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Changes in the level of blood glucose and tissue glycogen of nutritionally important catfish *Clarias batrachus* (Linn.) due to Sodium Arsenite intoxication

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Abstract

In this investigation freshwater catfish *Clarias batrachus*, were exposed to sublethal concentration (1mg/L; 5% of LC50 value) of sodium arsenite for 60 days. After 60 days of exposure, fish were transfer to fresh water and kept in the same for next 60 days in order to study the effect of sodium arsenite after cessation of intoxication. Blood glucose, serum glucose 6 phosphatase activity and total glycogen content determine in different organs system viz brain liver gills, muscle and skin at different interval (of 10 days, 30 days 45 days and 60 days) of exposure period and also after the release into toxicant free water for the same interval. Indeed a marked decline in glycogen contents in different tissues was observed throughout the exposure period, followed by improve during depuration period. Also arsenic produce hyperglycemic condition in fish which could be manifested by increased blood glucose levels and the elevated levels of blood glucose returned to a large extent of the control values after transfer of fish into arsenic free water. Assessment of these biochemical parameters in vital organ systems could be used as a diagnostic tool to characterise the arsenite toxicity.

Keywords: *Clarias batrachus. Depuration. Exposure. Glycogen. Sodium arsenite*

Introduction

Arsenic is a ubiquitous metalloid found in various chemical forms in soil, ground water and foods. Because arsenic in the bedrock is easily dissolved to surrounding water, inorganic arsenic is frequently present at elevated concentrations in ground water. However, much-elevated concentrations of arsenic have found in the freshwater of the areas with high geothermal activities (Moore 1984). In the freshwater, high concentration of arsenic is mainly due to industrial use to manufacture paints, fungicides, insecticides, pesticides, herbicides, wood preservatives, and cotton desiccants (Chakraborty et al. 1998). Also it is an essential trace element for some animals that is used as an additive in animal feed. Gallium arsenide or aluminium gallium arsenide crystals are components of semiconductors, light emitting diodes, lasers, and a variety of transistors. Fish appear to be particularly susceptible to arsenic toxicity as they are continually exposed to it through gills and intake of arsenic-contaminated food. Arsenic is known to cause adverse effects in aquatic biota, wildlife and also to human health (Shaw et al. 2007). Arsenic concentration in water influences the process of bioaccumulation on food chain in aquatic system. Studies on the effect of arsenic salt on carbohydrate metabolism are inevitable, because glucose is stored as glycogen which plays a major role in the carbohydrate

metabolism of all animals. The immediate energy demand of the body during starvation or stress is met by directly utilization of glucose molecules. Glycogen content in the liver and muscle is one of the sensitive biochemical indicators which reflect changes in the normal activity of various functional systems (Metelev et al. 1983). Toxicity tests for xenobiotics serves as a sensitive index in predicting and preventing damage to aquatic life in receiving waters by regulating the toxic waste effluents (APHA 1998). Throughout the animal kingdom, carbohydrate is known to be an important constituent of the organism. Therefore the aim of this study is to assess the biochemical changes in blood glucose and glycogen content in different tissue of *Clarias batrachus*. Since fish population is an important component of the food chain any effect of such pollution would in the due course, have adverse influence on the nutritive value of fish and on man through their consumption. Heavy metal contamination in aquatic environment exerts an extra stress on fish which tend to accumulate the heavy metals in metabolically active tissues and organ systems (Langston & zhou 1987). Hence these efforts have been made to analyses the toxic impact of arsenic salt sodium arsenite on important organ systems of nutritionally important catfish *C. batrachus* and it could be put forward to treat the fish from the contaminated area before they are marketed and thus prevent health hazard in fish consumers and also warn to human being to avoid the consumption of such contaminated fishes.

Materials and method

For this investigation irrespective of sex, live specimens of *Clarias batrachus* (16 ± 1 cm length, 45 ± 5g weight) belonging to a single population were collected from a local area Chaukaghat, Varanasi, India. Prior to stocking in the laboratory, fish were washed with the potassium permanganate (1:1000). The fish were acclimated in tap water (having dissolved O_2 6.3 $mgL^{-1,}$ pH 7.2, water hardness 23.2 $mgl^{-1,}$ and room temperature 28±3 °C) for 21 days under laboratory condition. Fish were regularly fed *ad libitum* with fresh mince goat liver after every 48 hours. The water in the fish container were renewed after every 24 hrs.

- *Estimation of LC_{50} value*

The 96h median lethal concentration (96h LC_{50}) of sodium arsenite was detected following trimmed Spearman-Karber method (Hamilton et al. 1977). It was found to 20 ppm.

- *Exposure to sodium arsenite ($NaAsO_2$)*

To study the chronic effect of the arsenic salt, twenty groups of 10 fish each were exposed separately to a sublethal concentration (1 ppm; 5% of 96h LC_{50} value) of sodium arsenite (Batch No G270707 Loba Chemie Pvt. Ltd. Mumbai, minimum assay 98.5-102%) in the plastic container containing 10 litres of the test solution. Simultaneously twenty control groups of 10 fish each were exposed to 10 litres of plain tap water (without having the arsenic salt) under identical laboratory conditions. The sublethal concentration of the toxicant was added directly into each plastic container after removal of the same volume of water and renewed daily in order to maintain constant concentration of the toxicant. For toxicity analysis nine fish were randomly selected from different experimental as well as control group and sacrificed by spinal dislocation after the stipulated periods of 10 days, 30, 45, and 60 days of exposure. After 60 days of exposure, adequate number of the fishes was transfer to fresh water and kept in the same for next 60 days in order to study the effect of sodium arsenite after cessation of intoxication. Liver, brain, gills, muscle and skin tissue were dissected and washed in normal fish saline (0.67% NaCl) to remove blood clots, if any, before processing. Blood samples were collected from caudal vein of the fish.

- *Determination of arsenic bioaccumulations*

Dissected organs and tissues were placed in cleaned petri plates and precisely weighted. Each of the samples was transferred to a 25 ml test tube and 1-2 ml of deionized water was added to wet the sample and then 5 ml high purity acid mixture of H_2SO_4: HNO_3: $HClO_4$ in ratio 1:6:1 was added slowly to the digestion pot and kept in oven to digestion for overnight at 105°C. Estimation of arsenic was carried out by atomic absorbance spectrophotometer (Eliko ASS, M-173) using arsenite (99%) as standard. Arsenic accumulation in different digested tissues of *C.batrachus* were undertaken at least in triplicate and the mean values calculated along with standard deviation and results were expressed as µg/g dry weight of tissue.

- *Glycogen and glucose estimations*

The quantitative estimation of glycogen from different tissue were analyzed by adopting universally accepted standard protocols of Carroll et al (1956) using a standard curve for the estimation of glycogen in fish tissue prepared from known weighed amount of pure glucose. Briefly the tissue samples (50-200mg wet weight) were digested in 30% KOH in a water bath at 90 ^{0}C for 30 minutes and cooled

overnight at 4^0C. The digested sample precipated with 95 % ethyl alcohol and centrifuged for 15 min at 1200g. Finally the residues containing glycogen were dissolved in distilled water and measured using anthrone reagent at 620 nm and glucose was estimated by using Fisher Kit of glucoxidase and peroxidase reaction method using a UV spectrophotometer. The results are expressed in terms of mg glycogen /g wet weight of tissue.

- *Glucose 6-Phosphatase (G6Pase) activity*

G6Pase was estimated by the method of Fiske and Subbarow (1925). The enzyme activity was expressed as nanomoles/minute/mg protein.

- *Statistical analysis*

The data of blood glucose and tissue glycogen presented in this communication have been based on mean±SEM (n=9) and the statistical significance of differences from control fish was evaluated by two tailed student's *t*-test using the software (SPSS, version 12). The criterion for significance was set at $p<0.05$, $p<0.01$ and $p<0.001$(Table 1-3).

Results and discussion

The level of arsenic in the unexposed control fish tissues of C.batrachus is below detection limit (BDL). Arsenic concentrations were increased in all the experimental tissues during exposure and vice versa during withdrawal period when compared to control fish (Figure 1). The glycogen contents in tissues of the untreated control fish ranged between 2.75±0.15 mg/g (in muscles) to 34.25±0.61 mg/g (in liver) (Table 1). In exposed fish its amount decreased in all tissue ranging from 1.40±0.11 mg/g in muscles to 10.80±0.12 mg/g in brain. Due to withdrawal of arsenic stress the glycogen contents in all these tissues recovered substantially with highest concentration found in liver (28.68±0.760 mg/g) and lowest in muscle (2.42±0.081 mg/g) Table 2.

The amount of blood glucose in unexposed control fish ranged between 20.96±0.76 to 25.96±2.65 mg %. After withdrawal of arsenic stress the blood glucose recovered substantially with highest concentration (29.86±0.750 mg/g) (Table 3).

The G6Pase activity in blood tissue of unexposed control fish was 42.29±2.99 nmole/minute/mg protein respectively. Following arsenic exposure the serum G6Pase activity decreases for increasing the glucose level to meet the enhanced energy demand to combat the arsenic toxicity. Following discontinuation of the arsenic exposure this enzyme activity recovered precisely from 26.16±2.77 nmole/minute/mg protein (in 60 days stressed fish) to 33.74±1.71 nmole/minute/mg protein. However it was marginally below the unexposed control level (Figure 2).

Table 1. Fluctuation in the levels of glycogen content (mg/g wet wt of tissue) in different tissues of *Clarias batrachus* at different period of exposure to sodium arsenite

Parameters	Exposure	Period of exposure (Days)			
		10 days	30 days	45 days	60 days
Brain	Unexposed (Control)	13.9±0.10	14.8±0.14	14.3±0.20	14.6± 0.24
	Exposed	15.3±0.21***	13.1±0.13***a	12.4 ± 0.13***a	10.8±0.12***a
Liver	Unexposed	33.23± 0.63	33.01±0.569	34.25± 0.61	32.31±0.57
	Exposed	16.91±0.46***	15.17±0.552***a	13.41±0.57***a	8.9±0.55***a
Gill	Unexposed	4.18±0.18	4.02±0.16	4.544±0.18	4.01±0.12
	Exposed	4.98±0.16**	4.04±0.16 a	3.744±0.14**	2.49±0.14***a
Muscle	Unexposed	3.11±0.13	2.75±0.15	2.85±0.11	2.90±0.16
	Exposed	2.32±0.09***	2.09 ± 0.06**	1.66±0.11***a	1.40±0.11***
Skin	Unexposed	4.22±0.13	4.63±0.24	4.79±0.13	4.73±0.076
	Exposed	4.98±0.13**	3.42±0.12**a	3.32±0.10***	2.93±0.130***a

Brain, liver gill, muscle and skin glycogen were observed in control fish (unexposed) and exposed (with sodium arsenite) fish at different period and value are shown as mean ± SEM (n=9) and the statistical significance of differences from control fish was evaluated by two tailed student's *t*-test at * $p<0.05$, ** $p<0.01$and *** $p<0.001$.

*-significant difference with respective control, a-significant difference between just previous group

Table 2. Fluctuation in the levels of glycogen content (mg/g wet wt of tissue) of various tissue of C.batrachus at different period of withdrawal to sodium arsenite

Parameters	Exposure	Period of withdrawal (Days)				
		0D WDL	10 D WDL	30 D WDL	45 D WDL	60 D WDL
Brain	Unexposed	14.60±0.24	14.60±0.13	14.90±0.16	15.00±0.14	15.00±0.20
	Withdrawal	10.80±0.12**	11.20±0.06**	11.60±0.09**	12.10±0.05**	13.1±0.11**
Liver	Unexposed	32.31±0.59	33.23±0.63	33.01±0.57	34.25±0.60	32.31±0.57
	Withdrawal	8.90±0.55***	10.83±0.12***	15.02±0.30**	21.47±0.58**	28.69±0.76*
Gill	Unexposed	4.00±0.12	4.10±0.14	4.27±0.11	4.42±0.15	4.85±0.12
	Withdrawal	2.48±0.14**	2.48±0.15*	3.55±0.08**	3.75±0.07*	3.85±0.12*
Muscle	Unexposed	2.9±0.12	2.87±0.16	2.75±0.15	2.85±0.11	2.90±0.16
	Withdrawal	1.40±0.12*	1.50±0.09*	1.76±0.08*	2.08±0.06*	2.42±0.08*
Skin	Unexposed	4.73±0.07	4.26±0.13	4.63±0.24	4.79±0.12	4.73±0.08
	Withdrawal	2.93±0.17**	3.18±0.12*	3.24±0.06*	3.50±0.09*	4.01±0.11*

Brain, liver gill, muscle and skin glycogen were observed in control fish (unexposed) and withdrawal (from sodium arsenite solution) fish at different period and value are shown as mean ± SEM (n=9) and the statistical significant differences from control fish was evaluated by two tailed student's *t*-test at * $p<0.05$, ** $p<0.01$and *** $p<0.001$. (* -significant difference with respective control group)

Table 3. Fluctuations in the levels of glucose contents (mg/dl) in control, exposed and withdrawal of exposure of Catfish *Clarias batrachus* (Linn).

Parameters	Exposure	Period of exposure and withdrawal (Days)				
		0 day	10 days	30 days	45 days	60 days
Blood glucose contents (mg/dl)	Control	21.96±0.42	21.96±0.42	24.33±1.50	26.86±2.33	25.96±2.65
	Exposed	21.96±0.42	26.56±1.07*	34.63±0.66**c	41.06±0.86*c	48.5±1.36** c
	Withdrawal	48.5±1.36***	41.16±1.01**b, c	37.26±0.69***b	34.26±0.46***b	29.86±0.75* b, c

In treated fish the glycogen content decreased in the liver and muscle of *Clarias batrachus* could be due to its enhanced utilization as an immediate source to meet the energy demand under arsenic stress. Arsenite has been reported to inhibit more than 130 different enzymes from various sources and this inhibition of enzyme activity might be central to some of the effects of arsenic poisoning (Webb 1966). Szinicz & Forth (1986) showed that arsenite strongly inhibited gluconeogenesis and might be here also decrease in glycogen level reveal the formation of glucose molecules by glycogenolysis mechanism. The decrease of liver glycogen was mainly due to accumulation of metal well documented (Haux et al. 1986). The most prominent metabolic changes occurred following NaAsO2 treatment and illustrate a marked depletion of carbohydrate (glycogen). The excessive glycogen depletion and most other glycolysis intermediates like pyruvate were lowered in guinea pigs due to arsenic toxicity (Reichl et al. 1988). Thereby the mechanism of arsenic toxicity, mainly pyruvate dehydrogenase inhibition, is probably also the cause of carbohydrate depletion in *C.batrachus*. Mitochondrial function and tissue respiration have been found in vitro to be highly sensitive to the toxicity of arsenic (Brown et al. 1976). Arsenic also uncouples oxidative phosphorylation and therefore leads to an inhibition of aerobic energy supply (Fluharty & Sanadi 1961). Thus, activation of glycolysis might be a reason of a consequential depletion of glycogen elucidated.

The carbohydrate is stored as a reserve fuel in the liver and muscular tissue of fish for endogenous source of energy during acute or chronic stress (Bonga 1997). It was reported that prolonged stress of metal toxicity exerts weakness and hypoxic condition with the inability of hepatocytes to preserve the normal cellular metabolism (Heath 1995; Vinodhini & Muthuswamy 2008). In liver and muscular tissues the glycogen contents decreased progressively throughout period of exposure. The liver is an important organ performing vital functions including biotransformation, migration of essential biomolecules, glycogen storage, and release of glucose into the blood (Rodriguez et al. 2001). The depletion of muscle glycogen content consequent on treatment for the heavy metals, including arsenic while making their observation on three different species of freshwater fishes like *Labeo rohita*, *Cirrhinus mrigala* and *Catla catla* well documented (Garg et al. 2009). Glycogen content of muscle and liver were significantly

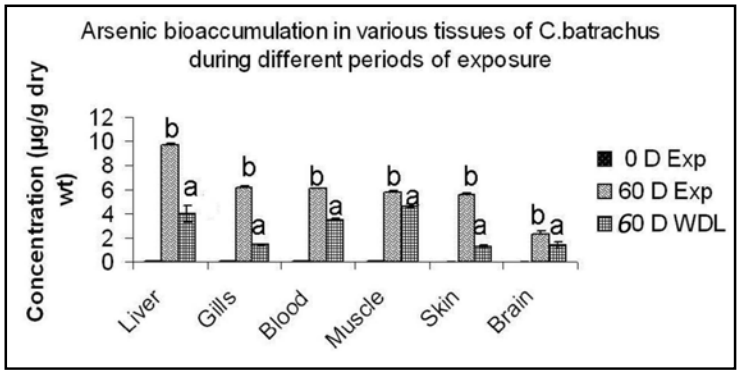

Figure 1. Arsenic bioaccumulation in different tissues of *C. batrachus* exposed and withdrawal to sodium arsenite

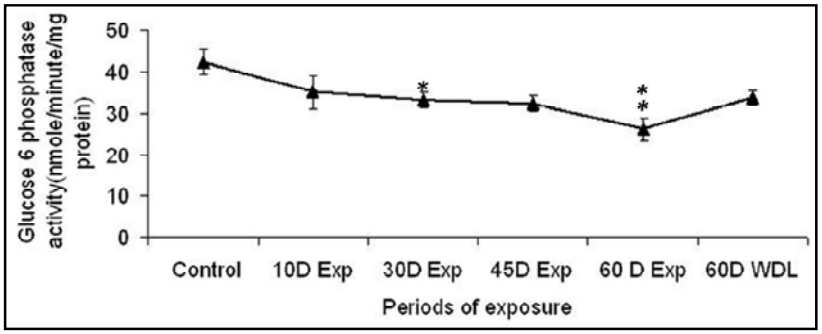

Figure 2. Effects of sodium arsenite exposure on the activity of blood glucose-6-phosphatase of air-breathing cat fish *C. batrachus* at various stages. All values are mean ± SEM (n=9) activity of enzymes are expressed as nanomole/minute/mg protein. Significant differences with the unexposed control groups are indicated with symbol: - * (p<0.05), ** (p<0.01) indicate significant differences with unexposed control group

depleted when the teleost Oreochromis mossambicus were exposed to different concentrations of lead. The depletion was organ specific and time dependent (James et al. 1996). Our findings were also showed similar results. The rate of carbohydrate depletion or elevation was time dependent and organ specific. Present study also found that the pattern of arsenic accumulation in different tissues were organ specific (Figure 1). Cicik and Engin were observed that the glycogen reserves in the liver and muscular tissue of Cyprinus carpio was decreased due to cadmium accumulation (Cicik & Engin 2005).

Arsenic crossed the blood–brain barrier and accumulates in the brain tissue (Rodriguez et al. 2001). The exact mechanism of action of arsenic exposure on the brain is not clear. Functional damage of the brain might occur without causing any structural damage to the brain. In animal models arsenic has been reported to alter brain enzymes (Tripathi et al. 1997; Itoh et al. 1990). Brain is a controlling organ which coordinates all vital activities. Hence it may be hypothesize that the glycogenesis is initiated to raise potential energy to combating of sodium arsenite toxicity. Because toxicity demand more supply of energy (as glucose) to compensate the physiological function. Prolonged exposure, the glycogen stores were steadily depleted and concentration of glycogen decreases. The decreased glycogen content in brain tissue after 10 days of exposure might be as a result of hypoxic or anoxic condition due to sodium arsenite toxicity.

Glycogen content of gill tissue of C. batrachus decreased significantly after 10 days of exposure. After liver, gills were accumulated more arsenic this could be due to thin barrier distance between the ambient arsenic and blood in their secondary lamellae. Accumulation of large amounts of several other heavy metals in the gills of exposed fishes is well reported. Also heavy metals interfere with carbohydrate metabolizing reactions in different animals

(Reichl et al. 1991; Madsen 1992). Arsenic salt produced several patho-morphological alterations in glycoprotein synthesizing activity by mucous cell in gills of *C. batrachus* has been reported 27. Complete loss of secondary lamellae from the entire respiratory epithelium with subsequent reduction in blood supply of the gills after prolonged exposure to sodium arsenate that resulted in reduced glycogen content in the gills (Singh & Banerjee 2009). In cutaneous tissue after an initial increase in glycogen content this is perhaps due to the acute requirement of sulphated slime to combat the toxicity of the arsenic salt. Cutaneous tissue of arsenic exposed fish, the mucous cell engaged in actively in glycoprotein synthesis and also secreted a thick layer of slime on the skin surface in an attempt to protect the skin from the toxic stress of the arsenic salt (Singh & Banerjee 2009). Following prolonged exposure of arsenic salt caused extensive loss and the altered nature of the slime which led to wear and tear and sloughing of the superficial cells that lead to reduction in glycogen content of skin.

Following exposure blood glucose level was elevated progressively and significantly throughout the period of exposure. The elevated levels of blood glucose in exposed fish returned to a large extent of the control values after transfer of fish into sodium arsenite free water.

Arsenite showed high affinity for sulfhydryl groups to form covalent bonds with the disulfide bridges in the molecules of insulin, insulin receptors, glucose transporters, and enzymes involved in glucose metabolism (e.g., pyruvate dehydrogenase and alpha-ketoglutarate dehydrogenase) (Tseng 2004). G6Pase is a key enzyme of gluconeogenesis it may inhibit the phosphorylation of glycogen synthase by cyclic AMP- stimulated protein kinase (Palasi & Guinovart 1997). We also found progressive decrease in activity of glucose-6-phosphatase enzyme in blood which might be due to inhibition of glycogenesis perhaps due to the initiation of gluconeogenesis in other tissues. In the exposed fish either by reducing the rate of glucose use and/or by increasing gluconeogenesis in prolonged exposure causes blood glucose levels were highest in exposed fish as compare to unexposed control fish emphasizing an adverse effect on glycogen metabolism which may result in a subsequent increase in glucose in the blood serum. On studying serum glucose level and tissue glycogen content, (Table 1 and 3) it was found that serum glucose increased and tissue glycogen decreased. The increase in blood glucose of exposed fish may be due to inhibition of glycogenesis mechanism. As a result, the normal functions of these molecules could be hampered and produce hyperglycemic condition in fish, which could be manifested by increased blood glucose levels which were further lead to primary characteristics and hallmark of diabetes mellitus. The diabetogenic effects of arsenic in animal model was well documented (Izquierdo-Vega et al. 2006). When the fish were transferred to freshwater then blood glucose and glycogen content showed progressively improve after 60 days of withdrawal period in comparison to control and exposed fish. It perhaps due to overcome the better of regular metabolism.

Conclusion

While studying the effect of arsenic toxicity on blood glucose, tissue glycogen and serum glucose 6-phosphatase enzyme activity in nutritionally important catfish *C. batrachus*. These molecules were greatly altered in certain organ systems (blood, liver, brain, gills, flesh and skin tissues) of *C. batrachus* due to sodium arsenite toxicity. Such alterations might be leads to a significant impairment of metabolism. However the sodium arsenite contaminated fishes were transferred to freshwater, it showed revival response.

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Flood mitigation measures in Chandrapur city

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Abstract

Chandrapur city is blessed with Irai and Zarpat River. Irai river water is used for domestic purposes and power generation. The flood history of Chandrapur city is known since 1790 AD as per the historical records. The notable floods which caused havoc in the city were in 1790, 1884, 1891, 1934, 1959, 1986 and 2006. It is pertinent to note that even through the flood prior to and in 1959 entered the city area cannot be said to have caused much disaster in the localities. The obvious reason being, the area were not thickly populated till 1959. Past flood disaster showed minimum risk because it was a natural hazard. After 1986, a considerable change in human settlement, industrial activities and deforestation has intensified the risk of floods in Chandrapur. Sustainable efforts are utmost needed to control floods. Various mitigation measures have been suggested in this research paper which incorporates the integration of engineering technologies and managerial aspects such as channel modification, modification of catchment area, embankment protection, flood forecasting and warning system, planning controls, acquisition of land and relocation etc. are discussed.

Keywords: *Flood prevention; Irai River; Chandrapur; Embankment protection*

Introduction

The human environment is becoming more and more hazardous. Natural disasters are more frequent and catastrophic. All land is subjected to natural hazards such as floods, droughts, landslides, earthquakes, typhoons and volcanoes. In the modern time, the cities are considered to be the lands of prosperity. Flooding is the most common of all environmental hazardous. The reason lies in the widespread geographical distribution of river valleys and low laying coasts, together with their long standing attractions for human settlement. No country is immune from floods, although in many cases the threat is limited to comparatively well defined flood plain and estuarine area. The nature and the scale of the flood risk vary greatly. In most countries river flooding is dominant.

In an international comparison of flood risk in selected areas Handmer (1987) concluded that less than 2 per cent of the population of England and Wales, and in Australia, was exposed to flooding compared with almost 10 per cent people in the USA who live within the 1:100 years floodplain. New Zealand has a low population density, nearly 70 per cent of New Zealand towns and cities with population in excess of 20,000 have a river flood problem (Ericksen, 1986). The worst problems occur in Asia where river floods damage about 4 million ha of land and crops, and affect the lives of over 17 million people every year (Smith, 1989). Some five million Chinese lost their lives in flood between 1860 and 1960.

Floods occur in many countries, developed and developing, are nearly annual

events (OECD, 1991; UNEP, 1991). Although many floods cause no deaths, others normally cause an average death toll of a few hundred. Between 1960-1990, severe floods caused the death of about 6592 people worldwide (Berz, 1991). The estimated economic losses from floods varies widely from one county to another, but have been estimated at a conservative figure of US$ 50 billion between 1970-1990. In OECD countries the estimated monetary damage from floods in the period 1975-1990 was about US$ 9 billion (OECD, 1991).

Chandrapur is situated on the banks of Irai and Zarpat river. The southern and western part of the city situated within and outside Chandrapur fort was never considered to be fit for human dwelling. The area was prone to floods since ages. Loss of rural populations have found migrated to the city in search of jobs. The most of vacant sites are diverted and divided into plots and construction activities started at rapid pace. The objectives of the present study were to evaluate past and present severity of floods in the Chandrapur city and mitigation of floods by integration of engineering methods and managerial aspects, awareness of people by administrative measures could be the effective pave a sustainable way to reduce risk of floods in future.

Materials and methods

Study area

Chandrapur is a district in Nagpur division of the Indian state of Maharashtra. Chandrapur is located in the eastern edge of Maharashtra in 'Vidharbha' region. The Chandrapur district is located between the latitudes 19030' N and 20045' N and the longitudes 78046' E and 80000' E. Area of the city regions is about 70.02 sq km. The north south length of the city is about 10.6 km and east west is about 7.6 km. It has an average elevation of 189.90 m above mean sea level. Physiographically, the Chandrapur district is situated within the Wainganga and Wardha river basins, respectively, flowing on the eastern and western boundaries of the district which are the tributaries of Godavari river. The Chandrapur city is located on the bank of Irai river, another river flowing through the city is Zarpath. The northern portion of the city is at higher elevation and southern portion is at lower elevation as per topographical map i.e. 56 m. The old city is situated inside a fort surrounded by 4 very big walls. In the north of the city, there is a dam made on Irai river, having a water holding capacity of 207 million cubic meter. The southwest monsoon brings a lot of rainfall during rainy season and there is no drought-prone area in the city. The average annual rainfall is about 1420 mm. The eastern part receives more rainfall then west. Average number of rainy days is 60 to 65 throughout the district. The relative humidity is very high during monsoon season, which exceeds 70%, but after monsoon season it falls down rapidly and in summer it is only 20%. The Irai river originates in the northern part of Warora tahsil and flows along due south over a length of 80 km until it meets the Wardha river just south of Chandrapur. Irai river has a long history of floods, the flood marks are marked on the wall of city i.e. Pathanpura gate.

Method

Floods affected families were identified and selected for this study during 2007-08. Interview program followed by questioners and onsite visit were arranged to analyze the severity of flood in the city. The justification included all basic information of family viz. education, economy, status, dwelling place, flood experienced by them, self protection and compensation etc.

Results and discussion

Floods in Chandrapur city

In the year 1959, the city had witnessed its growth towards northern side and beyond Jatpura gate area. The Jatpura gate is situated opposite to Pathanpura area. After 1959, the situation had changed rapidly because of migration of nearby rural population to the city. Rapid urbanization gathered momentum in the city and resulted in encroachment of most vacant sites situated in Pathanpura, Vitthal mandir and Binba gate area by buildings and some construction activities had also started beyond the area of fort. Floods before 1986 had less impact on the city.

The flood of 2006 in the city caused much disaster in low laying areas, situated inside and outside the fort. The houses made up of mud and old houses were collapsed and people were requested to move to other safe

places. The reason for flood disaster of 2006 cannot be totally attributed to heavy rainfall. Another major contributor was water from major rivers from the nearby areas. All these events had contributed to entry of flood water in the city and had caused a severe disaster which was not seen in past more than 100 years.

Overview of past floods disasters in rainy season, particularly in the months of August and September revealed that there was a heavy rainfall over region and adjoining area. The rainwater got accumulated in the river upto its maximum capacity. The water from Wainganga and Wardha river does not accumulated water of Irai and Zarpat river. As a result of which water was filled in Irai and Zarpat river and it started spreading in adjoining areas which moved in the direction of Chandrapur city, which is at a low level from the other areas. The water from Irai and Zarpat river firstly spread over agricultural land adjoining the Chandrapur fort area. The heavy and continuous rainfall resulted in increased in water level and started entering the city through Pathanpura gate and Vithoba khidki which were the open entrances for such water thus leading to disastrous flood situations in the past. The notable floods which have had caused havoc in the city were in 1790, 1884, 1891, 1934, 1959, 1986 and 2006.

Flood mitigation measures

To reduce such kinds of floods in future some mitigation measures are needed to be adopted. Flood mitigation can't work in vacuum. It needs integration of engineering technologies and managerial aspects simultaneously for effective results. Some of the flood mitigation measures have been discussed:

Levees

Levees (embankments or stopbanks) are the most common form of river control engineering structure which acts as a barrier between a stream and the area to be protected by flood water to the part of the flood where its passage caused little or no damage. They are designed to restrict flood waters to well defined, low value land on the floodplain. It is relatively cheap to construct and they offer protection up to the height or design limits of a particular flood.

Bypass flood ways

There are two functions in flood mitigation first, they create large, shallow reservoirs which store a portion of flood water and hence decreased the flow in the main channel below the diversion. Secondly, they provide an additional outlet for water from upstream, by improving flow characteristics and decreasing water levels for some distance outside the point of diversion.

Embankment protection

River bank protection wall would be required along Irai river in southwest side of the river. This will allow the river water to flow through a particular channel and the chances of water to come out of river and causing flood will get reduced significantly.

Channel improvement

Channel enlargement increases the carrying capacity of the river by enlarging the cross section area of the channel so that flood flows are contained within the banks. Flood relief channel can be used to provide extra over pill storage or can be used to divert water around an area or urban development. River beds should be mode clear and no deposits should be allowed over the river beds. Hydraulic improvements to the water course or to the flood plain and low flood channels within the flood plain may enable flood waters to be passed at a lower level then would occur naturally.

Construction of reservoir

Reservoir for flood reduction work on the principle of storing excess water in the upper drainage basin and, by careful regulation, water can subsequently be regulated at a non damaging rate. Surface storage reservoirs are a conventional technology, and have been used for over years.

Relocation and resettlement

The relocation of buildings and communities within the flood plain have long term economic, ecological and social advantages by adopting such measures future consequences arise due to flood can be minimized. Green belt development along the side of embankment should be carried out.

Conclusion

Natural hazardous such as floods are one of the most common environmental problems faced by human beings since time immemorial. Floods results in catastrophic destruction of ecological and environmental factors. Floods mitigation measures needs to

be adopted for effective management of it. For achieving this integration of technological options and managerial skills are required.

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Awareness of vector borne diseases among rural populations of Mizoram, India: reference of malaria

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Abstract

The awareness among the peoples of Mizoram living in malaria endemic areas are essential to develop behavioural change communication messages and for producing policy to prevent and control malaria in the state. The objective of this study was to assess knowledge, practices and behaviour of the people living in malaria endemic districts and relate with malaria control policy in Mizoram. The paper utilizes data from a cross-sectional study of 1330 households conducted during July 2012 to September 2013 in rural areas of Aizawl and Kolasib districts. The method used includes structured questionnaire and focus group discussions. The results revealed that 40% respondents were illiterates. Eighty-six percent respondents have heard about malaria but only 50% responded fever with chills as the sign and symptom of malaria. Seventy-three percent responded that mosquito bite causes malaria transmission and 74% respondents considered that malaria is the fatal disease but very few have knowledge that the treatment of malaria in time can save life. More than 50% did not have information on availability of free treatment of malaria in Mizoram. Still 16% were found consulting traditional healers for the treatment. Although bednet use practice was higher, only 4% had knowledge on insecticide impregnated bednets and 23% of them practicing it. Health education must be taken into account for communities in malaria endemic areas to produce desired outcomes in malaria control.

Keywords: *Behaviour; Community knowledge; Control policy; Malaria; Practice*

Introduction

Malaria caused by four species of Plasmodium is increasingly becoming a serious burden in most tropical countries and a major cause of death in children in sub-Saharan Africa. Approximately 300-500 million people worldwide are affected by malaria and between 1 and 1.5 million people die every year due to malaria (Winstanley et al. 2004). The present situation of malaria in India is best described as malaria endemic country with >95% of her population at risk of malaria. Reported cases of malaria vary from 1.8 to 2.0 million (1.2 million in 2006) and 1, 000 deaths per year. WHO SEARO estimates 15 million cases and 19,500 deaths, whereas WHO HQs estimates 70 million malaria cases (Sharma 2005).The prevalence of Malaria in Mizoram is 7359 per 100000 populations. The national average is 3697/100000 population. Mizoram is much higher prevalence state compare to national average. Rural people are more likely to suffer from Malaria than urban people. The prevalence of Malaria is higher in males than females. As recent as in the year 1998, about 20,000 people and an estimated 577,000 DALYs (disability-adjusted life years) were lost due to malaria in India. Malaria remains uncontrolled due to emergence of the drug

resistant parasite, insecticide resistant mosquito vector and non-availability of suitable and effective malaria vaccine. The disease burden is increasing in almost all the tropical countries since malaria creates socioeconomic problems and also leads to large number of deaths, particularly among young children (Wongsrichanalai et al. 2002). Ignoring community's attitudes and beliefs regarding malaria has contributed to the inability of control programmes to achieve sustainable control. Understanding community perceptions of an etiology, symptom identification and treatment of malaria is an important step towards the disease control (Govere 2000 & Simsek & Kurcer 2005). It needs for targeting health messages towards poorly educated people in order to empower them with the knowledge and resources to recognize and manage their health problems (Ibidapo 2006).

Health education remains an indispensable component for the malaria control activities in India. The main objective of the health education activities is to involve community as much as possible in different aspects of malaria control programme. This is done through different methods of health education activities such as personal contact, workshops, and malaria education to the school children. To achieve community participation, increased health education, distribution of malaria-related posters, pamphlets, booklets, calendars, etc. are adopted in the context of primary health care approach (Bista et al. 2005).

This cross-sectional study was conducted to establish baseline information assessing knowledge, practices and behaviour of the population in regard to malaria in two malaria endemic districts of Mizoram. The ultimate use of this study would enable to develop effective behavioural change communication (BCC) messages. An intervention will be designed and implemented by the National Vector Borne Disease Control Programme, Ministry of Health and Family Welfare.

Materials and methods

It was a cross-sectional study conducted to assess the knowledge, practices and behaviour related to malaria during July 2012 to September 2013. The sample was designed to provide estimates of the study objectives for the two malaria endemic districts, Aizawl and Kolasib North- Eastern Region of India. Further, the study population was selected from the disease endemic and malaria potential areas of the districts. The primary sampling unit was the Village Development Committee (VDC), a small geopolitical unit in different disease endemic/ epidemic areas of the districts.

Data regarding malaria status (endemic or epidemic) of the study districts were reviewed using Annual reports of the Department of Health Services and data were obtained through Health Management Information System (HMIS). The malaria endemic village development committees (VDCs) of the study districts, Aizawl and Kolasib and were listed using HMIS reporting data.

From each district, three VDCs were randomly selected. These VDCs represent different districts with different disease status (Table 1). The classification of the study area was based on the areas of the district where disease had become endemic/epidemic and areas of past epidemic.

After selecting study VDCs, the study households were selected by using sampling interval. The total number of households in that VDC was divided by 450 (the required sample size) and sampling interval was calculated. The households to be interviewed were then identified in every sampling interval of first randomly selected households.

Table 1. Study Village Development Committees (VDCs) and sample size

Districts	VDC	No. of Samples
Aizawl	Reiek	100
	Aiwlang	100
	Lungdar	100
	Sairang	100
	Sairang Dinthar	100
	Sihhmui	100
Kolasib	Khamrang	160
	Kawnpui	200
	Bualpui	170
	Bairabi	200
Total		1330

The questionnaire was prepared to assess the knowledge, practices and malaria-related behaviour in different selected malaria endemic district. The BCC materials developed by the Department of Health Services, State Vector Borne Disease Control Programme (SVBDCP) were also reviewed. The questions were developed in English and translated into Mizo. The study tool consisted of questions regarding demographic characteristics of the respondents, availability of communication media, preference of communication media, knowledge/information on malaria and mosquito, preventive and control measures of malaria, and availability of free treatment, bednet using practices and the

different preventive and control activities conducted by different institutions.

Training of field supervisors and enumerators was done to ensure quality and completeness of data collection, manage appropriate data collection in difficult situations and to handle difficulties, if any. The training was concentrated on sampling of households, validity and reliability of data, introducing each question of the questionnaire for easy of use. Altogether, 1330 questionnaires were filled constituting 600 from Aizawl, 730 from Kolasib. Focus group discussions were conducted in each district in seven to eight groups. These groups consisted of female community health volunteers, health professionals, mothers, pregnant women, school teachers, local clubs, NGOs, drug vendors and local health practitioners.

Ethical approval was taken from the Department of Health Government t of Mizoram. Verbal ethical consent was taken from the respondent before administering the questionnaire.

Database was prepared using Epi Info Version 6 and accordingly data entry was done. Data were analyzed using SPSS version 11.5. Chi-square test was used to test for significance among groups. A p-value of 0.05 was used to indicate statistical significance. Subgroup analyses were performed for gender, age, level of education and previous infection with malaria.

Results and discussion

Among total 1330 respondents constituting 600 from Aizawl, 730 from Kolasib, 35.5% were males and 64.5% were females. The mean age of the respondents was 36.8 ± 14.4 yr. The education level of the respondents showed that about 40% were illiterate. Others were literate (25.5%), 5–10 class (16.8%), 10 to 12 (16.3%) and graduate and above (1.7%). The average family size was 7 ± 4 ranging from 1 to 30. Majority of respondents had agriculture occupation (58.8%), followed by business (8.2%), housewife (9.4%), students (9.6%), carpenter/driver/tailor/ labour (7.7%), teachers (3.5%) and other services (2.7%). In those households, 98 (7.4%) suffered from malaria in the past. Among all of the respondents, 86.1% had heard about malaria. The respondents who have heard reported that radio (58.1%) and television (25.4%) are the media sources for malaria messages. Other reported health workers (21.7%), relatives/friends (13.5%), malaria patients (10.2%) and posters/pamphlets/newspapers (9.1%) as the source of malaria messages. Twenty-one percent of the respondents did not have knowledge about the signs and symptoms of malaria. Those having knowledge mentioned fever with chills (50.4%), and continuous fever (46.9%) as the symptoms of malaria. Among total, 72.6% respondents replied that mosquito bite causes malaria transmission. This was found significantly associated with male gender or previous infection with malaria in the household (p = 0.000). Some respondents considered dirty environment and staying with malaria patient as the cause of malaria transmission. Majority of the respondents (73.7%) replied that malaria is transmitted by the mosquitoes. Similarly, 41.9 and 9.6% replied that encephalitis and filariasis respectively are also the diseases transmitted by the mosquitoes. Regarding the breeding places of mosquitoes, 59.8% responded stagnant water. Rotten things and animal shed are considered as breeding places of mosquitoes by 20.9 and 20.6% respectively. Among total, 54.4 and 41.1% of the respondents considered dark corner of the house and bushes respectively are the living places of mosquitoes during the daytime (Table 2). Regarding the knowledge on fatality of malaria, 73.9% considered malaria as the fatal disease. Sixteen percent respondents replied that treatment of malaria in time can

Table 2. Knowledge and perceptions about malaria mosquitoes

Particulars	Frequency	Percent
Knowledge on signs & symptoms of malaria (n=1330)		
Continuous fever	625	46.9
Fever with chills	670	50.4
Others	69	5.2
Don't know	280	21.1
Perceptions of the causes of malaria transmission as reported by the respondents (n = 1330)		
Mosquito bite	966	72.6
Dirty environment	230	17.3
Staying with malaria patient	35	2.6
Don't know	263	19.8
Knowledge on breeding places of mosquito (n = 1328)		
Animal shed	274	20.6
Stagnant water	794	59.8
Rotten things	278	20.9
Others	9	0.7
Don't know	271	20.4
Living place of mosquito during the daytime (n = 1330)		
Dark corner of the house	725	54.5
Bushes	548	41.2
Paddy-fields	57	4.3
Others	18	1.3
Don't know	206	15.5

save life. Among the total, 90.1% respondents replied that people could protect from malaria. Regarding the method to protect from malaria, 41.9% replied to take precaution to prevent mosquito bite. Similarly, 41.3, 25.8 and 17.8% respondents replied to take prophylactic medicine, personal hygiene and spraying respectively. Regarding the knowledge on measures to limit the mosquito population, 73.2% respondents have knowledge on measures to limit the mosquito population. However, 66.7, 48.1 and 32.1% responded removal of the water collected in ditches, spraying insecticides and cutting of bushes respectively to limit the mosquito population. Few responded fish farming as a method of limiting mosquito population. Information on knowledge about protection from mosquito bite was collected. Among total, 92% responded the use of bed-net protects from mosquito bite. Similarly, the responses on cleaning environment, insecticide spraying, making smoke and using mosquito coil were 22.9, 18.9, 11.7 and 7.4%, respectively (Table 3). Among all respondents, 95.3% responded that malaria could be treated. Among them, 98.9% responded that health worker can treat malaria. Very few respondents (0.5%) have faith on traditional healer and 5.4% respondents still do not know the person who can treat malaria. Free treatment of malaria is available in Mizoram. However, 50.7% of the respondents didn't have information on free treatment (Table 4). Information regarding the sleeping habit of household members in the animal shed, in the open areas outside the house, 9.5% respondents replied that their household members sleep inside the animal shed. But the sleeping habit of the household members outside the house in the open is quite low (3%). Among total, 90.1% households are using bed-net as preventive measure. Among households having bed-nets in the house, all members are using bed-nets in 93.9% households. Few households (2.6%) have priority on children below five years for bed-net use. Since most of the households are using bed-nets, they also know the reason of using it. Among total, 95.2% responded that bed-net use is to prevent mosquito/ insect bite and 11.2% responded to prevent from malaria.

Table 3. Knowledge and information regarding preventive measures

Particulars	Frequency	Percent
Knowledge on methods to protect from malaria (multiple response) (n = 1198)		
Taking precaution to prevent mosquito bite	502	41.9
Killing mosquitoes *e.g.* spraying	213	17.8
Taking prophylactic medicine	495	41.3
Keeping personal hygiene	309	25.8
Others	2	0.2
Measures of limiting the mosquito population (multiple response)		
Know the measures	973	73.2
Removal of the water collected in ditches	649	66.7
Spraying insecticides	468	48.1
Cutting bushes	312	32.1
Fish farming	23	2.4
Others	8	0.8
Protection from mosquito bite (multiple response) (n = 1330)		
Using a bed-net	1224	92.0
Cleaning environment	304	22.9
Insecticide spraying	252	18.9
Plastering the wall/floor	36	2.7
Keeping away domestic animal/pets	56	4.2
Making smoke	155	11.7
Using mosquito coil	99	7.4
Others	4	0.3
Don't know	38	2.9

The knowledge of insecticide impregnated bed-net was low (3.6%). Among them, use of impregnated bed-net was also found low (22.9%). The respondents who don't have bed-net in the house were further asked for reasons of not having the bed-net in the house. Majority of them responded that they cannot afford it. Other responses were bed-net was not available locally (6.1%) and they do not like it (4.5%). The respondents were asked whether the insecticide spray was done in their houses within last twelve months. Most of them (86.8%) responded that they do not allow their houses to be sprayed. Among those who

Table 4. Information regarding treatment of malaria

Particulars	Frequency	Percent
Requirement of treatment of malaria (n = 1330)		
Yes	1267	95.3
No	35	2.6
Doesn't require treatment	28	2.1
Person can treat malaria (n = 1330)		
Health workers	1254	98.9
Chemists/pharmacists	11	0.9
Faith/traditional healers	6	0.5
Self-medication	1	0.1
Don't know	68	5.4

got their houses sprayed within last twelve months, 58% responded that they plastered or painted the house walls after spraying. They responded that 12.6% plastered/painted immediately after spray. Similarly, 39.1 and 20.7% plastered/painted within one month and two months of spray respectively. But 14.9 and 12.6% responded that they plastered/painted the walls within and after three months respectively. The reasons for plastering or painting the house walls within three months after spraying were bad smell (28.9%), festivals (57.9%), and regular activities of painting/plastering (14.5%) (Table 5).

Table 5. Households adopting preventive measures

Particulars	Frequency n = 1330	Percent
Households having bed-nets	1198	90.1
Information on insecticides impregnated bed-net	48	3.6
Household using ITNs	11	0.8
Households spraying insecticides within last twelve months	150	11.3

This study was conducted to provide baseline information about malaria related knowledge, practices and behaviour to be used in the development of community health education messages to increase community participation in the prevention and control of malaria. The development of behavioural change communication messages is to emphasize the need of bed-net use, early diagnosis and prompt treatment for effective control of malaria. Health education needs to be context sensitive, i.e. mindful of the ways in which knowledge will ultimately be transformed into action (Montgomery 2006). Health education was the main reason for an increase in knowledge about the vector and the use of bed-nets in Ecuador and Peru; which ultimately led to a decrease in malaria (Nieto et al. 1999). The study results show that majority of the respondents were illiterate. Illiteracy had a profound influence on their perception of cause and treatment seeking behaviour for malaria (Nieto et al. 1993). Most of the respondents have heard about the disease malaria through radio and television. The recognition of signs and symptoms of malaria was low in our study; however, this response was reported more than 80% in an African study (Booth & MacLean 2001). Majority respondents considered that malaria is the fatal disease but very few had knowledge that the treatment of malaria in time can save life. Almost 73% respondents replied that mosquito bite is the cause of malaria transmission which was lower as compared to more than 92% of Mpumalanga and Guyana studies (Govere et al. 2000; Booth & MacLean 2001). Response on water as a cause of malaria transmission is still significant similar to other studies (Tsuyuoka 2001). As compared to knowledge on diseases transmitted by the mosquitoes, the knowledge on breeding places of mosquitoes, living places of mosquitoes during the daytime is lower. To educate entire population, effective messages with relation to breeding places of mosquitoes and their role in disease transmission should be delivered. Regarding the treatment of past malaria cases in the household, most of them consulted with the health facilities. But 16.3% did not consult anywhere and 16.1% consulted with the traditional healers. Absence of health workers in the health facilities, lack of time to go to the health facilities and lack of knowledge where to go were the reasons of not consulting the health facilities for the treatment during fever with chills. Similar study reported inaccessibility of health care, waiting until the disease worsened, and a belief that febrile disease resolves spontaneously as the reasons for not seeking modern treatment in time. Among the total, 50 (Nyamongo 2002) 7% did not have knowledge on availability of free treatment of malaria in India. Necessity of full course of treatment and availability of free treatment of malaria need to be informed.

Conclusion

In Mizoram, the epidemic peak of vector borne diseases is higher during summer season starting from March/April and till the end of August and these are related to rainfall. Malaria peaks during the rainy season. It is notable to mention that environmental determinants favor malaria transmission almost throughout the year except a brief period of interruption due to cold weather (Dev et al. 2006a).Therefore, seasonality of malaria and its relation with mosquito bite need to be informed. The bed-net use practice was higher (90.1%) but the information and practice of using insecticide impregnated bed-net was quite low. Majority of respondents who were not using bed-net replied that they could not

afford it. Since the bed-net use was found higher in these areas, they are reporting higher number of malaria cases. It raises a question regarding the proper and regular use of bed-net and quality of the bed-net. It was found that most of the households did not use spraying. Therefore, recommending spray of households should be considered. The regular plastering and painting practices need to be considered even if the spraying is done. Health education in the community may be a more effective way to disseminate health information (Lewin 2005; Ali 2005). Based on this study, it can be recommended that health education materials oriented towards increasing the knowledge and practice to prevent and control malaria infection should be developed.

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Wild edible fruits found in and around the Eastern Highlands moist forests of Amarkantak region

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Abstract

The paper presents pictures and descriptions of some wild edible fruits around Amarkantak region, Madhya Pradesh. These plant parts are used by local people in various ways such as fruits, medicine, in curries-along with vegetables, and other traditional applications.

***Keywords**: Epiphytic lichens; ecological index; frequency and coverage; IAP; paper mill; zone map*

Introduction

The Eastern Highlands moist deciduous forests are a tropical moist broadleaf forest eco-region of east-central India. The eco-region covers an area of 341,100 square kilometers (131,700 sqare miles), extending across portions of Andhra Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, and Orissa states. The Eastern Highlands moist deciduous forests extend from the Bay of Bengal coast in northern Andhra Pradesh and southern Orissa, across the northern portion of the Eastern Ghats range and the northeastern Deccan Plateau, to the eastern Satpura Range and the upper Narmada River valley. The eco-region's forests are dominated by Sal (Shorea robusta), in association with Terminalia, Adina, Toona, Syzygium, Buchanania, Cleisanthus, and Anogeissus. The flora of the eco-region shares many affinities with the moist forests of the Western Ghats and the eastern Himalayas. These regions are inhabited by various indigenous tribes and other non-tribal forest dwellers which are dependent on forest. Among many uses of these forests wild edible fruits are one of the significant uses among the local inhabitant. The present paper describes some of the wild edible plants in eastern highlands near Amarkantak region.

Pictures and Descriptions

Common name	Madras thorn
Vernacular name	Ganga Imli
Family	Fabaceae
Local use	Pods are consumed
Medicinal use	Mesoamerican indigenous people use the pulp to treat gum ailments, toothache, haemorrhages, and the grounded seeds to clean ulcers

Common name	Sugar date palm
Vernacular name	Arecaceae
Family	Chhindi
Use by locals	Fruits are eaten and may also be used to prepare sweet-sour chutneys. The fruits are sold in local market

Common name	Marking nut
Vernacular name	Bhelva
Family	Anacardiaceae
Use by locals	Fruits are consumed. Villagers use the seed to treat wounds
Medicinal use	In Ayurvedic system, various parts of this plant is used to treat alimentary tract and certain dermatological condition. Reports have shown noticeable impact on illnesses related to the heart, blood pressure, respiration, cancer and neurological disorders
Caution	The oily secretion from the fruit and the tree can cause blisters on the skin

Common name	Black nightshade
Vernacular name	Mukkaiya
Family	Solanaceae
Use by locals	Fruits are consumed. Fruits can be added to curries.
Medicinal use	Infusions are used in dysentery, stomach conditions and fever. The juice of the plant is used to treat ulcers and some skin problems. Fruits are used as tonic, laxative, appetite stimulant. Leaves are used to treat mouth ulcers. Boiled extracts of leaves and berries are used to alleviate liver-related ailments. Juice from its roots is used against asthma and whooping cough.
Caution	Only known edible varieties should be consumed. Poisonous varieties exist which can resemble the edible varieties. Local people with adequate knowledge must be consulted

Common name	Big sage, white sage, red sage, tick berry
Vernacular name	Barmasiya, Putush
Family	Verbenaceae
Use by locals	Fruits are consumed. Petals may be used to make dry curry
Medicinal use	Leaves can display antimicrobial, fungicidal, and insecticidal properties. It has also been used in traditional herbal medicines for treating itches, leprosy, rabbies, chicken pox, measles, asthma and ulcers
Caution	Unripe fruits can be toxic

Common name	Wood apple
Vernacular name	Kaintha, Kod bel
Family	Rutaceae
Use by locals	Fruits are consumed raw and are used to prepare curry and chutneys owing to its sour and tangy taste. Fruits can also be prepared as salty, sour and peppery drink
Other use	Used in Tamil Nadu as food for Elephants, sticky layer around seeds act as gum and finds use in jewelry making, the glue also protect the paintings when coated on canvas

Common name	Banayan
Vernacular name	Barr, Bargad
Family	Moraceae
Use by locals	Fruits are eaten
Other use	According to Ayurveda, it is astringent to bowels and useful in treatment of biliousness, ulcers, vomiting, vaginal complains, fever, inflammations and leprosy

Conclusion

Many such information regarding medicinal and edible plants are yet to be highlighted and appreciated. The present paper can be a step towards this.

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Women and Sustainable Development

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Abstract

Sustainable development implies not only economic development but social progress and ecological integrity too. It seeks to achieve economic development, social equity and justice, and environmental protection in a balanced manner. In achieving the goals of sustainable development, gender specific contributions have rarely been studied. Sustainable development requires equal participation of women at all levels It is well known that women share more social responsibility than men but today this is a growing realisation that the economic contribution of a woman can't be ignored. Custodians of the social, economic and environmental set up of any region; it is strongly believed that with the diversified roles and responsibilities and unmatched capabilities women can contribute effectively towards sustainable development.

***Keywords**: Women; sustainable development; gender; society*

Introduction

The word sustainable development was defined twenty-six years ago by the Brundtland report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Sustainable development is based on three pillars: the economic, social and environmental and therefore seeks to achieve, in a balanced manner, economic development, social development and environmental protection. The fourth pillar – the preservation of cultural diversity has been proposed (UNESCO 2001). Focusing solely on any one of these would lead to undesirable consequences. Growth is necessary, but it will be unsustainable in the long run unless it is both socially inclusive and environmentally sound. (World Bank 2012). Despite the gains from growth, 1.3 billion people do not have access to electricity; 2.6 billion have no access to sanitation, and 900 million people lack safe, clean drinking water. In other words, growth has not been inclusive enough. (World Bank 2012).Sustainable Development is based on the principles of democracy where equal rights and opportunities are guaranteed to all.

Sustainable development encapsulates satisfying the needs of both men and women. (Warth & Koparanova 2012). Women experience everyday life differently than men. Traditional gender roles corner women into juggling multiple responsibilities in the home, at the workplace and in the society. Women continue to hold the vast majority of non-professional jobs; are in the lower income bracket; live in homes and areas vulnerable to climate change threats; sacrifice education in order to provide food, water and fuel for their families; face violence in the home as well as in society; encounter discrimination when trying to access productive and financial resources; encounter roadblocks to their sexual and reproductive health and rights; contract illnesses from burning biomass in their homes; lose access to communal and traditional land, as both local and international interests take over; and face environmental

hazards such as chemical spills and poor sanitation that have long-term health effects. (UN Chronicle 2012). Along with this, every day women take so many decisions that affect sustainable development, be it the use of water or energy. The current paper highlights the role of women towards sustainable development. Over and over again, research shows that women if given an opportunity could contribute significantly towards achieving the objectives of sustainable development and building sustainable societies.

Significance of the current study

Women play an imperative role in preserving the culture, language, and traditional customs of any community. They perform productive, reproductive and community management roles and in hence at the local level women have contributed to sustainable solutions for current environmental, economic and social problems.

More than three decades ago, Boserup (1970) documented the role of women in development. Principle 20 of the Rio Declaration states that Women have a vital role to play in environmental management and development. Their full participation is essential to achieving sustainable development'

Again Chapter 24 of Agenda 21 stated that Women should be fully involved in decision-making and in the implementation of sustainable development activities (and in) research, data collection and dissemination of information. The Agenda recommended that national governments develop strategies to "eliminate constitutional, legal, administrative, cultural, behavioural, social and economic obstacles to women's full participation in sustainable development and in public life.

It is crucial to understand that women participate as "agents of change" in order to achieve equitable and sustainable development. It is pertinent to understand that the policies targeting sustainable development must focus on gender specific initiatives. Traditions, customs and social norms often hold the key to understanding the roots of gender inequalities (Jutting et.al 2008).

Despite their roles, women are not adequately represented in the decision-making processes related to the issues of society at local, national or international levels. There is still a wide gap between women, gender and equality. According to UNDP Report 2013, in South Asia, the three driving factors of gender disparities are low female representation in parliament (18.5%), gender imbalances in educational achievement (28% of women have completed at least secondary education, compared with 50% of men) and low labour force participation (31% of women are in the labour force, compared with 81% of men)

Further there is high incidence of maternal mortality owing to lack of medical facilities and awareness coupled with the problems such as nutritional disparities, educational inequalities and various instances of violence against women. Partnerships and equality between men and women are the basis of strong families and viable societies in a rapidly changing world. (Tchouassi 2012). The community has recognised the status of the women and their contribution in not only managing their families, but also to social development of the entire community.

Women and Environment protection

Women are traditional protectors of the environment and are active in environmental management. A world survey on public attitudes on the environment sponsored by the United Nations Environment Program reveals that women choose a lower standard of living with fewer health risks rather than a higher standard of living with more health risks, behaviour in contrast to men. (Chelala 2001)

In most developing countries, women play a major role as farmers, animal tenders, and water and fuel collectors. They are often the primary users and managers of land, forest, water and other natural resources. Women in rural areas of developing regions spend major parts of their day growing food, gathering fuel wood, cooking and carrying water.

In Kenya, researchers have found that men's traditional knowledge is actually declining as a result of formal schooling and emigration while women retain not only a refined and widely shared level of general knowledge about wild foods, crafts and medicinal plants, but are also acquiring new – men's – knowledge about natural resources, as roles and duties change (Rocheleau 1995). Along with this, it is also found that women are most susceptible to several environmental threats. The studies have found that the poor, in urban and rural areas of rich and poor countries, bear the greatest burden of environmental degradation and pollution. The poor women are at a particular disadvantage from environmental degradation and lack of access to clean water and adequate, affordable energy.

Women also bear the worst consequences of environmental policies that ignore the

principles of sustainability. Because of their roles as home-managers, economic providers and their role in reproduction, women are susceptible to health problems and hazards in several situations. Where women in Bangladesh drink water with high salt content, they experience reproductive issues such as eclampsia, miscarriage and stillbirth 20 times higher than in other areas of Bangladesh (Islam 2013). According to UNEP 2013, women are particularly at high risk to various chemicals like industrial chemicals, pesticides and biocides, pharmaceuticals and chemicals associated with consumer products.

The linkage between women, environment and sustainable development is now increasingly acknowledged and understood. Women are perceived as a vital part of the solution to the crisis as environmental managers.

Rural women comprise 43 percent of the agricultural workforce worldwide, and in some parts of the world, about 70 percent. Women are responsible for most local food production in Africa and Asia. Consequently, they are responsible for the selection of seeds, fertilizers and pesticides and the maintenance of productive soil to nourish seedlings and plants. Indigenous women have a special relationship to natural resources. Women are also the managers of water resources - often walking miles to fetch water for basic household chores. Work load of women is directly proportional to the availability of water in the nearby areas. A suggestion to this is that the NGOs and voluntary organizations should have women members. Local women usually have the best knowledge of the water sources in their communities not just about where they are located but also whether they are reliable or not. This critical knowledge was earlier ignored but now the government policies are aimed at reducing the burden of women .Water stress leads to hardships for women, low vegetation, less fodder less cow dung and less milk. Thus there is a vicious circle between water stress and ecological damage.

Women have played vital roles in ensuring sustainable development by harnessing and managing rich biodiversity, yet they tend to be marginalized in decision making for management and preservation of the resources with which they are acquainted. Unfortunately, there is still a gap between the fields of gender and biodiversity (Badola & Hussain 2003). Women's limited access to resources and decision making processes increases their vulnerability to climate change.(Tahir 2012)

Women and economy

The World Development Report 2012 finds that productivity gains, enhanced growth prospects and improved outcomes for the next generation are associated with women's greater access to employment and productive assets such as finance. Market forces and gender blind economic policies cannot deliver sustainable development, social justice and equality. An increasing number of studies indicate that gender inequalities are extracting high economic costs and leading to social inequities and environmental degradation around the world.

An important portion of women's economic contribution is unpaid, unrecognized and undervalued, resulting in less attention to technology development and to investment in improving women's work than men's work. Women suffer from hunger and poverty at a great degree than men. 70 % of the world's estimated 1.3 billion people living in absolute poverty are women (Hemmati & Gardiner 2002). Since the 1970s, the number of rural women living below the poverty line has increased by 50 per cent, in comparison with 30 per cent for men. Women accrue less income than men over their lifetime for a variety of reasons. They get paid less for the same work and are more likely to work less in order to reconcile their careers with child or elder care. It also decreases the likelihood of receiving credit or loans. All these facts increase women's vulnerability to poverty, especially in old age.

It is estimated that if female employment were raised to the male rate, growth in gross domestic product (GDP) would be substantial, particularly in countries such as Japan (CSR 2007). Similarly, a study in the United Kingdom found that the country could gain 2% of GDP by better harnessing women's skills (WWC 2006). Care of children and household responsibilities fall in large part on women with deleterious effects on their working lives. Women are disadvantaged in the workplace by time poverty (juggling the needs of home and work), intermittency (taking time off to care for children or elderly parents), and lack of mobility (needing a job close to home and family). Countries which have mandated and funded family-friendly policies to address these anomalies are those which are reaping the economic benefits of more working women.

Challenges for women

Despite women's importance in the sustainable development, the impact of planning policies on women is rarely given special consideration when country leaders develop economic policies. As a result, these policies often have a disproportional impact on women and women fail to play their role effectively.

Gender bias plays an important role, for example, in influencing resource allocation. Patriarchal societies promote attitudinal barriers where men assume themselves superior to women and women are left with little presence in decision-making bodies, resulting in the neglect of their issues and concerns from the policy agenda. There is a general lack of awareness among both women and men about how gender issues affect sustainability issues. While many of the recommendations in Agenda 21 link gender and environment, it is relevant to conduct more gender-specific research in the area.

More capacity building programmes and training tailored to the needs of women are needed. In order to build women as catalyst for sustainable development, their role in family, community and society at large has to free from socio-cultural and religious traditions that prevent women participation. There is need for change of mindset, especially of the males who dominate the scene. The demands on women also leave them with less time than men for political involvement, and without a voice in the decision-making processes that impact their lives and their environment. Nambiar (2001) in her study of 'Making the Gram Sabha Work' noted the difference utilities in organizing the Gram Sabha. Majority of women reported that they were not informed or invited to the meetings.

Measures to promote women's participation to sustainable development

Women's empowerment is a process. There is a strong need to empower them and this means changing policies and laws to protect their rights and expand equal opportunities. It makes sense that the strategies are devised by women themselves to find solutions to their common problems. These strategies include management of resources, education of the girl-child, health and gender considerations, etc. Around the world, there are many encouraging practices. The most basic and important foundation for women's empowerment is peace and non-violence including domestic violence. There is a need to consider women's safety and security while planning infrastructure development, transportation as well as urban planning.

Some other important measures to promote women's effective participation are:

Gender mainstreaming

It is important to Gather and Disseminate Gender-Sensitive Information for active involvement of women. It is required to establish appropriate information-gathering mechanisms to encompass the complexity of women's experiences and concerns, simultaneously identifying problems, constraints and opportunities for enhancing gender equality in access to resources and decision making. Throughout the United Nations efforts continue to be taken to develop the capacity to identify and address relevant gender perspectives in all areas. Many organizations have established institutional arrangements to support gender mainstreaming, such as gender units and gender focal point systems and capacity building initiatives are undertaken across the system. As per MDG Report 2013, no More than 50 per cent of women report that they are given the opportunity to participate in the decision on large household purchases. These disparities are the direct result of differences between women and men in terms of their control over resources, including income and asset ownership.

Building women's capacity

Removing obstacles to women's full involvement and participation in sustainable development is one side of the coin of women's empowerment. The other side is to target women directly to enable them to get more involved. Capacity-building, making them financially independent and designing suitable training programmes are the tools to meet these objectives. As women dedicate more time to unpaid activities, they are often dependent on men and do not have their own financial savings, pension entitlements and property in their name. A number of woman's groups and non-governmental organizations throughout the world are working to empower women's leadership and integrate gender concerns in development policies and actions. Greater equity, including between men and women and among other groups, is not only essential in itself, but also important for promoting human development. (UNDP 2013)

Make women economically independent

A mother's education level is more important to child survival than is household income. (UNDO 2013) Govt. must focus women as economic agents. A recent survey of G20 countries found that the most developed economies also have the greatest gender equity. It is also relevant to seize opportunities in the "green economy" by providing training and support for women. It is essential to invest in women empowerment and capacity building. Subsequently, building of capabilities to create awareness, nurturing their skills, invoking leadership qualities and making them familiar to technologies, finance and to local governments will make them take active part in socio-economic development.

Conclusion

Women's contribution to sustainable development must be recognized. India has a rich tradition of coping with challenging social and environmental issues through an active civil society. Taking women's needs, concerns and their knowledge and skills into account will ensure a better understanding of the dynamics in society which create and perpetuate gender inequality and enable policymakers and other agents of change, including employers and civil society organizations, to develop appropriate policy responses and actions (Lisa & Koparaniva 2012).

The costs and benefits posed by adaptation and mitigation strategies must also be addressed through a gender sensitive lens in order to strategically tackle some of the equity and equality gaps that are delaying the achievement of sustainable development.

However, becoming an agent of change is not easy. Women world over are forced to live as second-class citizens due lack of education, skills, freedom, adequate job opportunities, and financial independence. They continue to confront barriers such as lack of equal access to education, healthcare, land, finance, markets and technology, and gender-based discrimination. Women can help or hinder strategies related to energy use, deforestation, population, economic growth, science and technology, policy making (UNEP 2010). Thus when women have equal access to resources and opportunities to participate in decision making processes they become drivers of sustainable development by taking environmental, economic and social action.

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Informations on *Indigofera caerulea* Roxb. var. monosperma – A "rare" plant in the forest of North Gujarat Region (NGR), Gujarat, India

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Abstract

Present paper deals with the status, distribution and importance of conservation of *Indigofera caerulea* var. monosperma – a rare plant in the forest area of North Gujarat Region. Using random transects method the plant was surveyed during the period of May 2005 to Dec 2006. A total of six individuals were recorded from two sites of North Gujarat Region. All the plants were recorded at hill tops of Dry Deciduous Forest, one from dense Dry Deciduous Forest and other five individuals were from open land dominated by grasses. The maximum individuals observed were from loamy course soil and only one individual from gravel substratum.

Keywords: *Conservation; Indigofera caerulea; North Gujarat region; Threat*

Introduction

A taxon is considered to be rare/endangered or endemic when its area of distribution is significantly smaller than the average taxa of the same rank in an area or region (Costa 1997). These taxa face a high risk due to their low population, limited geographic distribution and disturbance (Vischi et al. 2004). Hence, the habitats of these species must be protected from biotic and environmental degradations (Cox 1993) in order to impede the species extinction process Condit et al. (1998) proposed to understand and study the threatened species and their habitats, in order to make sound decisions for protecting those species and managing their habitats. An attempt was made to study the status and conservation of *Indigofera caerulea* var. *monosperma* in North Gujarat Region.

It is also known as *I. articulata* var. *monosperma*. Erect, under shrub with long argentocanescent rachis. Leaflets are elliptic-obovate or sub orbicular, flowers are axillary raceme. The colour of the flower is red. Fruits are pods elliptic-oblong nearly glabrous at length and greenish brown to light black in colour. The seeds are reniform, olive green shining glabrous and smooth (Shah 1978). Medicinally significant, contain saponin in leaves and alkaloids content both in stem and root bark (Sabnis & Rao 1983).

There is not much information about *I. caerulea* var. *monosperma* In the previous record in Gujarat, it was reported from Saurashtra (Shah 1978), Kachchh (Sabnis & Rao 1983) and Banaskantha districts (GEC, MSU & GUIDE 2002). The distribution is also restricted to specific substratum. So habitat conversion is a major threat for this plant and hence it comes under '**Rare (R)**' category (WCMC 1994) and **'Vulnerable (V)'** by GEC,

MSU and GUIDE (2002) as the extent of area of occupancy was estimated to be less than 2000 sq. km.

The purpose of evaluation of *I. caerulea* var. *monosperma* is to prevent its degradation from its native habitat. An important tool for this purpose is the determination of the degree of threat of the taxa to which a special significance is attributed with the following objectives.

- To assess the status and distribution of *I. caerulea* var. *monosperma* in North Gujarat Region.
- To assess the existing threats to *I. caerulea* var. *monosperma* and
- To prepare a conservation plan for a plant and its habitats.

Materials and methods

Study area

The North Gujarat region (NGR) lies between 23^o 35' 13.0" to 24^o 30' 57.0" N and 72^o 10' 28.0" to 73^o 24' 47.0" E and falls under three administrative districts *viz.* Banaskantha, Sabarkantha and Meshsana. It extends to about 8.7% (1638 km^2) of the total forest cover of Gujarat state (18,868.28 km^2) and includes protected areas *viz.* Jessore Sloth Bear Wildlife Sanctuary (JSBWS), Balaram Ambaji Wildlife Sanctuary (BAWS), Taranga hill and Vijaynagar forest.

Forest was the most predominant land use type of the study area covering 1638 km^2, followed by agriculture land use largely in the valleys. Third major land use is rocky barren surface, while mining areas cover over 15 km^2. Only 8 km^2 areas are in the form of water bodies or wetlands (Joshua et al. 2007). Although major forest types are found in the study area, they have been classified into two major sub-groups *viz.* 5A - Southern Tropical Dry Deciduous Forest and 6B - Northern Tropical Thorn Forest (Champion and Seth 1968).

Methods

Species inventory of the above mentioned threatened plant was carried out based on the forest map developed by Joshua et al. (2005). The survey was carried from May 2005 to December 2006. A probable list of locations of the species in the study area was prepared based on the literature, reports, thesis and informal interviews with the local people following Vischi et al. (2004).

Using the above information random transects were located and surveyed in two phases. A total of 123 transects were developed and surveyed. Searches were made for the *I. caerulea* var. *monosperma* along the entire diagonal length of belt transect within a width of 10-15 m. Along these transects whenever a targeted species was located, circular plot (8m radius) was used to enumerate its abundance. Other parameters *viz* associated species, macro and micro habitat parameters (habitats, terrain, slope, substrate, soil type and other related environmental information) and site specific threats were also noted.

Results and discussion

I. caerulea var. *monosperma* is restricted to specific habitats. A total of six individuals were recorded from two sites of NGR. All the plants were recorded at hill tops and steep slopes of Dry Deciduous Forest (DDF), one from dense DDF and other five individuals were from open land dominated by grasses (Figure 1). The maximum individuals observed from loamy course soil and only one individual from gravel substratum. Earlier records of this plant are mainly from Sandy Coast and Grasslands with gravel substratum (Sabnis & Rao, 1983; Nayar & Sastry 1988; GEC, MSU & GUIDE 2002). But, the species usually found, growing in flat terrain and to a lesser extent on gentle undulating terrain. It was documented from sites where the soil depth was more (GEC, MSU & GUIDE 2002). As against, the present study all the plants were recorded from hill tops with steep slopes on both sides where the less supportive of soil.

No specific threat to this species could be identified, but the habitats of this plant observed were found with grazing signs and land erosion. Though, environmental conditions (soil characteristics, terrain, slopes and microhabitats) play a major role, their relative impacts also influence the growth of this plant.

In NGR, the plant was not affected by any direct threat, but habitats of this plant were affected by intensive grazing and loss of surface soil. Hence a proper awareness about the ecological importance of the plant has to be created among the tribal communities and trespass grazers. While, conservation measures like soil and moisture conservation need to be taken up immediately.

Conclusion

Species needs to be substantiated with sapling grown in ex-situ condition so as to improve its population in the wild. In this regard in-depth study on the variation in different populations seed viability seed germination and dispersal agents are of importance. Therefore much more research should be developed using biotechnological approach.

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State, Ethics and Public health: Investigating cholera in colonial India

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Abstract

We see in recent times political movement, ethnic upsurges, socio-religious conflicts and various tensions on the one hand and unrestrained corruption, criminalization of politics, dictatorial regimes, bureaucratic inefficiency on the other have manifested many crucial problems constraining the systematic performance of governance in the third world countries. The developing country like India has been struggling to extend its areas of acceptability, accountability and legitimacy. India has experienced profound political ups and downs leading to multifarious crises of govern mentality from ancient times to present. In this present paper as we have seen the colonial masters were apathetic and indifferent to the serious outbreak of cholera and also public health problems. The ethics of colonial rulers was deeply missing. They never interested to stern action against cholera outbreak. The colonial government thought that intervention in the lives of indigenous people led to risk of civic unrest. The present paper attempts to study how colonial government is unethical regarding tackling cholera outbreak and public health problems.

Keywords: *Cholera; Colonial rule;*

Introduction

When we have a set of principles of values, which we have been learning for many years, we organize our life journey following this structure, and then we try to apply that frame of mind to practical situations in our life. But, when we find ourselves in a sort of uncomfortable position because the moment we try to apply our values to this very present practical issue, we feel that the situation is not as smooth as we would like, that we cannot tell very clearly which is the best possible alternative. Although, it is not a choice between good and bad answers, but may be between two good things or two bad things. We would like to be much surer about our decisions. When this happens in government, it is even worse because the whole society will be suffered by its decision. Government is not dealing with its own life. It is dealing with many millions of lives at the same time. May be things will never be the same again in the future because of your decision. So, ethical decisions in government are: How do you apply your theoretical values to practical decisions where you do not have pure answers and when the whole life of your society or community will be suffered? We see in recent times political movement, ethnic upsurges, socio-religious conflicts and various tensions on the one hand and unrestrained corruption, criminalization of politics, dictatorial regimes, bureaucratic inefficiency on the other have manifested many crucial problems constraining the systematic performance of governance in the third world countries. The developing country like India has been struggling to extend its areas of acceptability, accountability and legitimacy. India has

experienced profound political ups and downs leading to multifarious crises of govern mentality from ancient times to present. In the present paper as we have seen the colonial masters were apathetic and indifferent to the serious outbreak of cholera and also public health problems. The ethics of colonial rulers was deeply missing. They were never interested in stern action against cholera outbreak. The colonial government thought that intervention in the lives of indigenous people may led to risk of civic unrest. The present paper attempts to study how colonial government is unethical regarding tackling cholera outbreak and public health problems.

Public health in British India

The experience of public health in British India forms an important part of the development of colonial science. A study of health policy in colonial India clearly reflects the connection between the growth of knowledge of various disease, the economic and political interests of various groups and the government policy. The relationship between medical knowledge and colonial power, not to mention medicine central role in mediating power relationships of a patriarchal or communal kind. Response to epidemic disease-both within the colonial administration and in different sections of the indigenous population-have also attracted social historians, who have treated epidemics as windows through which to view colonial society. Recent studies of public health in India have attributed this slow progress to the Eurocentric priorities of the colonial government. In Colonial India, it is claimed, was a 'distinctly colonial mode of health care' characterized by residential segregation and neglect of the indigenous population (Ramasubban 1988). Arnold (1985) has criticised the government of India for devolving much responsibility for health to poorly-funded and inexperienced local authorities. Right from the 19th century questions relating to public health engaged both the official and public mind in India and the debates gradually became more intense in the wake of major cholera and plague epidemics. It ranged from assertions of imperial altruism to allegations of colonial callousness. The questions asked were what was the nature of colonial medical intervention? Does it merely enclaves or could it transcend certain geo-cultural boundaries? How effective it was and what more could have been done? in the end it left several questions unanswered and several quarters dissatisfied (Kumar 2010). In several times the colonial government had imposed legislation like contagious Disease act of 1868 and Epidemic Disease act of 1897 on Indian people. Before 1817, cholera had been confined to lower Bengal with sporadic outbreaks among the rural population, but not among Europeans enclaves in towns, or in military stations. In that year, however, the disease spread outside of its 'home' in Bengal to claim the lives of many thousands of Indians and Europeans in northern and eastern India and in the following years, in the presidencies of Bombay and Madras. The outbreak of what appeared to be a new disease epidemic cholera made a profound impression on Europeans arousing more fear and interest than any other disease. In India the debate over cholera intertwined with the issues of internal and maritime quarantine, and with questions of government finance Mark. Between 1818 and 1854 more than 8500 British soldiers were reported as having died of cholera. Though cholera was known in Asia and Europe much before the British arrival in India, its appearances in extremely virulent and fatal form was properly recorded only in the first quarter of the 19th century. Most commonly known as hazia from the Arabic word *hachazia* this disease was assigned different names such as morysey, *miritirissa, vizucega, mordeyin and mordechien* in different parts and different languages of India. The cholera epidemic ravaged in Bengal between 1817 and 1823 but almost disappeared in the following years (1823-25), except in its endemic areas. It returned again in 1826 with much greater virulence and ferocity and swept almost entire India in its sway. By the end of 1827, it was playing havoc in the NWP (particularly Hardwar), the Bombay Presidency, Sind and the Punjab. It reached Khiva and Heart via Kabul in 1829. It was the cause of 15 million deaths between 1817 and 1865 (Arnold 2000).

Government interventions

To enter the realm of medical theory in India in the 1860's and 1870s is to enter the abstract world of Dr. James Lumsdane Bryden, India's premier epidemiologist and government's chief adviser on epidemic cholera. Bryden was commissioned by the government to investigate the phenomenon of epidemic cholera. His main tasks were to establish the limits of the geographical distribution of the disease, the duration of epidemics, the influence of meteorological condition and most importantly, its mode of propagation and spread. In 1866 William Farr, compiler of abstracts at the register general office in London, observations had led him to believe that cholera was spread in contaminated drinking water, but until his death, Bryden remained convinced that cholera was an air and not a waterborne disease. James Mcnabb Cunningham (1829-1905) did not accept the cholera intervene policy of government. The government's most persistent critic was Annesley Charles Derenzy (1828-1914) sanitary commissioner of the Punjab. Derenzy mounted a concerted attack on Bryden's hypothesis and on the government for its inaction in the sphere of public health. He did not like Bryden theory and explained ''first it is calculated to severely retard sanitary progress second it has been the basis of the action of the government of India against cholera to substantiate the first reason, I have only to refer to almost every review of Dr.Bryden's book. It will suffice to quote here the opinion of one whose authority is universally admitted, Dr.parkes'' he says-Dr.Bryden's views strike at the heart of the usual preventive measures. The government came to adopt an official position on cholera which vindicated its policy of limited intervention in public health and its opposition to the quarantines imposed against India following the Constantinople sanitary conference of 1866. The first major outbreak of the disease since the report of the royal commission in 1863. Originating in Haridwar in the northwest provinces, where thousands of pilgrims had gathered for the *kumbhmela* (an annual religious fair), the epidemic appeared to spread outwards along the routes of returning pilgrims, affecting towns and military cantonments. The government had enacted Military Cantonment act in 1864. The direct threat posed to the health of European troops, and the demand by delegates to the Constantinople sanitary conference that the Indian government make sanitary provisions at places of pilgrimage within India, led the government to launch an enquiry into the causes of the 1867 epidemic. The two persons chosen to conduct the enquiry were Bryden and Dr. John Murray, Inspector general of hospital of N.W.P undertake the enquiry. Haridwar, Puri, Allahabad, Nasik, Tirupati and Tamilnadu's kanchipuram were the center point of epidemic. Bengal sanitary commissioner Lt. Col. G. B. Malleson opined that strict control upon the pilgrims should be continued. In 1867 W. R. Cornish Madras sanitary commissioner, demonstrated with respect to the famines of 1866 and 1876-8 that the 'abnormal conditions' to which the malnourished, migrant poor of the countryside were exposed to death, were lack of clean water and proper food, and their congregation in insanitary towns and relief camps made them particularly vulnerable to cholera as well as being agents in its wider dispersal (Cornish 1881). J. M. Cunningham, Sanitary Commissioner in 1880's stated that unless much stronger evidence can be adduced in favour of the pilgrim theory than as yet been brought forward such as measure of stopping the (Haridwar) fair would certainly be an un warrantable interference with the liberty and religious observances of the people (Cunningham 1879). It has been alleged by Ramasubban (1988) that the government was mercy using Indian cultural prejudices as an excuse not to spend money on sanitary measures, yet other evidence indicates that pilgrims at haridwar resented sanitary regulations and blamed them for the cholera epidemic (seeing them as a slight to the Goddess Kali on whom they had hitherto entrusted their fate). Elite Hindu newspapers such as the Hindu patriot also warned the government against interfering with pilgrimages warning that any intervention would be regarded as a 'great hardship by the people' (Harrison 1994).The government thought that if they attack on religious custom it led to political unrest. Robert Koch had discovered Bacillus. Only slowly, following international acceptance of Koch's Cholera Bacillus in the early 1890's did the government's position begin to shift in line with medical opinion outside India. In 1930's Allahabad *kumbhmela* vaccination was not compulsory. There is a political reason behind that Indian national congress had started civil disobedience movement. Improvements in public health depended on active co-operation between colonial officials and indigenous peoples, and this necessitated gradualism and sensitivity to Indian interests. It also required financial aid from central and provincial government, but the government displayed the kind of commitment necessary to the progress

of sanitation. Arguably such co-operation was impossible in a colonial situation in which notions of racial superiority and cultural distance made difficult constructive relations between rulers and ruled. The response of the Indian government to epidemic cholera embodied many of the contradictions and tensions of British rule in India. The protection of Europeans, and especially European troops, necessitated some degree intervention in the lives of Indigenous people but any such action carried with it the risk of civic unrest.

Bengal and epidemics

The 19th century Bengal was the scene of a rapid commercial and industrial expansion. The nature of the economic transformation and the ecological changes brought about under such expansion had far reaching and enduring effects on public health of that area (Klein 1972). Bengal was described as the 'birth place' and the 'chief epidemic home of cholera in the world' in medical journals. The reason for it is attributed to the insanitary situation particularly in the city of Calcutta and generally in the villages of Bengal. About the insanitary state of Bengal's villages, Macnamara reported that none of those villagers possessed a single road or thoroughfare properly so-called, to remove the filth (Kumar 1998). Epidemic Disease Act of 1897 gave the provisional government more power. The colonial government was dominated by the interests of the landlords, the higher professionals and the more wealthy merchants; they were not particularly sensitive to the awful health conditions of ordinary Indians. The Indian Medical Record lamented that ever since the outbreak of cholera in 1817 which first attracted notice in Jessore and afterwards spread throughout India and as far as Europe, cholera was never absent from Bengal. Year after year like some demon cholera extracted its recurring toll on human lives. The journal regretted that this appalling sacrifice of human lives was wholly avoidable (Bagchi & Krishna 2005). The Amrita Bazar Patrika of May 16,1929,observed that owing chiefly to acute water distress cholera raged in epidemic form in Mofussil of some nine districts of Bengal .In the villages of Bengal, pure drinking water was not easily available. The poor ryots died in the meanwhile by impure drinking water. In 1936 the Amrita Bazar Patrika published the annual report of the All India Institute of Hygiene and Public Health Calcutta which also mentioned that it was from Bengal, the home of cholera that big epidemics occasionally spread over vast areas in India and beyond (PHP 1937). A similar view was expressed by Seal (1945) in the Indian Medical Gazette in 1945.' In no country in the world to-day or perhaps at any time, has cholera been so prevalent as in India and particularly in Bengal (Seal 1945). The prevalence of cholera in Calcutta was described by the Amrita Bazar Patrika as 'a disgrace to the corporation' which spent 17 lakhs for the development of the sanitary staff. Immediately after the Rathjatra, Gangasagar festival and Haj, a large number of cholera patients were admitted to the cholera wards of the hospital in Calcutta. The patrika reported that 'We have an uncomfortable feeling that the Calcutta Hospitals do not provide sufficient accommodation for cholera patients during these epidemics'. The paper reported that the Cambell Hospital which had 51 cholera beds had taken in 81 cholera patients but the rush proved so great that it had to refuse admission to about 15 patients for want of accommodation. Warning notices by corporation regarding precautionary measures to be adopted during cholera outbreaks were published by the patrika. Arrangement for mass inoculation by the Government of Bengal and the Marwari relief society was also published by the paper. In may 1943 the patrika while advising the citizens of Calcutta to get inoculated, also advised to make arrangements for house to house inoculation but despite repeated warnings a large section of the city's population especially women did not get themselves inoculated. The residents of Calcutta also brought this to the notice of the press. The paper advised the health officers of the corporation to make surprise visits to some of the city markets and to exercise strict control over food sold in hotels and restaurants. Drive against cholera epidemics were published by the papers. It was reported by the patrika that in course of their drive against cholera, police officers were seen visiting markets in Indian quarters and inspecting stalls of fishes, meat, vegetables and fruits. In case of rotten fishes being sold the entire stock of such fishes was taken in charge by the police for destruction under the epidemic disease act. A few instances of indifferences of the local authorities mentioned by Bangabani may be mentioned. The paper reported cases of cholera outbreaks in Jamalganj Bogura but no health officials were seen there. Cholera epidemics which followed

in several districts like Pabna, Bogra, Rangpur, Faridpur, Bankura, Khulna and Mymensingh, it appears that no organized action was attempted by any local body. A readers' latter to Bangabani reported cases of cholera outbreaks in Mogura thana Jessore but there was no initiative to prevent the disease. Further the Union boards and the district boards did not consider it to be their duty. The paper reported that a letter of Dr. K. S. Ray, member of the Legislative Assembly, requesting to distribute anti-cholera inoculation in cholera-infected areas like Manikganj remained unresponsed by the Government. In North Bengal after the flood in 1923, to the problem of outbreak of cholera the Bandemataram remarked 'The bureaucracy have undertaken the responsibility of ruling the country but not of protecting it.

Conclusion

Present paper does throw some light on the policy making regarding cholera in colonial context. This case study shows clearly how different views about the practical usefulness of new medical knowledge among the various authorities in the bureaucracy could influence the formulation and implementation of policy measures. However, a more elaborate study covering the experiences of various other regions is needed to understand fully the nature and evolution of health policy in Colonial India. This study is only a small step in that direction. This paper tries to analyse in this small discussion that how the colonial government is unethical regarding the cholera outbreak and public health problems. The word 'Ethics' is totally absent in the dictionary of colonial state.

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Poverty, Environment, and Clean energy- The Indian paradox

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The sustainable energy investment story of 2009 was one of resilience, frustration and determination worldwide. And the determination on the part of many industry sectors and governments, especially in rapidly developing economies like India, prevailed and saw transformation of the financial and economic crisis into an opportunity for greener growth.

New investments in sustainable energy was $ 162 billions in 2009,or some 7% down from 2008 figure of $ 173 billions- an estimate revised up from the original $ 155 billions made at the time. 2009's figure was still the second highest annual investment total ever (and four times that sum in 2004) and spending on new capacity (including large hydro as well as other renewables) was for the second year running bigger than the investment in new fossil fuel capacity. This underlines that sustainable energy was not a bubble by-product of the ill-fated credit boom, but a global investment transition that is likely to strengthen overtime, according to the UNEP and Bloomberg New Energy Finance report, 'GLOBAL TRENDS IN SUSTAINABLE ENERGY INVESTMENT 2010'.

Supportive policies for clean energy expanded. Over 100 countries had some type of policy target or policy for promotion of renewable energy by early 2010. These have also been made possible as some $ 188 billions of 'green stimulus' commitments began to be spent in 2009, and public banks like the European Investment Bank and Germany's KfW helped bridge the financing gap.

The Copenhagen Accord, to which over 100 countries have now associated themselves, has brought developed and developing economies together for the first time on decoupling economic and emissions growth.

According to the above-referred UNEP report, developing countries in Latin America, Africa and Asia (excluding Brazil, India and China) received $ 7.5 billions of new financial investment in 2009, some 6.3% of the global total and 26% higher than 2008 levels. The so-called Big Three- China, Brazil and India respectively ranked first, fifth and eighth in the world, attracting a combined total of $ 44.2 billions in 2009, representing 37% of global financial investment in clean energy. Investment in India fell back in 2009 to $ 2.7 billions, from $ 3.4 billions the previous year, despite the economy's resumption of its rapid growth trajectory in 2008. Wind attracted 59% of the financial investment in clean energy in India in the year.

The reported investments in India are dominantly in the form of asset-based finance($ 1.9 billion, or 73%). Venture capital and public equity are yet to make any significant inroads in India.

So where do we stand in fulfilling our promises for energy security? How far we have been able to enlighten the house and mind of the last person in a remote village of India with the glow of even a simple incandescent lamp of Humphrey Davis?The published data shows an abysmally low achievement as it brings before us the count of such persons in terms of several hundred millions in India still without any access to electricity and living as well in

dire poverty. And they are overwhelmimngly located in rural areas. They rely on traditional biomass to cook their food and perform other chores. In addition to deforestation, traditional cooking fuels degrade the air quality, causing serious health problems and premature deaths. India,despite its status as the second fastest growing economy, is still home to around 500-600 million people who are 'energy poor'. And all these when we are talking of 9-10% GDP growth and of the need to maintain it through an inclusive growth strategy as repeatedly stressed by our government. This necessitates the power sector in India to grow at a matching rate, if not at a higher rate.

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Municipal Solid waste generated by Silchar town and its impact on surrounding area of dumping site at Meherpur, Silchar

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Abstract

Solid waste disposal has been a chronic problem, particularly in areas with high population density, high production of refuse, and scarcity of land adequate for landfills. Due to lack of efficient solid waste management system and improper dumping of MSW as open landfills, the groundwater and surface water is found to be contaminated in various places. Silchar is one of the fastest emerging urban areas of north east India. So is the case with its solid waste. Its management has become a big issue for the town and hence requires immediate attention. The present article throws some light regarding this.

Keywords: *Dumping ground; Silchar; Solid waste management*

Introduction

In most of the developing countries, municipal solid waste (MSW) disposal has been a chronic problem, particularly in areas with high population density, high production of refuse, and scarcity of land adequate for landfills (Sadek & El-Fadel 2000). Due to lack of efficient solid waste management system and improper dumping of MSW as open landfills, the ground water and surface water is found to be contaminated in various places (Rajkumar et al. 2010). Solid waste includes all the discarded solid materials from commercial, municipal, industrial, and agricultural activities. Land filling is the preferred method of municipal solid waste (MSW) disposal due to its favourable economics. However, poorly designed landfills can create contamination of groundwater, soil, and air. The most commonly reported danger to the human health from these landfills is from the use of groundwater that has been contaminated by leachate (Rajkumar et al. 2010). Generally municipal solid waste is collected and deposited in sanitary landfill, such unscientific disposal attract birds, rodents and fleas to the waste dumping site and create unhygienic conditions (Suchitra et al. 2007). The degradation of the solid waste results in the emission of carbon dioxide (CO_2), methane (CH4) and other trace gases. The unscientific landfill may reduce the quality of the drinking water and causes the disease like jaundice, nausea, asthma (MeBean et al.1995; Dhere et al.1995).

Types of wastes on the dumping ground, mostly non-biodegradable in Silchar

Silchar and Solid waste management

Silchar (24°49'47"N 92°46'11"E) is located at the southern part of Assam. Situated on the Barak River near the Bangladesh border, it is a trade and processing centre for tea, rice and other agricultural products. There is limited industry, principally papermaking and few small scale industries. The town has an airport and lies on both a rail head and national highways connecting Guwahati, Assam; Agartala, Tripura; Imphal, Manipur and Aizawl in Mizoram state. It has an average elevation of 22 meter (72 feet). Silchar town of Assam witnessed many problems associated with its fast pace of development; one of which is in managing Municipal Solid Waste (MSW). The situation is deteriorating day by day. Meherpur, the final disposal site is located at distance about 2.0 km away from the Municipal town boundary and is known as municipal open trenching ground. Dumping of wastes in the said ground is the only practice of the Silchar Municipality. Uncontrolled, unscientific and non-segregated (bio-degradable and non bio-degradable) solid waste dumping is a serious concern. Human habitats, which are in increasing order over the periphery of the disposal site, are prone to effect of solid waste. During rainy seasons and flood, habitation around the dumping site near about 10,000-12,000 of population is affected as the waste is open and scattered. Municipal waste is the refuse that arises out of human activities which includes household refuses, commercial waste, street sweeping, construction debris etc. The Solid Waste' includes garbage (food waste), rubbish paper, plastic, wood, metal, throw-away containers, glass etc., demolition products (bricks, masonry and pipes), sewage treatment residues, dead animals manure and other discarded materials.

Cattles on the dumping ground

Burning of the solid waste generating odorous smoke which directly effecting the surround habited areas

Conclusion

Municipal Solid Waste (MSW) is a heterogeneous mixture of rags, stones, soils, besides food and vegetable waste from kitchen and market. Solid waste if allowed to accumulate is a health hazard because as it decomposes and favours fly breeding, attracts rodents and vermin. Pathogen which may be present in the solid waste may be conveyed back to man's food through flies and dust. So there is a possibility of water and soil pollution and heaps of refuse present an unsightly appearance and nuisances from bad odours. There is correlation between improper disposal of solid waste and vector borne diseases. Therefore, in all civilized countries, there is an efficient system for its periodic collection, removal and final disposal without risk to health. It has become necessary to study and scientific implementable solution to the problems so that the town can be saved from further deterioration and also to safe-guard the public health by generating public awareness.

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Conservation of Medicinal plant Diversity in Gujarat

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Abstract

Gujarat state possesses rich plant diversity. It also has traditional knowledge rich ethnic society. This diversity and knowledge is facing the risk of extinction due to habitat destruction, over-exploitations and various other factors. There is urgent need of long term strategies for conservation of medicinal plant resource and using their rich associated traditional knowledge, for environmental, social, culture and economic benefits. This review paper discusses the status & distribution of medicinal plants diversity in Gujarat, threats faced by them and the possible strategies to conserve the diversity and traditional knowledge of medicinal plants.

Keywords: *Conservation; Gujarat; Medicinal plant diversity*

Introduction

Plants have been used as a source of medicine since ancient times. These medicines are safe and environment friendly. According to World Health Organization (WHO) about 80% of the world's population depends on traditional medicine for their primary health care. Between 40,000 and 50,000 plant species are known to be used in traditional and modern medicine systems throughout the world. India has probably the oldest, richest and most diverse cultural traditions in the use of medicinal plants. Over 7500 species of plants are used by several ethnic communities. In India, the sacred Vedas, which date back between 3500 B.C. and 800 B.C., give many references of medicinal plants. The Rigveda, dating between 3500 B.C. to 1800 B.C., seems to be the earliest record available on medicinal plants.

Gujarat state has a rich biodiversity with 13% of the flora of India in a diversity of ecosystem. The state is a unique state that has many kinds of habitats. These include dry deciduous forests, majestic grasslands, wetlands, marine ecosystems and rich moist deciduous forests. About 760 species of medicinal plants and 450 species of economically valuable plants used by local tribes have been identified so far. Gujarat is also a repository of considerable agro-biodiversity. Wild relatives of a number of indigenous varieties of crops originate from Gujarat.

The indigenous traditional knowledge of medicinal plants of various ethnic communities, where it has been transmitted orally for centuries is fast disappearing from the face of the earth due to the advent of modern technology and transformation of traditional culture. There is an urgent need to document the ethno biological information presently existing among the diverse communities before the traditional knowledge is completely lost (Rao 1996).

Conservation of medicinal plants is very important because it is connected to survivability of a larger number of people. Moreover income from medicinal plants

contributes significantly to rural household cash resources. Loss of medicinal plants will not only affect healthcare and household economy but also destroy the hope for discovering new medicines for disease like HIV-AIDS, cancer and other serious diseases. Therefore to conserve medicinal plants, first their habitat and related knowledge need to be protected and the dangers need to be identified then based on these information conservation strategy could be developed to address the problem. In this review paper the status of the medicinal plant diversity in Gujarat state, factors causing threat to medicinal plants and the conservation strategies were discussed.

Historical record of medicinal plants in India

India has one of the oldest, richest and most diverse cultural traditions associated with the use of medicinal plant. This knowledge is accessible from thousands of medical texts and manuscripts. This traditional knowledge forms the codified system of medicine and exists in the form of Ayurveda, Unani, Siddha, Homeopathy and Tibetan system of medicine. Also, there exists a vast knowledge in the form of folk / non-codified / oral traditions, which do not have standard forms because significant variations to the structure of this traditional knowledge have been introduced by the communities who are carriers of this knowledge over generations and across a large tract. It is believed that Ayurveda originated as early as 5000 BC in the Himalayan region as a result of the holy and arduous pursuits of spiritually enlightened rishis. Around 1500 BC it was delineated into two main schools: Atreya (school of physicians) and Dhanvantari (school of Surgeons). The most important books of Ayurveda are Charak Samhita, Sushruta Samhita and Ashtanga Hridaya. The other books include Bhavprakasha, Raja and Shaligram. The medicines used in Ayurveda are chiefly plant-based, but many are also of mineral and animal origin. It is capable of giving total and holistic treatment for various diseases by going to their fundamental and root causes.

According to Unani system, the body comprises four basic elements: earth, air, water and fire which have different attributes such as cold, hot, wet and dry. A disease is considered to be an imbalance in the elements and the treatment is aimed at restoring this balance. Siddha is one of the oldest traditional systems of pre-Vedic period which tried to organize and formulize the human knowledge acquired about the plants, chemicals and their role in curing diseases in southern parts of India. Tibetan medicine is a science and philosophy that provides a holistic approach to the total health care. It is based on the Buddhist philosophy of humanity, karma and ethics. Since ancient times mankind has been using herbal, organic material as well as that from the sea, rivers etc. for its betterment. These substances have been used as Food, Medicine etc. Amongst them substances having medicinal value has been extensively used for treating various disease conditions. Herbs being easily available to human beings have been explored to the maximum for their medicinal properties. Various parts of the plants like roots, leaves, bark, exudates etc. are used as per medicinal properties.

It is believed that about 35,000 to 70,000 plant species have been used for medicinal purposes across the globe. The Indian systems of medicine use more than 8000 species of medicinal plants. There are over 25,000 herbal products documented in medical literature. In our sacred literature – Vedas and many other important collections by Great Sages & Saints mentioned the importance of medicinal plants as Rigveda prescribes 67 M.P., Yajurveda prescribes 81 M.P., Atharvveda prescribes 290 M.P., Brahamana prescribes 130 M.P, Charaksamhita - 400 to 450 M.P., Shusrutsamhita - 573 M.P., Dhanvantri Nighantu - 373 medicinal plants based drugs, Raja Nighantu prescribes about 750 plant based drugs and Madanpala & Bhavprakash prescribes about 569 plant based drugs etc.

Status of the medicinal plant diversity in Gujarat

Gujarat is the western most state of India situated between the latitudes of 20°01’ N to 24°07’ N and 68°04’ E to 74°04’ E longitudes. It covers an area of 1,96,024 sq. km which accounts for nearly 6% of geographical area of the country. The state is bound by the Arabian Sea on the west, Pakistan and Rajasthan in the north and northeast, Madhya Pradesh in the southeast and Maharashtra in the south. The state of Gujarat contributes to country’s biodiversity in a big way. Despite, its adverse geo-climatic conditions, the state have a remarkable diversity of plant species owing to its four bio- geographic zones and five biotic provinces. This diversity is manifested in about 4320 plant species and medicinal flora forms a

major component of this biodiversity. The floristic diversity of Gujarat shows 2,205 species of higher plants including 27 species of mangroves. The state has 1315 recorded species of medicinal value. These include 754 herb species, 248 tree species, 165 shrubs and 148 climbers, 1016 plant species are wild where as 299 species are being under cultivation or plantation (Pandey et al. 2005). About 15% of Gujarat state population is tribal, which is represented by about 30 ethnic groups, well distributed in the southern and eastern part of the state, which incidentally coincides with the best forested areas. Important ethnic groups are of Bhil, Dhodiya, kolcha, koli, konkni, Gond, Gamit, Valvi, Talvi, Padhar, Pateliya, Rathava, Siddi, Waghri, etc. These tribal people mainly depend on forest for their shelter, housing material, food, fuel, fiber and feed. These ethnic groups through their observations and experiences with the nature have developed their own indigenous systems of treating ailments using different plants. In Gujarat the traditional practitioners amongst these ethnic groups are commonly known as 'Bhubas', 'vaidyas', 'bhagats', etc. According to one of the study, these people have the traditional knowledge and wisdom about the medicinal values of at least 500 plant species, however approximately 179 species are being used by these local practitioners. Zone-wise hotspots for medicinal plants in Gujarat state are as under in Table 3.

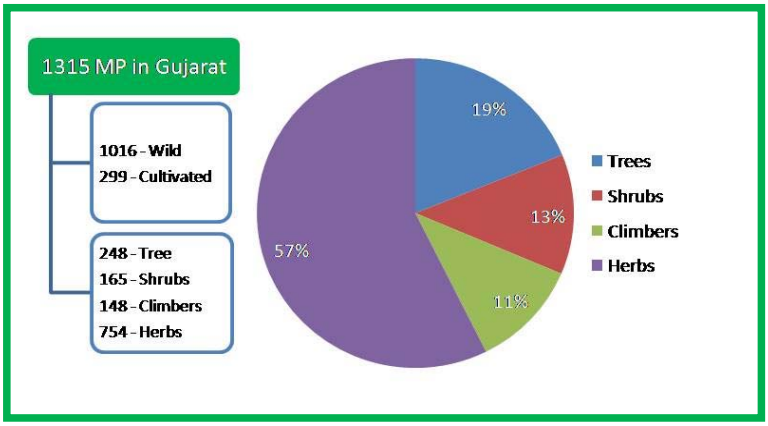

Figure 1. Different categories of medicinal plant diversity of Gujarat

Table 1: Habits of species utilized by ethnic people in the state *(Source: Pandey et al., 2005)*

Habits	Total no. of medicinal species in the state	No. of species used by ethnic groups
Trees	248	82
Shrubs	165	22
Herbs	754	45
Climber	148	30
Total	1315	179

Table 2: Zone-wise Medicinal plant species in Gujarat state *(Source: Medicinal plants of Gujarat, GEER Foundation, Gandhinagar)*

Sl. No.	Zone	Districts	Forest Divisions	No. of medicinal plant species reported				
				Trees	Shrubs	Herbs	Climbers	Total
I	South Gujarat	Valsad, Navsari, Dangs	Valsad(S), Valsad((N) Dangs(S), Dangs(N)	204	118	492	109	929
II	South East Gujarat	Surat, Bharuch, Narmada	Vyara, Rajpipla(W), Rajpipla(E)	217	129	542	114	1002
III	Central Gujarat	Vadodara, Panchmahal, Dahod	Chhota udepur Godhara, Baria	218	136	566	128	1048
IV	North Gujarat	Ahmadabad Gandhinagar Sabarkantha Mahesana Banaskantha Patan	Gandhinagar Sabarkantha(N) Sabarkantha(S) Banaskantha	187	118	513	100	918
V	Saurastra	Surendranagar Bhavnagar Amreli Junagadh Porbandar Rajkot Jamnagar	Surendranagar Bhavnagar Junagadh Jamnagar	198	128	539	112	977
VI	Kachchh	Kachchh	Kachchh(W), Kachchh(E)	112	106	406	67	691

Fig. 2: Different bio- geographic zones of GujaratTable

Table 3: Zone wise medicinal plants hotspots in Gujarat State (*Source: Pandey et al., 2005. Medicinal plants of Gujarat, GEER Foundation, Gandhinagar)*

Sl.No.	Zones	No. of Hotspots	No. of districts	
1	South Gujarat	3	2	923
2	Souteast Gujarat	6	2	1002
3	Central Gujarat	10	4	1048
4	North Gujarat	8	2	1018
5	Saurashtra	10	3	977
6	Kachchh	8	1	691
	Total	**45**	**14**	**1315**

Out of these six zones, Zone - I and II in South Gujarat has 70% of the 1315 medicinal plant species found in the state. These two zones comprise mainly of moist deciduous forests as per Champion and Seth's classification and receive an annual rainfall of 1500-2000 mm. The vegetation consists mostly of teak and its associates such as bamboos, *Terminalia* spp, *Gmelina arborea*, *Dalbergia latifolia*, etc. There is a well defined stratification of vegetation including herbs, shrubs, trees and climbers. In terms of density of species diversity (number of species per 100 sq. km), these two zones ranks first respectively in the state (Fig. 3). These two zones have endemic population of 71 species of medicinal plants of conservation concern, which constitutes 70% of the State's total. These two zones have also the richness in representing the 14 medicinal plant species, which are endemic to India. It is also noteworthing that these two zones also has a noticeable population of medicinal orchids such as *Nervilia aragoana*, *N. discolour*, *Vanda tasellata*, *Habernaria longicorniculata*, *Platenanthera sussane*, and medicinal lianas such as *Entada pursuetha* and *Radermachera xylocarpa.*

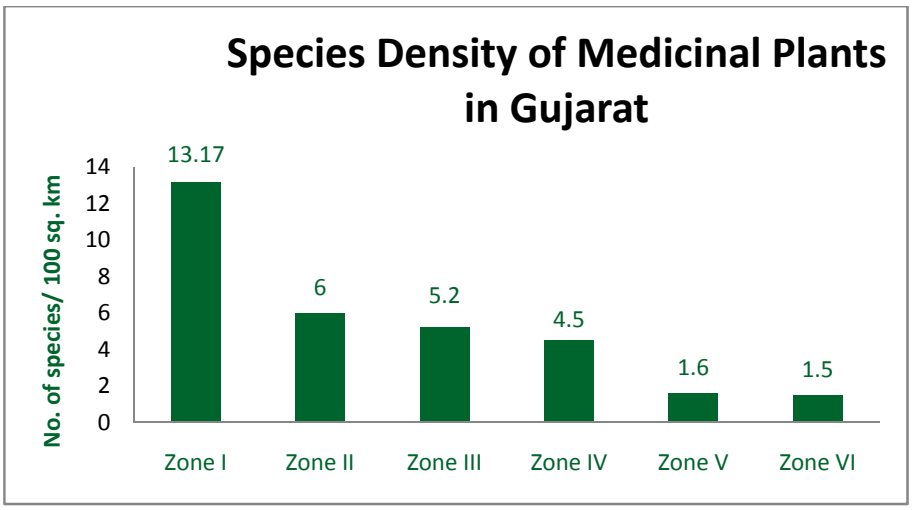

Fig. 3: Graph showing the zone-wise distribution of medicinal plant species in Gujarat. South Gujarat shows the highest density among all the zones.

Gujarat is one of the industrially developed states and a large number of pharmaceutical industries are present in the state. There are more than 605 ayurvedic pharmaceutical industries, which are using medicinal plant parts as raw material. According to a survey, 270 medicinal plants are being consumed by these units, out of which 201 species are indigenous and 69 species are imported from elsewhere. Out of 201 indigenous medicinal plants, 148 species (74%) are growing in wild and other 53 species (26%) are cultivated as crops. Out of 148 wild plants, 48 species of trees (32%), 22 species of shrubs (15%), 28 species of climbers (19%) and 50 species of herbs were found. A rough estimate revealed that these industries are using 3,755 metric tonne of plant parts annually.

Another market survey suggests that among the medicinal plants used by pharmaceutical industries, *Azadirachta indica, Terminalia bellarica* and *Terminalia arjuna* were used by all. This is followed by *Aloe barbadense, Asparagus racemose, Casia italica var.micrantha, Crateva nurvala, Curculigo orchiodes* and *Melia azadirachta* which are used by 80% of pharmaceutical industries. The survey also revealed that these units are experiencing the shortage of raw material for the plant products from species like *Aegle marmelos, Aloe barbadense, Asparagus racemose, Casia italica var.micrantha, Crateva nurvala, Curculigo orchiodes, Clerodendrum multiflorum (Burm.f.), Desmodium gagenticum, Gmelina arborea, Melia azadirachta, Oroxylum indicum, Steteospermum suaveolens, Solanum indicum, Solanum surattens, Tribulus terrestris, and Uraria picta* etc. It is also pertinent to mention that according to the survey, 90% of these medicinal plant species are being collected wild, mostly from forest areas and the existing natural resource is not commensurate with the growing demand.

Table 4: Annual demand of medicinal plants in focus

Sl. No.	Species	Common Name	Annual Demand (In Tones)
1	*Aegle marmelos,*	Bili	34
2	*Gmelina arborea,*	Gambhari	11
3	*Steteospermum Suaveolens,*	Patal	4.2
4	*Desmodium gagenticum*	Sarivan	4.3
5	*Oroxylum indicum,*	Aralu	3.9
6	*Clerodendrum multiflorum*	Arani	3.9*
7	*Solanum indicum,*	Brihat Kantkari	0.045
8	*Solanum surattens*	Kantakari	28.7
9	*Tribulus terrestris*	Gokharu	3.4*
10	*Uraria picta*	Pithwan	6.6*
11	*Saraca asoca*	Ashok	24.5
12	*Terminalia chebula*	Harde	120
13	*T. Belarica*	Baheda	81
14	*T. arjuna*	Arjun	24.5
15	*Semicarpus anacardium*	Bhilamo	0.8

**Extrapolated data from "Status of medicinal plant consumption by the pharmaceutical industries in Gujarat state" published by Singh A. P. and Minoo Parabia (2003)*

The study also emphasised upon the demand and supply of wild medicinal plants. The total demand of the industries has been pegged at 3,755 metric tonne annually out of 270 medicinal plants. The demand of 148 wild species was found 2,499 metric tonne against the supply of 980 metric tonne (39 per cent) out of 65 species. The rest of the wild species are collected but not recorded. The summary of demand and supply gap of indigenous medicinal plants (wild) with quantity is given in Table 5.

Table 5: Status of demand and supply scenario of wild medicinal plants *(Source: Medicinal plants of Gujarat, GEER Foundation, Gandhinagar)*

Plant Groups	No. of Species consumed	Quantity (Mt.)	No. of species collected	Quantity (Mt.)	Difference	
					No. of species	Quantity (Mt.)
Trees	48	788	24	782	-24	-06
Shrubs	22	278	08	55	-14	-223
Climbers	28	642	11	13	-17	-629
Herbs	50	791	22	330	-28	-661
Total	**148**	**2499**	**65**	**980**	**-83**	**-1519**

It is evident that out of 148 wild medicinal plants, only 65 species (45%) are collected authentically and legally while 83 species (55 %) are also collected from the wild and supplied to the pharmacies through their well established middle men network but remained undocumented. It is an eye opener that indigenous species are supplied largely, exploited ruthlessly and left the species endangered in nature. Out of these 148 medicinal plants 50 plants, including 16 trees, 8 shrubs, 12 climbers and 14 herbs, were discussed as threatened (Singh, A.P., 2003). A brief description of these threatened medicinal plant species is given in Table 6.

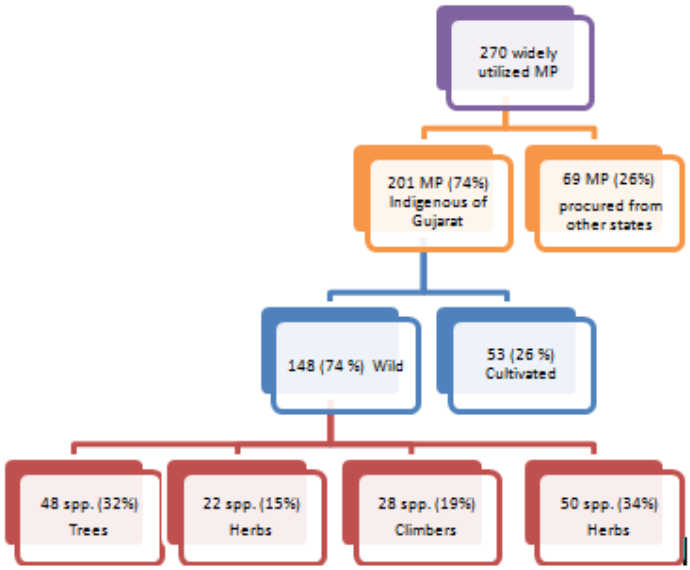

Fig. 4: Summary of medicinal plant status in Gujarat

Table 6: List of threatened medicinal plant species of Gujarat *(Source: Singh A. P., 2003)*

Trees				
Sl.No.	**Local Name**	**Botanical Name**	**Family**	**Use**
1	Harde	*Terminalia chebula*	Combretaceae	Paste of fruit pulp used in diarrhoea, Constipation, Skin diseases, anaemia, elephantiasis, indigestion, epilepsy, leprosy, asthma and diabetes
2	Arjun	*T. arjuna*	Combretaceae	Bark is used for Heart disorders, Fractures, bleeding piles, ulcers, sexual debility
3	Ashok	*Saraca asoca*	Caesalpinaceae	Bark is used in Diabetes, women disorders, dysentery etc.
4	Kanchnar	*Bauhinia variegata*	Caesalpinaceae	Bark is used for diarrhoea, skin diseases, leprosy, wounds, ulcers, inflammation, scrofula
5	Sivan	*Gmelina arborea*	Verbinaceae	Root is used in Skin diseaese, leprosy, Ulcers etc
6	Chandan	*Santalum album*	Santalaceae	Heart wood is used for vitiated conditions of Pitta, jaundice, cough, bronchitis
7	Patla	*Stereospermum suaveolens*	Bignoniaceae	Root is used for Blood purifier, appetizer, diuretic, febrifuge, cooling, aphrodisiac
8	Tetu	*Oroxylum indicum*	Bignoniaceae	Root is used for vitiated condition of Vata and Kapha, cancer, Dropsy, Cough, asthma
9	Ragatrohido	*Tecomella undulata*	Bignoniaceae	Bark is used for Skin disorders, jaundice, liver disorders, diabetes, cancer, obesity
10	Kadvo Sargvo	*Moringa concanensis*	Moringaceae	Bark decoction in throat cancer.
11	Kapilo	*Mallotus phillipinensis*	Euphorbiaceae	Fruit hair is used for Vitiated Conditions Vata and Kapha, wounds, cough, ulcers, poisonous affections, scabies, rignworm
12	Bhilamo	*Semecarpus anacardium*	Anacardiaceae	Fruit is used for vitiated conditions of Kapha and Vata, fever, diabetes, cancer . Bhilamo oil with charoli oil applied externally in arthritis.
13	Salai	*Boswellia serrata*	Burseraceae	Gum is used for Vitiated conditions of Pitta, Asthma, ulcers, skin diseases and rheumatism.
14	Vai-varno	*Crateva nurvala*	Capparaceae	Bark is used in vitiated Conditions Vata and Kapha, Heart trouble, Colic, cancer, cough, tubercular glands, inflammations
15	Biyo	*Pterocarpus marsupium*	Fabaceae	Bark is used in vititated conditions of Kapha and Pitta, leprosy, skin diseases, diabetes, ophthalmopathy, diarrhoea, Cough, sexual debility, asthma etc . Gum is used in tooth ache and leave pest is applied in wounds. Wooden glass for diabetes.

Shrubs				
Sl.No.	**Local Name**	**Botanical Name**	**Family**	**Use**
1	Guggal	*Commiphora wightii*	Burseraceae	Gum is applied on skin wounds and irritations. Vitiated Conditions of Vata, Gout, Sciatica, Facial paralysis, Arthritis
2	Vavding	*Embelia ribes*	Myrsinaceae	Fruit is used in Vitiated Conditions of vata, piles, leucoderma, paralysis, colic, constipation, ringworm infestation
3	Arni	*Clerodendron Phlomidis*	Verbinaceae	Root is used in asthma, obesity, diarrhoea, piles, rheumatism
4	Danti	*Baliospermum montanum*	Euphorbiaceae	Root is used in flatulence,constipation, jaundice, leprosy, vesical calculi, wounds, anaemia, leucoderma, fever and vitiated condition of Vata
5	Dhavdi	*Woodfordia fruticosa*	Lythraceae	Flowers used in Vitiated Condition Kapha and Pitta, bleeding, infertility, skin diseases, diarrhoea, diabetes
6	Ankol	*Alagium salvifolium*	Alangiaceae	Fruits eaten to enhance eye sight. Seed oil is used in Rheumatism, Leprosy
7	Bharangmool	*Clerodendron serratum*	Verbinaceae	Root is used in Vitiated conditions of Kapha and Vata, scrofula, piles, cough, asthma, bronchitis, dropsy, constipation, chronic nasitis, leucoderma, leprosy, fevers, epilepsy
8	Mindhan	*Randia dumentorum*	Rubiaceae	Fruit is used in Vitiated conditions of Pitta and Kapha, inflammations, leprosy, skin diseases, wounds, ulcers, tumours, cough, asthma, debility, fev.er etc. Causing Vomiting in emergency and on snake bite
16	Kadayo	*Sterculia urens*	Sterculiaceae	Gum is used for General debility, diabetes, lumbago, strangury, diarrhoea, dysentery,

Climbers				
Sl.No.	**Local Name**	**Botanical Name**	**Family**	**Use**
1	Galo	*Tinospora cordifolia*	Menispermaceae	Stem extractions use for all kinds of fevers, Stems are fed to cattles to increase milk production
2	Patha	*Cyclea peltata*	Menispermaceae	Root is used. Good drug for all types of fever and urinary tract diseases.
3	Shatawari	*Asparagus racemosus*	Liliaceae	Juice of roots is fed to mothers to increase milk.
4	Vachhnag	*Gloriosa superba*	Liliaceae	Root paste applied externally in eczema overnight
5	Dodi	*Leptadenia reticulata*	Asclepiadaceae	A very good remedy for eye diseases and poor vision. Leaves and Tender Fruits are used as vegetable to decrease eye numbers.
6	Anantmool	*Hemidesmus indicus*	Asclepiadaceae	Root is used in Leprosy, Skin diseases, asthma, fever and general debility.
7	Malkangni	*Celastrus paniculata*	Celastraceae	Seed oil is used. Flowers eaten as vegetable and fruits pickled.
8	Garni	*Clitoria ternatea*	Fabaceae	whole plant. Ophthalmopathy, Piles, Migraine, insanity, Skin diseases, vitiated conditions of Pitta and fevers
9	Hadsankad	*Cissus quadrangularis*	Vitaceae	Whole Plant. Used for bone fractures and dislocations.
10	Shikakai	*Acacia concina*	Mimosaceae	Fruits are used. Used for washing hair in combination with amla and aritha
11	Vidarikand	*Pueraria tuberosa*	Fabaceae	Root is used. A good Rasayan used in Rheumatism, Swellings, ulcers, diarrhoea, sexual debility, liver disorders.
12	Kadva Parvar	*Trichosanthes cucumerina*	Cucurbitaceae	Whole plant. Vitiated conditions of Pitta, burning sensation, fever, piles, leprosy, jaundice, toxiemia, acidity etc.
Herbs				
Sl.No.	**Local Name**	**Botanical Name**	**Family**	**Use**
1	Satodi	*Boerhavia diffusa*	Nyctaginaceae	Root is used. Kwath given in internal and external pain and swellings.
2	Kidamari	*Aristilochia bracteolata*	Aristilochiaceae	Leaves are used. Leaf juice to expel worms from ear.
3	Neerbrahmi	*Bacopa monnieri*	Scrophulariaceae	Tender shoot is used. Insanity, tumours, ulcers, skin diseases, vitiated conditions of Kapha and vata, to increase memory power.
4	Brahmi	*Centella asiatica*	Apiaceae	Whole plant. Vitiated conditions of Pitta, Insomnia, cardiac debility, epilepsy, hoarseness, leprosy and to increase memory power, It is also a Rasayan.
5	Chitrak	*Plumbago zeylanica*	Plumbaginaceae	Root is used. Root paste applied on eczema
6	Senna	*Cassia angustifolia*	Caesalpinaceae	Leaves are used. Constipation, leprosy, leucoderma, cough, typhoid fever and vitiated conditions of Pitta and vata
7	Kariyatu	*Andorgraphis paniculata*	Acanthaceae	Whole plant is used. Decoction is given in all kinds of fever
8	Bala	*Sida cordifolia*	Malvaceae	Root and seeds are used. Brush prepared from roots chewed in ashthma and rheumatism and to release milk from breast in mothers.
9	Shalparni	*Desmodium gangeticum*	Fabaceae	Whole plant is used. Important ingredient of Dashmulla, used in vitiated conditions of Vatta, Indigestion, dyspepsia, dysentery, fever, coughs and a tonic
10	Prushnaparni	*Uraria picta*	Fabaceae	Whole plant is used. Important ingredient of Dashmulla, used in swellings, Heart troubles, fevers, rheumatism, piles, fractures, skin diseases
11	Pevto	*Costus speciosus*	Zingiberaceae	Root is used. Eaten as food in scarcity by Tribals of Bastar in Chhattisgarh.
12	Shankhpuspi	*Convolvulus pluricaulis*	Convolvulaceae	Whole plant is used. A good rasayan, used in High blood pressure, sexual debility, diabetes, swellings, to increase memory power, insanity, hair disorders, skin disordrs and heart trouble.
	Kamal	*Nelumbo nucifera*	Nymphaeaceae	Root and seed is used. Seed churna is given in smallpox.

Out of 1315 medicinal plants, 102 species are of conservation concern and 76 are naturally rare ones. On the other hand, 186 species are commercially utilized and traded; where as 108 species are highly traded in Gujarat state. These species have both commercial along with ecological significance. The increasing pressure of commercial demand over the species is one of the major factors, which has caused the depletion in natural habitat. Some of the species are facing a very high level of danger and few of them which occur in this zone are also getting reflected in the threatened category. There are three medicinal plants occurring in this zone are enlisted in red data list of IUCN'2001 (*Dalbergia latifolia*, *Santalum album* and *Saraca asoca).*The focussed conservation programme for such species is certainly going to be a constructive step towards the saving of these threatened and valuable species.

Threats to medicinal plants diversity

Due to anthropogenic causes of different natures and magnitude, medicinal plants are threatened. Such threats differ for various species in different countries and within the country in different locations. Over exploitation of important medicinal plants that have been used to make traditional remedies including drugs to cure cancer, HIV, malaria and many other diseases has threatened the health of millions of people dependent on them.

The various factors affecting medicinal plants are deforestation, habitat destruction due to agricultural expansion, fire, overgrazing, unsustainable harvest practices, climate change (drought), unmanaged market, invasive alien species, unplanned tourism, lack of awareness, information gap, lack of incentives to conserve, urban and industrial development, lack of management and loss of traditional knowledge. Of these, commercial over-harvesting, pollution, competition from invasive species and habitat destruction does the most harm while others also contribute. Studies indicate that in developing countries, poverty is the root cause of threat to medicinal plants. Due to limited cultivable land and increased demand for food owing to population growth, there is rapid encroachment of forest and pasture (Choppra 2009). Such conservation of natural land cover to agricultural land and livestock grazing areas is leading to degradation of natural flora including medicinal plants.

Despite the immense importance of plant resources to social, ecological and economic aspects of rural livelihood, little attention has been given to these dimensions in land use planning and other rural development activities, and the knowledge of such plant-people interrelation is limited. Due to threats, a large number of medicinal species are endangered and the 2007 IUCN Red data list reveals that the number of threatened plant species is increasing gradually. This indicates the need for developing a conservation strategy based on analysis of threats to conserve ethno-medicinal plants and to revitalize knowledge related to them. The major threats to medicinal plants diversity are discussed below:

1. Habitat destruction

Habitat destruction is the major threat to the plant communities. This is the main cause of threat to 83% endangered plant species (BGCI 2009). Commercial harvest and agricultural expansion are the main cause of habitat destruction. Other human induced habitat destruction includes degradation of habitat, fragmentation, pollution, urban sprawl, infrastructure development, and changes to the characteristics of land, forest and other vegetation, fire, desertification and deforestation.

Studies indicate that unstable agriculture and unstable governments (politics) also accelerate habitat destruction.

2. Excessive grazing and reclamation of grassland

Free grazing of livestock is also a threat to medicinal plants in developing countries. Uncontrolled grazing has lead to degradation of pastures containing numerous medicinal herbs and shrubs (FAO 2003). Grazing also affects regeneration of trees and shrubs. Excessive herding has destroyed the primary vegetation and because of this many wild medicinal plants have been reduced and some of them have even became extinct.

In traditional living, the number of livestock used to be limited while forest and pasture land areas used to be big. Shrinkage of natural habitats due to encroachment by increasing population and industrial development intensified and concentrated grazing pressure leaving an adverse effect on plants and plant communities.

Depending on the grazing pattern, intensity and frequency, the effect of grazing varies from individual plants to plant

communities. Selective grazing decreases species diversity and also affects the soil temperature, nutrient cycle and energy flow (Kala et al. 2002).

3. Invasive alien species (IAS)

Invasive alien species (IAS) are considered to be one of the main direct drivers of biodiversity loss at the global level. IAS have social, economical and ecological effects. Travel, trade, and tourism associated with globalization and the expansion of the human population intentionally or unintentionally and by natural cause like floods, storms, animals or birds have spread invasive alien species beyond its biogeographical niches. Threat from IAS is very serious and is considered the second most serious threat to biodiversity after habitat destruction (Nature.ca 2009).

IAS can be predator, competitor, parasites, hybridizers, or disease of native and domestic plants. They threatened many species with extinction while some interfere with the ecosystem changing its function. Moreover, domination by invasive species will decrease local plant diversity and distinctiveness and change community structure and species composition of native ecosystems. In some cases they may also affects plants or the plant community by changing nutrient cycle. Through effects like competitive exclusion, niche displacement hybridization, predation and extinction invasive species could also alter the evolutionary pathway of native species (CBD 2009).

Invasive species have several effects on the environment and on human beings. IAS by affecting important species on which people are dependent for food, cloth, shelter, medicine and clean water or some times by transmitting diseases which harm human beings. Their effect is more severe among the indigenous people who are highly dependent on forest for their livelihoods.

4. Over exploitation

Over exploitation of medicinal plants has threatened the future of several species. Over extraction is mainly due to two reasons, one is increased market demand and the other is increased subsistence use owing to population increase. This not only affects people's access to traditional medicines, but also threatens commercially valuable wild species.

Over exploitation of some of the species for its latex, has resulted in reduction of bees and other insects populations which are main pollination agents. The reduction of pollinators also affects medicinal and other plants in the formation of seeds and fruits which will affect regeneration.

Besides, several medicinal plants have multiple uses and are also used as food, fodder, timber, firewood, fiber, resin, spices and for religious and cultural uses etc. similarly, many medicinal plants are used to cure more than one illness (Kala et al. 2004, Kala 2005, Rijal 2008). Increase in demand of these daily use materials owing to a larger population has magnified the threats to medicinal plants.

5. Effect of climate change

Climate change increases the heat stress on the plant which will reduce growth and production mainly in the tropical and subtropical areas. Effects of climate change like changes in seasonal patterns, weather events, temperature ranges and various consequences related to these have affected living organisms including medicinal plants. Effects on the life cycle and distribution of plants have been experienced and medicinal plants endemic to specific geographic regions or ecosystems are more vulnerable to climate change (IPCC 2007).

6. Market threats

The WHO has estimated the present demand for medicinal plants is approximately US $ 14 billion per year and the demand is growing at the rate of 15 to 25 % annually and according to WHO's estimate projection this demand might excess US $ 5 trillion in 2050 (FRLHT, 1996, Sharma 2004). Due to the increasing demand owing to population growth and commercialization, the future of wild plants that had helped human being from the unknown past and still important to millions of people is becoming uncertain. The rapid increase in the market for herbal medicine is threatening to wipe out up to a fifth of the plant species on which it depends, destructing their natural habitats and jeopardizing the health of millions of peoples (Edwards 2004). Two-third of the medicinal plants in use are still harvested from the wild, and research suggests that between 4000 and 10,000 of them may now be endangered (Hamilton 2003). This is serious in the case of species that involves destructive collection such as whole plants, bark, stem, heart wood, tuber, root, bulb or resin. Besides, household demands for medicinal herbs have also increased due to growth in population.

7. Lack of incentives

Poverty, limited cultivated land and lack of alternatives coupled with the need for longer term investment and difficult marketing discourages the locals from medicinal plant cultivation. Moreover, due to difficult access and absence of primary processing units the transportation cost of medicinal plants is high, leaving little profit margin for the growers (Rasool 2008). Financial and others incentives were needed for promotion of cultivation, processing and utilization of medicinal plants.

Another serious reason that discourages traditional herbal practices is the decrease in interest among the younger generation (Kala 2000, 2002, Rijal 2008) due to lack of information, unawareness of market skills, lack of storage facilities, lack of finential assets and low economic return from these practices.

8. Lack of information and awareness

Lack of information about the status of medicinal plants in the wild, impact of pressure on the status of wild medicinal plants, the trend of transmission of traditional knowledge, information on the herbal market and climate change effects are obstructing conservation of medicinal plants. For sustainable harvest information on resource base is very important (Peters 1994). Information on yield rate or growth rate of most of the medicinal plants is not available. Moreover, in many places harvest permits are issued without information on the resource base while there is a lack of field monitoring during harvest seasons. Due to such practices several medicinal plants have disappeared locally from many places (Rijal 2007) and continuation of such practices could lead to extinction of several important medicinal plants including many endemic species. Lack of such information also affected conservation management plant development.

Industries and consumers also were not aware about the threatened situation of different medicinal plants. Similarly, awareness of the environmental problems seems limited with government officials, politicians, policy makers and traders.

9. Loss of knowledge

Traditional knowledge is transmitted vertically from the elder to younger members of the family and also horizontally, through oral communication, imitations and participation in communal activities. (Gispert et al. 1986). But with the introduction of modern allopathic medicine the traditional/indigenous knowledge about medicinal plants is being lost rapidly (Sindigha 1995, Hill 2003, Rijal 2007). Indigenous people were encouraged to use modern medicine and change their life style, due to this younger generation stopped practicing spiritual and cultural activities including herbal treatment (Gurung 1995, Sindiga 1995, Hill 2003, Rijal 2007). The migration of people from the villages to cities has also led to the loss of traditional knowledge.

Changes of life style and socio-economic status of people reflected in a declining use of wild plants (Uniyai et al. 2003) among some indigenous communities which ultimately affects the knowledge transfer. When knowledge regarding use of medicinal plants is lost, it will make medicinal plants out of context for the people. This will also erode knowledge of conservation of medicinal plants and also the value for its conservation among peoples.

Loss of traditional knowledge/practices regarding the harvest method, distribution practices and conservation of resources base resulted in unsustainable harvest which has not only affected the resource base but also pushed some species to the verge of extinction (Rijal 2007).

10. Tourism

Several biologically important places have opened up for tourism; due to this local medicinal plants in such places have suffered damage in various degrees. They are either threatened due to collection by tourist, grazed by animals from the tourism market (horses, elephants, mules, camels), used as firewood for campfire, cooking or heating for tourists etc. besides, safari trips from these animals also destroy medicinal plants by trampling them. Safari animals and jungle walks or treks by tourists will also leave a trampling effect and soil compaction and clearance of vegetation and accelerated soil erosion due to land exposure from trekking trail development which also affects medicinal plants.

11. Urban and industrial development

Urbanization and industrial development have also affected forest and other habitats of medicinal plants. Due to economic development, industrialization and urbanization several new cities have been developed. Similarly, population growth has also contributed in the development if cities and more houses in villages, which has resulted in accelerated encroachment of different habitats reclaiming vast wild areas and has lead to the destruction of the resource base of the wild medicinal plants.

Development of reads and electric transmission lines, and establishment of industry has threatened medicinal plants by damaging their habitats and also by encroachment of such habitats. Moreover, construction of reservoirs for hydropower projects inundated large areas of forest and other vegetation types with massive destruction of medicinal plants.

12. Pollution

Pollution effects such as acid rain and eutrophication are affecting medicinal plants. Air pollution affects plants directly while other pollutants affects basic substances of survivability like water, habitat, nutrients etc. Combination of acidic air pollutants with water droplets make acidic air pollutants with water droplets make acid rain and this either damage leaves or the entire plants. It is also absorbed by the soil or mixed in aquatic habitats, thus becomes harmful for all living organisms (Gardiner 2006). Similarly, damage of the ozone layer by chloroflurocarbons (CFC's) exposed plants and other living organisms to the ultraviolet (UV) rays from the sun which otherwise used to be shielded by ozone layers.

It was also noticed that lack of pollinators either due to use of pesticides or pollution affected pollination which resulted in failure of seed (or fruit) formation for regeneration of several plant species (Gonbo 2006).

13. Lack of proper management

Lack of proper management systems is also responsible for uncontrolled extraction of medicinal plants. In the past, indigenous people practiced traditional/ indigenous management which was efficient to manage plant habitats and meet medicinal plant need of each household. Due to uncontrolled collection of medicinal plants in the absence of proper management arrangements and lack of information on resource base has a negative impact on plant species. Lack/ limitations of technical manpower to assess resource base commercial exploitation of medicinal plants has affected the resource base and also threatened several medicinal plants.

Conservation of medicinal plants

Human beings have always been very dependent on plants. People and plants share the same ecosystem and have delicate interactions or inter-dependence. Knowledge about the use of plants among indigenous people indicates their close affinity with plants of the area and with nature. Forest products are very important to rural communities and are harvested in significant quantities by a large number of households across globe. Most people worldwide rely on herbal medicines collected mainly. Conservation of medicinal plants is very important because it is connected to survivability of a larger number of people. Moreover income from medicinal plants contributes significantly to rural household cash resources. Loss of medicinal plants will not only affect healthcare and household economy but also destroy the hope for discovering new medicines for disease like HIV-AIDS, cancer and other serious diseases.

Demand for medicinal plants is increasing every year due to the rapid growth of the herbal industry, while more than 95% of the supply is still from wild collections. This indicates that a large number of wild medicinal plants are under pressure from overexploitation due to trade demand. To protect threatened medicinal plant species from extinction and also maintain a supply for human needs, several measures for conservation and proliferation of medicinal plants are necessary. Various international organizations are also involved in such activities with an objective of promoting conservation of medicinal plants and traditional knowledge for enhancing health and livelihood security and revitalizing local healthcare traditions.

The International Convention on Biological Diversity (CBD) provides a new impetus for collective and responsible action in the field of medicinal plant diversity. It provides the foundations upon which to build action-oriented programmes, and the framework for future progress. But the real foundations of the Convention are the commitments by signatory states and by people to conserve biodiversity, to sustainable use, and to share equitably the benefits arising out of its utilization.

The Global Biodiversity Strategy says, this will be achieved by the triple mechanism of ***saving it, studying it, and using it***, all components of which are mutually reinforcing and of the greatest importance. The Global Strategy for Plant Conservation also insists for 'Conservation and Sustainable use of Biological Resources' with special emphasis on medicinal plants. At National level, India is one of the signatories of the CBD and binds to follow and achieve CBD. National Forest Policy (1988) has also emphasised

conservation of biodiversity which includes medicinal plant diversity through peoples' participation.

To conserve medicinal plants, all of the threats identified previously in this review need to be addressed in a correct manner. Some activities are suggested here to address the problem and safeguard the future of the medicinal plants and the people dependent on them:

1. Afforestation/ farming of medicinal plants

Programmes should be developed to encourage people in establishing home gardens of medicinal plants would help to address the household demand of medicinal plants while to meet the commercial demand, farming of medicinal plant species would be appropriate. Afforestation or farming helps to establish a habitat of species and conserve threatened tree and shrub species. Similarly, cultivation of species that are threatened in natural habitats helps to divert pressure from the natural population of such species. Studies indicate that agro-forestry offers cultivation as well as conservation through integration of shade tolerant medicinal plants at lower strata (Rao et al. 2004). Farming of medicinal plants ensures authentication, reliability (standard quality and quantity) and continuity, while lack of quality planting materials, poor development and extension support in cultivation, processing and an unorganized market discourage farming of medicinal plants (Gonbo 2006). Similarly, lack of knowledge of the market, unfair marketing strategies and the lengthy cultivation cycle of some mountain species of medicinal plants, have made farmers reluctant to cultivate medicinal plants. To encourage them to cultivate medicinal plants several arrangements like training on farming practices, market information, buy back arrangements, harvest training, training on drying/ processing, storage, soft financial loans etc. are needed. To produce large scale of planting materials (seedling), tissue culture would be a viable option. Besides, the support of irrigation, pest control etc. are also needed for the farmers.

For the Conservation and Development of medicinal plants, Government of India created National Medicinal Plants Board (NMPB), New Delhi, in the year 2000. As per the guidelines of NMPB, Govt. of Gujarat also established SMPB in 2001. Under the Promotional and Contractual schemes of SMPB, many projects were sanctioned. For example, the Guggal Plantation (2007) in Kachchh and Saurashtra and Asoka Plantation in south Gujarat is being taken up on large scale under these schemes. Similarly, plantation of Dashmoola group of species in forest areas of Surat and Valsad circle was proposed in 2007 to cover 1300 ha area under the project. The list of plant species comprises mainly of: *Aegle marmelos, Gmelina arborea, Steteospermum Suaveolens, Desmodium gagenticum, Oroxylum indicum, Clerodendron multiflorum, Uraria picta, Saraca asoca, Terminalia chebula, T. bellerica, T. arjuna, Semicarpus anacardium, Asparagus recimosus Tinospora cordifolia piper longum, Gloriosa superba, Plumbago zeylanica* etc. Efforts were made to plant the grafted seedling of Harde and Baheda so as to facilitate the early benefit flow from the project. During this project period capacity building activities were carried out for all the stakeholders through training, exposure tours, awareness campaign etc. Sustainable harvesting methods for important conservation concerned species were also developed and promoted.

2. *In-situ* conservation

Cultivation ensures immediate supply of herbal materials but will not confirm long term conservation. Therefore, besides cultivation to meet commercial and subsistence demands it is also necessary to think of long term conservation. The best option for long term conservation of medicinal plants is *in-situ* conservation. *In-situ* conservation involves conservation of medicinal plants in its natural habitats by arranging protection through declaration of protected areas of different types (conservation areas, national parks, reserve forest/ shrublands/ grasslands or medicinal plant hotspots). *In-situ* conservation helps to conserve millions of species through the protection of natural areas and is the primary means for the maintenance of these resources in the absence of other reliable options. In Gujarat 4 National parks, 21 wildlife sanctuaries and many protected wetlands and mangrove areas were established, which help in the conservation of medicinal plant diversity in their natural habitats.

Religious and cultural institutions (temples, monasteries, sacred grooves, Guthi) from different parts of world have also been contributing in conservation of forests and different medicinal and aromatic plants. These institutions help in conservation of habitat and important plant diversity within them. In Gujarat 29 sacred groves and many such

places have been reported (Gupta et al. 2000) which play important role in the conservation of habitat and biodiversity.

Development of a Manual is also needed to make sustainable wild collection of medicinal plants. Collection of medicinal or other useful plants wherein the collection is non-destructive, for example fruits, flowers, leaves, seeds, twigs etc. should be allowed on a sustainable quantity from the wild because this will provide economic incentives to rural communities and attract them to conservation generating local stewardship for conservation of endangered biological resources of the area.

3. *Ex-situ* conservation

Botanical gardens could contribute in conservation of medicinal plants especially the highly endangered ones. There are more than 2500 botanical gardens in 150 countries that conserve 6 million accessions of living plant representing around 80,000 species i.e. only about 28%. This clearly indicates that many species still await conservation support.

There are a number of herbal gardens established in India to compile and provide information on medicinal plants existing in India. In Gujarat 10 herbal gardens were maintained by the Directorate of Medicinal and Aromatic Plant Research (DMAPR) of Indian Council for Agriculture Research (ICAR). The information of herbal gardens in Gujarat state is given in Table 5.

Table 5: Herbal Garden information *(Source: Singh A. P., 2003)*

Name of Herbs Garden s	*Area (in acre)*	*Year of Estab.*	*No. of Species*				*Total*
			Tree	Shrub	Climber	Herbs	
Gandhinagar	30	1976	94	50	27	63	234
Jeetnagar	200	1976	25	04	10	10	49
Vadiapalace	20	1975	47	17	18	38	117
Antarsuba	20	1976	29	17	21	35	102
Vashidanta	07	1979	24	03	05	09	41
Saputara	16	1979	25	06	09	17	57
Kukma	100	1979	05	01	02	02	10
Varod	20	1988	41	07	17	27	92
Rupvel	10	1988	45	24	16	05	90
Sasangiri	27	1988	113	45	39	47	244
Total	**450**		**120**	**50**	**45**	**75**	**300**

Similarly, by the National Medicinal Plants Board (NMPB), New Delhi, total 344 Medicinal plant gardens were established all over India. Out of which 13 are situated in Gujarat.

4. Genetic conservation of medicinal plants

To rescue plants from extinction, the establishment of gene banks of medicinal plants is necessary. These gene banks collect and conserve important medicinal plants that are rare/ endangered/ threatened/ vulnerable or which are commercially threatened. The gene bank maintains important medicinal plant species as live material in field gene banks, in the form of seed, *in vitro* materials and DNA. For long-term conservation, the accessions are stored under cryogenic conditions.

DMAPR along with its out reach programme on All India Networking Research Project on Medicinal and Aromatic Plants has taken several steps toward the vibrant research on some selected MAPS. They have maintaining 830 Germplasm of species of medicinal & aromatic plants in their gene bank.

Table 7: Germplasm status of DMAPR field gene bank (Source: http://www.dmapr.org.in)

Species Name	*No. of Germplasm*
Aloe spp.	55
Andrographis paniculata	60
Asparagus spp.	88
Cassia angustifolia	50
Chlorophytum borivilianum	54
Commiphora wightii	150
Cymbopogon martinii	07
Desmodium gangeticum	52
Gymnema sylvestre	43
Plantago ovata	84
Tinospora cordifolia	35
Urgenia spp.	12
Withania somnifera	140
Total	**830**

Some initiatives were also taken place by preparing ethnobotanical database, which provide information on medicinal plants. Such database which covers the ethnobotanical diversity in India are as below:

Table 8: Examples of Ethnobotanical database from India

Data source	*No. of species*
FRLHT Encyclopedia of Indian Medicinal Plants	6198
TKDL- Traditional Knowledge Digital Library	2147
Yuthog Foundation for Tibetan Medicine	200

5. Protection of indigenous knowledge

Traditional knowledge that builds upon the long experiences of people was adopted in social, economic, environmental, spiritual and political practices to maintain this delicate balance. Therefore, people's perception and use of their natural environment play an important role in the conservation of resources and the consequent sustainable development, due to this preservation of traditional knowledge has become an important aspect of biodiversity conservation (Alcorn 1993).

Traditional practices contributed in conservation of medicinal and other plants very effectively. Such practices include domestication, prohibition on grazing in specific areas, belief that holy spirits live in forest and plants, sacredness of trees, beliefs on sacred or religious forest, protection of plants at burial sites, near religious monuments, selective harvesting, collection of only dead trees and protecting seedlings from fire. Such knowledge could be used to deal with threats related to plants and also to address issue related to the daily lives of the people. Effectiveness of indigenous knowledge and the ability of indigenous communities to conserve biodiversity is also accepted by the Convention of Biological Diversity (CBD) and it encouraged signatory countries to protect indigenous knowledge related to biodiversity conservation.

Since indigenous knowledge is very useful for conservation, it should be studied and documented so that it can be used for conservation and economic development. Forest-related traditional knowledge should be included in the national policy and institutional setup to make for access to resources and benefit sharing.

6. Need of research

Ethno-botanical studies help to generate knowledge regarding use of different plant species, the ecological role of different plants and knowledge related to conservation. Such information could be useful to pharmaceutical research, to make supply of herbs sustainable, to conserve medicinal plants and their habitat and to protect traditional knowledge.

Unsustainable collection practices and issuing permits to collectors, without having resource base information could lead species to extinction. Hence, it is needed to carry out research on resource base and yield/ growth rate and need to practice issuing harvest (collection) permits only based on such information. Similarly, regular study of the medicinal plant market is also needed to assess pressure on medicinal plants. Such information on resource base or status of species and market pressure will be useful to develop a conservation strategy for threatened species.

Information on distribution of plant is important to declare any area as protected or medicinal plant 'hot spot' for promoting *in-situ* conservation. Therefore, study on distribution of medicinal plants is needed which could be used to design protected areas or arrange other protection arrangements.

When the status of any species becomes very vulnerable and needs strict protection then as an alternative the threatened herb could be substituted. But information on the biochemistry of most of the plants is unknown. Therefore, to support conservation and also to meet the market demand by supplying substitutes, information on biochemistry will be needed. Therefore, research on biochemistry of close relatives of all important medicinal plants need to be carried out.

The research is also needed to standardize the available herbal formulations for their efficacy and to establish a social capital trust for herbal practitioners in order to promote the traditional knowledge of medicinal plants.

The DMAPR (Formerly, National Research Centre for Medicinal and Aromatic Plants) at Boriavi in Anand district of Gujarat, is a national institute of Indian Council of Agricultural Research. It is mandated to develop appropriate production, protection and processing technologies for important medicinal and aromatic plants through basic, strategic and applied research and thus contribute to the growth and development of medicinal and aromatic sectors in India.

7. Incentives

Rural communities and indigenous (tribal) people are very much linked to the plants and ecology of their areas. Moreover, they also have sustainable harvest knowledge and conservation methods. Therefore, providing incentives to these people to conserve medicinal plants of their areas will be effective and would also interest them as these plants are very important to them.

Regarding the problems related to erosion of traditional knowledge or knowledge transmission to the younger generation in the uses of medicinal plants, incentives should be given to the traditional herbal healers to organize them. Traditional knowledge related to many lesser known medicinal plants has been declining rapidly and to address this it is necessary to document these lesser known medicinal plants. It has been experienced that to motivate people – benefits play an important role. In the link between health benefits and economic benefits with cultural practices can convince the younger generation of traditional people or rural communities then this will help to conserve traditional knowledge or the practice of traditional herbal culture. Moreover, securing patent rights and paying royalties for such knowledge will encourage people to maintain traditional practices and also conserve medicinal plants and their habitat.

8. Market Improvement

Increased commercialization of medicinal plants provides opportunities to increase rural economy and thereby enhance their livelihoods. But harvesters are not able to get a good price for their products due to lack of market information available to the farmers/ collectors and existence of oligopoly of the few middlemen (Rijal 2007). This problem could be resolved by arranging to sell the products directly by the producers to the industry. Bio-partnership and buy-back arrangements between farmers and companies/ industries would be useful in this regard.

Establishment of the relationship between consumers and suppliers will also be useful to safeguard the future of medicinal plants. Bio-partnership helps to satisfy both the short-term and long-term goals of the parties involved in the management of the resources. Traders/ industrialists will be interested in such partnership as this ensures the regularity of supply and the quantity and quality of herbal materials. However the traditional/ indigenous people should not be excluded from such partnership, rather the agreement should be with them and the rural communities and their knowledge could be useful in production and utilization of herbal plants. Bio-partnership will also encourage industrialists and traders to invest in conservation and cultivation of medicinal plants.

9. Prevention of IAS

It is very difficult to control Invasive Alien species (IAS) once it spreads and it is also expensive. The best option is to check entry of such pests by strengthening quarantine. But if the species has already entered, one option would be to eradicate them entirely from the area. This could be done only if the invasive species is detected in its early stage of arrival and before it spreads widely. If the pest has already spread widely, beyond the eradication level then efforts should be made to keep their population under limits through various measures like regular uprooting and burning, identifying the predator of that species, etc. In the case of protected areas or other natural areas, invasive species can be prevented from spreading into such areas by regular monitoring activities of people, goods carried into the park and regular field observation to detect such species and to destroy them.

Biological control is also one of the measures used to control invasive species. This includes the introduction of a natural enemy of the pest to control its population. But studies need to be carried out to identify the appropriate natural enemy so that it only attacks the target species and no other damage is done.

10. Bioprospecting

Bioprospecting describe the process of discovery and commercialization of new products based on the indigenous knowledge of biological resources, typically in less-developed countries. It concerns the recognition of ownership of indigenous and traditional knowledge. The declaration of Belém (International Congress of Ethnobiology, Brazil, 1988) and the Code of Ethics of the International Society of Ethnobiology (2005) states that "indigenous peoples, traditional societies and local communities have a right to self determination and that researchers and associate organizations will acknowledge and respect such rights" and that they "must be fairly and adequately compensated for their contribution to ethno-biological research activities and outcomes involving their knowledge". Thus, traditional and indigenous knowledge are to be considered both inventive and intellectual and therefore worthy of protection in all legal, ethical, and professional frameworks, which shall represent all such knowledge as property if its holders, who will be duly compensated for the utilization and conversion of such knowledge into a tangible product (Soejarto et al. 2005).

Some iniciatives were taken up by the National Medicinal Plants Board for the bioprospecting of medicinal plants for their bioactivities and screening potential for treatment of diseases. Some individual studies were also done for Bioprospecting of selected medicinal plants for antibacterial activity (Shrisha et al. 2011).

11. Policy solution

Conserving and protecting medicinal plants is being carried out through the enforcement of the Acts and Regulations. There are policies that favor conservation of threatened medicinal plants and also provide economic benefits through sustainable harvest; however poor implementation still remains a problem.

In most countries, the patent right on knowledge of medicinal plants its properties is not secured. Securing such rights and providing royalties from medical industries or other sectors for using such knowledge will help to improve the economy of indigenous/ rural communities and also the national economy of developing countries which will have a positive impact on medicinal plants and knowledge related to them.

To protect the knowledge of traditional medicinal plants, policy should be formulated to introduce such topics in the school curriculum of rural areas. This will not only increase the interest of children in traditional knowledge of plants, but also generate pride among those from indigenous communities. They would be willing to follow such practices and transmission of traditional knowledge related to the use and conservation of medicinal plants and ecosystem management would continue.

To regulate the herbal market, provisions for certification and introduction of a specific mark to identify sustainably harvested products is needed. This will help to control reckless collection and supply to the market. In the case of critically threatened species, a ban on trade can also be created as an immediate and short term solution which could be relaxed later after an improvement in the situation. Such a ban could be either complete on only on export of unprocessed products based on the status of the species and the nature of threat. Bans prohibit over-exploitation of wild endangered species.

Pollution problems are affecting human as well as plant life, either because of a lack of a proper policy or weakness in implementation. Therefore, a policy to check pollutions from industries transports and other pollutants need to be developed and implemented to check pollution related to the agriculture sector, that is pesticides and herbicides.

12. Awareness

People should be made aware of the ecological, economical and social importance of medicinal plants. They should be alerted of the different types of threats to medicinal plants. People should also be cautioned of existing harvest related problems and be trained in sustainable harvest methods. Students from schools and colleges can be taught the value of medicinal plants and also be familiarized with traditional herbal practices and threats. Field trips could be made to observe different valuable medicinal plants. Interaction programs could also be arranged for students and others with indigenous communities who have knowledge of herbal uses and conservation. Similarly, the electronic media could be used to generate

awareness through airing documentaries on herbal practices and traditional knowledge, medicinal plants, their ecology and conservation status and other awareness audio-visual clips.

The *Sanjeevani* project was proposed to be implemented in two major ecological regions of Gujarat, viz., the sub-humid ecological region of South Gujarat's tribal belt that is extremely rich in medicinal plant diversity, and the ecologically fragile, semi-arid ecological region of Saurashtra. This project tackles the problems of extinction of traditional knowledge through developing the potential of schools for community based conservation and education approach. The project will be implemented through 10 Post Basic Schools. The action projects will encourage the growth of medicinal plants as a commercial crop among community. Establishment of market linkages will further increase the market value of the herbal products. These village action projects will indirectly affect the livelihoods of all the inhabitants of the villages. They will be exposed to alternative livelihood options that can inspire them and can be taken up in the years to come. Traditional health healers from 20 villages will be selected and trained to enhance medicinal plant based health system in villages. The linkages between schools, medicinal plant cultivators (action project owners), traditional healers, research institutes, hospitals and medicinal plant based industries will be established through various networking, capacity building and liaison among them. This will increase their awareness for and capacity of preserving and conservation of the local biodiversity. In addition, communities as a whole will be more aware of the importance of their local biodiversity.

Conclusion

Wild plant species used for medicinal purposes continue to support indigenous and local communities that have relied on them for centuries for their traditional medicines. Indigenous knowledge related to medicinal plants has a significant role in making rural communities self-reliant in primary health care, in supporting livelihoods, certain of knowledge resources and generating rural employment. Loss in knowledge will make future generations ignorant of them and will not protect from grazing or other exploitation or make any special conservation arrangements. Similarly, loss of species will lead to loss of knowledge of its use. Both loss of species or knowledge will affect indigenous people and many others who are dependent on them for treating illnesses.

Several human induced and some natural threats have threatened the future of several medicinal plants that are very important to human beings. The extinction or threat to medicinal plants has also threatened loss of traditional knowledge related to them and their ecology. To address these threats initiation to implement long term strategies at the global, national and local levels for conservation of medicinal plant resource and using their rich associated traditional knowledge, for social, culture and economic benefits. For this, commitment is needed from all sectors of the society including the government, I/NGO, industries, political bodies/leaders, scientists, civil societies and rural communities. There should be an integrated approach for holistic conversation management so that the harvest will be sustainable, collection regularized by the certifying products, to formulate policies to conserve habitats, supply by encouraging cultivation and decrease wild collections and protect traditional knowledge. But to develop such holistic conservation efforts it is necessary to generate information on the status of different medicinal plants and traditional knowledge, dependency of indigenous and rural communities on wild plants in different countries.

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Geographic Information System (GIS) and Indigenous Knowledge in Natural Resource Management

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Abstract

Managing knowledge in general and indigenous knowledge in particular has become an important and valuable input in the management of sustainable development programmes. Historically, indigenous knowledge has been downplayed in the management of information. However, the growing realization that indigenous knowledge has a role to play in development as well as the knowledge management environment has led to the growth of interest in preserving and managing it. The major challenges to the management and preservation of indigenous knowledge are issues relating to collection development, intellectual property rights, access and the preservation media. Experience has shown that development efforts that ignore indigenous knowledge (IK), local systems of knowledge, and the local environment generally fail to achieve their desired objectives. IK systems are becoming extinct because of rapidly changing natural and social environments. A Geographic Information System provides a framework to document and store indigenous knowledge meaningfully. Participation by the local community in development initiatives is critical for achieving sound natural resource management to utilize the full potential of IK systems. The main purpose of this paper is to review the literature available on the approaches of integrating indigenous knowledge with Geographic Information Systems as a way of promoting natural resource management and giving opportunity to the local community to participate in development programs and decision-making both as contributors and as users of knowledge.

Keywords: *Indigenous Knowledge, Participatory Natural Resource Management, GIS, MIGIS, Expert System Approach*

Introduction

The complex nature of sustainable natural resource management demands research that uses a systems approach i.e. research that is interdisciplinary - combining bio-physical and socio-economic dimensions, and attempts to understand the interrelatedness of system components (Barr & Dixon 1998). Community based participatory natural resource management is being adopted widely as a possible solution to address such complex problems. Also, participation and knowledge of local groups (e.g. farmers, peasants) is understood to be a valuable resource in community level natural resource management, decision making and policy planning processes. It is generally recognized that indigenous knowledge (IK) plays an important role in the sustainable management of natural resources and can also have an impact on issues of global concern. This

recognition is directly related to the growing realization that scientific knowledge has contributed very little to the development of communities and societies; in fact it has commonly hastened the depletion of their social and natural resources (Murdoch and Clark1994; Norgaard 1992; FAO 1990; Ulluwishewa 1993). The potential disappearance of indigenous practices could have a negative effect primarily on those who have developed them and who make a living through them. A greater awareness of the important role that IK can play in the development process is likely to help preserve valuable skills, technologies, artifacts and problem solving strategies among local communities. It is a belief that indigenous knowledge and scientific technical knowledge can complement their strengths and weaknesses (Ogunbameru & Muller 1996).The documentation and mapping of indigenous knowledge and traditional knowledge is intended to preserve and honor knowledge held by local indigenous people, people whose ancestors have long inhabited a region, or people who are new to a region and bring their own traditions to a new community. However, the collection of information from diverse indigenous sources is often a laborious, time-consuming and costly process. Proper storage and management must be ensured if the information is to be made available and accessible for quick analysis and manipulation to all those who need it, e.g., planners and decision makers involved in the management of land resources. GIS is capable of performing these functions and is widely used in the management of information for planning and decision making purposes. GIS also makes it possible to create, analyze and process different scenarios, using the information stored in the computer (Jordan and Shrestha1999). Programs involving the integration of GIS and IK have for the most part been used within natural resource management projects where increased food or income source choices for local communities and effective participation in benefits sharing are the main goals (Mbile et al. 2003).GIS is a tool that combines ordinary statistics with geographic location to create meaningful, clear and attractive maps that can be applied to development needs (USAID 2002). Due to the spatial nature of Indigenous Knowledge Systems (IKS), Geographic Information Systems technology can facilitate the inclusion of IKS in local decision-making processes. However, up until now the possible application of GIS in IK management has been inadequately explored (Lawas & Luning 1996). There is an increasing interest in the use of GIS in a participatory context, with this development either causing alarm or being seen as providing a potentially valuable tool (Jordan & Shrestha1999). Research are on to date by various researchers who try to integrated IK with GIS, and demonstrates this through examples that show how such systems can facilitate the management of indigenous information. Examples also show how such systems can enhance its usefulness for natural resource management of local communities through participatory processes.

Indigenous knowledge (IK)

The term "indigenous knowledge", was coined by Brokensha, Warren, and Werner in their 1980 edited volume *Indigenous Knowledge Systems and Development*. According to Warren (1996) this term was constructed by the three (and independently by Robert Chambers in the UK at the same time) in an effort to overcome the biases associated with the term "traditional" that had been used to that point. Their goal, was to find a term that "represented the dynamic contributions of any community to problem solving, based on their own perceptions and conceptions, and the ways that they identified, categorized and classified phenomena important to them" (Warren 1996).

More recently, IK has come to be recognized as "local knowledge that is unique to a given culture. It is the information base for a society which facilitates communication and decision-making. Indigenous information systems are dynamic, and continually influenced by internal creativity and experimentation as well as by contact with external systems" (Flavier et al. 1995). This notion of dynamic knowledge has been expressed earlier, and seems to encompass this same notion. Colson (1984) states, "Values once thought to be fundamental for guiding the way particular people dealt with each other and their environment have turned out to be situational and time linked." This sentiment has further been applied even within local groups as Borofsky (1994) points out, "People living within the same community seem to espouse a range of beliefs, use a host of terms, that do not overlap in many cases" (Borofsky 1994).

Indigenous knowledge systems can, and should, be collected using a number of different methods. First, is the traditional survey methodology. This is effective in

gathering information on a particular question when the researcher is aware of the questions to be asked. Surveys are a quick method of information gathering; they are limited, however, in that it is structured to the researcher's own biases and may lead informants away from a particular line of thought that might be useful. Another method, participant observation, involves careful observation and participation in the daily lives of the informants for an extended period of time. This is an incredible learn-as-you-go process that alleviates some of the inherent biases in survey techniques, but in development there is often little time for careful long-duration observations. The optimum strategy appears to be a combination of the two, where survey and limited observation is conducted to begin policy implementation, followed by long duration participant observation to gain an understanding of the big picture. In all cases, though, problems exist which must be understood before conducting such research.

The primary reason for misinformation or invalid data is mistrust between the informant and the researcher. There are many possible sources that may result in this mistrust. For instance, culture shock on the part of the researcher may leave informants with a distorted impression of the researcher, and in turn, evoke feelings of uneasiness between the two. Also, because of field methodology in which data is collected, the studied communities may feel that researchers do nothing more than steal information from the people and give nothing back in return. Another source of mistrust may result from "fly-by-night" researchers (instant experts) who spend very little time in the community. This itself is a recently burgeoning avenue of research with the question of intellectual property rights. These instant experts rarely take the time to learn the language of the community and spend so little time with the people that the interpretation of the data is often inaccurate and the intricacies of the culture are often overlooked. Finally, researchers have often been criticized for dwelling on the traditional lifestyles of the population and not focusing on the current views of the people.

In addition to mistrust, other sources of misinformation abound. Researchers may have to confront issues such as the ideal versus the real. For instance, people in the group may provide information based on what they think they should say rather than provide answers that are more truthful or accurate. Also, researchers must often deal with omitted information that results from role-niching. Role-niching occurs when the informant forms a perception of the researcher and then places them into a particular role. Another problem that may be encountered is when the informant is joking or when there is a person in the group who is a con-artist. This individual may set himself up as a kind of "professional informant" who spreads misinformation.

To combat the mistrust that arises from culture shock, a researcher may consider the "halo-effect" in which initial good impressions make people perceive you in a positive way. Also, impression management, where the researcher enters the area as a traveler prior to research, may work to gain the trust of the community. In an effort to curb the suspicions that people may have (e.g. the belief that the collected data may be used against them), several methods can be employed. These methods include: involving informants in the editing process, sharing royalties, co-authorship with informants, taking on jobs within the community, and socializing in the community. Another way to gain trust, and to help ensure the collection of valid data, is to get involved in the politics of the community. This involvement could take the form of: acting as a liaison between the people and the government, researching the benefit of government programs to the people, and being a witness in court trials for things such as freedom of religion, and land claim cases.

Finally, data that is skewed by the so called "fly-by-night" researchers can be mitigated by using a team rather than the more traditional "Lone-Ranger style" of research (Rhoades 1986: 34). In addition to gaining the trust of the community, the collected effort of the researchers would most likely result in a more accurate collection of data. The key to overcoming some of the other sources of misinformation that a researcher must deal with can be avoided if great care is taken in selecting informants. Informants should come from as diverse a range as possible--transcending gender, age, and class differences. Also, by making an effort to learn the native language, by spending a great deal of time with the people, by giving back to the community, and by using several informant sources, most of the problems such as the ideal versus the real, omitted information, and games that people may play may be avoided.

Geographic Information Systems

GIS is being recognized as an important decision-making tool for natural resource management. GIS technology is used to address the problems associated with the storage, analysis and processing of indigenous information. It is also employed in the integration of the two types of information. Such a process is useful in planning and decision making for the sustainable management of resources (Lawas & Luning 1996). A GIS is mapping software that links information about where things are with information about what things are like. Unlike a paper map where "what we see is what we get", a GIS map can combine many layers of information (ESRI 2003). GIS is a specialized set of information and communication technology (ICT) that helps manage and interpret data about an area's resources and infrastructure, such as digital maps or images of a village, watershed, or entire country. Researchers, planners, and other technical specialists are making greater and greater use of this information. The tools include systems to store, manage, and analyze geographically referenced data (geographic information systems, or GIS); devices that measure geographic location (global positioning system, or GPS, receivers); and airborne data collection systems that provide periodic land use, land cover, and other thematic information (aerial photos and satellite remote sensing) (Deichmann & Wood 2001). While obstacles exist, particularly in developing countries, geographically referenced data are providing new insights into global issues such as the patterns and processes of human settlement, natural resource use and degradation, agricultural performance, disease, and potential conflict. GIS is a tool that combines ordinary statistics with geographic location to create meaningful, clear and attractive maps that can be applied to development needs. The impact of a map is related to the fact that data are visualized in their environment, letting the user take into account not only the data themselves, but also all the surrounding factors that make up those data like topological information such as adjacency, etc. It has been used for natural resource management for visualization, communication, data management, as development tool and for developing knowledge base systems. One of the most direct applications of GIS in developing countries is participatory mapping, where, for example, specialists interact with local communities (e.g. farmers) to create spatial inventories of natural resources, property status, land-use rights, and perceived problems. Such inventories feed into a consultative process aimed at building consensus on more equitable and sustainable resource-management arrangements. Experience has shown that villagers can quickly relate to geographic representations of their surroundings. Community mapping can also help foster the process of transferring greater decision-making power and fiscal responsibility from central to local levels of government.

Applying IK to Geo-system management

Since 1993, there has been a significant push to reconsidering resource management, where there is an emphasis on material value, to ecosystem management, which emphasizes environmental sustainability (Grumbine 1997). While this is certainly a significant step in heightening environmental awareness, it seems to swing the paradigmatic pendulum to the other side of the short-term/long-term goal fence, rather than rest comfortably in the center. This means that we have moved from thinking of human-above-environment to human-below-environment, when we should be considering humans and the environment as existing in a feedback system where sustainability can be maintained and resources acquired concomitantly. This returns us to a concept that was apparently overlooked and fell to the wayside--the geosystem (Zonneveld 1983).

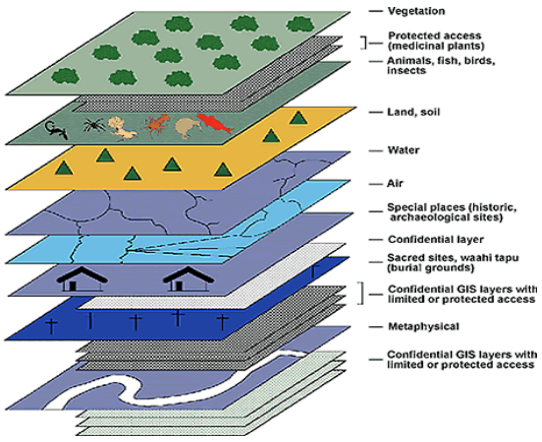
In the geosystem approach to land use decision making, the focus is on the interaction of the human and physical environment. In discussing the geosystem concept with regards to land use, we must recognize that "human action, expressed in terms of land development, depends primarily on human perception of the components of the geosystem. Assuming that perception motivates action, an evaluation is made that ascribes a benefit to be derived from the geosystem based on how the system is perceived" (Lein 1997). Since the concept of a geosystem has not been oft used, it is difficult to find examples of IK, or anything else, being used with it. However, IK has been used and proposed for use with various projects regarding geosystem problems including agriculture, aquaculture, forestry, medicine, livestock management and wildlife management to name a few. Such projects employed without the benefit of local knowledge considerations often meet with

untimely ends. Yet, when local knowledge is taken into consideration, benefits are abundant. The following two examples from Latin America illustrate this point.

The modernization of peasant agriculture in El Palmar, Columbia, for example, was fraught with environmental and economic problems (Reinhardt 1994). In this situation, the El Pamar community in the southwestern Andes of Columbia survived through subsistence farming and small-scale market agriculture. This community was introduced to new farming methods for nontraditional crops to be sold in urban markets. However, the reliance on three modern crops (coffee, tomatoes, and green peppers) and modern farming techniques led to soil erosion, economic instability, and crop health risks. Farmers, noting this risk, employed their own monitoring system and returned to growing more traditional crops. On the other hand, when IK is taken into consideration from the onset of a project, the benefits can be staggering. The International Potato Center (CIP), based in Peru, is perhaps the longest-running example of such a program (Rhoades 1986). CIP has been storing and maintaining a germplasm bank of wild and cultivated South American potatoes since the early 1970's. These varieties are sorted both by scientific Linnean classification systems and by native folk taxonomies. Doing so has allowed researchers to delineate the native system of four-level classification from what was a seemingly chaotic selection process. The understanding of crop selection, along with farming technology selection, has allowed for CIP to introduce new varieties and new equipment that are compatible with the local farming system. The result has been increases in yield while the culture and environment have remained in tact.

In geo-system technique, once information is classified and stored in a framework it can be spatially represented in the form of layers (*figure 1*). Each layer is characterized by different levels of detail, sensitivity and confidentiality, which together determine the degree of access at each level.

Figure 1. GIS layers and confidential sub-layers (Source: www.landcareresearch.co.nz)



Information too sensitive or confidential to store in a GIS is linked via a database directory to an individual person. This allows additional information to be obtained from an alternative knowledge source. Some of the available options are shown in the following table (1).

Table 1. Example of options for a knowledge directory (Source: Adapted from *Harmsworth 1998)*

S. No.	Type of information	Examples
1	Silent or concealed files	Recording the information in an archive or filing system, linked to a GIS database or a map.
2	Overlay or grid to flag sensitive areas	Recording the information for example as a grid network, which does not identify the actual position or location of confidential or sensitive information such as sacred sites.
3	Link to books maps, etc.	Setting up a directory to direct the enquirer to associated knowledge in books and maps.
4	Link to the	Setting up a directory to direct an enquirer, via a contact, to an individual for answers to

indigenous people	particular questions and associated traditional knowledge.

By following the options in the above *table,* highly sensitive or confidential information can be displayed in the form of a label on a map. Alternatively, it can be simply flagged in the GIS as a sensitive or restricted area and the enquirer directed to another information source. This latter option relies on the availability of people with accurate traditional knowledge. Sadly, traditional indigenous knowledge is diminishing at an alarming rate as the population ages (Maundu 1995).

Indigenous knowledge and GIS - literature review

Indigenous knowledge is not yet fully utilized in the development process. Conventional approaches imply that development processes always require technology transfers from locations that are perceived as more advanced. This has led often to overlooking the potential in local experiences and practices. Modern-day forest management paradigm considers Indigenous People (IP) and Indigenous Knowledge (IK) they possess, to be important and valuable inputs for forest management planning, database generation and even decision making process, drastically diverting from erstwhile concept of natives. The term Indigenous Knowledge by Brokensha, Warren and Werner while coining and first using in 1980 in their edited volume Indigenous Knowledge Systems and Development, their goal was to find a term that "represented the dynamic contributions of any community to problem solving, based on their own perceptions and conceptions, and the ways that they identified, categorized and classified phenomena important to them" (Warren 1996). Indigenous Knowledge, more recently has also come to be recognized as "local knowledge that is unique to a given culture" (Flavier et al. 1995). Sui and Waldron state "…IK should be treated as any other set of data to be factored in to the scientific decision-making process". Lawas & Luning (1998), states, "There is a general agreement that the concepts 'indigenous knowledge' (IK), 'traditional knowledge', 'local knowledge', 'community knowledge' and 'rural people knowledge' are all terms for knowledge belonging to grassroots people. Thus indigenous knowledge can be defined as the local knowledge processed by indigenous communities about their milieu. Therefore, terms indigenous knowledge, local knowledge and traditional knowledge refer to the knowledge possessed by the traditional inhabitants of the sanctuary about their surroundings.

Geographic Information System (GIS), the most modern tool available for a forest administrator enables a better quantification, storage and retrieval of collected IK. More over, it enables to create, analyze and process scenarios, using the stored data. GIS is simply defined as 'a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world' (Burrough1986). It is a system that acts as a platform for integrating information and ideas developed in many disciplines including the field of geography, IK, forestry, surveying and zoology, to name a few. The utility of GIS and its inseparable relationship with IP and IK is well explained by Pathak (1997); he states 'Geographical Information System (GIS) helps foresters meet the challenges of integrating bio-physical and socio-economic information and drawing inferences regarding the complex interaction between people and their environment… It (GIS) enables foresters to incorporate the knowledge and participation of community members in planning, managing and evaluating local forestry projects. This process helps link community needs with project benefits'. Indigenous People are considered as people who cherish their own distinct culture, are victims of the past and present day colonization and are determined to survive. Sui and Waldron states, "Researchers, by overlooking the role of indigenous knowledge (IK) have failed in sustaining the human-environment relationship…" Many other authors have stressed the value of indigenous people and the knowledge that they posses. However, indigenous knowledge has its own limitations and is not a means to the end by itself.

Coupled with scientifically organized knowledge, indigenous knowledge can be useful in almost all stages of forest management. IUCN and the WCDE also stress that the sustainable management of natural resources can only be achieved by developing a science based on the priorities of local people and creating a technological base that includes both traditional and modern approaches to problem solving. Combining indigenous knowledge and scientific knowledge means, integrating information collected from indigenous people with scientific information and technology. This

necessarily means that there are to be means devised to collect, store and process indigenous knowledge in a similar manner as that of the scientific knowledge. GIS with its capability to integrate information that originate from varied sources, is the most suitable means achieve the same.

Indigenous communities and the knowledge they posses are of great relevance to forest management. GIS can be a single platform on which, scientific knowledge and indigenous knowledge can be integrated. In the present situation of ongoing unrests between indigenous communities and administrators, across the world, it ensures community participation and will add value to the opinions of indigenous, local communities as a whole in a management, decision-making context. Such attempts to involve local communities in all possible aspects of forest management have to increase. By ensuring indigenous community participation in forest management, the administrators can ensure transparency, which is mandatory to modern day administration. Indigenous Knowledge incorporated in management planning ensures agreement as it is to the interests of the local community. Further, GIS acting as an integration platform will ensure that assess to stored information is quick and effortless, retrieval and analysis is easier and thereby, planning, decision making and management is fast and highly accurate.

Indigenous knowledge is a measure of local community capability, with the potential to set community members on an equal status with outsider 'experts', and maybe the only resource of which local groups, especially the 'resource-poor', have unhindered ownership. Indigenous knowledge and scientific knowledge frequently have similar cognitive structures, although the referents and units may be difficult to translate--as with, for instance, much indigenous technical knowledge (ITK) of pest management, soil and water conservation, ethnopedology, ethno-veterinary knowledge and ethno-medicine.

Indigenous technical knowledge is normally more reliable, and maybe also more accurate, because it embodies generations of practical essential knowledge, and it operates in interactive, holistic systems. Many examples of PGIS applied to ethnopedology can be found; for instance, comparison of farmers' and scientific soil classifications in the Senegal River valley (Tabor & Hutchinson 1994), a 'folk expert system' for classifying soils in the Colca Valley, Peru (McCall et al. 2005), and an extensive review by Barrera-Bassols and Zinck in 2000 (McCall et al. 2005). Another common natural resource management field using PGIS to map indigenous technical knowledge is pastoral management, e.g. remotely sensed images interpreted with Bedu shepherds in Jordan (McCall et al. 2005); and mapping indigenous knowledge of grazing lands in Burkina Faso (McCall et al. 2005). Beyond indigenous technical knowledge, there is indigenous knowledge that is apparently qualitatively different from scientific knowledge. This indigenous knowledge is symbolic, metaphoric, and visionary--mystical in 'scientific' terms--and commonly related to the land and land features. This deep knowledge, with its obligations of stewardship of the land, together with the specialized, location and resource-specific, problem-oriented indigenous technical knowledge, provide a basis for local people's participation in resource management. The advantages of using geographic information systems (GIS) and knowledge-based systems (KBS) to document indigenous knowledge have been described by Tabor and Hutchinson (1994) and Gonzalez (1995). Applications at the local level have been documented by Lawas and Luning (1996), while Marozas (1991) has examined how GIS are being used in American Indian land and water rights litigation. Madsen (1994) has provided interesting examples of the potential power of GIS and remote sensing for the exploitation of indigenous peoples, particularly by non-indigenous groups. Examples from both New Zealand (Ihaka M, *pers.comm*.; Māori GIS Conference 1996; Harmsworth 1995, 1997a, b) and Canada (Anderson et al. 1993) demonstrate that where indigenous peoples develop and employ GIS tools, they are able to add their own cultural imprint to existing applications. Moreover, such tools complement the indigenous knowledge systems traditionally used to store and transfer knowledge and information, whereby an important role is reserved for the relationship with individuals, places, cultural activities, experience and the spoken word.

Many authors (e.g. Mathias 1994; Labatut & Akhtar 1992; Warren 1992) have stressed the value of IK for development. But IK has its limitations (Bebbington 1993; Bonds 1991; Reijntjes et al. 1992; Leach & Mearns, 1988), and is not in itself capable of addressing all the issues related to sustainable development (Murdoch & Clark 1994). Sustainable development may well be better served by a system that incorporates both indigenous and scientific knowledge systems (Icamina 1993). Organizations like the IUCN (IUCN 1980) and the WCDE (WCDE 1987)

also stress that the sustainable management of natural resources can only be achieved by developing a science based on the priorities of local people, and creating a technological base that includes both traditional and modern approaches to problem-solving (Johnson, 1992). Incorporating indigenous and scientific knowledge means integrating information collected from farmers with scientific information and technology. This means that we must find a way to process indigenous information in the same way as scientific information (Lawas & Luning 1996). The resource assessment information needs do not replace the need for social information, but extend the range of information that has to be collected, analyzed, and collated. Much of this information has a spatial component, and GIS has been increasingly used for data management and analysis (Jordan & Shrestha 1999).

Though there are important spatial aspects to IK, until now the possible application of GIS in indigenous knowledge management has been under explored. Such a system can facilitate the management of indigenous information and enhance its usefulness (Lawas & Luning 1996). According to Marozas, 1991, due to the spatial nature of traditional knowledge, GIS can assist in the inclusion of indigenous knowledge in the local decision making process. Tabor and Hutchinson (1994) and Gonzalez (1995) have described the advantages of using GIS and knowledge-based systems (KBS) to document indigenous knowledge. Lawas and Luning (1996) have documented GIS applications at the local level in Northern Luzon, the Philippines, while Marozas (1991) has examined how GIS are being used in American Indian land and water rights litigation. Madsen (1994) has provided interesting examples of the potential power of GIS and remote sensing for the exploitation of indigenous peoples, particularly by non-indigenous groups. Examples from New Zealand (Harmsworth, 1995, 1997a, 1997b) demonstrate that where indigenous people develop and employ GIS tools, they are able to add their own cultural imprint to existing applications. Moreover, such tools complement the indigenous knowledge systems traditionally used to store and transfer knowledge and information, whereby an important role is reserved for the relationship with individuals, places, cultural activities, experience and the spoken word (Harmsworth, 1998).

Approaches for indigenous knowledge management using GIS

Researchers, by overlooking the role of IK, have not sufficiently understood the human-environment relationship in less developed regions (Nazarea-Sandoval 1995). While some have argued for the distinction between scientific knowledge and indigenous knowledge (Agrawal 1995), according to Waldron & Sui (1999), IK should be recognized as important as other types of information (e.g. in discussing agricultural suitability, factors could include soil, climate, hydrology, IK, etc.) that are factored into the scientific decision-making process. If used in this way, it would be important to understand clearly what IK is, where it comes from, how to collect it, store it, and process it in order to aid the decision-making process in ecosystem management (Waldron & Sui 1999). As there are important spatial aspects to IK, GIS is capable of storage, processing and management of this IK for planning and decision making purposes (Lawas & Luning 1996). Figure 1 illustrates some of the spatial aspects of IK and how the natural resource base of a community can be stored in a GIS. Many researchers have integrated indigenous knowledge into GIS for various purposes. Though almost all approaches are participatory in nature, the application has differed according to the need and objectives of the project or the community where such an approach is used. Waldron and Sui (1999) have described the use of GIS for integrating indigenous knowledge for land suitability analysis. Gonzalez (1995) used participatory approaches for integrating IK into GIS for natural resource management. In her approach she used aerial photographs and satellite images for mapping community situations and aspirations in the Philippines. Mather et al. (1998) used aerial photographs and 'photo-maps' for participatory mapping of community forests in Nepal. Jordan and Shrestha (1999) have also used GIS in participatory context for community forestry user groups (FUGs) in Nepal. Puginier (2001) used local knowledge in GIS as a communication tool for community level land use planning in northern Thailand. Mari and Bitter (1996) have used GIS and Rapid Rural Appraisal (RRA) in local level land use planning in Sri Lanka. Harmsworth (1998) has outlined a methodology for storing indigenous values of Maori culture of New Zealand in GIS. All the approaches adopted by these researchers for integrating GIS and Indigenous Knowledge for natural resource management have been participatory in nature

involving local inhabitants. This approach is called Participatory GIS. Participatory GIS is widely used for community mapping or for participatory resource mapping with little variation in techniques and participatory tools used by different researchers.

While Participatory GIS exists, there is a new technique called Mobile Interactive Geographic Information System (MIGIS), developed by McConchie & McKinnon (2002) for integrating indigenous knowledge for community based planning. McConchie and McKinnon (2002) have pioneered this methodology for integrating IK into GIS to produce community-based maps for collaborative natural resource management. The method has been successfully tested in Thailand, China and Cambodia, is presently being used in Bangladesh and will soon be tested in India (McConchie 2003). Both Participatory GIS and MIGIS methodologies are briefly described below.

Participatory GIS

There is an increasing interest in using GIS in a participatory context. However this application can either cause alarm, through fears such as misinterpretation, exploitation of knowledge and intellectual mining, or be seen as providing a potentially valuable tool that empowers communities (Jordan and Shrestha, 1999). In many projects the effective participation of a local community is of paramount importance and will affect the outcome. This could be quite negative if the participatory decision-making process is not tailored to local needs and non-participation often results in distancing the local community from the decision-making process. There is also increased potential for the information to be misused or wrongly interpreted, or not being used at all - if it is not decentralized. If poorly designed, the project can disempower underprivileged groups by not involving them in the participatory process, effectively excluding them from their own resource mapping and knowledge systems. On the other hand, if the GIS participatory process is well designed it can lead to the empowerment of local communities and has the potential of being a valuable tool for scaling up local knowledge and concerns to the regional level, so that community information can be incorporated into regional and national policy.

Participatory GIS is a spatial decision-making tool designed to utilize GIS technology in the context of the needs and capabilities of communities that are involved with, and affected by development projects and programs (Abbot et al., 1998) For the collection of primary data, a number of different data acquisition techniques are used, such as Rapid Rural Appraisal (RRA), village immersion, the farmer-based interview schedule, field visits and observations, the use of a checklist of questions, analog maps and aerial photographs. Such integrated techniques of data retrieval have proved efficient in obtaining reliable information from the farmers. Each technique is selected for a particular purpose. For example, aerial photographs used in Northern Luzon in the Philippines, enabled farmers to identify their own fields and to explain the previous use of specific areas of land for land resource management (Lawas & Luning 1996). The following five points need to be concentrated on when developing a participatory GIS (Jordan & Shrestha 1999):

- GIS should be used if there is a need and only if it adds to the participatory process.
- Collection and dissemination of information that are an integral part of a participatory process should be a priority rather than technical issues related to use of GIS in the process.
- Like any other participatory process, decision-making should be the focus of a participatory GIS activity. The information collected and put into a GIS should be useful to aid the decision making process in the community.
- Ownership of information, how it is stored and who has access to the information are also important issues to keep in mind when engaging in a participatory GIS activity.
- Infrastructural and institutional support to obtain participatory information, input it into a GIS, analyze it, and return it to the participants in a way they can use it, should be in place.

The expert system approach

Evelyn Mathias (1995) notes that for recording and documenting indigenous knowledge, "What is needed is in-depth research which records and analyzes indigenous knowledge, and packages information in a user-friendly fashion." An expert system is a computer program possessing the ability to capture the knowledge and experience of human experts and provide that information on demand to the user of the program. It is designed, in fact, to do precisely what Mathias has called for. The expert system stores knowledge as facts and

rules which are referred to as the knowledge base. The system will then use a methodology for processing these rules and facts, known as an inference engine, by prompting the user to respond to a series of questions and then process a decision based on the knowledge with which it has been programmed.

There is debate as to the usefulness of expert systems for acting as an anthropological informant, or as I have stated, processing indigenous knowledge. Fischer (1994) states that caution in the use of expert systems is warranted in that to most cultural researchers these are "black-boxes." However, the expert system is no more a black-box than a word processor or spreadsheet program. Expert system shells provide a user-friendly environment for the input and retrieval of knowledge by already containing an inference engine. The only thing the researcher needs to worry about is the collection of enough information to make adequate decisions and the purchasing of a shell that can handle a large volume of rules. If I seem vague, the terms "enough" and "adequate" are left open for the individual researcher to determine her/his own needs.

Selecting an expert system shell is based on the type of research and the budget with which one has to work. May shareware shells and demo versions are available, but are not useful when dealing with large knowledge bases. Advanced commercial shells can include graphics and other technological capabilities, but can cost in the thousands of dollars. Waterman (1986) provides the following general categories of applications to consider when selecting a shell:

- **Interpretation**- Used for analyzing data and determining its meaning. Rule-based shells that allow for forward chaining are the most desirable. Logic-based shells may also be useful.
- **Prediction**- Used for inferring the likely consequences of a given situation. Object-oriented systems are the best, but, procedure-oriented shells and forward-chaining rule-based shells are also useful.
- **Diagnosis**- Infer system malfunctions from data and request additional data when needed. Backward-chaining, rule-based systems have been most successful in this area.
- **Design**- Configuring objects given a set of constraints. Forward-chaining rule- based methods are best suited for these applications.
- **Planning**- Used to prepare a program of actions to achieve certain goals. Forward-chaining rule-based methods with frame-based methods, procedure-oriented methods, object-oriented methods, or access-oriented methods are all suitable for planning.
- **Monitoring, Debugging, and Repair**- Used for comparing observations with expected outcomes. Access-oriented methods are best suited for monitoring systems, while backward chaining rule-based systems are best suited for debugging.
- **Instruction and Control**- Instruction systems are used to teach the user about a domain, whereas control systems are used to control system behavior. Forward and backward chaining methods are best suited to instruction. Access-oriented, object-oriented, procedure oriented, and forward-chaining rule-based methods are all well suited to control applications.

The expert system approach to indigenous knowledge seemingly had a brilliant start with a two-issue treatment of the subject in *Anthropological Quarterly*, however, it has been nigh impossible to find research on the subject since the 1989 volume. The idea of expert system use with indigenous knowledge has been suggested more recently (Schoenhoff 1993), but little has been done to actually apply the technique. Conversely, expert systems have been applied to land use suitability analysis. Lein (1990) used the EXSYS expert system developmental tool (EXSYS 1985) to construct the prototype land suitability expert system SUITABLY. SUITABLY contained 14 natural landscape criteria for determining suitability, with 19 choices of types of development. Another application was used by Fedra et al. (1991) for water resource management along the Lower Mekong river using the MEXSES system. The MEXSES system also integrates with a GIS (geographic information system) for acquiring knowledge and displaying answers. According to Fedra (1995), the MEXSES system incorporates "environmental impacts from or in terms of ...historical/cultural values", but there is no discussion on how these values were obtained.

Again, none of these systems are known to incorporate indigenous knowledge as a factor land use suitability analysis. An expert system would provide a quick user-friendly environment for access to this

knowledge for environmental decision-making. Furthermore, by integrating indigenous expert knowledge and scientific expert knowledge through this medium, decision makers can make more informed choices when determining the suitability of a particular region for varying developmental or conservation activities. However, it is important to note that these systems cannot replace the value of the experts themselves. They are meant to serve as an aid when the experts themselves are not available. As the collected knowledge of indigenous peoples is generally not very accessible, this makes the expert system an invaluable tool for research.

Land use suitability analysis

Land use suitability analysis or developmental suitability as it is sometimes referred to, is a planning method based on the concept of determining what parts of the landscape in a given area are most capable of supporting various land uses. Land uses, can include housing, agricultural fields, wildlife habitats, recreation areas, and the like. This involves determining what the existing natural and cultural landscape features are, and how they can be better managed based on the component characteristics of the landscape.

For the most part, the characteristics used to determine suitability come from delineating soils, slope, hydrology, and climate. Properties of these various categories are weighed against the potential effects of certain land uses, and the decisions are made based on the most desirable physical characteristics. The problem is that all of this research is being conducted in labs far from the areas, and more importantly, the people that are being affected. Developers rarely stop to ask the local people what their needs are, and if the plans are plausible in the physical and cultural environment in which the project is being initiated.

Table 2. Knowledge System Characteristics

	Scientific Knowledge	*Local Knowledge*	*Synthetic Knowledge*
Methodology	Specialized, Partial Experimentation Immutable Mobiles	General, Holistic Observation Mutable Immobiles	General, Holistic Observation& Experimentation Mutable Mobiles
Resource Utilization	External Resources High Input Land Intensive Labor Saving Market Risk Specialized Strategies	Local Resources Low Input Land Extensive Labor Demanding Environmental Risk Diverse Strategies	Mostly Local With Small Exotic Mix Low Input With Minimum Critical Inputs Land Intensive Labor Demanding But Not Onerous Risk Adverse To Climate & Market Flexible Adaptive Strategies
Output	Low Productivity Cultural Disjunction Profit Goals High Degradation Not Sustainable	Low Productivity Culturally Compatible Subsistence Goals Low Degradation Sustainable (low Pop.)	High Productivity Culturally Compatible Food Security & Comfortable Living Regenerative Sustainable with High Population

Source: *Adapted from DeWalt, 1994*

Rossiter (1994) perhaps best explains the reasons for rural land use planning. Rural planning on private land seeks to produce the maximum benefit to the individual land owner/operator while preventing, or at least solving, conflicts with other individuals or with the needs of the society in general. Rossiter continues that it is not practical to allow landowners free reign over property use for reasons including:

- Possible direct and immediate effects to other land users (i.e. discharge in common water source).
- Possible indirect and/or delayed effects to other land users (i.e. water depletion from excess usage).
- Possible direct and immediate effects to resource base (i.e. water pollution).
- Possible indirect and/or delayed effects to resource base (i.e. air pollution = ozone depletion = climatic change).
- Societal need for certain land uses (produce self-sufficiency)

- Unattainable infrastructure requirements for intended land use (i.e. sewage systems, road access, etc.).

Indigenous knowledge can be used to alleviate these oversights. Scientifically derived knowledge and local observations have differing methods and outcomes, but are not mutually exclusive and can be used to create a synthetic land use analysis schema. Table 2, adapted from DeWalt (1994), illustrates this point.

Mobile interactive geographic information system (MIGIS)

MIGIS is the acronym for community based planning that uses a Mobile Interactive Geographic Information System in conjunction with, and fully informed by Participatory Learning and Action (PLA). MIGIS brings the best of indigenous knowledge and scientific information together to provide common ground on which farmers, government administrators, and planners can optimize their understanding of their environment and each other, and work as a team to plan for a better future. This approach adds a new dimension to existing PLA tools and can lead to a significant increase in our ability to define the environment and constraints on any development initiative or intervention.

According to McConchie and McKinnon (2002), the advantages of using GIS as a major component of the PLA activities undertaken for MIGIS are that it is highly visual and a powerful tool for storing knowledge. Besides these, the data are credible and quantifiable. It is easy to update and provides baseline information against which development initiatives can be evaluated. Within a GIS, it is possible to quantify and assess the physical and socio-economic constraints impacting the communities. The data can also assist in monitoring the situation, or any actions and interventions and is accessible to all. Most importantly GIS can be used to test scenarios and help address potential conflicts.

Common problems with the use of GIS for IK management

According to Jordan and Shrestha (1999), the main problem associated with using GIS for 'participatory' work is the way that the technology has been used. GIS has not been viewed as a tool in a participatory process, but as a technology in its own right, looking for an application. This illustrates one of the key principles of participatory GIS i.e., to evaluate at an early stage what GIS adds to the participatory process. As with any good participatory methodology, the focus has to be on the people, the participants. This has been the key problem with using GIS; the focus has usually been on the technology. The most charitable way of looking at this lack of participation associated with the traditional use of GIS in development work is to view GIS as enabling decision makers to correctly evaluate the required development input. But this is 'putting the technology before the people' (Jordan & Shrestha 1999). There is little or no consultative process with communities. Their needs have not been identified, and the information gathered does not reflect their requirements. The 'old top-down development paradigm is being actively encouraged' (Hobley 1996; Jordan & Shrestha 1999). While working in sub-Saharan Africa Jordan and Shrestha (1999) observed that most GIS applications for development work were used to demonstrate technological capability of GIS rather than for problem solving at local level. GIS is being often used at both local and national levels for demographic and socio-economic studies where there is little participation of local people in the implementation phase. This makes GIS a tool for the researchers, planners and policy makers rather than a tool for local people. Therefore the 'developmental' role of GIS is often one of disempowerment of local people (Jordan & Shrestha 1999). It encourages the separation of the planning process from the people affected. There is little or no discussion with villagers regarding what information would be useful to them, and what information a GIS could provide (Jordan & Shrestha 1999).

Achievements and benefits of integrating IK and GIS for NRM

All programs in which the approach involving the integration of GIS and IK have been used are within natural resources management projects where increased food and income source choices for local communities and effective participation in benefit sharing are the main goals (Mbile et al. 2003). The realization of these objectives regarding community benefits may only be attained and verified if project tactics and activities take into consideration community expectations and

perceptions, knowledge and fears in an iterative way that clearly state potential benefits to communities through application of this methodology. Intentions and plans do not benefit communities by themselves; their effective implementations do. The application of this methodology will ensure that, unlike examples where Participatory Rural Appraisal (PRA) acquired data are stored in huge socio-economic reports, not often read by decision makers, or where a large quantity of socio-economic information remains unanalysed, the data generated using this method will make PRA acquired data more readily available to decision-makers. Secondly, this method will allow each sample household to be monitored directly and intimately, thereby minimizing drawbacks of often misleading generalizations in decision-making derived from consolidated report-bound socio-economic studies. Finally, such household level interaction using participatory resource mapping methodology allows effective participation of local people in project implementation and evaluation. This is because the community is at the center of the data on which the implementation of community development project is based.

In planning and decision making exercises directed towards the sustainable management of natural resources, it is essential that the various types of information relating to a particular area of concern are available. As indigenous information is acknowledged to be a valuable input in those exercises, it must be available and accessible at all times. GIS technology makes this possible. It can provide spatial and non-spatial information, which facilitates both planning, and decision-making aimed at the sustainable management of natural resources. Another benefit of GIS is the fact that it can narrow the information gap between professionals and resource users by making indigenous information more transparent, understandable, and accessible to a wider audience. This is essential for achieving any development goal (Lawas & Luning 1996).

In a MIGIS project, a GIS was taken into a remote field area in southwest China. Data collected from two communities, via a range of PLA activities, were encoded, manipulated, and analyzed. The results were presented immediately back to the villagers, who then checked the data, validated any translations, provided credibility to the database, and reviewed and critiqued the findings. The GIS and PLA were regarded as two interacting, inter-dependent tools used within an iterative process, continually controlled, guided, and validated by the local people. While the PLA exercises produced a significant amount of “village focused” primary data, the MIGIS allowed these data to be geo-referenced, extrapolated, and explored within a wider context through the use of secondary data sources. Analyses also provided considerable insights into the natural and social environment and identified potential development issues that might have arisen (McConchie & McKinnon 2002).

Conclusion

Today the importance of indigenous knowledge for purposes of sustainable development is being recognized and promoted. Such knowledge is a valuable resource and requires proper management. The approach of using GIS in the natural resource management context increases the utility of indigenous information for development, as it has the potential for empowerment of local groups and communities, while at the same time provides a platform that can be shared by many users. These users include natural resource managers, project or development planners, decision makers, people with a particular interest in indigenous knowledge functions, and communities themselves. There is a great possibility that information stored in a GIS environment will actually be shared, since it is in a central spatial repository and can be easily accessed and analyzed. Moreover, comparisons can be made and scenarios created on the basis of the information stored in the system. While the use of a GIS may be at the beginning costly, it is important to consider the accessibility to data, which it offers, and the many other advantages to be gained from indigenous information. It is viewed by some as an exciting development as it allows spatial relationships for social, economic and natural resource issues to be examined, which were previously difficult to incorporate. The future might also bring cheaper and easier-to-use tools that enable local communities to generate or access information about individual and shared resources without external facilitators. With better information about land management status and options and the effectiveness of farming technologies and resource-management practices, communities may avoid resource-related conflicts as they build consensus on uses, management, and rights. However, the cost-effectiveness of introducing GIS technologies into poor communities and the potentially harmful social consequences will continue to require close scrutiny by

researchers and policymakers alike (Deichmann and Wood, 2001). An important challenge in using GIS in a participatory context is that the technology should not ignore the participatory process rather it should complement it; else it can result in the disempowerment of the local community. Thus there is a need for the researchers and policy makers to work with the communities to make GIS an effective participatory tool. Thus from the above discussion it can come to the conclusion that GIS is an effective tool for managing the communities' IK and natural resources. The participatory approach to resource mapping and management of natural resources can lead to sound decision-making regarding the communities' resource allocation. Participatory GIS as a tool also improves the participation of local groups (e.g. farmers, peasants) as well as empowers them and makes them feel important in the decision making process of their own resources while MIGIS facilitates the data to be geo-referenced, extrapolated, and explored within a wider context through the use of secondary data sources.

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The Importance of Aquatic Insects as Biomonitors of Freshwater Ecosystem

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Abstract

Aquatic ecosystems or freshwater ecosystems perform numerous valuable environmental functions. Aquatic insects comprise a taxonomically diverse and ecologically important and interesting group of animals in fresh water systems. They are known to play a very significant role in the processing and cycling of nutrients as they belong to several specialized feeding groups such as shredders, filter feeders, deposit collectors and predators. In this paper an attempt has been made to focus on the importance of aquatic insects as biomonitors of aquatic ecosystems.

Keywords: *Aquatic insects; Biomonitors; Ecosystem; Fresh water*

Introduction

The insects comprise the most diverse group of organisms that exist on the Earth. All over the world about 45000 species of insects are known to inhabit diverse freshwater ecosystem (Balaram 2005). Aquatic insects live some portion of their life cycle in the water. 3% of all species of insects have aquatic stages (Daly 1984). Thirteen orders of insects contain species with aquatic or semiaquatic stages. In five of these orders (Ephemeroptera, Odonata, Plecoptera, Megaloptera, and Tricoptera), aquatic stages are possessed by all species. The remaining eight orders contain terrestrial as well as aquatic or semi-aquatic representatives. Semi-aquatic species live in damp marginal habitats (e.g. some Hemipterans), or are associated with the upper surface of the air-water interface (e.g., some Collembolans), or normally live above the water surface only submerging temporarily, perhaps for concealment (e.g., some Orthopterans). With the exception of a few rare and interesting examples, only aquatic beetles and bugs contain species in which both adult and immature stages occur under water, aerial adults characterize the other aquatic orders that are, therefore, amphibiotic (Ward 1992).

Insects with their abundance and diversity dominate fresh water ecosystem. Although most invertebrate species are still not described, a high diversity is displayed by certain taxa. Limited number of studies has been carried out on the ecological aspects of aquatic entomofauna. Some recent works are those by Sivaramakrishnan et al. (1981), Thirumalai (1999), Anbalagan et al. (2004), Subramanian & Sivaramakrishnan (2005), Anbalagan & Dinakaran (2006), Dinakaran & Anbalagan (2007). Schmid (1984) estimated that India alone may support 4,000 species of caddisfly (Trichoptera), with perhaps 50,000 species in the Oriental Region as a whole and the single genus Chimarra (Phillopotamidae) may contain 500 Southeast Asian species (Malicky 1989).

Freshwater Ecosystem and Biomonitoring

Aquatic ecosystems or freshwater ecosystems perform numerous valuable environmental functions. They recycle nutrients, purify water, recharge ground water, augment and maintain stream flow, and provide habitat for a wide variety of flora and fauna and recreation for people. Biomonitoring of an ecosystem means checking the quality of that ecosystem. The definition of Biomonitoring is the use of organisms and their biological responses to evaluate changes in the environment. It is important because it reveal the effects of different pollutants or other changes in environmental conditions. This data is often collected and used to assess anthropogenic impacts to a system.

Around the world, freshwater habitats are being subjected to increased levels of human disturbance (Saunders et al. 2002). A recent assessment of the status of inland water ecosystems shows that globally most threatened river catchments are to be found in the Indian subcontinent (WCMC 2000). The organisms that are used for Biomonitoring are Fish, Invertebrates (Insects, Crustaceans), Algae, Mussels, Bacteria, etc. Aquatic insects and other benthic invertebrates are the most widely used organisms in freshwater biomonitoring of human impact. Because of the high monetary investment in freshwater management, decisions are often based on biomonitoring results, and a critical and comparative review of different approaches is required.

Aquatic Insects as Biomonitors

The improvement and development of existing and new biomonitoring tools using aquatic insects are a major effort among aquatic entomologists (Carter & Resh 2001). Aquatic insects comprise a taxonomically diverse and ecologically important and interesting group of animals in fresh water systems. They are known to play a very significant role in the processing and cycling of nutrients as they belong to several specialized feeding groups such as shredders, filter feeders, deposit collectors and predators (Lamberti & Moore 1984). Cummins & Klug (1979) classified the aquatic insects into five trophic categories: **collectors**, who feed on fine particulate organic matter (FPOM), in which the size of the organic matter particles (usually plant debris) is smaller than 1mm; **shredders**, in which the food particles (plant) are larger than 1mm (CPOM, coarse particulate organic matter); **scrapers**, that ingest the periphyton; **piercers**, that feed on dissolved organic matter; and **predators**, that hunt other macroinvertebrates, especially aquatic insects larvae. Thus different group of insects belongs to different trophic category playing different role in nutrient cycling. The abundance of a trophic group in an ecosystem indicates different quality of the systems. The higher abundance of shredders and collector trophic groups indicates a better ecosystem than the ecosystems dominated by predator and piercers.

Scientists have identified some as Indicator Species. These are species with different tolerances to pollution. Some are very sensitive; some are very tolerant. The very sensitive species like stoneflies, caddisflies, and mayflies are found in good healthy water systems and cannot tolerate pollutants in the water. There are some semi-sensitive species which can tolerate some portion of pollution in water, like dragonfly, damselfly, bugs, beetles, etc. Again tolerant species are found in any polluted water like, black fly, midge fly, etc. Thus the high abundance of stoneflies and caddisflies indicates clean and good quality systems, whereas the high abundance of blackflies indicates a polluted water quality. Most macroinvertebrates are sedentary and have long life cycles; therefore, they can act as *continuous monitors of* water quality.

Inspite of their importance as biomonitors, bioindicators, predators and bio-control agents, conservationists are far from able to enlist all species under threat and the analytic method for the identification of biodiversity hotspot omits invertebrates which are largely un-documented but probably make up at least 95% of all species, the bulk of them insects (Myers et al. 2000). Hence inventory of insects can be an essential tool in finding out proper conservation principles. There are many studies done on aquatic insects in the continent (Thirumali 1989; Bhattacharjee & Gupta 1991; Sinha et al. 1994; Bath & Kaur 1997; Nagendra & Smija 2004, Jana et al. 2009). Investigations of the lentic insects of North East India are also found (Yadava et al. 1984, Ahmed & Michal 1985; Majumdar & Gupta 2004, Das & Gupta 2010). The insect biodiversity of India amounts to about 10, 8,276 species (Khosoo 1994).

Conclusion

Biomonitoring can not entirely replace standard physico-chemical water quality methods. Standard physico-chemical water quality measures provide information on water quality at a particular spatial unit during the time of sampling. It cannot provide historical information on water quality. On the other hand, by knowing the ecology of aquatic insect community, biomonitoring tools provide some historic insights into the water quality. Standard physico-chemical water quality methods need to be carried out in conjunction with biomonitoring tools to comprehensively evaluate the health of freshwater ecosystems. This is particularly important when heavy metal or pesticide contamination is suspected (Subramanian & Sivaramakrishnan 2005).

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Environmental Ethics Prevalent in South Indian Culture, Beliefs and Practices with special reference to Tamilnadu

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Abstract

The philosophical traditions of India are rich and various, offering diverse perspectives on nature-culture relationships. Same ways in our day to day life cultural practices relate and imbibe with environmental values & associate human health with nature. In this paper an attempt has been made to study environmental ethics prevalent in south Indian culture, beliefs and practices with special reference to Tamilnadu.

Keywords: *Nature; Man; Belief; Practices.*

Introduction

"What's the use of a fine house if you haven't got a tolerable planet to put it on — Henry David Thoreau" The earth is our home; amongst countless billions of heavenly bodies this 'little speck of dirt' seems to be the only place in this vast universe where life, in its myriad forms, has evolved and where it thrives. The earth is the womb of the life; it is our mother - it gives birth, it nourishes, it consoles in grief, it receives in death. For centuries the Indian poets and sages have sung in its praise, invoking awe and wonder. The philosophical traditions of India are rich and various, offering diverse perspectives on nature-culture relations. Same way in our day to day life cultural practices relates and imbibes with environmental values & associate human health.

Observations

Birth and death are the two factual features in human life. Right from the birth of the child every auspicious occasion, function or festival has a deep relationship with the environment.
When a baby is born in a family, it is considered most auspicious happening of life. People throng around to play with the baby. They buy lots of clothes and toys. Present day people buy plastic toys with choking hazard but in south India traditional toys are made from *Marapachi* wood, which has great medicinal importance. Due to the natural sucking and biting tendency of the babies, saliva dilutes the wood and that helps in developing immunity among children.

Just after one week of birth, there is a tradition of placing the baby in a cradle (used in agricultural practices) as it is believed that, it regulates blood flow in the infant body, which has come out of its mother's womb after 10 months. Initially the baby is fed with breast

milk and after *Annaprasanam*, the baby is fed with any kind of hard food.

The hard food giving ceremony (*Annaprasanam*) is often followed by a game, in which the child is presented with a tray containing number of objects. These include a bangle or jewel (symbolizing wealth), a book (symbolizing learning), a pen (symbolizing career) and a clay pot or container of earth/soil (symbolizing property).

The child's future direction and prospects in life are indicated by the object which it *Thulabaram*, the weight of the baby is balanced with an essential item and according to the weight it is given to the temple which is distributed among the devotees. When the baby attains an age of 1 year, they perform a special *Hawan* or oblation of fire, commonly called as *Ayusha Hawan*. For that purpose entire family goes to their ancestral house for performing all the rituals. *Aksharabhyasam* is the tradition where the child is made to write the first letter of his mother tongue on rice grains using his fingers .It's a sign of respect to the farmers, as rice is the staple food in the southern part of India. The tradition symbolizes that the first word written in mother tongue is due to the hard work of farmers and energy provided by grains .Temple is a place of worship. In Tamilnadu, every temple is constructed with full consideration to the maximum magnetic force of the Earth.

In south Indian tradition when a girl attains certain age, she is made to walk step by step in a temple where her foot comes in contact with the uneven floor which acts like an acupuncture mechanism under the magnetism and there by her baby sac gets protected. Every temple posses a main tree (especially Neem tree, Banyan tree) where people perform their offerings. These trees are considered sacred in India .The Neem sticks & Indian Fig sticks are used for various purposes like cleansing your teeth, and for medical issues. In rural area it is still believed that the juice of Neem kills all the germs inside the mouth and increases the hunger. The tree *Ficus bengalensis* is believed to be auspicious.

Even while cutting a tree people offer a puja and also during *van mahotsav* 5-6 new saplings are planted. In Lord *Shiva* and Goddess *Amman* Temple these trees provide shelter to snakes, and the devotees worship these snakes by pouring milk.

These trees act as shelter for various birds, honey bees, monkeys and many other animals. The temple worship also depends on seasons and is special to various caste

system of the Hindu religion. Especially during Tamil month "*Purattasi*" non vegetarians foods are avoided. People use separate utensils for vegetarian foods. Some say this is due to the dedication as most of the festivals related to Godess Amman come during this month & this is the time for the animals to increase its breed. During this month people decorate temples with Pongal made of dried cow dung (*Gobar*) and are considered auspicious. During Navratri (which also falls during this season) every house is decorated using

traditional toys specially wooden and earthen toys.

This is another sign of respect towards environment. The temple symbolism relates to the conservations of biodiversity. Every *vahan* (Carrier) of Gods and Goddess symbolizes an animal, bird etc. Early morning women of every household get up and apply Kolam (South Indian form of *Rangoli*). this is meant for the birds to feed on it and thus this becomes the food for cute sparrows (which are nearly extinct today due to cell phone towers). A portion of the food cooked in each and every household is kept for the crows. Many consider it as the *Pithruh* or ancestors, the vehicle of God *Shani*. This relates to the vedic fact where it is said that the place where crow can live is fit for everyone to live as crow can adopt to any condition. The place where crows die more in number is considered to be inauspicious. There are 108 Divine Names for *Gomatha* or the Cow. Panchakavya the manure from this animal (mix of curd, milk, ghee, urine, dung) is found out to be an excellent substitute for artificial pesticides and fertilizers having medicinal value without causing any harm to environment. Performing Go-puja is an integral part of rituals like Upanayan *Sanskar , Griha Pravesh function* .

The dried cow dung is used for Agni hotram and the sticks from trees of Neem or Indian fig or Banyan tree along with ghee reduces environmental pollution. While discussing about animals we must not forget about elephants. In South India, each and every temple has several elephants. It is believed that public views of these elephants remove sins upto 7 births. Lord *Ganesha* too has a elephant head and considered as first god, lord *Shiva* also worshipped him to win a battle. While narrating these, who can forget about elephant *Guruvayur Keshavan* a tall

elephant which used to wake up early morning and be an alarm clock for the localities .

It was a diehard devotee of the local god. It was said *Keshavan* used to play on road with children without causing any harm. The elephant was a part and parcel of the life of the local people and even after his death, there are paintings and toys of gajraj *Keshavan* and a big statue exactly to the size of *Keshavan*. The temple has kept the tusks of the elephant as its memory.

Standing over 3.2 meters tall, *Kesavan* was known for his devout behavior. *Kesavan* died on December 2, 1976 aged 72, which happened to be *Guruvayur Ekadasi*, considered a very auspicious day. He fasted for the entire day and dropped down facing the direction of the temple with his trunk raised as a mark of prostration. The anniversary of his death is still celebrated in *Guruvauyur*. Many elephants line up before the statue and the chief elephant garlands it. *Kesavan* was conferred the unique title "*Gajarajan*" (Elephant King), by the Guruvayoor Devaswom.

In Kerala, on a particular day, before beginning of harvest, there is a competition of ploughing the cultivable land . This is done with the help of ox, which is considered to be auspicious. In the festival of *Pongal* (festival of harvest), celebrated in Tamilnadu (comprising of 4 days) , there are many rites and rituals associated with plants and animals.In this festival, consumption of sugarcane is considered auspicious. For that purpose, sugarcane is harvested earlier than other crops and as it has sponge like structures to absorb all nutrients, it helps in harvest of crops like rice and controls soil erosion. Moreover, it requires fewer pesticides, and is found tolerant to harmful insects and diseases.Consumption of the juice is good for health and cleanses all the harmful bacteria .Growing sugarcane is a profitable venture as it increases soil fertility for almost 2 years. On the second day of the festival, food items prepared in the previous day are offered to the birds (especially crows), and this is known as *Kanupongal.* On the third day Maatu *Pongal* (Pongal for Cow) is celebrated. In this festival, the cow is neatly bathed and its horns are painted. It is worshipped by many and the cows are fed well. Cow worship is always considered to be sacred. There are several places which are named after animals Mayiladudurai (Place where Peacock Dances), Irumpuliyur (Puli Means Tiger). During both the Shaivaite and *Vaishnavite* wedding bride dress the girl like goddess *Andal* (if she is vaishnav) or like goddess *Meenakshi* in case of a *Shaivaite*.

Most interesting thing is that both the goddess is fond of parrots and has one. In Chennai, there are many places in the name of flowers, birds or animals, such as Triplicane or Thiruvellikeni or Thiruallikeni : place where alli flower blossoms on the lake) Mylapore (place of peacocks) Mandaveli (place where flock of sheeps or goats go in group) . These places can be heard in the lovely song of Isaignani Ilayaraja sir's lovely song called "Sorgame endralum adhu namma oru pol varuma" (means even if you find heaven will it be equal to our motherland).Specially in southern states , applying gram flour and green gram flour, people take bath in the temple ponds , residue left in the water acts as a good fish food .People use shikakai powder which again is a fish food along with haldi which they apply on their face. Chewing betel leaves are considered auspicious. It removes lots of health hazards. Cultivation of betel leaves also increase the mineral salt content in the soil, as it absorbs them.

Conclusion

In each and every way man is related to the environment but due to advancement of science he has defied his path into ventures which harm environment. But now various sources have proved these kinds of ancient practices are scientific and were made with intention of safe guard our environment. Let us join together, imbibe these practices and understand its purpose and features, which safe guard our environment.

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Integrating Indigenous Knowledge in India's Formal Education System: The Potential for Sustainable Development in North East Region of India

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Abstract

The current paradigm shift toward promoting environmental education for sustainable development gravitates toward alternative approaches to school curriculum in India. It is argued that solutions to problems that currently plague the country must proceed from understanding of local capacities such as the role of indigenous knowledge in promoting sustainable development. In view of its potential value for sustainable development it is necessary to preserve the indigenous knowledge, which is scientifically validated, for the benefit of future generations. Perhaps, the best way to preserve indigenous knowledge would be the integration of time tested indigenous knowledge into formal education system. While the integration of indigenous knowledge into environmental education offers many advantages, attempts to do so may encounter difficulties. Therefore, the purpose of this paper is to explore the meaning of indigenous knowledge, provide rationale for valuing indigenous knowledge in formal education system and finding ways in integrating the indigenous knowledge into environmental education in India.

Keywords: *Indigenous Knowledge; Environmental Education and Concerns; North East Region*

Introduction

The current paradigm shift towards promoting Education for Sustainable Development (ESD) gravitates toward alternative approaches to school curricula in India. There is now a growing consensus that some of the solutions to problems that currently plague indigenous societies and communities must proceed from understanding the dynamics within the local context. Such dynamics include the role of indigenous knowledge (IK) and practices in the development processes (Dei 2002; Angioni 2003; UNESCO 2006).The strategy requires the adoption of an endogenous approach to education that involves the contextualization of the school curriculum by integrating indigenous knowledge with other relevant and useful knowledge into formal education. Education is therefore, acknowledged as being instrumental in harmonizing the different forms of knowledge bases and creating a social fabric for societies that can engender social, economic, and political sustainability. Strides are being made towards realizing the goal of ensuring the utilization of Indigenous Knowledge Systems by various academic institutions, individuals and NGOs throughout the world. India is no exception in this regard (Rajasekaran et al. 1992 and NCF 2005).

There exist profound enthusiasm and deliberate propositions to incorporate and integrate Environmental Education (EE), Indigenous Knowledge Systems in education (National Workshop on Indigenous Knowledge Systems 1998; Higgs et al. 2002; Odora-Hoppers 2002, Supreme Court of India 1991). Environmental education provides a vehicle to incorporate Indigenous Knowledge Systems into the school curriculum (O'Donoghue et al. 2001; NCF 2005; Abdi 2006).

Masuku-van Damme (1997) notes that in 1987, the World Commission on Environment and Development had already "advised that society at large has a lot to learn from traditional skills and knowledge to manage complex ecological systems". Furthermore, in 1992 the United Nations Conference on the Environment and Development (UNCED) resolved to promote diversity in general and bio-diversity in particular. To achieve this, the Conference committed itself to assisting and encouraging indigenous communities to protect and utilize natural resources. Moreover, it is refreshing to note that the Indian government has adopted a broad and holistic policy framework for implementing this international resolution (Centre for Environment and Development, MoEF, MHRD). Consequently, indigenous communities are encouraged and called upon to value indigenous knowledge and innovations. Furthermore, the centre for Indian Knowledge System, Centre of Environment and Development has made Indigenous Knowledge one of its focus areas in collaboration with the Ministry of Environment and Forest (MoEF) and Ministry of Human Resource Development (MHRD). The current dominating discourse on indigenous knowledge in the Indian education context for instance arises from the recognition of the need to address deficiencies of knowledge of development that is formulated in western contexts. With the integration of indigenous knowledge that is more appropriate to the needs of the indigenous communities it is hoped that local problems can be addressed effectively. Since the 1970s a growing number of scholars and United Nations organizations turned their attention to exploring how indigenous knowledge and institutions could contribute to more culturally appropriate and sustainable development (Dei 2002; 2003; Shiva 2003; NCF 2005; UNESCO, 2006).It has been realized that indigenous people are not only more aware of but also better able to identify their own needs than are outside developers. More so that those needs are culturally defined as ways in which the survival of indigenous peoples depend upon significantly Thus, the objective of endogenous approach to education is to enable India to develop the capacity to redefine their own paradigm of development based on diverse contexts of the local communities (Shiva 2002; Dei 2002; Angioni 2003; Purcell 1998). The assumption is that by creating awareness of the value and potential contribution of indigenous knowledge and practices to environment education and sustainable development, India would be able to realize alternative solutions to current pressing issues such as loss of indigenous knowledge, and the challenges attributed to natural resource management at grassroots levels. An endogenous approach to education is multifaceted and places among other factors environmental preservation practices as key to sustainable development. Thus, communities can be able to build their social and cultural capital in order to exercise their sovereignty in their own development processes. The idea is to set up appropriate institutional spaces for communities and educators to provide guidance to socio-economic development through multiple forms of knowledge including indigenous knowledge forms and pedagogies. Through this approach it is hoped that communities will be able to self-organize and self direct skills and knowledge that can support development at the micro level (Dei 2002; 2003; Shiva 2003; UNESCO 2006) and also save help the indigenous knowledge through its integration in EE system.

In India, the Constitution and the Government's commitment to the environment along with the rich tradition of environmentally sound practices (indigenous knowledge) is an important backdrop under which the countries EE strategy has been evolved. The Central Government and every state within India, now has a Ministry of Environment and all education departments recognize EE as an essential part of education. The law courts have been sympathetic to environmental issues and the Supreme Court has passed a directive that all students must go through a compulsory course on the environment which also includes indigenous knowledge and the media must show free of cost a certain amount of programmes to create environmental awareness. Therefore, the focus of an endogenous approach to education in India should involve the following goals. First it should aim to enable India to maintain a balance between economic, socio-cultural, and environmental issues that are unique to the country's local context. Second, it should be interesting and meaningful (NCF 2005).

Finally, it should recognize the authenticity and legitimacy of indigenous knowledge's and pedagogies and genuinely incorporate them into the formal educational system. The purpose of this paper is to: First explore the definition of indigenous knowledge, secondly provide a rationale for valuing indigenous knowledge in formal school system, and finally examine the dilemmas that continue to undermine and undervalue efforts to integrate indigenous knowledge in formal school curriculum finding ways of integrating the indigenous knowledge system into environmental education in north-east India.

Indigenous Knowledge System

As an emergent field of study, IK is characterized by various definitions, fragmented theoretical conceptions, and marginalized positions vis-a-vis the current mainstream knowledge system. Thus, a plethora of terminologies referring to the same phenomenon has resulted: indigenous knowledge systems, indigenous technical knowledge, ethno-science, local science, traditional science, people science, and village science (Atte 1989). Other names for it include: 'local knowledge', 'folk knowledge', 'people's knowledge', 'traditional wisdom' or 'traditional science' (Warren 1990). Sometimes, these terms tend to have negative connotations such as static, conservative or backward. There are different ways to frame and define Indigenous Knowledge Systems. Indigenous Knowledge Systems are embedded in the cultural milieu of all people, irrespective of race. People are historically and culturally bound and thus have a peculiar knowledge system, which enables them not only to survive, but also to become a civilized community (Ntuli 1999; Vilakavi 1999). According to International Labor Organization, there are about 5,000 different indigenous people living in 70 countries. At present the total population is estimated about 300 million, mostly in Asia (Emery et al. 1997). The word indigenous has often been used to refer to specific groups of people defined by ancestral territories, collective cultural configuration, and historical locations (Angioni 2003; Dei 2002; Purcell 1998; Warren 1990). In this context indigenous knowledge is a multifaceted body of knowledge, practices, and representations that are maintained and developed by peoples with long histories of close interaction with the local natural environment. The term indigenous, therefore, denotes that the knowledge is typical and belongs to peoples from specific places with common cultural and social ties. Thus, indigenous knowledge is a process of learning and sharing social life, histories, identities, economic, and political practices unique to each cultural group. This reflects the uniqueness of ways that specific societies make meaning of the world and how such forms of knowledge address local problems and solutions that are context specific. In this paper indigenous knowledge is framed as the complex set of activities, values, beliefs and practices that has evolved cumulatively over time and is active among communities and groups who are its practitioners. It remains so as long as the groups and communities who are its practitioners are committed to sustaining, creatively developing, and extending its potential enrichment within a specific setting.

Indigenous knowledge is developed and sustained through traditional education, which provides skills, trade training, and socialization avenues for many youths in traditional societies of the country today who never attended or dropped out of the formal school system. Indigenous education practices among Indian ethnic communities are holistic as it integrates all activities including rituals and skills required to sustain cultural practices, life of the family, and community. The aim is to prepare individuals for communal responsibility and interpersonal relationships as key components of the learning process. Therefore, combining specific skills acquisition with good character has been considered as virtues of being well educated and a well integrated member of the society. Finally from the above discussion it can be said that, IK is the local knowledge that is unique to a culture or society. Indigenous knowledge is also known as local knowledge, folk knowledge, people's knowledge, traditional wisdom or traditional science. This knowledge is passed from generation to generation, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain a society and its environment in many parts of the world for many centuries. Indigenous people have a wide knowledge of the ecosystems in which they live and of ways of using natural resources sustainably. However, colonial education systems replaced the practical everyday life aspects of indigenous knowledge and ways of learning with Western notions of abstract knowledge and academic ways of learning. Today, there is a grave risk that

much indigenous knowledge is being lost and, along with it, valuable knowledge about ways of living sustainably both ecologically and socially.

Rationale for valuing indigenous knowledge in formal education

Modern education was introduced during the colonial period in India with the objective of producing administrators, clerks, teachers, and interpreters, etc. This type of education was based on alien knowledge systems - scientific knowledge - which evolved and developed in the western industrialized world. Modern education systems have had no place for either IK or indigenous methods of education. It was assumed that IK was irrelevant, unscientific and outdated and, therefore, no attempts were made to integrate indigenous knowledge into the modern educational system. In other words, IK was rejected without anyone making any attempt to test its validity and potential value in solving contemporary problems. The formal western oriented education system inherited after independence not only cultivated among the elites a sense of denial to their indigenous heritage but also impacted individuals' sense of self-confidence in expressing and appreciating their native values and cultures.

Education was confined to classrooms and children separated from their culture and environment. The teacher-centered nature of formal education also separated children from parents and, consequently, parents became less able to pass on the knowledge they had inherited to their children. Local people's knowledge is not often taken into account when curriculum is prepared. It was, until recently, assumed that traditional indigenous knowledge was not irrelevant, unscientific and outdated. Therefore, few attempts were made to integrate traditional knowledge into formal education despite its potential value in solving contemporary problems. This knowledge is passed from generation to generation, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain societies in many parts of the world. Indigenous people have a broad knowledge of how to live sustainably. However, formal education systems have disrupted the practical everyday life aspects of traditional knowledge and ways of learning, replacing them with abstract knowledge and academic ways of learning. Today, there is a grave risk that much indigenous knowledge is being lost and, along with it, valuable knowledge about ways of living sustainably.

Sophisticated knowledge of the natural world is not confined to science. Human societies all across the globe have developed rich sets of experiences and explanations relating to the environments they live in. These 'other knowledge systems' are today often referred to as traditional ecological knowledge or indigenous or local knowledge. They encompass the sophisticated arrays of information, understandings and interpretations that guide human societies around the globe in their innumerable interactions with the natural milieu: in agriculture and animal husbandry; hunting, fishing and gathering; struggles against disease and injury; naming and explanation of natural phenomena; and strategies to cope with fluctuating environments (Nakashima et al. 2000). Indigenous knowledge is now gradually disappearing and remains only in the memory of some old-age people who live their own world. When these old people pass away, indigenous knowledge may be lost forever. However, there is now a growing recognition of the potential of indigenous knowledge and its consequent value in environmental management and sustainable development. It would therefore be wise to take some immediate steps to collect and document the remaining indigenous knowledge in traditional communities and integrate it into modern education. By so doing we would ensure the continuity of remaining traditional knowledge for the benefit of future generations especially by integrating indigenous knowledge about environment into EE.

Issues to consider when integrating indigenous knowledge in the curriculum

Despite the stated value and potential of indigenous knowledge in providing solutions to some of the problems inflicting indigenous communities, educators need to examine what implications the inclusion of this form of knowledge has for pedagogy and its sustainability in the current classroom settings. This is because of the diverse nature of India's ethnic communities and centuries of dominance of the country's education system by western epistemologies. First, educators and curriculum developers need to be cautious and avoid bundling together the diverse ways of knowing under one category of indigenous knowledge. This is because such

generalization may lead to separating these forms of knowledge from their specific contexts, a condition that may lead to over implication and superficial implementation. Also, such homogenization is likely to jeopardize the potentially unique and important contribution that specific forms of indigenous knowledge can make to development within specific localities and among local groups who embrace such knowledge.

At the same time educators need to recognize the fact that the uniqueness of indigenous knowledge in a particular culture does not necessarily mean that there is internal consensus or that all members of the same ethnic group adhere to the same knowledge base in their socio-economic and political decision-making process. Given the current acculturation and development of cosmopolitan communities individual members perceptions may differ significantly on specific ways of doing things. Central questions that need to be explored when integrating indigenous knowledge in the curriculum reforms are: What aspects of indigenous knowledge need to be incorporated in the integration process? What related features of indigenous ways of knowing and modes of learning are common across the diverse indigenous cultures and which ones are unique to particular ethnic groups? Answers to these questions would act as a guide to identifying those features of indigenous knowledge that can be made visible during the process of curricula development.

Integrating Indigenous Knowledge into Environmental Education

The objective of curriculum reconstruction has been to explore alternative solutions by utilizing local resources as a way towards addressing environmental and socio-economic problems that face India as a country. In National Curriculum Framework (NCF 2005) and Position Paper on Habitat and Learning has emphasized the inclusion of IK in Indian education system. As domain of knowledge have grown enormously, so it is necessary to select what is to be included in curriculum. As per NCF, 2005 only relevant, interesting and meaningful knowledge would be integrated in the curriculum development. Thus, traditional knowledge should be validated and tested on the above mentioned criteria before integration in EE.

This section would illustrate the ways in which the traditional knowledge can be integrated into formal education system in North-East Region of India. It can be achieved through creation of a Regional Knowledge Platform with an aim to generate awareness and disseminate possible strategies for adaptation of measures for integrating traditional knowledge in the formal education system through dialogue, networking and knowledge sharing by a participatory cross-learning journey across North-East region of India. The procedure of integrating the traditional knowledge into the formal Education system, elaborated below, can be carried out by the respective state governments of North-East states with the help of non-governmental organizations (NGOs).

Methodology

Identification of the Best Practices in Indigenous Knowledge

For initializing the knowledge platform, each state would identify several indigenous knowledge cases (from books, research reports, journal, etc.) which are being carried out successfully at present within the state. We would be considering three main heads where the traditional knowledge would be identified and small groups of participants would be allocated in one of the following uses of traditional indigenous knowledge to investigate:

a) Health and Medicines (Medicinal Plants)
b) Resource Management (Biodiversity Conservation, Soil and Water Conservation, etc.)
c) Agriculture (Production System)

These topics were chosen to reflect aspects of indigenous environmental knowledge of the North-East people.

Participatory Trips

The documented cases would be later validated through the field survey by the participants (See Fig.1). Detailed information would be collected about these traditional knowledge cases under the above mentioned heads. The trip would include several participants. The core group of the participants would comprise of experts on medicinal plants, ecologists, environmentalists, experts in

indigenous studies, cultural history and religious studies, teachers, educationists, the practitioners of the traditional knowledge, etc. Members of local indigenous groups are vital resource persons for this activity. This is because, sadly, few members of majority cultures have a wide understanding of indigenous environmental knowledge. Experts in indigenous studies, cultural history and religious studies may also be helpful as guests for this activity. If it is not possible to have such guest teachers at the workshop, a range of suitable books and other educational resources may be appropriate – but really only as a last resort.

Collating the Practices

Once the information are gathered from the field trip, they would be brought together and collated together and documented to create a handbook. Each state would identify their own successful cases of traditional knowledge and carry out the field trips and collate the information separately. So the outcome would be eight handbooks, one from each state.

North-East Regional Workshop

The eight trips (for eight North-East states of India) would culminate in a regional workshop, where in participants would be from all the north-east states. The participants would share the lessons learnt and discuss institutional and socio-economic factors in integrating the traditional knowledge in the formal education system. This regional workshop would have sessions led by eminent resource persons who work on issues of environment, ecology, traditional knowledge, educationists apart from the participants of the trips.

(a) There would be three separate working groups on health and medicine, resource management and agriculture. Each group would be having the handbooks of all the north-east states.

(b) The instructions which follow are based upon the assumption that at least one indigenous guest teacher is available to assist each working group in this activity. If a smaller number of guest teachers are available, it may be necessary to undertake this activity as a whole group or to allocate two or more of the topics to a group.

(c) Each working group will come out with a report and reconvene as a whole group to hear reports from each other.

(d) In debriefing, focus particularly on the contemporary status of the use of the particular aspects of traditional knowledge and the social and ecological 'costs' of the contemporary equivalent.

(e) Later on, the participants would be asked to rejoin their respective groups and to review their previous discussion of ways that traditional knowledge of their topic could be integrated into environmental education.

After the discussion in the workshop with the experts and indigenous people, it can be decided collectively that which aspect of the traditional knowledge can be integrated into formal education. They can summarise their ideas by identifying:

- syllabus subjects and topics into which teaching about traditional practices and resource uses can be integrated;
- teaching methods they could use that are based upon or similar to traditional approaches;
- any barriers they might face; and
- how these might be overcome.

Role of Facilitators

a) Facilitators should review their national and local curriculum guidelines to identify the place of teaching indigenous knowledge in them.

b) Traditional knowledge and practices vary greatly among states. Therefore, the activities and resources provided here need to be supplemented with local ideas and materials. Facilitators may find it useful to approach local indigenous groups, libraries and interested colleagues to arrange suitable examples and support materials on local indigenous perspectives on the environment. Indeed, facilitators should analyze all resources and activities for educational and cultural relevance, and adapt and/or replace any ideas in this handbook with local examples.

c) Workshop facilitators will need to adapt activities and emphasize different aspects on the workshop according to the curriculum contexts and needs of participants.

d) The depth of treatment and amount of time allocated to each activity will vary according to the background experiences of participants in classroom teaching and in environmental education. The

activities may need to be adjusted according to whether participants are experienced environmental educators seeking to update their appreciation of environmental education, experienced teachers who are relatively new to environmental education, or pre-service trainees relatively inexperienced in teaching and environmental education.

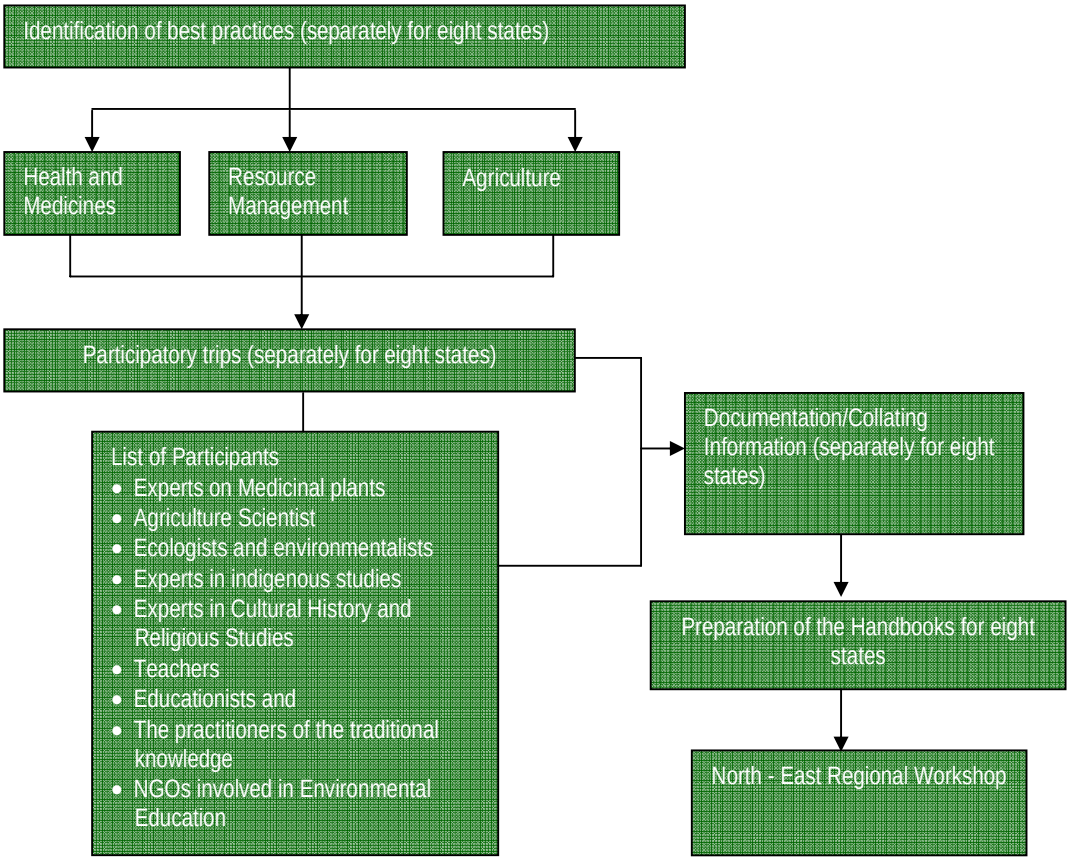

Figure 1. Method for integrating indigenous knowledge into formal education system

Conclusion

Indigenous knowledge has now become the central issue in global discourses as a strategy to solutions on environment, socio-economic, and political problems of the country. Endogenous approach to Education for Sustainable Development advocates for educational process that is based on a holistic perspective, practically based, and conceptualized to the local, national, and international needs of the students. Unless disciplines taught and methodologies adopted reflect genuine commitment to the integration of indigenous knowledge, acceptance of multiple perspectives of knowledge in the curriculum, and encouragement of local community inputs, school knowledge will continue to be abstract, and irrelevant to the country's students' needs. However, there is now a growing recognition of the potential of indigenous knowledge and its consequent value in environmental management and sustainable development. It would therefore be wise to take some immediate steps to collect and document the remaining indigenous knowledge in traditional communities and integrate it into modern education system. By so doing we would ensure the existence of remaining indigenous knowledge for the benefit of future generations especially by integrating indigenous knowledge about environment into environmental education.

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Marine Oil spill- A disaster

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Introduction

A marine oil spill is a form of pollution that accidentally released crude oil in to the ocean. It is basically a liquid petroleum hydrocarbon. It is one of the major threats to marine environment. Every year, millions of gallons of oil are spilled in to the oceans and seas. One of the biggest oil spills occurred at the coast of Saudi Arabia where more than 240 million gallons of oil spilled from its terminals during the Persian Gulf War (1991).

Consequence

An oil spill adversely affects harbors, beaches, wild lives, fisheries, human health, tourism and industrial plants. Therefore, oil spill incidents need to be addressed by way of advance preparedness or contingency planning. Because of oil spill large number of mammals and birds get affected badly. It penetrates in to the fur of the mammals and plumage of the birds thereby reducing their insulating ability and cause dehydration and digestion problems due to accidental intake of oil. The marine plants are also affected due to low sunlight penetration because of oil that spreads on the surface of the water which affects their photosynthesis. Fish and shellfish may not be exposed immediately, but can come into contact with oil if it is mixed into the water column. When exposed to oil, adult fish may experience reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and reproduction impairment. Oil also adversely affects eggs and larval survival.

Remediation

Most widely used remediation for removal of oils from the surface of the ocean water is bioremediation using “oil- eating” bacteria. There are three kinds of oil-consuming bacteria: Sulfate-reducing bacteria (SRB) and acid-producing bacteria are anaerobic, while general aerobic bacteria (GAB) are aerobic. These bacteria occur naturally and will act to remove oil from an ecosystem, and their biomass will tend to replace other populations in the food chain. But it takes long time to clear up the oils and by this time extensive lose took place including human which consumes polluted oil spilled fishes.

Genetic Engineering scientists enhance the ability of such bacteria’s metabolism by developing oil eating “Super-bug”. Apart from bioremediation the oceans have a high capacity to degrade the petroleum. Recently under islands in Arctic oceans, scientists found active hydrocarbon degradation underway even during the cold and darkness of the winter. Oil spill dispersant (OSD) is a chemical agent that also helps to combat the oil slicks. Thus, it seems that the cure for oil pollution is almost everywhere.

Indian perspective

In India, there are eleven coastal areas which have the major risks of oil spills. India has a coastline of about 5500 km in the mainland and about 2000 km in its offshore islands. The biodiversity in the coastal waters, Gulf of Mannar and Kutch, in the waters of Andaman, Nicobar and Lakshadweep islands and in the specialized ecosystems like Chilka Lake,

mangroves along east coast are significantly high. More than 5000 species of marine flora and fauna have been recorded so far the coastal and marine waters of the country. Therefore such species need to be conserved from oil pollution.

The issue of marine oil spill in India is given in Merchant Shipping Act -1958. The major sources of oil spills are marine tankers, oil installations & SPM etc. Such sources increase the risks of oil spills in Indian coastal areas.

Conclusion

Oil spills falls under the major marine pollution disaster which lasts for long time. Such issue needs to be addressed in International level to combat this pollution which not only affected the biodiversity but also included human beings.