

Water & Climate Resilience Programme (WACREP), India

Report on **Success Stories of No/Low Regret Investments for Rain Water Harvesting and Water Security in Maharashtra Traditional Canals Mechanisms and their**



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***Activity No. 3.7.1.A (Work Package-7): A study on coping mechanisms adopted by rural communities on their traditional wisdom and their relevance for adaptation to climate change, examining how science can add value to traditional/indigenous wisdom and vice versa***

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## WATER AND CLIMATE RESILIENCE PROGRAMME (WACREP)

Water and Climate Resilience Programme (WACREP) is an innovative initiative of Global Water Partnership (GWP) South Asia devised to improve the climate resilience of South Asian countries to withstand the impact of climate change. The major objectives of the programme are; (a) Develop and integrate 'no regrets' water security and climate resilience investments into their development plans, budgets and programs; (b) Identify solutions to address critical water security challenges to enhance climate resilience of countries and communities; (c) Build knowledge and capacity to enhance water security and climate resilience; and (d) Operationalize the GWP network with strategic allies and stakeholders to integrate water security and climate resilience in the development processes. More than 40 climate resilience interventions ~~are have been~~ planned for the first phase (October, 2013 to March, 2015) of the programme ~~with the financial support of GWPO and DFID~~. On successful completion of first phase, a set of new activities will be taken-up during the second phase.

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The WACREP was launched at the India Water week in April 2013 by GWP-South Asia to improve the climate resilience of South Asian countries to withstand the impact of climate change through the implementation of 8 work packages aligned with GWP strategic goals. The programme is being implemented by the Country Water Partnerships of GWP-South Asia namely; Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka with the support of national and regional partners. The programme is also having synergies with Regional Institutions and initiatives on on-going climate change projects to ensure its effectiveness. The first Phase of WACREP Programme started in October 2013 will continue until March 2015. This programme under second phase will take up new set of activities with additional funding.

~~Under Activity No. 1.3.1 A of Work Package 7 of WACREP, India Water Partnership (GWP-India) with the support of Institute for Development Initiatives (IDI) has documented 7 success stories based on coping mechanisms adopted by rural communities of Meghalaya and Mizoram (North-East States of India) using their traditional wisdom and their relevance for adaptation to climate change, examining how science can add value to traditional/indigenous wisdom and vice versa. An attempt has been made to look at the scientific innovations/ interventions which are required to make the traditional practices more capable of addressing the challenges of climate change from the drought-prone areas of Marathwada region of Maharashtra for rainwater harvesting and water security under low/no regret investments options. Taking lessons from these success stories, appropriate structures may be designed in other parts of the country having similar geographical situation to withstand drought and climate change.~~

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Based on the ~~case studies, success stories, the~~ GWP-India with support of IDI has also prepared a ~~documentary film, entitled "Water Harvesting for Climate Resilience – The Maharashtra Story-WACREP" and the same is uploaded on YOUTUBE and IWP website.~~

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## FOREWORD

Climate change is affecting communities at an unprecedented scale globally, affecting the lives and livelihoods of millions of poor people. The poor suffer most from the adverse effects of climate change due to resource constraints. Some of their traditional coping mechanisms and traditional wisdom help them may help in climate change adaptation.

The Global Water Partnership (South Asia) has embarked on the ambitious Water and Climate Resilience Programme for Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. In India the programme is being implemented by the India Water Partnership through the members of its network. The program aims to support the water partnerships in these countries to improve the resilience to climate change through the implementation of eight work packages. The strategic goals of the programme are (i) integrating 'no regrets' water security and climate resilience investments into development plans, budgets and programs; (ii) putting in place solutions for addressing critical water security challenges to enhance climate resilience; (iii) developing knowledge and capacity for enhancing water security and climate resilience; and (iv) operationalizing GWP networking to integrate water security and climate resilience in the development process.

One of the activities, which was assessed to be necessary for catalyzing change in policy and practice was to document the traditional coping systems and practices of local communities in the two Indian States of Meghalaya and Mizoram to tackle various issues related to their livelihoods. The documentation of such practices will increase awareness regarding traditional wisdom as an important resource for climate change adaptation policies strategies, when supported and improved by science and technology inputs.

Undertaking this challenging study for Global Water Partnership (SA)/ India Water Partnership gave immense satisfaction to all of us at the Institute for Development Initiatives. It is hoped that the report will help to meet the objectives of the Water and Climate Resilience Programme to catalyze policy and practice.

Prof. T. K. Oommen  
Chairperson, Institute for Development Initiatives, New Delhi



## ABBREVIATIONS

ADC	Autonomous District Council
GWP	Global Water Partnership
IWP	India Water Partnership
MBDA	Meghalaya Basin Development Authority
MCM	Million Cubic Meter
MGNREGA	Mahatma Gandhi Rural Employment Guarantee Act
MSMA	Meghalaya State Aquatic Mission
NAPCC	National Action Plan on Climate Change
NRWP	National Rural Drinking Water Programme
NTFP	Non Timber Forest Produce
PHED	Public Health Engineering Department
PMGSY	Pradhan Mantri Gram Sadak Yojana
TPS	Thousand Pond Scheme



## GLOSSARY OF VERNACULAR TERMS

Dao	Sickle in Khasi and Jaintia hills
Dorbar	Village Assembly of Khasis and Jaintias
Hima	Local kingdom of Khasis
Jhum	Shifting Cultivation (all over tribal areas in Eastern and North-East India)
Lyndoh	Khasi Priestly Class
Nokma	Garos Village Headman
Nokpante	Garos Bachelors' Dormitory
Schnong	Headman (Khasi)
Shoh-Kha-ru	Community Fishing in Khasi and Jaintia Hills
Syiem	Khasi Chieftainship
Umongap	Khasi word for Honey
Zawlbuk	Mizo Bachelors' Dormitory
Zu	Mizo home-made rice beer



## EXECUTIVE SUMAMRY

1. This study ~~has been~~was commissioned by the India Water Partnership (IWP), under the Water and Climate Resilience Programme (WACREP) of Global Water Partnership (GWP), Sweden ~~and through GWP-South Asia Water Partnership (Colombo)~~.
2. The WACREP programme addresses the task of improving the resilience of South Asian countries to climate change through the implementation of eight work packages aligned with GWP's strategic goals.
3. It also aims to boost the capacities of the partnership, institutes and stakeholders to integrate water security and climate resilience in development planning and decision making process leading to local climate resilience investment programmes and plans.
4. This assignment comes under *Strategic Goal Number 1 "Catalyze change in policy and practice"*, Activity No. 3.7.1.A "A study on coping mechanisms adopted by rural communities based on their traditional wisdom and their relevance for adaptation to climate change".
5. Linking traditional knowledge with respect to its relevance to climate change adaptation being a new area of research, this is an exploratory study on this theme.
6. An attempt has been made to look at the scientific innovations/ interventions which are required to make the traditional practices/coping mechanisms more capable of addressing the challenges of climate change.
7. Table overleaf presents the major findings of the study and suggests a way forward for suitable interaction between traditional knowledge, science and policy.



**Highlight of Documented Coping Mechanisms, their Relevance for Climate Change Adaptation and Way Forward**

Description of Documented case/coping mechanism/indigenous practice	Relevance to Climate Change Adaptation	Tradition-Science linkage
<p><b>Forestry Sector :</b> Coping system against loss of natural resources and biodiversity</p> <p><b>Sacred Forest of Mawphlang village, East Khasi Hills District</b> is preserved by the community through strong and effective traditional institutions, drawing strength from traditional religious beliefs, which provided the foundation of effective social fencing. The social institution has acquired a modern outlook by following modern scientific forest management practices, and undertaking a community based movement for establishing newer sacred forest areas in other villages. It was a coping mechanism against depletion of natural resources and the practice is almost five centuries old.</p>	<p>Acts as a bio reserve and carbon sink</p> <p>Promotes biodiversity</p> <p>Provides quality seedlings for propagation in newer forests</p> <p>Serves as an educational venue</p> <p>Facilitates networking for forestry activities in a cluster of villages</p> <p>Selected for carbon credits as the first REDD pilot in India</p>	<p>Forest Science can benefit from the experience.</p> <p>The community can gain from technical assistance provided by Forest Departments and research bodies.</p> <p>Highly replicable in other areas of India, by converting vast areas owned by religious places and institutions into sacred forests.</p>
<p><b>Water Resources Sector:</b> Coping system for water security</p> <p><b>Rejuvenation of Natural Springs in Mawlingbna village, East Khasi Hills</b> Natural Springs provided the most assured source of drinking water for a cluster of four villages since time immemorial. The springs were neglected and contaminated since many years due to over-reliance on Government water supply systems, which are becoming non-functional and unreliable. Village community therefore decided to protect the springs from pollution and contamination. They are also planning to establish a plant for producing bottled drinking water through reverse osmosis and other modern methods.</p> <p><b>Constraint:</b> Denudation of hills by cutting down trees and dumping of degradable and non-degradable waste etc. are diminishing the recharge capacity of the springs.</p>	<p>Protection of the water sources and the establishment of a drinking water bottling plant will not only solve the problem of drying up of water sources due to climate variability but will also result in economic benefits to the entire village community through their cooperative commercial venture.</p>	<p>Catchment area protection measures;</p> <p>Appropriate waste disposal systems;</p> <p>Water purification and quality testing systems;</p> <p>Financial support;</p> <p>Managerial and marketing support</p> <p>MGNREGA activity of constructing spring chambers must continue.</p>
<p><b>Water Resources Sector:</b> Coping system for Water Security</p> <p>Conveyance of water through bamboo pipes for drinking in South Garo Hills and irrigation and East Khasi Hills. The indigenous system of water conveyance through bamboo pipes is cost</p>	<p>Use of locally available material for irrigation and drinking water purposes is an environment friendly and</p>	<p>Enhancing the availability of bamboo by discouraging the destructive extraction</p>



<p>effective, environment friendly and suited to the local terrain and resource base. The system is the most reliable supply system for drinking water and protective irrigation and removes women's drudgery in fetching water. The commonly available bamboo is used as the supply systems through which water is diverted from natural springs (for drinking water) and from rivers and streams (for irrigation).</p> <p><b>Constraint:</b> Availability of bamboo; the activity requires high levels of skills but the number of people with such skills is decreasing. Due to the availability of plastic and iron pipes, the practice of bamboo based systems is becoming rare.</p>	<p>resource conserving practice which is highly suited to climate change adaptation.</p>	<p>of bamboo shoots and regenerating bamboo areas will improve the availability of bamboo.</p> <p>Protection of the catchments of water bodies through Rural Drinking Water Supply programme for sustainability structures.</p>
<p><b>Fisheries Sector:</b> Coping system against loss of aquatic resources.</p> <p><b>Sustainable conservation of local fish species in Amlayee fish sanctuary</b></p> <p>The self- directed efforts of the village community to conserve the endangered local species of chocolate mahseer fish, using their traditional knowledge about fish rearing and sustainable fish harvesting, is a commendable effort that can be replicated elsewhere.</p> <p>Replication: Following the lead of this village, the State Aquatic Mission is promoting fish sanctuaries throughout the State.</p>	<p>The study shows that when villagers are convinced about the importance of conserving their resources and organize themselves around their traditional institutions and use their indigenous knowledge, new opportunities are thrown up to tackle the impacts of climate change.</p>	<p>This local initiative is also supporting science by providing seed material for fishery research institutions for supply to new fish sanctuaries being established with Government, showing that science can also benefit from traditional knowledge.</p>
<p><b>Agriculture Sector:</b> Coping system for Food security</p> <p><b>Shifting cultivation (Jhum): Saitual and Kaifeng villages, Aizawl district, Mizoram:</b> Food grain production in Mizoram will continue to come from shifting cultivation, as less than 2% of total geographic area in the State is under wet rice cultivation. Traditional jhum, closely regulated by village institutions to sustain the fallow cycle for regeneration, and following multi crop based cropping system with total absence of external inputs, was fully organic and continues to be the foundation of agriculture in the State.</p>	<p>The traditionally regulated jhum cultivation system was environmental friendly and climate smart, but the reduction in the fallow cycles has resulted in forest degeneration. An appropriate policy framework is required to take the practice back to its past sustainability levels.</p>	<p>Appropriate silvi-culture packages for jhum fallows; Research on conservation of seed varieties that are becoming extinct.</p> <p>Strengthen the regulatory capacity of village institutions.</p>
<p><b>Traditional Weather Prediction systems:</b> Coping system that guides agricultural decisions</p>		



<p><b>Study in Reiek Village, Mamit District, Mizoram</b></p> <p>People accurately forecast rainfall, and other weather phenomena at the micro level by observing nature, behaviour of birds and insects and animals, movement of clouds, flow of water in water bodies etc.</p>	<p>Learning from traditional climate forecasting systems through observing nature can help people to cope with climate change especially when modern climate models are not accurate enough at micro level to enable farmers to plan for their agricultural operations.</p>	<p>Pioneering research efforts in Tamil Nadu to integrate traditional and modern weather forecasting systems need replication in North East India.</p>
<p><b>Transport Sector:</b> Coping Mechanism of remote villages being cut off by gushing streams from the rest of the world during rains</p> <p><b>Living root bridges in East Khasi Hills of Meghalaya:</b> bioengineering wonders unique to the region. By training the roots of the local rubber tree across streams, the tribal people built very strong and long surviving vegetative bridges to cross torrential streams.</p>	<p>The tribal people created these engineering wonders by observing the behaviour of plant resources abounding in their immediate environment. These bridges have served the people from ages, keeping them connected to the rest of the world during heavy monsoon rains. They require very little maintenance, do not require iron and cement and have almost zero cost.</p>	<p>Government's intention to bring these bio-bridges under the ambit of the PMGSY as a part of its efforts to provide all weather connectivity for habitations with a population of 250 persons may give a new lease of life to the dying art.</p>



## CHAPTER I: BACKGROUND AND METHODOLOGY

### 1.1 Climate Change, a Major Challenge of Our Times

The adverse impacts of climate change have become a major challenge for development in recent times. How to adapt to the changes induced by climate variability has come on the national agenda through the National Action Plan for Climate Change, whose guiding principles is “protecting the poor and vulnerable sections of the society through inclusive and sustainable development strategy, sensitive to climate change”. This principle is closely linked to the other principles, namely, achieving national growth objectives through measures that enhance ecological sustainability, leading to further reduction in greenhouse gas emissions; cost effective demand side management, developing appropriate technologies for both mitigation and adaptation and evolving new market and regulatory mechanisms for the measures planned under NAPCC<sup>1</sup>. Achievement of this national goal involves many proactive measures that can substantially reduce many of the adverse impacts of climate variability and contribute to livelihood security of the vulnerable rural population.

United Nations Framework Convention on Climate Change (UNFCCC), 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<sup>2</sup>.” There is a distinction between “climate change” attributable to human activities, and “climate variability” attributable to natural causes. In this report we refer to climate change as a statistically significant variation in either the mean state of the climate or its variability, persisting for an extended period.

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation<sup>3</sup>.

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<sup>1</sup> Government of India, Prime Minister’s Council for Climate Change, National Action Plan for Climate Change, p.6

<sup>2</sup> FAO website

<sup>3</sup> UN University, <http://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html>



Climate change poses severe threat to the livelihoods of the poor. Coping with the challenge requires proactive measures that address both livelihood improvements and environmental sustainability at the same time. Only such measures are necessary to substantially reduce the adverse impacts of climate change on the livelihood security of the vulnerable segments of the rural population.

### **1.2 Relevance of Traditional Knowledge for Climate Change Adaptation**

People have lived with climate change since a long time, though its severity is manifest in more in recent times. Several factors like population pressure, diminishing of resources, increased frequency of extreme climate events and increased spread of information about climate changes in different parts of the world through scientific research as well as through communication media has brought climate change into focus as a major threat. Over centuries, people have developed various coping mechanisms against the vagaries of the weather.

The UN Convention on Biological Diversity recognizes the importance of traditional knowledge not only for preservation of biological diversity but also for adaptation to climate change. The convention defines traditional (indigenous/local) knowledge as the knowledge, innovations and practices of indigenous and local communities representing traditional lifestyles that are of importance for the preservation and sustainable use of biological diversity. Local communities have developed this knowledge as a collective asset over the centuries. It passes on from generation to generation in the forms of stories, songs, cultural values, traditional laws, local languages, rituals, medical lore and agricultural practices<sup>4</sup>. This comprised the main coping mechanism for rural communities affected by environmental and climatic shocks and risks.

Changing climatic conditions and other factors such as markets, rising population, policy changes etc. compel rural people to give up their traditional practices, many of which become obsolete or forgotten over time. In spite of this, traditional knowledge and practices have great potential to provide communities with adaptation and/or coping strategies against changing climate.

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<sup>4</sup> Prime net Consulting, Case Studies of Climate Change Adaption through Traditional Knowledge in Tamil Nadu, 2013



### 1.3 Objectives and Scope of the Study

This study has been commissioned by the India Water Partnership (IWP), under the Water and Climate Resilience Programme (WACREP) of Global Water Partnership (GWP), Sweden. The WACREP programme addresses the task of improving the resilience of South Asian countries to climate change through the implementation of eight work packages aligned with GWP's strategic goals by supporting countries and regional organisations to integrate water security and climate resilience programming at trans-boundary, national and local levels through policy dialogues and participatory approaches. It also aims to boost the capacities of the partnership, institutes and stakeholders to integrate water security and climate resilience in development planning and decision making process leading to local climate resilience investment programmes and plans.

This assignment comes under *Strategic Goal Number 1 "Catalyze change in policy and practice"* and activity No. 3.7.1.A "A study on coping mechanisms adopted by rural communities on their traditional wisdom and their relevance for adaptation to climate change".

Linking traditional knowledge with respect to its relevance to climate change adaptation is a new area of research. This study explores existing or abandoned traditional knowledge that have been useful for climate change adaptation, and also makes an attempt to understand the relevance of traditional knowledge in the present. The study makes specific recommendations on the scientific innovation/intervention which are required to keep up with changing climatic conditions. In this context, the study has three objectives as follows:

- (a) Document a few successful instances of traditional, indigenous and local knowledge, that are useful for climate change adaptation in the North-Eastern Indian States of Mizoram and Meghalaya;
- (b) Explore relevance of traditional knowledge in strategies for climate change adaptation;
- (c) Make specific recommendations on the scientific innovation/intervention which is required on the selected traditional knowledge and practices in order to cope with the changing conditions.



The deliverables of the study are two- fold:

- i) An actionable report summarizing the traditional knowledge of the people of Meghalaya and Mizoram which have served as coping mechanism against livelihood challenges and which are relevant today for climate change adaptation, drawing clearly how science can add value to the traditional knowledge and practices and vice versa.
- ii) A short film documenting the traditional practices in Meghalaya only.

The above deliverables will help in the process of incorporating traditional wisdom into future climate change adaptation programmes in Meghalaya and Mizoram.

#### **1.4 Methodology**

The study combines literature review with in depth interaction with communities still practicing elements of traditional wisdom, which directly or indirectly help them to adapt to climate change, not necessarily knowing that the practices help them to adapt to climate change. Secondary literature reviewed include scholarly articles, newspaper and media features, folklore etc. Consultations were held with experts in North Eastern Hill University and key informants. Elder members of the village community interacted with our researchers, giving valuable insights into the practices they could recall. Members of the Village councils and the youth also gave us valuable information.

Based on the secondary literature review, we selected instances of traditional/local/indigenous wisdom, knowledge or practices that are assessed to be relevant for helping communities to various facets of rural living affected by climate change, be it issues like irrigation, drinking water, loss of biodiversity, conservation of endangered species etc. We targeted about six case studies. Ultimately, the following practices were selected and documented:

- i) Sacred Forest of Mawphlang: coping against forest and biodiversity loss
- ii) Bamboo drip irrigation and drinking water supply systems: coping with water issues
- iii) Spring rejuvenation and protection: coping with water issues
- iv) Sustainable fish rearing and harvesting practice: coping with depletion of fish resources
- v) Practices regulating jhum (shifting) cultivation in forested areas: coping with food security



- vi) Local weather forecasting: coping with variability of weather
- vii) Living-root Bridge: coping with the problem of crossing rivers.

### 1.5 Structure of the Report

The Report is structured in four chapters. Chapter I, which is the introductory chapter is followed by Chapter II, which describes the climate change scenario in Meghalaya and Mizoram. Chapter III details the case studies. The report concludes with Chapter IV, which is an analysis of the case studies from the perspective of climate change adaptation by rural communities.

The report highlights instances of traditional practices of local communities to tackle various issues related to their livelihoods, particularly in the context of problems posed by climate change. The report will increase awareness regarding traditional wisdom as an important resource for climate change adaptation policies strategies, when supported and improved by science and technology inputs.



P 1: Panoramic view of the plains of Bangladesh from Garo Hills



## CHAPTER II: CLIMATE CHANGE AND TRADITIONAL PRACTICES

### 2.1 Meghalaya and Mizoram: Biodiversity Hot Spot States

The North-Eastern Indian States of Mizoram and Meghalaya are part of the Indo-Myanmar biodiversity hotspot, one of 34 such hotspots across the world. Meghalaya, with 22,429 sq. km area covering Khasi, Jaintia and Garo regions, has an estimated forest cover of about 8,500 sq. km. The state is rich in water resources, being one of the wettest regions in the world with an annual average rainfall of 1200 cm. Cherrapunji, the wettest spot on planet earth is located in the West Khasi hills

of  
Meghal  
ya.



P 2 : Map of Meghalaya: Courtesy [www.indiaprofiles.com](http://www.indiaprofiles.com)

Mizoram, a small land locked State in North-East India has a total geographical area of 21087 sq. km. It is a rugged hilly region, plain lands being available only in the low lying areas in the North bordering Assam and in the West bordering Tripura and Bangladesh. This represents 0.95% of the total geographical area. The average rainfall is 2500 mm per annum, most of the rainfall being in the months of May to September.



Mizoram has 75% forest cover, which provides life-supporting, provisioning, regulating and cultural ecosystem services to its people and those in the border areas. About 61% of the total area of Mizoram is under open forest category (density of less than 40%). The percentages under very dense forest and moderately dense forest are 0.64% and 29.65%, respectively. The forests of Mizoram provide a major source of the livelihood to the people in the form minor forest products. However, these forests are highly vulnerable to climate change.

Land is essentially owned by the community through the institution of the Village Council. And the village councils control 48.5 % of the forest area. Another

5.7% is under the administrative control of the District Councils. The State Forest Department controls only 45.8% of the total forests. In this situation, the village councils play a very crucial role in preserving the quality of the forest area.

P 3: Map of Mizoram, Courtesy Agriculture Deptt, Mizoram

There are two types of Village forests in Mizoram:

- (i) Village safety/supply reserves of 2,648 km<sup>2</sup>. In these families can collect for their needs from supply reserves but not for sale or trade. Safety reserves are contiguous to the habitations and are meant for protection of village against storms, landslides, fire, conservation of soil and water sources and environmental balance. Under the Forest Act, village councils have the responsibility to maintain these reserves.
- (ii) Unclassed forest of 5,240 sq. km ( used for shifting cultivation);

In recent years, safety reserves have also come under considerable pressure due to population growth, settling immigrants in grouping centers, allotment of new house sites for new villages and towns, construction of village roads, allotment of land for horticulture etc.



## 2.2 The People of Meghalaya and Mizoram

Meghalaya is home to three main tribes, the Garo, the Khasi and the Jaintia. The Garos live mainly in the four districts of the Garo Hills and in the adjoining areas of Assam and Bangladesh. According to tradition, the Garos came originally from Tibet and settled in Cooch Bihar and later moved towards other parts of Assam and later to the Garo hills<sup>5</sup>. By the close of the 18th Century the Garo Hills were brought under the control of the British, who administered the area through Zamindars, against whom the Garos fought bitterly, which itself was a challenge to the British.

The Khasis people live mainly in the Khasi and Jaintia hills of Meghalaya. They speak a branch of the Mon-Khmer language of Austroasiatic origin, presently written in the Roman script. Khasis are a matrimonial society, with both inheritance of property and succession to tribal office passing from the mother to the youngest daughter. However the husband of the youngest daughter manages property as well as the tribal office. Their traditional religion of Ka Niam Khasi (Niam Tre in Jaintia)<sup>6</sup>.

The third major tribal group of Meghalaya is the Jaintia or Pnar, who mostly reside in the Jaintia hills. The Jaintias, like the Khasis, claim their origin from *Ki Hynniew Trep* (seven mothers). The Jaintias had a very strong king, who was conquered by the British in 1835. The traditional religion of the Pnars was Niamtre, whose three cardinal principles are right living and practice based on right livelihood, fulfillment of duties toward fellow men and showing respect to the members of one's father's and mother's clans).<sup>7</sup> Only a small fraction of all the three tribal groups now follow their traditional religion.

Mizos are believed to be a people of Mongolian origin spilling over into Burma and North Eastern India before settling down in the present area of Mizoram<sup>8</sup>. Even today many Mizo families have relatives in Myanmar. Conversion to Christianity started in the 9th century, and now most of the Mizos are Christians. The introduction of Roman Script by Christian missionaries spread education and facilitated development of literature in the language. Literacy level is as high as 95 %. The Mizo Village is usually set on the top of a hill with the chief's house and the bachelor's dormitory (Zawlbuk – training place cum

<sup>5</sup> Southgarohills.gov.in quoting Gazetteer of Bengal and North-East India by B.C. Allen, W.E.A... gait, C.H.G. Allen & H.P. Howard

<sup>6</sup> [http://en.wikipedia.org/wiki/Khasi\\_people](http://en.wikipedia.org/wiki/Khasi_people)

<sup>7</sup> [http://en.wikipedia.org/wiki/Pnar\\_people](http://en.wikipedia.org/wiki/Pnar_people)

<sup>8</sup> <http://www.mizoram.nic.in/about/people.htm>



dormitory) at the center. The main festivals are Mim Kut (maize harvesting festival in August-September), Pawl-Kut (harvest festival during December to January) and Chapchat Kut (observed in spring). Drinking of Zu, a home-made rice beer is common for most of the festivals. Several Mizo dance forms like the Sarlamkai, Cheihlam, Cheraw (the bamboo dance) are famous.

### **2.3 Climate Change: A Major Threat to Livelihoods in Meghalaya and Mizoram**

Climate change is affecting the availability of water in both the States. The economy of the both the States and the livelihoods of the majority of the people are highly dependent on natural resources and climate sensitive sectors like agriculture and forestry.

#### **2.3.1 Climate Change in Meghalaya**

The effects of global warming on the hydrological cycle in the State is becoming evident already with annual rainfall decreasing each year. One of the reasons for changes in rainfall pattern is increasing deforestation. As per Government statistics the forest area of Meghalaya has reduced from over 69% to 63%<sup>9</sup> during a 15 year period prior to 2005. One of the major effects of climate change is manifest on river hydrology as well as ground water in Meghalaya. Though small, the rivers, streams and lakes of Meghalaya are the sources of drinking water supply for both rural and urban areas, but they are threatened by siltation through coal mining, sand quarrying and deforestation. Siltation has caused the disappearance of several perennial streams and natural springs. Contamination by indiscriminate discharge of untreated municipal effluents and dumping of garbage are the other problems that threaten the water bodies. These are leading to scarcity of drinking water and extinction of aquatic species.

Meghalaya has ground water potential of 1226.44 million cubic meters (MCM) out of which only 1041.99 MCM is used for irrigation<sup>10</sup>. The ground water is also facing fast depletion due to deforestation and washing away of top soil of the hill slopes during monsoon and low recharge, leading to water balance becoming even more precarious. Even drought might become a reality in this high

<sup>9</sup> Department of Environment and Forests, Government of Meghalaya, **State of the Environment Report 2005, Meghalaya**

<sup>10</sup> Meghalaya Basin Development Authority, In Conversation with the people of Meghalaya, Water Mission.



rainfall region.

### 2.3.2 Climate Change in Mizoram

The climate of Mizoram is typically subtropical monsoonal. The valleys are hot during summer while the upper reaches stay comfortably cool with 110 C in winter and 20-300 C in summer. Winter is dry and moderately cold while summer is warm and humid and winter is generally rain free. Occurrence of frost is experienced in the Eastern part of the state during late December and whole of January. The summer temperature varies from 20<sup>o</sup> C to 30<sup>o</sup>C and winter temperature from 8<sup>o</sup> C to 18<sup>o</sup> C.

The average annual rainfall of Mizoram is about 2,445 mm, which is concentrated in the monsoon period between May and September. The mean annual rainfall varies from about 2,100 mm in the Northern regions of the state to 2,600 mm in the south. The pattern of rainfall in Mizoram for the 20-year period from 1986 to 2005 showed annual variations. Year 1995 recorded the highest rainfall of 3,185.98 mm and 1994 had the lowest rainfall of 2,278.29 mm. After 2005, the highest rainfall was in 2009 (2,963 mm) and lowest of 1,893 mm was recorded in 2008, which shows that variability has been sharper in the last two to three years.

Changes in the rainfall pattern, rise in temperature and variations in humidity are the main features of climate change in Mizoram, though the impacts have not been too severe till recently. Prof. Ravindranath et al<sup>11</sup> have projected temperature increase by 1.6 to 1.8 degree Celsius from the period 2010 to 2050 and an increase in rainfall of 5 to 15%, with variations in the districts/agro-climatic regions of Mizoram. Increase in untimely, unpredictable and erratic rainfall and particularly excessive or intensive rainfall events that cause heavy run-off and widespread soil erosion are already being experienced. At other times, when water is badly needed, there are long dry spells of 4 – 5 months leading to acute water scarcity and soil moisture stress, complete drying up of many streams in the off season and gradual increase in soil and atmospheric temperature since the past decades. There was 17% reduction in average rainfall during 1996-1997 and this reduced again by 25-30% in 2005-2006. The effects of this are aggravated by many local factors like shifting cultivation, burning of forests, and non-

<sup>11</sup> Prof. N.H.Ravindranath, Indian Institute of Science, Climate Change Variability Profiles for North East India [http://www.researchgate.net/publication/243970955\\_Climate\\_change\\_vulnerability\\_profiles\\_for\\_North\\_East\\_India](http://www.researchgate.net/publication/243970955_Climate_change_vulnerability_profiles_for_North_East_India)



scientific management of farming systems, heavy deforestation and so on. Rising temperature affected natural resources including agriculture, forests, and fish and livestock resources.<sup>12</sup> The result is land degradation, acute scarcity of water and food insecurity.

### 2.3.3 Bio-diversity: the most affected sector

According to a study by The Energy and Resource Institute (TERI) climate change is likely to result in large-scale changes in the biodiversity of the Northeast<sup>13</sup>. Change in temperature and the quantum and intensity of rainfall and other extreme weather conditions would have a long-term impact on the structure and composition of forests in the region. Forest cover in the region is under pressure due to intense demand on land for urban development, agriculture, fodder, fuel wood and timber. Natural hazards such as floods, forest fires and landslides and seismic activity add to climate variability.

Climate change will force a 45% change in forest vegetation in the North East of India by year 2100 (the Western Ghats in South India being the other region to have a similar change) according to a study by Centre for Sustainable Technologies, Bengaluru<sup>14</sup>. The other contributing factors to this change are low biodiversity, low tree density and fragmentation.

## 2.4 Traditional Coping Systems/Knowledge for Climate Change Adaptation

In many ways traditional coping systems based on ancient wisdom can come in handy for successful adaptation to climate change. Though rural and indigenous communities have a very low carbon footprint life style and contribute very little to climate change by way of carbon emission, it is their livelihoods that are most adversely affected by climate change. It destroys land, water sources, local biological diversity and ecosystem services, which are the source of sustenance and well-being of these communities. Many activities like large hydro-power projects displace people from their basic resource, which is land.

<sup>12</sup> Government of Meghalaya, Planning Department, State Action Plan for Climate Change Adaptation

<sup>13</sup> <http://www.thehindu.com/sci-tech/energy-and-environment/climate-change-to-have-largescale-effect-on-ne-biodiversity/article2093141.ece>

<sup>14</sup> Current Science, <http://www.conservationindia.org/news/study-identifies-north-east-forests-and-western-ghats-as-vulnerable-to-climate-change>



Over centuries, village communities have acquired community based and collectively held knowledge on nature. This knowledge can complement scientific knowledge. It can test and evaluate scientists' climate change scenarios and models. Hence it is very important to study and document traditional knowledge, which is mostly oral and passes on from generation to generation.

North East India is a largely unexplored part of India. It has a rich variety of cultures and practices. In this assignment, we make a modest attempt to document a few successful traditional practices that we are relevant for climate change adaptation actions.



## CHAPTER III: CASE STUDIES

### 3.1 Nature's Museum: The Sacred Forest of Mawphlang

Meghalaya is experiencing loss of biodiversity at an alarming rate. Many species of plants and animals, which are unique to the State, are getting added to the list of endangered species. This is due to the loss of forest cover, 60% of the forest area in the State being at various stages of destruction. The breakdown of traditional institutions, mining, urbanization, population growth and infrastructure development are the main reasons for this trend. Forests have become an exploitable community rather than a rich heritage that needs to be protected and conserved.

However, a revival campaign is taking place in Meghalaya, mostly led by community institutions, trying to integrate traditional wisdom and contemporary practices to protect forests and other natural resources. At the center of this campaign is the sacred forests spread out in various parts of Meghalaya, which represent the best tradition of community management of natural resources. There are about 101 identified sacred groves in Meghalaya, which together occupy an area of 10,000 ha.



P 4 Monoliths of Mawphlang

#### 3.1.1 The Sacred Forest at Mawphlang

Mawphlang is a Block in East Khasi Hills District, located 22 kilometers towards South of Shillong. The name Mawphlang itself is derived from the stone monoliths marking the boundaries of the forest, which were raised in memory of ancestors, and which are believed to protect the people and the forest from harm. The

name literally means grassy stones (Khasi word "maw" means "stone" and

*phlang* means "grassy").



According to village elders, the forest is about 500 years old and is spread in 78 ha of land. The forest is divided into three portions - the sacred forest area ("Law Kyntang") having about 40 ha, 'Law Raji' or Community Forest in 15 ha and the Langblah Clan Forest in 23 ha. It is believed that the forest originally belonged to the Blah tribe but they could not preserve it properly. The Lyngdohs (the clan of priests) wanted to protect the forest by taking full control over the area. To settle the dispute, the Lyngdohs planted two trees inside the demarcated area. If the trees survived, the possession of the area would pass on to the Lyngdohs, who will convert it into a sacred forest. Surprisingly, the trees survived and became the oldest trees in the forest.

### **3.1.2 Resource Management Arrangements**

The custodians of the forest are the Lyngdohs (priests) and the Siyem (chieftainship) who govern people and manage common property resources in the village. All decisions are taken consensually after thread bare discussion in the Dorbar (village assembly) composed of all the adult male members of the community. It is mandatory for every resident to follow the decision of the dorbar. Tring Lyngdoh is the religious, civil and judicial head of the Lyngdohship, assisted by Myntris (Ministers).

Tambor Lyndoh is President of the Mawphlang Village Council and Secretary of the Lyngdoh Council. He has been at the forefront of forest protection and generating awareness about community forestry in 18 neighboring villages which are part of the Lyngdohship. These village look upon Mawphlang to build up their own community forests out of barren and denuded land.

Tambor devotes much of his time for the management of the sacred forest and awareness generation campaigns. He believes that when the community is involved at every stage of forest management, people become actual owners of the forest and protect it as their own. His message to the communities is: "We lost our forests because we forgot the rules of our ancestors. We should not allow outsiders to cut down their forests".

### **3.1.3 Social Fencing as tool for Protecting the Forest**

There is a tollgate at the entrance to the grove, where all outside visitors have to pay an entrance fee. This income helps maintain and further develop the forest. The village council has special rules that



prevent abuse by tourists. Use of plastic carry bags and bottles is banned in the sacred forest and even within the village as they consider that it will contribute to global warming.

Social fencing is the tool used to protect the forest. The forest is revered and preserved according to the traditional culture and rituals of the Khasi community. The religious sanction behind this social fencing is the oral tradition that the sacred forest was established by the Khasi clan of to provide a home for two spirits taking the form of a leopard and a snake, who are defenders of the land. As per the tribal religion of Niam Khasi/NiamTre, those who cause any damage to the forest or takes any article outside the forest will be throttled to death by the two spirits – the leopard and the snake.<sup>15</sup> On the other hand if the village protects the forest from any harm the spirits will protect it from calamities.<sup>16</sup>

Due to this belief, no one removes even a twig or fruit from the forest as it is considered that misery will befall anyone who removes anything from the forest. One can eat the fruits inside the forest to ones heart's content. The Village Council has demarcated a special area adjacent to the main sacred forest of about 15 has as community use forest where people can collect firewood, but strictly according to need and not for commercial purposes. In this community use forest as well as the clan forest of about 23 ha, the Village council regulates fuel wood harvesting and grazing. It encourages villagers to use smoke-less cook stoves and to switch to higher value stall-fed livestock. It controls forest fires by laying down fire lines in ten-meter patches outside the forests. It has placed a blanket ban on mining.



Seema Bhatt. Deccan Herald. March 11, 2013.  
P 5: Site for Community Prayers in Mawphlang Sacred Forest

Certain religious ceremonies help cement people's relationship with the forest. Borndeng Blah, a villager says, "In the morning, before entering the forest, our elders pray before the monoliths and ask signs from Gods".

The head Lyndgdoh (priest) recites



the following prayer before entering the forest:

*“Dear forest, we are entering you with respect; please protect our Hima (kingdom) and guide us”.*

During the annual thanksgiving ceremony the priest prays for peace and protection of the khasi community thus:

*“Dear God, creator of universe and nature,  
We bow down before you on behalf of all the beings  
Black and white, khasi and foreigner,  
Protect and guide us, make us prosperous and healthy”.*

He then offers gifts in the form of grass, leaves, water and rice to the deity by reciting:

*“We offer you what is essential for our survival  
Grass and leaves, clean and protect us,  
This is water, essential for life,  
This is rice, needed for our livelihood  
We offer you these articles as thanksgiving  
We pray for our protection, health wealth, harmony and peace”.*

Here is a song about the Sacred Forest, composed and sung at traditional rituals by Pyrshailang Lyngdoh,

a resident and activist:



P 6: Local Poet singing a praise to the Forest

*O sacred forest, we are so proud of  
you...  
People come from all over—east and  
west— to see you, praise you....  
You beckon us with your colors,  
waterfalls, fresh air...  
Your fragrance spreads over all....all  
rites and rituals are for everyone,  
To heal all and bring peace and  
harmony for the whole Hima (domain)  
and the world.*

Pyrshailang Lyngdoh, the poet, says,  
“This forest is supernatural. The deity in  
residence protects Hima Mawphlong and

its people. It is the pride of Meghalaya”<sup>17</sup>.

<sup>17</sup> Key informant interview



Thus, the motivation for protection and preservation of the sacred grove come from the religious sentiments associated with the forest, respect for elders and the supernatural, respect for village leadership and pride in the community's common property resources.

However, some observers fear that in general there is a declining hold of the traditional value systems and this may prove to be detrimental to the preservation of common property resources like sacred forests. Prof. Saroj Barik of North Eastern Hill University confided to us: "Traditional beliefs and wisdom are losing their hold in Meghalaya. The control of traditional institutions on resources is becoming loose. Half- baked education makes people believe these are only myths. The result is the alarming decline of natural resources"<sup>18</sup>. Patricia Mukhim, Editor, Shillong Times has this to say: "It is difficult to even sell the idea of sacred groves, without marketing it as an exotic tourist place. Today, people do cut trees inside the forest, despite stories of how you will be haunted. I think this is because we have not done an assessment of our own indigenous value system"<sup>19</sup>.

### 3.1.4 REDD Pilot



P7: The sacred forest is the first Redd project in India

Aided by US-based non-profit environmental organization Community Forestry International (CFI), the Mawphlang community has set up a federation of 18 *Himas* (village kingdoms), called Ka Synjuk ki Hima Arliang Wah Umiam Mawphlang Welfare Society. This is India's first REDD pilot (Reducing Emissions from Deforestation and Degradation) project, which allows the participating village communities to earn income from carbon credits under the United Nations Framework

<sup>18</sup> Key informant interview

<sup>19</sup> Key informant interview



Convention on Climate Change<sup>20</sup> through the Plan Vivo Foundation. Innovative strategies adopted under the project include a wildlife corridor, eco-trails and awareness campaigns in schools and colleges. The project organizes community networking meetings to educate people about environmental needs, forest department requirements and government's plans and policies. At these meetings, every villager is allowed to air his views and people come forward to volunteer for various activities. Awareness generation programme for school children is an important activity under the project. The message to the children as well as adults is "if we protect our forests, they will protect us from rain, storm and disease. Otherwise we will have to run to the doctors".

### 3.1.5 Observable Benefits

The sacred provides several benefits forest to the village community and perform several ecosystem services including protection of the environment and regulation of the climate.

- i) Protection of Ground Water Sources: Mawphlang dam is the source of the Greater Shillong Water Supply system. This reservoir is always full with clean water and locals stress that the Mawphlang Sacred Forest is the reason for the abundance of pure, plentiful water in the reservoir. It also protects the streams and rivers nearby from becoming dry.
- ii) Conservation of plant and animal diversity: This dry semi-deciduous and savannah-transition zone forest is a treasure house of rare plant and animal species. About 70 species of birds have been reported from Mawphlang<sup>21</sup>. According to Prof. R.S. Tripathi<sup>22</sup>, the sacred groves of Meghalaya contain 514 species of flora, many of which are endangered. The dense growth of *Castanopsis kurzii* trees on the outer rim halts the intrusion of *Pinus kasia* (Khasi pine) found outside the sacred grove.
- iii) Conservation of rare and endangered medicinal Plants: Many of the rare medicinal plants that can cure many diseases for which modern medicine has no answers, are available in this sacred grove.

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<sup>20</sup> [http://rise.mahindra.com/indigenous-forest-conservation-in-mawphlang-how-a-community-protects-its-forest-and-generates-income-from-carbon-credits/forest\\_01/](http://rise.mahindra.com/indigenous-forest-conservation-in-mawphlang-how-a-community-protects-its-forest-and-generates-income-from-carbon-credits/forest_01/)

<sup>21</sup> Lahkar, K. (2002) Birds of Upper Shillong, Norpuh, Umiam and Mawphlang 41pp. Unpublished Report to the Bombay Natural History Society. Mumbai.

<sup>22</sup> R.S.Tripathi, Sacred Groves of North-East India and Their Floristic Richness and Significance in Biodiversity Conservation, International Society of Environmental Botanists, Vol. 11 No. 3 - July 2005 (INSA Senior Scientist, National Botanical Research Institute (Eco-education Division)



- iv) Home for practitioners of herbal medicine: Out of more than 20 traditional healers/herbal medical practitioners in Khasi and Jaintia hills five reside in Mawphlang, due to the rich availability of medicinal plants in the community and clan forests adjacent to the sacred forest. Of course collection from the sacred grove is not allowed. The practitioners include Bah I. Wankhar, Kong Jyrmon, Bah Shrall Kharkrang, Bah Bodshon Kharsahnoh, Bah Danel Kharkrang, Kong Trimai Lyngdow and Kong Trimsimai Marbaniang.
- v) Rich biodiversity: The sacred forest is full of aroids, pipers, ferns and orchids, butterflies, birds and small mammals<sup>23</sup>. In spring, two species of rhododendrons are in full bloom and provide a visual treat. The biodiversity here is similar to the biodiversity in some of the biosphere reserves in this region. Interior of the forest is dense and dark in complete contrast to the surrounding rolling grasslands.
- vi) Source for Planting Material: Studies by scientists at NEHU have shown that most of the primary tree species in the sacred groves have much greater density compared to the disturbed subtropical humid forests. Many of the trees like oak are very old and provide planting material for newer plantations.
- vii) Income from Tourism: This forest area has become the prime eco-tourism site in Meghalaya with nature lovers and tourists thronging it. A handsome amount is collected as entry fee, which goes for maintenance of the forest.
- viii) Educational opportunities: Several schools bring their students to this forest to observe and study nature.
- ix) The forest has successfully prevented soil erosion and is protecting the fragile eco system. The sacred-groves present a sharp contrast to the surrounding grasslands and degraded hills where only seasonal grass grow in the rainy season.
- x) The forest endows its surrounding areas with an equitable climate by providing an excellent carbon sink, making it eligible for earning carbon credit.
- xi) Some groups in the village specialize in making traditional musical instruments, using the wood taken from the community forest and clan forest, adjacent to the sacred forest. They chisel pine wood into beautiful shapes to form traditional indigenous musical instruments.



### 3.1.6 Discussion

Integrating the religious beliefs and traditional wisdom associated with the sacred groves with modern scientific forest management practices, will be highly helpful for biodiversity conservation in the region.

The establishment of the Mawphlang sacred forest is a kind of coping mechanism initiated long ago against the depletion of natural resources. The entire responsibility for establishment, protection and maintenance of the forest was taken upon themselves by the village community rallying under their traditional tribal institution and using their traditional wisdom.

Government needs to support the establishment and management of sacred groves wherever feasible. More than a 100 sacred forests have been identified in Meghalaya. The forest department can provide technical inputs to improve the canopy cover and regeneration of trees in the degraded sacred groves.

The scientific input required include suitable packages of conservational and eco-restoration strategies for the protection of sacred groves/forests. In this forest, important tree species find protection and they regenerate and grow abundantly due to social fencing. The big and ancient trees of the sacred groves can serve as a perennial source of seedlings for new plantations in other areas.

In many parts of India religious institutions and places of worship own vast extent of land, much of which has become wasteland. If the area is planted with trees, green oases can be created throughout the length and breadth of the country, providing carbon sinks and acting to mitigate the effects of climate change. The religious sentiments of the devotees can be channelized to adopt individual trees in the forest by naming the trees after their ancestors, as is being done in the Smriti vatika of Delhi. These newly created project can also come under the carbon credit scheme.



## 3.2 Natural Springs of East Khasi Hills, Meghalaya

### 3.2.1 Background

This is the inspiring story of how a village is trying to tackle the problem of drinking water by rejuvenating its natural springs. The village is situated near Mawsynram, which, receiving an average annual rainfall of 11,872 millimeter, competes with Cherrapunji as the 'wettest place on earth'. Springs were the chief source of drinking water to the village for centuries, but their condition had begun to deteriorate due to several reasons.

Village Mawlyngbna is located 75 km from Shillong in Mawsynram block of East Khasi Hill district, and just 17 km away from the border with Bangladesh. With an altitude below 1200m, the area has steep slopes, tracts of grasslands and isolated patches of forests. It is part of a larger cluster of 14 villages, which fall under Mawsynram Sordarship<sup>24</sup>, administered by a Syiem<sup>25</sup> (traditional chieftainship). The major market for the villagers is Mawsynram<sup>26</sup>. On the eastern side of the village flows the Umsyntai River. The village is renowned for its natural springs, believed to have curative qualities. People from distant places come to Mawlyngbna to take water from its springs. The rare and endangered Pitcher plants (*Nepenthes Khasiana*) grow in the wild form in some patches in the village. The villagers use the juice of this plant as a thirst quencher.

### 3.2.2 Demography and Livelihoods

The village has 340 households, dominated by people following the original khasi religion. Below Poverty Line households number 74. While the better off families (numbering 92) have cement and concrete houses, the poor have tin & stone houses (187). The remaining 61 houses have concrete walls and tin roofs. Farming provides the main source of livelihood to more than 90% of the households and the rest are engaged in casual labor, petty business or salaried employment. Farmers mainly grow

<sup>24</sup> "Sordar" means a Khasi traditional elected head of a village and includes a Headman or Rangbah Shnong of a village duly elected/ nominated by the adult males of the village concerned under the administrative control and territorial jurisdiction of Rambrai Syiemship as per the prevailing custom and under the provision of the Khasi hills Autonomous District (nomination and election of the syiem, deputy syiem, lyngdoh and sordar of rambrai syiemship) Act, 2010.

<sup>25</sup> "Syiem" means the traditional Chief and the customary administrative Head of Hima Rambrai who is a Khasi male adult belonging to the Syiem Sad clan of the Hima Rambrai and is duly appointed as per the prevailing customs and under the provision of the 2010 Act.

<sup>26</sup> In Mawsynram, there is a cave called the Mawjymbuin Cave, which, due to years of weathering, dripping of mineralized solutions and deposition of calcium carbonate, has thus given rise to some magnificent stalagmite, shaped like a massive Shivalinga. The cave also has a dome shaped rock called the Symper Rock. (<http://megtourism.gov.in/dest-khasi.html>)



commercial crops such as broomstick, bay leaf, areca nut and black pepper. Out of 320 farm households, only about 10 households have well developed farms and earn more than INR one lakh per year from farming alone. More than 80% of the farmers earn between INR 10 to 12 thousand per year from agriculture. Households who do not have much farmland and alternate sources of income are involved in stone mining and stone cutting. A hard working person earns up to Rs. 8,000 to 10,000 per month from sale of stone and bricks.

Households involved in business include shopkeepers as well as those who are involved in trading of farm produce – mostly as agents of traders. Three individuals in the village are involved in Bay leaf and Broom grass trading. Five families are involved in Betel nut trading and three individuals in trading of Black pepper. Fishery is the livelihood of eight households. Most of the villagers keep animals for pig and poultry for their own consumption and as source of cash in case of emergency needs. About six families keep cows. Realizing that the cultivation of broomstick is depleting the soil of all nutrients, the villagers have now restricted broomstick cultivation to the fallow lands and rocky ridges<sup>27</sup>. Apart from farming, other skills that are available with the villagers include knowledge of use of natural vegetation for food and medicine, betel nut processing; honey processing, bamboo product making, stone brick making, livestock rearing, handloom weaving etc. The youth of the village are well educated and take interest in community based activities.

### 3.2.3 Land Use Pattern

Out of the estimated 912 ha of village area, 100 ha is under Agriculture, 612 under forest (including open forest and 50 ha. fossil area), 50 ha under habitation and 150 ha under Wasteland. The slope decrease as one goes from north to south. From north to south, a few seasonal streams drain the area. On the northern part of the cultivated land is wasteland / grazing land and the southern most part contains lime stone area. The cultivated area is divided into upland (60%) and low land (10%).

Trend change analysis indicates that over the last 25 years, the area under forest has reduced by more than one third and the cultivated area has reduced by more than 50%.The community/clan owns a

<sup>27</sup> <http://www.theshillongtimes.com/2012/11/12/mawlyngbna-village-an-example-of-judicious-forest-conservation/#7YMbCri4JbFpB6G.99>



major portion of the land, which is managed by the institution of Syiem. Individual families have right to cultivate the land and usufructs but cannot transfer or sell the land. The Syiem also grants user rights for uncultivated patches of old fallows. The rights continue to be held by the household unless it leaves the patch of land uncultivated for three consecutive years.

The Syiem manages the wasteland, which are fallows of more than 15 years. The total wasteland is around 200 ha of grasslands and 50 ha of open forest (fossil area and animal foot print). The Syiem has given an application to the Government of Meghalaya for development of 500 acres of wasteland in the cluster with *pongamia pinnata* and other species.

### 3.2.4 Village Institutions

The main village level institution is the Village Council with authority to manage village affairs. All adult males of the village are members of the Dorbar. The executive committee of Dorbar consists of 18 male members who are elected every year. Every permanent resident of the village and belonging to a clan enjoys the right of protection from the Village Council and also the use of common property resources. The activities of the village council range from maintenance of law and order, settlement of intra-village disputes, protecting customary beliefs and practices, interacting with government departments for initiating and implementing development programmes for the benefit of villagers. The Village Council has a little source of income in the form of taxes and fines and donations from the youth. Government provides grants for development activities. The other institutions include:

- ) Seng-khasi Religion Cultural Club;
- ) Culture and Heritage Committee (formed in December 2011 for promoting village tourism, protect the fossils area, develop a fossil museum, organize and manage village cleanliness drive and develop viewing points for tourists);
- ) Farmer Association (formed in year 2002 by Village Dorbar for general welfare of the farmers and addressing issues related to production and marketing; closely involved in implementation of watershed programme of Soil & Water Conservation Department)
- ) Multi-Purpose Cooperative Society (supply inputs and good to the farmers and villagers at a reasonable rate and to support in marketing of the produce. It also manages the solar power



project supported by The Energy Research Institute (TERI). Four solar panels and 50 solar lanterns were provided.

- ) Ten SHGs, including two Women SHGs and eight men SHGs formed under SGSY. Six of these are linked to Meghalaya Rural Bank and have been provided credit up to Rs. Five lakh. They have initiated activities such as Piggery, Poultry, Fishery and Betel nut processing.

T S Karnaair, Chairman, Cultural and Heritage Committee, Mawlyngbna, says: “The highest power in our village is the Dorbar Schnong, comprising the Village Headman and Assistant Headman, the Secretary and Assistant Secretary and an executive committee of 20 people”. He adds: “We now use our ancient leadership structure for the preservation of our natural springs”.

### 3.2.5 Climate Change as Perceived by Villagers

Discussions with villagers on the changes in the climate they observed over a 50 year period showed that months with moderate temperature have decreased, hot months have shifted and cold months have increased. While there was continuous rainfall from April to September 50 years before, now there is intermittent rainfall from April to October, with very intense rainfall on certain days. This has led to change in vegetation and poor performance of crops and increase of diseases in the crops and animals. Major changes included the following:

- ) The village population has grown almost seven times in the last 50 years
- ) Share of diversified livestock based activities in family income has reduced.
- ) Cultivation of commercial crops has replaced maize, millets and vegetables, thus making the community highly dependent on external market.
- ) Total area under cultivation has reduced substantially.
- ) Agriculture is no longer a profitable activity for most of the villagers due to high cost of labour, pest attacks and absence of marketing facilities etc.
- ) Total area under forests has reduced by almost two third. It has become more scattered and less dense.

The major difficulties faced by the village people are:

- ) Lack of facility or processing of agro products viz., turmeric, bay leaf, broom stick, black pepper, areca nut.



- ) Absence of mechanization or storage facilities due to erratic electricity supply and non-availability of diesel;
- ) Lack of transportation facility (road, rope way footpath) from farm to village
- ) Low level of employment opportunities for youth

The perceptions about variability in the climate are reflected in official circles too. L Shabong, Officer on Special Duty, Meghalaya Basin Development Agency confirms: “Records from the last 20-30 years indicate a decrease in water availability due to low rainfall. Sometimes, we receive concentrated rainfall for a month or two, whereas earlier, that volume was spread over many months”<sup>28</sup>.

### 3.2.7 Major Development attractions in the Village

#### Community Irrigation project

Constructed by the soil conservation department and MBDA in 2011-12, the multi-purpose Umkhakoi reservoir is a huge dammed lake. It has the most unusual landscape with rocks forming shallow 'pools' through erosion. The community controls the use of the water for irrigation and guards the reservoir from over-harvesting of fish. The dam provides sufficient irrigation water to the dry downstream area. Government is supporting village communities throughout Meghalaya to construct such structures.

#### Forest Conservation Project

While the mountain ranges close to Mawlyngbna bear a barren look due to rapid deforestation, Mawlyngbna village has abundant greenery. This is due to the strict social sanctions regulating the use of tree resources. According the headman of Mawlyngbna village, Blah Bling Kynter, anyone in the village wanting to construct a house, has to apply to the Shnong with a fee of Rs 30. The Schnong gives a formal sanction allowing the person to cut a couple of mature trees. During festivities in the village, the Shnong allows lopping of dead branches of trees. Their effort at community conservation through judicious use of forests is exemplary. The villagers have realized that the three kilometer long verdant forest they have conserved is a perennial source of pure water. Although the forest area delineated is 612 ha, actual patch of dense forest seems is only around 100 ha. The forest area has decreased considerably over the

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<sup>28</sup> Key Informant interview



years. To halt deforestation, the Village Dorbar has established rules for proper management of the forest. Some of the rules enforced include:

- ) Only Mawlyngbna residents can use the forest.
- ) Causing fire in the forest would invite penalty by Village Council.
- ) No harvesting of flowers and small plants from the forest.
- ) Ban on shooting of animals and birds.
- ) People can collect only dead wood for firewood.
- ) People can get permission to remove a limited number of logs for constructing their own house.
- ) Violation of the rules attracts a minimum penalty of Rs. 1000 per offence.

The non-timber forest products (NTFPs) available from the forest area are fruits, berries, mushroom, lichen, jackfruit, wild potato, tubers, mushroom, wild banana and honey. The forest fringes are extremely vulnerable to shifting cultivation and cutting down of trees for fuel, firewood and timber. According to villagers, the main threat to the forests are accidental fires, illicit felling of trees by outsiders and existence of blank patches in the forest area.

#### Fossils of Sea Urchins dating back to the Cambrian Period

The village has a collection of fossils dating back to 450 million years, the late Cambrian period. The main fossils are those of sea urchins. After learning importance of the fossils, the village people have collected many fossils of sea urchins and are preserving them carefully as well as performing in-situ conservation. Size of Sea Urchins range from 6 to 12 cm. The largest of the species can reach up to 36 cm.

The Government of Meghalaya, through the Department of Community & Rural Development has been focusing on developing this village according to a detailed master plan. A road is under construction to this "Fossil Village," which resembles a dry seabed. Once the road is completed the number of visitors will increase, resulting in heavy carbon foot print and damage to the fossils. Building the capacities of villagers to understand the nuances of eco-tourism is integral to its sustainability.



### 3.2.8 Conservation and Rejuvenation of Natural Springs

“Scarcity in plenty”- this statement aptly describes this area which is the wettest place on planet earth. Though receiving the highest annual rainfall in the world, this area thirsts during the dry period from December to April. The village cluster has a drinking water supply system since mid-eighties through a common water tank. In 2011, Public Health and Engineering (PHE) Department of the Government constructed a water supply tank for the village. 150 households benefit from this system. Common taps have been installed, many of which are in need of repair and maintenance. The main water resources for the village are the following:

- i) Perennial Umsyntai river which is located in the western part of the village;
- ii) Perennial Umsylloi water fall located near the fossil area and
- iii) Two main streams, Umdiengkain and Umkhakoi, which drain the western region in the village, the main agricultural area.
- iv) Six springs - Lawdiengluin, Khlaw seij-iong, Umsait wait, Lawshangdiar, Mih-um and Wah uben

For centuries, Mawlyngbna and nearby villages depended on natural springs for most of their water needs. Even today people use spring water for domestic use (drinking, washing and cleaning) and irrigation of backyard vegetable beds. One of the springs is said to have medicinal properties.

#### Khlaw seij-iong spring

This spring is right below settlement of Lawbah village and water from the spring goes back into the ground after being on the surface for about 70 meters. Large quantity of water is available in spring though the quantity reduces by 30% to 50% during winter (dry season). People of Lawbah and Mawlyngbna villages use this spring mainly for bathing and washing. Though in the past there were strict rules for maintaining cleanliness of the area around the village, enforcement became difficult due to population growth and pressure on resources. As a result, the condition of the spring began to deteriorate. The wastewater from the washing point and garbage of Mawlyngbna and Lawbah villages mix into downstream water of the spring.



P 8: Khlaw Seij-iong spring



P 9: Mih-um Spring

### Mih-um Spring

Mih-um (um=water) spring is the lower most spring of the village and serves the need of three villages - Mawtepeiw, Umtyllun and Mawlyngbna. A large quantity of water is available throughout the year. Villagers believe that water from the Khlaw seij-iong spring emerges back as Mih-um spring, about 300 meters down the hill. The water flow is regular during summer (rains) but the quantity of water reduces during the winter (dry season). Sometimes, water flow stops for a few hours and later it starts again. It is believed that the water is emerging from a pool of underground water, which is being fed by an underground stream. Whenever the water level decreases in the underground pool the spring stops and again with increase in the water table the spring comes to life.

Water quality of the spring is variable. During rains, the water is muddy, indicating that the surface runoff affects the spring. Water in the spring is much cleaner and less contaminated during winter. Water test reports got conducted by the community show the water of this spring contained bacteria six times more than the permissible limit. There is a possibility that water from the polluted Khlaw seij-iong spring is contaminating the water of Mih-um spring.

### Other springs

The quality of water is best in Umsaitwait spring, followed by Lawshangdiar spring. Traditionally, the water from these two springs were used for drinking but the water availability during winter reduces



and people have to depend on other springs. The water of these springs requires filtering and boiling. Water from Lawdiengluin is used for drinking only by upper part of the village Mawlyngbna, which is inhabited by poor people.

#### Mining and Forest destruction spell death knell to the springs

Though the six springs are the main sources of water for domestic use for three villages in the cluster, growth of population and development works are slowly contaminating the springs through the infiltration of sewage and deposit of sewage and solid waste. These seep into the underground water and the springs get contaminated. The main reason for the deterioration of the quantity and quality of water was stone mining and cutting down of the forests in villages on the higher ridges lying in the catchment of springs. The villagers in Mawlyngbna cluster took up the issue with the Syiem and forest cutting and limes stone mining has stopped temporarily. However, there is pressure from the mining agents for resuming the activity. If the lease rights are given by the concerned villages to the rich mining undertakings it will be difficult for the villages in the Mawlyngbna cluster to stop mining and forest destruction. Due to the above problems, 60% of households of this “spring village” faces acute water shortage during the dry period.

#### Joint Spring Management Committee

The villagers decided to turn this challenge of water scarcity into an opportunity by establishing proper water storage and distribution system to support many water based economic activities such as agriculture, fisheries etc. They are planning to establish a packaged water-bottling unit for supply of RO and UV treated drinking water to market in Meghalaya with support from GIZ project on climate change adaptation. Water management is going to provide a source of income and employment to people in the village through marrying traditional knowledge to modern science.

Though owned by specific villages, springs are common resources used by multiple villages. Meghalaya Basin Development Authority is promoting Village Integrated Cooperative Society in all the villages for implementation of the Basin Development Programme. There are plans to form a Society in Mawlyngbna village. As many villages are involved, there is need for one coordinating body for several villages depending on the CPR located in any specific village. Realizing the need for this, the concerned villages have begun groundwork for forming Joint Spring Management Committee, with representation



from the villages of Lawbah, Mawtepeiw, Umtyllun, and Mawlyngbna for development, maintenance and management of all the springs.

The roles and responsibilities of the committee are to:

- ) Negotiate with other villages situated on the higher ridges forming catchment of the springs for controlling deforestation and mining.
- ) Construct water storage and distribution system on mouth of the spring, with assistance from the Government / Bank loan.
- ) Impose usage charge, based on the capacity to pay from different families, and use the sum collected for maintenance of the structures and repayment of loan.
- ) Establish common water treatment and purification system for drinking water supply
- ) Ensure that liquid or solid waste is not disposed of in the close vicinity of the springs.
- ) Protect the mouth of each spring and disallow activities like bathing and washing at the source.
- ) Construct separate usage points (washing, bathing, irrigation) away from the spring and transport the water by pipelines from source to the usage point.
- ) Ensure that waste-water from the usage points are not put back directly into the stream without treatment.
- ) Establish packaged drinking water bottling unit as an economic activity.

#### Protection from Contamination

Villagers have realized the importance of stoppage of water contamination and installation of purification systems. They have prepared plans to keep the usage points away from the mouth of each spring. Water pipelines will connect the usage points. Ideally, the water after usage has to be treated before it is released back in nature. The villagers have estimated that this will cost Rs. 4-5 lakh will be required for development of usage points and supply of water through pipelines, which they plan to finance through Government grants or through bank loan. They want the PHE department to prepare the detailed engineering design and cost estimate for each of the six springs. The villagers are ready to form a spring management committee and ensure maintenance of the assets so created. Collection of usage charges will help maintain the assets.

#### Packaged Drinking Water Bottling Unit

The village has proposed the establishment of a packaged purified drinking water bottling unit by the brand name Meghalaya Jal. As per ISI specifications, requisite amounts of essential minerals such as Barium, Iron, Manganese, etc. will fortify the water. Ownership will vest in the Mawlyngbna a Cooperative Society, under the aegis of Meghalaya Basin Development and Livelihood Programme. The



product is expected to be marketed well as the only source of bottled drinking water presently is in Assam. The plan is to set up an automatic plant for packaged drinking water, purified in 4 stages viz. pre-treatment / de-ionization, filtration, reverse osmosis, ultra violet treatment, before packaging.

### 3.2.9 Discussion

Traditional wisdom, fortified by modern technology can solve many of the problems confronting rural society. Rejuvenation and protection of springs, which provided assured safe water to village people for centuries offers a cost effective and sustainable solution to the problem of drinking water in States of the North East and other areas of plentiful rainfall. Piped water supply programme, promoted by the Ministry of Drinking Water and Sanitation, depending on gravity flow of water, has not been successful in many hilly States, as water cannot reach several habitations in the upper reaches.

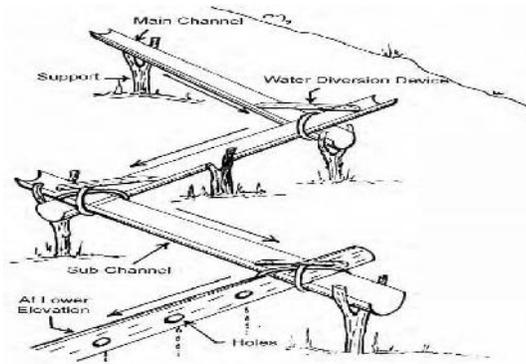
The attempt of the people of the village to fall back on their natural springs to solve their drinking water problems, and to make it a commercially successful venture for water bottling for marketing all over Meghalaya is laudable. It is a testimony to the fact that traditional wisdom has the potential of not only being cost effective but also offers income generating opportunities. A fruitful marriage of traditional wisdom and modern technology will be very useful. The unspent allocation of funds for sustainability structures, available under the National Drinking Water supply programme, can serve rejuvenation and protection of natural springs in Meghalaya through developing the catchments of the springs, which have undergone damage due to mining and severe deforestation.



### 3.3 Bamboo Pipe-Based Conveyance of Water for Drinking and Irrigation

#### 3.3.1 Bamboo Drip Irrigation

Since more than 200 years, people of *Garo, Jaintia and Khasi* hills of Meghalaya have been using an ingenious system of tapping of stream and spring water by using bamboo pipes to irrigate plantation crops of betel leaves, black pepper and betel nut (areca nut). There is extensive documentation of this



P 10: Sketch of Bamboo Drip Irrigation System (Courtesy, Singh and Gupta footnote 30)

system in the Nongbah village of the Thaldaskein Block of Jowai district. This system was used in the winter for betel leaf and black pepper crops that require relatively less water. Water from an uphill source is tapped and brought to the plantation by a main bamboo channel through gravity. The water is then regulated through a complex bamboo network of secondary and tertiary channels to all the parts and corners of a plantation, right up to the bottom of the hill. About 18-20 liters of water enters the bamboo pipe system per minute, flows over several hundred meters, and reduces to 20-80 drops per minute at the site of the plant<sup>29</sup>, wastage of water being minimal, due to the high skill of the craftsman. Flow of water into the lateral pipe is controlled by manipulating the position of the intake pipes<sup>30</sup>. The material needed include dao (a type of local axe), chisels, bamboo strands, forked branches of trees and ropes made of creepers. Two craftsmen can construct a network covering one hectare of land in 15 days<sup>31</sup>. Maintenance is limited to cleaning and reinforcement after seasonal monsoons.

<sup>29</sup> <http://www.rainwaterharvesting.org/Rural/Traditional3.htm>

<sup>30</sup> R.P.Singh and Gupta, Traditional Land and Water Management Systems of North-East Hills Region, Indian Journal of Traditional Knowledge, Vol 1(1), July 2002, p 38.

<sup>31</sup> <http://permaculturenews.org/2014/02/28/bamboo-drip-irrigation/>



### 3.3.2 Drinking Water Supply through Bamboo Pipes

On the road from Baghmara town, the headquarters of South Garo hills district to Chopkot, a Block headquarter in the same district, we came across several water conveyance systems through bamboo pipes. Particularly fascinating was bamboo based water supply system for the Someggre Government Lower Primary School. Someggre is a hamlet of Sibbari A village. The village, located in Gasuapara Block, is surrounded by Dalu Block towards west, Chokpot Block towards North, Baghmara Block towards the East, and Gambegre Block towards the North. Someggre is cut off from the main village through a tributary of the river Simsang. The river can be crossed with very narrow, unstable country made canoes.

Militant activity by the Garo National Liberation Army is a major law and order problem in the Garo Hills, bringing all development work on a standstill. Abduction of Government and bank officials, even teachers and ordinary people, has become the order of the day. The ban on coal mining has dried up one source of extortion income by the militants and now they are collecting money from even ordinary villagers. Gasuapara and Chopkot blocks are the epicenters of the militant activity and the area has witnessed many abductions and killings, almost on a daily basis. There was an attempt on the life of the Deputy Commissioner of the district a few months back. A woman was recently shot in the head on



P 11: Crossing the river through country made canoe

suspicion of being police informer. In some villages, there is a ban on using electricity after seven p.m. so that militants can move freely in the cover of darkness. Government officials are fearful of moving into the villages for fear of life. The bad security situation put severe constraints on our movement to the villages.

There is no provision for drinking water supply under the National Rural Drinking Water Programme in this village. The only source of the school is a spring about 500

meters on a higher elevation, at the mouth of which a check dam was constructed several years ago by the Government to meet the drinking water needs of the school. The check dam has now silted up but



still water is available in plenty in the mouth of the spring. The Public Health Engineering Department, the designated agency for NRDWP, built a water storage tank in the school compound. The plan was to bring water from the spring to the water tank through steel pipes to meet the drinking water needs of children. It was also planned to provide safe drinking water to all households in the village. The plan did

not come through somehow, except bringing a few iron pipes to the village.



P12: Split bamboo Conveyance system for Drinking water in Sommeffre

The Village Council then deliberated on how to bring water into the water tank. They decided to fall back on their traditional wisdom of using bamboo pipes for supplying water into the water tank. They mobilized the required funds for purchasing bamboo through voluntary contribution. The split the bamboo to form pipes and connected the

spring and the water tank with it. The system now requires weekly cleaning of the pipes

(fallen leaves get deposited in the pipes) and the replacement of the pipes every six months. The waste water from the water tank is carried to the paddy fields down below through another stretch of bamboo pipes and a single drop of water is wasted. Though the check dam has silted up, water from the spring is

available throughout the year.



P 13: School Water Tank in Sommeffre village

The PHE had planned a PWSS and had brought iron pipes for the purpose, but due to higher elevation, the area was not amenable for PWSS. Villagers distributed the pipes among the local residents and they use the pipes to divert water from the springs into their homes. Using locally available material for water supply is much more efficient than high cost water supply schemes



and needs to be encouraged.

Though spring water appears pure and natural, it is doubtful if it comes under the ambit it “safe” drinking water as defined by the Ministry of Drinking water supply. The MGNREGA has made efforts to make the water free of external contamination through constructing chambers around the spring, and this is of immense help to the villagers. The village does not have any arrangements for testing water quality, though field test kits was to be supplied to every habitation under NRDWP.

### 3.3.3 Constraints in continuing the practice



P 14: Bamboo shoots and vegetables for sale on NH from Tura to Baghmara

A major constraint in continuation of the practice is the decline in the production of bamboo due to a surge in rodent population, gregarious flowering, disease, and large-scale extraction<sup>32</sup>, including the destructive extraction of bamboo shoots which is a table delicacy all over the North East. Meghalaya has 3,108 square kilometers of bamboo forests, comprising 38 different species. In

1990, it was estimated that the total yield of bamboo in the state was 2.09 tons/hectare/year. Bamboo is harvested at the community level through the Autonomous District Councils (ADC).

### 3.3.4 Discussion

Several villages in Khasi and Garo hills today depend on natural springs, rivers, open wells and ring wells for drinking water. Even in habitations, said to have been fully covered under the National Rural Drinking Water Programme, the gravity based water supply systems do not work for households residing on hill tops and slopes. Further a large number of the iron /steel pipe based supply systems have become non-functional due to aging and non-maintenance. Thus people depend on natural springs and wells for drinking water. Irrigation facilities do not exist at all in most parts of the State. People have devised

<sup>32</sup> Centre for Science and Environment, Bamboo Drip Irrigation <http://www.cseindia.org/2839>



indigenous ways to meet the needs of drinking water and providing protective irrigation to betel nut and black pepper/citrus orchards. The commonly available bamboo is used as the conveyance systems through which water is diverted from natural springs (for drinking water) and from rivers and streams (for irrigation). What is needed is to protect the water source from contamination and provide storage facility for water to avoid wastage and water logging. In the Garo hills taking drinking water through bamboo pipes is a very commonly observed practice.

It is commendable that under schemes like MGNREGA spring chambers and bathing places are being constructed, which protect the springs from contamination. If such activities are done with the help of the engineering skills of PHE, the springs can become alternative and sustainable water supply systems. Treatment of the catchment of the springs should become an integral part of making spring.

When bamboo was readily available this was a zero cost technology. However, nowadays, bamboo forests are declining and production is low. One of the reasons for the low production of bamboo is the extraction of bamboo shoots for sale. As bamboo shoots are a delicacy it fetches high price and provides a major source of income for village people. This destructive practice needs to be discouraged.

The bamboo pipe based drip irrigations system requires high level of skills and only practiced hands can construct systems that will provide the right amount of water on a continuous basis to the root zone of plants. The use of bamboo pipes for drip irrigation is now practiced only in a very few villages and the craftsmen who install the systems are also becoming rare. It is possible that this age old knowledge may not survive for a longer period unless steps are taken to provide incentives. Also scientific help in preserving the longevity of bamboo pipes will reduce the costs of the systems.



### 3.4 Conservation of Endangered Fish in W. Jaintia Hills

This case study describes how the enlightened village leadership in Nongbareh, a small village, persuaded the people to give up the destructive practice of harvesting fish from water bodies of the village and build a fish sanctuary in Amlayee river. "The Amlayee River", a tributary of the Umngot River, originates from Khonglah village, at a distance of 5 km from Nongbareh Village. This is a small village in the Amlarem Community Development Block, about 21 Km from the Block headquarter. The village has 131 families and a population of about 600 persons. All the families belong to the Jaintia tribe. This village has the unique distinction of voluntarily giving up mining activity, realizing the harm to natural resources and the environment.

#### 3.4.1 The Problem

In Meghalaya, Village communities have been at the forefront of guarding rivers and streams. Though group hunting and community fishing have been popular sports of the indigenous communities, strict social norms ensured protection of animals and fish and their habitat. But, due to break down of traditional customs and practices these social norms became weak and people started using tuberous roots, barks and fruits of certain trees to poison the fish. Later people started using dynamite, bleaching powder, pesticides and electric current and other crude methods. These practices resulted in mass killings of brood fish and juveniles.

As population upstream of the river grew, contamination through washing clothes, dumping of household waste, sewage and plastic and debris from coal mines became common. Though many smaller streams join the river before reaching Nongbareh village, water in the river became scarce as people upstream diverted the water for domestic and agricultural use through pipes, as confirmed by Mawrek Pawlong, headman of the village. Flow of water in the river became scarce in the dry season due to winter rain becoming scarce and a gradual warming of the atmosphere. Reduced flow of water affected the quality of water and adversely affected the fish population.

The importance of fishing in social life of the tribal people of Meghalaya is evident from the fact that community fishing ("Shoh-Kha-ru"), was a traditional sport of Meghalaya. Even today many villages



organize annual fishing competitions, in which a lot of people participate by paying entrée fees. But over a period the sport deteriorated into crude exploitation of harvesting fish through destructive practices.

### 3.4.2 The Species

The indigenous fish species of chocolate mahseer (*Neolissocheilus hexagonolepis*) and golden mahseer (*Tor putitora*) became almost endangered due to the destructive practices, climate change, global warming and loss of habitat and aquatic biodiversity. Chocolate mahseer (local name Khasaw) and golden mahseer are important indigenous fishes of Meghalaya and a candidate species as State Fish. There has



P 15 Chocolate mahseer in the sanctuary

been a significant decline in most of their natural habitats<sup>33</sup> due to low water level in the river in the dry season and mass killing of brood fish and juveniles through destructive practices described above. The fish migrate upstream for spawning, feeding, and descend back after spawning. During both the phases of migration, the fish are killed through illegal fishing methods. Their breeding ground comprising of stones, gravel,

debris, silt, have been disturbed. River pollution is adding to the woes of the fish.

The fish has bottom-feeding habit, browsing the marginal shallows. Fingerlings feed mainly on insect larvae, aquatic beetles and flies. They eat aquatic vegetation and marginal grass. Artificial baits are of no use for the angling of chocolate Mahseer, as the fish prefers flour dough, sweet balls, dead fish fingerlings, earthworms and shrimps. The breeding season extends from May-June to August -September. Prolonged spawning season extends from May to September. The male fish attains maturity within two years while female matures in three years. Females are usually larger than males. A mature male weighs 300 to 400gm

<sup>33</sup> (Sarma and Bhuyan, 2007).



and the female weighs 600-800gm at first maturity. Gonads start developing in March and the reproductive phase lasts from April to October.<sup>34</sup>

### 3.4.3 Conservation efforts

People of Nongbareh realized the importance of conservation of their fish resources and arresting the deterioration of river hydrology as fishing formed an important part of their social life and nutrition. Forty years before, when the concept of conservation was virtually unknown in this part of the world, the people, under the leadership of the head Lyngdow (priest) started a quiet and self-directed conservation movement as a coping mechanism against climate change (though this concept was also not known to the villagers at that time). The Amlarem fish sanctuary is the first of such sanctuaries to be set up in the whole of Meghalaya, and that too, without much external support.

The first step involved converting 1.5 km stretch of the river into a natural fish sanctuary by practicing in-situ conservation. For this, they used a uniquely indigenous procedure of embanking the river with rocks and boulders. The boulder embankment provided safe sanctuary for natural propagation, supported by enforcing rules and regulations which prohibited fishing at the embankment site. Along with this they prohibited fishing in the reservoir, except for feeding the sick as the villagers knew that this species has therapeutic qualities. Anyone who catches the fish without due permission is fined Rs 1000 for each violation of the rule. Angling is allowed through permits issued by the Dorbar. Even angling was allowed only after the fish population attained a stage of stability. In the sanctuary they created appropriate environment for the breeding of fish. They fed the fish with locally available leaves and other material obtained from the forest using their traditional knowledge about the feeding habit of the fish. On every day, we can see people feeding the fish their favourite meals. The profits from the fish harvest goes to the community fund used for upkeep and maintenance of the sanctuary.

Solely relying on indigenous knowledge and displaying sheer perseverance the community found that over a period the fish population began to increase. Encouraged by the dramatic increase improvement in the

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<sup>34</sup> B. Mandal et al, Indigenous Knowledge Associated with Conservation of Chocolate Mahseer by the War-Jaintia community Practiced in Meghalaya, Indian Journal of Biological Sciences, 18 : 41-47, 2012



quality of water and increase of fish population, the community decided to lay down rules and enforce them strictly.



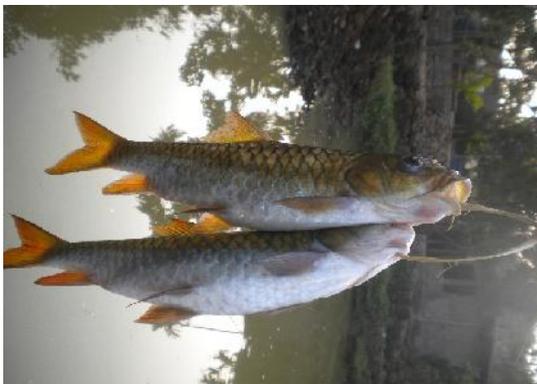
P 16: Check dam at the fish sanctuary

Much later, in the year 2000 the Meghalaya Basin Development Authority (MBDA) embanked the river up to the lower reaches. Later, the department built a permanent embankment, providing conducive ecological environment for propagation of fish. These structures also provided a permanent supply of water throughout the year. The height of the dam is designed in such a way as to allow free movement of fish in the upstream and downstream through spillways.

#### 3.4.4 The Impact

The Amlayee reservoir became a successful fish sanctuary with strict rules for sustainable fish harvesting system, using traditional knowledge that are environment-friendly and amenable to biodiversity conservation, making it a classic example of micro-management. This fish sanctuary is a nature reserve. There is complete ban of fishing of the endangered and threatened species. This has helped in preserving and enhancing aquatic bio-diversity. It provides breeding and feeding ground, increase the abundance of threatened species. It also serves as a tourist spot to benefit the rural people and improve their livelihoods.

The sustainability aspect of this practice is evident from the fact that the fish population in the sanctuary



P 17: A Good Catch

increased substantially. The Amlayee sanctuary became a model for the MSAM programme of the Government which established similar fish sanctuaries in many parts of Meghalaya. This sanctuary also meets research needs of scientific institutions dealing with pisciculture. Brooders from this



sanctuary are taken for experimental research in breeding techniques by the ICAR and St. Anthony's College, Shillong.

S. Lamin, a villager, says that this village is going to become the biggest supplier of mahseer in the country. Dr A K Nongkynrih, associate Professor at NEHU, feels that the Nongbareh village community deserves accolades for their concern and long term vision for conservation of ecology of their water body.

### 3.4.5 Replication

Amlayee fish sanctuary is just one of the water bodies, where more fascinating Mahseer fish sanctuaries can be created with active participation of the people. Taking a cue from Nongbareh, the State government replicated the experiment in Rombeggre village in West Garo Hills in the year 2006. Here in a wari (a deep pool) in the Simsang river basin, conservation of fish was initiated by imposing a temporary ban on fishing. When the fish population stabilized, the fish moved upstream, where they could be caught legally, enhancing the income of the people. According to Nipul Das of Meghalaya Rural Development Society (MRDS), a series of such waris in the upper and lower reaches preserves the gene pool of fish protect the water from contamination.

Enthused by the success of the Amlarem sanctuary, the Meghalaya State Aquaculture Mission (MSAM) is now engaged in developing fish sanctuaries for conservation of chocolate mahseer and other indigenous and endemic species of the State. The objective is enhancing and preserving aquatic biodiversity, providing breeding facilities as per the breeding habits of the fish, protecting the species from genetic pollution and enhancing the livelihoods of people. Government of Meghalaya is planning to declare Mahseer as the State fish and to ban unregulated fishing in selected water bodies, where fishing will be allowed only through rods and lines. In order to evolve a systematic rehabilitation policy for Mahseer water bodies, State Government is planning to undertake detailed surveys. The existing Mahseer sanctuaries in various locations will be protected, and will be developed as tourist destinations, in collaboration with the Department of Tourism. Some sites are being developed into sport fishing and aqua tourism centers.



The conservation effort has other economic advantages for the state, whose heavy demand for fish is met through imports from as distant places as Andhra Pradesh. The total consumption in the State is estimated at 19,000 MT and the gap between the demand and supply is approximately about 14,500 MT.

Another scheme was announced by the Government of Meghalaya in 2005, named 'Thousand Pond Scheme' (TPS). This innovative scheme brought about 500 hectares of additional water area under fisheries and provided assistance to 2,336 fish farmers over a six year period. Learning from the TPS, the Fisheries Department revamped it into a new scheme with provision for providing forward and backward linkages.

### **3.4.7 Discussion**

The Amlayee initiative is particularly relevant to adaptation to climate change for several reasons Firstly, it originated from the assessment of the village community that changes in weather patterns, along with other environmental factors and destructive fish harvesting practices had led to the depletion of their natural resources, represented by chocolate mahseer, the indigenous fish species. The experiment also clearly demonstrates that self- directed community action, under an able local leadership – whether religious or secular - is the best adaptation strategy against climate change. Thirdly it demonstrates that traditional knowledge can provide a lead to the scientific community in developing agenda for natural resource conservation activities.

The technique used by the communities of Amlayee could be adopted in various streams and rivers of the region for the survival of the fish population. This experiment has inspired several State wide programmes for development of fish sanctuaries for conservation of chocolate mahseer and other indigenous species by the State Meghalaya State Aquaculture Mission (MSAM), the intention of the State Government to declare Mahseer as the State fish and to check unregulated fishing in selected water bodies, development of fish sanctuaries as tourist destinations in collaboration with Department of Tourism etc.

It is evident from this study that when villagers are convinced about the importance of conserving their resources and organize themselves around their traditional institutions and use their indigenous knowledge, new opportunities are thrown up to tackle the impacts of climate change. A single initiative by enlightened village leadership without any external help has resulted in a fish resources conservation



movement spanning all over Meghalaya, Government chipping in with technical and financial support to village communities to establish fish sanctuaries. The fact that this local initiative is also supporting research efforts shows that science can also benefit from traditional knowledge.

In Meghalaya many new fish ponds are constructed every year under several government programmes like the MGNREGA (Mahatma Gandhi Rural Employment Guarantee Act). However, our interaction with village people, particularly in Garo hills, showed that many of these newly constructed ponds are not optimally utilized due to absence of technical knowledge and high cost of fingerlings and other inputs which are purchased through traders from the plains at high cost. The fisheries department appeared to be ill equipped with meeting the rising demand for inputs and technical assistance. We recommend an even more proactive role for the fisheries department to avail of the traditional knowledge and fish rearing skills of local people to bring about a revolution in the fisheries sector.



### 3.5 Shifting Cultivation in Saitual and Kaifeng Villages, Mizoram

#### 3.5.1 The Location

Saitual and Kaifeng villages are situated in Thingsulthliah Rural Development Block. According to people of the village, their ancestor, Dorawta settled in this village in 1915, naming it after the Mizo name for elephant. The population of the village is 5573 persons in 1150 households. Recently the village council has been bifurcated into three distinct village Councils - Saitual I, II and III. There are many educational institutions in this village due to which literacy rate is very high. Kaifeng village is named after an indigenous tree abundant in the area. It has 873 households with a population of 2145 males and 2010 females. There are 724 persons educated above matriculate level. The main drainage system in the two villages is the Tuivawl river, which originates from Rullam tlang (hill) at a height of 1590m above mean sea level and flows northward till it confluences to Tuivai river in the north. The river has eight tributaries.

#### 3.5.2 Land Use Pattern

The land use pattern of the two villages shows that about 78 % of the land area is under forest cover and about one fifth of the area is under shifting cultivation. In fact less than 2% of the total area is under permanent agriculture (0.06% under wet rice cultivation during Kharif). The rice fields on the river bank become unusable due to rubble washed into them by flash floods. Thus shifting cultivation forms the major source of food security for the villagers. The entire requirement of rice and other food grains and vegetables is met through jhum cultivation, in the absence of which the village will starve. Livestock rearing does not form a significant component of the livelihoods of the people. Though ration shops supply rice at subsidized rate, the villagers prefer the rice grown on jhum land. Due to Bamboo flowering in 2007, 2008 and 2009, vast bamboo forests got destroyed, forest fires became frequent and rodent population increased, threatening crops. Horticultural crops occupy 0.3% of the area, (citrus, tea, pineapple, banana and squash)<sup>35</sup>.

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<sup>35</sup> Soil Conservation Department, Detailed Project Report for IWMP



### 3.5.3 Village Forests: A Common Property Resource

There are two types of forests in Saitual and Kaifeng - village safety forests and unclassified forests. Both types are owned and controlled by the village council as per customary law. No one in the village dares to disturb the village safety forest which protects the village from storms and cyclones. Beyond the safety forests is the unclassified forests.



P 18: Jhum slope of Kaifeng Village

The village council land is the Common Property Resource (CPR), a resource set apart by a tribe for the use of its members without the right of private ownership. The community manages the resources collectively on the principle of equal usufruct rights. Customary laws govern use and administration of the resource and sustain people's culture, economy, social systems and identity. Customary laws were

accorded legal recognition in Mizoram through Article 371G of the Indian Constitution. CPRs provided members of the community both tangible and intangible livelihood, particularly the poor members. These benefits included fodder for livestock, food security (through shifting cultivation), edible fruits, leaves and vegetables, small timber and medicinal herbs.

### 3.5.4 Rules Governing Jhum Cultivation

The Village Councils of both the villages have demarcated patches of the unclassified forest as jhum land. Each year, the councils give temporary passes or "garden pattas" to families resident in the village to practice jhum cultivation. The patch of jhum land is allotted through draw of lots in the presence of the village assembly. In Saitual, each able bodied adult male is eligible to be allotted 2 acres of land and in Kaifeng, 1.5 acres. The family can cultivate on the cleared jhum patch for two years consecutively. The



Council enforces the customary law very strictly, with the result that forests are regenerating after cultivation for one to two years.

### 3.5.5 The Practice

There is a fixed time period during which preparation of field and burning takes place. Under the Mizoram (Prevention & Control of Fire in the Village Ram) Rules 1983, *jhum* burning can only be carried out between 15 February and 15 March each year. Any change in the timing has to be jointly decided by the community, assigning valid reasons. During this period, the family cuts down the trees on the demarcated patch and let the vegetation sun dry. They remove any useful timber or log for household uses. They then burn the slash in contained fires.



P 19: Harvested Jhum Rice on roof of resting hut in Saitual village

After the onset of the early monsoon they plant 15-20 different crops in the same plot through intercropping operation, meeting all the food security requirements of the family and sometimes of the entire community. Sharing the products in times of need was a common practice. No chemical or fertilizer is used and the food items are fully organic.

In olden times, the field was left fallow for over 12 years but nowadays, the field is cultivated for about two years and then left fallow for another 5 years. When the *jhum* cycle was longer, the rested fields rapidly regenerated into forests, each ha having over 10,000 bamboo culms in five years. Regenerating fields and forests in the *jhum* landscape provided resources for many years. These included firewood, charcoal, wild vegetables and fruits, wood and bamboo for house construction and other home needs. For every hectare of forest cleared for *jhum*, farmers retain 5 to ten hectares as regenerating fallow. After dense forests reappear on the original site, farmers return for cultivation.



### 3.5.6 Control Forest Fires Resulting from Jhum Burning

There are certain customary practices to prevent forest fire<sup>36</sup>. These include the following:

1. Determining the timing of jhum burning
2. Jhum burning is done usually in the late morning or early afternoon so that burning can be completed at the latest by early evening.
3. Jhum duties for family members are allotted by age and gender. Male members: notify village authorities, immediate neighbours and those having adjoining *jhum* fields about the date and likely time of burning. They go to the field and start the fire, remain in the field until the burning is completed ensuring that the fire does not spread to the adjoining forest patches. The female members store water for ready use and remain watchful for wind-borne spread of fire. Children also remain watchful and alert elders if they suspect spreading of fire.
4. A fire line is created by maintaining a cleared corridor about 8-10 m wide between the slashed vegetation and the adjoining forests.
5. Traditionally, jhum clearing and burning is a community activity and every able-bodied member is expected to be available during these two activities at the jhum site. The community may participate in the physical activities of preparation of the jhum land for cultivation, preparing fire lines and burning.
6. All family members along with friends and relatives recite communal prayers before undertaking each stage of the jhum activity.
7. A few leafy trees and bushes are left uncut in the fringes of the jhum field. This live vegetation not only prevents the spread of fire but also their leaves and branches can be used quickly for extinguishing fires,
8. A day or so prior to burning, the farmer along with his friends and neighbours inspect the fire lines to ensure that fires do not spread.

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<sup>36</sup> Vincent T Darlong, Traditional community-based fire management among the Mizo shifting cultivators of Mizoram in northeast India, FAO Corporate Document Depository, Regional Office for Asia and the Pacific.



Whenever forest fires occur the following steps are taken:

1. The Village Crier (messenger or announcer) has to alert the community.
2. On hearing the announcement the residents rush to the fire sight and try to control the fire.
3. While going to the jhum field for firefighting, they go mostly barefoot and wearing simple cotton clothing to ensure swift movement. They also carry water to put out burning logs. Labour is also divided across age and gender for *jhum* burning.
4. The village council or government can impose penalties on individuals, or on the entire community, for deliberately or accidentally causing forest fires. The penalty varies according to the extent of damage and cause of fire. The money collected is channeled to the Village Welfare Fund.
5. If local efforts fail, the Village Council seeks the help of Fire Fighting Authority to control forest fires.
6. Under the Mizoram (Prevention & Control of Fire in the Village Ram) Rules, every village must set up a Village Forest Fire Prevention Committee (VFFPC). The Committee nominates volunteers from amongst its members to be "Fire Watchers" who remain active particularly during the period of *jhum* burning.

Village elders recall that in olden times, the jhum activity was accompanied by singing and dancing, ceremonial prayers and other forms of community activity. Part of the harvest was offered to gods and for distributing to the poor sections of the village community. The communal nature of the jhum activity has declined over the years.

### **3.5.7 Jhum cultivation was eco-friendly in the past**

The Inter-Ministerial National Task Force on Rehabilitation of Shifting Cultivation Areas (2008) recognized that shifting cultivation was a sustainable agricultural practice within fallow lengths of 10 to 20 years and population density of less than 20 persons per sq. km<sup>37</sup>.

The report also concedes that the practice was able to secure the energy, protein and medicinal components of the household economy and to establish a vital linkage between biological and social

<sup>37</sup> Government of India, Ministry of Environment and Forests, Report of the Inter-Ministerial Task Force on Shifting Cultivation, 2008.



reproduction. Jhum cultivation is a completely organic agriculture, with no use of external inputs like chemical fertilizers, pesticides or exotic seeds. The ash resulting from burning nourished the soil. The fallow period helped the area to recover and rejuvenate into a new forest. A long time back, the jhum cycle was over 15 years.

In the past jhum cultivation caused little environmental harm as the system was practiced under strict social norms enforced by the village authority. Jhum cultivation took place in small forest patches. The village authority demarcated patches of forests early in the year for each family, depending on the number of able bodied men in the family, early in the year.

### 3.5.8 Concerns about jhum cultivation



P 20: A wide variety crops in Jhum Field in Saitual Village

Shifting cultivation is regarded by most people, particularly in Government circles as a wasteful and ecologically dysfunctional system, detrimental to forests and soil, and as needing to be eradicated by inducing cultivators to adopt other forms of livelihood. The philosophy behind Mizoram's New Land Use Policy is precisely this. This is countered by another perspective that shifting cultivation is a

legitimate practice that ensures the survival of people living on marginal lands and hence should be allowed to carry on.

The main factors that cause concern about jhum cultivation is that the jhum cycle has come down due to population increase, relocation and regrouping of villages, and expansion of urban settlements. There is no sufficient time for forest regrowth, thereby making jhum unsustainable.<sup>38</sup> The New Land Use Policy,

<sup>38</sup> TR Shankar Raman, "Bamboozled by Land Use Policy", The Hindu, May 14, 2014



the flagship programme of the State Government, which has been designed to stop the practice of jhum cultivation, has in fact been used by many people to continue to occupy the allotted land for normal jhum cultivation, in the long term converting it into private property.

Another worrying factor is that wherever the village councils are weak, people burn down areas that are not required for cultivation and try to retain the land permanently. Some people who were allotted community land (4 acres per family) for cultivation under the New Land Use Policy retained the land even when they could not cultivate the entire area. Soil erosion is a major problem in shifting cultivation areas. Only the top soil becomes wet during the rains, leading to increased runoff speed of rain water resulting in low underground water table. Natural springs which was a source of very good quality drinking water get dried up during winter months.

The thinning forest cover decreases moisture content of the soil making it unsuitable for plantation of trees and crops. Temperature also increases considerably because of this. Due to loss of top soil, the productivity of land decreases tremendously. The productivity of land in case of paddy is only 600 Kg per acre, which, the villagers say, is almost 50% less than 10-15 years ago.

### 3.5.9 Discussion

Jhum cultivation will continue to be the major agricultural activity and the source of food grain and vegetables in Mizoram for a very long period as only less than 2 percent of total geographic area is under wet rice cultivation. A very high proportion of the geographical area is under forests, but the area under dense forest cover is decreasing. Under the new land use policy and the promotional efforts of the soil conservation department, area under horticultural plantations will increase in the future, but food security will still come from jhum cultivation.

Opinion on the efficacy or the ill effects of jhum cultivation is highly divided, but the fact is that while agreeing with several worrying factors about shifting cultivation, we should also recognize the positive aspects of this traditional agricultural practice, which is perhaps the corner stone of the agricultural economy of Mizoram.



If the traditional wisdom and customary practices are followed, jhum cultivation can continue to exist as a good source for organic food items. Jhum should be allowed only in the areas traditionally demarcated for this activity and the customary rules should be strictly enforced by making the village councils respected by the village community. The reduction of the jhum cycle should not be encouraged so that the jhum land recovers its capability and excessive soil erosion and reduction in the water table and drying up of water sources do not take place.

Interaction with village people showed that climate change, represented by the changes in rainfall pattern, uncertain rainfall in winter, spread of invasive variety of weeds due to changes in temperature and humidity are affecting jhum cultivation also. Farmers are now unable to use the traditional variety of seeds of rice and vegetables. Many of the traditional seed varieties are facing extinction. Agricultural



P 21: Jhum rice ready for harvest

universities can chip in by doing research on conserving the germ plasm of traditional seed varieties and evolving new varieties that can withstand climate variability.

One of the major threats to shifting cultivation areas is washing away of top soil during heavy rainfall. The only sustainable way to tackle this problem is suitable silvicultural practices like Alder (*Alnus nepalensis*)-based agro-forestry in the shifting cultivation areas in

Nagaland. However the choice of species for agro forestry in jhum fallows must be location specific, based on indigenous knowledge and must on rely on mono cropping to rule out the possibility of pest attacks. This would require technical and scientific backstopping to the jhum community in the form of agronomical and silvi-culture experts and extension workers. There is scanty knowledge regarding appropriate silvi-culture practices for shifting cultivation. Knowledge generation in this area must be encouraged.



The main problem of shifting cultivation arises from the shortening of the fallow cycle and the associated unsustainable practices in the management of shifting cultivation lands. It is not possible, as in the past, to extend the area of shifting cultivation to keep the cycles. In the face of competition from lobbies plantation crops (rubber, tea, cashew nut, and pineapple), urban and industrial expansion, conservation for local ecosystem services and biodiversity, the interests of the jhum farmers are less likely to be supported.

Though the village councils in the study villages are continuing to regulate land allocation and management of shifting cultivation in the areas under their jurisdiction they need capacity building support to undertake perspective planning of development of their natural resources, to promote and sustain innovations and to adopt new technologies.

Capacity building should extend to local communities to be aware of perspective land-use planning, which would give space for forest conservation, agriculture development, and their other livelihood concerns. Perspective planning is necessary to focus on land optimisation and plot consolidation during annual plot allocation exercise by the community/ clan leaders. This will control wasteful clearance and more land will be available for forest fallow regeneration.

The forest fire management system of Mizoram is a blend of indigenous customs of fire management and formal rules by government. It relies on an extension education approach for eliciting voluntary support from the local communities. This can be replicated in other States having significant areas of shifting cultivation.

The returns of shifting cultivation farmers can be improved if the products are marketed as organic agriculture produce. This will reduce unnecessary extension of cropping area in the shifting cultivation cycle.

Agricultural scientists would be doing yeoman service if they are able to document, conserve and preserve the traditional seed varieties used in jhum areas, some of which are facing extinction.



## 3.6 Assessing Climate Change and Forecasting micro-weather by Observing Nature: Mizoram

### 3.6.1 Reiek Village

Reiek is a village located in Mamit district, about 30 km to the West of Aizawl on the sprawling Reiek mountain peak. With gentle slopes on its eastern side, the mountain has spectacular rocky cliffs, caves and caverns amidst luxuriant natural forest. A big cave in Reiek was the temporary headquarter of the Mizo National Front, banned in 1996.<sup>39</sup> The Tlawng Lui, the longest river of Mizoram gushes through a narrow rocky gorge in the village. The ridge hosts splendid meadow-like vegetation in an otherwise rugged, mountainous region. The ridge top is covered with tall grass. Right on top of the peak is a big boulder jutting out over a high precipice. The forests in Reiek, owned by the village community, house a fascinating variety of hill birds, including the rare Peregrine falcons, which can be seen perched on a lofty ledge or swooping on the cliff. Tourism department has developed here the model of a typical Mizo village consisting of distinctive traditional huts of Mizo tribe, chieftain's house, a bachelor dormitory etc. Reiek is also famous for the annual Anthurium festival. The rush of tourists has given rise to environmental problems, against which the village youth, led by the YMA (Young Mizo Association) have entered into advocacy campaigns.

There is an interesting folklore, according to which<sup>40</sup> the peaceful reign of Khawluahlali, the queen of the demon spirits of Reiek Tlang, was disturbed by the arrival of another demon in the form of the Tlawng river, which began to flow southwards through the passage between the two hills of Reiek and Lungdar. Queen Khawluahlali fought and defeated the Tlawng river demon, who showed his anger by taking a circular turn and coursing back. This spot is still known as 'Tlawng nuar' or 'Tlawng in a temper'. While the inhabitants of the village were celebrating the victory by dancing and celebrating, the Chawngchen, demon spirits of Chhawrpial Tlang attacked them. The demons of Chhawrpial tried to kill them by crushing them with the weight of the great protruding rock of Reiek Tlang. The heavy hammering caused cracks to appear at this great projection. The demons of Reiek transformed themselves into falcons and bitterly fought with their opponents, finally defeating the aggressors. The

<sup>39</sup> Jagadish Kumar Patnaik, Mizoram, Dimensions and Perspectives: Society, Economy, and Polity, Concept publications, New Delhi

<sup>40</sup> Lalsangzuala, Reiek Tlang and its Lores, Department of Mizo, Mizoram University



water of the river turned red with the blood of dead warriors. The demon queen's beautiful daughter Ngaiteii, died in the battle. Moaning the death of her daughter, the queen watched the sunset, sitting on the great rock projection at the peak of Reiek Tlang. The villagers believe that edge of the rock projection bears the imprint of her bottom.



P22 View of the hill ranges on way to Reiek

With 360 households, the population of Reiek is 1627 persons, of which 786 are males and 841 are females. The literacy rate is above 98% compared to the state average of about 91%. The village council of the village is quite active. Agriculture is the main occupation of 80% of the families.

food grain requirements. A few rice fields are there on the river bank but they become unusable due to



P 23 Meeting with Village Residents

Like most villages of Mizoram, Reiek also depends on Jhum cultivation for its rubble washed into them by flash floods. The entire requirement of rice and other food grains and vegetables is met through jhum cultivation, in the absence of which the village will starve. Though ration shops supply rice at subsidized rate, the villagers prefer to eat the rice grown on jhum land. The village council is strictly enforcing the rules regarding jhum cultivation,

ensuring that there is no environmental damage to the forest resources.

### 3.6.2 Local Perceptions about Climate Change



During our interaction with the people of Reiek village, we tried to understand how people perceive climate change and to learn about the traditional systems through which they tackled the problem of climate and its variability. Similar discussions were held in the villages of Saitual and Kaifeng also. From the information gained from the discussions in the three villages showed that climate change manifested to the villagers in the following ways:

- i) Till the recent past, there was insufficient fruiting of tamarind and betel nut trees in higher altitudes. Since about five years, these trees are flowering plentifully, leading to improved production. Villagers attribute this to a relative warming of the climate.
- ii) The size of citrus fruit is getting smaller and the taste is not as sweet as before, again reflecting a rise in temperature.
- iii) People reported hotter daytime temperatures. This affected the ability to work in fields.
- iv) Fungal and bacterial diseases of fruit of all kinds is increasing.
- v) The intensity of late monsoon rainfall is decreasing. In the past there used to be some rainfall in October-November. However, since last five years, rain is missing in this period. As a result the cropping cycle, which utilized residual moisture of late monsoon rains has been affected.
- vi) Rainfall in the main monsoon season is becoming unreliable and erratic. Early harvested jhum paddy variety is doing well but late harvested paddy productivity is going down due to the absence of October rains. Many of the farmers are switching to the early sown variety.



vii) Friendly insects like *cikada*<sup>41</sup> and *mole cricket* have disappeared. This is not due to pesticides since these are not used in jhum areas.

viii) Disappearance of several species of butterfly is taking place.

ix) Wilting of banana bunches before ripening has been observed.

<sup>41</sup> wikipedia. Cicadas are insects (order Hemiptera, suborder Auchenorrhyncha). Their eyes are prominent, though not very  
la) P 24: Drying up of parkia rosburghii, due to warming



- x) Rice bean and the tree species of *kangtek* and Tree bean (*Parkia roxburghii* - local name *lawngtah or zongto*)<sup>42</sup> cannot survive any more.
- xi) Eupatorium, a flowering plant, has disappeared but in its place a smaller variety also resembling eupatorium has emerged.
- xii) *Mikania micratha* (a variety of weed)<sup>43</sup> has infested many areas (it first appeared after 1959 during the bamboo flowering incident).
- xiii) Dry terrace areas are now being used for growing turmeric and not rice. Even in jhum land turmeric is grown for three years consecutively

### 3.6.3 Weather Forecasting through Indigenous Knowledge

Knowledge of the weather is very important for farmers to plan for their farming operations. Though Science & Technology based weather prediction models have recently become quite accurate, they very often do not reach farmers and are not been of much help at community level. Further these models depend on macro-parameters and become less accurate at micro-level. Traditional methods of weather prediction and observations about changes in the climate pattern have helped farmers in many parts of India to make decisions about crop and irrigation cycles<sup>44</sup>.

In Tamil Nadu, the Swaminathan Research Foundation has documented the indigenous weather prediction systems of rural communities. These predictions are quite accurate at the micro level and can be of durations of 24 hours, 2-10 days or seasonal. The reliability of the predictions are rated as high and they help in mobilizing labour for weeding, shifting of cattle, organizing fuel under shade, drying and collecting dried products etc. The Tamil Nadu Agricultural University is also engaged in documenting traditional knowledge of weather prediction.

Like in many other rural areas of India, in Mizoram too people rely on observing nature to predict the micro-weather in their locality. Such predictions help them to plan their agricultural operations and

<sup>42</sup> Tree bean is a nutritious leguminous tree, which used to grow abundantly in Mizoram, and thought to be ideal for planting on jhum fallows for soil binding. The pods are a delicacy costing up to Rs 80/kg. It has medicinal properties, certain parts can be used as insecticide and even as a face wash. See D.M Firake et al Current science, Vol. 104, N25. 12, 25 June 2013.

<sup>43</sup> Applying juice of the leaf is said to be good for clotting blood. Drinking a concoction of the leaves is a good remedy for dysentery. Ref Bhardwaj S et al, Ethno medicinal Plants used by Tribal of Mizoram to treat cuts and wounds, Indian Journal of Traditional Knowledge, Vol 4, No.1, 2005

<sup>44</sup> R. Rangalakshmi, linking traditional and scientific knowledge systems on climate prediction and utilization (Swaminathan Research Foundation).



adjust to the vagaries of the weather. Chinlapianga has studied the indigenous weather forecasting systems of the Mizos, using 16 bio- indicators<sup>45</sup>.

In Reiek village also the village elders could still recall some of the methods through which they can tell about weather patterns. These included the following:

- i) Appearance of reddish colour on the western horizon, particularly before the pre-monsoon season, indicates the likelihood of rain in two to four days. But the appearance of a reddish colour in the sky after prolonged heavy rainfall indicates that the rain is going to stop shortly.
- ii) A thick cloud on the southern or western side indicates heavier rain fall on that side, compared to the opposite side.
- iii) If a boulder or stone near a river outside of the tree canopy is turned over and the soil under the rock is found to be moist, summer rain is approaching.
- iv) If bubbles form on a stagnant water body, the rain will last the whole day.
- v) If dried chilli or tobacco leaves turn moist on days outside the rainy season, rainfall is imminent in a very short time.
- vi) If domestic chicken search for food on a rainy day, the rain will last the whole day. But if they stop searching for food and take rest it will stop raining.

The importance of these forecasting of weather in the short time frame is that they help farmers to plan for agricultural operations. Clearing of an area of bushes for jhum cultivation, burning of the jhum area, preparing the land, sowing of seeds, harvesting etc. are dependent on accurate weather information. Observing the sky, the water bodies, behavior of birds and animals as well as insects, people try to get as accurate information as possible.

#### 3.6.4 Discussion

Learning from traditional climate forecasting systems through observing nature can help people to cope with climate change especially when modern climate models are not accurate at micro level as they should be. Pioneering work is being done at Swaminathan Research Foundation and Tamil Nadu Agricultural University and other institutions to codify, test and integrate traditional weather prediction

<sup>45</sup> M. Chinlapianga, Traditional Knowledge, Weather Prediction and Bio-indicators: A case study in Mizoram, Indian Journal of Traditional Knowledge, Vol (10)1, January 2011, pp 207-211



systems into modern weather forecasting systems. This model can be replicated in Mizoram and other North- Eastern States as they have rich indigenous ways of forecasting micro-weather.



### 3.7 Living Root Bridges: Marvel of Bioengineering

The living bridges of Meghalaya, perhaps the only bridges in the whole world fully made of the roots of living trees, are marvels of bio-engineering and represent a perfect example of man living in harmony with nature. This sustainable and living architecture will live and grow for centuries, serving as the only means for people to cross torrential streams and rivers during the heavy rains in this wettest part of Planet earth. They exist mainly in the lower reaches of the southern slopes of Khasi and Jaintia hills, which abound in swift flowing mountain streams and rivers. According to oral tradition these bio-bridges are 100 to 600 years old. The earliest written record is found in the Journal of Asiatic Society of Bengal, where Lieutenant H Yule expressed astonishment about the engineering skill displayed by tribal people. Wooden and cement concrete bridges in this high rainfall region usually break down after a few years due to torrential rainfall. They are also too costly and government have does not have enough resources to connect every village by proper bridges. Thus the people resorted to an ingenious, indigenous and natural method of growing their own bridges.

#### 3.8.1 Living Root Bridge at Riwai

Riwai village is located 82 km away from Shillong, in the Pynursla Block of East Khasi Hills District. It is at a distance of 8 km from the village of Mawlynnong, which has been renowned as the cleanest village in Asia. The total number of households in the village is 78, with a population of 438 persons (224 males, 214 females as per Population Census 2011. The literacy rate is 81.7%. The main livelihood of the people is agriculture. The main products are broom grass, bay leaves, betel nut, betel leaf, black pepper, jackfruit, citrus fruits. The living bridge at Riwai is formed by joining roots of *ficus elastica*, the Indian rubber tree. Not a single bit of steel, iron, cement concrete, wood or any other material, other than boulders, is used for constructing these bio-bridges. In khasi language this bridge is known as jingkieng deingjri ('bridge of the rubber tree'). To reach the bridge, we walk through a forest buffer area through the stone paved King's way, used in ancient times for betel nut trade. From top of the viewing point constructed on an elevated bamboo structure, one can bask in the panoramic view of the plains of Bangladesh. One has to purchase a ticket to go up the bridge and another ticket to go up the viewing point. There is an average daily collection of Rs 1000 from visitors, which income goes into the upkeep of the bridge and the view point.



We interacted with Shri. Reynold Myllemngap, Secretary of the village dorbar, village elders and representatives of the youth. People of the village claim that this bridge is more than 300 years old and is getting stronger with passage of time. They say that in the past herds of wild elephants crossed the bridge without causing any damage to it.

There is some dispute is between this village and the neighboring village with respect to sharing of income from collection of entry fee from tourists. Due to this, the villagers were not very much forthcoming with their responses to our queries.



P 25: Living root bridge of Riwai

### 3.8.2 Social Norms for Use and Maintenance

The village dorbar collects a nominal entry fee to see the bridge, the proceeds of the same go towards the development of the village. There is an additional fee for going up the viewing point, a magnificent



bamboo structure. Village Dorbar strictly enforces rules to protect the bridge from any harm and to keep the environment clean. Near the bridge, there is a warning board, which highlights the following instructions with the warning that “Violators will be prosecuted as per laws prevailing in the village”:

1. Do not inflict any injury to the tree be it by cutting or plucking its roots and stems
2. Do not litter
3. Do not spit
4. Do not consume any intoxicating drinks here.
5. Do not make this spot a place of profit.

There is absolutely no government interference or support in enforcing these rules. The development and upkeep of bridges is a community affair, without any assistance from Government.

### 3.8.3 The Technology

*Ficus elastica* grows an enormous amount of secondary roots. It can perch itself on huge boulders along the river bank or in the middle of river. It then sends its roots down into the river bed. The tree has an amazing ability of withstanding heavy soil erosion caused by torrential rains and fast flowing rapids. The Khasi people used this peculiar property of this tree to solve their major problem of crossing torrential streams during monsoon. They trained the secondary roots to form a bridge like structure.



P 32 Viewing point at Riwai

This bridge was made by entwining roots of two trees on opposite sides of the river. The roots of the tree forms the base, sides and supports of the 20 meter span across the river. In such a wet world where a wooden bridge would soon rot, for hundreds of years villagers have trained the roots of trees across rivers. It takes 10-15 years for the bridges to become strong enough for use. Once complete, however, it will last for several hundred years and, unlike its non-living counterparts, will actually increase in



strength with age.

The following procedure is used to direct the roots in the desired direction:

1. Slice out betel nut tree trunks half in the middle for the entire length.
2. Hollow out the sliced out portion.
3. Position it according to the requirement.
4. Direct the roots to grow towards the desired end.
5. After the roots reach the other end of the stream, allow the roots to grow into the soil.
6. Over time two or more base spans and protecting railing spans develop.
7. Use stones to fill the gap in the base spans. Over time, the stones get embedded in the floor of the bridge.

#### **3.8.4 Other living bridges in the region**

The villagers informed us that there are many such bridges in the region. The most magnificent of these is the double decker bridge at Laitkynsew, 15 km from Cherrapunjee in East Khasi Hills, built across the torrential Umnoi stream. Said to be 100 years old, this bridge is 53 feet long. In the adjacent village of Nongriat, a bee-keeper village, two such living bridges have been created by weaving and inter-twining roots of a single tree. The bridge is 30 meter long and can take the load of 50 people at a time.

#### **3.8.5 Discussion**

For people of several villages, these living root bridges are their only access to the external world particularly during monsoons. These bridges are bio-engineering wonders and extremely durable. The average life span of the bridges is said to be more than 300 years after they are fully developed.

Unlike the wire cable bridges in the region, these bridges do not sway or swagger. Instead they get stronger with age. High rainfall and erosion in Meghalaya can destroy concrete bridges. According to the village people, compared to the concrete bridges of today, which grow weaker every day, these bridges grow stronger, as long as the roots are alive. Unlike wooden bridges even on the National highway, they are termite and insect resistant.

Construction costs are very low, and there is no environmental pollution. Despite all these benefits, the skills needed to make these bridges are being lost and the bridges are slowly becoming mere tourist



attractions. However, there is a ray of hope for this ancient bridge making skill. These bio-bridges may soon come under the ambit of the PMGSY as state government is planning to include them as a part of its efforts to provide all weather connectivity for habitations with a population of 250 persons. PMGSY gives special importance to eco-friendly engineering works. Providing all-weather connectivity to unconnected habitations with 500 people (250 n hilly regions) is a key principle of PMGSY. The state government is brainstorming how the villages with living root bridges can be brought under the PMGSY, so that villagers can be rewarded for their hard labour, as there is virtually no maintenance cost of the root bridges.

Living root bridges are unique to Meghalaya. The traditional knowledge of making these bridges should be preserved so that Meghalaya can be protected from Climate Change. More such low cost bio-bridges can solve the problem of communication in many remote villages.



## CHAPTER IV: WAY FORWARD

This report focused seven practices using traditional knowledge that represent the coping strategy of the tribal communities of Mizoram and Meghalaya and appear to have relevance for adaptation to climate change, which is now adversely affecting people and their livelihoods more than ever before. Traditional wisdom if preserved and fortified by modern technology, and find space in the official climate change adaptation strategies, can provide cost effective and efficient adaptation actions. A marriage of traditional wisdom and modern technology will be very fruitful and beneficial. The documented cases focus on different facets of the coping mechanisms of tribal communities, drawing their strength from traditional wisdom.

### 4.1 Forestry/ Natural Resources Sector

The first case documents how the tribal community of the Khasis tries to preserve an oasis of greenery in an otherwise big ocean of barren and denuded hill slopes. They are doing this by integrating the religious beliefs and traditional wisdom associated with the sacred groves with modern scientific forest management practices, and undertaking a community based movement of establishing newer sacred forest areas in more than half a dozen of neighbouring villages. This has been highly helpful for biodiversity conservation in the region. ~~Happy-t~~The Forest Department of Meghalaya and some international NGOs are providing technical and capacity building support to the communities in developing new sacred forests and preserving the existing ones (numbering more than 1000). The sacred forest has generated interest among nature lovers, botanists and foresters from all over the world and it has become the very first REDD plus pilot in India. By conserving the catchment of the water bodies that provide drinking water to Shillong city, by conserving rare and endangered species of trees and medicinal plants and by providing a carbon sink, the sacred forest of Mawphlang has become nature's own museum and a bulwark mitigating the effects of climate change. Development of more such sacred groves will be a great strategy for both climate mitigation and climate change adaptation. The experiment is worth replication elsewhere in India and needs to be supported by science and technology inputs. The forest departments can provide technical inputs to improve the canopy cover and regeneration of trees in the degraded sacred groves.



The scientific input required include suitable packages of conservational and eco-restoration strategies for the protection of sacred groves/forests. In this forest, important tree species find protection and they regenerate and grow abundantly due to social fencing. The big trees of the sacred groves can serve as a perennial source of propagates-propagation for new plantations in other areas.

#### 4.2 Water Sector

Rejuvenation and protection of springs, which provided assured safe water to village people for centuries, offers a cost effective and sustainable solution to the problem of drinking water in States of the North East and other areas of having plentiful rainfall. Piped water supply programme, promoted by the Ministry of Drinking Water and Sanitation, Government of India depending on gravity flow of water, has not been successful in many hilly States, as water cannot reach several habitations in the upper reaches. In this context, the attempt of the people of Mawlyngbna village to fall back on their natural springs to solve their drinking water problems, and to make it a commercially successful venture through bottling purified spring water for marketing all over Meghalaya, is a laudable venture that needs to be supported financially and through technical assistance. It is a testimony to the fact that traditional wisdom has the potential of not only being cost effective but also offers income generating opportunities. The unspent allocation of funds for sustainability structures, available under the National Drinking Water supply-Supply programme, can serve rejuvenation and protection of natural springs in Meghalaya through developing the catchments of the springs, which have undergone damage due to mining and severe deforestation.

Another initiative in this sector is conveyance of water through bamboo pipes for drinking water and irrigation. Several villages in Khasi and Garo hills today depend on natural springs, rivers and open wells and ring wells for drinking water. Even in habitations said to have been fully covered under the National Rural Drinking Water Programme, the gravity based water supply systems do not work for households residing on hill tops and slopes. Further a large number of the iron /steel pipe based supply systems have become non-functional due to aging and non-maintenance. Irrigation facilities do not exist at all in most parts of the State. People have devised ingenious ways to meet the needs of drinking water and providing protective irrigation to betel nut and black pepper/citrus orchards. The commonly available bamboo is used as the supply systems through which water is diverted from natural springs (for drinking water) and from rivers and streams (for irrigation). Drinking water supply through bamboo pipes



requires relatively less technical competence and engineering skill as the water sources are not too far from habitations. What is needed is to protect the water source from contamination and provide storage facility for water to avoid wastage and water logging. In the Garo hills taking drinking water through bamboo pipes is a very commonly observed practice.

When bamboo was readily available this was a zero cost technology. However, nowadays, bamboo forests are declining and production is low. One of the reasons for the low production of bamboo is the extraction of bamboo shoots for sale in urban areas. As bamboo shoots are a delicacy it fetches high price and provides a major source of income for village people. ~~Unless~~ This destructive practice needs to be discouraged.

The bamboo pipe based drip irrigations system requires high level of skills and only practiced hands can construct systems that will provide the right amount of water on a continuous basis to the root zone of plants. The use of bamboo pipes for drip irrigation is now practiced only in a very few villages and the craftsmen who install the systems are also becoming rare. It is possible that this age old knowledge may not survive for a longer period unless steps are taken to provide incentives for their practice along with or in preference over plastic based modern systems. Also scientific help in preserving the longevity of bamboo pipes will reduce the costs of the systems.

#### 4.3 Fisheries Sector

The third case study is about self- directed efforts of the village community to conserve the endangered local species of chocolate mahaseer fish, using their traditional knowledge about fish rearing and sustainable fish harvesting. The technique could be adopted in various streams and rivers of the region for the survival of the fish population. The replicability has already been demonstrated as the experiment has provided a way forward for the state aquatic mission to promote fish sanctuaries throughout the State.

It is evident from this study that when villagers are convinced about the importance of conserving their resources and organize themselves around their traditional institutions and use their indigenous knowledge, new opportunities ~~are thrown~~ come up to tackle the impacts of climate change. A single initiative by enlightened village leadership without any external help has resulted in a fish resources conservation movement spanning all over Meghalaya, inviting the State Government attention ~~chipping~~



to chip in with technical and financial support to village communities to establish fish sanctuaries. ~~The fact that this local initiative is also supporting research efforts shows that science can also benefit from traditional knowledge.~~

There is also a need to support the numerous fish ponds constructed every year under other Government programmes through making fingerlings and other inputs easily available to the practitioners and also to improve their technical knowledge about fish rearing. Though started without any core scientific knowledge, sheer perseverance using their indigenous knowledge, the village community was able to protect the declining population of Mahseer by providing safe sanctuaries for their natural propagation and by enforcing rules and regulations which prohibits fishing at the embankment site.

#### 4.4 Agriculture

Most food grain production is from shifting cultivation areas in the North East, particularly in Mizoram and will continue to be the major source of food security for several more years. In Mizoram less than 2 percent of total geographic area is under wet rice cultivation. Under the new land use policy and the promotional efforts of the soil conservation department, area under horticultural plantations will increase in the future, but food security will still come from jhum cultivation.

If the traditional wisdom and customary practices are followed, jhum cultivation can continue to exist as a good source for organic food items. Jhum should be allowed only in the areas traditionally demarcated for this activity and the customary rules should be strictly enforced by the Village Councils. The reduction of the jhum cycle should not be encouraged so that the jhum land recovers its capability and excessive soil erosion and reduction in the water table and drying up of water sources do not take place.

Interaction with village people showed that climate change, represented by the changes in rainfall pattern, uncertain rainfall in winter, spread of invasive variety of weeds due to changes in temperature and humidity are affecting jhum cultivation also. Farmers are now unable to use the traditional variety of seeds of rice and vegetables. Many of the traditional seed varieties are facing extinction. Agricultural universities can chip in by doing research on conserving the germ plasm of traditional seed varieties and



evolving new varieties that can withstand climate variability. This is another area of cooperation between traditional knowledge and science.

The problem of soil erosion arising from jhum cultivation can be tackled by adopting suitable silviculture practices like Alder (*Alnus nepalensis*)-based agro-forestry in the shifting cultivation areas. This would require technical and scientific backstopping to the jhum community in the form of experts and extension workers, and generating proven knowledge regarding appropriate silvi-culture practices for shifting cultivation.

Jhum cultivation in the past was an organic form of agriculture, which catered to the food security and nutrition security of the people of Mizoram. Due to various economic, demographic and external factors, the jhum cycle has reduced and forest and environmental degradation are increasing. Restoring the efficiency of village councils to enforce customary laws is essential for retaining the organic character of jhum cultivation and preventing further environmental harm. Restoring the efficacy of customary laws and traditional wisdom are absolutely necessary to strengthen the ability of the village community to adapt to climate change.

#### **4.5 Assessing Climate Change through Traditional Knowledge**

Rural communities have intimate knowledge of changes in the weather and climate patterns as their agricultural and allied livelihoods are entirely dependent on rainfall and its distribution throughout the agricultural seasons. Health of humans and animals, availability of drinking water, crop production, behavior aquatic bodies and fish are all closely linked to nature and communities are keen observers of any changes in the climate. In areas where scientific studies are few and far between on climate variability and its impact on agriculture, interaction with people can yield a wealth of information as the documentation in section 3.7 of this report testifies. This clearly is an area where climate change can be enriched by interacting with people.

#### **4.6 Weather Prediction based on Traditional Knowledge**

Learning from traditional climate prediction systems through observing nature can help people to cope with climate change especially when modern climate models are not accurate enough at micro level to enable farmers to plan for their agricultural operations. The efforts of Swaminathan Research



Foundation and Tamil Nadu Agricultural University in Tamil Nadu to test and validate traditional weather prediction systems and integrate them with modern climate prediction models can be replicated in Mizoram and other parts of North East India.

#### **4.7: Living root bridges: wonder of Bio-engineering**

The living bridges of Meghalaya are unique bio-engineering wonders, created by tribal people by observing the behaviour of plant resources abounding in their immediate environment. They have served the people from ages, keeping them connected to the rest of the world during heavy monsoon rains. Here again, the traditional practice is becoming obsolete with people having little time to be close to nature. Government's intention to bring these bio-bridges under the ambit of the PMGSY as a part of its efforts to provide all weather connectivity for habitations with a population of 250 persons may give a new lease of life to the dying art alive.