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Environmental Impact Assessment : Some Considerations on Evaluation of Flora - An Overview

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Environmental impact assessment (EIA) attempts towards predicting and assessing impacts of a developmental project on environment in total. Its role as an effective tool in mitigating these impacts by suitably modifying the project or developing environmental management plan (EMP) was underlined in the article 14 of the biodiversity convention. The author reviews the existing procedure of how EIA is being carried out in India and makes some proposals for consideration in execution exercises. These are based on the floral evaluation, one of the environmental components in impact assessment. Consultancies which generally undertake EIA studies have neither adequate access to literature nor can assess it with objectivity. These assessments are based on scanty information leading to vague impact predictions and failure in making suitable mitigation proposals. In India, different resource surveys (Botanical, Zoological, Anthropological, Forest, Archaeological and Geological Surveys) have well spread organisational set-up in various geographical zones and can involve themselves more directly in such jobs as inventorying different resources is their primary mandate. Environmental impact assessment groups, drawn experts from the above resource surveys, pollution control agencies and other related subject areas should help in scoping various environmental components with reference to project to clearly define the extent of investigation needed. Resource surveys should strive to develop organised databases where exploration surveys completed, so that, these be used for rapid assessments. Data eptimisation, formatting and retrieval may be made through programmes of environmental information systems. The literature related to floral evaluation is presented to elaborate limitations and options available. The desirability of direct participation of all the resource surveys is emphasized to reduce voluminous nature of the EIA documents simultaneously enhancing the objectivity of the exercise.

Key words: Aquatic macrophytes, Endangered species, Endemic plants, Ethnobotany and Mangroves

Background

Developmental activities invariably have an impact on the environment. While Government (Central or State) attaches high priority to the timely execution of developmental projects, it also desires that such development does not result in erosion of natural resources. The exercise of Environmental Impact Assessment (hereafter EIA) evolved in mid-seventies in the developed countries, has become an effective tool to assess the impacts of developmental projects. It is now realised that developmental goals and environmental aspirations have to be reconciled without conflict and the exercise would reinforce and enhance the benefits derived from projects.

EIA and Biodiversity Convention

Article 14 of the Convention on Biological Diversity calls for contracting parties to introduce appropriate procedures to assess the environmental impact of proposed developmental projects, programmes and policies. This article in the convention is designed to avoid or minimise adverse impacts

of development on biodiversity (Annexure I). The Govt. of India under Schedule I of EIA notification (Jan. 1994) lists 29 projects which require environmental clearance when investment exceeds 50 crores. These can be broadly categorised under 9 groups. 1. Industries 2. Mining 3. Thermal power plants 4. River valley 5. Harbours and Airports 6. Communication 7. Atomic energy 8. Transport (Railroad, Highway) and 9. Tourism (including hotels, beaches). Some industrial activities where the investments are relatively less also require clearance as these activities are considered hazardous even at minor scale. These are pesticides, bulk drugs and pharmaceuticals, asbestos, asbestos products, integrated paint complex including manufacture of resins and basic raw materials required in the manufacture of paints, distilleries, raw skins and hides, dyes, foundries and electroplating.

Under the same notification, certain areas were designated as ecologically sensitive/fragile and developmental projects (irrespective of their listing under schedule I) proposed in these areas need environmental clearance from the central government. They include identified coastal areas (under coastal regulation zone notification) and forests, wildlife sanctuaries, national parks, biosphere reserves, wetlands and mangroves.

Preparation of EIA reports

The assessment of environmental impacts with reference to a project is not always a straight and routine exercise. The entire exercise is to be evolved carefully drawing suitable methodology, apportioning jobs to qualified experts and compiling the relevant documented information. In India, the responsibility of the EIA study rests with the developer who employs

Annexure I

Article 14 states:

1. Each contracting party, as far as possible and as approriate, shall
   - (a) Introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse impacts on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures;
   - (b) Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account;
   - (c) Promote, on the basis of reciprocity, notification, exchange of information and consultation on activities under their jurisdiction or control which are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, by encouraging the conclusion of bilateral, regional or multilateral arrangements as appropriate;
   - (d) In the case of imminent or grave danger or damages originating under its jurisdiction or control, to biological diversity within the area under jurisdiction of other States or in areas beyond the limits of national jurisdiction, notify immediately the potentially affected States of such danger or damage, as well as initiate action to prevent or minimise such danger or damage; and
   - (e) Promote national arrangements for emergency responses to activities or events, whether caused naturally or otherwise, which present a grave and imminent danger to biological diversity and encourage international cooperation to supplement such national efforts and, where appropriate and agreed by States or regional economic integration organisations concerned, to establish joint contingency plans.
2. The conference of parties shall examine, on the basis of studies to be carried out, the issue of liability and redress, including restoration and compensation, for damage to biological diversity, except where such liability is a purely internal matter.

consultants to undertake this study and prepare the report. Consultancies, in majority cases, play down the impacts on vegetation in the interest of the proponents and in order to obtain administrative consent. This lead to some EIA reports appearing to be more formal documents required in the clearance process rather than objective assessments of environmental impacts of the proposed project. Other difficulties with assessment and evaluation include:

- EIA documents are prepared under different sections (different environmental components) by different persons without much interaction. Generally the nature and extent of impacts of a project are to be clearly stated by project proponents against which each environmental component is to be analysed for impact assessment. But assessments are made based on general perceptions of the impacts of the project.
- Secondly, literature evaluation by a hired agency lacks objectivity. For example, a majority of EIA reports under flora evaluation contain long lists of names of species including synonyms and basionyms, without knowing exactly what these names are referred to. Many reports miss to indicate / isolate significant floral elements such as endemic and endangered elements or plants having greater significance to local populations. Moreover, plants that come under special groups such as aquatic species, mangroves, sea grasses etc (when come under project area) or their critical habitats are least discussed. The finer aspects such as genetic diversity which is reflected in population variability in a given area cannot be easily picked up as it needs prior experience in plant survey along with clear knowledge of distributional pattern of the said species under consideration. The reports produced become voluminous without objectivity or any consequence.
- Lastly, the experts evaluating the report neither have coordination among themselves and are to relay on the write-ups, and their involvement commences only at the evaluation stage of the report and can do little except giving some disjointed suggestions as for the improvement of assessment document.

These omissions can be avoided by systematising or reviewing the entire process of execution. Permanent environmental impact assessment groups may be drawn from different resource surveys. The different environmental components and the number of parameters in each component to be studied with reference to project may be thoroughly screened through exhaustive discussions among members of this group and by a scoping meeting prior to undertaking EIA exercise. This helps in identifying the major project related issues to be addressed to and in defining the tasks. Personnel of resource surveys and pollution control agencies may take up these defined tasks as they are better equipped in executing such jobs. Reports prepared that way can even avoid further scrutiny by the licensing agency. The author finds support to his view point by elaborating the subject areas which have a bearing in the evaluation of floral component and explains limitations and problems as for the literature is concerned in this process.

Stages in Flora Evaluation

The exercise of floral evaluation involves 4 stages namely, 1) Baseline data collection, 2) Impact identification, 3) Impact evaluation on flora and 4) Preparation of environmental management plan.

Baseline Data Collection

Baseline data collection establishes status of a region with reference to flora. It involves collection of information from previous surveys followed by undertaking field surveys where

additional information is required. Considerable information exists in floras, checklists and in revisionary studies. These are reports of description, relatedness, and occurrence of various species in different areas. The Botanical survey possess this information on states, districts and some protected areas. This information was recently reviewed(Venu 1998). The data obtained from such sources are to be analysed and discussed to prepare species lists. Species lists as such are of limited value unless assessment is made with regard to conservation value of each species within the impacted area. Justification of the conservation of species and their habitats can be made on various grounds such as plants of ethnobotanical and economic significance, endemism, threatened status and population variability in a species. In the evaluation, much information can be drawn from different subject areas which are discussed below for the assessment of floral diversity in a given project area.

Ethnobotany

Ethnobotany deals with study of botany with anthropocentric orientation and gathers information on plants and their uses. India has all the three elements that contribute to the ethnobotanical richness - floristic diversity, ethnic diversity and rich tradition (Jain 1994). The unique and diverse flora is matched by the existence of 53 million tribal people in India belonging to 550 communities. Two third of the total tribal population live in central India in the states of Madhya pradesh, Orissa, Bihar, Gujarat and Rajasthan. The tribal population is over 79% of the total population in N.E. Indian states of Meghalaya, Nagaland, Mizoram and Arunachal pradesh (Pushpangadan 1992). EIA on floral diversity has relevance to the tribals as they depend upon plant resources and also sustain through their cultural relationships with biodiversity. These bonds are life supporting in contingent situations. EIA requires to give careful consideration to the impacts of the proposed projects on local communities when access to these resources is altered through projects. The study should include an analysis of existing benefits and their costs if diminished or lost, and compare these with the benefits expected from project. These aspects can be better elicited by drawing data on (i) lists of products used (ii) species locations with maps (iii) seasonality of products (iv) estimates of amounts harvested (v) amounts sold in market (vi) perception of product availability (vii) priorities of communities with regard to these products and their habitats. Research papers of Janaki Ammal (1956) and Jain (1963,1965) triggered ethnobotanical studies in India and the institutes involved in ethnobotanical research since 1960s include Botanical survey of India, Calcutta; Regional research laboratory, Jammu; Central drug research institute, Central institute of medicinal and aromatic plants and National botanical research institute, Lucknow and Central council for research in Ayurveda and Sidda, New Delhi. In the early 80s, the Botanical survey of India in collaboration with CSIR and over a dozen institutions initiated documenting of ethnobotanical information under an "All India coordinated programme on ethnobotanical research". During this time a society for ethnobotanists was established (1982) and a journal,"Ethnobotany" (1989) was launched to publish findings of ethnobotanical research. All these efforts lead to numerous publications from various states and completion of 80% documentation in the country. These papers were reviewed by Jain et al.(1984). Papers published thereafter were reviewed by Binu et al. (1994). Jain (1991) compiled data on 2500 plants from nearly 400 publications and published in the form of a dictionary. This work provided botanical name, local name, botanical description, the flowering and fruiting periods and folk names with details of dosage. Other notable publications from this author include Glimpses of Indian ethnobotany (1981) and Methods and approaches in ethnobotany (1987). A brief summary of some important reports

from different geographic regions is presented here.

Food and drinks: Access to a wide variety of edible forest products results in diverse diet in rural societies. Edible tubers, rhizomes, leaves, fruits, seeds from nearby forests in different seasons supplement food requirements. Edible tubers of *Chlorophytum tuberosum, Dioscorea* spp., *Pueraria tuberosa, Solena heterophylla*; corms of *Amorphophallus paeoniifolius* and *Arisaema tortuosum;* rhizomes of *Costus speciosus, Lasia spinosa* ; young leaves of *Aerva lanata, Ampelocissus latifolia, Ardisia solanacea, Begonia picta, Cayratia pedata, Derris scandens, Justicia glauca, Portulaca oleracea, Rivea hypocrateriformis* and fruits of *Aglaia elaeagnoidea* var. *beddomei, Ampelocissus tomentosa, Cordia dichotoma, Gardenia latifolia, Melastoma malabathricum, Polyalthia cerasoides, Syzygium operculatum* var. *obovatum, Uvaria hamiltonii* supplement food requirements of tribals of Andhra Pradesh (Ramarao & Henry 1996). In the border districts of Orissa and Andhra pradesh wild mangoes are collected by Savaras to make a kind of porridge, from the kernels of mango. Seeds of *Tamarindus indica* and powdered pith of *Caryota urens* are also used for the above purpose. Manilal (1981) reported 26 primitive varieties of rice used by triblals of Malabar. Roy et al. (1956a, b) studied the diet habits of Gonds of Madhya pradesh and listed 50 common wild plants used by them. The 'Ippa' (*Madhuca longifolia* var. *latifolia*) is a much prized tree all over central India, the flowers eaten either as dried or roasted, seed oil used in lamps, for cooking and also as hair oil and the flowers used in the preparation of 'Ippa sara'. Toddy tapped from *Borassus flabellifer, Caryota urens* and *Phoenix sylvestris* satisfy hunger in times of scarcity. Vartak (1981) recorded 120 wild edible plants used in hilly regions of Maharashtra and Goa. Jain and De(1966) surveyed less known plants used as foods by tribals of Purulia. Bhandari (1974) made a study of famine foods in the Rajastan desert. Arora (1989, 1995, 1997) described about 300 wild edible plants among tribals in Northeast India. Srivastava (1994) provided an account of wild edible plants of Sikkim Himalayas with emphasis on aspects of their conservation. Gaur and Semwal (1983) recorded little known wild edible fruits from Garhwal (UP). Bhattacharyya (1991) studied ethnobotany of Ladak and reported 57 species used as vegetables, personal hygiene and fodder.

Medicinal Plants

During the last few years several elaborate and often illustrated accounts of medicinal plants of India were published (Jain 1985, Kapoor 1990, Jain & De Filipps 1991, Chatterjee & Pakrashi 1991, Husain et al. 1992, Husain 1993). The majority of medicinal plants belong to the families of Acanthaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Asteraceae, Brassicaceae, Caesalpiniaceae, Convolvulaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Malvaceae, Mimosaceae, Poaceae, Polygonaceae, Ranunculaceae, Rosaceae, Rubiaceae, Rutaceae, Scrophulariaceae, Solanaceae, Verbenaceae and Zingiberaceae. Screening of plants for biological activity was initiated about 25 years ago mainly at CDRI, Lucknow. The phyto-chemical and pharmacological work on medicinal plants in India was recently reviewed in three volume work compiled at CDRI (Rastogi & Mehrotra 1990-1993). Medicinally important species, *Aconitum heterophyllum, Didymocarpus pedicellata, D. aromatica, Orchis ovalifolia, Malaxis acuminata, Valeriana* spp., *Nardostachys grandiflora* and *Jurinea macrophylla* by Shah (1987); *Allium wallichii, Angelica glauca, Betula utilis, Fritillaria roylei, Juniperus macropoda, Nomocharis oxypetala, Picrorhiza kurrooa, Rheum tibeticum, Stellaria media and Viola serpens* by Naithani and Bahadur (1983) and *Atropa acuminata, Berberis aristata, Valeriana wallichii, Podophyllum emodi, Physochlaina praealta, Orchis latifolia* and *Picrorhiza kurrooa* by Husain (1983) are some notable plants reported from Himalayan region. Varghese (1996) made intensive studies of cultural relationships of the Kharia in Bihar and Orissa with biodiversity and recorded about 75 less known medicinal

uses of plants. Detailed ethnobotanical investigations were carried out on *Trichopus zeylanicus and Janakia arayalpatra* (Pushpangadan et al. 1988, 1990) . Rajasekharan et al. (1989) reported the medicinal value of *Aristolochia indica and Aristolohia tagala* with reference to Kani tribe of Agystyar hills. Important medicinal plants like *Adhatoda vasica, Aegle marmelos, Ailanthus excelsa, Clerodendrum serratum, Gmelina arborea and Holarrhena antidysenterica* were enumerated from Jabalpur (Oommachan & Masih 1989). The same authors (1991) discussed conservational aspects of *Rauvolfia serpentina, Barleria ionitis, Smilax zeylanica.* Maheshwari et al. (1981) studied the ethnobotany of Tharus of Uttar Pradesh. Saxena and Vyas (1988) recorded 20 species used by Kols, Gonds, Lodhas and Gujars. Siddiqui et al. (1989) mentioned the uses of 50 species of pteridophytes and angiosperms in skin diseases. Saxena et al. (1988) studied the ethnobotany of Simli pahar forests and reported 200 species used for various purposes. Rao (1998) reported about 105 species of medicinal plants from the entire Eastern ghats ranges. Some medicinal uses of pteridophytes were reported by Dixit (1978).

There may be 8 to 9 million herbal vendors in India. Large number of plants are being traded in various states in weekly markets. *Pholidota imbricata* bulbs in Ranchi district for the treatment of rheumatism; *Selaginella* species for dysentery in South Bihar; *Coptis teeta* whole plant for fevers in Arunachal pradesh; *Bombax ceiba* flowers (calyx portion) for colitis and stomach diseases in Meerut district, Uttar pradesh ; *Centella asiatica* plants for blood purification and as an anthelmintic in West Bengal; *Geranium* species (leaves) for muscular pain and cold effects in Ooty and Coimbatore; *Elaeocarpus ganitrus* fruits for nervous diseases in Garhwal Himalayas ; *Syzygium cumini* seeds in diabetes in Western Himalaya; *Acacia arabica* fruits for general debility in Kola and Bikaner districts of Rajasthan. A case study by Sinha (1996) dealt with only 85 drugs dispensed by vendors in North India. Some species were reported to be used for multiple purposes. The Sahariya of Morena in Madhya pradesh use 327 out of 800 plants occurring in those forests. They put them to about 570 uses (Sikarwar 1990). The folk in Manipur utilize 523 plants for about 800 different uses (Sinha 1986). The tribals in Kumaon employ 483 species for over 830 different uses (Shah 1987). Among the Kharias of Bihar and Orissa, 277 species were reported to be employed for 425 uses (Varghese 1996). These aspects were recently reviewed by Jain (1997).

Other Uses

Many plants such as bamboos and timbers available locally are used as construction material. Singh and Maheshwari (1985) studied the forest life of tribals of Varanasi and reported species having importance in house building, cordage baskets, broom making and fuel. *Apluda flabellifer, Phoenix loureirii* and *P. sylvestris* are extensively used in thatching roofs. Leaves of *Aegle marmelos, Azadirachta indica, Butea monosperma, Ficus religiosa, Manilkara hexandra, Syzygium cumini* are used by tribals of Andhra Pradesh to decorate pandals during festivals. The inflorescence of the grass *Thysanolaena maxima* is used as brooms (Ramarao & Henry 1996). Pal (1970) lists the plants associated with Durga puja in Bengal. Thothathri et al. (1990) gave an account of the oil yielding plants of West Bengal. Singh and Pandey (1982) reported 42 species from Rajasthan which are used in rituals, rites, taboos and ceremonies. Importance of plants in the life of Garos was studied by Rao and Shanpru (1981) and reported 5 species to fish poison, 7 for fibers, 3 for dyes and 4 for magico-religious beliefs in Meghalaya.

Minor forest products (MFP)

Collection of MFP has certain disadvantages with regard to exploitation. They occur in widely scattered areas, sometimes inaccessible terrain, making exploitation difficult. Some are

perishable and pose problems of storage. The role of tribals in collection of MFP acquires significance in this light. The right of collection of MFP is sold by auction and the products are sold singly or in groups with a lease period of one year. The lessee engages agents who in turn approach the villagers to collect and deliver the produce to them. Wages are paid usually on quantity basis. Collection of the MFP is a secondary occupation for villagers living nearby forests. The MFP important in the external trade today are myrobalans, 'gum-karaya', gum arabic. Sandalwood oil, kokum oil, sal oil, bidi leaves and oil and mats from *Vetiveria zizanioides*. The natural dye obtained from *Bixa orellana* is used for colouring butter, cheese and other food stuffs. Important medicinal plants are serpentine roots from *Rauvolfia serpentina* and nux-vomica from *Strychnos nux-vomica* . Other important medicinal plants that have export demand include *Podophyllum, Nordostachys* and *Aconitum* (Krishnamurthy 1993).

The combination of *Emblica officinalis, Terminalia chebula and T. belleirica* constitutes "thriphala" in Ayurvedha medicine. This combination is extensively used as an adjunct to other medicines. The fruits of the latter two are used to increase the potency of alcholic spirits. The fruit pulp yields a dye and used in colouring hydes. Hog gum derived from *Sterculia urens* and *S. villosa* has a great commercial importance. Leaves of *Diospyros melanoxylon* (Tendu leaf) form the biggest single item of MFP giving maximum revenue to the states of Madhya pradesh, Orissa, Andhra pradesh and Maharashtra. Leaves of some other species such as *Bauhinia racemosa, B. vahlii, Butea monosperma, Castanopsis indica, Djras tomentosa and Nypa fruticans* are also used as substitute. Beedi-making is mainly a cottage industry. Palamau in Bihar; Bhandara, Gondia, Nasik in Maharashtra; Jabalpur, Sagar, Katni in Madhya pradesh; Nizamabad, Karimnagar, Warangal and Hyderabad in Andhra pradesh have beedi making centres. It provides employment to thousands of people engaged both in collection of leaf in the forest and factories where they roll beedies. *Agave sisalana* and *Boehmeria nivea* yield fibres of commercial value.

Much information on MFP was compiled by Krishnamurthy (1993) and Thakur and Thakur (1994). Surveys on distribution, exploitable yield, method and season of collection, processing details and marketing aspects are needed to assess these resources. The method and intensity of survey can vary depending on the importance of the species.

Wild cultivars

In northeastern tribal area genetic resources of rice, maize, buchwheat, coix, Saccharum, cucurbits, bean, adzuki bean, soybean, Citrus and jute occur. In the central Indian tribal belts, genetic diversity exists in rice, niger, Sesamum, minor millets, pigeon pea, and forage grasses. In the Western Himalayan tribal belt, there are genetic resources of buckwheat, amaranth, soybean, lentil, cowpea, and stone fruits. Similarly in Western ghats, species of *Alpinia, Amomum, Andropogon, Atylosia, Canavalia, Cinnamomum, Eleusine, Elettaria, Garcinia, Mangifera, Musa, Myristica* etc. are worth mentioning (Nair & Daniel 1986). Nayar (1997) identified some crop genetic resources with different tribal groups. Genetic diversity remains extremely important for future because of the increasing genetic uniformity and therefore vulnerability of improved varieties. These have a finite life and require periodic infusions of new genetic material, if pest and disease resistence is to be maintained. These plants have higher significance in baseline data as they constitute potential genetic resource for improvement of crop productivity.

Endemic plants

Angiosperms

The isolation of Indian flora in the north by the Himalayas and south by the peninsular region

surrounded by seas to a large extent helped higher % of endemism. Subramanyam and Nayar (1974) state that the hill tops of Western ghats resemble islands so far as the distribution of endemic species. Nayar (1977) mentioned that the Himalayan range acted both as a geographical barrier and as a crucible for the evolution of endemic species. Northeast India followed by southern parts of peninsular India and Northwestern Himalaya exhibit rich endemism as for the angiosperms are concerned. About 5725 species of the flowering plants are endemic and these are distributed in 147 genera and 47 families. Among the endemic species 3471 species are found in Himalaya; 2015 species in peninsular India and 239 in the Andaman & Nicobar Islands. The families Acanthaceae and Poaceae have the largest number of endemics (17 genera each). Moreover, endemics have varied significance, some of them having medicinal value or progenitors of cultivated plants or of ornamental importance (Nayar 1997). A consolidated account of the vegetation types, flora, endangered and endemic elements was published by Chauhan (1996) for Eastern India and North Bengal; Srivastava (1996) for Sikkim Himalayas and Chowdhery (1996) for Arunachal pradesh. Similar works in Northwest Himalaya was consolidated by Hajra and Vohra (1996). Ail the stray publications connected to each of these regions were referred to in these articles. Nayar (1980) reviewed the endemic flora of peninsular India with remarks of its significance. This was followed by an elaborate account of endemic plants of peninsular India (Ahmedullah & Nayar 1986). The Western ghats cover a distance of about 1600 km from the Tapti valley in Gujarat to Kanniyakumari in Tamil Nadu. These hill ranges run north-south traversing the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. Nair and Daniel (1986) report that western ghats harbour 57 endemic genera of which 46 are monotypic. The Orchidaceae exhibit high percentage of endemism. Two genera viz., *Proteroceros* and *Smithsonia* and about 100 species are endemic (Santapau and Kapadia 1966, Rathakrishnan and Chithra 1984). Other important families with high percentage of endemism are Poaceae (Karthikeyan 1983), Acanthaceae (Rao 1994) and Asclepiadaceae (Ansari 1984). Karthikeyan (1996) and Vajravelu and Vivekananthan (1996) presented more abridged accounts on Western ghats with reference to general flora, endemic and threatened species. The Eastern ghats in the peninsular India which run 1750 km partly cover the states Orissa, Karnataka, Maharashtra, Madhya pradesh, Andhra pradesh and Tamil Nadu and reported to possess 79 endemic taxa (67 dicots and 9 monocots under 58 genera and 25 families). Many such endemics have been located from Ganjam-Koraput range, Saparla - Maredumilli area, Nallamala hills, Palakonda range and isolated Sandoor hills. *Andrographis beddomei, A. nallamalayana, Justicia gingiana, Pimpinella tirupatiensis, Caralluma lasiantha, Boswellia ovalifoliolata, Shorea tumbuggaia, Habenaria ramayyana, H.panigrahiana* are some notable endemics of the Eastern ghats (Rao 1998). Andaman & Nicobar Islands are endowed with 239 endemics out of 2300 species. 60 of them are known only by the type collection (Nayar 1997). However, Lakshadweep islands in contrast are not as significant as Andaman & Nicobar Islands as for the the flora is concerned.

Lower Groups

Sixty four species of gymnosperms are found in India out of which 7 are considered endemic (Singh & Mudgal 1997). *Cycas* is represented by 5 species out of 20 species known to occur in the world. *C. beddomei* and *C. circinalis* var. *orixensis* are endemic to Eastern ghats. More than 1000 species of ferns under 70 families and 195 genera contribute to pteridophytic flora of India (Dixit 1984). Out of this 24.5% are endemic. Among the 195 genera, 20 genera are represented by single species. A detailed account of these species including ecology, distribution, status and the conservation

measures was presented by Dixit and Mondal (1994). *Ampelopteris prolifera, Brainea insignis, Christensenia aesculifolia, Dictyocline griffithii, Didymochlaena truncatula, Helminthostachys zeylanica, Lithostegia foeniculacea, Lycopodiastrum casuarinoides, Palhinhaea cernua* are some among the discussed species. Tree ferns with their beautiful and large foliage are represented by 12 species out of 600 found in the world. Bryophytes with a total number of ca 2600 species exhibit high % endemism. A perusal of literature shows that in the liverworts about 260 species including a family and five genera are endemic to different regions of the country with maximum representation in the Eastern Himalayas followed by Western ghats and Western Himalayas (Singh 1997). With regard to mosses, 678 taxa are endemic to India of which Eastern Himalaya alone account for 270 species followed by Western ghats (Vohra & Aziz 1997). The fungi in India are represented by more than 2300 genera and 14,500 species out of which 3500 species are endemic (Bilgrammi et al. 1991). This figure is much less compared to the estimates given by Khoshoo (1995). Indian algae is represented by 6500 species inhabiting both fresh water and marine environment. About 14% are endemic (Rao & Gupta 1997). The States have a responsibility with regard to protection of endemics from any human activity as their elimination in the concerned state means elimination from the surface of the earth.

Threatened plants

On a global basis, the IUCN have estimated that 10% of world's vascular plant species are under varying degrees of threat. In India, information on endangered flora was provided by Jain (1970), Qureshi and Kaul (1970), Sahni (1970), Subramanyam and Sreemadhavan (1970) and Henry et al. (1980). By late 70s, valuable baseline data on nearly 1000 threatened plants were gathered . The Red data book categories of IUCN to indicate the degree of threat to individual species were Extinct, Endangered (E), Vulnerable (V) and Rare (R) categories (Jain 1981a). In the year 1980, BSI prepared a small state of art report dealing with 134 plants (Jain & Sastry 1980). This was followed by a publication of the "The Indian plant Red data book-1 comprising red data sheets of 125 selected species (Jain & Sastry 1984). The categorisation was essentially based on qualitative parameters in these books. Later status report for another 427 species was reported in Red data books of the Botanical survey of India. Of the 427 endangered species (Nayar & Sastry 1987, 1988, 1990), 28 species were reported to be extinct and 24 insufficiently known. The families which have higher representation of threatened species are Acanthaceae (32), Annonaceae (35), Asclepiadaceae (53), Apiaceae (43), Araceae (39), Asteraceae (54), Balsaminaceae (42), Cyperaceae (31), Dioscoriaceae (10), Euphorbiaceae (31), Ericaceae (30), Liliaceae (38), Orchidaceae (152), Papilionaceae (73), Poaceae (133) and Rubiaceae (98). Over a seven year period, the IUCN criteria for endangerment used in compiling Red Data books were examined, revised, reviewed and improved over six different occasions. The present system, the IUCN Red list categories, (Mace & Stuart 1994) is considered more objective, numerate and consistent for all groups. The revised IUCN Red list categories provide a methodology for assessment and categorisation. These criteria are now used all over the world and is considered the best possible method for assessing the conservation status of species. The revised categories include Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Lower risk (LR), Data deficient (DD) and not evaluated (NE). This categorisation is done on 5 criteria which include A- Population reduction, B- Restricted distribution, C- Population estimates, D- Restricted populations and E- Probability of extinction. In the past four years, Zoo Outreach organisation, Coimbatore and FRLHT Bangalore conducted ten conservation assessment workshops covering a total of 1872 species of both plants and animals involving 376

participants from 170 scientific institutions. 315 species of seed plants and 23 species of marine algae were analysed under CAMP workshops. Results of each of these workshops are now available.

The Aquatic Plants

U.S. Fish and Wildlife service defines wetlands as "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water. Wetlands in India have not been comprehensively enumerated. According to the Wetland inventory (WWF-India 1992) natural water bodies account for 36% of the total area under wetlands, the balance being man-made. Marshes, swamps, flood plains, lakes, deltas, estuaries, lagoons and coral reefs are some important natural habitat types and reservoirs, tanks, fish ponds, canals and paddy fields are man-made wetlands. The high biological productivity and biodiversity values of wetlands and the subsistence that these habitats provide to local communities are well recognised. Water quality improvement, flood control and ground water recharge are the ecological functions of wetlands. Arber (1920) used the word 'water plants' for those growing in water. Later studies broadened the definition to include a variety of plants growing in water and on water logged or submerged soil (Weaver & Clements 1938), or plants whose seeds may germinate in water or on land but which spend a part of their vegetative phase in water (Reid 1961). Poaceae and Cyperaceae are represented by a number of species which grow in a range of habitats from truly aquatic or marshy situation to the semi terrestrial areas. Many taxa exhibit tolerance to flooding and in other cases the species are composed of different biotypes adapted to different hydrologic regimes. Mukherjee (1926) reported briefly on the vegetation of Dal Lake in Kashmir. Biswas and Calder (1955) described 117 species including lower groups for the wetlands of British India. Subramanyam (1962) listed 117 species covering 32 families. There are numerous reviews and project reports on many important wetlands (Billore & Vyas 1982, Gopal 1990, Kaul 1995, Mishra & Saksena 1992, Mukherjee 1975, Naskar 1990 and Prakasam 1991). India's Wetlands, Mangroves and Coral reefs (WWF-India 1992), Indian wetland directory (Anonymous 1993), A directory of Asian Wetlands (Scott 1989) and the Hand book of Wetland management (Gopal 1995) are other major sources of information on the aquatic flora of different wetlands of national importance. Lavania et al. (1990) compiled a list of 470 aquatic plant species from the Indian subcontinent. Of the 59 families represented, 8 dicotyledonous and 11 monocotyledonous families are exclusively aquatic. Poaceae with 29 genera and 40 species and Cyperaceae with 15 genera and 100 species are the largest among monocot families inhabiting aquatic habitats. Araceae, Scrophulariaceae and Podostemaceae are the families represented by 30, 25 and 24 species respectively. These are followed by Lythraceae (19 species), Hydrocharitaceae (15 species) and Lemnaceae (14 species). *Cryptocoryne* and *Rotala* are the largest genera represented by 14 species each. Naskar (1990) listed 270 species of aquatic angiosperms representing 76 families in the lower gangetic delta alone. Rao (1994) listed ca 300 aquatic plant species belonging to 69 families from India alone and reported 42 of them as endemic. Some families which have major representation of aquatic plants were revised or under revision. Families Nymphaeaceae, Nelumbonaceae, Cabombaceae (Mitra 1996), Aponogetonaceae (Hajra & Sanjappa 1996), Hydrocharitaceae (in press) and partly Podostemaceae (Matthew & Satheesh 1997) were revised. The families Araceae and Typhaceae are under revision.

Uses

The seeds of number of aquatic grasses including wild rice (Oryza) are used (Steeves 1952). The most important among them are *Coix*

lachryma - jobi, Echinochloa stagnina, Panicum miliaceum and *Paspalum scrobiculatum*. Seeds of *Nymphaea nouchali* and *N. stellata* are also eaten by poor people. Water chestnut (*Trapa bispinosa*) for tender kernels, lotus (*Nelumbo nucifera*) for edible rhizome and seeds and *Euryale ferox* for large mealy seeds are well known and in some states cultivated. The rhizomes and petioles of *Nymphoides indicum* and *N. cristatum* are used as vegetable (Anonymous 1962). Tender leafy shoots of *Ipomoea aquatica* (Satpathy 1964), and *Alternanthera sessilis* (Seshavatharam & Venu 1978) are used as a vegetable. The other green leaf vegetables are *Neptunia oleracea, Hygrophila auriculata, Sphenoclea zeylanica,* and *Ceratopteris thalictroides* (Badhwar & Fernandez 1964, Dixit 1998). Some emergent species are widely used as building materials. The culms of *Phragmites karka and P. australis* and the leaves of *T. elephantina and T. angustata* are extensively used for thatching house roofs in rural areas (Saha 1968). *Phragmites* shoots are used in making chairs, screens, baskets, trays and fishing baskets. The long fibrous roots of *Vetiveria zizanioides* are fragrant due to presence of an essential oil. The air passing through the wet screens made from the roots of this species becomes not only cool but fragrant. Perennial grasses, *Paspalum distichum, Leersia hexandra, Brachiaria mutica, Hygroryza aristata, Panicum paludosum, Echinochloa colonum, Paspalidium geminatum* and *Pseudoraphis spinescens* are good forage grasses. Shoots of *Typha elephantina* are fed to elephants. *Ipomoea aquatica* are collected by villagers around Kolleru lake. Aquatic plants have excellent aesthetic and ornamental value. Lillies and Lotus are commonly cultivated in temple tanks. *Aeschynomene aspera* the wood of which is used to produce a variety of decorative items in puja and marriages in West Bengal. It is also used as a green manure with *Sesbania acuelata, Azolla pinnata, Salvinia cucullata, and Hydrilla verticillata* (Seshavatharam 1990).

Mangroves

India with its long shore line is rich in mangrove flora. The Indian mangroves comprise approximately 59 species of 41 genera belonging to 29 families. Of these 32 species belonging to 24 genera and 20 families are present along the west coast. Mangrove ecosystems occur in quiet different situations from ancient relatively prestine untouched groves to those managed as biosphere reserves, such as those in the Gulf of Mannar, Tamil Nadu, Great Nicobar in Andaman and Nicobar Islands and the Sunderbans in West Bengal. Some mangrove forests exist in revenue lands and are exploited for fodder, fuelwood and bark. The state-wise break up in the west coast indicates that 20 species in Gujarat, 28 in Maharahstra, 20 each in Goa and Karnataka, 13 in Kerala and 4 in Lakshadweep islands (Damania & Deshmukh 1996). Medicinal properties of mangrove trees and shrubs have been reported by Nayar (1997). Most of them were categorised as critically endangered or endangered(BCPP CAMP workshop 1997). Industrial pollution, dredging for landfils and building ports, industrial estates, and housing estates for human habitation destroyed mangroves in India. Habitat protection is the only means to conserve this special group of plants since *ex situ* conservation is not successful with mangrove species.

Impact identification

Generally, this is done with the help of checklists and matrices. Checklists present a list of environmental parameters to be investigated for possible impacts. Matrices are two dimensional checklists in which possible project activities are listed on one axis and potentially impacted environmental characteristics along the other. Sometimes impacts on flora are direct and easy to realise. For example, in river valley projects, large areas get submerged and eliminate the

surrounding flora completely. Likewise, open mining also destroys the flora directly and promote weed growth. The construction of road and rail communication has deleterious effect on the natural flora in the long run. While, other projects bring in some changes in the abiotic environment which in turn affects the flora. In such cases, impact assessments are done in the light of past experience. Impact prediction involves projecting the baseline floral setting into the future stating the species to be affected with project implementation.

Impact Evaluation

The environmental impacts are usually expressed in monetary units for easy and objective comparison. The major problem as for the flora is concerned however, lies in assigning monetary values to its intangible parameters. It is worth relevant to mention the values attributed to biological diversity (Anonymous 1991). These are essentially divided into use values and non use values while the former is further classified into direct, indirect and option values. Under direct use, consumptive, productive and non-consumptive values were recognised. Consumptive values indicate the contributory level of floral diversity towards consumption by the local people, for example, the support of forest edible products as supplementary food. The productive values of floral diversity differ from that of consumptive value as this value of the diversity is traded instead of being consumed. The benefits derived by a tribal from the sale of MFP comes under productive value. The productive values also include benefits of biodiversity in agriculture, including new crops, improved varieties of existing crops and production of new drugs. Non-consumptive values include values associated with tourism and scientific research. These values can be estimated by developing suitable questionnaires and schedules and making a survey in areas under consideration.

Indirect use values of floral diversity refer to values of ecological processes only to the extent that these are dependent on species diversity. The central roles attributed to keystone species towards ecosystem structure and function is one such example. Valuable ecological services are provided by certain ecosystems. Ecosystem services come under indirect use values. Ecosystem services may be ground water recharging, oxygen regeneration, flood control in case of aquatic systems and storm protection, erosion control and waste water clean up in case of mangroves. An overall estimation of the value of ecosystem services attributable to biodiversity has never been attempted as there are no suitable methods available.

Equally there are no specific methods available to estimate indirect use vlaues or non-use values. Finally, the objective judgement of the adjudicating agency decides the value of such attributes of the diversity as they are less amenable to valuation.

Preparation of Environmental Management Plan

Prioritised species are to be identified for conservation as they are valued high or prone to eliminataion. It is necessary to plan corrective measures in the environmental management plans (EMPs). These plans should sufficiently use field data available with resource surveys to formulate viable schemes to mitigate impacts of the project. If necessary, the project is made to commit to recurring financial allocation for implementing the management plans to ensure the protection of the enlisted species.

The information provided here is by no means exhaustive but attempts to draw the areas of attention for consideration in EIA exercises. Species lists prepared in the project area using regional floras and rapid field studies are to be screened for prioritisation of conservation using above criteria. These taxa are later studied for population and other ecological studies as situation demands.

Some limitations in literature and suggestions in better execution of EIA are given below.

- The total angiosperm flora is represented by ca 17,000 species of which 20% constitute useful plants. In this, 1600 are medicinal species; edible plants which include cereals, pulses, fruits and vegetables constitute ca 2000 species and plants of other uses ca 2050 (Anonymous 1986). There is need to develop databases for the above plant groups in a suitably evolved format so that this information can be readily screened against the species lists prepared in EIA studies.
- The Survey should strive to develop organised databases in areas like ethnobotany, medicinal plants and particularly in case of endangered, endemic and aquatic species where considerable work was already done. Institutes like FRLHT on medicinal plants, M S Swaminathan Foundation, Chennai on mangroves are working on the said specific areas. These databases should be as elaborate as possible and open ended for continued upgradation. Such an effort is meaningful as it effectively puts to use the information acquired by various organisations specially the Botanical survey. Such programmes can be sponsored by Environmental information systems.
- There are three mega and 25 micro centres of endemism in India. Unfortunately many of the endemic centres are identified as "hot spots'. Among them are the Sikkim Himalayas , Arunachal pradesh and Eastern Himalayas, Lushai Hills, Tura Khasi hills, Aravalli, Simlipal and Jeypur hills, Bastar and Koraput hills, Visakhapatnam and Araku Valley hills, Tirupathi and Cuddapah hills, Saurashtra - Kutch, Mahabaleswar - Khandala ranges, Agumbe - Phonda ranges, Ratnagiri and Kolba ranges, Nilgiri, Silent Valley , Wynaad, Anamalais and Kalakad & Agastyamalai hills(all of Western ghats), Andaman islands and Great Nicobar islands. Such areas deserve serious attention and care when EIA studies are to be carried out.
- Many endemic species are found to occur in core habitats and these areas are little understood. Species like *Hubbardia heptaneuron* was completely eliminated which grow in spray of the water falls. Members of Podostemaceae, *Frerea indica, Haplothismia exannulata* and *Paphiopedilum druryi* are niche specific and are extremely threat prone. While assessing the impacts of a proposed industry, one is to carefully evaluate consequences giving more margins to such species. Data on past experience throw some light on objective assessment.
- Areas like islands provide homogenous habitats and if subjected to disturbances and habitat loss, the endemic species have no chance of finding alternate habitats and face extinction. As stated, Andaman and Nicobar islands host 239 endemics out which 60 are known by only type collection. Thus these areas and also the said endemics gain additional significance in EIA exercise.
- National and regional lists of inventories are to be prepared indicating fragile or threatened habitats of endemic species. It is necessary to develop database which should include mapped habitat of endemic and threatened species and their genetic value. In this connection, the mapped database prepared (Ramesh & Pascal 1997) for endemic plants is worth mentioning.
- Many of the threatened or endemic plants were introduced in many of the BSI experimental gardens. They include 67 in Dhanikari in Port Blair and 56 in Barapani in Dehra Dun, 6 in Allahabad , 26 in Yercaud, 13 in Gangtok, 13 in IBG and 9 in Shillong. Such introductions majorly help in conserving all the vulnerable species and

are to be encouraged even in all government funded gardens of the ministry. Such introductions facilitate documenting phenology and detailed autoecological studies of these species. The acquired data may be useful in EMPs.

- It is worth attempting to analyse the available data from the floras, herbarium collections, field note books and reports of rarity in scientific publications to sum up information on threatened plants.
- The concept and assessment of threatened species has changed considerably from early 1970s to late 90s. Status reports of threatened species were prepared basing on changing criteria of IUCN and are not comparable. The assessments carried out by FRLHT are based on revised criteria. But the inputs with regard to parameters taken under consideration were based on past experience of the experts of various organisations.
- Many genera under Rubiaceae, Acanthaceae, Lamiaceae and Euphorbiaceae present complexes and the taxonomy of such groups is yet to be resolved. Revisions of such groups in course of time resolve this problem.
- The boundary between land and water presents a spectrum of habitats ever changing in time and space, with a gradient of water regimes. A variety of plants occupy these diverse habitats and exhibit great plasticity in their response to the dynamic environment. Phenotypic plasticity and lack of adequate taxonomic explanation are problems in the correct taxonomic evaluation. Some examples were cited by Lavania et al. (1990) to emphasize taxonomic confusions in many aquatic taxa. Moreover, a number of aquatic species are known for not exhibiting reproductive structures (flowers) in the family like Hydrocharitaceae.

Many EIA reports ignore mentioning of lower groups with the contention that not much work was carried out in India. The work already done in India was consolidated and published (Mudgal & Hajra 1997). These attempts facilitate to know the gaps in the literature and use the available information.

Conservation biologists have been emphasiging the critical ecological roles of keystones. Defined operationally, a keystone species is one that by its effective absence from a system results in disappearence directly or indirectly, of several other species causing in other words an extinction cascade. Unfortunately there is not much data with regard to keystone species in various ecosystems and so such species go on par with others in the evaluation process.

- EIA exercises are supposed to analyse and express all the affected environmental components in monetary units for a more objective comparison. All the attributes of the flora cannot be converted to monetary units, some of them are to be left to decisions of the expertise in the concerned field.
- Also, in many cases, the changes occur in the flora are due to secondary impacts of the industry such as improved road communication, added human activity, more pressure on land surface which alter the habitats greatly. It is desirable to be aware of such possible impacts of industry by the persons involved in the evaluation of flora.
- Again, there is not much data which can evaluate pollution impacts of various industries on different species. It is difficult to apply some stray studies in the evaluation exercise of flora to come to meaningful conclusions. However, some case studies where the industries were not subjected to EIA studies prior to their establishment may be taken as base in assessing such situations. This would give some clues about the floral elements that get affected by the proposed industries.

Finally it is time to review our EIA documents to ascertain how these excercises contain the negative impacts of the developmental projects and achieved the desired goals. It helps to identify gaps in our ability in the production of such documents and management. Such an effort enhances our quality of planning in our future EIA exercises. Ideal development comes through generating productivity and income by developing industrial capital and natural capital side by side and sharing the benefits of the same by the local people of the area (Khoshoo 1988). Organised databases in relevent subject areas and better cordination among various experts make EIA as an effective conservation tool of our natural resources.

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