is an improvement in the locality's infrastructure after the quarry functioned, and 56.6% disagree. However, 38.3% of the respondents agree, and 2.3% strongly agree that there is infrastructural development after the functioning of the quarry in their locality.

In response to the question, "Has the commercial importance of your community increased since quarrying?" 45.3% disagree, and 38.3% strongly disagree. 1.6% of the respondents neither agree nor disagree with the statement. 14.1% of the respondents agree, and 0.8% strongly agree with the statement.

Considering the increase in the people's income after the quarry's functioning, 41.4% strongly disagree, and 23.8% disagree with the statement. 2.3% of the respondents neither agree nor disagree with the statement. However, 32% agree, and .4% strongly agree that the income of the people increased after quarrying. The agreement and disagreement of the respondents towards the economic impact of quarrying in the locality is summarised in the following figure.

Figure 5.8

Agreement Disagreement Summary- Economic Advantages to the Locality



Source: Primary Data

Figure 5.9 shows that in the case of all five components of economic advantages, the locality disagreement level is higher than the agreement level. That means even if quarrying is an economic activity; its benefits are not distributed in the local area where the quarry is functioning. The field study showed that employment opportunities for the local people are very limited in these quarries. Quarry operators hire non-Keralite migrant workers in their quarry sites. Likewise, infrastructure development is also confined to the construction of roads, which is unavoidable for the movement of extracted stones from the sites. These roads are too highly damaged due to the frequent use and less maintenance. From these analyses, the economic advantages of quarrying are not shared in the locality where the quarry is located. This is indirectly creating opposition among the local people against the quarrying activities. Where people get jobs, they are less resistant to quarrying.

5.4.3 Environmental Impact of Quarrying (EIQ)

As quarrying is an act of extracting non-renewable resources from the earth, its impact on the local area will be higher than that of the economic impact of it. Four significant variables are analysed to determine the environmental impact of quarrying in terms of the environmental disadvantage of quarrying to the locality. They are landscape Changes (LC), Air Quality (AQ), Noise Level (NL) and Water Level (WL). These components are selected according to the pilot study findings. Details of variables are given in the following section.

5.4.3.1 Landscape Changes

Landscape change is the most visible and immediate adverse effect of quarrying in any locality. Landscape changes considered six components. They are Disfiguration (LC_1), Wetland Destruction (LC_2), Loss of Topsoil (LC_3), Change in Soil Character (LC_4), Change in the productivity of Soil (LC_5), and Change in Natural Vegetation and Biodiversity (LC_6). Variables and statements are given in the following table.

Table 5.32: Landscape Changes- Variables and Statements

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Landscape Changes (Changes to Landscape, soil and biodiversity) (LC)	LC_1	Disfiguration					
	LC_2	Wetland Destruction					
	LC_3	Loss of topsoil					
	LC_4	Change in Soil Character					
	LC_5	Change in Productivity					
	LC_6	Change in Natural Vegetation and Biodiversity					

Author's Compilation

People's reactions to the statement related to the landscape changes related to the quarrying are given in Table 5.33.

Table 5.33: Landscape Changes (LC)

Scale of Agreement	Total Responses to Statements in Percentage					
	LC_1	LC_2	LC_3	LC_4	LC_5	LC_6
Strongly Disagree	0	1.6	0	0	0	0
Disagree	0	15.6	15.6	30.5	29.3	17.6
Neither Agree Nor Disagree	.4	.8	.8	4.3	.8	.8
Agree	33.6	69.1	66.0	45.7	55.5	59.8
Strongly Agree	66.0	12.9	17.6	19.5	14.5	21.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

Responses of people towards the statement related to the disfiguration of the location (LC_1) after quarrying show that 33.6% agree and 66% strongly agree that considerable disfiguration happened in their locality after the extraction process. Only .4% of the respondents neither agrees nor disagrees with the statement. It is also very concrete that nearly 100% of the respondents agree that the quarrying process caused the area's deformity and that none of them refutes it is, therefore, substantial.

The next component of the variable Landscape, LC_2, shows the agreement level of people towards the wetland destruction that happened in the locality after quarrying. 1.6% of the respondents strongly disagree, and 15.6 % disagree with the destruction of wetlands due to quarrying. 0.8% of the respondents neither agree nor disagree with the statement. However, 69.1% agree, and 12.9% strongly agree that quarrying activities severely affect wetlands. Some local people observe that the dumping of sediments and debris caused the disappearance of wetlands in the lower portions of the quarrying site.

15.6% of respondents who answered the question about topsoil loss (LC_3) disagree that quarrying causes topsoil loss in their area. 0.8% of the respondents neither agree nor disagree with the statement. However, 66% of the people agree, and 17.6% strongly agree that quarrying causes wetland destruction.

Changes in the soil character (LC_4) is the another component of landscape changes. 30.5% of the respondents disagree that soil character is affected by quarrying. 4.3% of the respondents neither agree nor disagree with that statement. However, 45.7 % of the respondents agree, and 19.5% strongly agree that soil character changes due to quarrying.

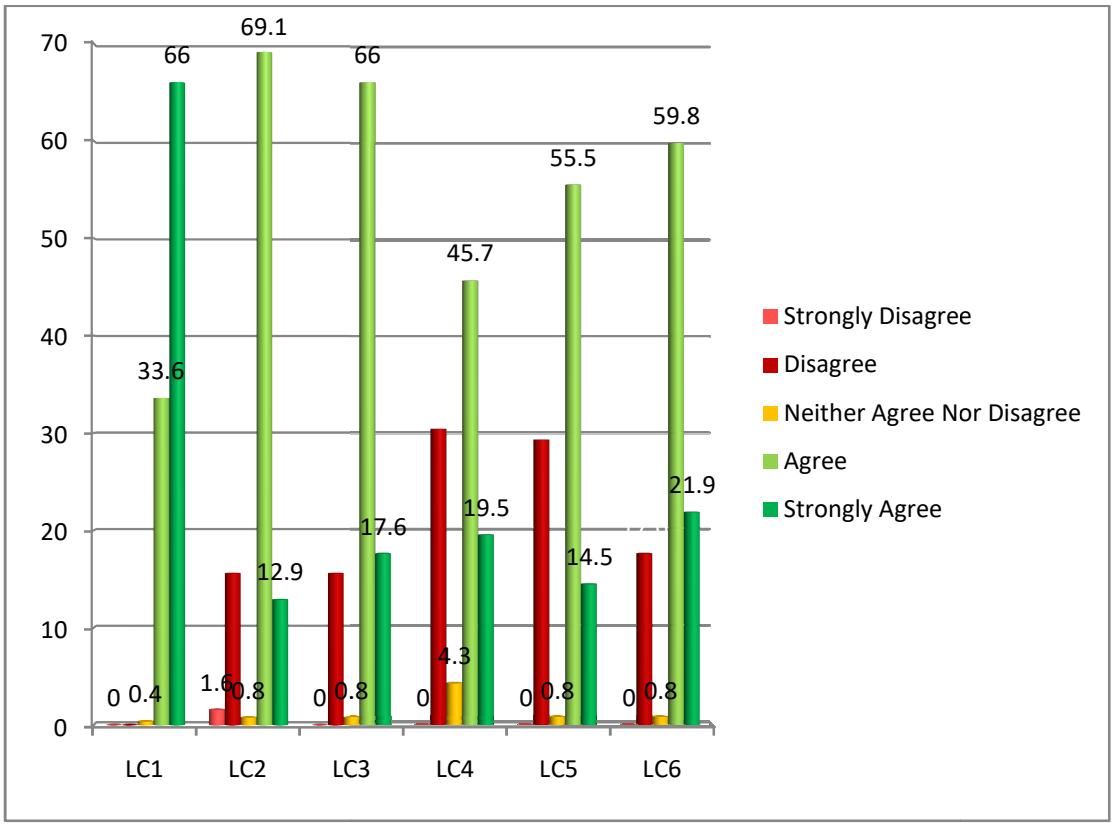
Responses to the statement related to the changes in soil productivity (LC_5) show that 29.3% of the respondents disagree that changes in soil productivity did happen due to quarrying-related activities. 0.8% neither agrees nor disagrees with the statement. However, 55.5% agree, and 14.5% strongly agree that the soil's productivity has decreased due to the soil alterations brought on by quarrying.

People’s reactions to the final component of landscape changes, LC_6 indicates that 17.6 % of them disagree that changes in natural vegetation and biodiversity occurred related to quarrying. 0.8 % of the respondents neither agrees nor disagrees with the statement. However, 59.8% of the respondents agree, and 21.9% strongly agree that quarrying considerably reduced their locality's natural vegetation and biodiversity.

The responses to the landscape-related questions are summarised in the following figure.

Figure 5.9

Agreement Disagreement Summary- Landscape Changes to the Locality



Source: Primary Data

Figure 5.10 illustrates that the disagreement level towards landscape changes is lower than the agreement level. That proves landscape changes to the locality because quarrying is accurate, and people are very aware of that.

5.4.3.2 Air Quality (AQ)

Air Quality consists of five components, namely: Dust Emission (AQ1), Shattering of rock particles (AQ2), Dust Deposition over Canopy (AQ3), Inhalation of fine particles (AQ4) and High Concentration of Chemicals (AQ5). Variables and statements are given in the following table.

Table 5.34: Air Quality- Variable and Statements

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Air Quality (AQ)	AQ_1	Dust Emission					
	AQ_2	Shattering of rock particles					
	AQ_3	Dust deposition on the Canopy cover					
	AQ_4	Inhalation of fine particulars					
	AQ_5	Higher concentration of Chemicals (Radon & Thorium)					

Author's Compilation

Responses of the local people towards the statement related to air quality components are given in Table 5.35.

Table 5.35: Air Quality of the Location

Scale of Agreement	Total Responses to Statements in Percentage				
	AQ1	AQ2	AQ3	AQ4	AQ5
Strongly Disagree	0	0	0	0	0
Disagree	5.1	18.4	21.9	30.5	23.8
Neither Agree Nor Disagree	0	.8	.8	1.2	12.5
Agree	48.0	39.5	69.5	65.6	63.7
Strongly Agree	46.9	41.4	7.8	2.7	0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

Responses to the statement related to the dust emission (AQ_1) in the locality show that none strongly disagree with the presence of dust emission. Only 5.1% of the respondents disagree that there is dust emission due to quarrying. However, 48.0% of the respondents agree that dust emission is there in their locality due to the functioning of the quarry, and 46.9% strongly agree with the statement. From the field experience, it is clear that dust emission is a severe environmental issue the local people face. Extraction, processing and traffic emit dust to

the locality harmfully. Dust emission is the reason for increased respiratory diseases in residential areas near quarrying sites.

Another component considered for assessing air quality was the shattering of rock particles (AQ_2). 18.4% of the respondents disagree that there is frequent shattering of rock particles during the explosion in the quarrying site. 0.8% of the respondents neither agree nor disagree with this statement. However, 39.5% of the respondents agree, and 41.4% strongly agree that the shattering of rock particles occurs frequently from the quarrying site.

The component dust deposition over the canopy (AQ_3) is considered to assess the intensity of dust emission. 21.9% disagree that there is dust deposition over the canopy of trees in their locality. o.8% neither agree nor disagree with the statement. However, 69.5% of the respondents agree, and 7.8% strongly agree with the statement.

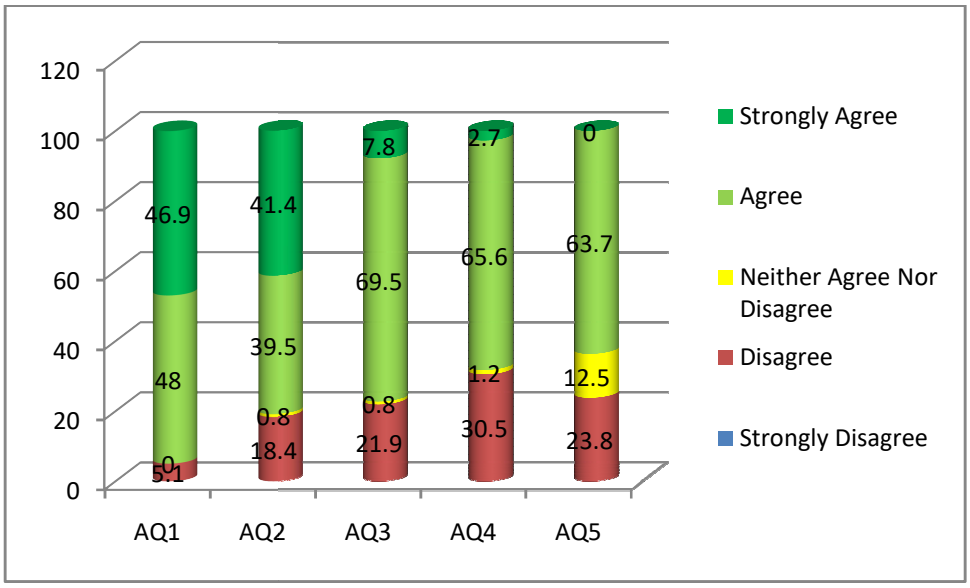
In response to the statement about inhaling fine particulars (AQ_4), 30.5% of the respondents disagreed that inhalation is due to quarrying-related dust emissions. 1.2% of the respondents were indifferent towards the statement. 65.6% of them agree, and 2.7% strongly agree that they are experiencing inhalation of dust due to quarrying.

Responses to the fifth air quality component related to the existence of high concentrations of chemicals (AQ_5) in the locality indicate that 23.8% of the people disagree with the statement. 12.5% of the respondents neither agree nor disagree with the statement. That shows some of them are unaware of chemicals in the air after blasting, or techniques used in different quarries may differ. However, 63.7% agree with the statement. Strong agreement or disagreement is absent in the case of this component.

An illustration of agreement and disagreement level towards the statement related to the air quality is given below.

Figure 5.10

Agreement Disagreement Summary- Air Quality in the Locality



Source: Primary Data

The figure implies that none of the respondents strongly disagreed with the statements related to the air quality. The agreement level of people regarding air quality issues is higher than disagreement in the case of all five components.

5.4.3.3 Level of Noise Pollution (NL)

Noise Level consists of 4 variables. They are Extreme and Continuous Grinding Sound (NL_1), Extreme Machinery Noise (NL_2), Extreme traffic noise (NL_3) and Extreme explosion noise (NL_4). Variables and statements are given in the following table.

Table 5.36: Noise Level- Variables and Statements

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Noise Level (NL)	NL_1	Extreme and continuous grinding sound					
	NL_2	Extreme Machinery noise					
	NL_3	Extreme explosion noise					
	NL_4	Extreme traffic noise					

Author's Compilation

Table 5.29 gives more details.

Table 5.37: Level of Noise Pollution

Scale of Agreement	Total Responses to Statements in Percentage			
	NL_1	NL_2	NL_3	NL_4
Strongly Disagree	0	0	0	0
Disagree	28.9	28.9	17.2	12.5
Neither Agree Nor Disagree	0	0	0	0
Agree	49.6	31.3	11.7	22.3
Strongly Agree	21.5	39.8	71.1	65.2
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

28.9% of the respondents disagree with the statement that extreme and continuous grinding sound (NL_1) exists in your locality from the quarry site. However, 49.6% of the respondents agree with the statement, and 21.5% strongly agree.

Responses to the second component, the extreme machinery noise (NL_2), show that 28.9% of the respondents disagree with the statement. However, 31.3% of the respondents agree with the statement, and 39.8% of the respondents strongly agree the statement.

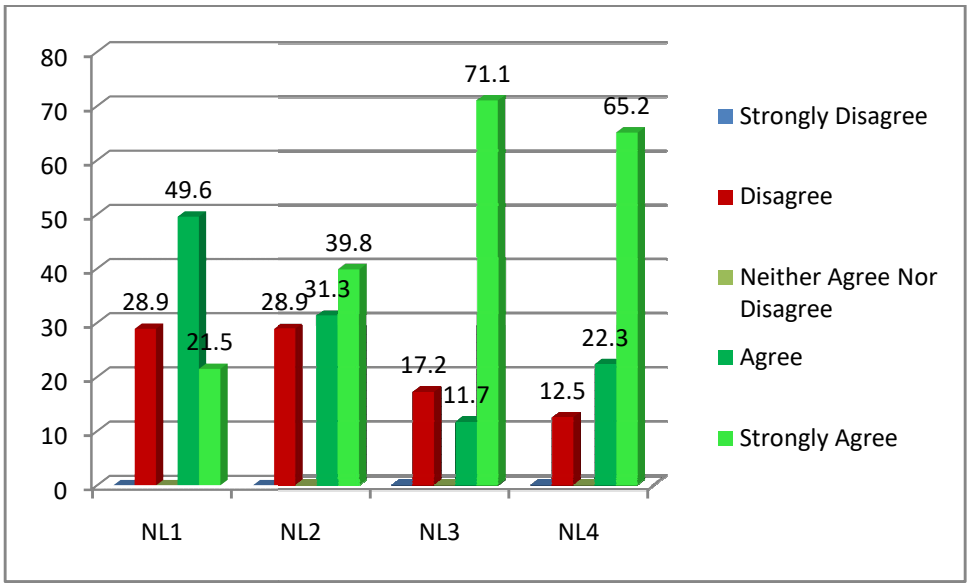
When asked about extreme traffic noise (NL_3) in the quarrying area, 17.2% of the respondents disagreed. 11.7% of the respondents agree and 71.1% strongly agree with that statement. This proves that traffic noise is severe in residential areas near quarrying sites.

An analysis of the responses to the statement about extreme explosion noise reveals that only 12.5% of the respondents disagree with the statement. 22.3 % of the respondents agree that there is extreme explosion noise in their residential area during blasting times, and 65.2% strongly agree.

The figure given below summarises the agreement and disagreement towards the statement related to noise level.

Figure 5.11

Agreement Disagreement Summary- Level of Noise Pollution in the Locality



Source: Primary Data

The figure illustrates that extreme noise is persistent in the residential areas near quarrying sites.

5.4.3.4 Water Related Issues (WI)

Water Level includes six variables, namely, Increased Runoff and Turbidity (WI1), Obstruction in the Water Flow (WI2), Contamination (WI3), Reduced Infiltration (WI4), Water Table Sinking (WI5) and increased use of Water (WI6). Variables and statements are given in the following table.

Table 5.38: Water Related Issues- Variables and Statements

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Water Issues (WI)	WI_1	Increased runoff and turbidity in water during the rainy season					
	WI_2	Obstruction in the water flow					
	WI_3	Contamination					
	WI_4	Reduced Infiltration					
	WI_5	Water table sinking					
	WI_6	Increased use of water					

Author's Compilation

Table 5.30 indicated agreement and disagreement of respondents towards statements related to the water level in the locality.

Table 5.39: Water Related Issues

Scale of Agreement	Total Responses to Statements in Percentage					
	WI_1	**WI_2**	**WI_3**	**WI_4**	**WI_5**	**WI_6**
Strongly Disagree	0	0	0	0	0	0
Disagree	17.6	32.0	30.5	31.3	25.0	11.7
Neither Agree Nor Disagree	0	.4	6.6	1.2	.4	0
Agree	28.9	50.4	59.8	28.5	34.0	14.1
Strongly Agree	53.5	17.2	3.1	39.1	40.6	74.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary Data

17.6% of the people disagree that there is increased runoff and turbidity of water (WI_1) during the rainy season after the functioning of the quarry. However, 28.9% of the respondents experienced increased runoff and turbidity of water in their locality after the functioning of the quarry. 53.5% of the respondents conveyed a strong agreement towards the statement.

However, in the case of obstruction in water flow (WI_2), 32% of the respondents disagree with the statement that after the functioning of the quarry, there is obstruction of water flow in the locality. 0.4% of the respondents neither agree nor disagree with the statement. However, 50.4% of the respondents agree with the statement, and 17.4% strongly agree.

While considering the responses towards water contamination (WI_3), it is evident that 30.5% of the respondents disagree that there is a problem of water contamination in their area due to quarrying. 6.6% of the respondents said they were undecided about the statement. Nonetheless, 59.8% of respondents agree, and 3.1% strongly agree that quarrying has contaminated the water.

Table 5.30 underlines that reduced water infiltration (WI_4) is significant in the quarrying area. 31.3% of the respondents disagree that quarrying has decreased the water infiltration in their locality. 1.2% of the respondents said they were undecided about the statement. However, 28.5% of the respondents agree, and 39.1% strongly agree that quarrying has caused a reduction in water infiltration.

Responses of the people towards the sinking of the water table (WI_5) reveal that 25% of the respondents disagree with that, and 0.4 % was indifferent towards such an issue. However,

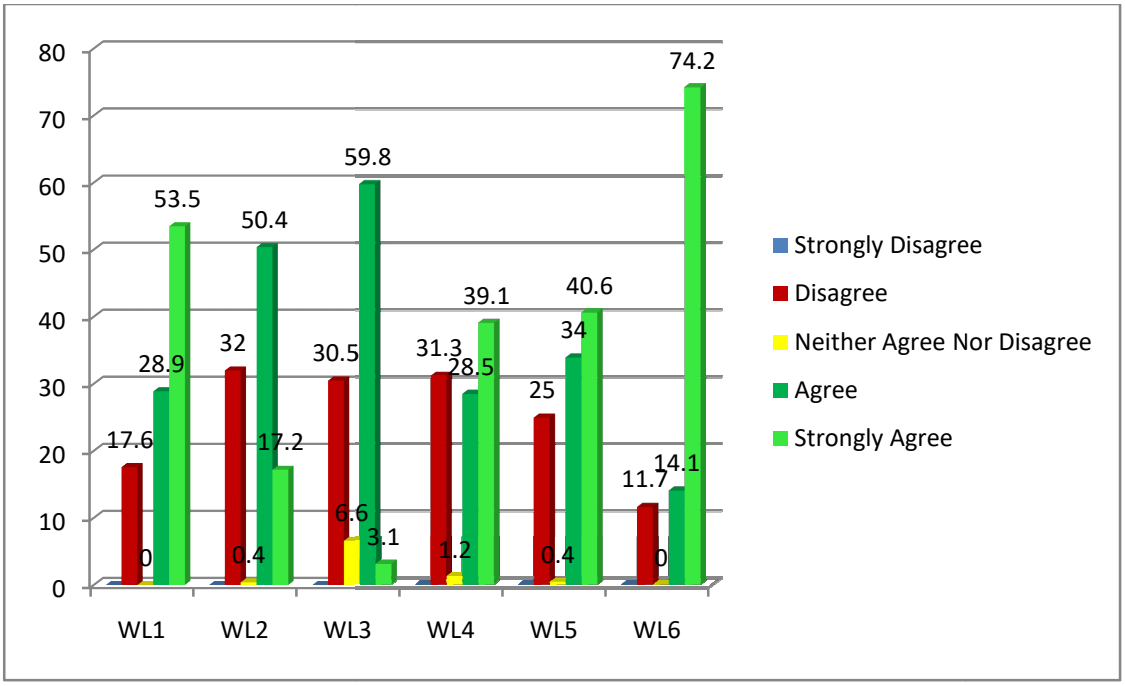
34.0% of the respondents agree, and 40.6% strongly agree that quarrying has caused water table sinking in their locality.

While assessing the responses towards the increased water consumption (WI6), it is evident that 11.7 % of the respondents disagree that there is a problem of water contamination in their area due to quarrying. Nonetheless, 14.1 % of respondents agree, and 74.2 % strongly agree that quarrying has increased water consumption.

Figure 5.12 visualises the agreement and disagreement summary of statements related to the water issues.

Figure 5.12

Agreement and Disagreement Summary- Water Related Issues in the Locality



Source: Primary Data

The figure illustrates that agreement towards the six components of water level is higher than that of disagreement level. Therefore, it is clear that quarries have created many water-related issues in the nearby localities.

5.6 Conclusion

Primary data analysis reveals that people residing near the quarries are exposed to severe negative impacts of quarrying. They face health issues, including mental disturbances, safety issues and damages to amenities as a social impact of quarrying. Considering the economic side

of quarrying, it is evident from the analysis that a very nominal number of local people are working in quarry-related activities. Though the road network in the quarrying areas has improved, their maintenance is poor, and traffic noise and damaged roads are threatening the peaceful life of the natives. Instead of increasing the value of their property, quarrying diminished the market value of their assets. Another critical threat of quarrying is environmental issues. Disfiguration and other types of landscape changes, low air quality due to dust emission and the presence of chemicals, increased noise levels due to traffic explosion and contamination and water table sinking are the major environmental issues faced by the people. The households' socio-economic characteristics reveal that most of them belong to low-income families. Therefore, they are very much vulnerable to the negative socio-economic and environmental impacts of quarrying.

Chapter 6

QUARRYING AND THREATS ON SUSTAINABLE LIFE OF THE LOCAL PEOPLE

- ***Introduction***
- ***Adverse Effects of Quarrying on Sustainable Life***
- ***Impact of Quarrying Index***
- ***Factors Influencing the Impacts of Quarrying in Local Area***
- ***Conclusion***

Chapter 6

QUARRYING AND THREATS ON SUSTAINABLE LIFE OF THE LOCAL PEOPLE

6.1 Introduction

The current chapter endeavours to meticulously analyse the third objective of the present study, which pertains to the detrimental effects of quarrying on the long-term well-being of the local population, the risks to their livelihood and ultimately, the threats to acquired human development. The analysis is conducted through both statistical and qualitative methods. This chapter also attempts to construct a sustainability index that quantifies the socio-economic and environmental impacts of quarrying. Moreover, the chapter delves into a detailed discussion of the major factors that influence the impacts of quarrying in the local area.

6.2 Threats to the Sustainable Life of the Local People

Based on the responses of the local people, a variable to assess the threat of quarrying on the sustainable life of the people, namely the Adverse Effect of Quarrying on Sustainable Life (AEQSL), is constructed. It is assumed that the variable AEQSL reveal the total impact of quarrying as a summation of its socio-economic and environmental impact.

Table 6.1 shows the case processing summary of the model. The Case processing summary details the frequency of different levels of disagreement towards the question, "Do you think the functioning of this quarry adversely affected the sustainable life of the people in this locality?" The summary shows that 62% of the respondents agree with the statement, and 17.6% strongly agree. A very nominal percentage of the respondents, 0.8%, neither agrees nor disagree with the statement. Only 2.3% strongly disagree with the statement, and 16. 8% disagree with the statement.

Table 6.1: Adverse Effect of Quarrying on Sustainable Life (AEQSL)

AEQSL	Scale of Agreement	N	Percentage
"Do you think the functioning of this quarry adversely affects the sustainable life of the people in this locality?"	Strongly Disagree	6	2.3%
	Disagree	43	16.8%
	Neither Agree Nor Disagree	2	0.8%
	Agree	160	62.5%
	Strongly Agree	45	17.6%
	Total	**256**	**100%**

Source: Primary Data

6.2.1 Rank Correlation of AEQSL, EAQ, SCQ and EnDQ

Since the data is not normally distributed, Spearman's rank correlation is applied for the analysis. This shows that AEQSL has a significant negative correlation with EAQ (-. 519) and a significant positive correlation with SCQ (.443) and EnDQ (.471). Details are given in table 6.2.

Where,

AEQSL = **Adverse Effect of Quarrying on Sustainable Life**

EAQ = Economic Advantages of Quarrying

SDQ = Social Disadvantages of Quarrying and

EnDQ = Environmental Disadvantages of Quarrying

Table 6.2: Rank Correlation of AEQSL, EAQ, SCQ and EnDQ

			AEQSL	T_EAQ	T_SDQ	T_EnDQ
	AEQSL	Correlation Coefficient	1.000	-.519**	.443**	.471**
		Sig. (2-tailed)	.	.000	.000	.000
		N	256	256	256	256
	T_EAQ	Correlation Coefficient	-.519**	1.000	-.808**	-.727**
		Sig. (2-tailed)	.000	.	.000	.000
		N	256	256	256	256
	T_SCQ	Correlation Coefficient	.443**	-.808**	1.000	.765**
		Sig. (2-tailed)	.000	.000	.	.000
		N	256	256	256	256
	T_EnDQ	Correlation Coefficient	.471**	-.727**	.765**	1.000
		Sig. (2-tailed)	.000	.000	.000	.
		N	256	256	256	256
**. Correlation is significant at the 0.01 level (2-tailed).						

Source: Computed from the primary data

6.2.2 Adverse Effect of Quarrying on Sustainable Life (AEQSL) - Regression Analysis

Since data is not normally distributed, Ordinal Regression Analysis is used for the analysis.

$$\mathbf{AEQSL = \beta_0 + \beta_1\, EAQ + \beta_2\, SDQ + \beta_3\, EnDQ + u}$$

Where,

AEQSL = Adverse Effect of Quarrying on Sustainable Life

EAQ = Economic Advantage of Quarrying

SDQ = Social Disadvantages of Quarrying

EnDQ = Environmental Damages/ Disadvantages of Quarrying

β_0 = Intercept

β_1, β_2 &β_3 = Slope Co-efficient

u = Random Error Component

Table 6.3 gives the model fitting information. The significance value in the table is 0.00. If the significant value is less than 0.05, we reject the Null Hypothesis. Here, the Null Hypothesis is that there is no significant difference between the baseline and final models. The baseline model is the model without any independent variable, or it is the regression through the origin. The final model is the model with possible independent variables. When we reject the Null Hypothesis, we accept that there is a significant difference between the baseline and the final model.

Table 6.3: Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	491.253			
Final	316.785	174.468	3	.000
Link function: Logit.				

Computed from the primary data

Table 6.4 gives the details of the goodness of fit of the model. In the goodness of fit table, we accept the Null Hypothesis if the Pearson Significant value exceeds 0.05. Here, the Null Hypothesis for the Goodness of fit is that the observed data has goodness of fit with the fitted model. If the Sig value is less than 0.05, we reject the Null Hypothesis; otherwise, we accept the Null Hypothesis. Therefore, the Pearson Sig value must be greater than 0.05 for a good model for a good model. The present model sig value is more significant than 0.05, i.e. 0.194. That means the data fit the model well.

Table 6.4: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	379.901	357	.194
Deviance	306.167	357	.976
Link function: Logit.			

Computed from the primary data

The next important information regarding the model is the Pseudo R- Square. In the Pseudo R Square, the Nagelkerke value is considered. Pseudo R- Square indicates the proportion of the variance explained by the independent variables on the dependent variable in the Regression Model. Here Pseudo R- Square as per Nagelkerke is .567. Details are given in the table 6.5.

Table 6.5: Pseudo R-Square

Cox and Snell	.494
Nagelkerke	.567
McFadden	.332
Link function: Logit.	

Computed from the primary data

Table 6.6 shows the parameter estimates. The economic Advantage of Quarrying (EAQ) and Social Cost of Quarrying (SCQ) exhibit negative estimates, and Environmental Damages exhibit positive estimates.

Table 6.6: Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	*95% Confidence Interval*	
							Lower Bound	*Upper Bound*
Threshold	[AEQSL = 1.00]	-8.563	2.231	14.735	1	.000	-12.935	-4.191
	[AEQSL = 2.00]	-4.414	2.077	4.516	1	.034	-8.485	-.343
	[AEQSL = 3.00]	-4.258	2.074	4.215	1	.040	-8.322	-.193
	[AEQSL = 4.00]	.905	2.071	.191	1	.662	-3.155	4.965
Location	T_EAQ	-2.212	.412	28.873	1	.000	-3.019	-1.405
	T_SCQ	-1.390	.480	8.386	1	.004	-2.330	-.449
	T_EnDQ	2.134	.492	18.780	1	.000	1.169	3.099

Source: Computed from the primary data

From Table 6.6, parameter estimates, Social cost of quarrying and Economic Advantages of Quarrying have negative parameter estimates. A negative estimate means that as the values of the independent variable increase, there is a decreased probability of falling at a higher level on the dependent variable. Here, SCQ and EAQ are significant negative predictors of the AEQSL. The negative coefficient shows that for every one unit increase in EAQ, there is a predicated decrease of 2.212 in the log odds of being on a higher level on AEQSL. Likewise, the negative coefficient of SCQ shows that for every one unit increase in SCQ, there is a predicated decrease of 1.390 in the log odds of being on a higher level on AEQSL.

Whereas Environmental damages of quarrying (EnDQ) has a positive estimate. A positive estimate means an increased probability of falling at a greater level on the independent variable as values rise on an independent variable. EnDQ was a significant positive predicator of employee performance. For every one-unit increase in EnDQ, there is a predicted increase of 2.134 in the log odds of being on a higher level on AEQSL.

6.3 Factors Influencing the Impact of Quarrying

The impacts of quarrying, whether social, economic or environmental, are unevenly distributed in the study area. The positive and negative impacts of them heavily depend on some factors. The important among them are:

1. Attitude of the Quarry Operators / Owners
2. Geography of the quarrying area and distance of the residential area from the quarrying site and
3. Livelihood of the Respondents

These factors are discussed in detail in the following sections.

6.3.1 Attitude of the Quarry Owners/ Operators (AQO)

The attitude of the Quarry Owners or operators plays a crucial role in the impact of quarrying and people's reactions towards quarrying. From the field study, it was evident that where quarry owners cooperate with the local people, people show little resistance towards quarrying operations. Six components are considered to assess the variable attitude of quarry operators or owners. They are quarry operators readiness to repair damages to property (AQO_1), readiness to maintain road networks (AQO_2), patience to hearing and solving the issues of people (AQO_3), Watering the roads and surroundings regularly for reducing dust (AQO_4), Proper managing of sirens and cautions (AQO_5), and extraction is as per the rules and guidelines are correctly following guidelines (AQO_6). Variables and statements are given in the following table.

Table 6.7: AQO- Variables and Statements

Variable		Statement	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Attitude of Quarry Owners/ Operators (AQO)	AQO_1	Helps to repair damages to property					
	AQO_2	Helps to maintain road networks					
	AQO_3	Patient to hear and Solve the issues of people.					
	AQO_4	Watering the roads and surroundings regularly to reduce dust					
	AQO_5	Sirens and cautions are appropriately managed.					
	AQO_6	Extraction is as per the rule and correctly following the guidelines.					

Source: Primary data

People's reactions to the statement related to the attitude of the quarry operators or owners are given in Table 6.7. While assessing the people's responses towards the readiness of the quarry operator to repair damages to property (AQO_1), it is evident that 61.7% strongly and 17.6% disagree with that statement. 5.5 % of the respondents said they were undecided about the statement. Nonetheless, 7.8% of respondents agree, and 7.3% strongly agree that the quarry operator or owner helps to repair damages caused to their property due to quarrying.

Responses to the second component, the readiness of the quarry operator to maintain road networks (AQO_2), reveal that people are not satisfied with the attitude of the quarry operator. 61.7 % of the respondents strongly disagree, and 16.8% disagree with the statement that quarry operator helps to manage damaged roads properly. 5.5% of the respondents neither agree nor disagree with the statement. Only 8.6% of the respondents agree and 7.4% strongly agree that quarry operators help to maintain damaged roads.

Table 6.8: Attitude of Quarry Owner

Scale of Agreement	Total Responses to Statements in Percentage					
	AQO_1	**AQO_2**	**AQO_3**	**AQO_4**	**AQO_5**	**AQO_6**
SD	61.7	61.7	68.0	68.0	67.6	68.0
D	17.6	16.8	11.3	6.6	4.7	11.3
NAD	5.5	5.5	5.5	4.7	5.5	5.5
A	7.8	8.6	7.8	13.3	14.8	7.8
SA	7.4	7.4	7.4	7.4	7.4	7.4
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary data

Responses to the third component indicate that 68.0% of the respondents strongly disagree and 11.3% disagree that the quarry operator has patience enough to hear and solve the issues of people (AQO_3). 5.5% of the respondents took an indifferent stand to this statement. 7.8% agree, and 7.4% strongly agree that the quarry operator is patient enough to hear and solve people's problems timely.

Examination of the fourth component reveals that timely watering of roads and nearby places (AOQ_4) of quarrying sites to reduce dust emission is not being done in most areas. 68% of the respondents strongly disagree, and 6.6% disagree that the quarry operator is cooperative enough to water the roads and surrounding area for dust emission reduction. 4.7% of the respondents neither agree nor disagree with that statement. However, 13.3% of the respondents agree, and 17.4% strongly agree that the watering of roads and surroundings is being done frequently.

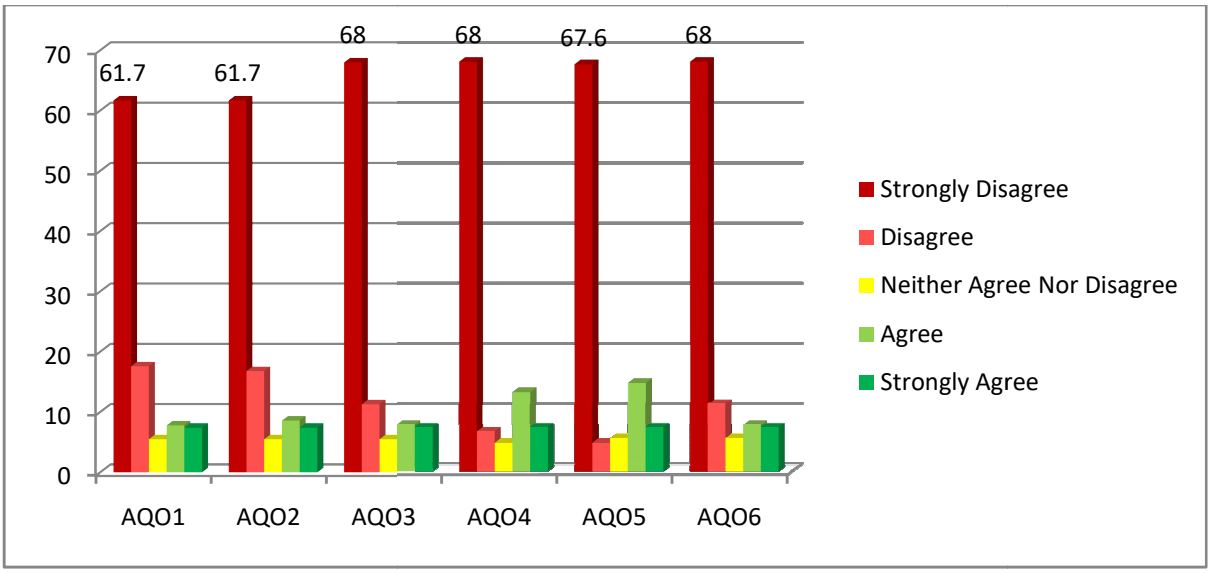
While asking about the proper management of sirens and cautions in the quarrying site (AOQ_5), 67.6% of the respondents strongly disagreed, and 4.7% disagreed with the statement that siren and cautions are appropriately managed in the quarry area. 5.5% of the respondents neither agree nor disagree with the statement. However, 14.8% of the respondents agree, and 7.4% strongly agree that the quarry operators appropriately manage sirens and cautions.

An analysis of the responses to the sixth component of AQO, AQO_6, reveals that 68.0% of the respondents strongly disagree, and 11.3% agree that extraction is as per the rules and guidelines are correctly followed. 5.5% of the respondents are indifferent towards the statement. However, 7.8% of the respondents agree and 7.4% strongly agree that granite building stone extraction is conducted per the rules and that quarry operators follow correct guidelines.

Figure 6.1 visualises the agreement and disagreement summary to statements related to quarry operators' or owners' attitudes.

Figure 6.1

Agreement and Disagreement Summary of Attitude of Quarry Operators/ Owners



Source: Primary Data

The figure illustrates that firm disagreement level is higher in all six components assessing the attitude of quarry operators or owners.

6.3.2 Geographical and Demographical Features of the quarrying area and distance of the residential area from the quarrying site

The geographical and demographical features of the study area significantly influence the impacts of quarrying. The high population density of the residential area, nearness of houses to the quarrying site and high elevation of the quarrying site. Increase the negative environmental impact of quarrying. The Kruskal Wallis test is conducted to analyse the hypothesis that the environmental impacts of quarrying are identical across all taluks. The result is given in the following section.

6.3.2.1 Kruskal- Wallis Test

Table 6.9 shows the mean rank of each taluk.

Table 6.9: Kruskal- Wallis Test- Mean Rank

Variable	Taluk	N	Mean Rank
T_EnDQ (Distribution of Environmental Disadvantages of Quarrying)	Chittur	46	109.61
	Alathur	33	182.33
	Ottappalam	53	164.42
	Mannarkkad	35	90.99
	Pattambi	89	111.66
	Total	**256**	

Computed from the primary data

The number of observations from Pattambi and Ottappalam taluks is higher because of population density. Table 5.39 shows the test statistic of the Kruskal Wallis test.

Table 6.10: Test Statistic[a,b]

	T_EnDQ
Chi-Square	46.805
df	4
Asymp. Sig.	.000
a. Kruskal Wallis Test	
b. Grouping Variable: Taluk	

Computed from the primary data

Table 6.10 observes that the Kruskal- Wallis test result is significant as the p-value is .000, less than the significance level of 0.05. Therefore, for the Null Hypothesis (H_0), the distribution of environmental disadvantages of quarrying is uniform across taluks can be rejected. That shows that environmental impact varies across different geographical and demographical features of the studied area.

Distance from the quarrying area also influences the impacts of quarrying. From the field study, it is clear that households near the quarrying area face negative impacts more severely.

6.3.3 Livelihood of the Respondents

From the field experience, it was observed that people's responses heavily depend on their livelihood. People working in a quarry- or related activities are unwilling to comment on the quarry. However, there are only very few natives working in the quarry. While considering the environmental impact, the occupation of the respondents plays a very significant influence on the responses. Farmers of casual labourers in agriculture are more aware of environmental issues. Mann- Whitney U test is conducted to observe the significance of this hypothesis. It is discussed in the following section.

6.3.3.1 Mann Whitney U Test

Table 6.11 shows the mean rank and sum of ranks of the test. The respondents' occupations are classified into two groups: farmers and non-formers. Group one farmers consist of farmers and casual labourers in the agricultural field. All others are categorised into group two.

Table 6.11: Mann- Whitney U Test- Ranks

Variable	Group	N	Mean Rank	Sum of Ranks
T_EnDQ	1. Farmers	44	149.50	6578.00
	2. Others	212	124.14	26318.00
	Total	**256**		

Computed from the primary data

Table 6.12 gives the test statistic.

Table 6.12: Test Statistics

	T_EnDQ
Mann-Whitney U	3740.000
Wilcoxon W	26318.000
Z	-2.074
Asymp. Sig. (2-tailed)	.038
a. Grouping Variable: Farmers and others	

Computed from the primary data

Table 6.12 observes that the Mann- Whitney test result is significant as the p-value is .038, less than the significance level of 0.05. Therefore, for the Null Hypothesis (H_0), the distribution of environmental disadvantages of quarrying is the same across the different occupational categories can be rejected. That shows that environmental impact varies across different occupational categories of the studied respondents.

6.3.4 Threat of Displacement

The threat of displacement is another factor that increases people's awareness about the negative impacts of quarrying. In the surveyed area, 27 households evacuated their homes due to the nearness of the quarry and safety issues. Many of the households are currently under the threat of displacement. Damages to the houses and accidents are frequent in the quarrying area. Respiratory diseases are high in these areas. As the nearness of the quarry increases, negative impacts also increase. The vulnerability is high in the quarrying sites. One of the selected ten quarries experienced landslides during the 2018 flood. Four houses were affected during these landslides, and these families shifted from their locality.

6.4 Conclusion

The process of quarrying, though an important economic activity, poses significant threats to the sustainable livelihood of the local people, and the associated negative socio-economic and environmental impacts are a cause for concern. The deleterious effects of quarrying can be seen in the damages caused to properties, as well as in the adverse impacts on the health and mental

well-being of the local population. A comprehensive analysis of the situation suggests that quarrying has the potential to significantly impede the human development of the affected communities. Therefore, it is imperative that appropriate measures are taken to mitigate the negative impacts of quarrying and ensure the sustainable development of these areas.

Chapter 7

COMPUTATION OF SUBNATIONAL SUSTAINABLE HUMAN DEVELOPMENT INDEX

- ***Introduction***
- ***Discourse on Sustainable Development***
- ***Incorporating Sustainability into the Human Development Index***
- ***Sustainable Human Development Index-Relevance***
- ***Computation of SHDI at the Sub-National Level***
- ***Conclusion***

Chapter 7

COMPUTATION OF SUBNATIONAL SUSTAINABLE HUMAN DEVELOPMENT INDEX

7.1 Introduction

Data and measurement are crucial in informing the public and policymakers about problems and raising their awareness about them. Environmental issues got minimal attention in the early phases of discourse on development, mainly because of a lack of measurement and data. Framing a methodology to measure qualitative things like environmental issues or environmental health is also challenging. When we try to calculate such things quantitatively, they will lack accuracy, but they can convey the intensity and degree of an issue or status more easily and clearly. It can also communicate on a broader platform. Considering these factors, incorporating an environmental component in measuring the Human Development Index is unavoidable.

Economic growth and human interference with natural resources are at an alarming phase. Therefore, to get a more realistic picture of what we got, what we went through, and what survived, we have to calculate a more realistic HDI, in the form of a Sustainable Human Development Index (SHDI). On this background, the present chapter briefly discusses sustainability and sustainable development. It also discusses the possibility of incorporating sustainability into the Human Development Index and the relevance of a Sustainable Human Development Index. An attempt to construct a Sustainable Human Development Index (SHDI) at the sub-national level was also made using secondary data following the Human Development Index Calculation Framework of UNDP.

7.2 Discourses on Sustainable Development

The two crucial reports that popularised the concept of sustainable development and fuelled the sustainability debates were "The Limits to Growth" and "Our Common Future", published in 1972 and 1987 respectively. Sustainability and Sustainable Development were comparatively newer terms in development literature then. Before coming directly to these concepts, tracing the idea of progress or development is essential.

7.2.1 Human Progress, Economic Growth and Material Advancement

An earlier word for development was progress. During the pre-modern period, human beings started to think about progress. Enlightenment and the Industrial Revolution increased the dimensions of the meaning of progress. Nisabet (as cited in Du Pisani, 2006) observed that "during the enlightenment and its aftermath (1750-1900), the idea of progress reached its zenith in the Western Civilization and as a result of the works of Turgot, Condorcet, Saint Simon, Comte, Hegel, Marx, Spencer and many others became the dominant idea of the period" with the unveiling of the industrial revolution dimension of human progress turned into economic growth and material advancement.

Donald Waster (as cited in Du Pisani, 2006) describes industrialisation as revolutionising people's outlook, and they began to dominate the natural order and produce consumable goods. Maximum economic production became the slogan of industrial economies. "The idea of a law of progress and its potential benefits took shape in the 19th century in Auguste Comte's writing on positive philosophy. Comte, Hegel, Marx, Spencer and others described humankind's inexorable, irreversible, and unstoppable advance through successive stages toward a golden age on earth. There was an optimism that scientific and technological progress could lead to the moral perfection of human progress. Immanuel Kant, who believed in progress through increased enlightenment, saw as the driving purpose of advancing humankind the attainment of ever more perfect conditions for exercising individual freedom".

However, the Industrial Revolution was not a blessing for all countries. Monetary and other advantages of increased production, consumption and sale flowed into the industrialist countries. It has widened the gap between rich and poor all over the world. In the later period, this mounting inequality and distribution injustice became a significant discussion point in development and sustainability discourses. Another big issue linked to industrial development was environmental degradation due to the over-exploitation of natural resources for raw materials. However, its full implications were not initially identified (Du Pisani, 2006).

7.2.2 The Conceptual Evolution of Sustainability

Deforestation, salinisation, and the loss of soil fertility were challenges faced by ancient civilisations such as the Egyptian, Mesopotamian, Greek, and Roman, and these concerns are now recognised as sustainability issues. In the latter half of the 20th century, the phrases

sustainability and sustainable development were first included in the Oxford English Dictionary. Hans Carl Von Carlowitz coined the term "sustainability" for the first time in the German Forestry Circle in Sylvicultura Oeconomica in 1713 (Du Pisani, 2006). Environmental problems have existed throughout human history. In the 18th century, there was much anxiety about the growing population and the corresponding resource demand. Writers such as Mathew Hale and William Petty tackled these issues as early as the 17th century. However, Thomas Robert Malthus's 1798 publication of "Essay on the Principles of Population as it Affects the Future Improvement of Society" sparked intense debate on population-related issues. Malthusian theory of population became a widespread debate among economists and other social scientists (Kula, 1998; Du Pisani, 2009). Malthus predicted that the population overweighs the food production, and everything ended up in starvation. His theory was meaningful for a constant state of technology, but his views pointed out the sustainability issue. Still, his views are valid, though with technological advancement, we shifted the gloomy Malthusian age.

The populace's attention switched to coal in the 19th century (Du Pisani, 2006); W. Stanley Jevons' publication of "The Coal Question" in 1866 addressed the danger of Britain's coal resources running out and its implications for industry. At that point, the concept of weariness entered the public discourse. Prior to Jevons, J.S. Mill made a distinction between mining and agriculture in his Principles of Political Economy (1848). He observed that "mineral deposits are infinite, but coal and metal deposits are limited" (Kula, 1998). David Ricardo's thesis of stagnation found solid support in the observations made by Mill and Jevons. According to Du Pisani (2006), Jevons' work "placed the exhaustibility of energy supply on the public agenda for good."

The concerns of sustainable development today were covered in several publications even before the phrase was widely used in writing. In 1864, George Perking Marsh's Man and Nature was published, becoming the conservation movement's foundation head (Du Pisani, 2006). He advocated preserving nature for human benefit rather than for its own sake, much like modern proponents of sustainable development (Du Pisani, 2006). The 1898 publication of Alfred Russell Wallace's book "Our Wonderful Century" served as a retrospective evaluation of the achievements and shortcomings of the 19th century. He talked about the reckless destruction of the stored-up products of nature in his book. He saw the unrestricted exploitation of the

rainforests and the mining of minerals, coal, oil, and gas as an "injury to the prosperity" (Du Pisani, 2006). Van Zon (quoted in Du Pisani, 2006) concludes that "Wallace's text already addressed every topic addressed in the 1987 Brundtland Report.

"Gifford Pinchot, G.A. Brender and Brandis and F.M. Jaegger discussed the limitations to the supply of raw materials and energy sources and warned against wasteful consumption" (Du Pisani, 2006) were among the figures who discussed these issues in the first half of the 20th century. The environmental difficulties noted by A.C. Pigou were similar to modern sustainable development. He acknowledged the depletion and exhaustion of natural resources and the claims of future generations in his thoughts on social welfare (Kula, 1998). Many significant works on environmental issues were produced in the middle of the 20th century. Resource exploitation and the appropriate use of resources for the existence of society were the subjects of William Vogt's Road to Survival (1948), Henry Fairfield Osborn's Our Plundered Planet (1948), and The Limits of the Earth (1953) (Du Pisani, 2006). K.W. Kapp published a summary of the majority of environmental issues in 1950.

Sustainability has been an issue of discussion since ancient times. Population growth, increased consumption and exploitation of wood, coal and oil pressured to think about sustainability. "Fears those present and future generations might not be able to maintain their living standards stimulated a mode of thinking that would inform discourses which prepared the way for the emergence and global adoption of sustainable development".

The potential of limitless progress provided by scientific and technological advancements was called into doubt throughout the first half of the 20th century by economic crises and world conflicts. However, optimism about raising living standards and achieving economic growth was eschewed following World War II. During this era of growing industrial and commercialization, environmental crises also took on a more significant role. Following the Industrial Revolution, there was a sharp increase in wealth, consumption, and production. "There seemed to be unrelenting economic growth during the three centuries between 1800 and 1970, when the world's population tripled from approximately 978 million to 3632 million, and the amount of manufacturing production worldwide increased by roughly 1730 times (Rostow, 1978 as cited in Du Pisani, 2006)." The average global economic growth rate from the 1780s to 1900 was 2.9% to 3.7%. It increased to above 4% at the start of the 20th century, fell to below 3% during World

War I, and then increased to above 4% in the 1940s. From 1948 to 1971, it was approximately 5.6%.

Unprecedented growth occurred in the 1950s and 1960s, and unrestricted growth became a famous goal. The extensive resource use was known to cause sustainability issues, which mainstream economists of the neoclassical orthodox school recognised. They did, however, guarantee that new technologies would be introduced to optimise the scarce input if a product or factor input became scarce. Since the middle of the 20th century, development has attracted much attention. On the other hand, inequality was also rising. The growing divide between industrialised and emerging nations, as well as between the rich and the poor, became a significant problem. The 1950s saw the establishment of dominant theories of development.

Liberal-valued modernisation theory proposes that developing nations should follow industrialised nations' lead and develop according to the Western development model. Development "assumes the mental models of the West (rationalisation), the institutions of the West (the market), the goals of the West (Worship of the commodity)," according to Peet's opinion (as reported in Du Pisani, 2006). Marxian analysis-based dependency theory ran counter to modernisation theory viewpoints. The 'core-periphery issue' is the main emphasis of dependency theory. In the centre, the dominant Western nations rule and govern the periphery or the former colonies. 'An autonomous, alternative and independent development path' is what dependency and global system theories recommend.

After the world war, people started to think about the other dimensions of science and technology. After the world war, people's attitudes towards science and technology changed considerably. They became aware of the wrong side of material advancement. It damaged the natural environment and destroyed the peace. After the 1960s, many books were published depicting human interventions and environmental issues. Rachel Carson's 'The Silent Spring' (1962), Paul Enrich's 'The Population Bomb' (1968), Edward Gold Smith's 'A Blue Print for Survival' (1972) and Fritz Schumacher's 'Small is Beautiful' (1975) are vital among them. People have become more conscious about environmental issues. Media, films, T.V., Music, everything popularised the theme of ecological crises. Earth Day was celebrated for the first time in 1970. The first environmental NGO, Green Peace and Friends of Earth, were started. Economic growth

and the endangered survival of human beings became a hot topic of discussion. An alternative model of development became essential.

7.3 Sustainability and Human Development

The publication of the Human Development Report and calculation of the Human Development Index (HDI) by the United Nations Development Programme (UNDP) in 1990 was a revolutionary step towards a more realistic, human-centric understanding of the growth and development of a nation. As we know, no such measures can give 100% accuracy. However, they help a nation's policymakers understand their country's economic status better and compare it with others. It also provides an insight into the weaker sections of a society, which should be improved further. HDI is one of the popular and straightforward measures to calculate the overall socio-economic conditions of a nation. Though its simplicity received wide criticism, it definitely helped to widen its applicability. The major drawback of HDI is that it lacks an environmental component in its calculation, which is necessary in the sustainability context. Many attempts have already taken place worldwide to incorporate environmental components, make HDI more realistic, and address the question of sustainability.

7.4 Incorporating Sustainability into HDI

The main obstacle to constructing a simple, sustainable human development index is the lack of an excellent dimensional index to represent environmental components. In 2020, UNDP introduced the Planetary Pressure Adjusted Human Development Index (PHDI) as an “experimental index that adjusts the HDI for planetary pressures in the Anthropocene. Yale University's Environmental Performance Index (EPI) is one of the significant contributions to analysing the state of sustainability. However, EPI is considering only sustainability in terms of environmental components. Attempts to incorporate sustainability are also limited to global data only.

Finding a good and straightforward component representing the environment is the first task in constructing a sustainable Human Development Index (SHDI). Therefore, the present study score of the Environmental Performance of states and union territories of India has been taken as the environmental component. Sub-national level data of India on Health Index, Income Index and Education Index have been taken from Global Data Lab publication. Following the UNDP

method of HDI calculation, the sub-national level SHDI of India has been calculated as the geometric mean of Health, Income, Education and Environmental Performance Indices.

7.5 Computation of SHDI at Sub-National Level

Subnational Sustainable Human Development of India is constructed based on secondary data. The Health Index, Income Index and Education Index of Indian states and union territories were taken from Global Data Lab. The Environmental Performance Index data was taken from the EPI of Indian States 2020 (Chandrasekharan et al., 2021). Since the scores of these indices are already normalised, they are used directly to construct the combined index. The following table shows the Sub-national level SHDI and HDI of India.

Where,

SHDI = Sustainable Human Development Index

HDI = Human Development Index

HI = Health Index

EI = Education Index

II = Income Index

EPI = Environmental Performance Index

SHDI is computed as the Geometric mean of the health, Income, Education, and Environmental Performance Index).

HDI is computed as the Geometric Mean of the health Index, Income Index and Education Index)

$$\mathbf{SHDI} = \sqrt[4]{\boldsymbol{HI} * \boldsymbol{EI} * \boldsymbol{II} * \boldsymbol{EPI}}$$

Table 7.1: Sustainable Human Development Index

SLNo	State/ Union Territory	HI	EI	II	EPI	HDI	SHDI	Difference in HDI & SHDI Scores
1	Andaman & Nicobar Islands	.86	.65	.73	.45	.74	.65	0.09
2	Andhra Pradesh	.77	.54	.66	.48	.65	.60	0.05
3	Arunachal Pradesh	.81	.55	.65	.44	.66	.60	0.06
4	Assam	.75	.54	.57	.40	.61	.55	0.06
5	Bihar	.75	.48	.53	.32	.57	.50	0.07
6	Chandigarh	.82	.73	.79	.36	.78	.64	0.14
7	Chhattisgarh	.73	.53	.59	.39	.61	.55	0.03
8	Dadra and Nagar Haveli	.81	.57	.64	.38	.66	.58	0.08
9	Daman and Diu	.81	.61	.72	.27	.71	.56	0.15
10	Goa	.85	.68	.77	.44	.76	.67	0.09
11	Gujarat	.78	.56	.70	.50	.67	.62	0.05
12	Haryana	.80	.61	.73	.32	.71	.58	0.13
13	Himachal Pradesh	.80	.65	.73	.43	.73	.64	0.09
14	Jammu and Kashmir	.80	.59	.69	.31	.69	.56	0.17
15	Jharkhand	.75	.51	.55	.34	.60	.52	0.08
16	Karnataka	.82	.58	.67	.48	.68	.63	0.05
17	Kerala	.88	.73	.75	.47	.78	.69	0.09
18	Lakshadweep	.83	.68	.75	.42	.75	.65	0.10
19	Madhya Pradesh	.73	.51	.59	.40	.60	.54	0.06
20	Maharashtra	.82	.61	.68	.40	.70	.61	0.09
21	Manipur	.82	.67	.62	.39	.70	.60	0.10
22	Meghalaya	.79	.57	.62	.42	.66	.59	0.07
23	Mizoram	.76	.63	.72	.43	.70	.62	0.08
24	Nagaland	.81	.60	.65	.38	.68	.59	0.09
25	New Delhi	.81	.68	.76	.34	.75	.61	0.14
26	Orissa	.76	.52	.57	.46	.61	.56	0.05
27	Puducherry	.83	.67	.72	.37	.74	.62	0.12
28	Punjab	.80	.62	.76	.32	.72	.59	0.13
29	Rajasthan	.76	.51	.64	.37	.63	.55	0.08
30	Sikkim	.83	.62	.72	.42	.72	.63	0.09
31	Tamil Nadu	.83	.63	.68	.44	.71	.63	0.08
32	Telangana	.79	.56	.68	.39	.67	.58	0.09
33	Tripura	.81	.59	.59	.41	.66	.58	0.08
34	Uttar Pradesh	.70	.52	.58	.38	.59	.53	0.06
35	Uttaranchal	.77	.61	.68	.41	.68	.60	0.08
36	West Bengal	.80	.55	.60	.41	.64	.57	0.07

Computed from Secondary data

When HDI is sustainable, SHDI will be equal to HDI. Table 7.1 shows that no states or union territories have the same SHDI and HDI. A high SHDI shows a more sustainable achievement in human development. For all states and Union territories, HDI is greater than the SHDI.

7.6 Conclusion

In today's world, sustainability has become a prominent concern for policymakers, researchers, and the general public. To assess the progress made in human development, it is imperative to devise a measure that considers economic and social factors and incorporates an appropriate environmental component. Such a measure can provide a more holistic understanding of the state of human progress while also highlighting the need to achieve sustainability. However, constructing a Sustainable Human Development Index that incorporates environmental factors at the local level is a complex task. It requires a comprehensive understanding of the environmental status of the region and the appropriate indicators to communicate that status effectively. Therefore, it is crucial to have better data on the region's environmental conditions and develop suitable indicators to measure progress towards sustainability. Such data and indicators can help formulate policies that contribute to sustainable human development.

Chapter 8

SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

- ***Summary of the Procedure***
- ***Summary of Major Findings***
- ***Policy Implications***
- ***Limitations and Areas of Further Research***

Chapter 8

SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

8.1 Summary of Procedure

The present study tried to analyse Kerala's economic development and environmental imbalances by examining the socio-economic and environmental impacts of quarrying in Palakkad district. Primary and secondary data were used to analyse the study's stated objectives and a mixed method is used for data analysis. The primary data were collected from the 256 households randomly selected from the selected active quarry sites of five taluks of Palakkad district. There are only few studies that assess the environmental and social damages of resource extraction in a social science aspect. Therefore, the present study attempted to fill this research gap. The study tried to quantify many qualitative aspects of quarry-related issues. How these activities threaten the acquired human development was the primary concern of the present study. The procedure followed to examine each objective of the study and the summary of the content of main chapters are given in the following sections.

Reviewing the course and features of the region's development is essential to study development-related environmental issues. Therefore, the present study has two background chapters: Chapter Three, which examines the nature and pattern of economic development in Kerala, and Chapter Four, which focuses on Kerala's environment. Chapter three briefly introduces the development history of Kerala, economic development and performance of different sectors, social development and demographic indicators, human development and challenges to the development. Secondary data extracted from the economic review of Kerala census reports of the Government of India were mainly used to analyse major variables presented in this chapter. Descriptive statistics, descriptions, tables and figures are used to analyse and present the data.

Before examining a particular environmental issue, examining the current status of the environment of that region is also necessary. Therefore, the fourth chapter examines features of the environment of Kerala, environmental regulations and environmental activities of various departments, development and environmental retrospect, impacts of economic growth on the environment, factors contributing to the environmental pressure, mineral resource extraction and quarrying in Kerala. Data from the economic review of Kerala, census reports of the Government

of India, urbanisation report of Kerala, building statistics of Kerala, websites of Biodiversity Board of Kerala, Mining and Geology Department of Kerala, State Disaster Management Authority and various study reports were used to analyse important variables in this chapter.

The thesis's fifth, sixth and seventh chapters examine the major objectives of the present study. Chapter 5 analyses the socio-economic and environmental impacts of quarrying based on primary data. This chapter consists of primary details of selected quarries, details of sample households and environmental impacts of quarry on local people of quarrying sites. Descriptive statistics is used to analyse the details of sample households. Tables and graphs were used to present the data. The socio-economic and environmental impacts of quarrying were analysed using the data collected from the sample households on a five point Likert scale. Scores were given in the following manner: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), strongly agree (5). Variables were fixed based on the review of the literature (Vandana et al., 2020; Sajeev & Alex, 2017). To assess the social impact of quarrying, four variables were considered, namely, Health Issues (HI), Tranquility of Surroundings (TS), Security Issues (SI) and Damages to Amenities (DA). Each of these variables included sub-variables to make measurement more clear. Likewise, Economic Advantage to Household (EAH) and Economic Advantage to Locality (EAL) were included to examine the economic impact of quarrying. Each of these variables has sub variables. Environmental Impact of Quarrying is measured using Landscape Changes (LC), impacts on Air Quality (AQ), Noise Pollution Level (NL) and Water Issues (WI). Each of these variables includes sub-variables. Responses are analysed using percentages.

Chapter 6 analyses the threats of quarrying and environmental degradation on the study area's sustainable life and human development. Major statistical analyses are included in this chapter and it mainly discusses the adverse effects of quarrying on the sustainable life of local people, impact of quarrying index and factors influencing the impacts of quarrying in the local area. Threats to the sustainable life of the people are assumed based on the Adverse Effect of quarrying on Sustainable Life (AEQSL) variable. It is assumed that the variable AEQSL reflects the total Socio-economic and environmental impacts of quarrying. AEQSL is considered as the function of Environmental Advantages of Quarrying (EAQ), which is measured as the mean score of Environmental Impacts of Quarrying, Social Disadvantages of Quarrying (SDQ), which

is calculated as the mean score of Social Impact of Quarrying and Environmental Disadvantages of Quarrying (EnDQ), which is counted as the mean score of Environmental Impacts of Quarrying. Since data is not normally distributed, Spearman's Rank Correlation is applied to measure the degree and direction of association between these variables. An Ordinal Logistic Regression Analysis is also conducted to understand the influence of independent variables on the dependent variable AEQSL.

Along with these analyses, factors influencing the impacts of quarrying were analysed. The Kruskal Wallis Test is conducted to test the hypothesis that the environmental impact of quarrying is identical across all taluks. Mann Whitney U Test is used to validate the hypothesis; the distribution of environmental disadvantages of quarrying is the same across the different occupational categories.

The seventh chapter of the present study discusses the policy challenges and the possibility of constructing a Sustainable Human Development Index at the sub-national level. This chapter consists of discourse on sustainable development, the relevance of the Sustainable Human Development Index, the possibility of incorporating sustainability into the Human Development Index and the computation of SHDI at the sub-national level. SHDI is computed using the Geometric Mean of Health, Income, Education, and Environmental Performance Indices.

8.2 Summary of Major Findings

The major findings of the present study can be summarised as follows. The analysis of the nature and pattern of the development of Kerala shows that the state's achievements in various dimensions of development are remarkable. Though the state's economic growth was below the national average in the first phase, it has now advanced to one of the high-income states of the country. The composition and performance of various economic sectors show that the state's tertiary sector is more prominent than the other two sectors. While considering the state's socio and human development achievements, it is evident that it had an excellent infrastructure to deliver services on education and health to the public. In the case of human development, the state stands first among the Indian states with attainments comparable to developed countries. However, there exists a paradoxical situation where the achievements in education and social and political consciousness of the people never reflect in issues like environmental exploitation.

Kerala has a diversified environmental feature. It positively helped the state to make achievements in different dimensions of development. However, the unlimited developmental needs of the state put pressure on limited resources. Natural resource extraction for the sake of manmade infrastructure has reached a dangerous level in the state. There is a turnaround of sustainable social development to unsustainable economic development. Though there are many regulations and policies to control the intervention of the people in the environment, all these systems need to be fixed. The lack of sufficient data is a big problem here. In the case of quarrying, lack of efficient supervision threatens the people's sustainable life. Natural disasters like landslides became frequent in Kerala. Population density, urbanisation, changes in land use patterns, changes in consumption patterns, construction boom, growth of real estate, construction-induced hike in the prices of and demand for natural resources are the major factors that increased the pressure on the environment of Kerala.

Primary data analysis of the study reveals that quarries located in the residential areas are a real threat to the people living around them. Demographic features of the sample households show that people living near the quarries belong to economically or socially backward communities. In the study area, the composition of the General category was only 15.2%. Likewise, the ration card category of the sample household depicts that 74.6% of them are in the priority group. That shows an inequality in the distribution of natural resources like land. Social and economically marginalised people are forced to live in unfavourable conditions. It is a matter of equity, too.

The educational qualification of the respondents shows that only 9.77% of the respondents are illiterate. If we consider education as a factor that creates environmental awareness, responses are more logical because 90.23% of the respondents have primary or above educational qualifications. The mean years of residents of the respondents in the locality are 26.45 with a standard deviation of 17.871, which shows that households can respond about pre and post-quarrying experiences. This data also reveals that displacement for the people who live in their native places for an average of 26 years will be very difficult. 98% of the households are owners of surveyed houses, a crucial variable affecting their attitude and possessiveness to their house and other assets. Another interesting finding from the study area is that 41% of the sample houses were constructed in 1-11 years. Therefore, the chances for damages due to the oldness of

the houses in the sample are minimised. Considering the size, 41.4% of houses belong to the 700- 1000 Sq ft. group and 45.7% to 1000- 1300 sq. ft. That means the size of houses is medium or low in the study area, which also indicates the economic status of the people. Considering the proximity of houses to the quarry, it is clear that only a few houses are located very near to quarries. Only 2.3% of houses are located within 100-150 meters and 150-200 meters of quarries. However, the density of houses is high at 200 to 700 meters. 15.6% of the sample households live within a 200-300 meter distance, 59.4% live in a 300-500 meter distance, and 14.8% live in a 500- 700 meter distance. As the proximity of houses to the quarry increases, disadvantages also increase.

Considering the Social Impact of quarrying, the following results are significant:

Health Issues (HI): The majority of the households experience respiratory diseases due to dust (83.2%) and fear and anxiety due to quarrying operations (68.3%). A significant portion of the households experiences hearing Impairment due to high volume of sound (32.1%) and mental disturbance (44.6%).

Tranquillity of Surroundings (TS): Most of the respondents, about 73.4%, experience a loss of calmness in their locality due to quarrying operations. However, 50.4% disagree that uneasiness exists in their locality. Whereas 59.0% of the respondents agree that loss of concentration is there. Disturbance to students, kids, aged, and patients is significant in the quarrying area. 27.7% of the respondents agree and 49.2% strongly agree with that statement.

Safety Issues (SI): The threat of feebleness or cracks on houses is significant in the houses near the quarries. 26.2 % of the respondents agree and 49.2% strongly agree with the statements. 21.5% of the respondents agree that they fear landslides, especially during the monsoon, and 55.5% strongly agree with that statement. 57.8% of the respondents fear that an earthquake will damage their settlement.

Damages to Amenities (DA): 50 % of the respondents agree, and 34.4% strongly agree that there are cracks on their houses due to blasting from quarry. The possibility of cracks depends on the area's elevation, distance from the quarry, and frequency of blasting and strength of the building. 35.2% of the respondents agree that quarry-related traffic damaged the road networks in their area and 53.2% strongly agree with that statement.

The following results are significant in the case of the Economic Impact of quarrying:

Economic Advantages to the Household: Most respondents, 85.5 %, denied that quarry activities provided them with job opportunities. Likewise, the majority of the respondents strongly disagree (38.3%) and disagree (48.0%) that quarrying activities helped to improve the market price of their land or property. 34.8% of the respondents strongly disagree, and 47.7% disagree with the statement that the quarry's functioning has increased the household's income. 3.1 % of the respondents strongly disagree, and 59% disagree that infrastructure near their houses improved after the functioning of quarrying. These results show that though quarrying is an economic activity, its benefits to local people are marginal.

Considering the Environmental Impact of quarrying, the following results are significant:

Landscape Changes (LC): Responses of the people towards the statement related to the disfiguration of the location after quarrying show that 33.6% agree and 66% strongly agree that considerable disfiguration happened in their locality. Likewise, 69.1 % of the respondents agree, and 12.9% strongly agree that quarrying activities severely affect wetlands. 66% of the respondents agree, and 17.6% strongly agree that quarrying caused topsoil loss in their area. 45.7% of the respondents agree, and 19.5% strongly agree that soil character changes due to quarrying. 55.5% agree, and 14.5 strongly agree that the soil's productivity has decreased due to the soil alterations brought on by quarrying. 59.8% of the respondents agree, and 21.9% of the respondents strongly agree that quarrying considerably reduced the natural vegetation and biodiversity of their locality.

Air Quality (AQ): 48.0% of the respondents agree that dust emission is there in their locality due to the functioning of the quarry, and 46.9% strongly agree with that statement. 39.5% of the respondents agree, and 41.4% strongly agree that the shattering of rock particles occurs frequently from the quarrying site. 69.5% of the respondents agree, and 7.8% strongly agree that there is dust deposition over the canopy of trees in their locality. 65.6% of the respondents agree, and 2.7% strongly agree that they experience inhalation of dust due to quarrying. 63.7% of the respondents experience the presence of chemicals in the air.

Impact on Noise Level (NL): 49.6% of the respondents agree, and 21.5% strongly agree that extreme and continuous grinding sound exists in their locality. 31.3% of the respondents agree

and 39.8% of the respondents strongly agree that there is extreme machinery noise from the quarry. 11.7% of the respondents agree, and 71.1% strongly agree with the presence of extreme traffic noise. 22.3% of the respondents agree that there is extreme explosion noise in their residential area during blasting times and 65.2% of the respondents strongly agree with the statement.

Impact on Water Level (WL): 28.9% of the respondents experienced increased runoff and turbidity of water in their locality after the functioning of the quarry. 53.5% of the respondents conveyed a strong agreement towards the statement. Regarding obstruction in water flow, 50.4% of the respondents agree with the statement, and 17.4% strongly agree. While considering the responses towards water contamination, 59.8% of respondents agree, 3.1% strongly agree that quarrying has contaminated the water, 28.5% of the respondents agree, and 39.1% strongly agree that quarrying has caused a reduction in water infiltration. Responses of the people towards the sinking of the water table reveal that 34.0% of the respondents agree, and 40.6% strongly agree that quarrying has caused the water table to sink in their locality. While assessing the responses towards the increased water consumption, 14.1 % of respondents agree, and 74.2 % strongly agree that quarrying has increased water consumption.

All these results show that quarrying had severe negative socio-economic and environmental impacts on the locality. All the impacts affect the sustainable life of the people near the quarrying area. The correlation of the Adverse Effect of Quarrying on Sustainable Life (AEQSL) variable and EAQ, SDQ and EnDQ shows that AEQSL has a negative correlation with the Economic Advantage of Quarrying (EAQ). That means as the Economic advantage of quarrying is higher; the Adversity on the life of the people will be lower. However, AEQSL SDQ and EnDQ have a positive correlation. That means as the Social disadvantages and environmental damages increase Adverse Effect of Quarrying also increases. An Ordinal Logistic Regression of these variables shows that SDQ and EAQ are negative parameter estimates of AEQSL, and EnDQ is a positive parameter of AEQSL.

The attitude of the Quarry Owner or Operator is a critical factor in reducing the socio-economic and environmental disadvantages of quarrying. The results of the Kruskal Wallis test show that environmental impact varies across different geographical regions being studied. The Mann-

Whitney U test shows that environmental impact varies across different occupational categories of the respondents being studied.

To become more aware of environmental issues, quantifying environmental status is essential at the policy level. An attempt to construct Sustainable Human Development is made in this background. The Sustainable Human Development Index constructed at the sub-national level shows that no state or union territory in India has the same SHDI and HDI. A high SHDI shows a more sustainable achievement in human development. For all states and Union territories, HDI is greater than the SHDI.

8.3 Policy Implications

The quarrying and construction constitute a significant portion of Kerala's GSV. Many native and migrant workers depend on these sectors for their livelihood. A tremendous change in consumption patterns and increased investments in buildings increased the pressure on the natural resources in Kerala. Environmental disparity caused by development affects a society's acquired human development and widens socio-economic and environmental inequity. Natural resources like building stones are not renewable. Overuse of such resources creates critical imbalances in the environment. Vertical and horizontal expansion of manmade infrastructure occurs through the vertical and horizontal extraction of natural resources. Quarrying and mining in Kerala are located mainly in and around the Western Ghats, a highly sensitive biological hotspot worldwide. It is considered a susceptible ecological area, and the population density of Kerala as a small geographical unit is very high in these regions. As Kerala is a small state geographically with a high population density, any threats to her environment without much delay adversely affect the sustained achievements in her people's socio-economic and human development. Therefore, to achieve sustainable well-being of the people, policy suggestions of the present study are the following:

- Reliable data on environmental and socio-economic indicators are necessary for policy-making—proper measurements of environmental status help to improve the awareness of the environment and environmental issues.
- Incorporating the environmental component in the human development index and calculating it locally will help assess the sustainability of achieved human development.

When environmental factors are included, HDI measurement becomes more realistic. At the policy level, it also helps to diagnose the environmental health of a society along with its economic and social prosperity.

- The overexploitation of resources and harmful effects can be reduced by decentralising environmental management. It also helps to increase the participation of local people in environmental management.
- The absence of efficient environmental policies aggravates the environmental issues. Therefore, strict monitoring of efficient policies is needed.
- Reshaping the development concept is also essential for environmental sustainability to sustain achieved economic and social development. Therefore, we cannot avoid the environment for materialistic advancement.
- A comprehensive construction policy is a part of an efficient environment policy. Permission for buildings should be granted on the grounds of its need. Construction in ecologically sensitive areas should be strictly avoided. Utilisation of Unutilised and underutilised buildings should be ensured. Adequate and scientific methods should be used to avoid wastage of resources. Research for Substitutes for existing building materials should be done.
- Purchase and sale of natural resources for profit making should be avoided.
- Special consideration should be given to the protection of non-renewable resources.
- Proper scientific planning should ensure a balance between development and environmental protection.

8.4 Limitations and Areas of Further Research

Variables used in analysing the socio-economic and environmental impacts of quarrying are limited in the present study. As most of the variables are qualitative, they are quantified by scoring the people's perceptions using the Likert scale. Secondary sources to support the study are also very limited. Sustainable Human Development is calculated based on secondary data at the sub-national level. If it is constructed on the primary data, the relevance of the study will be increased further. A more sound methodology and framework should be developed to construct a more realistic SHDI. These limitations can be considered as areas for further research.

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APPENDIX

Schedule (Household Survey)

Data from Residents near active quarries

Part 1

1. Basic information

1.	Name of the Respondent	
2.	Taluk	0. Palakkad 1. Chittur 2. Alathur 3. Ottappalam 4. Mannarkkad 5. Pattambi 6. Attappadi
3.	Name of the Panchayat / Municipality	
4.	Ward No:	
5.	Gender	0. Male 1. Female 2. Others
6.	Nature of locality	1. Village 2. Urban
7.	Religion	0. Hindu 1. Christian 2. Muslim 3. Others
8.	Social Group	0. ST 1. SC 2. OBC 3. EBC/OEC 4. General
9.	Type of ration card	1. White 2. Blue 3. Yellow 4. Pink 5. No card
10.	Years of Residence in this locality	
11.	House Ownership	1. Owned 2. Rented 3. Leased/ House of Relatives
12.	Year of construction of the house	
13.	Type of Roof	1. Sheet 2. Tile

		3. Concrete (Semi) 4. Concrete (Complete) 5. Others
14.	Type of Wall	1. Mud 2. Stone/ Bricks (Plastered) 3. Stone/ Bricks (Non- Plastered) 4. Others
15	Total Floor Area	
16	Educational Qualification of the Respondent	0. Illiterate 1. Literate 2. Primary 3. High School 4. SSLC 5. Pre Degree/ Plus Two 6. Technical Course 7. Degree 8. Professional Degree 9. Post Graduation and Above 10. Student 11. Below School Going Age
17	Occupation of the Respondent	1. Farmer 2. Casual Labourer (Agriculture) 3. Casual Labourer (Non- Agriculture) 4. Self Employed 5. Professional 6. Salaried Employee in Government Sector 7. Salaried Employee in Private Sector 8. Job in Gulf Countries 9. Job in Foreign Countries (Other than Gulf) 10. Small Scale Business 11. Large Scale Business 12. Pensioner 13. Unemployed 14. Quarry Worker- Mess 15. Quarry Worker- Driver 16. Quarry Worker- Others 17. Quarry Owner/ Operator
18	Average Distance From Quarry	
19	Do you own a land?	1. Yes 2. No
20	If yes, size of the land owned (in cent)	
21	Do you own a vehicle?	1. Yes

		2. No
22	If Yes, type of vehicle	1. Two Wheeler 2. Auto Riksha 3. Four Wheeler 4. Other Light Vehicles 5. Heavy Vehicle
23	Source of Enenrgy	1. Electricity 2. Solar 3. Kerosene 4. Others
24	Average Monthly Income	

1. A. Socio- Economic and Demographic Characteristics of Household Members

Sl. No.	Name	Relation with HH Head	Sex	Age	Marital Status	Education	Employment	Earnings
1	2	3	4	5	6	7	8	9

Code for 1.A

Item (3): Relation to head:

Head of family-1, Spouse of head- 2, Married Children-3, Son-in-law/ Daughter in law- 5, Unmarried Children-5, Grand children- 6, Father/ Mother/ Father-in-law/ Mother-in- law-7, brother/ sister/ other relatives-8, Servants/ Employees-9, person belonging to a different family (related through blood, marriage or adoption) living in the household-10

Item (4): Sex:

Male-1, Female- 2, Transgender- 3

Item (6): Marital Status:
Married-1, Unmarried-2, Widowed-3, Divorced/ Separated-4

Item (7):
Illiterate- 0, Literate- 1, Primary- 2, High School- 3, SSLC- 4, Pre Degree/ Plus Two- 5, Technical Course- 6, Degree- 7, Professional Degree- 8, Post Graduation and Above- 9, Student- 10, Below School Going Age – 11

Item (8):
Farmer- 1, Casual Labourer (Agriculture)- 2, Casual Labourer (Non- Agriculture)- 3, Self Employed- 4, Professional-5, Salaried Employee in Government Sector- 6, Salaried Employee in Private Sector- 7, Job in Gulf Countries-8, Job in Foreign Countries (Other than Gulf)- 9, Small Scale Business- 10, Large Scale Business-11, Pensioner- 12, Unemployed- 13, Quarry Worker- Mess- 14, Quarry Worker- Driver- 15, Quarry Worker- Others- 16, Quarry Owner/ Operator- 17

Part 2

General Attitude towards quarrying activities

Do you think stopping the functioning of this quarry is essential for the sustainable life the people in this locality?

1. Strongly Disagree
2. Disagree
3. Neither Agree Nor Disagree
4. Agree
5. Strongly Agree

Did you ever visit quarrying site?

1. Yes
2. No

Do you expect a shifting from the present home to more safe and sustainable places?

1. Never
2. Not now but may be in the future
3. Yes, surely in the future
4. Yes, surely in near future

Whether quarrying affected your livelihood?

1. Yes
2. No

If, yes, give details.
Have you ever received any type of compensation?

Economic Impact of Quarrying

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Economic Advantage to the Household (EAH)	EAH_1	Direct and indirect employment opportunities to the household increased					
	EAH_2	Market price of the property or land of the household increased					
	EAH_3	Income of the household increased					
	EAH_4	Infrastructure /Road facilities near the household improved					
Economic Advantage to the Locality (EAL)	EAL_1	Direct and indirect employment opportunities to the people in the locality increased					
	EAL_2	Market price of the land of the Locality increased					
	EAL_3	Infrastructure Facilities of the locality increased					
	EAL_4	Market Places improved					
	EAL_5	Income of the people increased					
Economic Disadvantage to the Household (EDH)	EDH_1	Market price of the property or land of the household decreased					
	EDH_1	Quarrying activities damaged the infrastructure/ road networks near the household					
Economic Disadvantage to the Locality (EDL)	EDL_1	Market price of the land of the Locality decreased					
	EDL_2	Quarrying activities damaged the infrastructure/ road networks of the locality					

Scale of Agreement

1. Strongly Disagree (SD)
2. Disagree (D)
3. Neither Agree Nor Disagree (NAD)
4. Agree (A)
5. Strongly Agree (SA)

Social Impact of Quarrying

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Health Issues (HI)	HI_1	Respiratory Diseases due to increased dust particles					
	HI_2	Hearing Impairment due to high volume of sound					
	HI_3	Mental disturbance due to quarrying activities					
	HI_4	Fear and anxiety					
	HI_5	Injuries due to falling of stone particles or other quarrying activities					
Tranquility of Surroundings (TS)	TS_1	Loss of Calmness					
	TS_2	Prevalence of uneasiness					
	TS_3	Loss of Concentration					
	TS_4	Disturbance to kids, aged, students and patients					
Safety Issues (SI)	SI_1	Threat of cracks or feebleness of house					
	SI_2	Fear of loss of settlement					
	SI_3	Fear of landslides					
	SI_4	Fear of earthquakes					
Damages to Amenities (DA)	DA_1	Cracks on house					
	DA_2	Over use of roads					
Attitude of Quarry Owners/ Operators (AQO)	AQO_1	Helps to repair damages to property					
	AQO_2	Helps to maintain road networks					
	AQO_3	Patient to hearing and Solving the issues of people					
	AQO_4	Watering the roads and surrounding s regularly to reduce dust					
	AQO_5	Sirens and cautions are managing properly					
	AQO_6	Extraction is as per the rule and correctly following the guidelines					

Environmental Impact of Quarrying

Variable		Items	Agreement Scale				
			SD	D	NAD	A	SA
			1	2	3	4	5
Landscape Changes (Changes to Landscape, soil and biodiversity) (LC)	LC_1	Disfiguration					
	LC_2	Wetland Destruction					
	LC_3	Loss of topsoil					
	LC_4	Change in Soil Character					
	LC_5	Change in Productivity					
	LC_6	Change in Natural Vegetation and Biodiversity					
Air Quality (AQ)	AQ_1	Dust Emission					
	AQ_2	Shattering of rock particles					
	AQ_3	Dust deposition on Canopy cover					
	AQ_4	Inhalation of fine particulars					
	AQ_5	Higher concentration of Chemicals (Radon & Thorium)					
Noise Level (NL)	NL_1	Extreme and continuous grinding sound					
	NL_2	Extreme Machinery noise					
	NL_3	Extreme explosion noise					
	NL_4	Extreme traffic noise					
Water Issues (WL)	WI_1	Increased runoff and turbidity in water during the rainy season					
	WI_2	Obstruction in the water flow					
	WI_3	Contamination					
	WI_4	Reduced Infiltration					
	WI_5	Water table sinking					
	WI_6	Increased use of water					