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Biodiversity Restoration in Brackishwaters

P.J. Sanjeeva Raj*

ABSTRACT

Keystone species like the Edible Oyster can be attracted to settle experimentally on hard substrata like roof-tiles in batteries, as an artificial fish (biodiversity) habitats. These keystone species have attracted 83 other species of biodiversity, including 39 species of fish, thus serving in eco as well as biodiversity restoration in the degrading Pulicat Lake.

Keywords : Keystone species, Tile-batteries, Artificial Biodiversity Habitats, Eco-restoration, Biodiversity restoration.

Introduction

Coastal Ecological Heritages

Our coastal (inshore) waters are being degraded by industrial and sewage pollution and by beach-erosions. They are also depleted of their biodiversity by indiscriminate bottom-trawling. Similarly, our brackishwaters in estuaries, lagoons and backwaters are not only getting silted up but are also getting degenerated as 'septic tanks' due to industrial, agricultural and sewage pollution and eutrophication. These ecological heritages and their valuable biodiversity are to be preserved for our posterity. Unfortunately, we have no legislation to protect our aquatic biodiversity (Sanjeeva Raj, 1995).

Degrading Pulicat Lake

Pulicat Lake has been fast shrinking both in its water spread area as well as in its depth, chiefly due to the massive monsoon siltation, at a rate of one metre per century (Caratini, 1994). Such a siltation buries all benthic (bottom) vegetation and other suitable substrata and all its rich biodiversity. Added to this, the rich biodiversity of this lake (Chacko *et al.*, 1953; Sanjeeva Raj, 2006) has been subjected to mass-mortality due to the pollution from the North Chennai Thermal Power Station (Sanjeeva Raj, 1999 and 2000), aquacultural (Sanjeeva Raj, 1993) and the recent jellyfish and seafood processing in the lake.

Experiments to restore biodiversity

How can we restore the vanishing biodiversity of the Pulicat Lake? This was a WWF (India)-funded project, during 1997 to 1998, (Sanjeeva Raj *et al.*, 2002).

Habitat restoration: It is well known that habitat restoration would automatically lead to species or biodiversity restoration. In a shallow aquatic ecosystem, the key-

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habitat is perhaps the bottom (benthic) habitat. Therefore, if benthic habitats are conserved or promoted, food-chains and biodiversity, at all levels in an aquatic ecosystem, would be automatically built up.

Keystone species: In order to restore the declining biodiversity in any ecosystem, the first exercise is to identify local keystone species. Because, once the keystone species are restored, amazingly rich biodiversity would also be restored, and in quick succession. Keystone species in any ecosystem can be identified through an- year-round study of the biodiversity aggregation or colonisation at each local species of vegetation (flora) and animals (fauna), so as to choose the species that harbours the largest number of co-inhabitant species, from the same ecosystem.

Edible oyster, the keystone species: Nearly 35 years of our ecological and biodiversity research studies on the Pulicat Lake (Joel and Sanjeeva Raj, 1981., Thangavelu and Sanjeeva Raj, 1988) have indicated to us that the edible oyster, *Crassostrea madrasensis* (Preston) is perhaps the keystone species in the Pulicat Lake. This edible oyster, native to India (not an exotic) was first introduced into the Pulicat Lake by the Fisheries Department of the erstwhile Madras Presidency (Hornell, 1908). It flourished in the lake as extensive oyster-beds, which have even been serving as 'fish-aggregating devices' (FADs), from where local tribals have been getting good catches of fish, using cast-nets.

Destruction of keystone species: However, since the recent 30 years, not only monsoon siltation has been burying all oyster-beds, but also the clandestine trade in oyster-shells for baking them into lime, has resulted in the decimation of this keystone species, along with all its associate biodiversity and fisheries.

Hypothesis: Therefore, it has become clear to us that if the declining benthic biodiversity and fisheries in the Pulicat Lake are to be restored experimentally, restoration of oyster-beds is a pre-requisite.

Experimental methodology

Edible oyster needs hard substrata to settle on, but siltation buries all such hard substrata in the lake. To provide such hard substrata or artificial habitats, locally available and cheap country-tiles from dilapidated houses were procured.

'Tile-batteries": Five tiers of such tiles, two in a tier, each tier at right angles to the adjacent tier, were tied tightly with a coir rope, to make up a 'tile-battery'. It serves as an artificial fish (Biodiversity) habitat (ABH).

"Protected area": 100 such 'tile-batteries' were placed in different designs, to make up what we call a 'protected area'. 16 such 'protected areas' were identified all over the lake, to represent different habitats.

Such 'tile-batteries' which are about 15 inches in height would overcome the problem of siltation at the bottom. Also, they would not be easily washed away by the monsoon floods.

Results

Within a month of deploying such artificial habitats in the lake, the first settlers on them were the barnacles, followed by the oyster-spat (young ones). Within eight months these oysters grew to a large size.

By then, about 44 species of other organisms were attracted to these oyster-settlements, and about 39 species of fish and totally 83 species were found to be attracted to these artificial habitats, of

which 15 species of fish were common and which fishermen started fishing.

Interestingly, two species of polychaete worms, not recorded earlier from this lake, were also attracted to these oyster-beds.

From such restoration sites, both oysters as well as their associate biodiversity started breeding and spreading to the nearby suitable spots in the lake.

People's participation

Local fisherfolk's participation in such biodiversity restoration experiments was found to be absolutely necessary for the success of such experiments. It is not only by way of their unanimous consent for experimenting in their traditional fishing grounds, but also, the necessity for their enthusiastic participation in awareness education, co-operation in deploying the artificial habitats and in the protection of such experiments, and above all, in the future replication of such models, all by themselves.

Recommendations

This appropriate technology of the 'Pulicat Model' for biodiversity restoration in brackishwaters, could be evolved into a 'people's technology' to spread it to all brackish waters in India, particularly to our nearby Adyar estuary, Pallikarani swamp and the Kovalam backwaters, which are all totally degraded, today.

The only constraint is that since oyster-shells are sharp-edged, fisherfolk are hesitant to spread oysters, lest their nets and bare-feet get cut. However, oyster-beds could be restricted to shallow, non-fishing regions of any brackish water body.

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Student-Teachers' Environmental Awareness and Attitude towards Local Environmental Issues

V.K. Ushadevi* and **R. Dhanya**

ABSTRACT

Teacher preparation assumes greater significance as teachers, with the right attitude and will to equip the future generation moulded during this period. In the present study the investigators highlight the need to understand one's immediate surroundings and the right attitude to preserve our local environmental resources at all costs. The study was conducted on 814 student-teachers at secondary level belonging to eleven teacher education colleges in the district of Palakkad, Kerala, selected by stratified sampling technique, using Environmental Awareness Test and Scale of Attitude towards Local Environmental issues developed and standardized for the purpose. Pearson's Product Moment co-efficient of correlation, One-way Analysis of variance and Mean comparison for large independent samples were worked out. Results showed that student-teachers with high level of Environmental Awareness have more favourable attitude towards local environmental issues. Environmental Awareness has significant effect on student-teachers' attitude towards local environmental issues. Gender differences are not significant whereas differences in subject of specialization are significant in the case of the two variables. There is significant difference due to locale of residence only in the case of the variable Environmental Awareness. Implications point out to the urgency of strengthening Environmental Awareness in student-teachers and more in depth case studies on environmental issues at local level should be carried out towards this purpose.

Keywords : Student-teachers, Environmental awareness, Local environmental issues, Statistical analysis.

Introduction

Man is only one of the millions of species existing on earth. At the same time, man is exploiting nature to the extent that nobody will escape from the harm caused out of the greedy grabbling. Human demands are never ending. The continuing depletion of natural resources, deforestation, extinction of many plants and animals species, rise in global temperature, environmental pollution and thinning of life-saving ozone layer are few examples of environmental degradation. It is estimated that by the year of 2050 global warming due to climatic changes will cause 150 million environmental refugees, and the developing countries are more prone to these severe environmental hazards. It has seriously been felt that multifaceted approach to solve environmental problems at the international, national, state and local level is the need of the hour.

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The UNESCO-UNEP International Environmental Education Programme has emphatically pointed out that to improve the effectiveness of Environmental Education Teacher Preparation is be ranked as "the priority of priorities". UGC has reconstructed the Teacher Education Programmes in Universities by including Environmental Education in the curricula for Teacher Education. The major aim of these educational programmes is to provide scientific knowledge and insight into the real nature, scope, importance and conceptual clarification of the issues involved, to prospective teachers and teacher educators, and developing skills to impart proper Environmental Education to school students in a natural but comprehensive way. A strong Environmental Education system which has its footings on environmental pedagogy is what is required at present at all levels of education. Teachers with the right attitude and will to equip the future generations to enable them imbibe the virtues of Sustainable Development are to take the lead.

Trained and untrained student-teachers at various levels do not differ in their environmental attitude (Shahnawaj, 1990, Praharaj, 1991) which is contradictory to the findings of Jaus (1978). Gender differences in Environmental Awareness and in attitude towards Environmental Education have been reported in many studies such as Ballanlyne and Hooby (1995), Gardos *et al* (1997), Tymys (2000)and gender and locale differences in Environmental Attitude have been reported in school children as per Abraham & Arjunan (2005). Attitude towards Local Environmental Issues have not been explored much. Therefore, the present study has been undertaken.

Objectives

The objectives set for the study are the following:-

❖ To estimate the extent of relationship between Environmental Awareness and Attitude towards Local Environmental Issues among student-teachers at secondary level.

❖ To test for the effect of Environmental Awareness on Attitude towards Local Environmental Issues.

❖ To test for differences if any, in Environmental Awareness among student-teachers at secondary level based on Gender, Locale of residence and Subject of specialization.

❖ To test for differences if any, in Attitude towards Local Environmental Issues among student-teachers at secondary level based on Gender, Locale of residence and Subject of specialization.

Hypotheses

The hypotheses formulated for the study are;

❖ The relationship between Environmental Awareness and Attitude towards Local Environmental Issues of student-teachers will be positive and significant.

❖ The effect of Environmental Awareness on Attitude towards Local Environmental Issues of student-teachers will be significant.

❖ Significant difference exists in Environmental Awareness among student-teachers at secondary level based on Gender, Locale of residence and Subject of specialization.

❖ Significant difference exists in Attitude towards Local Environmental Issues among student-teachers at secondary level based on Gender, Locale of residence and Subject of specialization.

Methodology

The method used for the study was survey and the type of sampling followed was stratified sampling. Data were collected from 814 student-teachers at secondary level from eleven teacher education colleges of Palakkad district giving due representation to Gender, Locale of residence and Subject of specialization. The tools used were Environmental Awareness Test (Ushadevi &Dhanya, 2008) and Scale of Attitude towards Local Environmental Issues (Ushadevi & Dhanya, 2008).

The relationship between Environmental Awareness and Attitude towards Local Environmental Issues was estimated using Pearson's Product Moment Coefficient of Correlation and its significance was tested by means of Fisher's 't' test. One-way Analysis of Variance was carried out to find out the effect of Environmental Awareness on Attitude towards Local Environmental Issues. Two tailed test of significance of mean difference was carried out to find out whether significant difference in Gender, Locale of residence and Subject of specialization exists in the case of the two variables.

The details of the coefficient of correlation between the variables Environmental Awareness and Attitude towards Local Environmental issues for the total sample are summarized in Table 1.

The coefficient of correlation for the total sample is 0.283 (N=814). When tested for significance by Fisher's 't' test, the 'r' value is found to be significant beyond 0.01 level of significance. The relationship is positive suggesting that an increase or decrease in Environmental Awareness will be followed by a corresponding increase or decrease in Attitude towards Local Environmental Issues.

The shared variance shows the percentage of overlap of variance of Environmental Awareness and Attitude towards Local Environmental Issues and it is 8.009. That is, 8.009 percent of the variation in Attitude towards Local Environmental Issues is due to the variation in Environmental Awareness.

The 95 percent confidence interval (0.95 CI) is [0.223 to 0.346] suggesting the limits within which the 'r' value of the population lies, the probability being 0.95. Thus, results on the estimation of relationship between the two variables reveal that there exists significant, positive relationship between the variables.

814 student-teachers were classified into three groups viz, High Environmental Awareness; Average Environmental Awareness; and Low Environmental Awareness groups using the score cutoffs from the mean. The means and standard deviations of the variable Attitude towards Local Environmental Issues for the three Environmental Awareness groups were worked out and compared using one-way Analyst of Variance. Data and results of the comparison are given in Table 2.

TABLE 1
Data and Results of the Correlation Analysis for the Total Sample

Variables	Sample Category	Sample size No	Coefficient of correlation r	S.Er	Confidence interval CI (95%)		Percentage overlap
					Lower limit	Upper limit	
Env.A.A. L.E.I	Total sample	814	0.283**	0.032	0.223	0.346	8.009

** indicates 'r' significant 0.01 level.

TABLE 2

Data and Results of One-way Analysis of Variance Between Student Teachers classified on the basis of Environmental Awareness

Variable	Category	Mean Attitude Scores	Standard Deviation of Attitude Scores	Source of variance	Sum of squares	Degrees of freedom	Mean Sum of Squares	F
Attitude towards Local Environmental issues	High Environmental Awareness group	166	15.740	Between group	17608.721	2	8804.361	29.884**
	Average Environmental Awareness group	158.530	17.370	Within groups	238935.400	811	294.618	
	Low Environmental Awareness group	151.350	17.950	Total	256544.100	813		

** indicates difference significant at 0.01 level

TABLE 3
Data and Results of the Mean Comparison of scores of Attitude towards Local Environmental Issues between High-, Average-, and, Low Environmental Awareness groups

Sl. No.	Test groups	Sample Size (N)	Mean	Standard Deviation	Critical Ratio
1.	High Environmental Awareness group	160	151.350	17.952	
	Vs				7.844**
	Low Environmental Awareness group	168	166.000	15.743	
2.	High Environmental Awareness group	160	151.350	17.952	
	Vs				5.160**
	Average Environmental Awareness group	486	158.530	17.367	
3.	Average Environmental Awareness group	486	158.530	17.367	
	Vs				4.424**
	Low Environmental Awareness group	168	166.000	15.743	

** indicates difference in the mean scores significance at 0.01 level.

The F value obtained is 29.884 (for 2,811 d.f) indicating significant effect of the variable Environmental Awareness on Attitude towards Local Environmental Issues. The details of the follow-up test by means of two-tailed test of significance of difference between means for large independent samples are presented in Table 3.

The pair-wise comparison of the three group pairs shows that there is significant difference in Attitude towards Local Environmental Issues among all the three groups based on Environmental Awareness.

Two tailed test of significance of mean difference was used to compare the Environmental Awareness of male and female student teachers, rural and urban subjects and subjects belonging to language and arts group and science group. The details are presented in Table 4.

The results indicate that there is no significant gender difference in Environmental Awareness whereas the difference between rural and urban subjects is found to be significant and the difference between language and arts group and science group is found to be highly significant.

The details of the mean comparison in the case of the variable Attitude towards Local Environmental Issues has been presented in Table 5.

The results of the two-tailed test of significance of difference between means show that there is no significant gender and locale difference in Attitude towards Local Environmental Issues of the student teachers but the difference is significant in the case of student teachers belonging to different subjects of specialization.

TABLE 4
Data and Results of the Test of Significance of Difference in the Mean Scores of Environmental Awareness based on Gender, Locale of Residence and Subject of specialization

Sl. No.	Classificatory Variables	Sample	Total Number (N)	Mean	Standard Deviation	Standard Error of Mean	Critical Ratio
1.	Gender	Male	45	21.600	5.990	0.890	
		Female	769	20.390	5.860	0.210	1.318^{NS}
2.	Locale of Residence	Rural Subjects	679	20.68	6.07	0.22	
		Urban Subjects	135	19.34	17.84	0.52	2.359^{*}
3.	Subject of Specialization	Arts & Language group	500	19.830	5.730	0.260	3.859^{**}
		Science group	314	21.460	5.950	0.340	

** indicates difference in mean scores significant at 0.01 level.
* indicates difference in the mean scores Significant at 0.05 level.
NS indicates Non-Significance of mean difference

Findings

The major findings of the study are:

❖ Significant positive relationship exists between Environmental Awareness and Attitude towards Local Environmental Issues of student-teachers.

[r=0.283, t=8.409, p<0.01]

❖ Environmental Awareness is a variable that affects Attitude towards Local Environmental Issues of student-teachers.

[CR, F = 29.884 for (2,811) d.f., p <0.001]

❖ The student-teachers with High; Average; and Low Environmental Awareness differ significantly in their Attitude towards Local Environmental Issues.

High vs. Low [CR, t=7.844, p<0.01];

High vs. Average [CR, t=5.160, p<0.01];

Average vs. Low [CR, t = 4.424, p<0.01] Group.

❖ No significant gender difference exists among student-teachers in the case of Environmental Awareness and in the case of Attitude towards Local Environmental Issues.

Environmental Awareness [CR, t=1.318, p>0.01],

Attitude towards Local Environmental Issues [CR, t=0.102, p>0.01]

TABLE 5
Data and Results of the Test of Significance of Difference in the Mean Scores of Attitude towards Local Environmental Issues based on Gender, Locale of Residence and Subject of specialization

Sl. No.	Classificatory Variables	Category	Total Number (N)	Mean	Standard Deviation	Standard Error of Mean	Critical Ratio
1.	Gender	Male	45	158.42	16.57	2.47	0.102^{NS}
		Female	769	158.68	17.84	0.64	
2.	Locale of Residence	Rural Subjects	679	159.25	17.20	0.66	1.893^{NS}
		Urban Subjects	135	155.73	20.20	1.74	
3.	Subject of Specialization	Arts & Language group	500	157.53	16.09	0.72	2.186*
		Science group	314	160.46	20.04	1.13	

* indicates difference in mean scores significant at 0.05 level.
NS indicates Non-Significance of mean difference

❖ Rural and urban subjects differ significantly in Environmental Awareness but there is no significant difference between rural and urban subjects in Attitude towards Local Environmental Issues.

Environmental Awareness [CR, t=2.359, p<0.01]

Attitude towards Local Environmental Issues [CR, t=1.893, p>0.01]

❖ Student-teachers belonging to language and arts group differ significantly in Environmental Awareness and in Attitude towards Local Environmental Issues.

Environmental Awareness [CR, t=3.859, p<0.01]

Attitude towards Local Environmental Issues [CR, t=2.186, p<0.05]

Conclusion

From the above core findings, it can be concluded as follows:

Student-teachers at secondary level possess significantly high level of Environmental Awareness and they have more favourable Attitude towards Local Environmental Issues irrespective of gender. The highly significant relationship between the variables and the significant effect of Environmental Awareness on Attitude towards Local Environmental Issues point out to the urgency in strengthening Environmental Awareness among student-teachers. Field studies incorporating local issues and community-oriented projects should therefore be compulsory in the teacher education curriculum.

As there is significant difference in Environmental Awareness and in Attitude towards Local Environmental Issues between language and arts group and science group, the latter having higher mean scores, more opportunities to participate in environment related activities be provided to the former group.

To sum up, the magnitude of the local environmental issues which the investigators came across is more than that is being presented through statistical data from various sources. Therefore, prospective teachers must be oriented every year to carry out case studies on environmental issues of local significance and laws and regulations for environmental protection need to be strengthened with immediate effect.

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Key Management Issues of Forest - Invasive Species in India

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ABSTRACT

Management of Forest Invasive Species (FIS) is a priority issue under the Convention on Biological Diversity (1992) as they can proliferate and spread in the environment in ways, which can harm or are likely to harm ecosystems, economies, and human health. FIS are now the major focus of international conservation concerns and subject of cooperative international efforts, such as Global Invasive Species Programme (GBISP).

Intentional introduction of exotic plants including trees and shrubs are increasingly subjected to preliminary risk assessment for potential invasiveness. In this respect, a list of introduced, naturalized and invasive trees finds applications in forestry, ornamentals, urban forests, agro forestry and trees outside forests. Such a listing is prerequisite for any national or international biosecurity and plant protection strategy.

Currently, knowledge of invasive species and medicinal plants is particularly lacking for forest ecosystems although National Biodiversity Strategy and Action plan–India (NBSAP) has laid emphasis on the documentation of these species.

In this paper, an updated information on floral (weeds and plants) invasive species, impacts on different ecosystems as recorded at national level and their management is attempted The category of critically threatened species and their habitat due to FIS may be scheduled for priority action, and need coordination of regional measures to address transboundry issues through the development and implementation of regional framework. This support would be useful for policy makers, planners, developmental agencies, and all those having a stake in forestry to generate new ideas concerning the importance of assessment of FIS, requirements of research needs related to FIS and provide an insight to the current status of FIS in India.

Key words : Forest Invasive species (FIS), Conservation on Biological Diversity (CBD), Global Invasive Species Programme (GISP), National Biodiversity Strategy and Action plan – India (NBSAP), Quarantine, Exotic Plants.

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Introduction

Invasive species are the species that are non-native to a particular ecosystem and whose introduction causes, or is likely to cause, **economic** or **environmental harm.** Invasive species are characterized by rapid growth rates, extensive dispersal capabilities, large and rapid reproductive output and broad environmental tolerance.

Forest Invasive Species is damaging a number of natural or agricultural ecosystems, including native forests and their biological diversity. They are posing a danger to human health as well as to other human enterprises. Rapidly accelerating trade in forest-associated products, tourism, transport, and extensive travel over the past century have dramatically enhanced the spread of invasive species, allowing them to surmount natural geographic barriers. For example, *Parthenium* has invaded agricultural areas & forest areas (Goyal & Brahma, 2001), *Lantana* in forest areas (Chattorjee and Pakrashi, 1994) and *Eupatorium* in mountain ecosystems etc.

Forest Invasive Species are very crucial in the national context as the bioclimate of India is highly congenial for the alien species to invade into various landscapes and ecosystems. The invasive species are the biggest threat to biodiversity, after habitat destruction. There is a threat of cross hybridization of indigenous elements with alien elements, which might take on vigorous and gregarious dimensions. There is a gap in the knowledge on the biology, geographical distribution, genetic diversity and inter-crossing (hybridizing) potentials of the invasive alien species.

As per the, Commonwealth Agricultural Bureau International (CABI) global review, 2002 on the phenomenon of naturalization and invasiveness of forest tree and shrub species, out of **1121 tree species** reported to be introduced, naturalized or invasive in particular situations, **442** were reported as invasive forest trees (Haysom and Murphy, 2003).

As per the India Country Report on 'Stock taking of National Activities on FIS' submitted to the Asia Pacific Forest Invasive Species Network (APFISN) during October 2005, **61 species** of plants (including **12 species of fungi**) and **14 species** of insects have been identified as invasive having national distribution and **36 species** with regional distribution. About **28 plant species** are reported to be **native to India** but have taken invasive proportions in other bio-geographical regions of the country. However, for better understanding of the entire dimension involved, there is need to have a detailed scientific inventory of the FIS in India. (Forest Invasive Species ICFRE Publication, 2005).

Under the Convention of Biological Diversity (CBD), 1992, Governments are working together to take more aggressive measures to prevent alien species from **invading forest areas** in the first place and to **prepare a checklist of Forest Invasive Species,** at the national level. The Asia–Pacific Forest Invasive Species Network is constituted to build international consensus and develop strategies to reduce the threat posed by FIS and promote the exchange of information on the existing weeds and approach for combating the menace of such weeds and plants in forest ecosystem.

Management of FIS is a priority issue under the Convention on Biodiversity. Certain alien species such as *Lantana, Alternanthera, Eichornia and Euphorbia* are established / naturalized in our country and are being utilized / experimented for better use. There is an immediate need to look into the 'One time use' or sustainable use of these species. The better option might be eradication vis-à-vis 'One time use', thereby discouraging their further promotional aspects.

BCC Division, ICFRE, Dehradun is actively involved in collecting and compiling information on Forest invasive Species located in geographical domain of different Regional Institutes of ICFRE on Floral (weeds and plant) Forest Invasive Species, Entomological (insects) FIS, and pathogenic

(fungi) FIS of different ecosystems and their distribution at national and regional levels for its dissemination to all stakeholders, researchers, scientists and developing agencies. It would facilitate generation of new ideas concerning the importance of assessment of FIS and provide an insight to the current status of FIS in different agro-climatic zones of India. (Forest Invasive Species ICFRE Publication, 2005)

As the inventory / documentation of Forest invasive species – including pests, diseases, weeds and sometimes-certain tree species – have become the main focus of the Ministry of Environment and Forests, Govt. of India, an attempt has been made in this paper to update information on floral (weeds and plants) invasive species, its impacts in different ecosystems as recorded at national levels and their management.

1. The Indian Scenario on Weeds

India is one of the megabiodiversity countries in terms of flora and fauna. Many invasive species have entered into India accidentally. These species have the potential to cause enormous direct or indirect loss to ecosystems and threaten biodiversity and water availability. Some of the most **important noxious aquatic weeds** of alien origin in India are ***Salvinia molesta*** *(Salvinia)*, ***Eichhornia crassipes*** (Water hyacinth) and ***Alternanthera philoxeroides*** (Alligator weed), and terrestrial weeds like ***Opuntia* spp.**, ***Lantana camara***, ***Ageratina adenophora***, ***Chromolaena ordata***, ***Parthenium hysterophorus***, ***Leucaena leucocephala*** and ***Mikania micrantha.*** Most of these weeds have occupied such niches where chemical or mechanical control measures are neither feasible nor economic. These include forest areas, tea, rubber and other plantation crops, vacant or grazing areas and water bodies. Biological control offers effective and environmentally-friendly solutions to the problem of invading alien weeds. However, proper planning in the introduction of host-specific exotic bioagents to combat the alien invasive weeds is essential. The maximum degree of success in classical biological control has been achieved in aquatic weeds (55.5%), followed by terrestrial weeds (23.8%) (Singh, S.P. 1997).

The reasons for transmission of invasive species can broadly be classified into three categories: **horticulture, conservation, or accidental**. In some cases invasive species were simultaneously introduced for multiple purposes. However, when we look at the percentages of introductions, horticulture is the clear leader. Conservation organizations are not free of blame either. In the name of erosion control, windbreaks, and wildlife food and cover, conservation groups have brought many invasive species. Accidental introductions make up a small, but important sector of introductions.

Invasive species are distributed in different bio-geographical areas because of their very effective seed dispersal mechanisms that allow them to spread quickly over a large area. These mechanisms – wind, water, and birds, give them an advantage over many native species which employ ants, mammals or gravity to disperse their seeds. Many invasive plant species are also the first plants to leaf out in the spring, and the last to drop their leaves in the autumn. This "first and last" strategy gives invasive species an advantage, – they are photosynthesizing and storing up energy for reproduction and growth longer than most native plant species. Invasive species can compete with native plants and animals, displace them, consume them, act as parasites or transmit disease, reduce growth and survival rates, cause the decline or extinction of local populations or even entire species, and uproot or damage plants.

2. Major Floral Forest Invasive Species in India

Some of the invasive species are listed below:

2.1. Lantana camara is an obnoxious weed that has encroached most of the areas under community and reserve forestlands. The outer fragile Himalayas are almost

completely encaptured by this rapidly spreading weed. The weed not only ruins common agricultural and forestlands but also serves as hideouts for wild animals. This weed also makes shade as well as allelopathic impacts on the regeneration of important forestry species. Due to spread of *Lantana*, the yields of crops and pasture get reduced. The harvesting costs have increased manifold. Afforestation cost is also increased due to loss of stand and slower growth rate due to weed competition.

2.2. Parthenium hysterophorus weed is difficult to control as it seeds prolifically. Seed germinates readily and the plant tolerates a wide variety of conditions. The weed is a menace to agriculture because it has allelopathic effect and competes with pastures and reduces carrying capacity. The weed affects human and animal health by causing respiratory problems and severe dermatitis.

2.3. Eupatorium glandulosum is found in the temperate region of the south and the north; ecological disruption has given way to this weed. This weed spread fast and checks the regeneration of other species, particularly in Western Ghats, and has replaced the valued flora at places. It comes up in disturbed soil. In most of the goat-travelled path it comes up well; that is why it is locally known as goat weed. Since the plant has no local or commercial use, it has widely spread in denuded and forestlands.

2.4. Ulex europaeus was introduced to India from England and other European countries. It is a thorny shrub, naturalized in Nilgiri and Palni Hills, at high elevations. This species colonizes in grasslands and encroaches into shola forests. It invades watersheds, which supply a substantial amount of drinking water. It is threatening agricultural and grazing lands. Thickets are impenetrable to humans and have persistent thorny litter.

2.5. Acacia mearnsii was introduced in Western Ghats particularly in the Nilgiris to provide fuel wood to the rural people to save the Shola forests, which were degraded in the past by human activities. *A. mearnsii* was also planted in the tea gardens to provide shade to the tea plants but it has now covered most of the Shola forests and has become menace in the Nilgiri hills. Regeneration of Shola forest is affected due to profuse spreading of this tree.

2.6. Mikania micrantha is a perennial fast growing weed of Neotropical origin, has become a major menace in natural forests, plantations and agricultural systems in northeast and southwest India. It is a herbaceous climber invading, especially the young teak plantations. The survival of teak saplings is very much affected by the overgrowth of this weed.

2.7. Cytisus scoparius was introduced from the European countries into the Western Ghats for ornamental purposes but now it has become menace in the Nilgiri hills particularly in the Shola forest and in grazing lands. It reduces the regeneration of Shola species and invades the grasslands, thus decreasing the production of grass for the cattle in Nilgiris. This species is spreading fast in the areas disturbed by forest fires or biotic interferences.

2.8. Opuntia vulgaris is a succulent thorny shrub which, colonizes the dry deciduous forest areas and the rain shadow portions of the Western Ghats and the Eastern Ghats. The plant is native to America, but naturalized in many parts of India.

2.9. Prosopis chilensis is a small thorny tree, with spreading branches. The species is commonly found in plains of Tamil Nadu and Andhra Pradesh and has spread to dry deciduous forest areas. *P. chilensis* is native of South and Central America and widely naturalized in tropical Asia.

2.10. Euphorbia royleana comes up profusely and has covered thousands of hectares of land in the Himalayan zones. This plant is shifted to a desert environment. Being cactus in habit, it has no role in conserving soil. Similarly, in this zone there

are other plants viz. *Artemisia vulgaris*, *Carrisa carander* and *Dodonea viscosa*, which have also become weeds and have large areas under their control. *Cannabis sativa* weed has spread to most of the deforested and community lands, complicating land management. Beside the above, unabated free grazing and intense human activities have led the way to many other plant species having no use in supporting ecology and economy of the region. These are *Agave catula, Ageratum conizoides, Cassia tora, Clerodendron viscosum* etc.

3. Measures to Prevent Introduction of FIS

It is now widely known that due to lack of proper information, man has introduced many exotic trees and shrubs under the lure of fast growing species. This has not only changed the socio-economic structure of the local communities, but also influenced the entry of invasive plants, which because of wide ecological amplitudes has overpowered the native vegetation. Therefore, some immediate actions are needed to control the explosion of invasive species which are summarised below :-

3.1. Pre-activity Invasive Plant Survey: An invasive plant survey should be completed prior to the commencement of any land-disturbing activities to identify potential problem areas. Sites with invasive plants identified on them should be made note of in order to alter practices to limit their spread (e.g. control prior to land disturbance, cleaning of equipment and materials before leaving the site). As the pre-activity invasive plant survey acts as a base-line for potential infestations, a follow-up survey should also be undertaken to assess the invasive plant spread as a result of the pre-activities.

3.2. Limiting Soil Disturbances: Unnecessary soil disturbance should be avoided to prevent establishment of invasive plant infestations.

3.3. Immediate Re-vegetation of Disturbed Sites: Re-vegetation of the area with an approved species in a timely manner, should be done to check the establishment of invasive plants on disturbed ground.

3.4. Use of Certified "Weed Free" Seed for Re-vegetation of Disturbed Sites: Application of virtually invasive plant free seed mix needs to be ensured. This can be achieved by using "Certificate of Seed Analysis" methodology. In which, rather than using the typical 25 gm sample to confirm the validity of the sample, request should be made to the supplier for the analysis of a larger seed sample. Alternatively, one can start with pure seed and then prepare the seed-mix manually.

3.5. Clean Equipment and Materials: It should be ensured that all equipment, materials and vehicles are free of invasive plant seeds and plant parts before arriving on site. All agricultural implements or any equipment potentially exposed to invasive plants must be cleaned, prior to use. Also equipment, materials and vehicles exposed to weeds are to be cleaned, prior to leaving the plantation site.

3.6. Use of "Weed Free" Hay Bales for Erosion Control and Feed: The use of straw bales for erosion control is discouraged. Unlike hay, it is very difficult to determine if the straw bales are free of invasive plant seeds. Therefore, certified "weed free" hay bales acquired from producers with a "Certificate of Inspection" should be used for erosion control. Hay imported for feed should as well be certified "weed free."

3.7. Early Detection and Eradication: Continuous monitoring for early detection and eradication of invasive plants is essential through proactive approach. To do this effectively, field staff should be trained in the identification of restricted and noxious invasive plants, collection of survey information, and the importance of destroying individual invasive plants and reporting new infestations in a timely manner.

3.8. Limit Seed Introductions in Fill: Prior to the movement of the material, inspection should be done for gravel pits, soil stockpiles or other fill sources to ensure the product has a low risk of introducing invasive plants.

3.9. Incorporate Invasive Plant Management in Planning Phase: Invasive plants should be considered in all operational plans to ensure effective and efficient management. Effective invasive plant management plans incorporate education, survey, control, and prevention.

3.10. Communication: Communication between various stakeholder and Provincial Municipal and Government agencies is beneficial to transfer information promoting regional awareness. Information such as the invasive plant history of certain locations or invasive plant infestation locations may be beneficial to all parties.

3.11. Education and Awareness: Invasive plant education and awareness programs developed co-operatively or individually by companies and agencies are essential in order to put the above preventive measures into practice.

4. Common Methods of Weed Control

4.1. Mechanical: Mechanical control measures involve hoes, cultivators, harrows, rotary weeders, discs, ploughs, scythes, mowers and so on. With these tools, the weeds are physically lifted from the soil, cut off or buried.

4.2. Chemical: This is one of the most common methods employed for control of FIS. Most chemicals are species specific though their use might not always be desirable due to environmental degradation and pollution that they often cause.

4.3. Tillage: Tillage helps in the burial of most small annual weeds. If all growing points are buried, most annual weeds will be killed. Tillage also disturbs the rooting system of most of the perennial weeds. The root system is cut enough so that the plant dies from desiccation before it can re-establish its roots. In moist soils or if it rains soon after tillage, the roots may quickly re-establish themselves. In effect, one may transplant the weed with little or no injury. Mowing is effective on tall growing plants. Tall annual weeds are mowed or scythed to reduce competition with crop plants and to prevent seed production.

4.4. Crop Competition: Crop competition is one of the cheapest and most useful methods that farmers can use. It amounts to using the best crop production methods so favorable to the crop that weeds are crowded out. Actually competition makes full use of one of the oldest laws of nature-"Survival of the fittest". Weeds compete with crop plants for light, soil moisture, soil nutrients and carbon dioxide. Early weed competition usually reduces crop yields far more than late season weedy growth. Therefore, early weed control is extremely important. Late weed growth may not seriously reduce yields, but it makes harvesting difficult, reduces crop quality, and rein fests the land with seeds and harbours insects and diseases.

In planning a control programme, it is important to know the weed's life cycle. Possibly the cycle can be interrupted with an easy but very effective control. In crop production, this may be a shift in planting date or a well-timed chemical spray, thus affording the crop an upper hand or competitive advantage.

Smothering with plastics, tar, paper, straw, saw dust or any other similar material is largely a matter of competition for light. Most weed seedlings cannot penetrate the thick coverings and are killed due to lack of light.

4.5. Crop Rotation: Certain weeds are more common in some crops than in others. Besides the annual weeds, for the parasitic weeds such as Striga in sorghum and Orabanche in tobacco, the hosts should be the crop grown. Rotation of crops is an

efficient way to reduce weed growth. A good rotation for weed control usually includes strong competitive crops grown in each part of the rotation. In growing mixed crops as in the tropics, the weed problem is eliminated to a greater extent in most of the irrigated crops.

4.6. Biological Control: In biological weed control, a 'natural enemy' of the plant is used which is harmless to the other desired plants. Insects or disease organisms are the usual natural enemies. Also, parasitic plants, selective grazing by livestock and highly competitive replacement plants are other forms of biological control. The outstanding example of biological weed control is Cactus (*Opuntia spp*.) with a moth borer *Cactoblastic cactorum* and or *Lantana camara* with several kinds of caterpillars and a fly, which damages the berries. Researches have located and tested numerous biological agents against *Parthenium* weed. These have included a gall-forming moth, leaf minor, weevil, beetles and a rust fungus.

5. Control Measures Undertaken for Major Forest Invasive Species in India

5.1. *Lantana camara:* Various attempts viz. mechanical, biological and chemical for control and eradication of this weed have been tried in the past. All these methods have proved costly and partly successful.

5.1.1. Biological Control: A survey of the natural enemies of *Lantana camara* yielded 148 species of insects but only *Lantanophaga (Platyptilia) pusillidactyla* (pterophorid) was of some importance. However, *L. pusillidactyla* has a number of natural enemies, which impaired its effectiveness. A polyphagus scale insect viz. *Orthezia insignis* (Brown) has been recorded suppressing the Lantana population in many parts, but it cannot be used as it attacks a number of economically important forest trees.

Another insect *Teleonemia scrupulosa* was imported from Australia in 1941 by Forest Research Institute, Dehra Dun. After host specificity tests, the insect was declared unsafe owing to its feeding on Teak (*Tectona grandis L.)*, a valuable timber tree, hence the whole culture was destroyed in 1943. However, in 1951 it was recorded from Dehra Dun and the subsequent surveys showed its presence up to the distance of 40 km from the point of the escape. It was further reported to kill *Lantana* in Bhimtal, Nainital, U.P. In 1976, *T. scrupulosa* was reported infesting *Lantana* at various locations in Karnataka and Tamil Nadu, although no case of complete death was recorded. Subsequent observations have also shown that inspite of defoliation by this insect the plants were not killed.

For biological suppression of *Lantana*, *Diastema tigris* Guenee, *Saliba* (Syngamia) *haemorrhoidalis* Guenee and *Uroplata girardi* Pic. (origin: Mexico) have also been introduced. Similarly *Epinotia lantanae* (Busck) has established in certain pockets of South India. *E. lantanae in* combination with *Octotoma lantanae* affects 95% of the fruits of *Lantana* in Bangalore.

5.1.2. Chemical Control: To eradicate *Lantana* a series of experiments with different chemicals were conducted. The experiment was conducted by R. C. Ghosh , during 1980 at Forest Research Institute, Dehra Dun. Twenty five treatments comprising of different concentrations of weedicides, namely Tordon 10 K, Tordon 22k, Brush Killer 64, Weedone concentrate 48 and 2, 4, 5-T 20 percent Amine were tried in split plot design with three replications for eradication. It was found from the results that application of different concentrations i.e. 10 lit / ha., 5 lit / ha and 3 lit / ha of Tordon 22k and 10 Kg. / ha of Tordon 10 K completely killed Lantana weed followed by Tordon 155 @ 10 lit / ha and Brush Killer 64 @ 10 lit / ha.. Tordon 22K @ 3,5,10 lit/ ha., Tordon 10 K @ 10 Kg / ha. and Tordon 155 @ 10 lit / ha are recommended. The research findings were implemented in the various forest types of India and in plantations.

5.1.3. Mechanical Control: The Forest Operation Unit of Silviculture Division, FRI, has developed a series of tools for mechanical

eradication of *Lantana*. The tools were Stalk Puller (Light and Heavy duty). The uprooting of Lantana by these tools was found to be efficient and economical with involvement of less labour. Various forest officials of the country were trained in handling of the tools.

5.2. *Parthenium hysterophorus*

5.2.1. Biological control: During the last few years much emphasis has been given to control *Parthenium* through various biological agents like pathogens, insects and plants.

5.2.2. Control by Insects

a) Indigenous Insects

Many insects like, mealy bugs, aphids and grasshoppers have been reported feeding on *Parthenium* as an alternate host. A stem-boring scolytid beetel, *Hypothenamus erudistus* was reported to cause widespread damage to *Parthenium* in 1979. *Oberea* spp. has also been found to kill this weed significantly. Severe attack of a cerambycid *Leptrocentrus taurus* (F.) and a scale insect *Orthezia insignis* (Brown) were reported from Mysore and Bangalore, respectively (Joshi, S. 1991)

b) Exotic Insects

In 1983 a Chrysomelid beetel *Zygogramma bicolorata* was imported from Mexico. Both the larvae and adults caused severe defoliation of Parthenium and encouraged the growth of vegetation formerly suppressed by this weed. The beetle has spread to Haryana, Punjab, Karnataka, Madhya Pradesh, Tamil Nadu, Himachal Pradesh and Andhra Pradesh.

5.2.3. Mechanical Control: Recently, Silviculture Division, F.R.I. has conducted experiments on preparation of compost from *Parthenium* weed. The compost was prepared by Barkley & Indore process and it was proved to be successful in eradicating carrot weed from the area.

5.2.4. Chemical Control: The following chemicals were tried to eradicate *Parthenium*.

❖ **Gramoxone:** *Parthenium* can be killed by application of 2-3 litres / ha.

❖ **2-4 D Ethyl Easter:** The chemical spray @ 0.2% in water proved to be the best treatment for killing of *Parthenium*. This application proved to be most effective.

❖ **Ammonium Sulphate:** It was found that spray of 20% of chemical in water has killed the weed.

5.2.5. Control by Utilization: *Parthenium* has been well documented for its insecticidal, nematicidal and herbicidal properties and biogas production. It increases the rate of decomposition of cowdung. Methane production is possible from Sodium Hydroxide (NaOH) treated *Parthenium*.

5.3. *Opuntia* spp.

5.3.1. Biological Control: The first outstanding success in biological control in India was achieved when *O. vulgaris* was controlled in Central and North India by introduction of the Mealy bug (*Dactylopius ceylonicus*) from Brazil. This, of course, was not a deliberate attempt as *D. ceylolicus* was mistaken for the true cochineal insect *Dactylopius coccus* Costa and was introduced for commercial production of cochineal dye. But the potential of classical biological suppression was established by using the insect to control the weed. The area became fit for cultivation within five to six years. *D. ceylonicus* being restricted to *O. vulgaris* proved a failure when introduced and distributed in South India to suppress *O. stricta* var. *dillenii* (Haw). In 1926, *D. opuntiae* (a North American spp.) was imported from Sri Lanka and its colonization resulted in spectacular suppression of *O. stricta* and related *O. elatior* Mill. More than 40,000 ha area was thus cleared.

5.4. *Mikania micrantha*

5.4.1. Biological Control: Biological control causing a host specific thrips, *Liothrips*

mikaniae from Trininad was tried without much success.

5.4.2. Chemical Control: The treatments of 1.2 kg gramaxone, 0.8 kg gramaxone+1 kg 2, 4-D amine / ha significantly reduced the growth of Mikania. Control of 50-60% weed was noticed 2-3 days after spraying of gramaxone and 2, 4-D amine. There was no further growth of the weed up to 80 days after spraying.

6. Conclusion

Forest Invasive species (weeds and plants), due to their inherent properties of efficient nutrient uptake, easily invade disturbed lands, and adversely affect the ecosystem. They, thus, pose a serious challenge to sustainable management of forests along with agricultural ecosystems and conservation of biodiversity. Although several methods including biological, chemical have been attempted from time to time to control these species, no single method has been found effective on sustainable basis. On the basis of this information, it could be concluded that:

❖ There is a strong need for better environmental education and greater accountability for sectors that are responsible for the introduction of invasive species. The Government of India needs to officially designate the State Forest Departments and ICFRE Institutes as authorities for monitoring, control of FIS and implementation of import / export controls from forest, national parks and other protected areas.

❖ A national inventory and assessment of invasive and potentially invasive species needs to be made to create a database and to determine the status of their threat to the country.

❖ Effective communication systems among the local institutions responsible for specific tasks relating to the management, monitoring and eradication of invasive species should be established.

❖ An Action Plan on how participating institutions can effectively contribute to an "Invasive Species Monitoring Programme" should be developed.

❖ Local resources and sources of funding to enable participating institutions to effectively implement proposed invasive species activities should be identified.

❖ Local institutions should be aware of which invasive species are in our neighboring countries and devise ways to detect their presence and prepare eradication strategies.

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Studies on Environmental Awareness in School Students from Aurangabad City

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ABSTRACT

This paper deals with studies on environmental awareness among school students of different media, from the Aurangabad city. To study the environmental awareness level, students of IXth class were selected from six schools with different media of instruction. (Marathi, English & Urdu).

A preliminary survey was conducted for selecting the six schools for the present investigation. Questionnaire method was adopted based on the syllabus for compulsory environmental education, as per the directives of the Honorable Supreme Court. Answers given by the respondent students are converted into True or False form. The comparative environmental awareness level in students from the selected schools in percentage was calculated by using CEA formula.

The results obtained from the present study reveal that environmental awareness level in students from English medium schools, have the maximum awareness level, whereas the level of awareness in students of Marathi medium have moderate awareness, as compared to students from Urdu medium with minimum level.

Key words : Environmental awareness, Education, Schools, Questionnaire, Comparative Environmental Awareness (CEA).

Introduction

In the modern age of development with the progress of industrialization, urbanization and adoption of modern technologies in agriculture, environmental problems have become a concerning issue for human society.

By considering the importance of environmental conservation, most developed countries also have included the issues of environmental protection in their political agenda.

It has been widely accepted that to conscientious the human society about the environmental issues and to make perspective plans for mitigation of environmental problems, environmental education is an important tool through which the goals for awareness can be achieved easily.

Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, to aware of how to help solve these problems, and motivate to

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work towards their solution (Stapp *et.al*. 1969). The subject of environmental education has been discussed at several national and international seminars, workshops and conferences (Sharma, 1996).

Environmental education acts as an indispensable tool in the battle against the degradation of the living environment. It has an appeal to launch *an international environmental education Program (*United Nations, 1972*).*

Along with the adoption of modern eco-friendly technologies to minimize the stress of human activities on environment, for the protection and conservation of the environment of the globe, environmental education plays an important role. However, it plays a crucial role in the process of sustainable development also. (Tbilisi Declaration, 1977, RIO, 1992, Montreal, 1997).

There is a paramount need to create a consciousness of the environment. It must permeate all ages and all sections of society, beginning with the child. Environmental consciousness should be inculcated into teaching in schools and colleges (NPE, 1986).

Environmental education is a key to the success of any overall environmental strategy, determined to help in the setting up of a Center of Excellence in Environmental Education, to play the vital role of setting the pace and agenda for Environmental Education in the country (Kartikeya, 2000).

In India, the Supreme Court in their judgments of writ petitions (M.C. Mehta Vs Union of India, 1991; M.C. Mehta Vs Union of India, 2003) has directed for the urgent need for environmental education. The Supreme Court Bench had issued an order on November 22, 1991 to all state governments, and to the State Education Boards, to make environmental education, a compulsory subject (*India times,* 2003).

The Supreme Court issued notice to some of the country's key educational bodies and State Governments for negligence in the implementation process of environment, as compulsory subject. The Court fined Rs. 15,000/- to ten States, including the Maharashtra State for such a failure. The government of Maharashtra directed the Secondary and Higher Education Board to adopt environmental education as a compulsory subject for school students (GOM, 2003).

The Supreme Court *inter alia,* directed the NCERT to take appropriate steps to prescribe a course on environment and to consider the feasibility of making environment a compulsory subject at the school level. In pursuance of this, the NCERT framed the syllabus and incorporated environment education as compulsory subject from IXth to XIIth standards. In this regard Maharashtra Government implemented the environment education from the academic year 2005 – 2006 for the IXth class, 2006 - 2007 for the Xth and XIth, 2007 – 2008 for the XIIth class (Mehta, 1991, MSSHEB, 2005).

The marks distribution pattern for this compulsory environment education, i.e., 60 marks for theory and 40 marks for field work / project, and the marks obtained by the students are incorporated in the mark sheet. While in the primary implementation stage some changes have been introduced and the examination pattern also was changed, i.e., it was decided that instead of by the Board, the examination will be conducted at the school level itself. (MSSHEB, 2006).

However, considering the workload for teaching this compulsory environment education, prescribed qualification for the teacher to teach the environment education in school, two lectures per week for this subject and no need of a separate qualified teacher from the principle subject (i.e., Environmental Science) were adopted. (MSSHB, 2007).

Hence, by considering the vision of the Honorable Supreme Court to make environmental education as a compulsory subject, and the lacunae in policy decisions during the implementation phase of this subject, the present study has been undertaken to study the environmental awareness level among students of some selected schools from the Aurangabad city.

Materials & Methods

Aurangabad is the headquarters of the Marathwada region of the Maharashtra State. There are good numbers of educational institutions such as schools, colleges, and a university etc. in the Aurangabad city.

Six different schools viz. Bal Dyan Mandir High School Khadkeshwar and Zilla Parishad High School Behind Z.P. Office for Marathi medium, Little Flower High School in Cantonment Area and Christ Church High School near Milind College for English medium and Indira Gandhi Urdu Girls High School in Sabji Mandi and Maulana Azad High School, Near Aurangabad Municipal Corporation for Urdu medium were selected for this awareness study (Table No. 1).

The questionnaire administered includes ten different questions based for the syllabus of the compulsory environment education, for IXth class. Objective type of questions, with four options for each question was given, and the medium of the questionnaire is the same as the medium in the school.

The percentage of environmental awareness in students was calculated on the basis of True Answers (TA) and False Answers (FA) given by the respondent students.

$$TA\ (\%) = \frac{STA \times 100}{SRQ}$$

Where, TA = True Answer, STA = Number of students who given as True Answer, SRQ = Total number of students that have responded to the Questionnaire.

$$FA\ (\%) = \frac{SFA \times 100}{SRQ}$$

FA = False Answer, SFA = Students given False Answer, SRQ = Students Responded to Questionnaire.

The Comparative Environmental Awareness in percentage of six different schools selected from the city, for the present investigation was calculated.

$$CEA\ (\%) = \frac{TATQ}{10}$$

Where, CEA = Comparative Environmental Awareness, TATQ = Total Answer of Ten Questions.

Results and Discussion

To study the awareness levels in school students from the Aurangabad city, the name of selected schools, medium of teaching, total number of students in each division, total number of students in class who responded to the questionnaire were summarized in (Table No. 1). The environmental awareness in school students from selected schools in percentage, based on the answers given by the students in the True and False form for the questions provided in questionnaire were summarized in (Table No. 2). However, the comparative environmental awareness level in percentage, in students were summarized in (Table No. 3 and Fig. 1 and 2).

The maximum percentage of True answers given by respondent students was 100 and minimum 2 in the Little Flower High School and Maulana Azad Urdu High School, respectively. Whereas, the percentage of awareness level in students of False answers ranges from 16 to 92 and 0 to 45.

However, the results of comparative percentage awareness level in students from the selected schools of different media reveals that the maximum percent level of 94.1% was observed in the Little Flower High

School i.e., from English Medium, 52.1 % in Bal Dyan Mandir High School from Marathi medium and 68.3 % in Indira Gandhi Girls Urdu High School, whereas minimum was observed at 21.3 % in Maulana Azad Urdu School and moderate in Chirst Church High School.

Conclusion

The results obtained from present study reveals that, the students of English medium schools have comparatively the maximum environmental awareness level, whereas the students from Marathi medium having moderate awareness about environmental aspects as compared to students from Urdu medium, with minimum awareness level.

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Fig.1: Comparative chart of Environmental Awareness (%) in students of three different medium schools.

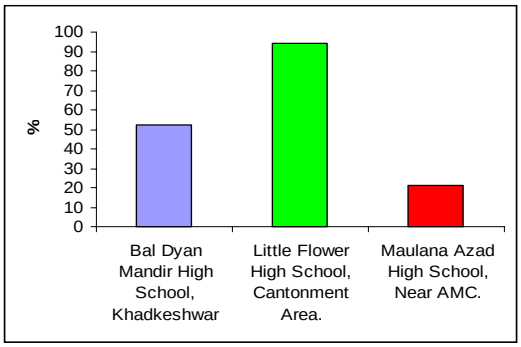

Fig.2: Comparative chart of Environmental Awareness (%) in students of three different medium schools.

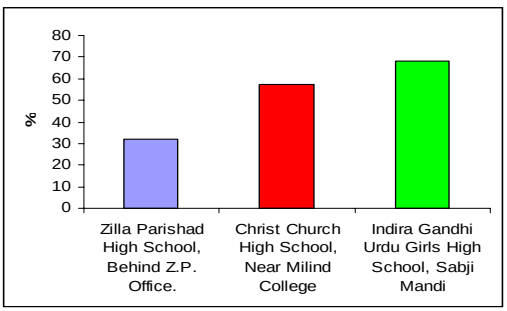

Table No. 1: List of schools selected to study the Environmental Awareness in students.

Sr. No.	Name of School	Medium	Total No. of Students in Class	Total No. of Students in Class responded
1.	Bal Dyan Mandir High School, Khadkeshwar.	Marathi	60	54
2.	Zilla Parishad High School, Behind Z.P. Office.	Marathi	40	27
3.	Little Flower High School, Cantonment Area.	English	70	57
4.	Christ Church High School, Near Milind College.	English	39	29
5.	Indira Gandhi Urdu Girls High School, Sabji Mandi.	Urdu	50	37
6.	Maulana Azad High School, Near AMC.	Urdu	84	62

Table No. 3: Comparative statement of Environmental Awareness (%) in school students.

Sr. No.	Name of School	Awareness in %
1.	Bal Dyan Mandir High School, Khadkeshwar	52.1
2.	Zilla Parishad High School, Behind Z.P. Office.	31.9
3.	Little Flower High School, Cantonment Area.	94.1
4.	Christ Church High School, Near Milind College	57.3
5.	Indira Gandhi Urdu Girls High School, Sabji Mandi	68.3
6.	Maulana Azad High School, Near AMC.	21.3

Table No. 2: Environment Awareness (%) in school students from Aurangabad City

Sr. No.	Name of School	No. of Questions in Questionnaire provided to school students																			
		1		2		3		4		5		6		7		8		9		10	
		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F
1.	Bal Dyan Mandir High School, Khadkeshwar.	88	12	36	64	13	87	49	51	49	51	94	6	48	52	42	58	8	92	94	06
2.	Zilla Parishad High School, Behind Z.P. Office.	22	78	14	86	11	89	55	45	7	93	48	52	52	48	48	52	7	93	55	45
3.	Little Flower High School, Cantonment Area.	95	5	96	4	90	10	95	5	98	2	84	16	93	7	99	1	91	9	100	-
4.	Christ Church High School, Near Milind College.	68	32	58	42	24	76	26	74	58	42	68	32	62	38	63	37	63	37	83	17
5.	Indira Gandhi Urdu Girls High School, Sabji Mandi.	70	30	84	16	59	41	81	19	43	57	66	34	78	22	67	33	54	46	81	19
6.	Maulana Azad High School, Near AMC.	00	100	2	98	1	99	47	53	3	97	13	87	87	13	6	94	1	99	53	47

Note :i) T – True & F – False. ii) All Figures in table are in %

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