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Address for correspondence:
Principal
Kohima Science College (Autonomous),
Jotsoma- 797002
Nagaland

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RÜSIE

*Translation: 'A movement for a cause' is the literal translation of the Tenyidie word **'Rösie'**. It is a movement of united action and efforts by a group or a community for a specific purpose.*

The name 'Rösie' befits the journal which is also a movement for a cause- of Science and Social issues. A forum to disseminate ideas and knowledge through united and collective efforts.

Name of the journal proposed by Dr Shörhozelie Liezietsu, President, Ura Academy.

Cover & back photos: Views of the college campus

CONTRIBUTORS

Dr. Anungla Aier
Principal
Kohima Science College (Autonomous),
Jotsoma, Pin- 797002
Nagaland, India
e-mail: anunglaaier@gmail.com

Dr. J. Meren Ao
Principal
St. John Higher Secondary School
Dimapur, Pin-797112
Nagaland, India
e-mail: stjohncollegedimapur@gmail.com

Dr. KezhakielieWhiso
Geo-scientist
KDM Institute of Petroleum Exploration,
ONGC, Dehradun, Pin- 248195
Uttarakhand, India
e-mail: kezha_whiz@yahoo.com

Abeni Odyuo
Assistant Professor
Department of Geology
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: abenikapfo@gmail.com

Dr. Chumbeni Kikon
Principal-in-charge
John Government Higher
Secondary School
Viswema, Pin- 797005
Nagaland, India
e-mail: chumbek@gmail.com

Dr. S. Boopathi
Professor
Dept of Economics
Bharathiar University, Coimbatore
Pin- 641046
Tamil Nadu, India
e-mail: somuboopathi@gmail.com

Dr. C. Periasamy
Associate Professor
Department of Economics
Zunheboto Government College
Zunheboto, Pin- 798620
Nagaland, India
e-mail: 1963@gmail.com

Dr. R Vineetha Pillai
Assistant Professor
Department of Chemistry
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: Vineethapillai63@gmail.com

Sakhoveyi Lohe
Assistant Professor
Dept. of Geography
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: sakhoveyi_1@yahoo.com

Dr. Prasanta Barman
Assistant Profesor
Department of Statistics
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: bprasanta@gmail.com

CONTRIBUTORS

Sheikh Faruk Ahmed
Assistant Professor
Department Of Statistics
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: sh.farukahmed@gmail.com

Md. Jakir Ali
Assistant Professor
Department of Statistics
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: mdjakirali@rediffmail.com

Prajadhip Sinha
Assistant. Professor
Department of Computer Science
Kohima Science College (Autonomous)
Jotsoma, Pin- 797002
Nagaland, India
e-mail: prajadhip@rediffmail.com

Meripeni Ezung
Assistant Professor
Department of Physics
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: m_ezung@yahoo.com

Partha Roy
Research Scholar
Department of Physics
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: partharampurhat@gmail.com

Dr. Sanjay Sharma
Associate Professor
Department of Physics
Kohima Science College (Autonomous)
Jotsoma, Pin-797002
Nagaland, India
e-mail: sanjay_sharma11@hotmail.com

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DEVELOPMENT SCENARIO IN NAGALAND: AN ANTHROPOLOGICAL CRITIQUE

Anungla Aier
Kohima Science College (Autonomous), Jotsoma- 797002, Nagaland
e-mail: anunglaaier@gmail.com

Abstract: Over the last few decades, the Naga society which is a tribal society has been undergoing tremendous transformation from a rural based close knit society to a more urban based market driven society. Such transformation has been largely influenced by the development driven flagship state programs for rural and tribal development. Despite the obvious physical indicators of development and modernization of the society, there also exists a wide array of social and cultural problems that has arisen as a corollary to the unfolding transformation from tradition to modernity. This article makes a modest effort to explore and discuss some of the problems.

Keynotes: Tribal society, Development policies, changes and problems.

Introduction

Soon after independence, India as a free nation adopted planned development programs starting from 1951 with special programs for tribal area development. The guiding principle of the nation's polices with regard to tribal development as stated by B.D.Sharma (1984) was in consonance with the principle laid down by Pandit Jawaharlal Nehru in the famous *Panchsheel*; which are - progression according to their own genius; change to be internally guided and executed through a simple administrative system; honouring their traditional rights on land and forest; material advancement and improving the quality of life through special development programs. However, various studies have shown that the development efforts of the government have not resulted in the desired direction and that India's tribes are plagued with numerous social, political and economic problems. Sharma (1984) goes on to state that *national effort for development and modernization are giving rise to such torrential forces which the simple communities may not be able to stand. The basic question is as to how the pace of change should be moderated and how the path of development should be guided.* Dube (1972) also noted that o*n an operational level, it would be useful to examine why many development projects launched with great fanfare in tribal areas failed to yield the results they promised…focus will have to be on incompatibilities between innovation and culture, on communication gaps, on bureaucratic inadequacies and dysfunctions and on the soundness or unsoundness of the strategies of development planning and implementation.* With regard to tribal policies and issues, Bhupinder Singh (1977, p.80) also stated that *the results of the efforts of the past decades have been lack-luster…the point is that we have experimented with the idea of planned development being an official program with the people in tow*. Such observations point to the ground realities of development efforts where the ideals of development programs are declared with pomp and the people are expected to accept and follow passively. Such practices have led to situations where after the development fund is drained out, the people are left in no better position if not worse. In this regard, the observation of Nongbri (1997, p.326) is worth mentioning. She stated that *India's draft Five-Year plans on tribal development loudly proclaimed Nehru's policy of cultural pluralism and the preservation of tribal cultures and their distinctive identity. In*

reality, however, Nehru's vision of a self-sufficient and functionally independent tribe existing against their pristine cultural backdrop remains a distant dream.

It is in the context of these situations that one needs to ask with Haimendorf (1980, p.1-15)[1], *why do populations who for millennia persisted in a state of almost complete self-sufficiency, having developed their own way of life and cultural individuality without any need for outside assistance, have now to be protected and aided by government. This question appears to be all the more pertinent as only one or two generations ago many tribal communities enjoyed the advantages of a well balanced ecology fully in tune with the natural resources of their environment and could boast an overall quality of life superior in many ways to that of large sections of the Indian rural population. Adequate food supplies, a non-exploitative social structure, freedom from indebtedness and other forms of dependence on non-tribal outsiders, equality of the sexes and a remarkable tolerance in all interpersonal relations were the outstanding characteristics of such tribal societies.* Probably the explanation can be found in what a former member of the Planning Commission is reported to have stated. '*Every Plan has the poetic part of the Chapter on objectives, approach and policy, often from the guiding principles of the Constitution. Having once gotten over this poetic preamble, the operational part got down to the serious business of ensuring the subversion of every one of them'.*(Gadgil Madhav, cf. Fernandes, 1997, pp 163) As noted by Tiplut Nongbri, (op.cit, p. 329), *Development in India has been perceived as an instrument of political reconstruction.* The task of economic development therefore is aimed not only to fully exploit its natural and human resources and attain a level of productivity that would give it a respectable position in the community of nations, but also to achieve political stability. Within this broad theme of national development, the strategy and policy approach to tribal development have been adopted. However, the plethora of studies on tribes generated in the recent times has not only highlighted the failure of development paradigms to address the social and cultural consequences, but the development itself has become an instrument of economic exploitation and cultural subjugation.

Development Situation in Nagaland

The contemporary political boundary of Nagaland as a state is a post independence phenomenon. More than three fourths of the total population of the state consists of Nagas who are categorized as schedule tribes under the Indian Constitution. The classical definitions of a 'tribe' recognize 'A politically and socially coherent and autonomous group occupying or claiming a particular territory'. Such definitions have emerged from the classic studies of tribes in Africa, where the tribe is defined as the largest group within which compensation is paid for and in which is manifested the machinery for reconciliations. However, such a definition of tribe(s) does not seem to have much applicability to the traditional Naga socio-political situation. The Nagas are known throughout history for their practice of head-hunting even within their own tribe and had no binding political organization so to speak of above the village level. For each Naga village was a self-contained politically autonomous unit from whence the notion of 'village-states' came into being. However, looking at the broader themes on which each of the villages was organized, we can also see that though the villages were autonomous in their functioning, they all were organized on more or less similar structural principles. The clusters of villages speaking the same language and ingrained in common culture were concretized as tribal entities during the colonial times and were solidified with the passage of time.

The process of change from a close tribal economy with isolated social systems to a highly monetized economy and complex social system has resulted in severe distressing situations. The severity of the distress cannot be measured only in material or instrumental terms. More distressing are the cultural and social degradation. One of the glaring evidence of such social development is the increasing number of people, particularly young people who are discontented, lacking the skill and the resources to earn a livelihood with self-respect. The culture of hard work, traditional exchange of services and competitiveness earlier symbolized by the feasts of merit have become things of bygone days. Given that development directed at bringing about change in the conditions of existence, it would be disastrous to disregard the socio-cultural framework within which development is to take place, and if development is directed at a particular people, how do we perceive that the course adopted is the desired goal of that people? Development cannot be measured exclusively in material terms. Also, the yardsticks used to measure the needs and expectations of a particular society cannot be applied to another in the exact manner.

Nagaland state is no stranger to failed development projects. To state the extreme, failure of government development projects is expected, fully knowing that there will be no social audit, the officials involved and few political elites of the community take advantage of the situation while the public looks on helplessly particularly the rural masses, with no mechanism to voice their frustrations. The trend of development in Nagaland is conspicuously marked by the practice of giving Government subsidy to applicants without verifying the authenticity of the proposed projects. The methods, infrastructure, resources both human and natural and the workability of the projects are not studied. Moreover, development of the necessary skills and capacity building is totally neglected. So much so, that the people are reduced to being dependant instead of being self-reliant. The experience of this writer in some Naga villages indicates that peoples' perception of 'projects' is associated with 'subsidy' and their interests are roused fastest only when the magic word (subsidy) is used. Such a development is the outcome of doling out development funds for the sake of satisfying program targets of beneficiaries without proper assessment and for political expediency.

As the main implementing agency, the success of the government development programs depends upon the sincerity and efficiency of the people who man the various organs of the bureaucracy. In reality, what we see in Nagaland is that the bureaucracy approaches the development issues as an easy way to amass wealth instead of finding ways to build up the society by making the people self-sufficient and self–reliant. Thus, the problems of the people have been multiplied manifold by an unresponsive and corrupt bureaucracy. In this process, a close nexus between the bureaucracy, the politicians and the favored opportunity seekers and beneficiaries is developed and political interference is the rule rather than the exception in all spheres of development. Often it is alleged that development programs suffer/fail because of the simplicity and ignorance of the people who are unable to absorb the benefits specially meant for their welfare. Due to dearth of infrastructural facilities and the low cost nature of their traditional economies, the development inputs earmarked may not be ingested, but we could hardly blame the people for these factors. The empirical evidence suggests that more often than not, it is the failure of the implementing agencies in taking development to the people and building up their built-in social and cultural mechanism rather than the ignorance of the latter. The experience of the last few decades has shown a painful inadequacy of development in providing the

needed skills and the opportunities for the communities to train, organize and design their development using local resources and knowledge.

It is against this background of the negation of development intervention by the bureaucracy resulting in economic stagnation, deprivation and breakdown of traditional institution and cultural ethos that we can understand the spate of armed conflict and anti-social activities in Nagaland. Nagaland state with a dominant tribal population is also the state with the longest history of political unrest in the country. The GOI with the purpose of dampening the political movement has funneled huge funds for development purposes and projects. However, faced as they are with ineffectual government machinery that hardly fails to replace the breakdown of traditional institutions; and social distancing of the decision makers and the people, they continue to turn towards politics to find solutions to their problems. In their search for internal stability, the use of ethnicity for political mobilization comes easy to the Nagas, who see political power as a viable instrument for short term solutions. In the light of the prevailing social and economic conditions in Nagaland, a new approach to development is called for. What is urgently needed is the participatory approach, not just in policy terms, but also in the practical implementation level. So far, the practice has been to impose programs upon the people with complete disregard of what they actually need. This has proved to be ineffective. What we need to do is to explore within our own cultural system in our own terms for our own development.

Anthropological insight has shown that a people when detached from their cultural moorings tend to show signs of disenchantment, apathy, and gradual detribalization of the society. With regard to the development of tribal communities in particular, anthropological writings have always suggested the need to work from within their cultural system. It has always been the long standing position of anthropology that tribal development should be in tune with the cultural ethos and not contrary. Development of a society should be manifested by the strengthening of their traditional institutions, respect for the cultural ethos, building up of the traditional knowledge system the people can identify themselves with by creating conditions that boosts their self-confidence and high moral. This can be achieved only when the people are given the opportunity of developing the security of knowing their self-worth. The example of Japan as one of the wealthiest nations of the world is witness to this fact of developing the society from within, based on traditional culture of self respect through hard work. The development practices in Nagaland however, have seen a complete neglect of such anthropological insight, which is detrimental to the present order of social development in the Naga society.

The Naga society is a traditional society in the sense that despite all the various shows of modernity by way of a formal state order and organized socio-political and economic pursuits, the basic core of the society on which rests the frame of reference for self-identification and interpersonal relationships lies with the traditional mode of reckoning. Sufficient evidences both written and oral forms exist that prove that traditionally the Naga people were a self-sufficient and self-contained people. Sadly, the situation today tells a different story. Naga people, whether in the urban or rural areas are not self-sufficient. One can just wonder how many starvation deaths will occur if the center at New Delhi stops the flow of fund into the state treasury. Though there has been much hype about *grass-root level development*, the truth is that the plan policies and programs designed by planners who have the least knowledge of local needs are simply imposed upon the people. At the implementation level also, a

mechanical process of carrying out the program is followed without exploring local solutions and local knowledge systems for solving the development problems. The consequences of the present development trends have amply illustrated that we as a people cannot afford to remain as silent spectators to the scene that is unfolding before us nor must we be just passive *'development targets'*. We need to take stock of our social and cultural capital and develop or revive such assets to evolve an indigenous mechanism for the optimum utilization of the resources to become self-reliant. In this context, the revival of some of the abandoned traditional institutions and the strengthening of the existing ones can be explored for building it up according to local needs as a viable mechanism for the development of the people for capacity building as well as economic development. At the same time it is also necessary to remind ourselves that no culture can survive if it continues to blindly hold on to ancient practices and beliefs and so it is equally important to change the mindset and do away with such cultural practices which are not tenable with the present times.

As evidenced by the various descriptive accounts and monographs, the traditional society presents structural variations in their social and political organization. However, a general theme based on egalitarian principle is operative in all the Naga communities. The Naga society is made up of cross-cutting ties; and the individual and the household are integrated into the society by being life members of larger functional units such as the lineage, clan, age group, Morung, and khels. The individual's life cycle and the routine of daily life are expressed through the inter-play of these social groups in operation. In anthropological parlance, such social groups are termed as social institutions, where the various cultural complexes are woven together in relation to the basic interests of social living within which the individuals' place and role in the society is defined and finds meanings for life as a productive member of the society. As stated by Radcliffe brown (1983) such institutions signify the status and roles of a person within a social system. Most anthropological critiques of development projects criticize planning which is insensitive to the cultural and social complexity of local conditions and thus the diverse effects of externally induced change. In Nagaland also is seen a replay of such insensitive development planning and the inadequacy of the developing agencies in implementing various programs with the objective of building the society to be self reliant and infusing positive pride and confidence in the system.

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DEVELOPMENT OF *HYLA ANNECTANS* JERDON, 1870 FROM NAGALAND, INDIA

J. Meren Ao
St. John Higher Secondary School, Dimapur-797112, Nagaland, India
e-mail: stjohncollegedimapur@gmail.com

Abstract: *Hyla annectans* breeds during May to July in temporary rain pools, terraced fields and other water logged areas (depth 5-7 cm). Normal development has been studied from the egg through metamorphosis for four breeding seasons (four years) under laboratory conditions. The time required for completion of a life cycle varies under different weather conditions in the field. In the laboratory (16-22^0) the frog completes its life cycle in 64 days 14 hours.

Key words: *Hyla annectans* , developmental stages, normal development, Nagaland, laboratory condition, metamorphosis.

Introduction

Studies on the breeding cycle, spawning behavior and successive development are important in understanding the ecology of a species and for planning conservation measures. Various authors (Dutta and Mohanty Hejmadi, Mohanty-Hejmadi and Dutta , Agarwal and Niazi, Roy and Khare , Kiyasetuo and Khare , Dutta *et al*,) have contributed to the study of normal developmental tables of Anuran amphibians in India.

Hyla annectans , is the only species reported from India of the family Hylidae. This species was recorded from Khasi Hills and upper Burma (Mynamar). In Nagaland, its distribution is along the Borail range at various altitudes ranging from 1400-2440 m ASL. The frog is leafy green dorsally and yellowish white ventrally. Female is larger (48 mm;Fig ii) than male (40 mm; Fig. iii). A light brownish streak connects the eye and the nostril. A black streak on the lateral side behind the arm runs up to the groin, terminating in 2 to 3 black spots of different sizes. A few black spots are present on the inner surface of the femur and tibia.

Observations

Breeding activity starts from March, when they come out of hibernation and live deep in the sheath of banana plants (Fig. i) bamboo stamps and damp places. During this period, the average temperature ranges from 11.4 to 24.8^{0}C and precipitation from 4.5 to 110 mm. The breeding period starts from May when they live mostly near water bodies. During this period, the average atmospheric temperature ranges from 16^0 to 26.6^0 C, precipitation ranges from 128.23 to 428.33 mm and water temperature ranges from 14 to 28.5 ^{0}C. Breeding activity lasts till july end. Post breeding period starts from August, when they become arboreal and are found on trees and other vegetations. Average atmospheric temperature ranges from 14.37 to 23.85 ^{0} C and precipitation from 116.97 to 307.02 mm. By the end of November, these frogs are rarely sighted and hibernation period lasts till February. The average atmospheric temperature during this period ranges from 6.3^0 C to 17.8^0 C and precipitation from 0.1 to 56 mm. *Hyla annectans* breed in temporary pond, rainpool puddle and terraced paddy fields, at the edge of forests where water logging is observed. The sound of mating call of the male frog is comparatively much lower than its body size. The number of eggs laid is between 570 to 630 and are laid in 6-10 batches. Each batch contains about 60-90 eggs within a jelly film(*Fig.* 1*)*.The total period of development from egg to metamorphosis is 1550 hours

(64 days 14 hours) at room temperature(16-22^{0}C).

Methodology

Amplexing pairs were collected from the field and transferred to aquaria or glass containers with water, allowing only half of the body to be submerged. Eggs are laid between 0100-0440 hours in the aquaria as well as in the field. Embryonic development was observed for a period of four breeding seasons. Culture was maintained in clean enameled trays. They were reared in the laboratory at 16-22^{0}C . Larvae were fed with *Spirogyra*, which is common in the breeding habitats. Tadpoles were staged according to Gosner. Developmental stages were fixed in 5% formaldehyde solution; measurements were taken from preserved specimens. Photographs for number 2-16 were taken from preserved specimens, while for number 17-24 live individuals were used.

Developmental stages

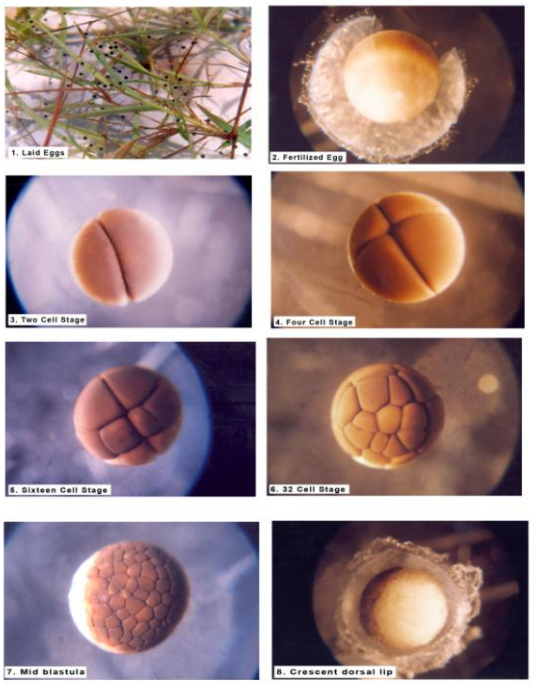
Fertilization stages

Stage 1: *Fertilize egg* (Age 0 hrs; length 1.52 mm). the egg is spherical. The animal pole is pigmented dark brown, paling to white at the vegetal pole. *Fig.2*

Stage 2: *One celled stage* (Age 0.55 hrs; length 1.52mm). A lightly pigmented area, the grey crescent appears between the animal and vegetal pole towards the pigmented hemisphere.

Cleavage stages

Stage 3: *Two cell stage* (Age 1.50 hrs; length 1.52 mm). The meridional furrow originates at the animal pole and proceeds to the vegetal pole which divides the egg completely into two equal halves. *Fig. 3.*



Stage 4: *Four cell stage* (Age 2.20 hrs; length 1.52mm). The second meridional furrow originates at animal pole and extends to the vegetal pole at a right angle to the first , dividing the egg into four cells. *Fig. 4.*

Stage 5: *Eight cell stage (*Age 2.45 hrs; length 1.52mm). The third division is latitudinal , slightly above the equator, which forms eight cells of unequal size.

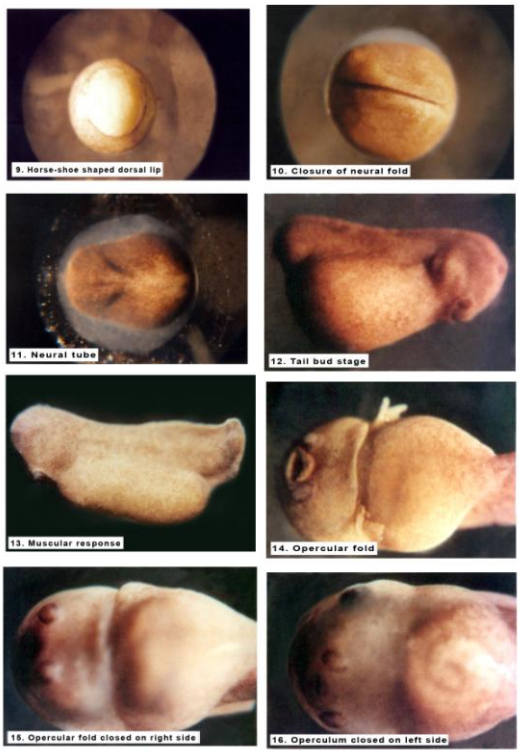
Stage 6: *Sixteen cell stage* (Age 3.20 hours; length 1.52 mm). The eight cell stage divides vertically to form sixteen cell altogether. *Fig. 5.*

Stage 7: *Thirty-two cell stage* (Age 3.52 hrs; length 1.56 mm). The sixteen cell stage divides latitudinally and bring about the formation of thirty two cells. *Fig.6.*

Stage 8: *Mid blastula* (Age 7.54 hrs; length 1.56 mm). The number of cells increased to

more than 64 cells. The surface of animal pole resembles a cluster of beads.*Fig.7.*

Stage 9: *Late blastula* (Age 12.10 hrs; length 1.56 mm). The surface of the animal pole has granular appearance, which gradually becomes smooth.



Gastrulation stages

Stage 10: *Crescent dorsal lip* (Age 15.05 hrs; length 1.56mm). The surface of the animal pole forms the dorsal lip of blastopore which is crescent shaped. *Fig.8.*

Stage 11: Horse-*shoe shaped dorsoal lip* (Age 16.50 hrs; length 1.56mm). The epibolic migration of micromeres over the vegetal pole reduces the exposed area of the unpigmented macromeres, which is surrounded by the lateral lips of semicircular or horse-shoe shaped blastopore. *Fig. 9*

Neurulation stages

Stage 12: *Neural plate* (Age 34.40 hrs; length 1.6 mm). The embryo is slightly elongated. The dorsal surface is flattened to form the neural plate which is differentiated with the concentration of pigments along its borders.

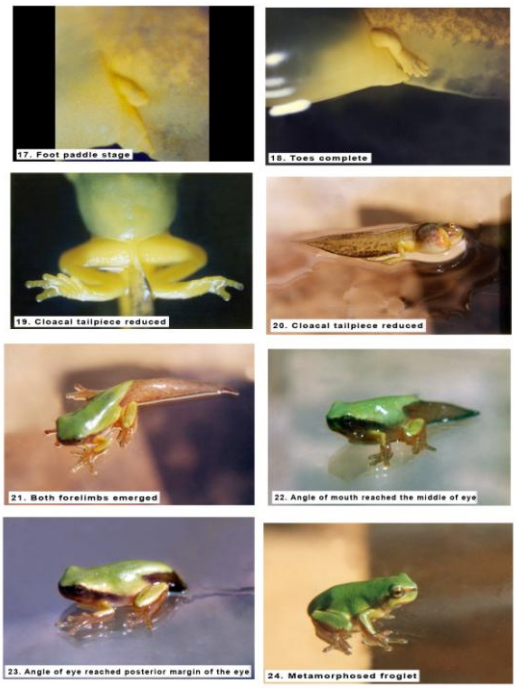
Stage 13: *Closer of Neural fold* (Age 38.20 hrs, length 1.72 mm). The posterior end of the embryo becomes broader. The neural plate further come closer and touch each other, both in the cerebral and spinal cord region, forming a shallow neural groove, which is broader in cerebral region. *Fig. 10.*

Stage 14: *Neural tube* (Age 40.50 hrs; length 2.0 mm). The neural folds have fused completely to form the neural tube, which is raised at the mid dorsal ridge and is demarcated by a darkly pigmented strand. *Fig. 11.*

Stage 15: *Tail bud* (Age 42.50 hrs, trunk 2.44mm, tail 0.47 mm). The part of the embryo above the blastopore becomes elongated beyond the blastopore, which forms the rudiment of the tail bud. The tail bud is wider than long and directed dorsoposteriorly. Stomodeal groove and buldges of gill plate become distinct. *Fig. 12.*

Stage 16: *Muscular response* (Age 60 hrs, trunk 2.71 mm, tail 0.75 mm).The muscular response occurs with the initial slow uni-lateral flexures of the head with mechanical stimulation. Head region is well defined with optic bulges and bulges of the gill plates becoming distinct. Due to gradual elongation of the embryo, the tail starts curving laterally either on the right or left within the contour of the vitelline membrane. *Fig. 13.*

Stage 17: *Heart beat* (Age 70.07 hrs, trunk 3.10 mm;, tail 1.4 mm). The pulsation of the heart is seen below and behind the gill bud



when viewed from side under the strong reflected light. A pair of external gill buds has erupted from each gill plate. Dorsal and ventral fins are well marked but transluscent. Stomodeal pit becomes triangular.

Stage 18: *Gill circulation* (Age 72.29 hrs, trunk 3.28 mm; tail 1.5 mm). Gills distinct and rudimentarily branched. Gill circulation is seen as a movement of corpuscles through the external gill filament.

Post embryonic

Larval or tadpole stages

Stage 19: *Larva hatched* (Age 102.29 hrs, head and trung 3.22 mm, tail 3.2 mm). Olfactory pit deepens. Cornea of the optic lobes begins to be transparent. Stomodeal pit becomes deep and triangular to form a simple mouth but no feeding activity.The anterior end of the head causes a bulge in the already thin and weak vitelline membrane. At this

point the membrane breaks, the larva emerges from the mass of jelly and the larva settle at the bottom for sometimes from where it swims short distance at an interval.

Stage 20: *Tail fin circulation* (Age 117.29 hrs; head and trunk 3.4 mm; tail 3.6 mm). Tail fin circulation starts at the base of the anterior part of the fin just above the trunk as the corpuscules move slowly through the vessel.

Stage 21: *Opercular fold* (Age 143.59 hrs, head and trunk 3.6 mm, tail 4.5 mm) . A small skin fold, the orperculum covers the base of the external gills. *Fig. 14.*

Stage 22: *Operculum closed on the right side* (Age 172.29 hrs, head and trunk 3.7 mm, tail 5.o mm) The operculuar fold has fused with the belly skin on the right side covering the external gills of the right side. The upper and lower labial jaws surrounding the mouth becomes dark and keratimized. *Fig. 15.*

Stage 23: *Operculum closed on the left side*(Age 185.29 hrs, head and trunk 4.2 mm, tail 6.0 mm) Operculum closed and gills disappear. Spiracle formed and the anal tube opens. The tadpole starts feeding. *Fig. 16.*

Stage 24*: Foot paddle stage* (Age 748 hrs, head and trunk 11.5 mm, tail 20.1 mm). Hind limbs formed and the distal end of the hind limb bud is flattened mediolaterally to form a foot paddle. *Fig. 17.*

Stage 25: *Toes complete* (Age 1136 hrs, head and trunk 140mm, tail 29.00 mm). Formation of all toes in the hind limbs is completed. *Fig. 18.*

Stage 26: *Cloacal tail piece reduced* (Age 1392 hrs, head and trunk 14.8 mm, tail 30.0 mm). The cloacal tail piece gets reduced and only a narrow strip remains in between bases of the thigh. The fore limbs are visible through the skin. Green pigmentation of the dorsal surface begins. Keratodonts (teeth) starts shedding. *Fig. 19 & 20.*

Stage 27: *Both fore limbs emerge (*Age 1422 hrs, head and trunk 14.5 mm, tail 25.1 m). Both fore limbs emerge, usually the right fore limb emerge first, followed after a few hours by the left. Corners of the mouth starts widening. The horny teeth is shed. The cloacal tail piece disappear. The tail starts darkening. Fig. 21.

Stage 28: *Angle of mouth reached the middle of eye* (Age 1462 hrs, head and trunk 14.oo mm, tail 5.0 mm). The widening angle of the mouth has reached the level of the middle eye. Tail re-absorbed considerably. *Fig 22*

Stage 29: *Angle of mouth reached posterior margin of the eye* (Age 1498 hrs; head and trunk 13.5 mm; tail 1.0 mm). The widening angle of the mouth has reached the posterior margin of the eye. The tail is re-absorbed to a small triangular stub. *Fig. 23*

Stage 30: *Metamorphosed froglet* (Age 1550 hrs, head and trunk 13.5 mm, tail 0.0 mm) . The triangular tail stub with dark tissue disappears completely. A complete froglet is formed and leaves the breeding site. *Fig. 24.*

Discussion and conclusion

Hamburger, Gosner, Rugh, Nieukoop and Faber were referred for preparing the normal table. Gosner proposed 46 stages with simplified criteria for staging developmental events. In the present study, the development of *Hyla annectans* was divided into 30 stages. Certain variants have been noted in the present study.

Developmental stages have been divided into nine major sub headings: (1) Fertilization two stages (2) Cleavage seven stages (3) Gastrula three stages (4) Neurula four stages (5) Tail bud one stage (6) Muscular response one stage (7) Heart beat one stage (8) Gill circulation one stage (9) Post embryonic twelve stages

Characteristic features of development include the tail bud, initially indicated by a strong upward arching of dorsum. Hatching of the embryo occurs in stage 19 when cornea just begins to be transparent. However the cornea becomes fully clear only towards the end of the stage 20 and beginning of the stage 21. At the stage 20 the circulation in the tail fin begins, but the tail fin is not transparent as in Gosner series and remains dusky. Narrow cloacal tail piece persists and disappears only in the stage 27 unlike in Gosner series.

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EARLY EOCENE (YPRESIAN) MARINE TRANSGRESSION IN MIKIR HILLS, KARBIANGLONG, ASSAM

KezhakielieWhiso[*] and Abeni Odyuo[**]
*KDM Institute of Petroleum Exploration, ONGC, Dehradun- 248195. Uttarakhand, India
** Department of Geology, Kohima Science College (Autonomous), Jotsoma- 797002, Nagaland, India
*e-mail: kezha_whiz@yahoo.com

Abstract: Occurrence of benthic foraminifera *Nummulitesburdigalensis* and planktic foraminifera *Planorotalitespalmerae*, in the Dillai Parbat limestone quarry gives an oldest age of early Eocene (late Ypresian/Cusian) for the exposed carbonates. While *P. palmerae* (total range) corresponds to standard planktic foraminiferal Zone P9 (*Acarininapentacamerata* PRZ), *N. burdigalensis* is referable to the shallow benthic zones SBZ 10 & SBZ 11. These two important taxa occur along with other planktic foraminifera *Morozovella* sp., *Acarinina* sp., *Subbotina* sp., *Chiloguembelina* sp., smaller benthic foraminifera and other fossil groups. The assemblage indicates a shallow but transgressive, open marine conditions, punctuated by possible lagoonal set-ups, duringYpresian in south east Mikir Hills. These evidences from Dillai are correlated with early Eocene transgressions in other basins, which are well known in the Tethyan realm.

Key words: Benthic foraminifera, Ypresian, Dillai Parbat, shallow benthic zone, Mikir Hills

Introduction

Nummulitic limestone is exposed in the Dillai Parbhat quarry, which is covered in Survey of India toposheets no. 83F/12 and 83G/9. Dillai Parbat is located 44 km northeast of Diphu, the district headquarters of Karbi Anglong and about 28 km southwest of Bokajan, where the CCI (Cement Corporation of India) has its cement factory. The open limestone quarry lies on the south-eastern slopes of the Mikir Hills and has yielded a highly diverse assemblage of microfossils (Whiso*et al*., 2007, Venkatachalapathy and Whiso, 2010), mammal fossils (Whiso*et al*., 2009), Bivalvia, Gastropoda, Bryozoa, Echinoidea and rare ammonites (?Nautilus). This assemblage has helped understand the paleoenvironmental/ paleobathymetric conditions in the Ypresian of Mikir Hills. The occurrence of the 'transgressive' taxon *N. Burdigalensis* corroborates well with the widespread early Eocene (Ypresian) transgression in the Tethyan realm. Co-occurrence of *P. Palmerae* (Whiso *et al*., 2007) further helps in calibrating precise age for the section.

Geological setting

Dillai Parbat limestone quarry is located on the south-eastern flank of the Mikir Hills, which is mainly made up of gneisses and granite gneisses of Achaeanage. The quarry exposes both the carbonate Jaintia Group of rocks represented by the Sylhet Formation and the overlying arenaceous/ argillaceous Kopili Formation. The Jaintia Group of rocks are considered the shelf equivalents of the geosynclinal/ flyschoidal Disangs exposed further northand northeast of the present location. The Jaintias overlie the Langpar Formation, the rocks of which are exposed in the Shillong plateau. The largely carbonate Sylhet limestone grades into the Kopilis, which are predominantly clastic and poorly fossiliferous in the study area.

Lithology

Field investigations in the Dillai quarry revealed two limestone units separated by a sandy/ shaly unit. The lower limestone unit is 16-19mthick in which the lower part (4m) is alternated by calcareous shale beds. The upper part is composed of hard, grey *nummulitic* limestone. The lower section (Fig. 2a, 3) has yielded planktic foraminifera along with *N. burdigalensis* while the upper part is characterised by typical Middle Eocene larger foraminifera. The middle unit is composed of unfossiliferous sandstone and shale beds varying in thickness from 9-12m. The upper limestone unit is 4-5 m thick and at places inter-bedded by shale.

The limestone is grey to yellowish, sandy and oolitic at places. This unit is followed up by the largely unfossiliferous sandstone and shale of the Kopilli Formation. The lower 4m of alternating limestone and calcareous shale is further investigated in this study.

Fossil assemblage

The calcareous shale bands have yielded a rich assemblage of fossils including larger foraminifera, smaller benthics, plankticsbesides bivalvia, gastropoda,ostracoda, and rare ammonites. Vertebrate fossils are also recorded in the form of isolated fish teeth (Whiso*etal*., 2009). The limestone beds are fairly to poorly fossiliferous yielding both larger and smaller benthicforaminifera.

Early Eocene transgression

Early Eocene sea transgressions are recorded from various parts of the subcontinent and often attributed to the repeated tectonic

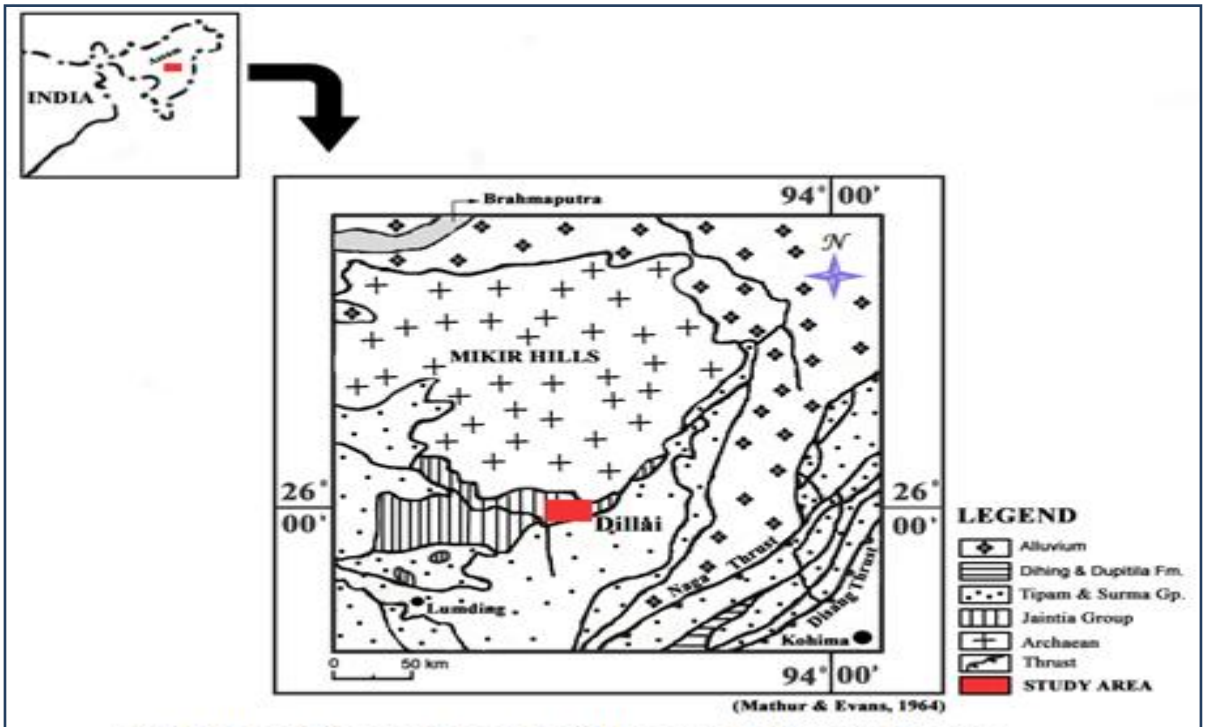


Fig. 1. Location and geological map of the study area.

Fig. 2a: Dillai Parbat quarry exposing the lower limestone unit, showing alternating beds of limestone and calcareous shale

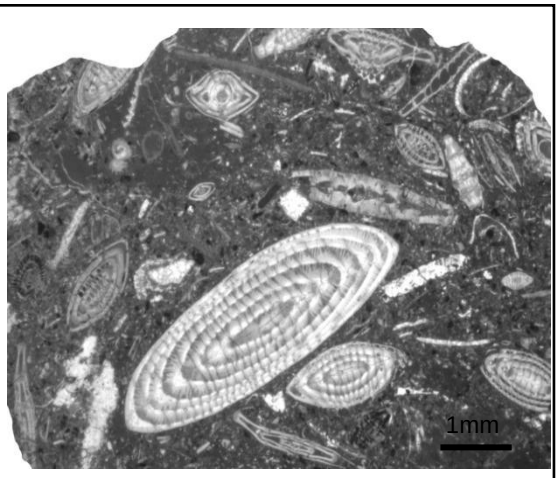
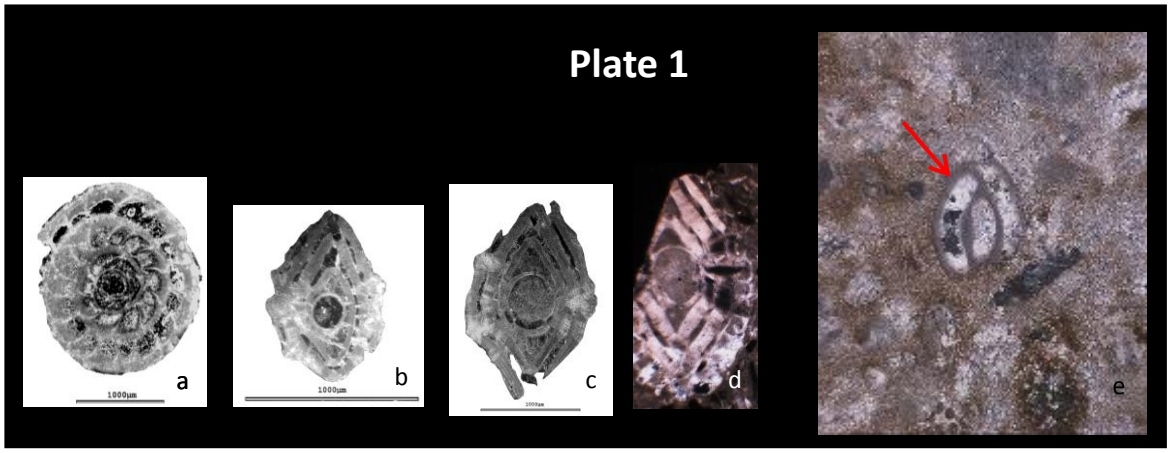


Fig. 2b: Thin section of upper unit nummulitic limestone showing axial sections of *Nummulites*sp and *Assilina* sp.

disturbances at the collision boundary between Indian and Eurasian plates (eg. Singh, 1988). Raju et al (1999) described the sea-level fluctuations during Cretaceous-Cenozoic times in India. In the west coast, latest Early Eocene marinetransgressions are recorded in the subsurface of Bombay High region (Narayan et al., 1996).

Mehrotra (1996) also reported Late Paleocene and Early Eocenetransgressions in several wells in the Cambay region.In the Vastan Lignite Mines (Gujarat) the *N. burdigalensis* horizon represents the peak of the Early Eocene transgression in the Cambay Basin (Sahni, et al., 2006). In the east coast, early Eocene transgressions are recorded from wells drilled in the Krishna-Godavari Basin (Ramesh, 1996). In all these basins a moderately deep to shallow inner shelf conditions have been assigned to the Early Eocene sediments.

In Dillai quarry, about 4m of Early Eocene is exposed in the lowermost part of the lower limestone unit (Fig. 3). This section is characterised by alternating beds of hard, grey limestone and calcareous shale. The upper limit of this unitis marked at the last appearance (LADs) of *P.palmerae* and *N. burdigalensis.*Thisis overlain by a thick limestone unit characterised by typical Middle Eocene faunaincluding *N. beaumonti, N. atacicus, N. discorbinus*and *N. obtusus*. The underlying sequence is not exposed and unknown in the area.



Explanation of Plate 1

a, *Nummulitesburdigalensis*, megalospheric, half cut of equatorial section;
b, *N. burdigalensis*, megalospheric, half cut section of axial section;
c, *N. burdigalensis*, megalospheric, half cut section of axial section;
d, *N. burdigalensis*, megalospheric, thin section of axial section;
e, Miliolid (arrow) embedded in micritic lower limestone unit.

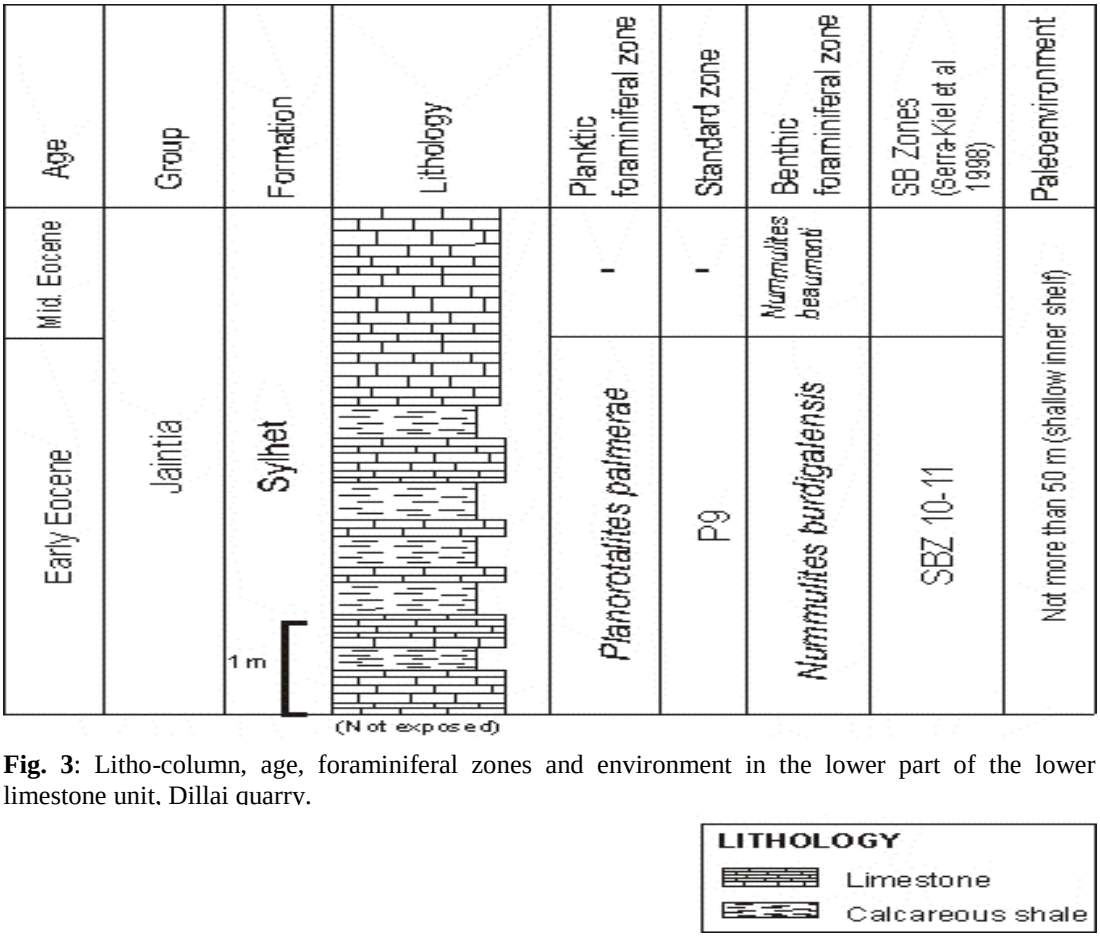


Fig. 3: Litho-column, age, foraminiferal zones and environment in the lower part of the lower limestone unit, Dillai quarry.

Discussion and conclusions

The Dillai Parbat limestone quarry exposes both the fossiliferous limestone beds of the Sylhet Formation and the overlying, largely unfossiliferous, arenaceous/ argillaceous rocks of the Kopili Formation. The section at the base of the lower limestone unit,which was examined for this investigation, is characterised by alternating limestone and calcareous shale, and has yielded a rich assemblage of fossils, particularly the important larger benthic foraminifera *N. burdigalensis* and the plankticspecies *P. palmerae*. Fossil assemblage indicates an Early Eocene (Ypresian) age. The presence of planktics in the calcareous shale of the section suggests the development of standard Zone P9 of Berggren (1970). *P. palmerae*total range corresponds to the standard planktic Zone P9 of Berggren (1970), which is defined by the *Acarininapentacamerata* PRZ. *N. burdigalensis*, corresponding to shallow benthic zones SBZ 10 and SBZ 11 of Serra-Kiel, *et al*. (1998), is comparable to Early Eocene (Ypresian) sequences recorded in wells drilled in the west and east coasts of India and parts of western onland areas.

The recorded fossil assemblage of planktic and larger benthic foraminifera in the lower limestone unitis indicative of a shallow, open marine condition with an overall transgressivephase.This latestEarly Eocene (Ypresian) transgressive sequence is well known in the Tethyan realm- both in the western and eastern basins of the Indian sub-continent.An inner shelf paleobathymetry of 50m or less is suggested for this section.

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ECONOMIC AND ENVIRONMENTAL CONSEQUENCE OF CLIMATIC CHANGE AS A FREE RIDER PROBLEM: A CASE EVIDENCE FROM HOUSEHOLDS, ERODE DISTRICT

S. Bhoopathi* and C. Periasamy**
*Dept. of Economics, Bharathiar University, Coimbatore- 641046, Tamil Nadu, India
**Dept. of Economics, Zunheboto Govt. College, Zunheboto- 798620, Nagaland, India
*e-mail: somuboopathi@gmail.com

Abstract: India is the seventh largest country in the world with geographical area of 328.73 million hectares representing 2.45 per cent of the world's geographical area. The total population of the country is 1027 million, which is equal to 15.70 per cent of world's population. Agriculture continues to dominate India's economic development, accounting 27 percent of its Gross Domestic Product (GDP) and one-fifth of foreign exchange. This sector provides more than 67 percent of the total labor force in the country. Apart from this, its forward linkages and backward linkages with other sectors of the economy are the other established facts. Studies have acknowledged the potential of climate change consequence and its influence on environment particularly agriculture. Several efforts have been ongoing to estimate the economic impacts of projected changes in climate on important sectors, such as agriculture. The present study entitled "Economic and Environmental Consequences of Climatic Change as a Free Rider Problem: A Case Evidence from Households, Erode District" is an attempt on the direction and whose result it is hoped would have a definite implication on policy planning at the national level and agriculture growers for rational production decisions at the grass root level in the country.

Keywords: Economic, climate change, agriculture, Erode.

Introduction

1. *Climate Change*

Global warming or climate change is any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework convention on Climate Change, where climate change refers to a change that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC, 2007). It is important to recognize that human influenced emissions of greenhouse gases, have the potential to alter the climate system and provide an assessment of the understanding of all aspects of climate change. The Intergovernmental Panel on Climate Change (IPCC) established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988, play a major role in studying the various aspects of climate change.

Over the past 250 years, deforestation, combustion of fossil fuels and production of agricultural commodities, food crops, commercial crops and livestock have caused atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases to rise significantly. Greenhouse gases absorb energy radiated from earth to space and warm the atmosphere.

There has been increase in the mean global temperature from 0.3^{o} C to 0.6^{o} C since the last 19^{th} century but it has been estimated that the greenhouse gas emissions could cause the global temperature to rise from 1.4 ^{o}C to 5.8 ^{o}C by the end of the 21^{st} century.

Temperature is known to strongly influence the distribution and abundance patterns of both plants and animals, due to physiological constraints of each species (Parmesan and Yohe, 2003; Thomas et al.,

2004). Hence, changes in temperature due to climate change are expected to be one of the important drivers of change in natural and managed systems. Non-climate drivers, such as land use, land degradation, urbanization and pollution, affect all the systems directly and indirectly through their effects on climate. These drivers can operate either independently or in association with another (Lepers et al., 2004).

2. *Impact of Climate Change on Agriculture in Erode District*

Erode district is one of the districts in Tamil Nadu which is often affected by natural calamities. The area of this district is 5714 sq kms, accounting for 4.4 percent of the area of the state. The climate of Erode district is variable, while it is fairly pleasant during the south-west monsoon in Perundurai taluk, the climate is comparatively mild in Gobichettipalayam, Bhavani and parts of Erode. By the end of August, the South-west monsoon becomes moderate and during September, there are slight and variable winds. Temperature ranges in this district from – maximum 37.7 C - minimum 19.2 C. The normal annual average of rainfall in the district has decreased from 717.00 mm to 711.4 mm between 1979-80 and 2009-10.

The District as a whole has a total cultivated area of 2.24 lakh hectares. Of which the net area sown was 1, 99,389 hectares, accounting 88.70 percent while about 25.40 thousand hectares were cultivated more than once. The net irrigated area constituted 1.56 lakh hectares, accounting for 78.36 percent of the net sown area. The main sources of irrigation were canals and wells which covered as much as 99.57 percent of the total irrigated area in the District. The total irrigated area brought under cultivation certain principal crops in the district was 2,07,124 hectares in 2000-2001 which showed a decline 60,879 hectares in the year 2009-2010, which might be due to the seasonal failures of monsoon which have limited the scope of irrigation in the district. It is expected that this variation will be still higher due to climate change and decrease in land, water availability. Hence an assessment of vulnerability and impact of climate change in Erode district of Tamil Nadu will positively help to adapt farming for maximize agricultural production in the district.

3. Objective of the Study

The overall objective of the study is to assess the vulnerability as well as impact of climate change and suggest suitable land use analysis for planning a sustainable food security in different agro climatic zones of Tamil Nadu. The specific objectives are:

i. To assess the vulnerability to climate change in different agro climatic zones of Tamil Nadu.
ii. To quantify the economic impact of climate change on area, productivity and production of major crops in Tamil Nadu.
iii. To develop optimal cropping patterns for sustainable food security with respect to existing as well as climate change scenarios in different agro climatic zones of Tamil Nadu.
iv. To prepare weather based insurance chart for major crops based on rainfall linking vulnerability of agro climatic zones due to climate change.

4. Scope of the Study

It has been observed from past studies that there has been a continuous decline in production and farm income over the years due to the effect of climate change. Developing countries may be more vulnerable to climate change than developed countries because of the low capital intensive, the incomplete markets, the predominance of agriculture and other climate sensitive sectors and their relatively warm baseline climates. However, the empirical research on impact of climate change on agriculture in developing

countries is limited. So these hypotheses are yet to be tested. The need of information about vulnerability, impact of climate change and land use planning for sustainable food security strategies in developing countries consequently have to be addressed.

5. Limitations of the Study

This study only considers the impact of climate change on area, productivity and production of major crops and the effect of climate change on water availability for agricultural activities. But the climate change will affect the variety of factors like length of growing period, change in water consumption level, seeds, fertilizer and crop shift from one area to another. These variables are also taken into consideration to predict the impact of climate change on agriculture in Erode and caution should be exercised while drawing conclusions for farm level applications. Hence the results of the study derived from the different agro climatic regions of Erode district may not be generalized for other areas.

Concepts and review of literature

An in-depth understanding of various concepts relating to the identified research problem is vital for having a sharp focus of any research work. To develop clarity and comprehension in any study, it is necessary to review various concepts, research methodologies and analytical tools used by researchers in earlier studies. Such an attempt would help the researcher to have better and precise understanding of the perspective of the research problem and would facilitate the researcher to modify and improve the present analytical framework in the right direction to suit the problem situation. The findings of the earlier studies would help the researcher in setting the hypothesis and objectives and enable him to evaluate the validity of his own findings. Hence, this chapter briefly reviews the concepts, analytical tools and findings of the past studies, which are relevant to the present study.

Climate

Climate is usually defined as the "average weather" or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO, 2007), (IPCC, AR4).

Weather

Weather is a short-term phenomenon, describing atmosphere, daily air temperature, pressure, humidity, wind speed, and precipitation (IPCC, 2007).

Climate change

IIPCC (2007) defined climate change is that which refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines climate change as a change of climate, which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Dadhwal (1989) studied the effect of temperature on wheat in India. The results of this study followed a simple approach to quantify the effect of temperature on wheat in the field by sowing the crop on different dates, testing across the large seasonal changes in temperature for the different thermal regimes found in India.

Dinar et al, (1998) measured the impact of climate change on Indian agriculture and they suggested that climate change would have an overall negative impact on agriculture. A warming scenario of 2° C rise in mean temperature and a 7 percent increase in mean precipitation levels would create a 12 percent reduction in net revenues for the country as a whole. Rising temperature is damaging and increasing precipitation is beneficial. These

effects would vary by season and region. There were regional impacts from warming even within India. Coastal and inland regions of Gujarat, Maharashtra and Karnataka were most negatively affected. The high value agricultural regions of Punjab, Haryana, and western Uttar Pradesh showed a small loss. The agriculturally low value, hot and dry districts of Rajasthan and central India were negatively impacted. However, districts in many eastern states of Andhra Pradesh, Orissa and West Bengal benefited mildly from warming. These regional outcomes were largely caused by initial climate differences between regions.

Senthilnathan et al. (2008), have studied on "Socio-Economic Impact of Climate Change on Rice Production in Southern India and Assessing Uncertainties in Regional Climate Model Projections", and they attempt to understand how the projected monsoon changes impact rice production. As a first step, the present study is focused on assessing uncertainties in the current climate and its imprint on current yield. This aspect is carried out by performing high-resolution regional model climate simulations (IPRC_RegCM) with multiple lateral forcings, and the climate variables from regional model serve as input on economic model (Multiple regression model). The study results indicated that uncertainties in IPRC_RegCM simulations are reflected more in monsoon rainfall in temperature. However, there is a close correspondence between years of anomalous climate conditions and rice yield departures. The uncertainties in climate variables, particularly rainfall, are reflected in large diversity in yield.

K. S. Kavi Kumar's study on (2007), "Climate Change Studies in Indian Agriculture" has a discussion of the existing literature on the effect of climate change on Indian agriculture, covering three strands of assessment – impact, vulnerability and adaptation. For the adaptation assessment, the existing tools used for impact assessment may not be useful. For instance, as mentioned above in the discussion on impact assessment, if the aggregate impact assessment shows that inter-farmer communication has a significant influence on climate sensitivity, it remains to be analyzed what kind of communication and communication between who would result in reducing climate sensitivities. Two important changes in research direction are essential for achieving this objective. Firstly, the future climate change projections must be complemented with local level information and knowledge as it is at the local level that most of the adaptation would take place. This enables a more comprehensive assessment of the system's vulnerability and also helps in "mainstreaming" climate change policies. Secondly, new tools and approaches must be explored to carry out adaptation assessment. One emerging tool in this context is agent-based modeling for analyzing social interactions of agents. Their use in the context of climate policy issues is relatively new but growing [Downing et al 2001; Ziervogel et al 2005].

Design of the study

Methodology

Selection of sample households

The study has been conducted in Western Agro Climatic Zone of Tamil Nadu. This zone is one of the major agricultural growing zones in the state. Agriculture crops are grown as a major field by majority of the farmers in the district and has a maximum area of canal irrigated. Therefore, this Zone forms the universe of the study. Purposive-cum multistage random sampling technique is employed to select areas and sample households covered in the study. In the first stage, this western zone consists of two agricultural extension blocks viz., Coimbatore and Erode, out of which Erode district has been purposively selected for the study based on its specific agro-climatic features, extent of area under canal irrigation, cropping pattern, irrigation intensity and other socio -economic characteristics. Secondly, the district has 20

blocks, out of which 4 blocks viz., Gobichettipalayam, Perundurai, Ammapet and Anthiyur blocks have been selected on purpose on the ground that these four blocks have wet, mixed, dry and hilly land areas in this district. At the third stage, one village in each of these blocks has been randomly selected in such a way that each village is situated within the border of the Erode district concerned. A complete enumeration of all the farmer households in the selected villages has been done so as to identify their occupational pattern, level of operational holdings, cropping pattern, the extent of area under cultivation of crops and other socio- economic features suitable to the study. Finally, a total of 445 sample farmer households cultivating different crops in wet land, dry land, mixed land and hilly land, and an area of 50 percent or more of their total cropped area has been selected from the 4 villages giving equal representation to all sample villages chosen for the study. Taking into account the composition of farms cultivation and the area covered the selected farmers have been then broadly classified into three categories viz., Small, Medium and Large farmers through post-stratification method. Thus, the present study is confined to a total sample of 445 crop cultivating farmer households, selected from 4 villages of Erode District in Western Agro-Climatic Zone of Tamil Nadu as presented below:

Analytical methodology

For the objective evaluation of data relating to the various socio-economic characteristics of the study, statistical tools starting from simple tabular and percentage analysis to the multiple regression analyses have been employed in the study. The conventional statistical analyses viz., Mean and Median values of the variables have also been included to identify the mean statistics of the variables in the study.

1. Annual rainfall (mm^2)
2. South west monsoon (mm^2)
3. North east monsoon (mm^2)
4. Maximum temperature ($°C^2$)
5. Minimum temperature ($°C^2$)
6. Diurnal temperature variation ($°C^2$)

Profile of the study area

Western agro-climatic zone

Geographical area

Western Zone comprises of 21 revenue taluks carved out of 8 districts *viz*., Coimbatore, Tiruppur, Erode, Namakkal, Karur, Dindigul, Madurai and Theni. It comprise all the revenue taluks of Coimbatore, Tiruppur and Erode districts, Thiruchengodu of Namakkal District, Karur and Manapparai of Karur District, Nilakottai and Palani of Dindigul District, Usilampatti of Madurai District and Uthamapalayam and Periyakulam of Theni district. This zone constitutes an area of 15,678sq.km. The Erode district comprising of 5 taluks constitutes more geographical area of 8228 sq.km. followed by Coimbatore district with 7469 sq.km. The minimum geographical area is from Namakkal district wherefrom Thiruchangodu taluk alone falls under the zone with a spread of 864 sq.km. The geographical area of the zone altogether works out to 24567 sq.km.

The western zone is situated between 9° 30' and 12° North latitude between 70° 30' and 78° East longitude. The altitude of the zone ranges from 160 to 2700 m above MSL. The 21 taluks of the zone comprises 67 blocks covering 1369 villages. The zone has undulating topography sloping towards west to east with small hillocks here and there having an altitude ranging from 171 to 1525 m above MSL. The western and northern parts of the zone are bounded by the Western Ghats bordering Kerala and Karnataka states with peaks ranging from 1000 to 2700 m above MSL. The Nilgiris on the Nort-west and Anamalais on the South are the chief ranges that attain heights over 2400 m. The eastern part of the zone is bordered by the Namakkal, Karur and Dindugul districts. The southern part of the zone lies in Madurai and Theni districts having contours of various altitudes.

The northern part of the zone bordering Karnataka state which contains one block namely Thalavadi, has undulating plains and hills. The rest of the area is an undulating plain sloping gradually from west to east. The

mountain pass in the Western Ghats lining the Coimbatore district brings the South-West monsoon from Kerala to the bordering taluks of the zone.

Erode district

Location

Erode District was carved out of Coimbatore district in September 1979. It is one of the 32 districts in Tamil Nadu, where progressive agriculture is being performed on a large scale. This district is located between $10^{o}35^{o}$ and $11^{o}60^{o}$ of the Northern Latitude and 76^{o} 49^{o} and $77^{o}58^{o}$ of the Eastern Longitude and above the mean sea level of 171.91 metres. The district has its southern border with Dindugal District and eastern border with Salem and Karur Districts. In the North it is bounded by the state of Karnataka. On the west it has Coimbatore and the Nilgiris Districts. Thus Erode is essentially a land locked area having no sea coast of its own.

Topography

By and large, topography of the district can be described as a long undulating plain gently sloping towards the river Cauvery in the south-east. The long stretch of mountains in the north which slopes gradually and is drained by three major tributaries of the river Cauvery viz, Bhavani, Noyyal and Amaravathi. Cauvery which enters the district from Salem runs in the southern direction.

The river Cauvery originates in the Coorg of Karnataka State and after a long journey enters Erode District but does not benefit the district in a big way. Enroute, the river Bhavani and several small tributaries join it. Before the river Bhavani confluences with the Cauvery at Bhavani (Town), a dam at Bhavanisagar and a check dam at Kodiveri have been constructed across it. These two dams together cover almost the entire district except Dharapuram Taluk. Thus, it is the river Bhavani that sustains the rural economy of the district.

The river Amaravathi has its origin in the Travancore region of Kerala State enters Tamil Nadu through Udumalpet Taluk of Coimbatore district from where it flows through Dharapuram Taluk in Erode district before it joins Cauvery in Trichirapalli district. River Noyyal is almost a jungle stream unreliable for any irrigation purpose. But it often gushes out heavy floods during monsoon period.

Rainfall

Weather occupies an important role in every phase of agricultural activities from the preparatory tillage to harvesting and storage. Farmers decision regarding the agricultural activities is mainly based on the weather conditions. Erode district experiences a dry climate with scanty rainfall. Rainfall is the most important of the climate factors. Weather stations located in the northern part of the district have registered medium rainfall. The rainfalls received by the southern parts are relatively less as compared to the rainfall received by northern parts. During the northeast monsoon period, the northern places receive relatively greater amount of rainfall than the southern places. The average rainfall recorded in the district over a period of 1979-80 and 2009-10 is presented in table-III.

TABLE-III
RAINFALL IN ERODE DISTRICT

YEAR	Actual Rainfall	Normal Rainfall	South west Monsoon	North east Monsoon	Winter Season	HotWeather Season
1979-80	932.40	717.00	337.1	378.60	NA	72.70
1980-81	489.51	726.10	210	.00	NA	NA
1981-82	751.50	717.00	421.05	.00	NA	NA
1982-83	745.80	717.00	470	.00	NA	NA
1983-84	838.00	717.00	413.6	151.40	47.5	87.20
1984-85	675.00	717.00	173.4	229.20	119.8	152.60
1985-86	745.40	726.10	413.6	152.50	90.1	90.30
1986-87	739.70	717.00	148.7	204.40	1.2	64.10
1987-88	999.30	717.00	235.3	476.70	1.8	285.70
1988-89	601.60	717.00	318.1	107.40	NA	187.40
1989-90	803.50	660.10	97.1	240.90	NA	NA
1990-91	645.90	660.10	237.5	250.50	NA	NA
1991-92	570.60	660.10	334.6	319.50	2	61.9
1992-93	685.60	660.10	316.8	261.90	11.2	95.1
1993-94	837.10	711.40	193.5	487.80	44.4	126.5
1994-95	803.50	803.50	126.1	505.50	8.7	158.9
1995-96	568.20	711.40	305.9	215.00	NA	NA
1996-97	636.90	660.10	241	322.80	NA	NA
1997-98	772.45	660.10	255.9	487.30	NA	156.29
1998-99	765.10	660.10	289.7	307.90	NA	151.6
1999-00	715.20	660.10	99.8	427.20	39.7	81.9
2000-01	687.08	660.10	281.9	223.40	17.48	117.7
2001-02	537.70	711.40	160.3	255.10	2.1	81.2
2002-03	568.20	711.20	113.9	238.00	2.1	134.8
2003-04	811.80	711.20	136.1	352.00	1.8	326.7
2004-05	799.60	711.40	305.7	307.4	31.6	274.9
2005-06	1022.00	711.40	267.9	640.4	640.2	7.9
2006-07	627.70	711.40	174.5	386.2	0.6	66.4
2007-08	893.50	711.40	203.9	446.7	27	215.9
2008-09	743.20	711.40	229.9	308.5	20.7	154.1
2009-10	710.60	708.60	390.5	445.5	NA	NA

Source: Assistant Director of Statistics, Erode District.

From table-III it is observed that the average amount of rainfall in the district has decreased from 717.00 mm to 711.4 mm between 1979-80 and 2009-10.

The maximum amount of rainfall has been recorded during the North-East monsoon period. South-West monsoon also showed the same trend.

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TABLE-IV
DEMOGRAPHIC PROFILE OF ERODE DISTRICT

Sl. No.	Particulars	Persons	Males	Females
1	Total population	2259608	1134191	1125417
	a. Rural	-	557133	545082
	b. Urban	-	577058	580335
2	Scheduled Castes	18.68	-	-
3	Scheduled Tribes	0.78	-	-
4	Decadal population Growth (%)	12.05	10.68	13.47
5	Population in the age 0-6	181188	92638	88550
6	Percentage decadal growth child population 0-6 years 2001-2011	-9.79	-10.76	- 8.75
7	Literates: a. Absolute numbers	1516380	841728	674652
	b. Literacy Rate:	73.96	80.81	65.07
8	Population Density (Per Sq. km)	397	-	-
9	Sex Ratio (Female Per 1000 males)	992	-	-
10	Child Sex Ratio(Girls per 1000 Boys in 0-6 age group)	956	-	-
11	Level of Urbanisation (%)	51.43	-	-

Source: Census of Tamil Nadu, 2011

Erode district according to 2011 census has 22,59,608 lakhs population, of which 11,34,191 are males and 11,25,417 lakhs are females. The district as on 2011 has the rural male population of 5,57,133 lakhs; while the female rural population is 5,45,082 lakhs. The urban counterpart in the district has 5,77,058 lakh males and 5,80,335 lakhs for females, with a decadal population growth of 12.05 percent out of which 10.68 and 13.47 respectively are male and female growth rates. The population in the age of 0-6 years in the district is 1,81,188 lakhs out of which 92,638 are male and 88,550 are female; while the decadal growth rate of child population in the age of 0-6 years is negative indicating the fact that the overall child population in the district has shown a declining trend in the District's birth rate. Moreover, the district has a literate population of 15,16,380 lakhs; of which 8,41,728 are males and 67,465 are female population. The total literacy rate in the district is 73.96 percent of which 80.81 percent is male and 65.07 percent is in the female category. Further the density of population in the district is 397 per sq.km. The sex ratio and child sex ratio of the district are 992 and 956 females per 1000 males respectively.

Agriculture

Agricultural sector occupies a predominant position in the economy of Erode district. It is the main occupation of the people in the district. The salient features of the agricultural economy of Erode district are given in Table-VIII.

TABLE-VIII

AGRICULTURE IN ERODE DISTRICT: 2009-10

Particulars	**Area in Hectares**	**Percentage**
1. Land Utilisation		
a). Total cultivated Area	2,24,786	100
b). Net Area Sown	1,99,389	88.70
c). Area sown more than once	25,397	11.30
2. Irrigation		
i. Net Irrigation Area by		
a. Government Canals	82,559	52.84
b. Tanks	66.93	0.04
c. Tube Wells	18,304.96	11.72
d. Open Wells	54,101.40	34.63
e. Supplementary Irrigation Wells	596.3	0.38
f. Other sources	1,209	0.77
Total	**1,56,241**	**100**
ii. Gross Irrigated Area	1,56,241	

Source: Erode District Handbook 2009-2010

The District as a whole has the total cultivated area of 2.24 lakh hectares, of which the net area sown is 1, 99,389 hectares, accounting for 88.70 percent while about 25.40 thousand hectares are cultivated more than once. The net irrigated area constitute 1.56 lakh hectares, accounting for 78.36 percent of the net sown area. The main sources of irrigation are canals and wells which covered as much as 99.57 percent of the total irrigated area in the District.

More specifically, the chief source of irrigation in the district is the canals and wells which constitute the main stay among the farmers. The total length of canals in the district is about 850 kms. The Lower Bhavani Project (LBP) and Mettur West Bank Canals extensively irrigate the agricultural lands in the northern parts of the district. The entire ayacut of LBP is divided into two parts and water is supplied in two seasonal turns. LBP irrigates about 39,057 hectares in the first turn and 38,645 hectares in the second turn. The Mettur –West Canals which takes off from river Cauvery irrigates about 7,000 hectares in Bhavani Taluk. Thedappalli – Arakkankottai canals are the river canal systems based on the water of Bhavani. They irrigate about 7,144 hectares and 2,772 hectares respectively in Gobi, Bhavani and Erode Taluks. Kalinkarayan canal irrigates about 7,060 hectares mostly in Erode taluk. Amaravathi River with a number of small ayacuts, irrigates about 2,672 hectares in Dharapuram taluk. Parambikulam – Aliyar Project (PAP) and Uppar project are the other important projects, which benefit to a significant extent, the southern part of the district. They irrigate about 15,880 hectares and 2,180 hectares respectively.

The crop-wise area irrigated and put under cultivation in Erode district is presented in Table-IX.

TABLE-IX
AREA IRRIGATED BY CROPS

SI. No	Crop	2000-01		2009-10		Variation
		Area in Hectares	%	Area in Hectares	%	
1	Paddy	57,888	27.95	38,064	26.03	-19,824
2	Cholam	2,456	1.19	253	0.17	-2,203
3	Cumbu	291	0.14	148	0.10	-143
4	Ragi	190	0.09	16	0.01	-174
5	Maize	3,048	1.47	8551	5.85	5,503
6	Green Gram	640	0.31	153	0.10	-487
7	Red Gram	80	0.04	90	0.06	10
8	Black Gram	927	0.45	477	0.33	-450
9	Chilies	1,197	0.58	863	0.59	-334
10	Turmeric	13,986	6.75	9,854	6.74	-4,132
11	Sugarcane	31,926	15.41	34,597	23.66	2,671
12	Onion	2,571	1.24	1,631	1.12	-940
13	Banana	4,440	2.14	10,891	7.45	6,451
14	Groundnut	14,637	7.07	4,381	3.00	-10,256
15	Sun Flower	443	0.21	274	0.19	-169
16	Gingelly	19,449	9.39	9,799	6.70	-9,650
17	Cotton	9,785	4.72	1,421	0.97	-8,364
18	Tobacco	4,708	2.27	3,574	2.44	-1,134
19	Fodder	9,407	4.54	8,241	5.64	-1,166
20	Others	29,055	14.03	12,967	8.87	-16,088
Total		2,07,124	100.00	1,46,245	100.00	-60,879

Source: Assistant Director of Statistics, Erode, 2009-2010

The total irrigated area brought under cultivation certain principal crops in the district is 2,07,124 hectares in 2000-2001 which shows a decline of 60,879 hectares in the year 2009-2010, which might be due to the seasonal failures of monsoon which have limited the scope of irrigation in the district. Among the principal crops being paddy, sugarcane, banana, turmeric and maize, paddy continued to be the major crops followed by sugarcane inspite of the fact that the area under irrigation of paddy tended to decline from 27.95 percent to 26.03 percent between 2000-2001 and 2009-2010. The irrigated area under sugarcane is on the rise, indicating for a shifting cropping pattern by farmers towards sugarcane in the district.

Distribution of Land Holdings

The farm size-wise distribution of land holdings in Erode district furnished in table reveals that according to 2008-2009 data, there are 291275 holdings of different sizes covering a total cultivable area of 482575.67 hectares, operating in the district.

TABLE-X
DISTRIBUTION OF LAND HOLDINGS IN ERODE DISTRICT (2008-09)
(in hectares)

Size of holdings in hectares	Approximate number of holdings	Percent to total holdings	Total area of holdings in hectares	Percent to total area
0-0.5	68465	23.51	20338.83	4.21
0.5-1.0	68465	23.51	50318.81	10.43
1.0-2.0	79586	27.32	114925.93	23.82
2.0-3.0	34980	12.01	84673.99	17.55
3.0-4.0	16409	5.63	56803.70	11.77
4.0-5.0	8878	3.05	39530.93	8.19
5.0-7.5	8990	3.09	54146.29	11.22
7.5-10.0	3157	1.08	26906.47	5.58
10.0-20.0	2114	0.73	27381.55	5.67
20.0 & above	231	0.08	7548.12	1.56
Total	291275	100.00	482575.67	100.00

Source: Erode District Handbook 2009-2010

Of which majority of the holdings are in the size group of 1-2 hectares, accounting to 27.32 percent followed by farms of less than 1 hectares, indicating the fact that about 75 percent of the holdings are still small and marginal category, covering an area of about 40 percent of the cultivable area in the district.

Cropping Pattern

Cropping pattern of Erode district depends on several factors viz, soil, climate, irrigation facilities, price and demand for farm products etc. As in other parts of the state, food crops predominate over the commercial crops. Paddy, cereals and pulses constitute the major food crops. Sugarcane, groundnut, gingelly and cotton are the important commercial crops being cultivated in the district. According to 2009-2010 Erode District Hand Book Report, food crops constitute 60.09 percent of the area sown while leaving the rest of the cultivable area to non-food crops as shown in table-XI.

TABLE-XI
PERCENTAGE DISTRIBUTION OF AREA UNDER IMPORTANT CROPS 2009-10

Particulars	Area (Hec.)	Percentage
Food Crops		
a. Paddy	38113	22.42
b. Millets and other Cereals	58894	34.65
c. Pulses	5134	3.02
Non-Food Crops		
a. Sugarcane	34597	20.36
b. Groundnut	19392	11.41
c. Gingelly	12922	7.60
d. Cotton (BT)	914	0.54

Source: District Hand Book 2009-10

Among the food crops, millets and other cereals occupies a significant area of 34.65 percent.

Paddy and pulses together cover 25.44 percent of the area under food crops. In the non-food crops side, sugarcane is the leading crop occupying an area of 20.36 percent followed by groundnut with 11.41 percent of the total cultivable area of the district. Moreover, food crops are grown on an extensive scale, making the district economy almost self-sufficient in food production. Paddy and sugarcane are extensively cultivated in the ayacut areas of Bhavani and Cauvery river projects covering Gobichettipalayam, Bhavani and Erode taluks. Groundnut, Gingelly and cotton are mainly cultivated in the rainfed areas of Perundurai and Nambiyur Taluk.

Land Utilization Pattern

Land utilization pattern in Erode district for the year 2009-10 is presented in table-XII which shows that the total geographical area of Erode district as on 2009-20s10 is 8,22,447 hectares. The net area sown accounted for 24.24 percent of the total area, the area under forest constituted 27.66 percent while the land put to non-agricultural uses formed 6.44 percent. About 7.82 percent of the area is currently fallow and 0.76 percent is barren and uncultivable land. Cultivable waste is to the extent of 0.21 percent. Other fallows, permanent pastures and other grazing land and land under miscellaneous tree crops and groves form 2.44 percent of the total area.

TABLE-XII
LAND UTILIZATION PATTERN IN ERODE DISTRICT 2009-10

Sl. No.	Classification	Area in hectares	Percent
1	Forests	227511	27.66
2	Barren uncultivable land	6270	0.76
3	Land put to non-agriculture use	53004	6.44
4	Cultivable waste	1707	0.21
5	Permanent pastures and other grazing lands	101	0.01
6	Land under miscellaneous tree crops and groves	913	0.11
7	Current fallows	64311	7.82
8	Other fallows Land	19057	2.32
9	Net area sown	199389	24.24
10	Geographical Area according to village Records	572264	69.58
11	Total Cropped Area	224786	27.33
12	Area Cropped more than once	25,397	3.09
	Total geographical area	8,22,447	100.00

Source: Asst. Director of Statistics, Erode, 'G' Return Erode District, 2009-10.

Irrigation

The chief source of irrigation in the district is the canals and wells which constitute the main stay among the farmers. The total length of canals in the district is about 850 kms. The Lower Bhavani Project (LBP) and Mettur West Bank Canals extensively irrigate the agricultural lands in the northern parts of the district. The entire ayacut of LBP is divided into two parts and water is supplied in two seasonal turns. LBP irrigates about 39,057

hectares in the first turn and 38,645 hectares in the second turn. The Mettur –West Canals which takes off from river Cauvery irrigates about 7,000 hectares in Bhavani Taluk. Thedappalli – Arakkankottai canals are the river canal systems based on the water of Bhavani. They irrigate about 7,144 hectares and 2,772 hectares respectively in Gobi, Bhavani and Erode Taluks. Kalinkarayan canal irrigates about 7,060 hectares mostly in Erode taluk. Amaravathi River with a number of small ayacuts irrigates about 2,672 hectares in Dharapuram taluk. Parambikulam – Aliyar Project (PAP) and Uppar project are the other important projects, which benefit to a significant extent the southern part of the district. They irrigate about 15,880 hectares and 2,180 hectares respectively.

The area covered under various sources of irrigational system in the district is shown in table-XIII

TABLE-XIII
AREA IRRIGATED BY DIFFERENT SOURCES IN ERODE DISTRICT 2009-10

SI.No	Sources	Area irrigated	
		Total Area (in hectares)	% to total Area
1	Canal	1,00,547	56.37
2	Tanks	583	0.33
3	Wells	75,891	42.54
4	Others	1,360	0.76
Total		1,78,381	100.00

Source: District Handbook 2009-10

It could be observed from the table that the total area irrigated by different sources in the district is 178.381 hectares. Of this, the area irrigated by canals is 56.37 percent to the total area. About 42.54 percent of the area is irrigated by wells. Tanks and others constitute only 1.09 percent to the total area.

Industrial Structure

Erode district is one of the industrially developing districts in the state of Tamil Nadu. Industry and Trade occupy a place of prominence in the economy of the district. Industries that flourished in early days in and around Erode area are handloom, weaving and carpet manufacturing. The advent of modern era has changed these industries to some extent and the powerloom weaving is slowly replacing it. There are 24,189 registered Small Scale Industry units in the district besides 59 large scale units.

The district has high concentration of powerloom and Handloom weaving, rice milling and edible oil expelling units. The other industries are Tanneries, Chemical and Plastic Products, paper products, basic metal products, etc.

Agriculture

Agricultural sector occupies a predominant position in the economy of Erode district. It is the main occupation of the people in the district. The salient features of the agricultural economy of Erode district are given in Table-VIII.

TABLE-VIII
AGRICULTURE IN ERODE DISTRICT: 2009-10

Particulars	**Area in Hectares**	**Percentage**
1. Land Utilisation		
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i. Net Irrigation Area by		
a. Government Canals	82,559	52.84
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c. Tube Wells	18,304.96	11.72
d. Open Wells	54,101.40	34.63
e. Supplementary Irrigation Wells	596.3	0.38
f. Other sources	1,209	0.77
Total	**1,56,241**	**100**
ii. Gross Irrigated Area	1,56,241	

Source: Erode District Handbook 2009-2010

The District as a whole has the total cultivated area of 2.24 lakh hectares, of which the net area sown is 1, 99,389 hectares, accounting for 88.70 percent while about 25.40 thousand hectares are cultivated more than once. The net irrigated area constitutes 1.56 lakh hectares, accounting for 78.36 percent of the net sown area. The main sources of irrigation are canals and wells which covered as much as 99.57 percent of the total irrigated area in the District.

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The crop-wise area irrigated and put under cultivation in Erode district is presented in Table-IX.

TABLE-IX AREA IRRIGATED BY CROPS

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3	Cumbu	291	0.14	148	0.10	-143
4	Ragi	190	0.09	16	0.01	-174
5	Maize	3,048	1.47	8551	5.85	5,503
6	Green Gram	640	0.31	153	0.10	-487
7	Red Gram	80	0.04	90	0.06	10
8	Black Gram	927	0.45	477	0.33	-450
9	Chilies	1,197	0.58	863	0.59	-334
10	Turmeric	13,986	6.75	9,854	6.74	-4,132
11	Sugarcane	31,926	15.41	34,597	23.66	2,671
12	Onion	2,571	1.24	1,631	1.12	-940
13	Banana	4,440	2.14	10,891	7.45	6,451
14	Groundnut	14,637	7.07	4,381	3.00	-10,256
15	Sun Flower	443	0.21	274	0.19	-169
16	Gingelly	19,449	9.39	9,799	6.70	-9,650
17	Cotton	9,785	4.72	1,421	0.97	-8,364
18	Tobacco	4,708	2.27	3,574	2.44	-1,134
19	Fodder	9,407	4.54	8,241	5.64	-1,166
20	Others	29,055	14.03	12,967	8.87	-16,088
Total		2,07,124	100.00	1,46,245	100.00	-60,879

Source: Assistant Director of Statistics, Erode, 2009-2010

The total irrigated area brought under cultivation certain principal crops in the district is 2,07,124 hectares in 2000-2001 which shows a decline of 60,879 hectares in the year 2009-2010, which might be due to the seasonal failures of monsoon which have limited the scope of irrigation in the district. Among the principal crops being paddy, sugarcane, banana, turmeric and maize, paddy continued to be the major crops followed by sugarcane inspite of the fact that the area under irrigation of paddy tended to decline from 27.95 percent to 26.03 percent between 2000-2001 and 2009-2010. The irrigated area under sugarcane is on the rise, indicating for a shifting cropping pattern by farmers towards sugarcane in the district.

Distribution of Land Holdings

The farm size-wise distribution of land holdings in Erode district furnished in table reveals that according to 2008-2009 data, there are 291275 holdings of different sizes covering a total cultivable area of 482575.67 hectares, operating in the district.

TABLE-X
DISTRIBUTION OF LAND HOLDINGS IN ERODE DISTRICT (2008-09) (in hectares)

Size of holdings in hectares	Approximate number of holdings	Percent to total holdings	Total area of holdings in hectares	Percent to total area
0-0.5	68465	23.51	20338.83	4.21
0.5-1.0	68465	23.51	50318.81	10.43
1.0-2.0	79586	27.32	114925.93	23.82
2.0-3.0	34980	12.01	84673.99	17.55
3.0-4.0	16409	5.63	56803.70	11.77
4.0-5.0	8878	3.05	39530.93	8.19
5.0-7.5	8990	3.09	54146.29	11.22
7.5-10.0	3157	1.08	26906.47	5.58
10.0-20.0	2114	0.73	27381.55	5.67
20.0 & above	231	0.08	7548.12	1.56
Total	291275	100.00	482575.67	100.00

Source: Erode District Handbook 2009-2010

Of which majority of the holdings are in the size group of 1-2 hectares, accounting to 27.32 percent followed by farms of less than 1 hectares, indicating the fact that about 75 percent of the holdings are still small and marginal category, covering an area of about 40 percent of the cultivable area in the district.

Cropping Pattern

Cropping pattern of Erode district depends on several factors viz, soil, climate, irrigation facilities, price and demand for farm products etc. As in other parts of the state, food crops predominate over the commercial crops. Paddy, cereals and pulses constitute the major food crops. Sugarcane, groundnut, gingelly and cotton are the important commercial crops being cultivated in the district. According to 2009-2010 Erode District Hand Book Report, food crops constitute 60.09 percent of the area sown while leaving the rest of the cultivable area to non-food crops as shown in table-XI.

TABLE-XI
PERCENTAGE DISTRIBUTION OF AREA UNDER IMPORTANT CROPS 2009-10

Particulars	Area (Hec.)	Percentage
Food Crops		
a. Paddy	38113	22.42
b. Millets and other Cereals	58894	34.65
c. Pulses	5134	3.02
Non-Food Crops		
a. Sugarcane	34597	20.36
b. Groundnut	19392	11.41
c. Gingelly	12922	7.60
d. Cotton (BT)	914	0.54

Source: District Hand Book 2009-10

Among the food crops, millets and other cereals occupies a significant area of 34.65 percent. Paddy and pulses together cover 25.44 percent of the area under food crops. In the non-food crops side, sugarcane is the leading crop occupying an area of 20.36 percent followed by groundnut with 11.41 percent of the total cultivable area of the district. Moreover, food crops are grown on an extensive scale, making the district economy almost self-sufficient in food production. Paddy and sugarcane are extensively cultivated in the ayacut areas of Bhavani and Cauvery river projects covering Gobichettipalayam, Bhavani and Erode taluks. Groundnut, Gingelly and cotton are mainly cultivated in the rainfed areas of Perundurai and Nambiyur Taluk.

Land Utilization Pattern

Land utilization pattern in Erode district for the year 2009-10 is presented in table-XII which shows that the total geographical area of Erode district as on 2009-20s10 is 8,22,447 hectares. The net area sown accounted for 24.24 percent of the total area, the area under forest constituted 27.66 percent while the land put to non-agricultural uses formed 6.44 percent. About 7.82 percent of the area is currently fallow and 0.76 percent is barren
and uncultivable land. Cultivable waste is to the extent of 0.21 percent. Other fallows, permanent pastures and other grazing land and land under miscellaneous tree crops and groves form 2.44 percent of the total area.

TABLE-XII
LAND UTILIZATION PATTERN IN ERODE DISTRICT 2009-10

Sl. No.	Classification	Area in hectares	Percent
1	Forests	227511	27.66
2	Barren uncultivable land	6270	0.76
3	Land put to non-agriculture use	53004	6.44
4	Cultivable waste	1707	0.21
5	Permanent pastures and other grazing lands	101	0.01
6	Land under miscellaneous tree crops and groves	913	0.11
7	Current fallows	64311	7.82
8	Other fallows Land	19057	2.32
9	Net area sown	199389	24.24
10	Geographical Area according to village Records	572264	69.58
11	Total Cropped Area	224786	27.33
12	Area Cropped more than once	25,397	3.09
	Total geographical area	8,22,447	100.00

Source: Asst. Director of Statistics, Erode, 'G' Return Erode District, 2009-10.

Irrigation

The chief source of irrigation in the district is the canals and wells which constitute the main stay among the farmers. The total length of canals in the district is about 850 kms. The Lower Bhavani Project (LBP) and Mettur West Bank Canals extensively irrigate the agricultural lands in the northern parts of the district. The entire ayacut of LBP is divided into two parts and water is supplied in two seasonal turns. LBP irrigates about 39,057 hectares in the

first turn and 38,645 hectares in the second turn. The Mettur –West Canals which takes off from river Cauvery irrigates about 7,000 hectares in Bhavani Taluk. Thedappalli – Arakkankottai canals are the river canal systems based on the water of Bhavani. They irrigate about 7,144 hectares and 2,772 hectares respectively in Gobi, Bhavani and Erode Taluks. Kalinkarayan canal irrigates about 7,060 hectares mostly in Erode taluk. Amaravathi River with a number of small ayacuts irrigates about 2,672 hectares in Dharapuram taluk. Parambikulam – Aliyar Project (PAP) and Uppar project are the other important projects, which benefit to a significant extent the southern part of the district. They irrigate about 15,880 hectares and 2,180 hectares respectively.

The area covered under various sources of irrigational system in the district is shown in table-XIII

TABLE-XIII
AREA IRRIGATED BY DIFFERENT SOURCES IN ERODE DISTRICT 2009-10

SI.No	Sources	Area irrigated	
		Total Area (in hectares)	% to total Area
1	Canal	1,00,547	56.37
2	Tanks	583	0.33
3	Wells	75,891	42.54
4	Others	1,360	0.76
Total		1,78,381	100.00

Source: District Handbook 2009-10

It could be observed from the table that the total area irrigated by different sources in the district is 178.381 hectares. Of this, the area irrigated by canals is 56.37 percent to the total area. About 42.54 percent of the area is irrigated by wells. Tanks and others constitute only 1.09 percent to the total area.

Industrial Structure

Erode district is one of the industrially developing districts in the state of Tamil Nadu. Industry and Trade occupy a place of prominence in the economy of the district. Industries that flourished in early days in and around Erode area are handloom, weaving and carpet manufacturing. The advent of modern era has changed these industries to some extent and the powerloom weaving is slowly replacing it. There are 24,189 registered Small Scale Industry units in the district besides 59 large scale units.

The district has high concentration of powerloom and Handloom weaving, rice milling and edible oil expelling units. The other industries are Tanneries, Chemical and Plastic Products, paper products, basic metal products, etc.

Results and discussion

The results of the study based on the data collected from 445 sample respondents and evaluated with reference to the objectives mentioned are presented into five main parts

viz., I) Socio-Economic Characteristics of the Sample Farmer Households, II) Assess the vulnerability to climate change, III) Quantifying the Economic Impact of Climate Change on Food and Non-Food Crop Production, IV) Farmer's Perception about Effects of Climate Change on Food and Non-Food Crop Production and V) Strategies for Farm Adaptation and Factors Influencing Climate Change Adaptation Practices among Crop Farmers in Erode District of Western Agro-Climatic zone in Tamil Nadu, of varying size groups viz., Small, Medium and Large Farmers, cultivating food and non-food crops in Erode District of Tamil Nadu.

Socio-economic characteristics of the sample farmer households in erode district

This part of the study deals with the socio-economic characteristics of the selected sample farmer households in Bhavani, Gobichettipalayam and Perundurai Taluks of Erode district of Tamil Nadu. The important socio-economic characteristics chosen for analysis in the study are total population at household levels, dependent ratio, type of family, family size, age, educational status, annual income, asset, total area of land owned, type of the soil and area under irrigation of the sample farmer households of different size groups in Erode district of Tamil Nadu which are presented in table-XV.

TABLE-XV
SOCIO-ECONOMIC CHARACTERISTICS OF THE SELECTED SAMPLE FARMER HOUSEHOLDS

Variables	Farm group			All Farms
	Small	Medium	Large	
No. of sample farmer households	141	211	93	445
Total population	515	885	433	1833
No. of Males Active	270 (52.43)	459 (51.86)	227 (52.42)	956 (52.15)
No. of Females Active	245 (47.57)	426 (48.14)	206 (47.58)	877 (47.85)
No. Dependents	186 (36.12)	246 (27.80)	90 (20.79)	522 (28.48)
Dependent Ratio	41.52	41.30	41.44	41.55
Type of family				
Nuclear	89 (63.12)	130 (61.61)	51 (54.84)	270 (60.67)
Joint	52 (36.88)	81 (38.39)	42 (45.16)	175 (39.33)
Total	141	211	93	445
Family size				
Below 2 Members	13 (9.22)	6 (2.84)	5 (5.38)	24 (5.39)
2 - 4 Members	84 (59.57)	141 (66.82)	57 (61.29)	282 (63.37)
Above 4 Members	44 (31.21)	64 (30.33)	31 (33.33)	139 (31.24)
Total	141 (100)	211 (100)	93 (100)	445 (100)

Average family size	3.65	4.19	4.66	4.12
Age Groups				
Below 30 Years	8 (5.67)	15 (7.11)	5 (5.38)	28 (6.29)
30 - 60 Years	111 (78.72)	163 (77.25)	68 (73.12)	342 (76.85)
Above 60 Years	22 (15.60)	33 (15.64)	20 (21.51)	75 (16.85)
Total	141 (100)	211 (100)	93 (100)	445 (100)
Average age	51.39	50.61	52.62	51.28
Farming experience (in Year)				
Below 10 years	30 (21.28)	36 (17.06)	21 (22.58)	87 (19.55)
10>20 years	27 (19.15)	55 (26.07)	20 (21.51)	102 (22.92)
20>30 years	51 (36.17)	57 (27.01)	30 (32.26)	138 (31.01)
30>40 years	26 (18.44)	52 (24.64)	14 (15.05)	92 (20.67)
Above 40 years	7 (4.96)	11 (5.21)	8 (8.60)	26 (5.84)
Total	141	211	93	445
	(100)	(100)	(100)	(100)
Educational Status				
Illiterates	32 (22.70)	34 (16.11)	16 (17.20)	82 (18.43)
Literacy at Primary Level	19 (13.48)	28 (13.27)	16 (17.20)	63 (14.16)
Literacy at Secondary Level	65 (46.10)	119 (56.40)	52 (55.91)	236 (53.03)
Literacy at Higher Secondary and Above	25 (17.73)	30 (14.22)	9 (9.68)	64 (14.38)
Total	141	211	93	445
	(100)	(100)	(100)	(100)
Income Distribution by Groups				
Below Rs.50,000	10 (7.09)	20 (9.48)	5 (5.38)	35 (7.87)
Rs.50,000 - Rs. 1,00,000	47 (33.33)	69 (32.70)	32 (34.41)	148 (33.26)
Rs.1,00,000- Rs. 1,50,000	39 (27.66)	60 (28.44)	26 (27.96)	125 (28.09)
Rs. 1,50,000 – Rs.2,00,000	30 (21.28)	33 (15.64)	16 (17.20)	79 (17.75)
Above Rs. 2,00,000	15 (10.64)	29 (13.74)	14 (15.05)	58 (13.03)
Total	141	211	93	445
	(100)	(100)	(100)	(100)
Average Income (Rs.)	138162.77	142626.78	147119.35	142151.24
Asset distribution by Groups				

Below Rs.10 lakhs	19 (13.48)	29 (13.74)	10 (10.75)	58 (13.03)
Rs.10 - Rs.15 lakhs	29 (20.57)	50 (23.70)	14 (15.05)	93 (20.90)
Rs.15 - Rs.20 lakhs	26 (18.44)	40 (18.96)	22 (23.66)	88 (19.78)
Above Rs.20 lakhs	67 (47.52)	92 (43.60)	47 (50.54)	206 (46.29)
Total	141	211	93	445
	(100)	(100)	(100)	(100)
Average asset (Rs.)	2290714.33	2136864.27	2544728.49	2270851.30
Area under irrigation (in Acres)				
Canal	17.50 (2.56)	18.00 (1.84)	5.00 (0.90)	40.50 (1.82)
Open well	19.50 (2.85)	17.00 (1.73)	16.00 (2.87)	52.50 (2.36)
Bore well	95.50 (13.95)	108.00 (11.01)	30.00 (5.38)	233.50 (10.50)
Canal / Bore well	115.25 (16.83)	317.50 (32.38)	141.50 (25.36)	574.25 (25.83)
Open / Bore well	437.00) (63.82)	520.00 (53.03)	365.50 (65.50)	1322.50 (59.48)
Total	684.75 (100.00)	980.50 (100.00)	558.00 (100.00)	2223.25 (100.00)
The colour of the soil				
Red	379 (55.35)	461 (47.02)	231.5 (41.49)	1071.5 (48.20)
Black	151.5 (22.12)	211 (21.52)	173.5 (31.09)	536 (24.11)
Grey	141.5 (20.66)	260.5 (26.57)	124.5 (22.31)	526.5 (23.68)
Yellow	12.75 (1.86)	48 (4.90)	28.5 (5.11)	89.25 (4.01)
Total	684.75	980.5	558	2223.25
Type of the soil				
Sand	203.5 (29.72)	284 (28.96)	174 (31.18)	661.5 (29.75)
Loam	218 (31.84)	294.5 (30.04)	182.5 (32.71)	695 (31.26)
Silt	80 (11.68)	120.5 (12.29)	89 (15.95)	289.5 (13.02)
Light Clay	143 (20.88	222.5 (22.69)	100.5 (18.01)	466 (20.96)
Heavy Clay	40.25 (5.88)	59 (6.02)	12 (2.15)	111.25 (5.00)
Total	684.75	980.5	558	2223.25

Source: Survey Data

Figures in parentheses indicate percentages

The socio-economic background of the sample farm households selected for the study reveals that out of the 445 sample farm household units selected for the study, 141 are from small farmer; 211 are from Medium farmer group and 93 from large farmer group of Erode district. The total of male population worked out for the entire sampling units in the district are 956, while 877 are females adding to the grand total population of 1833 which includes children below the age of 15 years. Out of the total sample units selected for the study, vast majority of the households are registered as nuclear type of families while only 39.33 percent of them are in the category of joint family. The average family size of the sample farm households selected for the study is worked out to 4.12 and farm size group differences in the family type / family size between farm households are largely found absent.

Farm group wise analysis on the socio-economic characteristics of the selected sample households reveals that out of the 141 sample farm households selected for the study in small farmers, 9.22 percent of the households have family size of below 2 members, 59.57 percent have 2-4 members, and 31.21 percent are with family size of more than 4 members.

Assessment of the vulnerability to climate change of erode district in western agro-climate zone of Tamil Nadu

This part deals with the assessment of the vulnerability to climate change of Erode district in Tamil Nadu. Vulnerability is often reflected in the condition of the economic system as well as the socio economic characteristics of the population living in that system. The study attempts to construct a picture of socio-economic context of vulnerability by focusing on indicators that measure both the state of development of the region as well as its capacity to progress further. The study aims to build a vulnerability index and rank of Erode district of western agro-climatic zones of Tamil Nadu in terms of their performance.

This index tries to capture a comprehensive scale of vulnerability by including many indicators that serve as proxies. Specifically, the index looks at four different sources of vulnerability viz., demographic, climatic, agricultural and occupational factors. The results arrived at from the vulnerability index explaining that the climatic variations, agricultural development and demographic patterns, are the major sources of capturing the nature of vulnerability of the people living in Erode district of western agro-climatic zone of Tamil Nadu.

Vulnerability index is integrative and multidimensional concepts for evaluation of the potential effects of climatic change, but they are complex concepts that are difficult to observe directly. However, it is necessary to identify the proxy variables or indicators for estimating the vulnerability. Desirable indicators provide the relevant information that makes vulnerability visible.

The vulnerability index calculated for Erode district of Western agro-climatic zone of Tamil Nadu for the three different time periods are presented in Table-XVI.

TABLE-XVI
VULNERABILITY INDEX AND RANKS FOR WESTERN AGRO CLIMATIC ZONES OF TAMIL NADU

S. No.	Taluks / Zone	1979-80 to 1989-90	Rank	1990-91 to 1999-2000	Rank	2000-2001 to 2009-2010	Rank
1	Erode Taluk	0.1343	1	0.1455	1	0.1367	2
2	Bhavani Taluk	0.2101	3	0.2096	3	0.2054	3
3	Perundurai Taluk	0.1870	2	0.1662	2	0.1219	1
4	Gobichettipalayam Taluk	0.2625	5	0.2624	5	0.2527	5
5	Sathyamangalam Taluk	0.2318	4	0.2244	4	0.2112	4
	Erode district	0.1503		0.1420		0.1715	

From the table-XVI it is indicated that the variation in the index can be due to all variables in the four major sources of vulnerability included in the model. The sources like demographic and agricultural vulnerability have a direct impact on the people living in the Erode district. The next source, which is climatic vulnerability, will also have an impact on the vulnerability of the people through their impact on the agricultural production and the demographic structure. The major variables included under this source were variance of annual rainfall, variance of minimum temperature, variance of maximum temperature and variance of diurnal temperature. As far as occupational vulnerability is concerned, it will also influence the vulnerability of the people in the different taluks of Erode district, which includes the factors like number of cultivators and agricultural labour work force available in the Erode district. The occupational structure of an area has very important significance. The more is the occupational vulnerability, the more people become vulnerable, that is, the more will be the change in occupational structure of the workforce. Hence this also determines the overall vulnerability of the people living in the Erode district of Western agro climatic zone of Tamil Nadu.

The Spearman's rank correlation analysis is used to check the vulnerability index under different time periods. It shows that how these vulnerability indices under different time periods are moved with reference to each other. The results of correlation matrix between three different time periods are presented in table-XVII.

TABLE-XVII
CORRELATION MATIRICS BETWEEN THREE DIFFERENT TIME PERIODS OF ERODE DISTRICT

Periods	Vulnerability Index 1979-80 to 1989-90	Vulnerability Index 1990-91 to 1999-2000	Vulnerability Index 2000-2001 to 2009-2010
Vulnerability Index 1979-80 to 1989-90	1	0.781**	0.781**
Vulnerability Index 1990-91 to 1999-2000	0.781**	1	0.715**
Vulnerability Index 2000-2001 to 2009-2010	0.781**	0.715**	1

** Significant at 5 percent level

From table-XVII, it is observed that the ranks of Erode district and taluks are highly significant and correlated with each other. The value of correlation coefficient is 0.781 and this suggests that there is a high degree of correlation of vulnerability index across different time periods, and it is also significant at five percent level.

Change on food and non-food crop production in erode district

This part of the study deals with the food and non-food crop farmer's perception to climate change effects on crop production in Erode district of Western Agro Climate Zone of Tamil Nadu. The Primary data obtained from 445 sample farmer landholds selected from 6 villages of Erode District have been utilized for analysis. A simple descriptive statistical analysis based on mean and standard deviations have been performed to work out the mean scores of the variables included in the study.

Proxies have been used in the study for all 28 negative and positive perception statements and the level of awareness of the respondent to each is indicated as Strongly Agree (SA), Agree (A), Neutral (N), Disagree (DA) and Strongly Disagree (SD) assigning scores of 5, 4, 3, 2 and 1 for positive statements and reversed for negative statements. The maximum score obtainable was 140 (28 items), while the minimum was 28. Each of the items has a mean of rating. The overall mean score was obtained and used to categorize farmers into having unfavourable (3≥ mean) and favourable (3 < mean) perceptions.

The results of the descriptive statistics performed in the study are presented in table-XXII.

TABLE-XXII
DESCRIPTIVE STATISTICAL ANALYSIS OF THE FARMER PERCEPTION OF CLIMATE CHANGE EFFECTS (COMPOSITE DATA) N=445

Variables	SA	A	N	DA	SDA	Mean	Std. Dev.
Continuous rise in annual temperature reduces production of common food crops	52.3596	21.3483	11.0112	7.4157	7.8652	4.0292	1.2810
Yearly rains are not supporting food crop production as before	48.0899	16.1798	16.1798	8.3146	11.2360	3.8157	1.3989
Infestation of crops by pest is common due to climate change	53.0337	25.8427	6.5169	6.7416	7.8652	4.0944	1.2521
Climate change reduces working hours of food crop farmers	60.0000	6.2921	11.4607	8.0899	14.1573	3.8989	1.5190
There is a rapid loss of soil nutrients to erosion due to climate change	42.6966	8.3146	25.1685	13.0337	10.7865	3.5910	1.4170
Labour availability is being reduced due to climate change	54.1573	10.5618	15.9551	11.9101	7.4157	3.9213	1.3575
There is poor germination rate of food crops due to climate change	44.7191	26.5169	11.4607	8.9888	8.3146	3.9034	1.2900
Poor harvest of food crops cannot be due to climate change	12.5843	11.6854	24.9438	26.7416	24.0449	2.6202	1.3073
Climate change will make food available the more	41.3483	32.1348	10.5618	9.6629	6.2921	3.9258	1.2123
Farming operation is becoming more tedious because climate is changing	37.7528	16.6292	31.2360	6.7416	7.6404	3.7011	1.2495
Climate change does not lead to prevalence of crop disease	58.4270	11.4607	8.5393	15.2809	6.2921	4.0045	1.3606
High cost of food cannot be traced to climate change	37.3034	17.3034	29.4382	6.9663	8.9888	3.6697	1.2844
No food Farmers are quitting farming due to climate change	24.0449	8.3146	18.6517	25.8427	23.1461	2.8427	1.4864
Occurrence of flood in the recent days is not traceable	37.3034	13.7079	35.7303	6.9663	6.2921	3.6876	1.2170

to climate change							
Climate change does not force food crop farmers into planting different crops	20.0000	12.3596	17.3034	21.7978	28.5393	2.7348	1.4892
Climate change does not lead to high production cost of food crops	32.1348	14.3820	32.3596	7.4157	13.7079	3.4382	1.3652
Farmers are losing interest in farming due to climate change	60.6742	15.2809	11.0112	8.9888	4.0449	4.1955	1.1855
Incidences of drought during the rainy season cannot be due to climate change	39.3258	28.3146	15.7303	7.8652	8.7640	3.8157	1.2742
Climate change will lead to larger farm size of farmers	28.9888	21.7978	30.1124	9.4382	9.6629	3.5101	1.2656
Climate change cannot lead to malnutrition	47.6404	17.0787	15.7303	9.2135	10.3371	3.8247	1.3806
Climate change has nothing to do with food crop production	18.6517	16.8539	17.0787	21.1236	26.2921	2.8045	1.4643
Degradation of land is more pronounced due to climate change	12.8090	13.9326	18.8764	13.0337	41.3483	2.4382	1.4578
Climate change will continue to affect storage of food crops	41.1236	30.3371	12.5843	6.7416	9.2135	3.8742	1.2743
Access to usable water for farming activities is gradually decreasing and this is due to the ever rising annual temperature	14.3820	9.6629	23.5955	9.6629	42.6966	2.4337	1.4699
Climate change has led to an increased demand for irrigated farming	32.8090	23.1461	24.7191	10.5618	8.7640	3.6067	1.2789
Climate change is not a problem because it is long way off the future. No cause for alarm.	18.8764	12.5843	17.5281	21.5730	29.4382	2.6989	1.4793
With this trend in rainfall pattern, we may be forced to permanently change the type of crops being grown, as time goes on.	18.6517	18.8764	10.5618	15.2809	36.6292	2.6764	1.5664
Increasing annual rainfall increases the quality of crops produced.	13.2584	29.2135	20.0000	10.1124	27.4157	2.9079	1.4200

Source: Primary data

The table-XXII shows the mean statistics of sample farmers' perception of 28 climate change statements included in the study. It is seen from the analysis that out of the total sample farmers (445) selected for the study on an average of 53.7 percent of the food and non- food crop farmers. This implies that the farmers have unfavourable perception to climate change in the Erode district of Western Agro-Climatic Zone in Tamil Nadu. This suggests that they would also have positive attitude to adapting to climate change with a view to increasing their levels of food and non–food crop production. This further affects.

It is seen from the analysis that out of the total sample farmers (445) selected for the study, on an average of 60.68 percent of farmers of the food and non- food crops, are strongly agree that farmers are losing their interest in farming due to climate change and 60 percent of farmers are strongly agree that climate change reduces working hours of farmers of food crops and non-food crops in Erode district. Moreover, 58.43 percent of the farmers strongly agree that climate change does not lead to prevalence of crop disease, 54.16 percent of them strongly agree that labour availability is being reduced due to climate change, 53.03 percent strongly agree that infestation of crops by pest is common due to climate change and 52.36 percent of the sample farmers strongly agree that there is continuous rise in annual food crop farmers in Erode district of Western Agro – Climate Zone in Tamil Nadu.

This implies that the farmers have unfavourable perception of climate change in the Erode district of western zone in Tamil Nadu. This suggests that the farmers also have positive attitude to adapting to climate change with a view to increasing their level of food and non-food crop productions. This further attests to the unfavourable perception that farmers have of the various effects of climate change on food production in the area. Meanwhile, majority of the respondents have unfavourable perception of the effects of climate change, while 40 percent of the respondents have favourable perception of climate change effects in Erode District of Western Zone in Tamil Nadu.

Summary and conclusion

India is the seventh largest country in the world with geographical area of 328.73 million hectares representing 2.45 percent of the world's geographical area. The total population of the country is 1027 million, which is equal to 15.70 percent of world's population. Agriculture continues to dominate in India's economic development, accounting 27 percent of its Gross Domestic Product (GDP) and one-fifth of foreign exchange. This sector provides more than 67 percent of the total labour force in the country. Besides, its forward linkages and backward linkages with other sectors of the economy are the other established facts. Nearly 80 percent of India's population lives in rural areas and is directly or indirectly dependent on agriculture. However, climate is one of the main determinants of agricultural production. Throughout the world there is significant concern about the effects of climate change and its variability on agricultural production. Researchers and administrators are concerned with the potential damages and benefits that may arise in future from climate change impacts on agriculture, since these will affect domestic and international policies, trading pattern, resource use and food security. The Climate change is any change in climate over time that is attributed directly or indirectly to human activity that alters the composition of

the global atmosphere in addition to natural climate variability observed over comparable time periods (IPCC, 2007). Since climatic factors serve as direct inputs to agriculture, any change in climatic factors is bound to have a significant impact on crop yields and production.

Studies have acknowledged the potential of climate change consequence and its influence on environment particularly agriculture. Several efforts have been ongoing to estimate the economic impacts of projected changes in climate on important sectors, such as agriculture, forestry and ecosystem, coastal zones and fisheries, water resources, and energy development. These studies have tried to investigate the impact of climate change on productivity, mostly in agricultural sector. Hence, there needs to carry out study that can investigate economic impacts of climate change particularly, in agriculture, assess the level of adaptation of the affected farmers and use the findings to inform policy directions. The sustainability of agricultural production and yields for the countries depend mainly on the quality of rains. The effect of changes in climate on agricultural activities has been shown to be significant for low input farming systems; subsistence farming in India is located to a lot of extent in marginal areas. There are growing evidences that further increases in global warming will lead to change in main climate variables such as temperature, precipitation, sea level, atmospheric carbon dioxide content and incidence of extreme events. These variables will significantly affect Indian agricultural productions. If this global warming is not put in check, livelihoods of subsistence and pastoral farmers, who make up a large portion of rural populations in the country, could be negatively affected. There has been extensive research on the impacts of climate change, but there are little known studies on the economic impacts of climate change on agriculture in India. None of these studies, however, has looked into the economic impacts of climate change and factors influencing adaptation approach decisions by farmers. Some attempts have been made to estimate the impact of climate change on food production at the country, regional, or global scale. Insights from these studies are crucial to appreciating the extent of the problem and to designing appropriate mitigation and adaptation strategies at the global or regional level. Therefore, the present study entitled "Economic and Environmental Consequences of Climatic Change as a Free Rider Problem: A Case Evidence from Households, Erode District" is an attempt on the direction.

Conclusion

To conclude, based on the empirical results and discussion it was observed that the adaptation analysis strongly suggest that the farmers do adapt to climate change by shifting to multiple crops cultivation under dry land and diversification to non-farm. Majority of the respondents who took no adaptation measures point at lack of information, lack of money/credit and labour. Examining a set of future climate scenarios using Ricardian approach, the model predicts that the estimated Ricardian coefficient for adaptation is positive and statistically significant, because farmers who adopted climate change adaptation strategies had higher net revenue than those who did not. In other words, the effect of climate change will be reduced by such a magnitude if households take effective adaptation measures.

The study observes that various adaptation strategies farmers employed in response to climate change as well as factors influencing these decisions. The results of the study revealed that entree to timely

information about climate change, access to formal and informal lending institutions tend to improve their farms performances. Consequently, there is need for effective and reliable access to information on changing climate. In addition, credit or grant facilities are crucial in enhancing farmers' awareness. This is vital for adaptation decision-making and planning. Combining access to extension and credit ensures that farmers have the information for decision-making and the means to take up relevant adaptation measures. The government, private sector, and NGOs can improve net farm performances for smallholder farms through increasing training for farmers and helping them acquire necessary land management techniques and effective adaptation strategies to climate change. Also there is need to provide timely whether alerts accessible to these farmers in a way they can use it.

Policy makers should anticipate that adaptation is important, that the magnitude of changes depends on the climate scenario, and that the desired changes depend on the effective adaptation measures used. Moreover, policy that can facilitate process of mitigation institutions such as encouraging planting of trees, organic farming, discouraging bush farming among others.

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EFFECTS OF LEPTIN ON THE PLASMA LEVELS OF TRIIODOTHYRONINE (T_3) AND THYROXINE (T_4) IN THE AIR -BREATHING FISH *CLARIAS GARIEPINUS*

Chumbeni Kikon
John Government Higher Secondary School, Viswema- 797005, Nagaland, India
e-mail: chumbek@gmail.com

Abstract: Leptin is a hormone secreted primarily by the adipocytes and it influences several physiological and metabolic processes. Leptin has been found in the circulation of many fish species and the peptide structure of fish leptin has been found to be similar to that of mammalian leptin. However there is paucity of information on the effect of leptin on thyroid hormones in any fish species. Therefore in order to know whether leptin has any effect on thyroid hormone in fish, dose dependent effect was studied on the plasma levels of T_3 and T_4 in fed and starved adult male *Clarias gariepinus* during winter and summer/rainy seasons. Leptin administration increased plasma T_3 and T_4 levels in fed groups in a dose dependent manner during both the seasons but it had no effect in the starved groups irrespective of seasons. From the findings we can conclude that (a) leptin has stimulatory effect on thyroid hormones (b) the stimulatory effect of leptin depends on the feeding status of the fish and (c) T_3 levels seem to be more sensitive than T_4 levels.

Keywords: Leptin, Triiodothyronine(t_3), Thyroxine(t_4), Hypothalamo-hypophyseal

Introduction

Leptin is a multifunctional hormone and plays a keyrole in the regulation of energy metabolism in vertebrates by modulating food intake, thermogenesis, as well as glucose and lipid metabolism (Ceddia, 1999; Spiegelman and Flier, 2001; Ahima and Osei, 2004. It also influences several physiological and metabolic processes (Huang and Li, 2000; Ren, 2004; Hukshorn and Saris, 2004). Similarly thyroid hormones have been known to play an important role in the regulation of thermogenesis in mammals (Tata, 1964; Silva, 2001; Yen, 2001; Angelin-Duclos *et al*., 2005).Therefore leptin can affect thermogenesis directly or indirectly via its effects on the hypothalamo-hypophyseal thyroid axis. In, mammals fasting results in low leptin levels associated with decreased secretion of thyrotropin-releasing hormone (TRH) and low levels of thyroid hormones (Orban *et al*., 1998). Administration of leptin has been reported to prevent the fasting induced fall in the serum thyroid hormones and TRH (Seoane *et al*., 2000). Leptin has been reported to stimulate thyroid activity in fasting mammals primarily by stimulating the synthesis and release of TRH from the hypothalamus by its action at the gene level (Legradi *et al*., 1997). In Fishes there is still scarcity of information on the effect of leptin administration on the thyroid hormone levels. Leptin has been reported to have an anaeroxigenic effect in fish, indicating a role in regulation of growth and energy homeostasis (Johansson and Bjornson , 2015). As in mammals starvation also results in decreased leptin concentration in the green fish, *Leponis cyanellus* (Johnson *et al*., 2000), Burbot, *lota lota* (Nieminen *et al*. 2003). However leptin administration in Coho salmon *oncorhynchus kisutch* had no effect on thyroxine level in both fed and fasted fishes (Baker *et al*., 2000).

In fishes, thyroid hormones are well known to play an important role in regulation of somatic growth and metabolic functions (Peter and Oommen, 1989), energy metabolism (Lynshiang and Gupta, 2000), breeding cycle (Volkoff *et al*., 1999) sexual maturation (Pavlidis *et al*., 2000), migration (matty 1985) growth and development (Power et *al*., 2001) electrolyte and water metabolism (Peter *et al*., 2000) etc. The variation in circulating levels of T_3 and T_4 levels in fishes species are regulated by temperature, physical activity, photoperiod, feeding etc(Liener *et al*., 2000**)**. Further as in the case of fasting-induced decline in leptin level in fishes (Johnson *et al*., 2000; Nieminen *et al*. 2003) the levels of thyroid hormones have also been reported to decrease following starvation (Leiner *et al*., 2000) and to increase feeding (Toguyeni *et al*., 1996). Since starvation reduces levels of both leptin and thyroid hormones, there is a possibility that the feeding and fasting associated effect of leptin on the fish physiology are also expressed due to the effect of leptin on thyroid activity, and hence thyroid hormones.

But so far no attempt has been made to investigate the effects of thyroid hormones in any fish species with special reference to seasons, temperature and feeding status. Therefore it was thought worthwhile to investigate the effects of leptin on circulating levels of thyroid hormones in fed and fasted fish *clarias gariepinus* both during summer and winter.

Materials and Methods

All experiments were conducted *invivo* both during the summer/rainy and winter months. For this experiment, male *clarias gariepinus* (body weight; 90-110g); body length: 18-22cm), fishes were maintained in plastic cages and acclimatized in the laboratory. After acclimatization, the fishes were divided into different groups of four fishes each for different types of treatment. The desired dose of the hormone was injected intra-muscularly on the lateral side of the dorsal fin.

Hormonal treatments

Experiment No.	Month (Temperature)	Dose	Duration of Treatment
Effect of leptin in fed and starved fishes	January (9-11^{0}c) July (20-22^{0}c)	Control (saline) 0.5µg leptin/fish/day 1 µg leptin/fish/day 2 µg leptin/fish/day	7days

Collection of plasma samples

Fishes were decapitated and blood samples from the post-caudal region were collected in numbered heparinised centrifuge tubes, avoiding the body fluid. The blood samples were centrifuged at 3000 rpm for 10 minutes to obtain the plasma. The plasma samples were stored at -8 to-10^0 c in a refrigerator for measuring the levels of thyroid hormones using radioimmunoassay (RIA)

Radio immunoassay of Thyroid Hormones (T_3 and T_4)

The plasma concentration of total T_3 and T_4 were measured with the help of radioimmunoassay kits (RIA4/4 for T_3 and RIAK5/5A for T_4. The RIA was conduced following the manufacturers protocol with slight modifications where the hormone free serum was replaced by hormone free fish plasma. The radioactivity in the bound fraction was counted with the help of a well -type

gamma counter. The concentrations of total T_3 andT_4Were expressed as ng/ml of plasma

Statistical Analysis

The data were analyzed statistically with the help of student's t test and regression analysis (Snedecor, 1961). A $P< 0.05$ was considered as significant.

Results

The data are presented in table 1 and 2. Effect of leptin on the plasma levels of thyroid hormones was found to be dose dependent and season dependent and was also influenced by feeding status. During winter, only 2 µg dose of leptin significantly increased the plasma levels of T_3 anf T_4 in the fed groups while the other two doses had no effect on the plasma levels of thyroid hormones, However during summer only 0.5 µg dose of leptin had no effect on the levels of thyroid hormones while the plasma levels of T_3 and T_4 were significantly increased in the fed groups following treatments with 1 µg and 2 µg dose of leptin. Unlike in the fed fishes all the three doses of leptin have no significant effect on the plasma levels of thyroid hormones in the starved fishes irrespective of seasons.

When the data were analyzed statistically with the help of regression analysis, a positive correlation was found between the doses of leptin and the plasma levels of both T_3 and T_4 during winter and summer. In contrast, a negative co-relation was found between the doses of leptin and the plasma levels of both T_3 and T_4during both the seasons. Further, a negative correlation was always found between the doses of leptin and theT_3/T_4 ratio in both the fed and starved groups except in the fed groups during summer when a positive correlation was found.

Table 1 - Effects Of Leptin on the Plasma levels of T_3 and T_4 in fed and starved *Clarias gariepinus* during winter.

Treatment	Plasma Levels of Thyroid hormones (ng/ml) T_3	T_4	T_3/T_4
FED			
Saline (control)	0.55±0.01*	10.25±0.36	0.053
0.5 µg Leptin	0.56±0.01	10.75±0.20	0.052
1 µg Leptin	0.58±0.01	11.10±0.30	0.052
2 µg Leptin	0.59±0.01 [a]	11.50±0.32[a]	0.051
Correalation Coefficient (r)	0.96	0.97	-0.95
STARVED			
Saline (control)	0 .51±0.02	9.80±0.24	0.052
0.5 µg Leptin	0 .50±0.01	9.68±0.21	0.051
1 µg Leptin	0 .50±0.02	9.52±0.16	0.052
2 µg Leptin	0 .49±0.01	9.45±0.20	0.051
Correalation Coefficient (r)	-0.95	-0.94	-0.50

*All values are expressed as mean±standard error (S. E); N=4

[a] Differs significantly from the respective control group $p<0.05$

Table 2: Effects of Leptin on the Plasma levels of T_3 and T_4 in fed and starved *Clarias gariepinus* during summer

Treatment	Plasma Levels of Thyroid hormones (ng/ml) T_3	T_4	T_3/T_4
FED			
Saline (control)	1.33±0.05*	17. 50±0.18	0.076
0.5 µg Leptin	1.48±0.06	18.01±0.20	0.082
1 µg Leptin	1.60±0.08 [a]	18.40±0.16 [b]	0.086
2 µg Leptin	1.73±0.09[b]	18.60±0.15[b]	0.093
Correalation Coefficient (r)	0.97	0.93	0.99
STARVED			
Saline (control)	1.26±0.06	17.32±0.25	0.072
0.5 µg Leptin	1.25±0.04	17.28±0.16	0.072
1 µg Leptin	1.22±0.07	17.16±0.15	0.071
2 µg Leptin	1.20±0.04	16.99±0.16	0.070
Correalation Coefficient (r)	-0.97	-0.99	-0.96

*All values are expressed as mean±standard error (S. E); N=4

[a,b],Differs significantly from the respective control group $p<0.05$ and 0.01, respectively.

Discussion

The administration of different doses of leptin increased the plasma level of T_3 and T_4 levels in fed *clarias gariepinus* during both summer and the winter seasons in a dose dependent manner. However leptin administration had no effect on the plasma levels of thyroid hormones in starved groups irrespective of seasons (Table 1 and 2). These findings seem to suggest that the effect of leptin on plasma levels of thyroid hormones depend on the feeding status as well as on seasons. Stimulatory effect of leptin on the level of thyroid is more prominent on the fed fishes during summer as compared to that during winter. Unavailability of food (starvation) completely blocked the stimulatory effect of leptin on circulating levels of thyroid hormones. Fasting (starvation) has been reported to reduce leptin secretion in fish species (Johnson *et al*., 2000; Nieminen *et al*., 2003). The present findings indicate that fasting block the effect of leptin on the thyroid hormones. Thus the present and earlier findings, when considered together suggests that unavailability of food triggers some physiological adjustments which not only reduce leptin levels but also block its effect on thyroid hormones probably to decrease the metabolic rate to ensure conservation of energy when food is either not available or scarce. It is important to mention that leptin administration in fasting mammals has been reported to increase the levels of TRH (Legradi *et al*., 1997; Harris *et al*., 2001; Ortiga- Carvalho *et al*., 2002) and Thyroid hormones (Seoane *et al*., 2000). However, in the present study, leptin had no effect on the levels of thyroid hormones in the fasting fishes irrespective of season and/ or temperature. These findings, thus, indicate that the response of the circulating levels of thyroid hormones to leptin is different in fasting/ starving homeotherms and fasting or starving poikilotherms. Further, the neuroendocrine response to fasting/ starving also seems to be different in the homeotherms and poikilotherms. It seems that, unlike in mammals, the hypothalamo- hypophyseal-thyroid axis of the fasting/ starving fish becomes insensitive to leptin. Initially leptin was viewed as a hormone designed to prevent obesity, but several studies now suggest that leptin signals the switch from the fed to starved states (Schwartz *et al*., 2000; Flier *et*

al., 2000). It seems that fasting induced suppression of leptin levels induced metabolic, endocrine and behavioral responses that conserve energy and stimulate food intake, and thereby enhance the chances of vertebrates to survive through a period of food deprivation (Flier 1998; Flier *et al*, 2000, Flak, *et al*, 2014).

On the basis of the present findings, we conclude that leptin plays an important role in the regulation of the thyroid hormones. The plasma levels of thyroid hormones are positively regulated by leptin in fed fishes via the hypothalamo- hypophyseal –thyroid axis. Slow stimulatory effect of leptin on the levels of thyroid hormone seems to indicate that leptin increases the level of thyroid hormones by stimulating the synthesis of the thyroid hormones. Fasting (starvation) seems to render the hypothalamo- hypophyseal –thyroid axis of the fish insensitive to leptin action. This might be a mechanism for energy conservation under the conditions of food scarcity or non-availability of food. Further leptin seems to act as a switch to regulate peripheral deiodination of T_4 to T_3 in relation to availability of food. Leptin mediated inhibition of peripheral deiodination of T_4 to T_3 (more potent form) can also play an important role in the energy conservation in the fish facing scarcity of food.

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ESTIMATION OF WASTAGE OF PAGES IN NAGALAND UNIVERSITY EXAMINATION

Md. Jakir Ali
Department of Statistics, Kohima Science College (Autonomous)
Jotsoma-797002, Nagaland, India
e-mail: mdjakirali@rediffmail.com

Abstract: This study was carried out on a sample basis to estimate the number of pages being wasted by students during semester examinations conducted by Nagaland University and to sensitize the people to reduce pollution from the pulp and paper industries.

Keywords: Paper wastage, examination, paper pollution

Introduction

The production and use of paper has a number of adverse effects on the environment which are collectively known as paper pollution. Since people need paper product, and the amount of paper and paper products is enormous, so the environmental impact is also very significant. It has been estimated that by 2020 paper mills will produce almost 500,000,000 tons of paper and paperboard per year. So great efforts are needed to ensure that the environment is protected during the production and each and every individual use these paper products judiciously, and utmost care should be taken in recycling / disposal of this enormous volume of material. Pulp and Paper pollution is a serious problem. Pulp and Paper manufacturing companies pollute our water, air and soil. The pulp and paper industry is one of the largest and most polluting industries in the world. There are many thousands of pulp and paper mills in the world. With global annual growth forecast at 2.5&, the industry and its negative impacts could double every 28 years. Worldwide, the pulp and paper industry is the fifth largest consumer of energy, accounting for four percent of all the world's energy use. The pulp and paper industry uses more water to produce a ton of product than any other industry. Pulp and paper mills contribute to air, water and land pollution. Discarded paper is a major component of many landfill sites, accounting for about 35 percent by weight of municipal solid waste (before recycling). Even paper recycling can be a source of pollution due to the sludge produced during de-inking.

The environmental impacts of paper pollution are quite significant because it directly leads to deforestation, air pollution and water pollution.

Deforestation

Deforestation is often seen as a problem in developing countries but also occurs in the developed world. Worldwide consumption of paper has risen by 400% in the past 40 years, with 35% of harvested trees being used for paper manufacture.

Air pollution

Nitrogen dioxide, Sulfur dioxide, carbon dioxide, are all emitted during paper manufacturing. Nitrogen dioxide and sulfur dioxide are major contributors of acid rain,

whereas carbon dioxide is a greenhouse gas responsible for climate change.

Water pollution

Water is an integral part of operations within the paper and pulp industries and on average, the paper and pulp industries release tens of millions of waste water per day. Waste water discharges from a pulp and paper mill contains solids, nutrients and dissolved organic matters. Organic matter dissolved in fresh water, measured changes ecological characteristics, and in worst case scenarios leads to death of all higher living organisms.

Objectives

The main objective of the present study is to estimate the number of pages being wasted by students during semester examinations conducted by Nagaland University and to bring awareness to the students in particular and the people in general to reduce pollution from the pulp and paper industries.

Results

In last semester examination in 2013 of Nagaland University about 2400 answer scripts were used by approximately 600 students in Kohima Science College, Jotsoma. Each answer scripts had 30 pages to write the answers. But at the time of submission, it was found that many pages were not used by the students. In order to find the number of pages being wasted during university examinations a study was carried out on a sample of 100 scripts which was recorded as given below:

No. of pages wasted	26	23	22	21	19	16	15	14	12	10	8	7	6	5	4	3	2
No. of students	2	2	3	4	4	8	6	6	8	8	7	6	6	8	7	6	9

x_i	26	23	21	19	16	15	14	12	10	8	7	6	5	4	3	2	Total
f_i	2	2	4	4	8	6	6	8	8	7	6	6	8	7	6	9	$100=\sum_{i=1}^{17} f_i$
$f_i x_i$	52	66	84	76	128	90	84	96	80	56	42	36	40	28	18	18	$1040 = \sum_{i=1}^{17} f_i x_i$

On the basis of the record given above I have decided to find the average number of pages wasted by the students and also to estimate the total number of pages being wasted by the university. It may be noted that according to the website www.nagauniv.org.in under Nagaland University there are 54 affiliated colleges and a total 24000 under graduate students in 2013-14.

We denote number of pages wasted by x_i and the number of students by f_i.

From the above results it is found that on an average 10.40 pages and approximately 2400 × 10.40 = 24960 pages were wasted by the students of Kohima Science College alone in a semester examination under Nagaland University.

Now if we consider this sample mean of **10.40** pages for the entire students of Nagaland University then we found that **24000 × 4 × 10.40 = 9,98,400** pages were left unused by the students during semester examinations under Nagaland University .

Methodology

Here I have used the Simple Random Sampling technique of sample survey.
The formula to estimate the average number of pages wasted by the students is given by:

$$\bar{x}_n = \frac{1}{\sum_{i=1}^{17} f_i} \sum_{i=1}^{17} f_i x_i$$

- And to compute the total number pages being wasted by the students of Kohima Science College, the formula is given by: $\hat{X} = N \times \bar{x}_n$
- Here N = total number of answer scripts used by the students of the college = 2400[1],

NB.1. Here no. of answer scripts being used are taken as 2400 because each students has to sit in the examination for 4 subjects.

Conclusion

Now if the Nagaland University authority decides to give 16 pages answer scripts to the students in examination then almost half of these i.e. approximately **4,99,200** pages will be saved and can be utilized to make around **31,200** additional answer scripts for the students.

Results of this study reveals that a huge amount of paper are wasted during the course of an examination no matter whether it is an internal or end-term examination. We should try our level best to minimize the use of paper in order to save our mother earth and I think one best way to reduce pollution from the paper industry is to use recycled paper, since in a study conducted by the United States Environmental Protection Agency has found that recycling causes 35% less water pollution and 74% less air pollution than making virgin paper. Another reason of going for recycling may be well justified from the following facts:

For every tonne of paper used for recycling, the savings are:

- at least 30000litres of water
- 3000 - 4000 KWh electricity (enough for an average 3 bedroom house for one year)
- 95% of air pollution.

Recycling paper also decreases the demand for virgin pulp and thus reduces the overall amount of air and water pollution associated with paper manufacture. Recycled pulp can be bleached with the same chemicals used to bleach virgin pulp.

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GEOCHEMICAL VARIATION OF RARE EARTH ELEMENTS IN DISANG SHALES OF KOHIMA, NAGALAND.

R. Vineetha Pillai
Department of Chemistry, Kohima Science College (Autonomous)
Jotsoma-797002, Nagaland, India
e-mail: Vineethapillai63@gmail.com

Abstract: The area of investigation including Kohima Town and its surroundings is approximately 80 sq. kms. Here the Disang and Barail Groups of rocks of Eocene-Oligocene age are exposed. The Disangs comprise abundant bluish grey to buff coloured splintery Shales and siltstones. The thin beds of fine grained sandstones and siltstones. The Barail are made up of well bedded and massive sandstones alternating with minor papery Shales. All Disang Shale Samples show LREE enrichment. The REE Patterns of the surface Shales show a gently inclined slope. Whereas the core samples show as almost flat shale-Normalised REE patterns. In the case of surface sample most of the which indicate contribution from a mixed source i.e. granite & basaltic. The clay minerals of the Disang shale include Koalinite, illite, choritemontnorillonite and traces of nontronile. These sediments were derived from grantic and basaltic source. The sediments are weathered products of sub-temperate climate beds where moderately high pH conditions prevailed. Post depositional alteration affected the sediments. These sediments were deposited in a near-shore, shallow marine environment, probably a lagoon, under anaerobic condition. This was a miogeosynclinal set-up of a Passive Continental margin.

Key words: Disang, Shale, granite source, basaltic source, kohima, claymineral, REE Nagaland.

Introduction

The area of investigation includes Kohima Town and its surroundings. It is incorporated in topsheet No. 83 K/2 of the Survey of India and is bounded by North parallels 25° 38’ 00’ and 25° 42’ 30’’ and East meridians 94° 05’ 00’ and 94° 07’30’’. It is approximately 80 sq. kms in area and (fig.)1 falls within the belt of schuppen and comes within the territorial boundary of Nagaland (Fig 2), Mathur and Evans (1964), a stratigraphic sequence for the part of Nagaland (Table I), given after Directorate Of Geology and Mining (1978).

In this area rocks of the Disang and Barail Groups are exposed. The Disang sediments, a flyschfacies of Upper cretaceous – Eocene age, is made up of abundant splintery shale intercalated with very hard, fine grained, flaggy sandstones and siltstones. The DisangShales are highly fissile and readily split into thin semi-flexible sheets. These Shales show concentric surfaces. Carbonaceous Shale intercalated with minor non-carbonaceous massive Shale and occasionally fine sandstones also occur in patches, particularly at fault zones. The Shales are mostly fawn to reddish brown coloured at very old exposures whereas in fresh surfaces they are commonly dark grey to black in colour. At many of the recent exposures, sulphur is noted as white encrustations which represents the residue of the weathering processes (Vineetha R. 2003). The thickness of the sandstones gradually increases towards

the top with the gradual depletion of shales The Disang grade laterally and vertically into the overlying Barail molasses.

TABLE 1. STRATIGRAPHY OF NAGALAND

(Modified after Directorate of Geology & Mining, Nagaland, 1978)

Age (Approx.)	Group	Litho-formation in Belt of Schuppen& Southern Nagaland
Quaternary & Recent		Alluvium & high level terraces
Pleistocene	Dihing	
Miocene	Tipam	Girujan Clay Tipam Sandstone
---------- Unconformity ----------		
Lower Miocene	Surma	
Upper Eocene – Oligocene (molassic sediments)	Barail	Renji Jenam Laisong
Upper Cretaceous – Eocene (flysch sediments)	Disang	

Methodology

Nine samples of DisangShales (both core & surface together) are analysed for REE by ICP-MS method. For the purpose an ICP-Mass Spectrometer Model ELAN DRC II (Perkin – Elmer Sciex Instrument US) is used.

The system is optimized for maximum intensity of approximately 40,000 counts (see across the mass range using alng/m/ solution of Mg, Rb, In, Ba, Ce, Pb& U). A dual detector is used. The samples are decomposed by the open-acid digestion method (Balaram et al, 1996). The mass spectrometer is operated in mass scanning mode cases with comparable accuracies (Balaram et al, 1999).

Normalization against NASC is a measure of how typical a sediment is, and may identify subtle enrichments and deficiencies in certain elements (Rollison, 1993). In order to smoothen out natural odd-even effects of REE concentrations, the REE values of theDisangShales are divided by the corresponding values of North American Shale Composit (NASC) [Gromet et al, 1984; Govindaraju, 1994]. The normalized data are plotted following (Boynton 1983).

The clay minerals of the DisangShales are analysed by the X-Ray diffraction technique. Seven representative samples of Shale of the area analysed for the clay minerals by X-Ray diffraction. The representative samples are disintegrated into powder using a mortar and pestle from which unoriented mounts are prepared. To increase the random orientation of the minerals the powdered rock samples are sieved into a holder and pressed lightly with a wide blade to obtain the necessary flat surface to coincide with the surface of the holder. Philips Analytical PC-APD software, PW 1710 based diffractometer is usedfor the analysis. The powdered samples are run on the X-Ray diffractometer with CuKα radiation and Ni filter (wavelength 1.5406 Å to 1.54438 Å). The instrument is operated at 40KV and 20 mA. The scanning speed is maintained at 2°/min. The samples are scanned within the 2θ range of 10° to 70°. The 2θ values of peaks are converted into molecular repeat distances (d-spacing) in terms of angstrom (Å) units. The clay minerals are identified from the diffractograms (Vineetha – 2004) with the

help of values in the Powder Diffraction File (JCPDS).

Description of samples

The DisangShales show minor variation in physical characters. Samples S_4 & S_9 is made up of dirty grey to buff coloured shale. Sample S_{14} comprises semi weathered with white encrustations of sulphur. Sample S_{19} comprises semi weathered muddy shales. Many of the surface shale samples are associated with white encrustations of weathered sulphur which represent the residue of weather process. Sample C_6 comprises PhylliticShales with minor sandstones and S_H stones. The Shales are dark grey in colour. The alternating sandstones are very hard and compact and about 5 cms thick. Sample C_9 comprises dark grey compact Shales intercalated with sandstones. These Shales are pebbly in nature with white encrustations of weathered sulphur. Sample C_{18} is grey colour in nature mixed with mud. Sample C_{30} & C_{38} is made up of dark, grey massive beds of shale, which are carbonaceous in nature and strongly supports high carbonaceous content.

Analytical result

The DisangShales are analysed for REE, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb& Lu. The analysed values are I parts per million. In the surface samples these elenents range from (24.12 to 40.46, 52.57 to 99.79, 4.77 to 9.53, 17.16 to 35.44, 40.46 to 52.57 to 99.79, 4.77 to 9.52, 17.61 to 35.44, 4.68 to 6.83, 1.05 to 1.48, 3.65 to 5.59, 0.47 to 0.73, 3.01 to 3.69, 0.49 to 0.75, 1.42 to 1.92, 0.23 to 0.29, 1.26 to 1.62 and 0.18 to 0.23 ppm respectively (Table 1 (1a)). The total REE values range from 113.2 to 207.00 ppm. In the core samples, they range from 18.34 to 22.62, 30.99 to 45.33, 3.31 to 4.21, 12.28 to 26.17, 3.6 to 4.16, 1.01 to 1.05, 3.73 to 4.08, 0.53 to 0.63, 2.67 to 2.98, 0.53 to 0.59, 1.2 to 1.52, 0.17 to 0.24, 0.98 to 1.51 and 0.21 to 1.21 ppm respectively (Table 1(1b)). The total REE values range from 83 to 108 ppm.

The REE comprise the lanthanides La – Lu (La_{z57} to Lu_{z71}) including Yttrium (Y_z= 39). Geochemically Yttrium resemble Dysprosium (Dy-z=66) and Holmium (Ho-z=67) and is typically included with the Heavy Rare Earths (HREE), Gadolinium (Gd-z-64) to Lutetium (La_z=57). These HREE are commomly known as Yttrium Earth.

TABLE 1 I (A)
Rare Earth Elements (ppm) of the surface samples of the Disang Shale

Elements	**S4**	**S9**	**S14**	**S19**	**Crustal average***
La	40.46	24.11	30.48	34.30	30.00
Ce	99.79	52.58	73.44	78.20	60.00
Pr	9.52	04.78	6.54	7.56	8.20
Nd	35.44	17.62	29.44	30.13	28.00
Sm	6.8	4.69	5.90	6.61	6.00
Eu	1.32	1.05	1.39	1.48	1.20
Gd	5.06	3.65	4.89	5.59	5.40
Tb	0.60	0.47	0.63	0.73	0.90
Dy	3.01	2.39	3.03	3.69	3.00
Ho	0.61	0.50	0.68	0.75	1.20
Er	1.92	1.42	1.50	1.67	2.80
Tm	0.29	0.21	0.23	0.27	0.50
Yb	1.62	1.27	1.32	1.31	3.40
Lu	0.23	0.20	0.18	0.18	0.50
∑ REE	206.70	114.94	159.65	172.47	151.10

(*) after Mason and Moore (1982)

TABLE 1 II (B)
Rare Earth Elements (ppm) of the core samples of the Disang shale

Elements	C 6	C 9	C 18	C 24	C 30	C 38
La	18.35	20.25	22.62	21.44	19.45	18.62
Ce	42.55	43.55	45.33	42.80	40.47	31.00
Pr	4.21	4.16	4.10	4.09	3.99	3.31
Nd	26.17	24.16	14.89	3.74	12.28	15.37
Sm	4.14	4.03	4.14	1.05	4.16	3.60
Eu	1.03	1.02	1.03	4.03	1.01	1.02
Gd	4.06	4.04	4.09	0.61	3.84	3.74
Tb	0.58	0.54	0.63	2.97	0.58	0.53
Dy	2.84	2.67	2.95	0.59	2.98	2.69
Ho	0.54	0.52	0.59	1.50	0.59	0.52
Er	1.21	1.24	1.48	0.24	1.52	1.19
Tm	0.20	0.20	0.24	1.40	0.24	0.18
Yb	1.13	1.17	1.26	1.20	1.51	0.99
Lu	0.16	0.16	0.20		0.21	0.14
∑ REE	107.17	107.55	103.55	99.89	92.83	82.89

TABLE 2 I (A)
NASC normalized values of the surface samples of the Disang shale

Elements	S 4	S 9	S 14	S 19
La	1.28	0.76	0.95	1.07
Ce	1.37	0.72	0.01	1.07
Pr	1.25	0.60	0.83	0.96
Nd	1.07	0.53	0.89	0.91
Sm	1.20	0.82	1.03	1.16
Eu	1.07	0.85	1.12	1.19
Gd	0.97	0.70	0.94	1.07
Tb	0.70	0.55	0.74	0.87
Dy	0.52	0.41	0.52	0.64
Ho	0.59	0.48	0.66	0.73
Er	0.56	0.42	0.43	0.49
Tm	0.58	0.42	0.46	0.53
Yb	0.52	0.41	0.43	0.42
Lu	0.49	0.41	0.38	0.38
Eu/Eu*	1.15	1.16	1.16	1.07
Gd/Yb_N	1.86	1.72	2.20	2.55
La/Sm_N	1.07	0.92	0.92	0.38

TABLE 2 II (B)
NASC normalized values of the surface samples of the Disang shale

Elements	C 6	C 9	C 18	C 24	C 30	C 38
La	0.57	0.65	0.71	0.67	0.61	0.58
Ce	0.58	0.59	0.62	0.59	0.55	0.42
Pr	0.53	0.53	0.53	0.52	0.50	0.42
Nd	0.79	0.73	0.45	0.42	0.37	0.47
Sm	0.73	0.71	0.73	0.73	0.73	0.63
Eu	0.83	0.82	0.83	0.85	0.81	0.82
Gd	0.78	0.78	0.79	0.78	0.74	0.72
Tb	0.69	0.63	0.74	0.72	0.68	0.62
Dy	0.49	0.46	0.51	0.51	0.51	0.46
Ho	0.52	0.50	0.57	0.57	0.57	0.50
Er	0.36	0.37	0.44	0.44	0.45	0.35
Tm	0.40	0.40	0.48	0.49	0.50	0.35
Yb	0.37	0.38	0.41	0.45	0.49	0.32
Lu	0.33	0.34	0.41	0.35	0.44	0.29
Eu/Eu*	1.09	0.11	1.10	1.51	1.10	1.21
Gd/Yb_N	2.13	2.06	1.93	1.72	1.56	2.27
La/Sm_N	0.079	0.093	0.097	0.093	0.083	0.09

The Light Rare Elements (LREE), Lanthenium to Samarcium ($La_{z54} - Sm_{z62}$) are known as Cerium Earths. (Fair bridge, 1972) Normalization of data. (Table-2a and 2b)

Discussion

Nature of REE Pattern and their Significance

As a result of the geochemical behavior of the REE, the concentration of the REE in shale is widely used as indication of crustal provenance because of the near quantitative transfer of these elements in sedimentary system, low natural abundance in sea water and relative immobility in sea water, and during digenesis' and metamorphism (TaylerandMcLennan, 1985) McLennan, 1989.

The Disang surface shale's show a gently inclined sloped (fig. 1) whereas the

core samples show an almost flat shale normalized pattern (fig. 2). In the surface sample most of the values lie above 1 while those of the core samples lie below 1. Values above 1 normally indicate contribution from basaltic source while those showing values less than 1 suggest granitic source. According to Thamban and Rao (1995), shale patterns indicate that they retaines the REE Patterns of weather alumino-silicate rocks. The flat REE pattern is because of the Eu/Eu. According to Rudnik (1992), such anomalies are slightly above the normal of other sediments. This may be due to the contribution from plagioclase that was enriched during igneous fractionation of magma in the lower crust. A positive Eu/Eu is indicative of basaltic sources. A positive Eu/Eu* anomaly (>1) implies accumulation of plagioclase in the partial melt and negative anomaly (<1) suggests fractionation of plagioclase (M. Jayabalan *et al*., 2015)

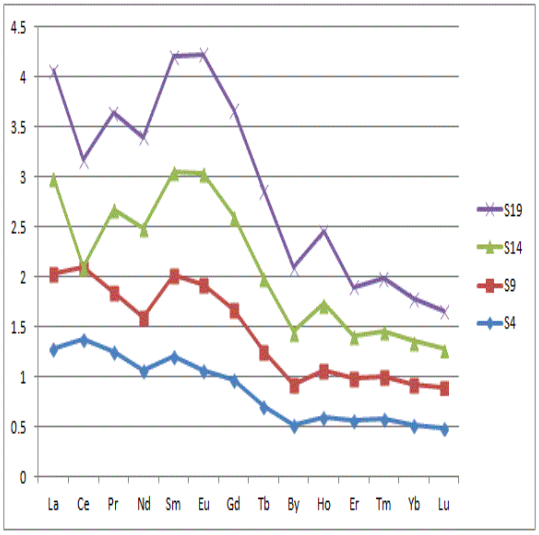

Figure 1: NASC normalised REE pattern of Disang Surface Samples

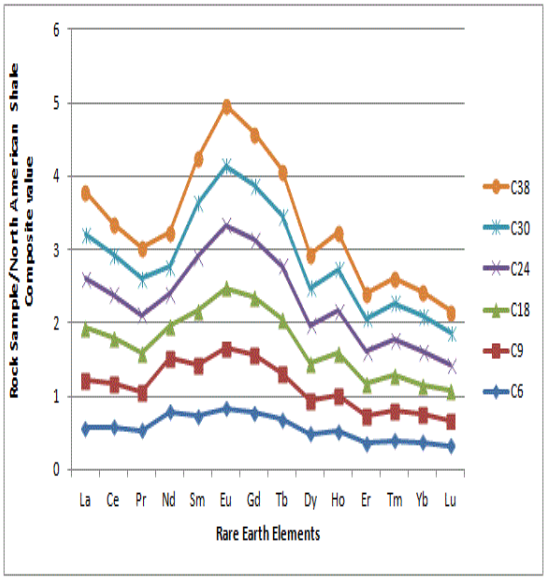

Figure 2: NASC normalised REE pattern of Disang Core Samples

Varitation in the Eu/Sm ratio in sedimentary rocks is attributed to provenance, digenesis or reducing condition in sedimentary processes causing concentration of Europeum (Cullersetal, 1979), although Eu/Sm ratios do not change during digenesis of peltic sediments (Chaudhari and Cullers, 1979). Some of the Disang Sample show negative Eu anomalies. According to Freyer (1977) such values indicial anoxic condition during deposition. This is supported by the presence of pynite in Disang sediments. However most of the samples show positive Eu anomaly. This may be due to the fact that the Disang shale's are being oxidized at present.

The majority of the REE plots lie below1. The LREE of the surface samples have rocks NASC values that more mostly greater than 1. The same off the core samples are less than 1. However the HREE of both categories retain the same character. Alkali basalts are highly enriched in LREE relative to HREE. Basaltic source generally give values

in greater than 1 while granitic source give values lesser than 1. In the area of investigation, because of the nature of rocks, shale's in particulars, it is known that groundwater percolating through the surface removes fine detrital clay particles. It is possible that some of the REE are absorbed by these clays and hence, be slowly transported to lower region this would account for the anomalous distribution of the REE in the surface and core samples.

The Eu anomaly is calculated by geometric mean after Taylor and McLennan (1985). The geometric mean of the Eu/Eu range from 1.06 to 1.15 for the surface samples and 1.09 to 1.51 for the core samples. Such values indicate a positive anomaly, which supports a basaltic origin. The present study show that the sediments also show LREE enrichment which indicated by high La/Sm. It is similar to that of sediment from mature continental crust it also shows a high EREE which is similar to that of sediments derived from young undifferentiated terrains. The reason for this anomaly in the DisangShales is that their sediments were derived from mixed source. The older continental crust that contributed some of these sediments was probably the ancient Precambrian Mikir Hill Massiffs the younger source rocks may be those of the Ophiolite Belt of Nagaland.

Distribution of Clay Minerals

Kaolinite is found in good amounts while illite is present in good to considerable amounts. Chlorite is found in considerable amounts in some samples and in small amount in others. Montmorillionite is also found in considerable amounts in some sample whereas in others it is present in small amounts. It has not been detected in one sample. Montronite is very rare in these sediments. Its presence is noted in small amounts only in two samples. Clay Minerology is a reliable tool for identification of Paleo environmental conditions (Chamely, 1989) Paleo climatic condition may also be deduced from clay mineral variations (Das, 2001) clay minerals form in environments of moderate temperature and abundant moisture. Their presence therefore suggests humid climatic condition at the provenance.

Clay Minerals identified in the Disang shale are Kaolinite from (005), (132), (113) and (333) reflections. While Illite from (130), (221), (100), (222) and (004) reflections. Chlorite has been identified from (002), (020) and (111) reflections. Montmorillonite has been identified form (203) and (110) reflections and nontromite from (010) and (040) reflections. Kaolonite is the dominant clay mineral found in this area after which the next most abundant is illite. This is followed by chlorite and montronite. Nontronite is found in traces in some of the samples (Table-3)

ChloriticShales have a common clay mineral assemblage (k>illite>ch) that indicate high fluvial condition and diagenetic alteration effect on illite to chlorite (Jha S.K et al, 2012) Clay mineral assemblage (kalonite> chlorite) is supported the intensive weathering of rocks high fluvial conditions in the region of humid tropical climate. The kaolinite is converted into illitean chlorite (Hower et al. 1976). Dominance of Kaolinite in this sediments indicated both moist and acid tropical environments where drainage conditions were good. The Shales of marine origin are characterized by illite and chlorite, LagoonalShales, however is richer in both potash and manganesia than the marine Shales. In theDisang sediments the contents of these two oxides are high (Vineetha, 2003). The occurrence of kaolinite along with illite

and chlorite is probably due to diagenetic change taking place slowly and continuously. Montmorillonite-rich zones correspond with open massive areas. Chlorite is an constituent of near shore massive environment, while kaolinite is non-marine.

TABLE 3: Clay minerals in the Disang Shale (Relative amounts)

Sample No.	Good	Considerable	Small
S 4	Kaolinite	Illite	Chlorite Montmorrill-onite
S 9	Kaolinite	Illite Chlorite Montmorrillo-nite	
S 14	Kaolinite	Illite Chlorite Montmorrillo-nite	
S 19	Kaolinite	Illite	
C 6 (Depth) (10–16 mts)	Kaolinite-Illite	Chlorite	Montmorrill-onite
C 9 (16-25 mts)	Kaolinite-Illite	Montmorrillo-nite	Chlorite Nontronite
C 18 (50-60 mts)	Kaolinite		Chlorite Montmorrill-onite
C 24 (90-95 mts)	Illite	Kaolinite	Chlorite
C 38	Kaolinite	-	Chlorite

Conclusion

From the above findings, it is concluded that the Disangflysch are clastic sediments that were derived from very complex sources. The provenance include granitic, basaltic (probably volcanic) low to medium grade metamorphic and sedimentary terrains. This was a near-shore environment at plate interior along a passive continental margin. Sedimentation took place in a dominantly marine environment where other water flowed into cause mixing. This was a lagoon environment where reducing condition prevailed. These sediments are presently part of the Kohimasynclinorium. Ventilation and drainage condition were good in the depositional basin. These are chemically matured sediments.

The basalts, metamorphic rocks are recycled sediments have been derived from the ophiolite complex of the Indo-Myanmar range, the granitic source was the Mikir Hills Precambrian Massifs.

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HUMAN RESOURCE BASE -A CASE STUDY OF PHEK DISTRICT OF NAGALAND

Sakhoveyi Lohe
Department of Geography, Kohima Science College (Autonomous)
Jotsoma- 797002, Nagaland, India
e-mail: sakhoveyi_1@yahoo.com

Abstract: People with knowledge and skill are the most important resources. Various natural resources will be useless if there is no human skill and technology to use them for the benefit of mankind. Therefore, the development of human resources now has become a key to progress. The purpose of this study is to examine the total potential of human resources available in the district, the role of education in human resources development and the infrastructural facilities available for human development and improvement in the quality of life.

Keywords: Human resource, population, education and literacy, Human development.

Introduction

Human resource refers to the population of an area and the efficiency, productivity, skill and far sightedness of its inhabitants. A country or region may be blessed with various natural resources (land, soil, water, flora and fauna, mineral and human beings) but all of them are of no use unless there is human skill and technology to use them for the benefit of mankind. Thus people (with the knowledge and skill) are the most precious resources. Human resources are important for the development of both the country and individual. Education plays a very significant role in this regard because a country having highly educated and skilled people can produce more with ease, without wasting resources. All human beings engaged in some useful activities represent human resources. Population is the most potent resource which can alter the entire face of the country, if utilized prudently. Not only it provides trained and skilled man-power for economic reconstruction but like other natural resources it can be exported to earn regular income and meet financial crisis. But an illiterate and unskilled population full of ethnic and linguistic diversities poses a number of problems whose solutions are always not easy to find out. Not only that, if population is not guided into productive assets, population can be a bane or liability to its nation. Sometimes, Population growth is considered as a retarding factor of economic development when there is less employment avenues.

Objectives

The objective of this study is to find out the different categories of human resources available in the district on which the development of the district is based upon. It also aims to find potential human resources available when all the available population in the district is employed in some useful activities as a resource.

Data and Method

This study is based on secondary data. Demographic and other socio-economic data, etc. were collected from Directorate of Census, Directorate of economics & Statistics, Nagaland and other sources. Data have been, sometime, used in absolute term and sometime, used for percentage analysis to find out the percentage share. Data have been diagrammatically illustrated by using appropriate cartographic techniques.

Results and Discussion

Population resource

Phek district of Nagaland with an area of 2026 sq km has a population of 163294 with

83684 (51 %) males and 79610 (49 %) females (Census 2011). It accommodates 8.24 % of the population of Nagaland (Fig. 1). Phek district is the seventh largest district in size and ninth in density. Phek district has 135756 people in the Aged 7 & above and 27538 of Child population in the age group 0-6.

During the decades from 1981 to 2001, Phek district experienced a high growth of population with growth rate exceeding 44 percent in all the decades. During 2001-2011, the district recorded a modest growth rate of 10.19 % with 0.97 % as average annual exponential growth rate.

Human resources refer not to human beings as such, but to the qualities they possess and which can be used by the community for some useful purpose (Sexana, 2013 p-40). In this regard, to qualify as a resource, he/she should be engaged at least in some useful purposes. In Phek district, only 48 % of the population is considered as workers and about 52 % are non- workers (Fig. 2). Out of this working population, about 19.5 % are marginal workers which mean only 38.8 % of the population of Phek district is real workers (Table 1). This reflects heavy dependence of population on working force. According to 2001 Census report, there are 27090 people within the age group of 0-6 constituting 18.2 percent of the district population. They cannot be considered non workers as they are not yet mature to work and therefore cannot be included in the 52 percent of non workers. Not only that, a small percentage of aged people who can no longer work can also be excluded. Even after their exclusion, one can easily assess the quantum of unemployment in the district by taking into consideration the 55.5 % of the country's population in the working age group (15-59). This is the root cause of many problems which we are facing today.

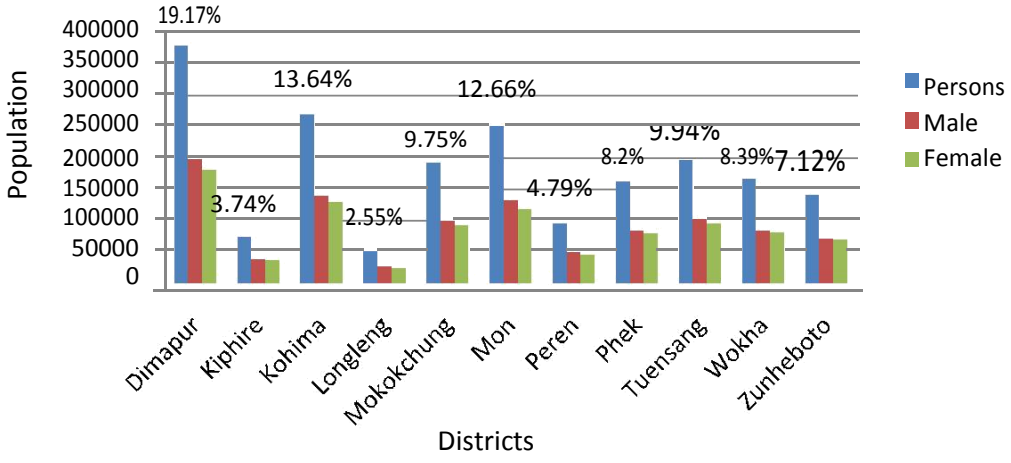

Fig.1: District wise Population of Nagaland (2011) (Source: Census of India 2011)

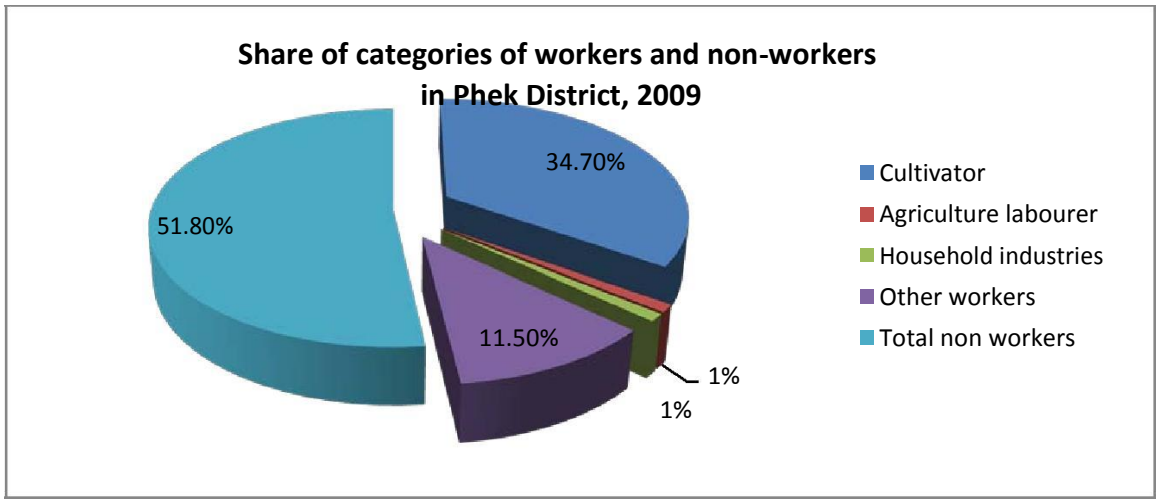

Fig. 2: Share of categories of workers of the Phek district

Table 1: Summary of Population of Workers, Percent of Workers' to Total Workers' Population & Percent of Workers' to the Total district Population, according to 2001 Census.

Sl. no.	Type of work		population		% to the total workers population		% to the total district population	
1.	Cultivator		51360		72		34.7	
2.	Agriculture labourer		1478		2		1.0	
3.	Household industries		1562		2.2		1.0	
4.	Other workers		16998		23.8		11.5	
5.	Total worker s	Main workers	71398	57454	100	80.5	48.2	38.8
		Marginal workers		13944		19.5		9.4
6.	Total non workers		76797		N/A		51.8	

Source:Directorate of Economics and Statistics

District population during 2001= 148195 (Total workers +Total Non- workers)

Education and Literacy

Education is an important factor for the development of human resource. Education-general, technical and medical improves the level of understanding. It also adds to the capacity of human stocks to produce more, increases the mental efficiency of the people. Education can play an effective role in raising production from its low level. General and technical education develops the efficiency among the labourers to use highly advanced

techniques of production for the optimum use of the existing resources. Thus, a rational educational system produces skilled and trained workers, promotes science and technology and creates a scientific outlook, enlarges the mental horizon of the people and increases the mobility of labour and meets cultural needs and develops human personality.

There has been an immense expansion of general education facilities. There are 305 schools and 1676 school teachers, with 3 colleges (2 Govt. colleges and 1 Theological college) and 72 college teachers in Phek district. Schools and colleges are the two institutions that employ huge numbers of human resources itself. As the number of schools and colleges increased, the enrolment number too went up. The educated man power as such increased very much. Table 2 shows the schools/colleges and teachers employed/engaged in human resources development in Phek district of Nagaland.

Free and compulsory education to all children in the age group 6-14 years was planned but it has not been achieved so far. Women education is also encouraged. In addition, there are Industrial Offices/ Boards/ Emporiums, Banks, Police Stations, Government Offices that train as well as use/ employ human resources in the district.

Literate resource

Literate resource is a resource when a person can read and write with understanding in any language. It may be remembered that all the literate persons (i.e., who can read and write with understanding in any language) cannot be true resources in the strictest sense

Table 2: Number of Schools/ Colleges in Phek district, Nagaland 2012-13

School/college	Govt.	Pvt.	No. schools	Teacher (Govt.)	Teacher (Pvt.)	Total Teacher
*Primary school	147	19	166	676	303	978
*Upper primary	60	16	76	393	210	603
*Secondary	35	20	55	47	0	47
*Higher secondary	2(+1)	5	8	41+	7	48
Total school	**245**	**60**	**305**	**1116**	**520**	**1676**
College	2	1	3 colleges	(26+32)=58	14	72
Grand total	**247**	**61**	**308**	**1174**	**534**	**1748**

Source: *Abstracted from UDISE Data 2012-13. (School Education, Nagaland).

(+1 Govt. Higher Sec. Schl. Meluri is not functional at the time of this data entry)

of the term. According to Erich W. Zimmermann, 'the word resource does not refer to a thing or a substance but to a function which a thing or a substance may perform or to an operation in which it may take part (function or operation of attaining a given end such as satisfying a want). Thus, a resource satisfies individual human wants or attains social objectives. When we talk about resource we mean, in simple term, a thing that is useful to human kind or society. A literate person can prove to be a liability to the society and may not qualify to be called a resource in this regard.

According to Census 2001, there are 85562 literate persons out of 121108 aged 7& above years in Phek district with 70.65 percent as literacy rate. The literate population increased to 1, 07,427 along with increased in total population, with 79.13 percent as literacy

rate in 2011. This shows a quantum jump of literacy rate within a decade with a net increase of 8.4 percentage point though the rate was way behind the state figure with a net increase of 13.52 percent during the same decade. Data related to Literate population and literacy rate of Phek district, Nagaland are contained in Table 3. Though, Phek district has achieved considerable reduction in illiterate population during 2001-2011 by net increase in literacy rate of 8.4 percentage point from the previous decade figure, the district still has considerable gaps to bridge to achieve cent percent literacy rate considering the fact that there are large numbers of school dropout in rural areas even after the implementation of Right to Education with its associated policies of no detention.

Health infrastructure

Human development and improvement in the quality of life are the ultimate objectives of planning. This is to be achieved through policies and programmes aimed at promoting both equity and excellence. Human health is one of the important determinants of human life expectancy which is one of the parameters used for estimation of Human Development Index (HDI). HDI reflects the state of development for the society as a whole. Lack of adequate health infrastructures and lack of access to health care facilities are two important reasons for low level of HDI. Health infrastructure status of Phek district is presented in Table 4.

Though health care facilities are available in the district, it is a matter of fact that still many rural people do not get access to health care facilities due to various reasons.

Table 3: Literate and literacy rate of Phek district, Nagaland (1991-2001 to 2001- 2011)

year	population	Aged 7 & above	Literate population	Illiterate population	Literacy rate
1991-2001	148195	121108	85562	35546	70.65
2001-2011	163294	135756	107427	28329	79.13

*Literacy rate of Nagaland during (1991-2001) & (2001-2011) was 66.59 % & 80.11 % respectively.

Source: Census of India 2011, provisional population totals part 1 of 2011, Nagaland series14

Table 4: Health infrastructure statistics of Phek district, Nagaland.

particulars	year			
	2007-08	2008-09	2009-10	2010-11
District Hospital	1	1	1	1
Community Health Centre	3	3	3	3
Primary Health Centre	17	17	22	22
Subsidiary Health centre	2	2	--	--
Dispensary	3	3	--	--
Sub Centre	44	44	44	44
STD Clinic	1	1	1	1
Total	71	71	71	71

Source: Directorate of Health and Medical Services.

Table 5: Numbers of medical personnel in Phek district

particulars	year		
	2008-09	2009-10	2010-11
Doctors	45	45	42
Pharmacists	37	37	37
Nurses	168	161	171
Total	250	243	250

Source: Directorate of Health and Medical Services.

Health Manpower

The district health care facilities are manned by 42 doctors, 37 Pharmacists and 171 Nurses during 2010-11. Numbers of various medical personnel posted in the district health centres during 2008-09, 2009-10 and 2010-11 is presented in Table 5.

Conclusions

Human resources refer to qualities of human beings which can be used by the community for some useful purpose. In fact, human resources are the energies, skills, talent and knowledge of people which potentially can and should be applied to the production of goods and services. Phek district has a population of 163294 accommodating 8.24 percent of the population of Nagaland. But only 48 percent of the population is considered as workers and about 52 percent are non-workers. There has been an immense expansion of general education facilities and as a consequence there is quantum jump of literate population with 79.13 percent as literacy rate in 2011. Though there has been immense improvement in literacy rate, a large number of school drop out students in rural areas, even after the implementation of Right to Education with its associated policies of no detention is a major hindrance in the way of human resource development. To achieve human development and improvement in the quality of life, health care facilities are made available and a number of various medical personnel are posted in the district. But still, many rural people do not get access to health care facilities due to various reasons.

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LONGER LIFE BUT POOR HEALTH? MEASUREMENT AND DYNAMICS

Prasanta Barman
Department of Statistics, Kohima Science College (Autonomous)
Jotsoma-797002, Nagaland, India
e-mail: bprasanta@gmail.com

Abstract: The longevity gain does not necessarily mean healthier life, but it may translate to an increased percentage of older people with poor health. In this paper, an attempt has been made to estimate the life expectancy free from chronic non-communicable diseases for urban population of Kohima and Dimapur towns of Nagaland. The analysis revealed that at birth males/ females are expected to live 53.91/ 54.03 years without chronic disease.

Key words: Life expectancy, Health, chronic disease, Non-communicable, Sullivan.

Introduction

The health status of a population is generally measured in terms of life expectancies, death rates etc. Despite dramatic successes in improving human life expectancy, various studies indicate that longer life expectancy does not necessarily mean healthier life (Crimmins et al., 2004). Many sick people who have been rescued from early death continue to live to older ages with an increased risk of acquiring chronic conditions over their remaining lifetime and ending up with multiple diseases, some with disability (Verbrugge, 1989). Thus, it is difficult to reach at a conclusion about the health status of a population by taking only the death rates or life expectancy into account.

Health expectancy is an index that combines the fundamental dimensions of health (i.e. mortality and morbidity) into a summary indicator to provide information on the health and length of life. It is defined as the number of remaining years at a particular age that an individual can be expected to live in a healthy state (howsoever, health may be defined) if current mortality and morbidity prevails.

The life expectancy free from chronic disease is defined as the number of years that one can expect to live in the absence of chronic diseases.

The concept of health expectancy is relatively new in Nagaland. No studies are so far available, which can highlight the health scenario of the state. So, in this paper, an attempt has been made to estimate the health expectancy free from chronic non-communicable diseases for urban population of Nagaland, during 2001-2010 using Sullivan technique.

Data

To estimate health expectancy, the data requires is the age-specific proportion of population with chronic disease and age specific mortality rate. The age-specific proportions (prevalence) of persons with chronic disease is obtain through a household survey conducted in Kohima and Dimapur towns of Nagaland during May – August 2010. Altogether 4640 respondents are interviewed from both the town. The age specific mortality rate for urban areas of Nagaland is taken from the urban life table for Nagaland, 2001-05 (Choudhury et al., 2013).

Methodology

In the usual notation of life table, the life expectancy at age x (e_x^0) is given by-

$$e_x^0 = \frac{1}{l_x}\sum_{i=x}^{w} L_i \quad ;$$

Where, L_x is the total numbers of years lived by the cohort in the interval (x to x+1), l_x is the number of persons at age x and w is the value of the last age interval.

The calculation of health expectancy also follows similar lines. If we assume two states called, chronic disease free (CDF) and with chronic disease (CD), then the chronic disease free life expectancy at age x ($CDFLE_x$) and life expectancy with chronic disease ($CDLE_x$) are defined by

$$CDFLE_x = \frac{1}{l_x}\sum_{i=x}^{w} L_i(CDF) \quad \text{and}$$

$$CDLE_x = \frac{1}{l_x}\sum_{i=x}^{w} L_i(CD)$$

(Jagger, 1999)

Where, L_i(CDF) and L_i(CD) are the number of person years lived from age x onwards in the states CDF (without chronic disease) and CD (with chronic disease) respectively.

Using the Sullivan method as an approximation of health expectancy, we have

$$L_i(CDF) = (1-\pi_i) * L_i \quad \text{and}$$

$$L_i(CD) = \pi_i * L_i \qquad i=0,\ldots,\omega,$$

Where, π_i is the prevalence of chronic disease at age i. Thus for $x = 0,\ldots,\omega$

$$CDFLE_x = \frac{1}{l_x}\sum_{i=x}^{w}(1-\pi_i) * L_i \quad \text{and}$$

$$CDLE_x = \frac{1}{l_x}\sum_{i=x}^{w}\pi_i * L_i$$

Where, l_x is the number of survivors at age x in the hypothetical life table cohort.

L_x is the number of years of life lived by the life table cohort between ages x and $x+n$.

π_x is the proportions of person with chronic disease between ages x and $x+n$ in the population.

Results and Discussion

The age-specific life expectancy, life expectancy with chronic disease and chronic disease free life expectancy for urban population of Nagaland for the period 2001-2010 are presented in Tables – 1. It is found that, at birth males (females) are expected to live 53.91 (54.03) years of life without chronic disease. The corresponding life expectancy at birth is 64.94 (65.79) years (Choudhury et al., 2013). In other words, at birth males (females) are suppose to live 11.03 (11.76) years of life with chronic disease. On comparing the results of the present study with a similar study conducted in Guwahati city of India during 2006 for the period 1992-2002 (Choudhury et al., 2005), similar result were observed, where males (females) were expected to live 52.58 (54.07) years of life without chronic disease. The corresponding life expectancy at births was 60.53 years for males and 61.97 years for females.

The number of remaining years lived with or without chronic disease declines with ages. They reach a convergence at about age 60 years for both males and females where a crossover is noted with more years expected to be spent in an unhealthy than healthy state. Consistent observation also has been

Table - 1: Age-specific total life expectancy, life expectancy with chronic diseases and chronic disease free life expectancy for urban areas of Nagaland 2001-10.

Age	Males			Females		
	Total Life Expectancy	Life Expectancy with chronic disease	Chronic disease free Life Expectancy	Total Life Expectancy	Life Expectancy with chronic disease	Chronic disease free Life Expectancy
x-x+n	e_x^0	CDLE	CDFLE	e_x^0	CDLE	CDFLE
0-1	64.94	11.03	53.91	65.79	11.76	54.03
1-5	68.52	11.81	56.71	69.71	12.63	57.08
5-10	66.50	12.16	54.34	67.95	13.05	54.90
10-15	61.93	12.20	49.73	63.40	13.11	50.29
15-20	57.11	12.18	44.94	58.58	13.15	45.43
20-25	52.33	12.23	40.10	53.81	13.13	40.68
25-30	47.56	12.26	35.30	49.06	13.14	35.92
30-35	42.82	12.18	30.64	44.32	13.13	31.20
35-40	38.11	12.02	26.09	39.63	13.06	26.57
40-45	33.49	11.79	21.69	34.98	12.87	22.11
45-50	29.00	11.37	17.62	30.42	12.55	17.87
50-55	24.70	10.69	14.01	25.98	11.89	14.09
55-60	20.71	9.47	11.24	21.78	10.89	10.89
60-65	17.05	8.59	8.46	17.88	9.55	8.33
65-70	13.86	7.09	6.77	14.38	7.94	6.44
70-75	11.10	5.81	5.29	11.32	5.63	5.69
75-80	8.85	4.44	4.40	8.76	3.84	4.92
80-85	7.03	3.54	3.48	6.70	2.55	4.15
85+	5.58	1.12	4.46	5.11	2.27	2.84

observed by Crimmins et al. (1997) and Rogers et al. (1989) in advanced ageing societies. For males, a highest proportion (0.75) of person suffering from chronic disease is observed for the age group 80-85 years, where males are expected to live 3.54 years (50.43 percent) of their remaining life with chronic disease out of 7.03 years of remaining total life expectancy. Similarly for females, the highest proportion (0.67) of chronic disease has been observed for the age group 65-70 years, where a female is expected to live 7.94 years (55.22%) of her remaining life with chronic disease out of 14.38 years of remaining total life expectancy. It has also been noticed that, for females the percentage of remaining life expected to live with chronic diseases is maximum for this age group 65-70. For males, the corresponding age group is 70-75 years, where males are expected to live 5.81 years (52.34%) of their remaining life with chronic diseases out of 11.10 years of total life expectancy.

The results of Tables - 1 also reveal a clear gender differentials with the females exhibiting an advantage in the total number of

remaining years lived but with greater risk of chronic disease compared to the males. For example, a fifty year old male can expect to live 10.69 years or 43.28 percent of remaining life in chronic disease compared to 11.89 years or 45.76 percent, for the females. The highest gender disparity in life expectancy with chronic disease (1.42 years) for urban areas of Nagaland has been observed for the age group 55-60 years where males are expected to live 9.47 years of remaining life in chronic disease compared to 10.89 years for females. Until age 70 years, males are expected to live a lower proportion of their remaining life with chronic disease compared to females. Beyond 70 years of age, men henceforth expect to live a higher proportion of their remaining years in an unhealthy state than women do.

Conclusion

A population certainly may experience longer life expectancy but may be with worsening health condition. In urban areas of Nagaland a considerable proportion of older people spend their remaining life with a state of chronic illness. The result of the present study may be applied to improve understanding of the determinants of health, identify health inequalities and impact of public health policies in urban areas of Nagaland, India.

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MORBIDITY PREVALENCE AMONG THE GOVERNMENT EMPLOYEES IN RURAL AREAS OF NAGALAND IN 2011: A CROSS SECTIONAL STUDY

Sheikh Faruk Ahmed
Department Of Statistics, Kohima Science College (Autonomous)
Jotsoma-797002, Nagaland, India
e-mail: sh.farukahmed@gmail.com

Abstract: Chronic non communicable diseases (NCDs) are the fastest growing causes of morbidity among government employees and influencing factors need to be analysed. Objectives are to find the prevalence rate of specific diseases, examine the existence and strength of influencing factors of morbidity due to non communicable diseases (NCDs) among the government employees in rural Nagaland. This study is based on cross-sectional primary data. A sample of 825 government employees was taken for the purpose of this study. Final analysis for the strength of association between multi-category independent variables and dichotomous dependent variable (i.e., presence or absence of NCDs) was done by using multiple logistic regression analysis with the reduced sample of 479 government employees who attained 40 years of age on the date of survey. The overall morbidity prevalence rate was 21% of which 16.1% was due to NCDs and 5.0% was due to communicable diseases. In the reduced sample of 479 government employees, 25.3% of the total morbidity was due to NCDs. The leading causes of communicable diseases were tuberculosis (15 per 1000 employees) followed by respiratory infections (10 per 1000 employees). On the other hand, the leading causes of NCDs were Cardiovascular Diseases (52 per 1000 employees) followed by Diabetes mellitus (41 per 1000 employees), Cancer (15 per 1000 employees), diseases of digestive system (15 per 1000 employees) and diseases of liver (10 per 1000 employees). Independent factors such as age, body mass index and habit of smoking had significant effect on the prevalence of morbidity due to NCDs among the employees aged 40 years and more. The average number of years an employee of age 40 years and above was living with disease was highest due to cardiovascular diseases (7.3 years) followed by respiratory diseases (5.8 years) and diseases of liver (5.3 years).

Key words: Non communicable diseases, influencing factors, morbidity prevalence, association, multiple logistic, regression.

Introduction

Employees constitute the workforce of any organization and as such are vital to carry out the plans and programmes of the concerned organization. Government employees are the main subgroup of the adult workforce as far as the country's government is concerned. The execution of all the government plans and policies are dependent on this subgroup of the adult workforce. Thus, health of the employees is a major concern as any impairment to this subgroup of adult people through morbidity or mortality will affect the country's economy (Saikia and Ram, 2010).

The term morbidity is expressed in different ways. Health in the individual is said to be related to levels of physiological function, an equilibrium that is threatened or disturbed by disease and here at this stage Wood says that there is morbidity (Wood and Foster, 1986). Foster (Wood and Foster, 1986) refers to morbidity as the condition of being diseased or morbid.

The diseases that are responsible for the cause of illness and death can be classified mainly into two categories – communicable and non-communicable or degenerative diseases (Murray & Lopez, 1996). From several studies conducted in the developed as well as developing countries, it has been observed that

the deaths due to communicable diseases have drastically gone down during last few decades, whereas deaths from non-communicable diseases like cardiovascular diseases, cancer, diabetes, etc., are alarmingly increasing (Gaminiratne, 1984). This phenomenon has occurred in all developed countries, and the developing countries are in transition towards this state (Crimmins et al., 1994).

Health transition characterized by demographic transition in age profile of people and epidemiologic transition marked by the shift of the burden of diseases from communicable diseases to non-communicable diseases (NCDs) is witnessed largely throughout the world since the second half of the twentieth century (Omran, 1971; Olshansky and Ault, 1986). Many parts of India have also been undergoing rapid epidemiological transition as a consequence of economic and social changes (Gupta et al, 2001; Reddy et al., 1998 and Reddy et al., 2005).

The employees as adult people are more likely to be affected by the non-communicable diseases (NCDs) such as cardiovascular diseases, malignant neoplasm, diabetes, etc., in their later ages (Choudhury and Biswas, 2012; Ahmed and Choudhury, 2014). The share of burden of non-communicable diseases has increased from 47% in 1990 to 56% in 2000 in developing countries and it has been estimated that this share will reach 69% in 2020 (Boutayeb and Boutayeb, 2005). Globally, the labour units lost owing to NCD deaths and the direct medical costs of treating NCDs have reduced the quality and quantity of the labour force and human capital (Mayer-Foulkes, 2011). It is estimated that by the year 2025, majority of the developing countries are likely to face an enormous burden of chronic non-communicable diseases (WHO, 2001).

The effect of socio economic and demographic factors on health outcomes particularly prevalence of different diseases may result from a variety of social and individual factors that vary by social class and adoption of life style behaviours that are associated with prevalence of diseases (Lowry et al., 1996). The primary determinants of disease are mainly economic and social, and therefore its remedies must also be economic and social (WHO, 2001).

The Socio-Economic Status (SES) gradient does not occur for all diseases but it does occur across a wide range of diseases that carry a heavy burden of morbidity and premature mortality. In terms of specific diseases and syndromes, there is a strong and consistent SES gradient for cardiovascular disease, diabetes, metabolic syndrome, arthritis, tuberculosis, chronic respiratory disease, gastrointestinal disease, and adverse berth outcomes as well as for accidental and violent deaths (Cunningham and Kelsey, 1984; Mathews et al., 1989; Kaplan and Keil, 1993; O'Campo et al., 1997; Canwell et al., 1998; Pamuk et al., 1998).

Usually demographers continue to place a great deal of focus on demographic and socio-economic factors to analyse morbidity and mortality (Rogers et al., 2005). But, the importance of health behaviour factors such as habit of smoking, chewing tobacco and drinking alcohol have been increasing in developing countries in recent time from a changing pattern of cause of death. Smoking or chewing tobacco and drinking alcohol are very important factors affecting premature death in India, even after controlling for other socio-economic and demographic factors (Thun et al., 1997; Jurgen et al., 2003; Gajalakshmi et al., 2003; Jha et al., 2008).

Morbidity prevalence among the employees may hinder the pace of development of the concerned organisation/country due to the loss of working hours by the employees. Being the subgroup of adult population, the employee's ill health and mortality can directly affect the production, earnings, investment and consumption and health of the other living members of the household (Over et al., 1992). As of 2005, India experienced the "highest loss in potentially productive years of life" worldwide (Reddy et al, 2005). In the United States, men with chronic diseases worked 6.1 percent fewer hours and women worked 3.9 percent fewer hours (Suhrcke et al., 2006).

Therefore, it is important to know the factors affecting the health of the government

employees by causing morbidity. Morbidity due to some specific diseases such as cancer, renal diseases, etc., may cause the loss of working hour. Therefore, it is also important to estimate the mean length of morbidity caused by a specific disease to the government employees of Nagaland.

Objectives

1. To study the morbidity prevalence rate among the government employees in the rural areas of Nagaland
2. To examine the existence and strength of association between various socioeconomic, demographic, physiological and risk health behaviours with non-communicable diseases among government employees at ages 40 years and above
3. To estimate the mean length of morbidity caused by a specific disease to the government employees of Nagaland.

Methods and Materials

This study is based on cross-sectional primary data collected through household survey during May-July, 2011 for the purpose of Minor Research Project (MRP) sponsored by UGC-NERO, Guwahati. The multi-stage sampling design was adopted to collect data. First of all Kohima and Dimapur districts were selected by judgement sampling as first stage sampling units. In the second stage sampling, the sampling units were the Rural Development Blocks (RDBs). According to 2001 census, there were 7 RDBs in Kohima district. But after the creation of Peren district, Kohima district was left with only 4 RDBs. Thus, there were 4 RDBs in both Kohima and Dimapur district and from each district we selected 2 RDBs by simple random sampling without replacement (SRSWOR). The villages under the selected RDBs were the third stage sampling units. It was obvious that the village sizes were not same. As per 2001 census, there were total of 154 inhabitate villages in the selected RDBs of Kohima and Dimapur districts from which 23 (14.94%) villages were selected for investigation by probability proportional to size (PPS)(Lahiri Method). The households under the selected villages are the ultimate sampling units. Here, the household indicates the family living under the same roof and sharing the same kitchen. The households to be included in the sample for each village were selected by systematic sampling techniques so that the entire village can be covered and a representative sample can be obtained.

In our study, a sample of 1150 (550 from Kohima district and 600 from Dimapur district) households was considered from the selected 23 villages of Kohima and Dimapur districts. Data were collected from all the members of the selected households. For the purpose of collecting data from the respondents, a semi-structured schedule was prepared which was pre-tested by pilot survey in order to test the validity of the questions incorporated with regard to the objectives of the study. Altogether, we interviewed 5404 respondents from the total sampled households. It was a very difficult and challenging task to reach out the sampled households in the remote villages due to very bad road connectivity in the jungle hilly terrain.

The enquiry on morbidity or the prevalence of diseases was conducted with a reference period of 30 days. All spells of ailment suffered by any member of the sample household during the 30 days preceding the date of enquiry, whether or not the patient was hospitalised for treatment, were covered in the survey. A respondent was classified as afflicted by diseases if he/she reported to be ailing from any kind of disease within the reference period. The morbidity data collected in the survey were based on the respondents' own assessment of their medical status, rather than on medical examination. While collecting data, we checked their prescription if the respondents reported to have visited any doctor and noted down the symptoms accordingly. But, for those who reported to have afflicted by diseases and did not visit any doctor, for them only the symptoms of the disease were noted down. The identification of a particular disease was done in consultation with a government doctor of

Nagaland on the basis of the collected information regarding the diseases' symptoms and these diseases are coded in accordance with the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10-CA) (Canadian Institute for Health Information, 2012).

The independent factors that influences the prevalence of diseases in the rural areas of Nagaland were classified into three broad categories namely- Demographic, socio-economic and behavioural (Choudhury et al., 2009). Gender, age and marital status were included under demographic factors. Regarding socio-economic factors, we considered education, occupation, per capita income and fuel used for cooking. For the behavioural factors, we included habit of smoking, chewing tobacco and drinking alcohol. If a person had had the habit of smoking minimum 2/3 sticks of bidi or cigarettes, at least 3 times chew tobacco and drinks alcohol minimum once in a day then he or she was regarded as smoker, chewer and alcoholic. Moreover, additionally, we considered body mass index (BMI) as one of the independent factors to see the physiological effect on the prevalence of diseases. BMI was calculated as weight in kilograms divided by height in meters squared, rounded to zero decimal place based on the information supplied by the respondents regarding the height and weight of the individuals. We considered three categories of BMI namely- Underweight (BMI<18), Normal (BMI=18 to 25) and Overweight (BMI>25).

While data were disaggregated with respect to the occupation, we found that 825 persons had government jobs as occupation. Therefore, these 825 persons who had government jobs as occupation were considered for the purpose of analysing the morbidity prevalence among government employees in the rural areas of Nagaland.

Of the total interviewed respondents (i.e., 825 government employees including retired employees) only those respondents were considered for the final analysis of non-communicable diseases (NCDs) who attained 40 years or more on the date of interview. This censoring was necessary as very few cases of NCDs were reported under age 40 years (Table-2 and Figure-1). Therefore, for the analysis of prevalence of non-communicable diseases (NCDs) among the government employees in the rural areas of Nagaland, 346 government employees were discarded who didn't attain 40 years of age on the date of survey. Consequently, we carried out our analysis for NCDs with 479 employees of which 366 were males and 113 were females.

The prevalence rate of morbidity due to NCDs were determined by

$$Morbidity\ \Pr evalence\ Rate = \frac{No.\ of\ ailing\ persons\ due\ to\ NCDs}{Total\ population\ present\ in\ the\ sample} \times 1000$$

The data were quantified by preparing cross tables to see the existence of association between the independent characteristics and the prevalence of NCDs. The strength of association between each of the independent factors and dependent variable was examined by multiple logistic regression analysis as the dependent variable is dichotomous (i.e., presence or absence of morbidity prevalence) and the independent factors are categorical.

Let, Y denotes the dichotomous variable and $x_1, x_2, x_3, \ldots\ldots\ldots, x_n$ be a set of independent variables. Then the form of the logistic regression model is

$$\pi_x = \frac{1}{1+e^{-z}};$$

Where,

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots\ldots\ldots\ldots + \beta_k x_k$$

A transformation of π_x is the logit transformation which is defined in terms of π_x as

$$\therefore g(x) = \log_e[\frac{\pi_x}{1-\pi_x}] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots\ldots\ldots + \beta_k x_k$$

[Hosmer and Lemeshow, 1989]

Moreover, to see how the working hours might be affected due to some specific cause of morbidity, the mean length of morbidity (in years) per employee was calculated with the following formula:

$$Mean\ length\ of\ morbidity\ per\ Employee = \frac{No.\ of\ years\ suffered\ due\ to\ a\ disease}{Total\ no.\ of\ employees\ suffered\ by\ that\ disease}$$

Results and analysis

The overall morbidity prevalence rate was 21 percent of which the prevalence of non communicable diseases (NCDs) (133 out of 825 i.e., 16.1 percent) was found to be much more than that of communicable diseases (41 out of 825 i.e., 5.0 percent) among the employees in rural areas of Nagaland. The prevalence rate of NCDs was 25.3 percent and Communicable diseases was 4.4 percent in the reduced sample of 479 government employees who attained 40 years of age on the date of survey. The prevalence of non-communicable diseases was 56.99 percent among the rural adults of age 20 years and more in Nagaland in 2011 (Ahmed and Choudhury, 2014). The leading causes of communicable diseases were tuberculosis (A-15-A19) (15 per 1000 employees) followed by respiratory infections (B15-B19) (10 per 1000 employees). Several studies have revealed a strong association between tobacco smoking and tuberculosis with the disease being more common among smokers than non-smokers (Kolappan and Gopi, 2002; Maurya et al., 2002). Smoking increases the risk of morbidity due to tuberculosis and other respiratory diseases (Lin et al., 2007; De Boon et al., 2005). Smoking, which increases the incidence of clinical tuberculosis, is a cause of half the male tuberculosis in India, and a quarter of all male deaths in middle age i.e., 25-69 years (Gajalakshmi et al., 2003).

On the other hand, the leading causes of NCDs were Cardiovascular Diseases (I00-I99) (52 per 1000 employees) followed by Diabetes mellitus (41 per 1000 employees), Cancer (15 per 1000 employees), diseases of digestive system (15 per 1000 employees) and diseases of liver (10 per 1000 employees). Behavioural risk factors such as tobacco use, alcohol consumption, low consumption of fruit and vegetables and a lack of physical activity lead to the intermediate risk factors such as obesity, hypertension, raised blood glucose and cholesterol levels, and contribute to cardiovascular diseases, cancer and diabetes (Basu et al., 2013; Carrao et al., 2004; Doll et al., 1994; Thun et al., 1995; World Health Organization, 2002; Murthy and Mathew, 2004).

The higher prevalence of NCDs compared to communicable diseases suggests a detail analysis of the factors responsible for the prevalence of non communicable diseases (NCDs) among the government employees in rural areas of Nagaland.

As mentioned earlier, we have used the multiple logistic regression analysis technique to test the significance of association between the multi-category independent characteristics and the dichotomous dependent variable. In order to check the appropriateness of the fitted model, we have generated the predicted outcomes, and compared them with the observed or actual values. Frequencies for actual and predicted outcomes, derived from logistic regression analysis are presented in Table-3. The overall correct percentage of 75.6% is quite satisfactory. The cut off value for determining the predicted outcome has been arrived at using the procedure outlined by Crammer (1999).

The results of multiple logistic regression analysis with the reduced sample of censored data have been tabulated in Table-4. From this table, it is found that the differentials in the factors like age, body mass index (BMI) and habit of smoking had significant effect on the prevalence of morbidity due to NCDs among the employees aged 40 years and more.

It is observed that the age of the employees was significantly associated with non communicable diseases. In reference to the old retired employees (60 years and above), the employees in the age group 40-49 years were 60 percent less likely (OR=0.40; 95% CI=0.22-0.71) and the employees in the age group 50-59 years were 50 percent less likely (OR=0.49; 95% CI= 0.28-0.85) to suffer from NCDs. The findings were similar to those of Gupta et al. 1995; Kumar et al. 1995 and Momin et al. 2012. They reported an increase in the prevalence of coronary heart disease (CHD) and hypertension with the increase in age.

To examine the physiological effect on NCDs, we calculated body mass index (BMI) of the government employees in Nagaland. BMI was calculated as weight in kilograms

divided by height in meters squared, rounded to zero decimal place based on the information supplied by the respondents regarding the height and weight of the individuals. The BMI was found to be significantly associated with NCDs among the government employees in Nagaland. The employees with normal weight had almost 40 percent less chances (OR=0.57; 95% CI=0.35-0.93) of suffering from NCDs compared to overweight employees. Overweight leads to obesity which increases the risk of a number of health conditions including hypertensions, adverse lipid concentrations, and type-2 diabetes (National Institute for Health, 1998).

We also examined the association of behavioural characteristics such as habit of smoking, and drinking alcohol with morbidity due to non-communicable diseases (NCDs). An employee was regarded as smoker and alcoholic if he had had the habit of smoking minimum 2/3 sticks of bidi or cigarettes and drinks alcohol minimum once in a day. The employees having smoking habit had almost double risks (OR=1.87; 95% CI=1.04-3.37) of suffering from NCDs compared to those employees who had not have the smoking habit. The smoking habit has significant hazardous impact on the health of a person. Many previous studies at the national as well as international level indicated the hazardous impact of smoking (Jha et al. 2008; Gajalakshmi et al, 2003; Doll et al. 2004; IDSP, 2007-08).

The characteristics such as gender, level of education, marital status, fuel used for cooking, sanitation facility, drinking alcohol and chewing tobacco had weak association with prevalence of non-communicable diseases among the government employees of Nagaland.

We have also obtained the mean length of morbidity in terms of years which represents the average number of years an employee of age 40 years and above was living with disease. The result is shown in Table-5. It is clear from this table that the mean length of morbidity due to cardiovascular diseases was highest (7.3 years) followed by respiratory diseases (5.8 years), diseases of liver (5.3 years). The long time prevalence of some diseases among the older population is possible because of the advancement in medical science and its application. Crimmins (2004) observed that the prevalence of most diseases has increased in the older population as people survive longer with disease. From Table-5, it is seen that the least mean length of morbidity was due to renal diseases (2.3 years) and cancer (2.5 years) was the second from the last. Although the mean length of morbidity due to cancer was low, yet it is very significant in the sense that there is every possibility of loss of working hours by absenteeism due to cancer and also an economic burden in terms of cost of treatment. A recent study conducted by the American Cancer Society estimated the cost of disability adjusted life years (DALYs) due to cancer worldwide in 2008 at US$ 895 billion (John and Ross, 2010). Of course, it does not include direct medical cost, suggesting that it provides a lower bound estimate of the true economic burden.

Here, the scope of further researches are there to find the actual loss of working hours by absenteeism i.e., how many days an employee was absent from his work due to the ailment of specific diseases may be ascertained. Moreover, the economic burden due to morbidity can also be assessed in terms of cost of treatment.

Drawbacks

A small set of 825 government employees was taken as a sample to be representative of the government employees in the rural areas of the entire state. The data set was further reduced to 479 government employees who attained 40 years of age for the final analysis of morbidity due to non communicable diseases (NCDs). The strength of association between multi-category independent variables and dichotomous dependent variable of this small sample of 479 government employees was analysed using multiple logistic regression analysis. It is known that the results of logistic regression analysis are sensitive to sample size, more significant results tending to occur with larger sample sizes.

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Table-1: Disease Specific Morbidity Prevalence among Government Employees (including Retired Employees) in rural Nagaland in 2011:

Communicable Diseases		
Disease Type	**n=825**	**n=1000**
Tuberculosis(A15-A19)	12	15
Hepatitis (B15-B19)	3	3
Malaria (B50-54)	7	9
Respiratory Infections (J00-J22)	8	10
Diarrhoea & Dysentery (A06-A09)	7	9
Measles & Pox (B01-B05)	1	1
Typhoid (A01)	2	2
Eye Infection (H00-H59)	1	1
Sub-Total (1)	**41**	**50**
Non-Communicable Diseases		
Disease Type	**n=825**	**n=1000**
Diseases of Respiratory System (J30-J99)	9	11
Cardiovascular Diseases (I00-I99)	43	52
Diabetes Mellitus (E10-E14)	34	41
Diseases of Liver (K70-K77)	8	10
Cancer (C00-C96)	12	15
Arthritis (M00-M99)	5	6
Renal Disease (N17-N29)	4	5
Dental Problems (K00-K08)	6	7
Diseases of digestive System (K20-K38)	12	15
Sub-Total (2)	**133**	**161**
Overall	**174**	**210**

Figure-1: Proportion of Government Employees (including Retired Employees) suffering from NCDs in rural Nagaland in 2011:

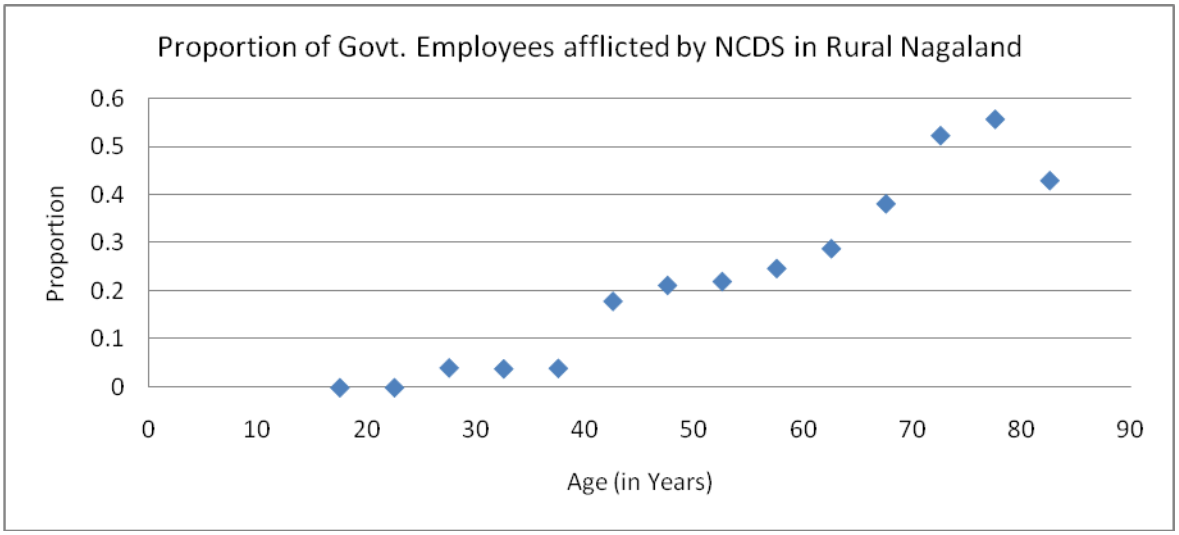

Table-2: Proportion of Government Employees (including Retired Employees) suffering from NCDs in rural Nagaland in 2011:

Age (in Years)	Proportion of Employees afflicted by NCDs
15-19	0
20-24	0
25-29	0.041
30-34	0.039
35-39	0.04
40-44	0.179
45-49	0.212
50-54	0.22
55-59	0.247
60-64	0.288
65-69	0.381
70-74	0.522
75-79	0.556
80 and more	0.429

Table-3: Classification Table for Logistic Regression Analysis for the prevalence of NCDs among the Government Employees (including Retired Employees) in rural Nagaland in 2011:

Observed		Predicted		Percentage Correct
		Prevalence of NCDs		
		absence	presence	
Prevalence of NCDs	absence	347	11	96.9
	presence	106	15	12.4
Overall Correct Percentage				75.6

The cut Value is 0.500

Table-4: Associations of Demographic, Socio-economic and Behavioural factors with morbidity due to NCDs among Government Employees (including Retired Employees) in rural Nagaland in 2011:

Independent Factors	Sample Size (n)	Prevalence Percentage	Significance Probability (P)	Odds Ratio	95% C.I. for Odds Ratio	
Age (in Years)						
40-49	194	19.6	0.002*	0.397	0.221	0.714
50-59	173	23.1	0.012*	0.485	0.275	0.854
60 & more	112	38.4	Ref.			
Gender						
Male	366	24.9	0.557	0.829	0.443	1.551
Female	113	26.5	Ref.			
Marital Status						
Never Married	11	27.3	0.378	1.913	0.453	8.080
S/W/Divorced	54	38.9	0.134	1.734	0.844	3.565
Currently Married	414	23.4	Ref.			
Level of Education						
Primary	103	35.0	0.239	1.468	0.775	2.781
Secondary	258	22.1	0.740	0.911	0.524	1.582
College	118	23.7	Ref.			
BMI						
Underweight	12	16.7	0.181	0.327	0.064	1.684
Normal	339	23.0	0.023*	0.572	0.354	0.925
Overweight	128	32.0	Ref.			
Fuel used for Cooking						
LPG	295	22.0	0.342	0.789	0.484	1.286
Wood	184	30.4	Ref.			
Sanitation Facility						
Flush Toilet	388	22.9	0.163	0.662	0.371	1.182
Pit toilet	91	35.2	Ref.			
Habit of Smoking						
Yes	94	35.1	0.038*	1.868	1.037	3.366
No	385	22.9	Ref.			
Drinking Alcohol						
Yes	94	29.8	0.727	0.894	0.477	1.677
No	385	24.2	Ref.			
Chew Tobacco						
Yes	190	29.5	0.129	1.488	0.891	2.483
No	289	22.5	Ref.			

Table-5: Mean length of Morbidity for those Employees who attained 40 years of age or more:

Name of Disease	Mean length of morbidity (in years)
Cardiovascular Disease	7.3
Respiratory Disease	5.8
Liver Disease	5.3
Diabetes	4.2
Cancer	2.5
Renal Disease	2.3
Others	5.0
Total	5.3

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PART OF SPEECH TAGGING IN NEPALI LANGUAGE USING HYBRID APPROACH

Prajadhip Sinha
Department of Computer Science, Kohima Science College (Autonomous)
Jotsoma- 797002, Nagaland
e-mail: prajadhip@rediffmail.com

Abstract: Part-of-speech (POS) tagging is the process of marking up the words in a text (corpus) as corresponding to a particular part of speech based on both its definition, as well as its context. In this paper, we have proposed a Hybrid approach using Hidden Markov Model (HMM) integrated with Rule-Based method towards POS tagging and achieved the accuracy of 93.15%.

Keywords: NLP, Tagging, HMM, Chunking, Ambiguity, Parsing, POST, Corpus, Rule-based, Statistical approach, Tagger

Introduction

Part of Speech (POS) tagging is the essential basis of Natural Language Processing (NLP). It is the process in which each word is assigned to a corresponding POS tag that describes how this word is used in a sentence. The development of an automatic POS tagger requires either a comprehensive set of linguistically motivated rules or a large annotated corpus (Dandapat, 2009). But such rules and corpora have been developed for a few languages like English and some other languages. POS taggers for Indian languages are not readily available due to lack of such rules and large annotated corpora and moderate accuracy can only be achieved in rule based techniques. To overcome these problems, we propose Nepali Part-Of-Speech Tagging method based on hybrid approach which combines the rule-based approach with a statistical approach that relies on the Nepali sentence structure improving the POS Tagging.

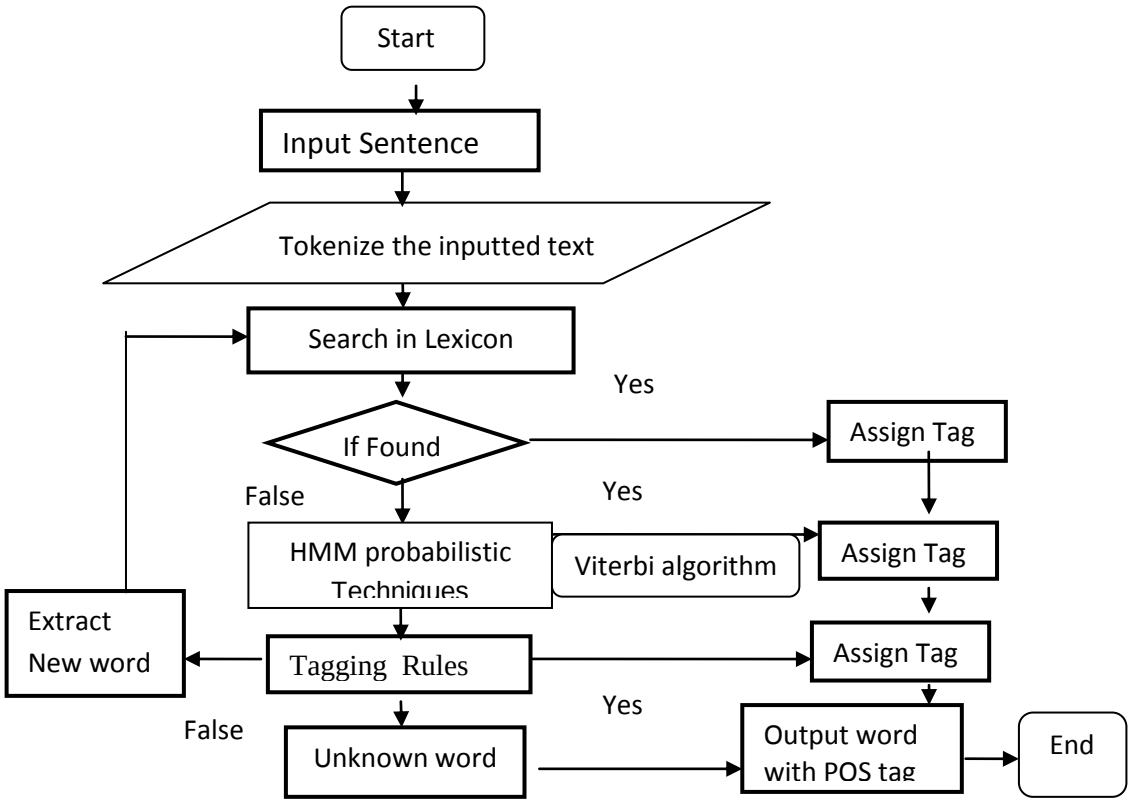
Nepali is an Indo-Aryan language spoken in Nepal, Bhutan, and some parts of India and Myanmar (en.wikipedia.org/wiki/Nepali_language). It is the national language of Nepal and also one of 23 Official languages of India incorporated in 8th annex of the Indian Constitution.

Objectives

POS tagging is useful in speech generation, speech recognition, parsing, machine translation, information retrieval, information extraction, WSD (word sense disambiguation), question-answering, etc. Manual tagging, though more accurate, is a time-consuming, long and continuous process. Hence, the automatic tagger is essential to speed up the process of POS tagging with less chance of errors and inconsistencies. The main objective of this study is to design and develop a POS tagger in Nepali text and also study and develop the tag set in Nepali language.

Methodology

The proposed POS tagging is implemented by undergoing several distinct steps. Given below is the flow diagram and its related explanation:



Proposed System Design of Nepali POS Tagger

1. *Tokenizer:* Tokenization is the first step in part of speech tagging of any natural language. It segregates words, punctuation marks and symbols of an input text, and subsequently assigns them into tokens by creating whitespaces between them.
2. *Lexicon:* In this step, a lexicon of word list in Nepali language is defined. This lexicon includes all categories of POS tagging viz., prepositions, adverbs, conjunctions, interrogative particles, etc. Initially a tagged lexicon is developed manually by collecting limited words from Nepali newspapers, books and dictionaries. All the words in the input text have to pass through this phase. If a word is found in the lexicon, then the entered word itself will be assigned with an appropriate tag. Else, it passes to the next step (HMM probabilistic Techniques).
3. *Hidden Markov Model (HMM) probabilistic Techniques:* A HMM[5] is Statistical Model which can be used to generate tag sequences. Basic idea of HMM is to determine the most likely tag sequences (Singh et al). For this purpose we have to calculate Transition probability. Transition probability shows the probability of travelling between two tags i.e. forward tag and backward tags. The Transition probability is generally estimated based on previous tags and future tags with the sequence provided as an input. The following equation (6) explains this idea-

   P (ti/wi) = P (ti/ti-1). P (ti+1/ti). P (wi/ti)..... (6)

   P (ti/ti-1) is the probability of current tag given previous tag &P (ti+1/ti) is the probability of future tag given current tag.

P (wi/ti) Probability of word given current tag
It is calculated as- P (wi/ti) = freq (ti, wi)/ freq (ti)…..... (7)

This is done because we know that it is more likely for some tags to precede the other tags. In HMM we consider the context of tags with respect to the current tag. It assigns the best tag to a word by calculating the forward and backward probabilities of tags along with the sequence provided as an input. Powerful feature of HMM is context description which can decide the tag for a word by looking at the tag of the previous word and the tag of the future word.

4. *Rule based tagging*: Almost all the words are recognized by the previous two phases. However, some disambiguated words require to be further analyzed, which can be resolved with the help of Rule based tagging.

Result

In order to measure the performance of the system, we use tag set consisting of 43 grammatical tags (Bal et al) and create corpus with different number of words collecting from Nepali Newspaper and other sources. Initially, a very limited lexicon was present in POS tagger and its accuracy was low. However, when more text is tagged and manual corrections are done for those words that are new words to lexicon, the lexicon will grow After some time, the accuracy level will also be increased. All these are summarized in the Table 1.

Precision or accuracy of the POS tagging is calculated using the following equation:

$$\text{Precision (P)} = \frac{\text{No of correct POS tags assigned by the system}}{\text{No of POS tags assigned by the system}}$$

The present lexicon size is approximately 15500. As such the computation of accuracy of the system is based on the results derived in experiment set 3; the values ranging from 92.2 to 94.2. Thus the POS tagging of the Nepali language through hybrid approach is yielding an accuracy of 93.15%.

Input text

छ वर्ष सम्म टि .मार्शल हान जुनियर ले भद्र र शान्त जर्ज बुस शैली मा निगम अभिग्रहण गरे । अब को प्रश्न : उहाँ कठोर रूप मा काम गर्ने टेडी रुजेवेल्ट ले जस्तो काम गर्न सक्नुहुन्छ ? जर्जिया-प्यासिफिक कर्पोरेसनका अध्यक्ष तथा मुख्य कार्यकारी अधिकृत ६२ वर्षीय श्री हानले ग्रेट नर्दन नेकुसा कर्पोरेसन को लागि वन्य-उत्पादन विषय को ३.१९ विलियन डलरको अप्रार्थित बोलपत्र हेरिरहनु भएको छ ।

Output

छ/CD वर्ष/NN सम्म/POP टि/.FB मार्शल/NNP हान/NNP जुनियर/NNP ले/PLE भद्र/JJ र/CC शान्त/JJ र्ज/NNP बुस/NNP शैली/NN मा/POP निगम/NN अभिग्रहण/NN गरे/VBO अब/RBO को/PKO प्रश्न/NN :/YM उहाँ/PP कठोर/JJ रूप/NN मा/POP काम/NN गर्ने/VBNE टेडी/NNP रुजेवेल्ट/NNP ले/PLE जस्तो/JJM काम/NN गर्न/VBI सक्नुहुन्/VBF ?/YF जर्जिया/NNP प्यासिफिक/NNP कर्पोरेसनका/NN

Experiment set-1 5000(Tokens)			
Exp	**Total words**	**Correctly tagged**	**Accuracy**
1	1000	506	50.6
2	1500	755	50.333
3	2000	997	49.85
4	2500	1269	50.76
5	3000	1538	51.26
6	3500	1829	52.25
7	4000	2210	55.25
8	4500	2512	55.82
9	5000	2903	58.06

Experiment set-2 10000(Tokens)			
Exp	**Total words**	**Correctly tagged**	**Accuracy**
1	1000	682	68.2
2	1500	1036	69.066
3	2000	1420	71
4	2500	1708	68.32
5	3000	2078	69.266
6	3500	2445	69.85
7	4000	2734	68.35
8	4500	3151	70.022
9	5000	3523	70.46

Experiment set-3 15000(Tokens)			
Exp	**Total words**	**Correctly tagged**	**Accuracy**
1	1000	922	92.2
2	1500	1392	92.8
3	2000	1837	91.85
4	2500	2301	92.04
5	3000	2803	93.43
6	3500	3275	93.57
7	4000	3790	94.75
8	4500	4211	93.57
9	5000	4706	94.12

Table: 1

अध्यक्ष/NN तथा/CC मुख्य/JJ कार्यकारी/JJ अधिकृत/NN ६२/CD वर्षीय/JJ श्री/NN हानले/NN ग्रेट/NNP नर्दन/NNP नेकुसा/NNP कर्पोरेसन/NN को/PKO लागि/POP वन्य/NN उत्पादन/NN विषय/NN को/PKO ३/१९.CD विलियन/CD डलरको/NN अप्रार्थित/JJ बोलपत्र/NN हेरिरहनु/VBI भएको/VBKO छ/CD ,/YM नेकुसाले/NN प्रस्तावलाई/NN सार्वजनिक/JJ उदासिन/JJ व्यवहार/NN गरेको/VBKO छ/VBF।/YM

Graphical user interface tool

The researcher has highlighted his work in Nepali POS tagging on the website created by him www.researchnlp.com.A Graphical User Interface tool named "POSTIM" has been developed by using PHP.

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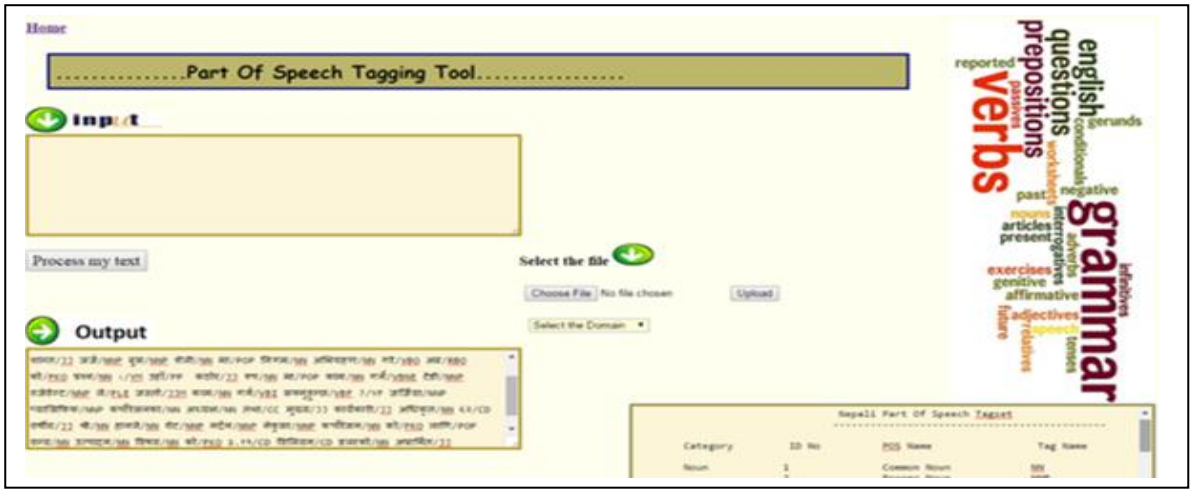

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RAIN DROP SIZE DISTRIBUTION AND ITS APPLICATIONS IN RAIN RETRIEVAL FROM RADAR REFLECTIVITY MEASUREMENTS: A SHORT NOTE

*Meripeni Ezung, Partha Roy and Sanjay Sharma
Department of Physics, Kohima Science College (Autonomous)
Jotsoma-797002, Nagaland, India
*e-mail: m_ezung@yahoo.com

Abstract: Rain drop size distribution is studied by using the measurements from Joss Waldvogel Disdrometer (JWD) and its results are utilized to develop a power law Z-R relation for rain intensity(R) estimation from radar reflectivity (Z) observations. The JWD is located at National Atmospheric Research Laboratory (NARL), Gadanki (13.8˚N, 79.18˚E), Tirupati, India. Rain drop spectra are fitted with the exponential and gamma distribution model.

Keywords: Joss Waldvogel Disdrometer, Rain drop size distribution (RDSD), Radar Reflectivity factor (Z), Exponential DSD, Gamma DSD, Lognormal DSD.

Introduction

Rain drop size distributions (RDSD) is an important parameter in many areas like radiowave communication at higher frequency, satellite meteorology, cloud physics and rainfall measurements by remote sensing techniques. For rainfall measurements, many ground based instruments like disdrometer, rain gauge and weather radars are used. With the importance of rainfall measurements by remote sensing technique, RDSD has become an important parameter to be studied. Accurate rain rate estimation requires detailed knowledge of RDSD. Using the JWD, many researchers have studied the rain RDSD and its characteristic. The study of rain DSD has a long history (Wiesner, 1895; Marshall and Palmer. 1948; Atlas and Chmela, 1957; Joss and Waldvogel, *1967;* Ulbrich, 1983; Feingold and Levin, 1986; Zawadzki and Antonio,1988; Hu and Srivastava, 1995; Sauvageot and Lacaux, (1995), Huggel et al., 1996; Tokay and Short 1996; Atlas et al., 1999, Maki et al., 2001; Testud et al., 2001; Atlas and Williams, 2003; Biringi et al., 2003; Uijlenhoet, 2003; Atlas and Ulbrich, 2006; Konwar et al., 2006; Ulbrich and Atlas, 2007; Sharma et al. , 2008).

Modelling of RDSD is a primary requirement for various applications in remote sensing of the precipitating systems. Significant variability in the characterstics of RDSD is reported world wide (Fujiwara, 1965; Cataneo and Stout, 1968; Battan 1973; Wladvodgel, 1974; Carbone and Nelson, 1978; Austin, 1987; Tokay and Short, 1996; Cifelli et al., 2000; Steiner and Smith, 2000; Maki et al., 2001; Rao et al., 2001; Bringi et al., 2003) implying highly variable Z-R relationship. Elaborate microphysical aspects of the coefficients and exponents of Z-R power law relations are reviewed by Steiner et al. (2004). Though significant work has been carried out on RDSD over the midlatitude region, but over the tropical region the study on RDSD is limited. In the present work an attempt is made to understand the RDSD at a tropical station at NARL, Gadanki India. The present work is organized in the following five sections. The description of various RDSD models are provided in section 2. The working principal of JWD is described in section 3. The results and conclusions are provided in section 4 and 5 respectively.

Rain drop size distribution models and rain integral parameters

Three different RDSD models are commonly used by researchers to study the characteristics of the rain drop size spectra. These models are exponential, gamma and lognormal. The description of each model is provided in the following sub section.

Exponential RDSD

The functional form of exponential RDSD is given by the following expression (Marshall and Pamer 1948)

$$N(D) = N_0 \exp(-\Lambda D) \quad (1)$$

Where N(D) (m^{-3} mm^{-1}) is the number of raindrops per unit volume per unit interval of drop diameter ΔD (mm), D (mm) is the drop diameter, N_0 and Λ (mm^{-1}) are the intercept parameter and the slope parameter of the spectra respectively. In this distribution, Marshall and Palmer suggested a fixed value for $N_0 = 8 \times 10^3 (mm^{-1}m^{-3})$ and $\Lambda = 4.1\ R^{-0.21}$ where R the rainfall intensity in mm h^{-1}.

Gamma RDSD

The functional form of gamma RDSD is given by the following expression (Ulbrich 1983)

$$N(D) = N_0 D^{\mu} \exp(-\Lambda D) \quad (2)$$

where N_0 (m^{-3} mm^{-1}) is the intercept parameter, μ (mm^{-1}) is the shape parameter and Λ is the slope parameter.
The relationship between Λ and μ for this distribution is given by;

$$\Lambda = (\mu + 4)/D_m$$

$$\text{Where } \mu = (11G - 8) + [G(G + 8)]^{1/2} / 2(1 - G)$$

$$\text{with } G = M_4^3/M_3^2 M_6 ,$$

and $M_n = \sum N(D) D^n \Delta D_i$ is the n^{th} moment of the RDSD spectra.

lognormal RDSD

The functional form of the log normal RDSD is provided by the following expression (Feingold and Levin, 1986)

$$N(D) = [N_t/(2\pi)^{0.5} (Ln\sigma)D] * \exp[-Ln^2(D/D_g)/2Ln^2\sigma] \quad (3)$$

where N_t (m^{-3}) is the total number of drops, D_g (mm) is the geometric mean of the drop diameter and σ is the standard geometrical deviation of the drop diameter.

Rain Integral parameters as estimated by RDSD

Using the JWD observations, the radar reflectivity factor (Z) and rain intensity (R) are measured and the relation between them are fitted.

The sixth moment of the RDSD gives the reflectivity factor Z ($m^{-3}mm^{-6}$), given by the relation,

$$Z = (1/AT)(\sum (n_i/V(D_i))D_i^6) \quad (4)$$

And the third moment of the RDSD gives the rainfall intensity R (mm h^{-1}), given by the relation,

$$R = (\pi/6)(3.6/10^3)(1/A*T) \sum (n_i D^3) \quad (5)$$

Where A = 0.005 m^2, is the area for collecting raindrops of the Disdrometer, T is the integration time, n_i and D_i are the number of drops and the mean drop diameter of the i^{th} channel of the Disdrometer respectively.

Using the Z and R values, we establish the power law relation given by, $Z = aR^b$, where a and b are the model parameters. For our present study, we have used the exponential and the gamma model for analysing the RDSD and we established the Z-R relation for improvement of the rainfall retrieval.

Description of JWD

The JWD is an instrument used for determining the size, in terms of the equivalent diameter of the raindrops and the integral rain parameters continuously and automatically. Manufactured by Distromet Ltd. of Switzerland, this device was originally developed by Joss and Waldvogel (1967). The JWD is one of the most used instruments for analyzing the RDSD. The instrument transforms the vertical samples of an impacting raindrop into an electric pulse whose amplitude is a function of the drop diameter and gives statistically meaningful samples of raindrops. The arrangement consists of a Disdrometer RD-80 and a PC. The Disdrometer RD-80 consists of 2 units, the processor and the sensor as shown in figure 1. A cable of length 20 metre long is used to connect the sensor and the processor.

Fig 1: The distrometer processor and the sensor

The processor has three main functions:

1. It supplies power to the sensor,
2. It processes the signal from the sensor and
3. It contains circuits for testing the performance of the instrument.

The processor contains circuits to eliminate unwanted signals, mainly the ones occuring due to acoustic noise. It is connected to a PC, which receives the datas through a program. The JWD RD-80 measures the size distribution of raindrops falling on the sensitive surface of the sensor. The range of drop diameters that can be measured ranges from 0.3 mm to 5 mm. The sensor is exposed to the raindrops to be measured. It produces an electric pulse for every drop hitting it. In the processor RD-80, these pulses are divided into 127 classes of drop diameter and for every drop hitting he sensor, a seven bit ASC11 code is transmitted to the serial interface of the PC. A computer program, which is delivered with the Disdrometer system, can be used to put the data in a suitable format for recording in a file. To reduce the amount of data and to get statistically meaningful samples, the 127 drop size channels are combined into 20 drop size classes. The output data from the Disdrometer is connected directly to the PC and the data cable from the Disdrometer is logged every minute to the PC. An in-build programme in the Disdrometer enables the users of the RD-80 Disdrometer to record and evaluate the drop size measurements with the PC.

Results

The RDSDs are studied by fitting the rain drop spectra with exponential and gamma distribution within the range of rainfall intensity from 1 to 10 mmh^{-1}. Within this rainfall intensity range, the average spectrum is obtained by averaging 12 spectra. The exponential and gamma RDSD model parameters are calculated from the moment method as described in section 2. The model parameters for this rainfall intensity range are given in Table 1.

Table 1: Model parameters for two RDSD models

Rain rate	Exponential distribution		Gamma distribution		
R (mmh^{-1})	N_0 ($m^{-3}mm^{-1}$)	Λ (mm^{-1})	N_0 ($mm^{-1-\mu}m^{-3}$)	μ (mm^{-1})	Λ (mm^{-1})
4.12	1519.89	2.21	1838.16	0.53	2.46

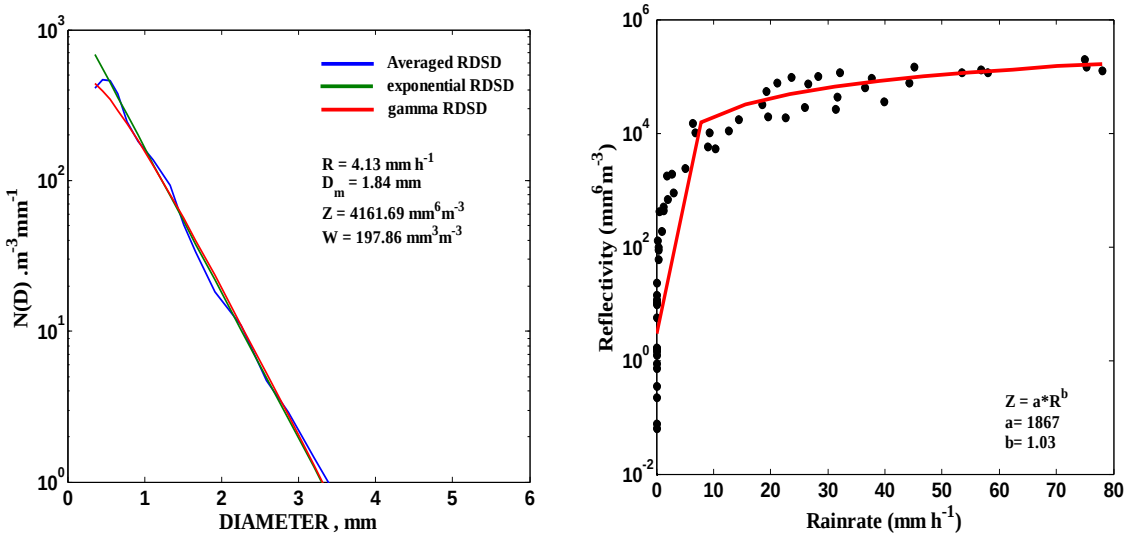

Figure 2: (a) Plot of N(D) Vs Diameter for R = 4.13 mmh^{-1} and (b) Plot of R Vs Z

Figure 2(a) shows that for this rain rate range, the exponential and gamma models are showing good fit to the observed RDSD. Within the observed 12 spectra, the values obtained for R and Z are 4.13 mmh^{-1} and 4161.69 mm^6m^{-3} respectively. Using the power law, the relationship between Z and R is developed with the fitting parameters given by a = 1867 and b = 1.03.

Conclusion and discussion

The results show that the exponential and gamma distributions are good fit within the low rain rate range (1 to 10 mmh^{-1}). The developed Z-R relation can be used to estimate and evaluate the rain intensity. In future, we will study the fit for the three models (including lognormal) for larger period of time and higher rain rate range and also find the Z-R relation for different types of rainfall event.

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