Environment-Cultural Interaction and the Tribes of North-East India

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Edited by

Banshaikupar L. Mawlong
and Marco Babit Mitri

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PREFACE

"Man is the measure of all things," said Protagoras, an ancient Greek philosopher, setting the tone of human chauvinist perception. Throughout the course of recorded human history, mankind has often placed itself in a privileged and glorified position. History consists mostly of human ideas, creations, acts of courage and conquests, etc., while the environment is often only given minor importance. However, it is an indisputable fact that we cannot imagine human existence outside of the natural environment. The evolution and history of humankind took place in this very environment, which has its own history. David Lowenthal in his article "Environmental History: From Genesis to Apocalypse" contended that it would be narrow-minded to discuss the history of mankind starting only from the emergence of the written word, and to describe the earlier period as *protohistory* and *prehistory*, as humankind's entire past and history are inextricably linked to its environment which has always been more than just background scenery. A sense of crisis and insecurity of the late1960s (the energy politics of the Cold War and the threat of a nuclear annihilation) brought about the much needed paradigm shift in the philosophical world in its approach to the questions of the consequences of human actions on the natural environment- from complete *negligence and indifference* to due *attention, respect and recognition* (to the natural environment), giving birth to the emergence of Environmental Philosophy as an academic discipline. Thus, environmental philosophy- ethics and values, starts with human concerns for a quality, sustainable and safe environment.

This book, a result of the National Conference, "The North-East Umbrella Environment-Cultural Interaction and the Tribes in the Region", organised by the Department of History and Political Science, Union Christian College, Meghalaya, India, on the 29th-30th May 2014, is an attempt to introduce and to explore the possibility of bringing a holistic, sustainable and ethical approach to development. This approach attempts to revisit and examine the historical, environmental and philosophical models of the tribal indigenous culture, theories and practices about appropriate concern for, values in, and duties regarding the natural world. The book emphasises on the explanatory value and role of tribal ethics and culture in

shaping and understanding mass political behaviour and institutional politics towards environment and sustainable sciences.

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CHAPTER ONE

INTRODUCTION

BANSHAIKUPAR L MAWLONG

Life, a miracle of the universe, appeared around four billion years ago and we humans only 200 thousand years ago (Transcript from "Home", the documentary: Good Planet). That's when the history of human interaction with nature came into the picture 200,000 years ago. One of the basic components of this interaction is the fragile, subtle, interdependent and complementary interaction which Humans share with the natural world. This interaction between humans and the environment is so indispensable, not only for their survival, but their very existence depends on it, that environmental questions have assumed proportions affecting all humanity. The growth of civilisations bring with it its corresponding fruits of industrialization, urbanization, population explosion, poverty, over-exploitation of resources, depletion of traditional resources of energy and raw materials, and the research for new resources of energy and raw materials. Over the ages, the quest for Power has derived to capture psyche of nature.

Environmental philosophy in its modern form developed in the late 1960s, the product of the geometric rate at which the environment is being depleted and exploited and the growing recognition of a deeply rooted, global ecological crisis- a crisis marked by such well-known problems as the destruction and transformation of ecosystems, rapid species loss, intensifying levels of pollution and bioaccumulation of toxins, climate change, human population growth and overconsumption, and so on.

The modern history of the emergence of environmental philosophy can be traced to the publication of Rachel Carson's best-selling book *Silent Spring* in 1962, which documented the accumulation of dangerous pesticides and chemical toxins throughout the planetary food webs. In 1968, Garrett Hardin in his paper "The Tragedy of the Commons" provided the academic impetus for the growth of environmental students

when he argued that human self-interest and a growing population would inevitably combine to deplete resources and degrade the environment. This shift of focus towards the growing importance of environmental philosophy is further evident in the writings of scholars like Aldo Leopold, Murray Bookchin and Holmes Rolston III. Bookchin remarked that it is impossible to achieve a harmonization of man and nature without creating a human community that lives in a lasting balance with its natural environment (Bookchin, 1985 [1965]). Aldo Leopold's ideal of land ethic that: 'land is to be loved and respected is an extension of ethics' (Leopold, 1949: viii-ix) and that "a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community" (Leopold, 1949: 224–25) catalysed the thinkers in Australia and the United States in their approaches towards the environment.

However, it was in 1975, that environmental ethics came to the attention of mainstream philosophy with the publication of Holmes Rolston III's paper, "Is There an Ecological Ethic?"Rolston was of the view that humans have duties not only to individual humans and animals but also to larger wholes—species and ecosystems (Rolston, 1975). In addition to any duties humans might have towards his society, they also have duties to preserve the species and processes that sustain life on earth, biological processes merit respect because they are intrinsically valuable, embodying the sacred nature of God (Rolston, 1989, 1999).

This sense of duty towards, and respect for, the natural environment finds its best expression, differently in the Cultural practices of the people at different epochs in history. Culture, thus, acts as one of the predominant and crucial factors (the others include the political and economic systems) in shaping and defining human relations with the natural environment. Anthropologists like Kroeber and Kluckhohn contended that "culture" is the centripetal factor in defining humanity (Kroeber, *et al*, 1952). Environmental activists and theorists have argued that the grave and diseased state of the natural Environment cannot be effectively addressed through strictly technical measures, because they are intertwined within a crisis of politics, of values, and of worldview. In other words, the ecological crisis is not merely a scientific fact to be addressed through 'technological fixes', but it is more importantly- a cultural fact: it is conceived, imagined, discussed, and acted upon through the diverse cultural activities of humanity. It is 'made sense of'culturally, and our responses to the crisis are enabled as well as constrained by our imagination and interpretation of the crisis.

The development of critical social and cultural theory, especially within the field of cultural studies, in the last few decades has provided an array of theoretical and analytical tools useful in understanding the ways cultural practices are implicated within the perpetuation and contestation of relations of power. Focusing primarily on the terrain of 'popular' and 'alternative' cultures and subcultures, dominant or hegemonic cultural formations, and the mass media, cultural studies have been especially concerned with understanding the workings of culture in relation to social and political struggles, and with enhancing the possibilities for social and cultural change. Meanwhile, the fields of cultural geography, cultural anthropology and sociology, have featured a deepened concern with cultural practices, issues of representation, identity and difference, and more recently with questions of 'social space' and the environment.

The emancipatory focus in cultural studies and critical theory regarding questions of class, race, gender/sexuality, and identity/difference, offers a series of 'lenses' or 'optics' through which environmental issues and struggles can be viewed, engaged, and understood. At the same time, environmentalists' focus on relations between humans and the non-human world presents cultural studies (and the social sciences in general) with a serious and radical ecological challenge. Environmental cultural studies (or 'cultural environmental studies') represent the point at which these traditions meet and overlap; as such, it can be seen as a response to a crisis that is simultaneously social/cultural and ecological.

According to Steward’s ideas, a culture unable to pay attention to changes in the environment and to adapt to them is likely to face serious problems. The relationship of culture and nature is a dialogue between two relatively equal entities- each complimenting the other (Steward, 1955).

Regardless of whether culture is or is not an adaptive system, the relationship between humans and nature is determined by culture. In agreement with Steward’s concept of cultural ecology we can state that technology and economy determine our relationship to the environment to a certain extent, but not completely. Both technology and economy are parts of the very complex cultural system, consisting of interlinked material artefacts, norms, values, ideas and other manifestations of human enterprise. This means that environmental problems do not only depend on the level of technology, but they are rather anchored in the whole cultural complex that is not able either to recognize or solve them.

Different cultures at different periods in human history have developed within its civilisation a sense of respect and concern for the environment.

The cultural and religious heritage of India shows a deep concern for the protection and preservation of the environment. Indian Culture emphasises that human existence is composed of and dependent upon the five basic elements of nature that is earth, air, water, fire, and sky. This close relationship between nature and mankind highlights the fact that environment shapes culture and vice versa, and culture affects the environment. Human values are not to be grafted; they require perseverance and cultural base. Hence, scientific and cultural efforts should proceed hand in hand for the progress of humanity.

Since ancient times, Indian traditions and cultures have been protecting our trees, ponds and other water bodies, wild animals, etc. However, in modern times some of these cultures have been encroached by the greed of development while others are doing fairly well in conserving resources. The need of the time is to protect all of our traditions and cultures that in any way protect our environment. Here are examples of some important Indian traditions, customs and cultures that were and still are in practice in different parts of India.

The concept of keeping forest reserves was first developed by Kautilya, an Indian scholar in the past. Trees of different species are protected and preserved in sacred groves in most parts of the country. Sacred Groves are small patches of native vegetation, traditionally protected by local communities. The local communities in different Indian states have been protecting and worshipping sacred groves since the emergence of civilisation. Many sacred grove areas are designated as sacred places of Gods and Goddesses where people go for worship. The concept of Panchvati (a group of five Banyan trees; vati is derived from the Sanskrit word ‘vat’ meaning vat-vriksha or banyan tree) has been elaborated in many Indian Epics. Bisnois of Rajasthan have a tradition of protecting wildlife including Black Buck and Khejri trees since 1451.

Different environment and water conservation strategies and traditions have been in practice in many parts of India. Some of those indigenous strategies are- Tanka and Kund in Rajasthan and Mizoram ; Bamboo drip system in Sohra (Cherrapunjee), Meghalaya, sacred grooves in Meghalaya, Eris in Tamil Nadu; Haveli in Madhya Pradesh; Apatani in Arunachal Pradesh; Ahar Pyne system of water conservation in Bihar and adjacent West Bengal; Zabo system in Nagaland etc.

Environmental protection, as discussed earlier, embodies a variety of duties which any human individual has to perform. It is a matter of moral and cultural ethics. Traditional knowledge had always contributed to

environmental conservation, modern medicine and health care. We have to preserve this aspect of culture and amalgamate it with modern methods to work toward environmental conservation. An era of responsibility has to be ushered in because of the sense of urgency and the need of the hour to protect Mother Nature.

This book is, thus, an attempt to give an insightful look into such cultural practices of the different tribes of North-East India[1] relating to the questions of environmental conservation, protection and ethics. Marco Babit Mitri and Jim C. Marak in their article "Pre-historic Cultural-Environment Relationship: Impact of Iron Ore Manufacture on the Dynamics of Vegetation in Khasi Hills", argue that the inhabitants of the Khasi-Jaintia Hills are one of the earliest pioneers in the field of iron-tools manufacturing. In the paper, the process of iron smelting, which could be traced to the pre-historic age, was elaborately explained and the calamitous impact of charcoal production on vegetation was argued. The attempt to protect forest areas through the institution of sacred groves based on religious beliefs was also discussed.

The third chapter stresses on the role of non-state actors such as NGOs, CBOs and other allied agencies in voicing the concerns of the vulnerable sections of society and their significant influence over the policy makers in the run up to bring about positive changes. The author Anna Nath through her article "Non-state actors and indigenous Environmental Struggles in North-East India: Mapping the Potential and Possibilities of a Common Ethno-ecological Movement" highlighted some of the isolated movements led by some ethnic groups of North-East India. Besides offering important probable suggestions, the author also pointed out the absence of concerted and organised efforts by the people of the region in dealing with such environmental issues.

Lasara M. Lyngdoh and Bennathaniel H. Diengdoh, in their article entitled, "A Study of the Relationship Between Economic Growth and Environmental Damage in North-East India with focus on the State of Meghalaya: The Validity of the Environmental Kuznet's Curve", attempted to determine the nature of the relationship between economic growth of the region and environmental degradation. They concluded that North-East India and Meghalaya are in the early stages of economic growth and, as such, evidence for the existence of an inverted U-shaped

[1] North-East India is a geographical nomenclature for the States of Assam, Meghalaya, Nagaland, Manipur, Tripura, Mizoram, Arunachal Pradesh and Sikkim.

EKC is premature. Hence, the applicability and robustness of the EKC could not be empirically established for the region. However, they pointed out that there exists a possibility of pursuing economic growth and avoiding further environmental degradation; and the possibility of tunneling through the EKC by drawing on resources and experience of other.

The fifth Chapter, “Ecology and Spirituality: Eco-Theology of the Khasis "co-authored by Magdalyne Syiemlieh and Naomi Carey Nonglait expounded the theory of Eco-theology, the source of which, emanated from the Origin Myth. The authors stressed on how Nature has its imprint on each and every aspect in the life of the Khasis. The authors also contended that the depletion of the earth’s resources had brought a paradigm shift in the developmental discourse around the globe and call for a need to revisit and revive the age-old eco-theology of the Khasis. Jennifer Thangkhiew in her article, “Ecology and Spirituality: A study in the Khasi Context”, further accentuated the close affinity that the Khasis have with Nature, with God and with one another. They adhered to a belief system which is earth-oriented and believe that a healthy and an ethical approach would not disturb or destroy the ecology.

Mankhrawbor Dunai gave a critical and a theoretical insight into the understanding of Khasi myths and folktales in his article, “Man and Nature: Spiritual Communion and Conflict with special reference to Khasi Folktales”. He emphasised on how folktales may become sources of insight whereby their metaphorical take on ideological as well as cultural issues may be applied to achieve a balanced and an ecologically stable co-existence between Man and Nature. Darlene Sawian further exfoliated the essence and meaning of Khasi Myths in her paper, “The Revelation of the nexus between Man and Nature found in ‘Ki Khanatang”. She asserted that in order to re-build and restore the bond between Man and Nature, the primitive knowledge system of the Khasis ought to be examined and appreciated.

The next Chapter titled, "U Shulong: The myth, the Legend and the Reality", co-authored by Jane E. Warjri and Dondor Giri Nongkhlaw, highlighted the ground reality of geology, geography, climate and culture and their interrelationship with the myth and the legend attributed to *U Lum Shillong*. The paper concluded that the references are not merely incidental allusions or speculations but are experiences that the people live through.

Julie. S. Wahlang, in her article, "Seeing with a Native Eye: The Land Ethic versus Economic Enterprise", highlighted how over the years, human energy, self-deception based on the desire for security and gain, and mechanical inventions broke the balance of nature that had sustained the ecology for centuries. Concomitantly, the author passionately made an appeal to nurture Mother Nature.

An alternative understanding of environmental crisis and their probable solutions, based on Martin Heidegger oeuvre, was put forward by Shining Star Lyngdoh in his article "Modern Developmental Philosophy of Nature and traditional Khasi Ecology: Thinking with Heidegger" to mitigate ecological imbalances. The author stated how the Khasis traditionally had a worldview on their environment without any dichotomy between man and his surrounding, in contrast to the present scientific and technological understanding.The article “Ecosophy and the Indigenous Khasi Beliefs” by Iahunlin Khyriem expounded the environmental philosophy of Arne Naess, a Norwegian philosopher. With Naess’ philosophy as the basis, the author argues that we need a new ecological wisdom which recognizes the values and status of all living organisms, their inter-relations and self-realisation. The author also underscores the point in the Khasi belief that Man is part of Nature and Nature is part of Man. A very intimate relationship exists between Man, Nature and everything in Nature and this idea is inherent in the Khasi thoughts and beliefs since time immemorial.

Chinmoy Roy in his article, “Indigenous People and Environmental Politics (With Special Reference to North-East India)”, stressed on the vital role played by tribal culture and ethics in relation to environmental conservation and management. The author also highlighted the importance of tribal ethics and the indigenous knowledge with regard to environmental protection and conservation. He also contends that indigenous knowledge needs to be developed and integrated into the local, national, regional, or even global development efforts.

Charles Reuben Lyngdoh discusses the emerging trends in land relations in the Khasi Hills of the state of Meghalaya. The author underlines the detrimental changes that have taken place in the land holding pattern system in the Khasi Hills. He also contended that control over land has a close link to the identity (Khasi ethnic identity) of the people and the threat of land alienation is a threat to this identity.

The next chapter, “Tradition and Culture of Tribals in Tripura: An Environmental Interaction”, the author Jaharlal Debbarma expounded on the culture and tradition of the Borok community of Tripura, which is

highly rooted in the environment. He stressed on three major points – ritual practices relating to births and deaths, religious practices and religious belief system, and folktales, folksongs and superstitious beliefs – all having their origin in the natural environment in which the tribe subsists. The author contended that these practices and beliefs played a significant role in the conservation of nature. The author also attempted to show how contact with the modern world has changed the tribal's traditional way of life and brought about ecological imbalance, but he maintained that the Borok community, with its nature-centric environmental philosophy, has been able to maintain its deep respect for religious and cultural veneration of the natural world.

P. Banerjee and M. Mukherjee, in their article, "Promoting Sustainable Development through Climate-Mitigation Projects: With Special Reference to North-East India", discussed sustainable development in the context of Kyoto Protocol with regard to the emission of greenhouse gases (GHGs) and deliberated on the beneficial effects to India for partaking in this endeavour. The authors evaluated the present position of Clean Development Mechanism (CDM) in the country and demonstrated how sustainable development can be ensured by implementing cost effective projects under this emerging sector, particularly in North-East India. This has given birth to an innovative business model whereby a business entity can make synergies between economic, social and environmental dimensions of business and discharge its responsibility towards the environment and society without jeopardizing its own financial sustainability.

An endeavour to connect North-East India to the rest of the South-East Asia through Myanmar was attempted by Debashis Nath through a paper titled "Promoting Sustainable Development in North-East India through the look east policy". Maslow's Hierarchy of needs was highlighted through the presentation, where the author stated that the development of the region should be made from within and not without.

Dasarathi Bhuiyan in his article, "*Ecological Citizenship: Solution to Environment Problems*", focuses on a total re-orientation of science and technology which is very much an essential solution to environmental problems. The paper also calls for the expansion of classical (Aristotelian) conception of citizenship as the "required commitment to the common good and active participation in public affairs" and the need to inculcate a sense of responsibilities toward the environment. One's duties to nature, as an ecological citizen, cannot be abstracted away from one's larger duties to a human community. The paper finally suggests that Ecological

Citizenship and Sustainable Infrastructure is the only way out. An exposition on the adverse social, cultural, and environmental impacts of mega hydro-power projects Dongzu area, Sikkim, is highlighted by Tikendra Kumar Chettry and Neeraj Adhikari in their article, "Developmental Deficit(s)?: Insight(s) to Environment and Indigenous community Protection Movement in Dzongu Valley, Sikkim".

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CHAPTER TWO

PREHISTORIC CULTURAL-ENVIRONMENT RELATIONSHIP: IMPACT OF IRON MANUFACTURING ON THE DYNAMICS OF VEGETATION IN THE KHASI HILLS OF MEGHALAYA

MARCO MITRI AND JIM C. MARAK

Introduction

Human cultures in the dimmest part of prehistory were generally described as midgets before the expansive world of wild flora and fauna. A depiction of the forces of the forest can be found in oral narratives around the globe sharing common stories about the forest and its landscape as being inhabited by semi-divine fairies, werewolves, tiger-men, goblins and a host of malevolent forest dwellers that protect the wild landscape. This was that stage in human culture when man still behaved in the likes of Dryden's oxymoronic *noble savage* (John Dryden:1672)[1], essentially transpired an underlying idiom of 'benevolence' of the natural world and the values it instilled on primeval human cultures. The embedded idea also produced sparks of inspiration which became a model for philosophers in their quest to provide answers to the perplexing question of inequality that prevails in modern societies (Rousseau, 1754).

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[1] "I am as free as nature first made man,
Ere the base laws of servitude began,
When wild in woods the noble savage ran"
Dryden had picked up the expression "noble savage" from a 1609 travelogue about Canada by the French explorer Marc Lescarbot, in which there was a chapter with the ironic heading: "The Savages are Truly Noble".

The *Noble Savage:* Archaeological Analogy

The illustration of a *noble savage* coincided with the period when cordial relationship existed between human culture and the natural environment. That stage of *nobleness* can be best appropriated with the period which empirically corresponds to the early stages of the prehistoric stone-age cultures (Palaeolithic and Mesolithic Period)[2]. The evidence of that period is archaeologically detectable through the discovery of rudimentary stone tools found in different parts of the world since the later part of the 19th century. Although studies have shown that the period of early stone age in human prehistory dates back to as early as 1.75-1.90 million years ago (Leakey, M.D., 1984), traits of prehistoric behaviour are, however, visible even in the modern 20th and 21st century in some cultural pockets of the world. Over this long-stretch of prehistoric cultural behaviour, human material culture submitted ungrudgingly to the impulse of nature, and thrived under the natural rule of survival, taking only whatever nature allowed for it to retain[3]. But around 10,000 years ago, a sudden shift in human prehistoric cultures took place, whereby a new phase in human cultural history known as the New Stone-Age or the Neolithic period appeared. This phase was remarkable since it established a new dialogue between human cultures and their environment in a uniform manner around the world. This cultural stage saw the beginning to an end of the one-sided tussle for supremacy and displaced the dominance of the natural environment over human culture. By this period, different cultures had learnt to make inroads into the secrets of nature.

The natural cycle in the world's climatic fluctuation inspired an innovation in human stone tool technology and survival strategy eventually fostering a revolution in human material and cultural progress (Childe, 1936). The Neolithic period saw the *wild* being domesticated and the forest with its natural habitat tamed. Human cultures armed with an advanced and complex variety of stone tools called the *Neoliths*[4] began to domesticate

[2] The stone tools during these phases of human cultures performed only basic requirements capable only for hunting and practice of incipient agricultural functions.

[3] The Paleolithic period is identified with the Scavenging, Foraging and Hunting economy.

[4] These are the most advanced and most complex form of stone tool technology capable of multiple functions. It is the last stage of the stone-age and the technology developed from this stage became the precursor of the metal tools in the age of metal.

the wild forest and brought them closer to their hearth[5], symbolically representing the conceptual separation of the house from the untamed world (Hodder, 1996). Living proof of the Neolithic cultural behaviour is still visible in many pockets of the world today which can be attested by the common practice of hanging animal skulls in houses thereby showing close attachment of the hearth with the wild.

The gulf of Human-Environment relationship shifted further in the period of the Iron-age. The knowledge of iron fostered a new stage of advancement in metallurgy and with the aid of metals, human cultures further exercised dominance over the environment. Metallic tools being highly effective for clearance of large tracts of forested lands, soon converted forests into agricultural tracts and human settlements, a phenomenon antecedent to the growth of civilisations. The Iron-age brought in stupendous changes which witnessed large-scale deforestation, destruction of the natural habitat and the reshaping of the natural landscape. The increased use of metal technology which eventually replaced stone tool artefacts, established new economic activities and altogether altered human culture's relation with the environment. This transformation brought about an end to the long discourse of the cordial relationship between human culture and the environment. Humans, in the name of cultural progress, became perpetrators of the natural world and much of the wild that thrived in it.

The Iron-Age in Khasi-Jaintia Hills

The inhabitants of the Khasi-Jaintia hills of Meghalaya boast for being one of the earliest manufacturers of iron tools. The tradition of iron manufacturing in these hills continued undisturbed throughout the preliterate period and survived into the time of the British annexation of these hills in the later part of the 19th century. Scholars contend that the Khasis (collectively; including the Pnars) are the authors of the iron industry in the hills and could probably be the first iron-using culture among the innumerable tribes of North-East India (Sen, 1984). Documentation of the Iron Industry in its dying stage was recorded by officials and ethnographers of the British Government. They provide us with authentic reports to measure the scale of the Industry during the early

[5] "The shift in the mode of subsistence to agro-pastoral farming remains the only process which is relatively closely defined, geographically widespread and sufficiently archeologically detectable to act as signature of the Neolithic".

and Middle part of the 19th century (Hunter, 1879; Oldham, 1854; Yule, 1943 and Gurdon, 1914).

Iron slag which is the staple to archaeo-metallurgical research is the most abundant and best-preserved product which offers clues to understanding iron manufacturing right from its incipient stage. Radiocarbon dating or C-14 date of a charcoal which was extracted from one such iron slag from the site at Nongkrem of Khasi hills produced a date of 2040 ± 80 years BP (Prokop, 2013). Iron manufacturing in the Khasi Hills was, therefore, initiated at least 2000 years ago[6] and continued right up to the middle of the 19th century. The large-scale metallurgic production from these hills was a response to the demand for iron from the adjacent lowlands, which did not have iron ore-resources.

Iron Smelting and Charcoal Fuel Consumption

Charcoal which can burn to about 1100 degrees Celsius is high enough to reduce the oxides in the ore and therefore became the basic ingredient of fuel used for smelting iron in the early stages of human cultures. Using a primitive iron manufacturing bloomery furnace, like the ones that are found in Khasi hills, experiments were conducted by a team of scientists from the National Metallurgical Laboratory, Jamshedpur to understand the quantity of Iron: Slag ratio production per unit. The results from such an experiment produced the following figures (Vaish, 1997):

Experiment Study Results
25 Kg Iron Ore + 30 Kg Charcoal **Produce** 5.51.Kg Wrought Iron + 21 kg Slag

It has been known that a considerable quantity of iron was exported from the Khasi Hills into the plains of Bangladesh through Sylhet. The earliest record by Colonel Lister in 1853 showed that approximately 20,000 mounds of finished iron products and pig iron were exported to the Assam and Surma valley (Gurdon, 1914). A more precise report came in 1864 which accounted that the annual export of pig iron was estimated to be

[6] World's earliest date for Iron manufacturing is fixed at 1350 B.C, on the basis evidence from the site of Gerar, Palestine dated by Sir.Flinder Petrie way back in 1927.

45,000 *maunds* valued at about Rupees 67,500/- in those days (Oldham, 1854 and Hunter, 1879). The figures certainly helped to evaluate the role of iron as a base of the people's economy besides agriculture. Thomas Oldham also provided a detailed report on the process of manufacturing iron. He stated that, there was a complete division of labour after the stage when pig iron was finished into working implements in the hills itself to the extent that different villages have specialised in the manufacturing of selected implements. In the Khasi hills, charcoal was the only fuel used for the entire process of iron smelting and manufacturing. The best charcoal from these hills was produced from local oak species, but in cases where there was a lack of a hardwood other kinds of trees was used for carbonization (Hooker, 1854).

While estimating the amount of iron production from the above mentioned report of Khasi hills, it is imperative to consider that the estimates are based only for the exported material which was recorded in 1864, a stage when the industry had declined considerably. Based on the calculations arrived from the said experiments on traditional iron smelting (in bloomery furnace as those used by the Khasi smelters), the following figures can be generated in the context of the Khasi hills:

Annual Exports from the Khasi hills

45000 Maunds = 1800000 Kgs

Based on Experiment Study

5.54 Kgs of Charcoal **Produce** 1 Kg of Wrought Iron

Result for Khasi Hills=9972000 Kgs of Charcoal **Produce** 1800000 Kgs of Pig Iron

There are studies which also try to investigate the amount of charcoal usages and its impact on deforestation due to traditional iron smelting. The following figures are the model results (Sashi, 2009):

Figures Derived From Study Report

1tree **Produce** 500 Kg wood

4-7 Kgs of wet wood **Produce** 1 Kg charcoal

16 Kgs of charcoal (80-110 Kg Wet Wood) **Produce** 1Kg of refine Iron

Applying the Experimental Study and the Study Report, the following are the results on the range of deforestation in Khasi hills caused by traditional iron smelting as per the colonial reports:

1 single Tree **Produce** 70-120 Kg Charcoal
16 Kgs charcoal **Produce** 1 Kg Refined Iron
1 Single Tree **Produce** 4-7 Kgs of Refined Iron
Annually 260000 – 450000 Trees **Produce** 1800000 Kgs Pig Iron

Charcoal Production and Forest degradation

Way back in 1910, P.R.T. Gurdon observed that in the higher ranges, the hills are denuded of forests and covered with short grasses. The landscape was, thus, laid barren of trees as the wood was being used for fuel for iron smelting (Gurdon, 1914:4). The denudation of the forest was also caused by the method of extraction of metals from rock boulders which led to large scale erosion of the soil.

The impact of charcoal on the ecosystem occurs at every stage in the production-consumption chain, but the focus of this paper is only on the impacts of production in the sub-tropical forest ecosystems, a condition prevailing in the Khasi-Jaintia hills. Charcoal is produced from aboveground tree biomass, implying that the whole or parts of trees must be felled, followed by the wood carbonization process in traditional kilns. In most cases there have been reports highlighting the concerns about deforestation and forest degradation accompanying the iron production process. Forest degradation refers to less obvious changes in woody canopy cover while deforestation is the complete loss of the forest cover that is often associated with forest clearance (Grainger, 1999). Degradation, therefore, represents the temporary or permanent reduction in the density, structure, species composition or productivity of vegetation cover (Chidumayo, 2013).

The impact of producing a specified amount of charcoal depends primarily on size of the tree and the density which vary among the forest types. In the present study, traditionally managed private and community forests in the state of Meghalaya, called the "sacred groves"[7], are used as the

[7] In the Khasi traditional belief, there is much taboo attached with the Sacred Grooves. It is said that whoever cuts down a tree from these forests would face the wrath of the forest's presiding deity and would suffer physical deformity.

reference of the forest types that once thrived in the area of the investigations. As of today 79 such groves have been documented (Tiwari, 1999) in Meghalaya, of which 32 are located in East Khasi Hills, 13 in West Khasi Hills, 3 in Ri Bhoi, 15 in Jaintia Hills and 16 in Garo Hills.

Today these forests have a sharp contrast to their immediate surrounding grassland. Out of the total area of 10,511.7 ha under sacred forests cover, 138.1 ha area which constitutes a little over 1% of the total, is still undisturbed which includes the Mawphlang sacred grove in East Khasi Hills District, Raliang and Ialong sacred groves in Jaintia Hills. These groves represent the climax of subtropical broad-leaved forests. The most common tree species found in these grooves are shown in the appendix.

Regeneration of Vegetation

Biomass for charcoal production is obtained from natural forests in which natural regeneration is the main source for forest recovery. Regeneration of the tree species takes place either through sexual or vegetative means. Sexual regeneration is achieved through the process of seed germination and establishment of seedlings and their recruitment into the tree phase. Vegetative regeneration occurs through the recruitment of sprouts or re-sprouts into the tree phase from pre-existing trees that are cut or damaged, often termed as coppice. Sprouting is the production of secondary trunks as an induced response to injury or to the profound changes in growing conditions. The significance of these regeneration mechanisms depends on the floristic composition of the forest and the nature of disturbance. Seedlings are a more significant source of regeneration in the tropical moist forests after disturbance, such as cutting, than in tropical dry forests where regeneration from the saplings is more important. Re-sprouting is a common source of regeneration in both the moist and dry forests because many tree species are capable of re-sprouting. However, re-sprouting may be more important in the tropical dry forests than in the moist forests because of the longevity of trunk bases and the adaptation of plants to seasonal drought.

Impact of Iron Smelting and Alteration of Forest cover in Khasi-Jaintia hills

In the study, the mean density (1200 ha^{-1}) of trees found in the sacred groves today is used for estimating the degree of clearance of forest for charcoal production. The trees within the range of 5-15 cm dbh class

constitute about 60% of the total forest cover, while those above 60 cm dbh class make up only 5% of it.

Taking into consideration that at least 2, 60,000–4,50,000 trees were required to achieve an annual production of 18,00,000 Kgs of pig iron in Khasi hills, and the mean tree density of 1200ha^{-1} found in the sacred groves, it is estimated that 217–375 ha of forest cover had to be cleared annually. Taking mean density of individual trees to be 11 ha^{-1}, it would thus require an estimated area of about 23,636–40,909 ha (236.36 – 409.09 sq.km) within the same period of time (see variation in table below).

Year (s)	**Clear Cutting**		**Selective Cutting**	
	1200 ha^{-1}		**11 ha^{-1}**	
1	216.67 (2.17)	375.00 (3.75)	23636.36 (236.36)	40909.09 (409.09)
10	2166.67 (21.67)	3750.00 (37.50)	236363.60 (2363.63)	409090.90 (4090.90)
15	3250.00 (32.50)	5625.00 (56.25)	354545.50 (3545.45)	613636.40 (6136.36)
20	4333.33 (43.33)	7500.00 (75.00)	472727.30 (4727.27)	818181.80 (8181.81)
25	5416.67 (54.17)	9375.00 (93.75)	590909.10 (5909.09)	1022727 (10227.27)

Note: all figures in **ha**; figures in parenthesis **sq. km.**

Many tropical forests have the potential to regenerate after clearing for charcoal. The forest regeneration rates are a function of the forest type, cutting system, rainfall, fire management and grazing intensity. Considering the poor natural seedling regenerations of tree species such as *Quercus*, *Lithocarpus, Schima, Symplocus, Ligustrum,* etc. which are most commonly used, and the high demand for charcoal requirement, coupled with very large forested area to be covered to collect selective tree species, it is most likely that there had been very little species and size selection in tree felling for charcoal, such that there was a virtual clear-felling of the woodland around a kiln site. It would imply that 2,166.67 – 3,750.00 ha (21.67 – 37.50 sq.km) to 3,250.00 – 5,625.00 ha (32.50 – 56.25 sq.km) respectively were required to be cleared within a span of 10 – 15 years.

The presence of marked vast grasslands adjacent to each of these sacred groves in both Khasi and Jaintia hills today is an indication of large-scale non-selective forest clearance. Over the years, the clearance of large forest areas for charcoal production had altered the structure, species composition and productivity of the harvested areas and gradually transformed them into grasslands. Owing to the same factors, spaces were created for the other fast-growing and resilient species to populate the forest covers.

It is also important to consider the role of microorganisms and the nutrient levels of these forest areas with regard to the successful establishments of seedlings. The areas are known to receive very high precipitation (2500 mm) and this factor coupled with steep slopes of such areas might have accelerated the removal of nutrients from the top soil along with the microorganisms (such as *ecto* and *endo mycorrhizae*), which play a crucial role in establishment of seedlings at their early stages. Another important factor that exacerbated the poor regenerations might have come from unregulated forest fire, which is practiced by the people of the area. Under severe wood resource depletion, even the stumps left over from previous charcoal production may be dug up and used to make charcoal, resulting in acute reduction in the potential for natural forest regeneration.

Analysis

In the assessment of the impact of charcoal production in sub-tropical forests of the study area, it is assumed that clear-cutting rather than selective cutting for charcoal production is the primary reason for the alteration of vegetation[8]. Forest re-growth in the areas of high tree species diversity indicates clear cutting or removal of the entire canopy (Hosier, 1993). The sacred groves of these areas were reported (Upadhaya, 2003) to have very high species diversity. It is assumed that the very idea of traditional managements of such sacred groves attached to religious beliefs was an attempt to prevent such large scale clearance of forests. It is interesting to note that 40%[9] of the total sacred groves documented till date are concentrated in a relatively small area of East Khasi Hills on the southern slopes of the central highland, areas that are relatively closer to the iron smelting sites of the past.

[8] From the broad leaf species to confer vegetation which forms the major forest cover of Khasi-Jaintia hills today.