

Traditional Ecological Knowledge System as Climate Change Adaptation Strategies for Mountain Community of Tangkhul Tribe in Northeast India

Tuisem Shimrah

Abstract—One general agreement on climate change is that its causes may be local but the effects are global. Indigenous people are subscribed to “low-carbon” traditional ways of life and as such they have contributed little to causes of climate change. On the contrary they are the most adversely affected by climate change due to their dependence on surrounding rich biological wealth as a source of their livelihood, health care, entertainment and cultural activities. This paper deals with the results of the investigation of various adaptation strategies adopted to combat climate change by traditional community. The result shows effective ways of application of traditional knowledge and wisdom applied by Tangkhul traditional community at local and community level in remote areas in Northeast India. Four adaptation measures are being presented in this paper.

Keywords—Climate change, adaptation, Tangkhul, traditional community, policy, Northeast India.

I. INTRODUCTION

INDIGENOUS people can be identified by their inextricably linked livelihoods with nature. They usually settle predominantly at environmentally fragile and ecological margins such as mountains, islands and coastal areas. The natural surroundings from where they depend for their livelihoods have been put under various threats due to habitat destruction for infrastructural development and urbanization. Such activities have adversely affected on their natural ecosystems often leading to depletion of vast natural resources. As a result, livelihoods of millions of traditional people on the earth are now subjected to tremendous pressure such as food insecurity, water supply, health, and energy.

Over many decades and centuries, indigenous people have learnt to avert the effect of climate change through traditional knowledge system [1]. Traditional farmers often cope with climate change by way of selection of crop varieties and/or management practices such as selection of drought-tolerant local varieties, proper supply of water and planting of plant species which can enhance carbon sequestration, extensive planting of crops, mixed cropping, or agroforestry practices, opportunistic weeding, wild plant gathering and other traditional farming system and food production techniques [2]. Such practices ensure increase in productivity and conservation of native species.

Indigenous or traditional communities may be minority in

terms of human demography in the world but hold critical position in resource utilization as they comprise only 4% of the world's population (250 to 300 million people), but they utilize 22% of the world's land surface [3]. Interestingly, the portion of land they occupy is repository of majority of biodiversity. They are in control of 80% of the planet's biodiversity as they inhabit in areas of biodiversity rich natural landscape. 85% of the world's protected areas have the presence of traditional communities and as such their lands are huge repository of carbon stocks. Such resources are being managed sustainably through application of traditional knowledge inherited from their forefathers over a period of several thousand years. The contribution and responsibilities of such communities deserved to be understood, acknowledged and appreciated by scientific communities in the world. It is unfortunate, however, that quite often the policy makers disregarded and undermined traditional communities as indicated by omission of traditional knowledge system in the policy framework. One of the most visible indications of absence of traditional communities' role in decision making is the lack of references and documents in the field of climate change discourse. Although the role of indigenous knowledge in conservation of biodiversity has been recognized by scientific communities and policy-makers [4], there is still lack of involvement of these communities in mitigation and adaptation of climate change [5].

The traditional knowledge system offers immense scope for promoting the cause of sustainable development of the landscape [6]. Studies done in Australia have suggested that Australia's indigenous communities are especially vulnerable to the impacts of climate change; in particular, climate models indicate that sea level rise and storm surges will affect Australian indigenous coastal communities [7]. Emergent research also indicates that Aboriginal and Torres Strait Islanders who depend on bush or sea food for their livelihoods (both subsistence and market-based) are particularly at risk to future climate changes [8]. Thus, the manner in which indigenous communities responding to climate change is occupying an increasingly prominent space in discussion amongst policy makers [9]-[11].

II. STUDY SITE

Tangkhul community is listed as one of the scheduled tribes of India. They inhabit in Ukhrul District (24° N – 25°41' N and 94° E – 94°47' E) in Manipur state of Northeast India and are basically traditional in their approach and indigenous in

their history. Although small in geographical area, these mountain ranges occupy a strategically significant place in the ecological point of view; being a confluence of two biodiversity hotspots of the world, i.e., Himalayas in the west and Indo-Burma hotspots in the south. This area is the threshold of both these hotspots with presence of endemics flora and fauna. Many species have become rare, threatened and some are on the verge of extinction. With more than two hundred ethnic villages, each having its own independent customary rules and practices, village governances, etc., the degree of pressure on land and its resources are also different. Moreover, in order to meet increasing demands of population (Table I), people resorted to more and more expansion of agricultural fields in forest areas leading to rapid change of land use/cover change. Such competition leads to activities related to rapid clearing of forest; the ultimate result being release of carbon dioxide in the atmosphere.

The agroecosystem practiced by Tangkhul traditional community can be broadly classified into two distinct types, viz., (i) wet paddy fields (settled farming practiced) in the riverside and terraced slopes (Tangkhul; *Ngayailui*) and (ii) shifting agriculture (Tangkhul; *Ahanglui*) practiced on the hill slopes. In the hills, agricultural operations are carried out up to a maximum elevation of 2500 m with 'slash and burn' method (in such areas like *Shirui*, *Lunghar*, *Mapum*, etc).

III. METHOD

Study was carried out by visiting different villages and holding participatory community workshop/meetings, followed by interview with local knowledgeable people as focused group. The analytical approach applied for this study was community-based vulnerability and capacity assessment (VCA) approach described by [12]. The finding from meetings and interview is confirmed by keen observations during the last two years.

TABLE I
 SOME OF THE ATTRIBUTES OF STUDY SITE

Features	Attributes
The Total Geographical Area (km ²)	4544
Population as per 2011 (2001) census	183,998 (140,778)
Climate type	Sub-Tropical Monsoon
Average annual temperature	30 ^o C max & 3 ^o C min
Soil	alluvium, lateritic black regur and red ferruginous
Location	24 ^o 28' - 25 ^o 41' N; 94 ^o 45' - 94 ^o 80' E
Density/km ² as per 2011 (2001) census	40 (31)
Proportion to population of Manipur (%) as per 2011 (2001) census	7.16 (6.14)

IV. RESULTS AND DISCUSSION

A. Some Indications of Climate Change in Ukhrul District

Most of the adult respondents (20 years old and above) in the survey (89.36%) reported that climate change is happening. They cited some examples, such as erratic weather conditions and rise in temperature causing substantial

reduction in crop production and prevalence of diseases which were unknown earlier. For example, the beans of *Parkia roxburghii* (English - tree bean), of the family Fabaceae, is one of the most important delicacies of Manipur. It was introduced to Ukhrul from warmer valley areas in Imphal in the last 15-20 years. The crop has not only tremendous economic value but also has equal cultural values too, e.g., 'Ningol Chakkouba' festival; (annual feast hosted by brother for sisters), cannot complete without a dish prepared with the beans of this tree. It was almost disappeared from Manipur in the last 3-5 years. Fortunately, it has found a new place/habitat in Ukhrul District [13].

Other observations pointing to impacts of climate change were reported by local community, e.g., large scale dying of dominant species such as pine [14] and Rhododendron at the higher altitude areas in the district. The similar phenomenon has been reported in another northeastern state, Sikkim [15] where climatic and topographical features are very much alike with that of Ukhrul. The prevalence of mosquitoes to the interiors of Ukhrul District is also another strong manifestation of environment change in this region. It is reported that the optimum temperature for mosquito and its larva ranges from 25 to 28 °C [16].

Similarly, prevalence of leeches, once known to survive in tropical climate, has been found in wild and agriculture areas in recent times. There are unconfirmed and unofficial reports from local communities regarding disappearance of some flora and fauna, and instead appearance of new species, some which are human introduced while others are natural migration from warmer regions. For example, *Lantana camera*, an invasive alien species (IAS) introduced from other parts of the world as an ornamental plant and also as fence material in home garden, due to its robust and thorny structure is now growing luxuriously in hill areas of Ukhrul.

B. Challenges

Today, traditional knowledge system is eroding fast throughout the world before its value is realized. One of the reasons, being that, this system is passed orally from one generation to another without proper documentation. With coming of Christianity compounded by modern formal education, younger generations place less importance to traditional ecological knowledge. Moreover, in pursuit of higher education as a result of enhanced inspiration and aspiration and to have better way of life, much of the traditional knowledge system has been neglected. This resulted into moving further away from land based activities and ultimately detaches from nature. Further, with limited avenues from land based activities as livelihood option, this disconnect becomes more wide leading to diminishing of the affection and attachment to nature. On the other hand with increasing population and availability of markets in elsewhere places, young generation move out from their parental places which further contributes to loss of traditional/indigenous knowledge in Tangkhul community.

C.Adaption Approaches by Tangkhul Community in Response to Climate Change

Visible four approaches are being adopted as an adaptation measure to counter climate change, namely; biological, institutional, technological, policy and ecosystem approaches to deal with climatic variability and shifts.

1. Biological Approach

Biological approach as a tool for adaption includes changes in terms of crop composition and combination, selection of crops and change in farming systems, and also selection of growing season and fields to suit in the changing climate. Presence/introduction/invasion of new species as a response to change in climate could be vigilantly observed in order to take timely protective action.

The new agricultural practice on the hill slope of other village; *Lunghar*, where peas and broad beans are grown after the harvest of maize, potatoes, cucurbits and beans, as a response to warmer climatic condition, finds to be very successful. The cultivation of pulses and beans which are otherwise known for their nitrogen fixing ability are grown in

slope agricultural fields so as to enhance fertility. Moreover, since most of the pulses and beans are grown as rabi crops, cropping of kharif crops during winter season better productivity. Besides, by cropping the field throughout the calendar year, agricultural fields remain under greeneries.

In some villages such as *Peh, Hoomi, Phungcham, Paorei, Parkiarox burghii*, a fast growing and economically useful tree such as tree beans (*Parkia roxburghii*), with its gestation period of 6-7 years, is extensively grown. Apart from its economic value, the robust structure of its body can sequester huge amount of carbon with minimum involvement of labour for its management. The climatic, edaphic and topographic conditions of Tangkhul inhabiting landscape are ideal for growing of such crops. The labour productivity of such agriculture is observed to be very high as compared to any other form of agriculture being practised by Tangkhul community at present. One tree of this crop can fetch somewhere in between Indian Ruppee 10000 to 30000 (US\$ 170 – 510) in a year within the field itself. Across the villages, there are few crops introduced and few are abandoned as an adaptive and mitigating measure to climate change (Table II).

TABLE II
 CROPS ABANDONED AND INTRODUCED AS A RESPONSE TO CLIMATE CHANGE

Crops abandoned	Reason/ explanation	Crops introduced	Reason/ explanation
<i>Coix lacryma-jobi</i> (Job's tear)	The crop was grown only for brewing for local beer which is not used for commercial purpose	<i>Parkia roxburghii</i> (Tree bean)	Economically lucrative, fast growing, earlier this crop was not suitable due cold climatic condition but due to warming climate it is growing luxuriously, great demand in the market as the growth in previously growing areas are reducing
<i>Setaria italic</i> (Finger millet)	It is not used as staple food, instead it used as snacks which is of no economic value	<i>Vigna angularis</i> (Azuki bean)	Economically lucrative, easy to grow in all kinds of season, earlier this crop was not suitable due cold climatic condition but due to warming climate it is growing luxuriously, great demand in the market
<i>Saccharum</i> sp. (Sugarcane)	This crop is used as snacks; not as food	<i>Viciafaba</i> (faba bean)	Economically lucrative, easy to grow in home garden at all seasons, earlier this crop was not suitable due cold climatic condition but due to warming climate it is growing luxuriously, great demand in the market
		<i>Cajanus cajan</i> (Pegion pea)	Economically lucrative, easy to grow in home garden, earlier this crop was not suitable due cold climatic condition but due to warming climate it is growing luxuriously, great demand in the market

2. Institutional Approach

The traditional institutions can be an effective strategy as an adaptive response to climate change and can be incorporated into former scientific knowledge in order to manage not only natural resources but also as an adaptive measure in the events such as natural calamities, crop failure due to change in climate, so as to bring about win-win situation for conservationists and traditional farmers. In the present situation, the traditional communities have both formal and informal institutions to govern natural resources. Efforts can be made to improvise adaptations at individual level as well as at community level.

(i) Formal Institutions

Each village is headed by its chief called 'Headman' whose position is hereditary and his council called as 'Hangva' consisting of 10-20 members who are proportionally representing from all clans.

In a village, two main categories of land exist; (i) community land which is the major portion of village land, and (ii) private land which is generally smaller in size and owned by individual households. Several subcategories of

land are identified and managed separately as land reserved for forestry, land for shifting agricultural fields, land for settled agriculture, land for grazing and land for other sedentary mode of agriculture. Within the community forest, there are several ranges out of which village council can identify certain sites/range where timber extraction is permitted for specific period of time in a year on a rotation basis. In no way vegetation in strategic areas such as rivers, streams and lakes are allowed to grow without any disturbance and as a result, such ecosystems remain intact.

In early 1990s, for various reasons, a new democratic institutional was set-up in many Tangkhul villages. Of many reasons, one among them is to govern and manage natural resources more effectively. For example, in Peh Village, the traditional Village Council (VC) system was bifurcated into two components; (i) traditional Headman's VC, headed by village 'Head' or 'Chief' who is hereditary and (ii) newly introduced Village Development Council (VDC) headed by the democratically elected 'Chairman'. Along with parallel existence of two village institutions, the powers and functions of both these institutions are distributed and well defined. The newly introduced VDC now has taken some of the powers and

functions of traditional Headman's VC for better management of natural resources. This new set-up is comprised of Chairman, Vice Chairman, Secretary and council members consisting of 10 – 15 who are clan representative after due election within respective clan.

(ii) *Informal Institution*

Within the village, there exist several informal institutions such as clan ('*Shang*'), locality ('*Tang*'), youth association, women association and religious groups (churches), with various functions. Responsibilities such as water harvesting, construction and management of water wells and plantation at the courtyard, construction of inter-village or agricultural footpath/road along with plantation activities, and maintenance of trees are some of the responsibilities of such institutions.

Recently introduced statutory body such as 'V-Narm-G' (Village Natural Resource Management Group) may not be indigenous in nature but it is traditional due to its concept originating from local communities. This type of institution greatly enhances conservation by way of mediating and interlinking between scientific knowledge and indigenous knowledge of conservation.

3. Technological Approach

Changes in the amount, timing, and intensity of rainfall are the primary concern of the traditional farmers across the area. Electricity in villages is virtually absent although state government claims that most of the villages are electrified. With limited options left, villagers resorted to unregulated extraction of fuel wood from the community forests leading to significant reduction in vegetation cover in the landscape.

To reduce extraction of fuel wood from woodland, residential houses are skillfully constructed so that there is effective or minimum use of fuel wood in the kitchen fireplace. Water harvesting from various sites such as rooftop, surface runoff and raindrops were developed. With minimum technology or no technology, farmers keep performing breeding and selection of hybrid crops continuously. Some clans and societies have developed innovative ideas in order to reduce fuel wood extraction. For example, *Kharay*; one of the clans of Peh village comprising 50 to 60 households has generated some funds in their own way and used it for, the purchase of Liquefied Petroleum Gas (LPG). Out of the interest earned during one year, some of the households (of about 4-5) are provided with LPG set through lottery system. Within 10-12 years, all of the households have got LPG connections. This idea has been replicated to other clans too. Thus, the pressure of extraction of wood from the forest has been greatly reduced.

4. Policy Approach

(i) *Regulation of Lands*

Within the village, land use was regulated and proper management policies were adopted and implemented for effective use. The management of forestland was spatial and temporal based on the health of the land use such that village

lands were divided and managed as land for agriculture, timber extraction, hunting activities, grazing and conservation. Selected areas such as site for spring water or hilltop of land were identified and maintained as 'set aside' and no activities were permitted within this land use. Activities such as hunting, fishing, grazing, extraction of timber were regulated so that no activity is allowed during breeding season.

(ii) *Ceiling of Agricultural Land-Holdings*

One of the defining characteristic features of traditional society is more or less equal measure of economic condition that is reflected in similar standard of living. With more and more exposure to modern way of life and accessible amenities, this concept does not hold true. The pace of human development and skills are not same anymore among individuals and communities. A few but clever members among the community become richer within the society, while the majority of the people become poorer, and as the time passes, the gap between the haves and have-nots widens. In order to avoid exploitation of forest lands and also concentration of village lands under few rich people, (thereby causing deprivation of all of land to poorer section of people), necessary preventive measures are being taken in few villages. There is mechanism of land ceiling, especially agricultural lands to a limit of three hectares for a family per year.

(iii) *Regulation of Movement of Forest and Non-Forest Products*

Much of the natural resources in the lands of Tangkhuls have been destroyed to the point of extinction and many are in the line of devastation and ruin. The villagers are of the view that unless strong and effective regulation of movement of forest and its product from village is introduced, the rich natural resources will be depleted soon. The use of non-timber forest products (NTFPs) within the village landscape can be attributed as a means of promoting sustainable rural development together with achieving the goal of environmental conservation [17].

5. Ecosystem Approach

(i) *Garden*

A typical Tangkhul residential construction is identified by two houses; one smaller as compared to other, and a home garden with varieties of crops. This home garden/orchard is recognized as an effective place for germplasm repository. Such traditional ecosystem hosts rich biodiversity. At the same time these are the sites where one can maintain greeneries throughout the year occupied with varieties of plants of vegetables, fruits, ornamentals. The traditional people have been maintaining this ecosystem from generations.

(ii) *Agroforestry*

Agroforestry has several advantages especially in agricultural areas in hill landscape where the wild woody plant serves as source of nitrogen and other organic manure for the crops and in turn the biomass of crop plants acts as manure for woody plants. Therefore, in such fragile hilly landscape, the practice of agroforestry is pertinent. Whereas the alder-based

agroforestry in shifting agriculture-dependent Angami community in Nagaland state are widely reported in literature [18], the traditional management of *Alnus nepalensis* and *Quircus* sp. in agricultural fields are not mentioned in literature. In fact, Tangkhul community has been effectively managing those plants which are economically important in their shifting agricultural areas.

(iii) *Landscape Conservation*

The local communities identified and maintained some strategic areas in their own way for generations. For example, *Shirui hill* the habitat of world famous endemic species *Lilium macklinae* is being conserved sustainably by tradition community of Shirui village. Similar case is with Khangkhui Cave; one of the tourist attractions is being protected by Khangkhui Village Youth. Moreover, those sites which have strategic ecosystem services are not be disturbed; rather promoted to remain intact. For example, vegetation in some sites such as hill top, streamside or spring side, riverside and field edges are not cut so that the water table is remain intact.

In response to climate change and livelihood of traditional community, the Peh village is contemplating implementation of some policies and guidelines through Village Council Level (Table III).

TABLE III
 NEW INITIATIVES TAKEN UP BY PEH VILLAGE AS AN ADAPTATION MEASURE TO CLIMATE CHANGE

Policy	Explanation
Diversification of agricultural land use	To ensure minimum loss from the risk of unpredictable weather condition, as a result of global environment change, diversification of agricultural land use is found to sustainable strategy.
Land use classification and management in time and space	Classification of land as per local needs and convenience will make the governance of resources more effective, such as land for grazing, land for shifting agricultural areas, conservation areas, etc
Intensification of agricultural fields	Maximize time and crops in limited space. That will check destruction of natural habitat for agriculture purpose
One village - one product	Out of so many crops cultivated in a village, identify the best one or two crops in terms of its viability on physical, climatic and biological factors and specialize on production of that crop in larger scale in terms of its quantity, quality and technology.
Regulation of movement of forest and non-forest products	In order to check free flow of tangible and intangible products from village, there should be proper guidelines laid down by each village
Promotion of cultural landscape	Any site which is related to culture of the community should be preserved in an ecosystem level
Green Village Campaign:	Plant as many plants wherever possible and live with nature

V. CONCLUSION

Application of traditional knowledge in combating climate change cannot be neglected any more since resilience in the face of change is embedded in indigenous communities. The traditional knowledge and know-how, diversified resources and livelihoods, social institutions and networks, and cultural values and attitudes of such communities should form a significant tool in discourse of adaptation towards climate change. Any policy responses to climate change should

therefore support and enhance indigenous resilience. With collective knowledge of the land, sky and sea, these people are excellent observers and interpreters of change in the environment and they can predict future course of climate variables. Moreover, such time-tested knowledge provides a crucial foundation for community-based adaptation and mitigation actions that sustain resilience of social-ecological systems in fragile ecosystem inhabited by traditional communities [4]. The application of such knowledge may be at local level but its result may have regional or global scales.

Today's challenges brought on by global environment change are beyond the lived experience of all knowledge holders, whether scientific or indigenous. Effective adaptation planning and policy require access to the best available knowledge, whatever its source. In the face of climate change risks and unpredictable weather condition, there is a growing need for policies and action that foster collaborative efforts involving community-based knowledge holders and natural and social scientists.

The effect due to global environment change is not uniform across countries and geographic areas. Some are negatively affected whereas others can benefit from it. One should learn to take it an opportunity rather than crying over it. For example, with melting of snow, some places adjacent to water bodies is projected to submerge; on the other hand, those barren areas in the mountain covered with snow or extremely cold places in higher altitude, can be colonized by vegetation as a result of global warming. This results in shifting of treeline towards the higher altitude. Thus, the local communities can select those crops suitable as per the changed climatic condition and introduce them in their fields.

Any intervention from the government should have prior knowledge and understanding of local communities in order to avoid any conflicts in future. Therefore, drawing confidence of the traditional society remains one of the biggest challenges for conservationists and governmental organizations. This can be overcome through farmers' education and proper explanation and demonstration of the objectives.

To ensure that the views of indigenous peoples are incorporated into climate change adaptation plans, customary rights to lands and natural resource should be recognized.

ACKNOWLEDGMENT

The author acknowledges Department of Science and Technology, Government of India for providing financial support in the form of Research project to carry out this study.

REFERENCES

- [1] Turner, N.J. and Turner, K.L. 2008. Where our women used to get the food: cumulative effects and loss of ethno botanical knowledge and practice; case studies from coastal British Columbia. *Botany*, 86 (1): 103 – 115.
- [2] Dey, P. and Sarkar, A.K. 2011. Revisiting indigenous farming knowledge of Jharkhand (India) for conservation of natural resources and combating climate change. *Indian Journal of Traditional Knowledge*. 10 (1): 71 – 79.
- [3] UNDP (United Nations Development Programme). 2011. Human Development Report 2011: Sustainability and Equity – A Better Future

- for All. New York, Palgrave Macmillan.
- [4] Anaya, J. 1996. Indigenous peoples in international law. Oxford University Press, New York, New York, USA.
- [5] Raygorodetsky, G. 2011. Why traditional knowledge holds the key to climate change. <http://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html> accessed on 13/12/2011.
- [6] Shimrah, T., Rao, K.S., Maikhuri, R.K., and Saxena, K.G. 2012. Land use and local livelihoods in the face of global change: An analysis from Arunachal Pradesh, India. In: K.G. Saxena, L. Liang, K Tanaka and S. Takahashi (Eds.), Land Management in Marginal Mountain Regions: Adaptations and Vulnerability to Global Change. Bishen Singh Mahendra Pal Singh. Dehradun, India.
- [7] Hennessey, K., Fitzharris, B., Bates, B.C., Harvey, N., Howden, S.M. and Hughes, L., 2007. Australia and New Zealand. In: M.L. Parry Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution to Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp. 507–540.
- [8] Green, D., Jackson, S., Morrison, J. (Eds.), 2009. Risks from Climate Change to Indigenous Communities in the Tropical North of Australia. Department of Climate Change, Canberra.
- [9] Hunter, N. and Leonard, S. 2010. Indigenous weather knowledge and biotemporal indicators of climate change. In: Presented at the 2010 International Climate Change Adaptation Conference: Climate Adaptation Futures, Gold Coast, Queensland, Australia, 29 June.
- [10] Petheram, L., Zander, K.K., Campbell, B.M., High, C. and Stacey, N. 2010. Strange changes: indigenous perspectives on climate change and adaptation in NE Arnhem Land (Australia). *Global Environmental Change* 20, 681–692.
- [11] TSRA (Torres Strait Climate Change Strategy 2010–2013), 2010. Report prepared by the Environmental Management Program, Torres Strait Regional Authority, May 2010.
- [12] Macchi, M. 2011. Framework for Community-Based Climate Vulnerability and Capacity Assessment in Mountain Areas. Katmandu: ICIMOD. Pp 32.
- [13] The Assam Tribune. Yongchak finds its new home. Guwahati. (www.assamtribune.com/scripts/detailsnew.asp?id=dec0811/oth07). Accessed on 08/11/2011.
- [14] *The Sangai Express*. After Yongchak, it is pine trees to stare a bleak future in Ukhrul. (www.e-pao.net/ge.asp?heading=4&mx=&src=051010) accessed on 04/10/2010.
- [15] Singh, K.K. 2008. In vitro plant regeneration of an Endangered Sikkim Himalayan Rhododendron (R. Madden Hook. F.) from Alginate-Encapsulated shoot tips. *Biotechnology*, 7 (1): 144 – 148.
- [16] Dhiman, R. C., Pahwa, S and Dash, A. P. 2008. Climate change and malaria in India: Interplay between temperatures and mosquitoes. *Regional Health Forum*. 12 (1):27-31.
- [17] Shimrah, T., Rao, K.S. and Saxena, K.G. 2013. Composition, diversity and regenerating potential of plant species in shifting agricultural landscape in North East India; A case study in and around Dihang-Dibang Biosphere Reserve, Arunachal Pradesh, India. *Environment and We*, 8:1-17.
- [18] Ramakrishnan, P.S. 1992. Shifting Agriculture and Sustainable Development. UNESCO and Parthenon Publishing Group, UK.