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Academy Sponsored Report

Current Status and Management of Scientific Information Relating to Indian Environment

MADHAV GADGIL[1,*] and CHINMAYA S RATHORE[2]
[1]*D. D. Kosambi Visiting Research Professor, Goa University, Taleigao, Goa 403 206, India*
[2]*Professor, Indian Institute of Forest Management, Nehru Nagar, Bhopal 462 003, India*

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Summary

To address the important challenge of taking good care of India's environment, we require substantial, good quality, and reliable information. Unfortunately, such information is in very short supply. Most of it is collected through the state machinery. With a few notable exceptions like India Meteorological Department and the Indian Space Research Organization, the agencies involved exhibit a number of shortcomings. These include: (1) Failure to maintain records, (2) Very patchy, incomplete information, (3) Suppression of accurate information, (4) Deliberately falsified information, (5) Failure to make information publicly available, and (6) Failure to involve public in generating useful information. Three significant avenues for involving the public in generating useful environmental information, namely, preparation of ward-wise Environmental Status Reports by Local Bodies under the 73rd and 74th Constitutional Amendments, preparation of People's Biodiversity Registers by Local Bodies under Biological Diversity Act, and compilation of information generated through student projects under educational system-wide compulsory Environmental Education courses are being scarcely tapped.

To address this challenge, the Ministry of Environment, Forest and Climate Change (MOEF&CC) established around 1983 an Environmental Information System whose 68 centers focus on newsletters, research papers, court orders, etc. and little on useable environmental databases. In view of this inadequacy MOEF&CC started a new environmental information facility called the Environmental Information Centre in 2002. Regretfully EIC has altogether stopped functioning around 2010.

Evidently, the prevalent exclusionary culture of bureaucratic management of information cannot be maintained in the modern, open democratic society of India. In response, the Government has promulgated the National Data Sharing and Accessibility Policy and set up a Nataional Spatial Data Infrastructure. This ought to lead to a sustained effort to geocode environmental information and make it available as GIS ready datasets. To this end, we need to start a fresh initiative to create a new Environment Infromation Infrastructure that can act as an umbrella platform to collate and disseminate environmental information in the country. We must also strive towards creating partnerships with public sector and private sector digital platforms, in particular (a) ISRO's Bhuvan and (b) Google Public Data Explorer.

To these proposals, we must now add one more dimension, namely, that the information system should not only be publicly accessible, but be a participatory system involving all interested citizens. It should be broad in scope and involve not only various Central and State Government agencies, but also all the Local Bodies and organizations such as industries and mines that are expected to document their pertinent activities. However, the fact that with the notable exception of the Sikkim springs programme of the Government of Sikkim, several long-standing opportunities such as Biological Diversity Act have so far not led to any concrete actions, indicates that the citizens must step in and take the initiative on their own. Such a people's movement for making good environmental information openly available could very effectively piggyback on the hugely successful Wikipedia experiment.

**Author for Correspondence: E-mail: madhav.gadgil@gmail.com*

Preamble

The new century is being heralded as the knowledge age. The very rapid growth over the last five centuries of science and science-based technologies has by now made possible an intensification of human use of material, energy, and informational resources to astonishingly high levels. However, mere intensification of material, energy, and informational resources cannot be stand-alone objectives; what people desire are services from resource uses. Since there are inevitable physical limitations on continuing increases in material and energy resource use, what is desirable is to obtain more and more services from such uses through better and better use of information; there being far less stringent limitations on the growth and use of informational resources. Thus, what we need is not generate and consume more and more electricity for its own sake, but secure more services such as illumination or comfortable ambient temperature. What matters in terms of the quality of life are the per capita *useful* energy and material use, not per capita *gross* energy and material use, as the latter leaves out of consideration the potential for enhancing efficiencies. Consider, for example, the great advances made through use of LED lights based on augmenting and then deploying greater understanding of science underlying light emission. Clearly, the key to further progress in the knowledge age is deploying our rapidly growing stocks of information to enhance end-services provided by use of material and energy resources.

Humans desire manifold end-services. Electricity may provide us illumination, or heat or energy to manufacture a variety of desired goods and so on. But we also desire clean air and water, and if electricity generation, say coal-based, entails a deterioration of air and water quality, that also needs to be factored in. Hence a significant aspect of enhancing desired services to human society is to deploy information on unintended and undesirable consequences of use of material and energy resources so as to minimize such unwanted consequences. An excellent example is the information conveyed through Rachel Carson's famous book, "Silent Spring" (Carson, 1962). This path-breaking work pointed out that while the use of the pesticide DDT enhanced food production – and more food on the plate was certainly a desired end-service - it led to decimation of the bird populations, and the song of birds in the spring season was also a highly desired service. This awareness led to a ban on DDT, and welcome recovery of wildlife.

The village of Hivare Bazar in Ahmadnagar District of Maharashtra provides another notable example of how good information on consequences of intensification of energy and resource uses can result in enhanced end-use services. Ground water is needed to meet domestic needs and to cultivate crops in this agricultural village. Energy is needed to lift this ground water. In many villages surrounding Hivare Bazar electricity is used to lift ground water from bore-wells, and the resulting use at non-sustainable rates has led to digging of ever deeper bore-wells and use of more and more electricity to pump water out. The village community of Hivare Bazar examined the situation and decided to restrict use of bore-wells for drawing water through hand-pumps for domestic use, and only permit open wells for irrigation. They also implemented several measures for recharging ground water based on detailed locality specific information and action. As a result of such good use of pertinent information, Hivare Bazar has ensured greater availability of water for irrigation and domestic use at far lower costs than the surrounding villages (Gadgil, 2015 pers. obs.; Pawar, 2015 pers. comm.).

Nation's Four-fold Capital Stocks

As the Nobel Prize winning economist Joseph Stiglitz emphasizes, any nation must aim at a harmonious development of its four-fold capital stocks: not just man-made capital that GDP highlights, but natural capital, human capital and social capital as well (Stiglitz, 2012). To move in this direction, it is vital that the society has at its disposal good information, not just on a limited range of economic activity but on a whole range of parameters relating to natural, human and social capital. It is such information that the Environmental Impact Assessments and Social and Economic Cost-Benefit Analyses are meant to provide, but currently failing to do so. Consider, as an example,

the controversial Chembanmudy hill stone quarries of Pathanamthitta district of Kerala. This enterprise will count as positive economic development gains not only quarrying, crushing and truck transport, but also the boosting of sales of anti-cancer and anti-asthmatic drugs as a result of the ill-health caused by quarrying activities. In the absence of proper records, other relevant elements of economic activities such as the decline in agricultural productivity and loss of employment for agricultural labour that ought to be counted on the debit side are being overlooked.

In addition, the GDP-centric view totally ignores the on-going grave depletion of natural capital, human capital and social capital. Thus, in the case of Chembanmudy, landslips and blockage of streams are adversely impacting land, water, forest and biodiversity resources. Health, education and employment are three important components of human capital. In the Chembanmudy case, health has suffered, with even young children developing lung cancer. Mothers have petitioned that the noise pollution attendant on unceasing truck traffic does not permit their children to focus on studies. As to employment, there is little for local community members. Most of the small number of labour employed are from tribal tracts of Orissa or Jharkhand, people whose livelihood has been destroyed by rampant mining in their own native districts. There are horror stories making rounds of how this disorganized labour force is ill-treated, with no compensation for accidental injuries or even death (Kuttoor, 2013).

Social capital resides in social harmony, cooperation and trust. These too are suffering under the prevalent economy of violence. This economy is promoting grabbing and spoiling of land, water, mineral and forest resources to benefit a few, at the cost of the larger society. This is being facilitated by lawlessness and social injustice, as witnessed by the very large number of illegal quarries currently operational in Kerala, reportedly estimated at 1700 out of a total 2700 functional quarries (Gadgil, 2013 pers. obs.).

Obviously, we need fullest possible understanding of manifold environmental consequences of intensification of energy and resource uses. The issue that this report attempts to address is whether or not we are collecting, organizing, and using environment related scientific information well, and if not, why not and, finally, on how we can improve on the current practices.

What is Science?

Modern science is a highly effective system of growing knowledge that entails observing facts directly, often with the help of carefully designed experiments, discerning patterns, inferring processes that give rise to the observed patterns, making models of working of the system under consideration, formulating hypotheses about the system, making predictions, verifying predictions through fresh observations of facts, revising models of the working of the system, and then making new predictions, in an ever-continuing process (Moore, 1993). In the march of science, anybody is welcome to challenge any assertion: whether it is of facts supposedly observed, or of models of how the system works. Along with rejection of all authority, science has given up claims of arriving at any absolute truth. Science deals in knowledge that is always treated as provisional, that is open to being supplanted by newer and more effective observations and theories (Bernal, 1939).

It is this openness that has ensured that in science the proportion of empirically sound to unsound information is very high, and any deliberate manipulation of information is quickly exposed and weeded out. In consequence, the rate of growth of scientific information has been continually accelerating. On the other hand, classical knowledge, with a tendency to rely on authority, has grown rather slowly; for instance, Ayurveda has remained largely stagnant over last 1500 years (Gadgil, 2001a).

Systems: Simple and Complex

Science deals with a whole gamut of phenomena ranging from simpler ones such as the oscillations of a pendulum to highly complex ones such as the weather systems that give monsoon rains. Our understanding of the sciences of the simpler systems has grown far more rapidly than that of the more complex ones. This is because experimentation, involving extensive

replication of conditions where just one or a few parameters are permitted to vary at a time is a key ingredient of the scientific method. Experimentation has worked well in the case of simpler systems that can be specified adequately in terms of a small number of parameters. This has permitted the formulation of a number of generalizations, of universally applicable laws with considerable predictive power. As a result, human understanding of simpler physical and chemical systems has progressed enormously. This understanding underpins a whole range of powerful technologies.

But with the more complex systems, the situation is different. Complex systems characteristically require a large number of parameters for their specification. As a corollary, each manifestation of the system tends to be unique. Thus every patch of forest harbours a set of animal species slightly different from every other patch in the world, or every cyclone in the Arabian Sea is different from every other. Since the experimental method depends on the experimenters' ability to control all relevant parameters and to replicate conditions at will, it cannot be readily applied in the study of complex systems like ecosystems (Shrader-Frechette and McCoy, 1993; Goldenfeld and Kadanoff, 1999).

Understanding Complex Systems

Since experimentation is difficult, arriving at an understanding of complex systems depends on extensive observations as witness the network of weather stations or river gauges dotting the country. Naturally the State becomes involved and comes to control the basic observational data as well as its interpretations. The state invariably caters to a variety of conflicting interest groups who may find some of the facts on the ground unpalatable, and who may therefore wish to control and manipulate the data as well as its interpretation. As Whitehead (1925) puts it, science is firmly anchored to the bedrock of empirical observations, however unpalatable these may be to some people; hence any such attempts to control and manipulate are incompatible with the spirit of science.

Bernal (1939), who pioneered the study of practice of science as a social activity provides a most illuminating definition of science: 'Science is an organized enterprise of skepticism'. In other words, science is a system of continual open scrutiny of the procedures being employed towards any given set of objectives, such as estimation of forest stocks and yields that can be sustained, and of the level of reliability of the results these procedures produce. On this view, the main ingredients of the scientific enterprise are:

- Open access to all facts and inferences,
- Rejection of all authority other than that of empirical facts and logical inferences,
- Welcoming all interested parties to question all assertions relating to facts as well as logic.

The state controlled scientific endeavors dealing with environmental issues do make claims to be science based, but catering as they do to a variety of special interests wishing to manipulate data and its interpretation, they tend to violate the spirit of science. Additionally, the state controlled scientific endeavors tend to be distrustful of the substantial body of understanding of complex systems that is part of the experience and tradition based informal knowledge that resides with the "barefoot ecologists" of the country (Gadgil, 2001b).

Experiential Ecological Knowledge

The experience of a group of Bengaluru based ecologists investigating the fate of wild *amla* (*Phyllanthus emblica*) populations on the nearby B R T Hills provides an interesting example of the value of folk knowledge. The hypothesis of the professional ecologists was that the regeneration of *amla* is governed by the amount of fruit collected for commercial use, and that the then prevailing low levels of regeneration were related to excessive harvests. So they laid out statistically well-designed experiments to test the influence of different levels of harvests. The local Soliga tribals felt that these experiments would yield no results of interest, because, according to their understanding of the ecosystem based on many years of first hand observations, the levels of

regeneration were primarily influenced by forest fires. *Amla* seeds required fire to germinate well, and the Soligas felt that low levels of regeneration were related to suppression of forest fires in recent years. The scientists did not initially give credence to this suggestion and continued their experiments. Only later did they come to the conclusion that the Soligas were indeed right (Murali, K. S. *pers. comm.*).

Thus, since it is difficult to discern what the relevant parameters are in a complex system, it is hard to design meaningful experiments. This does not, of course, mean that experiments have no place in the study of complex systems. But, the BRT hills example points to the fact that field observations, including historical observations are vital to the understanding of such systems. Such field observations are at the heart of the folk knowledge systems, often dealing with highly complex systems. The resultant experiential ecological knowledge underpins many prudent and sustainable folk practices of management of natural resources. Such practices, largely ignored by the bureaucracy, include protecting keystone ecological resources such as trees like banyan and peepal belonging to genus *Ficus*, protecting sacred ponds and pools in the river and protecting sacred forest groves and regulated harvests from village forests (Gadgil, 2000).

Official Management of Knowledge

The management of environmental information, dominated by official agencies, influenced as it is by special interests, suffers from many deficiencies. The prevalent practices largely lack traditions of transparency, and of sharing of the results, the methodology employed to arrive at them and the logic followed in the inferences made. Of course, the official, supposedly scientific, natural management follows certain systematic procedures such as of Detailed Project Reports for River Valley Projects or Forest Working Plans. But, science is not merely a matter of systematic procedures. Much more importantly, it is a system of continual open scrutiny. How far the supposedly scientific management of environmental resources such as forestry departs from this ideal became evident to one of us (MG) while attending a meeting in early 1980s in Kolkata, presided over by the Finance Minister of West Bengal to discuss environment and forest issues. During the course of this meeting, the head of the forest department asserted that working plans are technical documents that must never be made available to general public. In such absence of openness, we continually encounter problems such as the highly inflated estimates of bamboo stocks, or the false claims of the numbers of tigers in Sariska and Goa. (Prasad and Gadgil, 1981; Tiger Task Force, 2005).

In consequence, there are several serious shortcomings in management of scientific information relating to Indian environment. These include:

1. Generating and managing information under false pretenses
2. Falsification of data
3. Suppression of scientific information
4. Failure to collect / examine pertinent data
5. Suppression of scientific activity
6. Failure to act on pertinent legislation

False Pretenses

As a striking case of false pretenses at being scientific, consider forest and wildlife management systems. These exercises are not grounded in good empirical data or sound logic, they do not encourage public scrutiny, and they do not attempt to verify the predictions made.

Weakness of Empirical Basis

Forest management decisions have often been taken without adequate empirical evidence. Thus, preservation plots, established to measure growth rates of diverse tree species of Indian forests in early 1900's have been mostly destroyed; little data has been collected (Gupta, 1981). Large scale plantations of Eucalyptus were propagated in high rainfall tracts of Western Ghats by clear cutting rain forest without adequate trials. Realized productivities of these plantations, seriously affected by fungal diseases, were 1-3 tonnes/ha/yr as opposed to projected

productivities of 14-28 tonnes/ ha/ year (FAO, 1984; National Commission on Agriculture, 1976; Prasad, 1984). Similarly, no data was maintained for pilot Tropical Pine plantations meant to serve as the basis of decision on whether to take up large scale plantations in Bastar. Nevertheless, a programme of large scale plantations was being pushed through (Gadgil, Prasad and Ali 1983). The estimates of bamboo resources of Karnataka were exaggerated by a factor of ten to facilitate acceptance of a project to set up a new paper mill. As a matter of fact, the 1964 Working Plans for Dandeli in Uttara Kanada showed high levels of bamboo stocks for compartments that had been deforested 10 years earlier to set up West Coast Paper Mill because the figures were blindly copied from an earlier Working Plan. The project documents for establishment of paper mills in Karnataka did not take account of possibilities of gregarious flowering and death of bamboo clumps over extensive areas, although there were many historical records pointing to this possibility. Furthermore, the Karnataka Forest Department prescribed a regime of harvest of bamboo based on a faulty growth model that did not recognize that bamboo clumps grew exponentially (Kadambi, 1949). The silvicultural practices by West Coast Paper Mills involved cleaning of thorny covering that develops naturally at the base of a bamboo clump. This "*clump cleaning"* was meant to decongest the clump and promote better growth of the new shoots. This practice was counter-productive, for the removal of the thorny covering rendered the young shoots readily accessible to grazing by a whole range of herbivores. As a consequence, the recruitment of new culms to the clumps remained very poor and the bamboo stocks remained stagnant. In contrast, the local villagers were fully aware of this difficulty attendant on clump cleaning and left the thorny cover intact while harvesting bamboo for their own use (Gadgil and Prasad, 1978; Prasad and Gadgil, 1981).

The pharmaceutical industry in Karnataka uses 300 plant species. While limited data on stocks of 27 of these, largely based on records of auctions, is available, there is no data whatever on the stocks of the remaining 273 species (Karnataka Planning Board, 1996). Similarly, a negative list banning export of drugs using certain plant species had to be withdrawn when the Government could provide no data to justify the list (Gadgil and Rao, 1998).

The State of Forest Cover (SFR) report, which biannually maps the total forest cover for the country, is being produced since 1987 by the Forest Survey of India. The SFR uses remotely sensed data from the Indian Remote Sensing Satellite for its assessments. The term 'Forest Cover', as defined by SFR refers to "all lands more than one hectare in area with a tree canopy of more than 10% irrespective of ownership and legal status including orchards, bamboo and palm. 'Forest Cover' thus indicates presence of trees on any land irrespective of their ownership" (SFR, 2013). Ravindranath *et al*. (2012) and Ravindranath *et al*. (2014) have reported that the SFR, due to the above definition of forest cover, has been overestimating forest cover in India.

Barring humans, and very small biological populations, only Indian forest departments provide exact numbers such as 17456 'wild bears' in 2005 in Karnataka (Gadgil, 2006a). Otherwise, it is universally accepted that total counts are impractical and likely to be highly unreliable and what is appropriate is estimates of the total population based on sampling studies with appropriate confidence limits. There is practically no data on significant issues such as number of human habitations inside Tiger Reserves, levels of human-wild life conflicts and costs of conservation imposed on local communities (Tiger Task Force, 2005). Similarly, authorities of the state of Madhya Pradesh (MP) have provided no information on impact of fishing in Tawa reservoir on the biodiversity in response to a request by Tawa Matsya Sangh.

Working Plans as Hypotheses

The modern scientific method has been termed as the "hypothetico-deductive" method. Hence, a truly scientific enterprise would treat documents such as "Forest Working Plans" as scientific documents to be made available for peer review by all interested parties, not as official secrets. The yields expected to be realized, and the stocks expected to be left behind after the harvests would be treated as hypotheses to

be tested. If the yields do not materialize, or the stocks are not sustained, then a scientific enterprise would acknowledge that there are obvious errors of fact or logic, and attempt to look for and correct them. It would also try to bring on board all interested parties, technical experts, as well as other stakeholders from the civil society, in the effort to understand the mistakes and correct them. None of this has ever been practiced. Because of these serious scientific deficiencies, a study of Forest Working Plans reveals that nowhere in India have the forest resources been utilized in a sustainable fashion. Instead, there has been a universal pattern of sequential overexploitation (Gadgil and Guha, 1992).

Failure to Sustain Forest and Wildlife Resources

- Working Plans of Quilon Division in Kerala successively converted Protection Circle into Selection Felling Circle and then into Clearfelling Circle as the forest resources of ever steeper slopes were exhausted (FAO, 1984).
- To quote one casual observation from a Working Plan: In the Yekkambi - Sonda area the A coupes under Edie's plan and replacement felling areas under Garland's plan have resulted in total exploitation of all valuable species and these areas have only bamboos and useless growth. Most of the overwood of valuable species had been removed under the so - called "uniform system" over large stretches of reserve forest area in the false hope of inducing natural regeneration of teak and other valuable species. As much as 30,834 acres were totally exploited of which 8235 were planted up ... Garland's replacement fellings under uniform system was a total failure as it failed to induce or establish natural regeneration of teak or other valuable species. (Wesley, 1964).
- West Coast Paper Mill was expected to meet its resource requirements in perpetuity from Uttara Kannada circle. Within 20 years of its operation it had not only exhausted these, but was moving further and further away, to Andhra Pradesh (AP), then Garhwal and finally to Nagaland to bring in supplies of bamboo (Gadgil and Prasad, 1978).
- Karnataka Forest Department successively added harder and harder species to its list of softwood to be made available to plywood industry at highly subsidized rates as the stocks of the more desirable species were exhausted (Gadgil, 1989).
- In 1980, the Forest Conservation Act was enacted and commercial use of Indian forests reduced only following exhaustion of supplies from Indian forests and beginning of large scale imports (Gadgil and Guha, 1992). Wildlife and biodiversity conservation efforts, too, have not been focused and have not been securely grounded in scientific understanding.
- Without adequate scientific evidence it has been assumed that subsistence uses by local people are necessarily detrimental from a conservation perspective. On the contrary, shifting cultivation over millennia is probably responsible for enriching India's biodiversity by promoting evolution of hard ground race of Barasinga (*Rucervus duvaucelii*).
- Salim Ali and experts of International Crane Foundation recommended that ban on grazing by buffaloes at Bharatpur would greatly enhance the quality of habitat for water birds. In fact, cessation of grazing promoted profuse growth of *Paspalum*, a water loving grass, choking the wetland and making it a worse water bird habitat (Vijayan, 1987).
- Studies by ATREE have documented that use of non-timber forest produce by Soligas in BRT hills in Karnataka is fully sustainable. In spite of this evidence all such use is being banned.
- Research units attached to most Tiger Reserves have remained inactive, mostly without any staff in place, and with little output to show.
- A high proportion of country's protected areas lack properly formulated management plans (Tiger Task Force, 2005).

Falsification of Data

There are many examples of quite deliberate falsification of data.

Bamboo Stocks

The forest based industries were vigorously promoted in early years of independence. These included paper, plywood, polyfibre and the matchstick industry. One such paper mill was set up in Dandeli in Uttara Kannada district of Karnataka in 1958. At the time it was established, the Forest Department had assessed that the bamboo resources of Uttara Kannada district would provide the raw material for the paper mill in perpetuity. However, the raw material was, in fact, exhausted within a decade. Field studies by the Indian Institute of Science, Bengaluru showed that this was partly due to the fact that the figures for the availability of the bamboo stocks had been grossly exaggerated, by as much as a factor of ten times (Prasad and Gadgil, 1981).

ENERCON

India is today engaged in a drive towards enhancing energy production through every available route. One of these is the so-called *green* wind energy. A company named ENERCON has set up wind mills in Pune district on the crest of Western Ghats just south of Bhimashankar Wild Life Sanctuary, famous for the presence of giant squirrel, Maharashtra's state animal. This is the northernmost stretch of evergreen forest on the Western Ghats and its southern continuation in Mahabaleshwar has been constituted as an Ecologically Sensitive Area (ESA) as far back as 1999. The Indian Board for Wild Life (IBWL) had resolved in 2002 that a zone of 10 km next to all Wild Life Sanctuaries and National Parks should be constituted into Ecologically Sensitive Areas. When the wind mill project was mooted, the concerned Range Forest Officer had faithfully recorded the presence of significant plant resources as well as extensive populations of wild life species including Giant Squirrel in areas where the windmills have now come up after being cleared in 2009. Some Gram Sabhas and Gram Panchayats also refused to give consent to the project.

The green wind energy projects are exempt from Environmental Clearances but require clearances from Forest Department in accordance with 1980 Forest Conservation Act, FCA. When the request came from ENERCON, the IBWL stipulation of 10 km ESA was set aside, Forest Rights Act was shelved, some Gram Panchayats' *No Objection Certificates* were apparently forged, RFO's honest submission was suppressed and the concerned Forest Conservator gave a palpably false statement and promptly cleared the project (WGEEP, 2011).

Environmental Impact Assessments

Currently the whole process of assessment of environmental consequences of various human interventions is being comprehensively sabotaged with large scale falsification of data. This is well-brought out by an officially sponsored study of the quality of the Environmental Impact Assessments (EIA) submitted, compliance with Environment Clearance (EC) conditions and the adequacy of the Environmental Management Plans (EMP) with respect to 105 mines in operation in Goa by the Center for Environmental Education (Gadgil and Dongre, 2013). Essentially, every EIA contains deliberately falsified information with respect to:

- Existence of water sources within leases and adjoining the leased boundary
- Demographic profile in terms of presence of ST communities
- Actual distances between the boundaries of mine leases and protected areas

Specifically:

a. T.C. No. 01/51 belonging to Shaikh Salim situated at Devpan Dongor of Caurem village in Quepem taluka does not make any mention of the existence of perennial water spring within the mining leased area. The EC has a specific condition in their letter not to disturb the water spring and maintain 50 meters of natural vegetation on each side and enrich this area by planting native species of vegetation. This condition is completely violated.

b. T.C. No. 14/52 of M/s Badrudin H. Mavani documents the presence of a nallah flowing about 6 km away from the lease area but does not make any mention of river Kushavati which is adjoining to the mine lease boundary.

c. The river Bicholim which is classified as a flood prone river and touches the lease boundary of TC number 28/53 of M/s Zateye and Co. finds no mention in the document.

d. TC No. 35/51 denies the existence of any perennial water bodies in the mining lease areas and mentions the presence of only one spring adjacent to the mining leased area. As per the survey carried out by the water resource department Govt. of Goa ref. WRD/WDII/SDIII/F35/322/2009-10 dated 18.12.2009, there are around 30-40 springs including the famous *Takazor* in close vicinity to the mining site. The Agriculture Department of Government wide their report No. 3/5/ext/46/mining/2009-10/D.AGREE/489 dated 5th Nov. 2009 mentions that the area has 30 natural springs that help in providing water recharge to Kushawati river besides supporting plantation crops and paddy fields plus drinking water.

e. With respect to TC numbers 4/55, 8/50, 2/57, 60/52 and 19/52, the EIA document does not mention of water courses in and adjoining mining lease but EC issued by the Ministry of Environment makes mention of water courses.

The citizen respondents consulted during the course of this study were unanimous in stating that while preparing the EIA, the consultants have never consulted the local people for any information, nor are the people aware that such an exercise was being undertaken, and that data given in EIA relating to social, economic aspects, to biodiversity, agriculture and demography are often not correct (Gadgil and Dongre, 2013).

Even organizations like National Environmental Engineering Research Institute (NEERI), a CSIR lab, The Energy Research Institute (TERI), Ernst & Young, Engineers India Limited (EIL) etc. have been involved in presenting fabricated data. Thus, the EIA report for the Dandeli 18-MW Mini-hydel project in Karnataka prepared by Ernst & Young was found to be based not only on fraudulent data but also heavily plagiarized from another EIA report prepared for the Tattahalli Augmentation Scheme. Scanned pages of both these reports enumerating how pages after pages of one report were used for the second report are available on the Environmental Support Group website (ESG, 2000). Interestingly, when this case was extensively highlighted by the media, TERI was engaged by the Government of Karnataka to prepare a fresh EIA which again turned out to be based in part on fraudulent data (Daniels, 2000).

An EIA submitted for Umbarshet bauxite mining in Ratnagiri in 2006, Maharashtra was found to be heavily plagiarized from an EIA report of a Russian aluminum company to mine bauxite in the Komi Republic of Russia submitted to the European bank in 2004. While located on an entirely different continent, the Umbarshet bauxite mining EIA report reproduced amongst other things, even environmental data from the Russian report which included data on water quality, rainfall, animal densities and number of species (Dutta & Sreedhar, 2011). Other fraudulent practices of falsification of data in EIA's submitted in India and the secrecy around EIA reports have been widely documented (Kohili and Menon, 2005; Dutta, 2007; Dutta, 2008; Swidereska *et al*., 2008; Bindra, 2009; Mukherjee, 2012; HRW, 2012; Dutta, 2014)

Suppression of Scientific Information

Zoning Atlas for Siting of Industries

The Zoning Atlases for Siting of Industries (ZASI) provides a striking example of suppression of scientific information. This set has been prepared for most of the districts throughout the country as a coordinated effort of Central and State Pollution Control Boards. The exercise was justified by the Government of India (GoI) agencies themselves on grounds that this information would facilitate proper location of new industrial units which would benefit industrial development by ensuring that industries do not propose new units in unsuitable spots, thereby avoiding undue

delays and obviating protests. ZASI adopts a systems perspective, and attempts to evaluate potential cumulative impacts that may cross some unacceptable thresholds. With this in view the reports consider the pollution load-bearing capacity of various parts of any given district, prevalent levels of pollution and levels of permissible additional pollution generating activity. Astonishingly, the Ministry of Environment and Forests, GoI itself has suppressed this vital data set that was generated at large public expense and much investment of human resources. Even its own Western Ghats Ecology Expert Panel was not informed of this data set by the Ministry of Environment and Forests despite specific inquiries for all available data sets, till the Panel learnt of its existence through some local concerned citizens of Ratnagiri district. As a result of requests, the Panel was then provided a copy of the Ratnagiri Zoning Atlas for Siting of Industries, although it failed to access any others, except that of Goa, the only one in the whole country to have been made public due to citizen pressure (WGEEP, 2011).

Ratnagiri ZASI's (MPCB, 2006) clear conclusion is that no more polluting industries should be located in the Lote MIDC area. Despite this there are plans to set up a new 550Ha Petro-Chemical complex next to MIDC area; a completely inappropriate decision.

The Regional Plan for Goa (RPG-2021)

Goa is (and continues) as the only State in India to have a State Level Regional Plan. Thereby the entire territory is covered by differentiated regional level land uses. The planning process has become more and more information intensive and participatory with each successive plan, the latest in the series being Goa Regional Plan 2021. The first step in this RPG-2021 planning was compilation of a comprehensive, spatially referenced, database on land, water and other natural resources of Goa state. This information was selectively shared with all Gram Sabhas and their suggestions as to possible errors in the database and desired pattern of land use obtained, consolidated and used as one important basis for preparation of the final plan. Regrettably, the Government of Goa has not continued with the dialogue, failing to go back to the Gram Sabhas when it felt it appropriate to diverge from the Gram Sabha suggestions. Nevertheless, this is an important scientific database for all further exercises and would have provided an excellent basis for WGEEP. Regrettably, despite repeated requests, this data was never made available even to WGEEP, an official Panel set up by the Government of India (Ribeiro 2011 pers. comm.; WGEEP, 2011).

Failure to Collect/Examine Pertinent Data

Much important, environment related information is simply never collected. Indeed, the grave disregard in this context is reflected the observation in Justice Shah Commission's Report on Illegal Mining in Goa (Shah Commission, 2012):

"Part IV. Section 24 of the Mines and Minerals (DR) Act, 1957 was not observed at all and that no inspection was carried out of iron ore mines…. which has caused loss to the ecology, environment, agriculture, ground water, natural streams, ponds, rivers, biodiversity, etc."

The objective of EIA exercise mandated under the Environment (Protection) Act 1986 is to protect the environment. This Act defines the "Environment" as including water, air and land and interrelationship which exists among and between water, air and land and human beings, other living creatures, plants, microorganisms and property. Hence, the scope of the EIA exercise is broad, and should not be interpreted in a restrictive fashion, even though specific guidelines were not issued till 2010. These guidelines also clearly underline the broad scope as indicated by its mention that "Vehicular traffic density outside the mine lease area, existing and after beginning of the mining activities should be given. The mode of transport of mineral and waste including loading, unloading in mining area should also be discussed. Vehicular load must be calculated. Further, the mineral transportation outside the mining lease area (road, rail, conveyor, rope way, water way, pipeline etc.) may be specified" (ASCI, 2010).

We examined the Goa EIA, EC, EMP experience on this background (Gadgil and Dongre, 2013). Mining has substantial impacts that pervade

through the entire state of Goa, impacting the Western Ghats, the midland plateaus and the coastal regions, the land and the waters, the forests, the agriculture and human settlements. Clearly, these need to be viewed in a comprehensive and integrated manner if the environmental impact of mining is to be properly assessed and addressed through appropriate management measures. Such a holistic view has been lacking, and specific enquiries under the Right to Information Act have brought out that essentially no information has been collected by the concerned agencies on the important issues highlighted in Table 1.

Athirappilly Hydro Electric Project

The proposed 163 MW Athirappilly Hydro-electric project on Chalakudy will be seventh of large dams on this 144 km small, but heavily dammed river. Chalakudy, with her magnificent waterfalls and rapids and her unique biodiversity rich gallery forests has one of the highest levels of fish diversity among Western Ghats rivers. It is clear that the Environmental Impact Assessments prepared for the project, and the public hearings conducted were flawed and the High Court has repeatedly set them aside. The River Research Centre's (RRC) assessment of the project brings out that the project report has made exaggerated claims of availability of water in the river; it has not looked into the likely adverse impacts on the currently available irrigation from the river, and on the scenic waterfall and thereby the thriving tourism business (WGEEP, 2011).

Ratnagiri Tree Cover

Another case in point relating to failure to maintain proper information relates to the forest cover of Ratnagiri district of Maharashtra. At the time of the initial forest settlement in late 19th century, only 1% or 2% of the district's forest was taken over by the state, the rest was left in private hands. While this was heavily exploited initially to meet Mumbai's demands in 19th century, and later to support the mill labour strike in 1980's, the forest has regenerated very well after these assaults. Today some 48% of the district has such a good secondary forest cover, although the government statistics claims that it has practically none. Notably enough the official exercise of preparation of Zoning Atlases for Siting of Industries, that has supposedly employed satellite imagery in its work shows only 2% of the land as being under forest cover, obviously because it has blindly relied on the State Forest Department maps instead of actually looking at the satellite data (MPCB, 2006).

Agriculture

Our Agricultural research establishment, including Agricultural Universities have kept no track of vital parameters on India's farmlands such as levels of organic matter and mineral nutrients in the soils, development of pesticide resistance amongst crop pests or spread of introduced genes for production of Bt toxins in GM crops.

Suppression of Scientific Activity

Forest Departments continually obstruct scientific activity in areas under their control, which extends over 1/5th of the country and harbours some of the most interesting sites for ecological research. This harassment has steadily increased over the years as was repeatedly stressed by many scientists deposing before the Tiger Task Force. For instance, Raghunandan Chundawat stated (Tiger Task Force, 2005):

> *"Unfortunately in last three decades no system has been created that encourages or institutionalises access to available professional research in protected areas nor that takes advantage of the growing body of professionals with expertise in relevant areas who work outside the government. We need to change the attitude of our management from a guard protecting jewels to a librarian who is managing library of unexplored knowledge and inviting people for learning. These problems occur now and again because we have failed to create a system, which supports and provides protection to independent research in the country."*

This is apparently linked to the desire to suppress the fact that the authorities are continuously engaged

Table 1: Goa mining related environmental issues and agencies

Issue	Agencies
Lowering of ground water level	Water Resources
Drying up of springs and other water courses on the hills	Water Resources
Siltation & shallowing of streams, river beds and estuaries	Water Resources
Change in the flow of water in the river and increased floods	Water Resources
Formation of waves due to barge movements	Captain of the Ports
Increased water turbidity	Pollution Control Board
Increased nitrate, iron and manganese content	Pollution Control Board
Oil pollution	Pollution Control Board
Depletion of ground water and water supply to farmlands and orchards and loss of agricultural productivity	Agriculture
Destruction of springs and other water sources and consequent disruption of irrigation to farms and orchards and loss of agricultural productivity	Water Resources, Hydrogeology and Agriculture
Siltation of farms and orchards leading to loss of agricultural productivity	Water Resources and Agriculture
Breaking of estuarine khazan land bunds due to over barge traffic movement in rivers leading to loss of agricultural productivity	Agriculture, Hydrogeology, and Water Resources
Loss of agricultural productivity due to oil pollution of water and soil	Pollution Control Board and Agriculture
Loss of agricultural productivity due to excess iron and manganese content in water and soil	Pollution Control Board and Agriculture
Turbidity in water, impact on photosynthesis and plant productivity, as well as productivity of filter feeding crustaceans in streams, rivers and khajan lands	Pollution Control Board and Fisheries
Increased sedimentation and choking of bottom dwelling shell fish and other organisms in streams, rivers and khajan lands	Pollution Control Board and Fisheries
Iron and manganese pollution impact on aquatic organisms in streams, rivers and khajan lands	Pollution Control Board and Fisheries
Oil pollution impact on aquatic organisms in streams, rivers and khajan lands	Pollution Control Board and Fisheries
Disturbance to aquatic animals due to waves created by barge movements in streams, rivers and khajan lands	Pollution Control Board and Fisheries
Destruction of special habitats like hill plateaus (sada), hill streams	Wild Life and Biodiversity Boards and Forest
Impact on coastal fisheries of increased barge traffic in rivers	Pollution Control Board, Captain of the Ports and Fisheries
Impact on coastal fisheries of increased ore loading points and of barge and ship movement in the coastal and offshore waters	Fisheries
Reduction in availability of land based as well as aquatic wild food	Wild Life and Biodiversity Boards and Forest, Fisheries and Health
Impacts of air, water and noise pollution on health	Health
Extra burden on women because of depletion of drinking water, fuelwood and other resources	Health, Social and Tribal Welfare
Loss of employment in fisheries, agriculture, horticulture and forestry sector	Fisheries, Agriculture, Horticulture, Forest and Social and Tribal Welfare

in disseminating false information, a fact that would come to light if independent researchers were involved in the studies. Consider as an example the experience of Sariska Tiger Reserve. In early years of the present century, the officials kept claiming that sizeable number of tigers were present, while the tourists failed to sight any. The Prime Minister then appointed a Task Force to look into the matter. This task force had access to the diaries of forest guards which showed that they were well aware that the tigers were being poached out. But the higher authorities did nothing beyond propagating false information on tiger numbers to the public as is evident from the figures (Table 2) from the report of the Tiger Task Force (2005).

Failure to Act on Pertinent Legislation

Lote Chemical Industries Complex

Stiglitz and many other economists insist that polluters must pay for cleaning up pollution and other related social costs fully to ensure healthy economic growth (Stiglitz, 2012). In India today this principle is being totally ignored, in spite of the existence of legislation such as the Water Act. A case in point is that of Lote MIDC chemical industry hub in Chiplun taluka of Ratnagiri district in Maharashtra. During the WGEEP meeting with Government of Maharashtra officials in Mumbai on 30th September, 2010, the Panel was informed that a Ratnagiri District Environment Committee chaired by the Ratnagiri District Collector, and a very active 'Lote Abhyas Gat' attached to Lote MIDC was making sure that pollution was kept under effective control. It turned out that no Ratnagiri District Environment Committee was in existence. However, the Lote Abhyas Gat did exist, and WGEEP had a meeting with them on 5th October 2010. It transpired that although the Abhyas Gat was constituted in 2006, only two meetings had been held till that date, the last being in 2008. Representatives from Kotavale, the worst hit village were not included in the Abhyas Gat despite their request. The Abhyas Gat had prepared some norms on effluent discharge, but these were not being followed. It is understood that many industries at Lote are pumping toxic waste into ground water through bore wells. Apparently, three such cases were brought to light, but there has been no action.

This Abhyas Gat meeting was followed by a field visit to Common Effluent Treatment Plant (CEPT) and some surrounding areas, as well as visits to Dabhol creek and discussions with many community members. It was revealed that the CETP cannot handle the quantity of effluent it is receiving, and its functioning is highly defective. There are other problems too. Around August 2010, toxic wastes were dumped by a tanker in the Boraj Dam which supplies water to Khed town. The town water supply had to be stopped for several weeks, but nobody has been brought to book. There has been significant decline in fish landings from Dabhol creek due to Lote chemical pollution, and severe loss of employment opportunities for members of fishing communities. No proper study has ever been undertaken of any of these issues (WGEEP, 2011).

Public Hearings

One other area that has been at the core of controversy in terms of manipulation and falsification of information is the mandated public hearings during the EIA process. It has been widely reported that the public hearing process is non-participatory and mostly 'managed' in favour of the proponents with little information about the project or its environmental impacts shared with the local people (Sinclair & Diduck, 2000; Martin, 2007; Diduck *et al*., 2007; HRW, 2012). Suppression of information and

Table 2: Tiger population estimates in Sariska Tiger Reserve

Year	1998	1999	2000	2001	2002	2003	2004
Tiger population (official census)	24	26	26	26	27	26	17
Tiger sightings by staff*	17	6	5	3	0	1	0

* Number of distinct animals present as judged by field staff

intimidation of villagers is common practice at most public hearings (TOI, 2015). Pallavi (2014) in her article in the Down to Earth magazine describes the situation at the public hearings of the proposed Rs 9,393 crore Ken-Betwa river link project in MP's Chattarpur and Panna districts. The hearings were largely confined to seeking fair compensation without any significant reference to environmental impacts. The following reaction of a villager quoted in the article, is typical of the manner in which EIA public hearings are held:

> "*We do not know what this project is about. We came only because a jeep came to our village, saying we were going to be displaced and that we should come to the public hearing. We have come to demand a fair compensation for displacement, because we know we can't stop the government from throwing us out*".

Plachimada Experience

A rare instance of a case where impacts of industrial activity on the capital of natural resources and on the livelihoods of people has been carefully assessed comes from Plachimada, a Panchayat in Palakkad district of Kerala where a Coca Cola plant is located. The Coca Cola plant has severely polluted as well as depleted ground water in the area, leading to drying up of wells, loss of agricultural productivity and concomitant negative impacts on livelihoods. The state government agencies had collected no pertinent information on what was happening. But Kerala has made substantial advances in decentralized governance and the Plachimada Panchayat stood its ground, forced a proper scientific inquiry into the losses suffered by the Plachimada residents and went ahead and rescinded the license of this global soft drink major. While canceling the license, the panchayat argued that it has the duty to protect the well-being of its subjects. So it has the right to cancel or refuse permission to anything that affects its subjects adversely. As a response, the state government constituted a Technical Expert Panel that has estimated the economic loss suffered by the residents of Plachimada at Rs. 260 crores and the state legislature has gone on to unanimously pass a bill named "Plachimada Coca Cola Victims Relief and Compensation Claims Special Tribunal Bill 2011" (WGEEP, 2011). It is notable that this Act is still awaiting President's signature and the local people have not received any compensation whatsoever.

System in Operation

The currently operational system of management of environment related data in India may thus be characterized as follows: Governmental agencies are responsible for collecting most of the information that pertains to environmental issues. A few agencies such as India Meteorological Department (IMD) discharge part of their responsibility competently, for example, properly recording temperature and rainfall data. In recent years IMD has also begun to share much of this information freely using the medium of the Internet. Even in the case of the meteorological data, the official network is very sparse and often has serious gaps. For instance, it has little good information from hilly terrain. In such contexts, owners of tea estates in Nilgiris have maintained excellent information that has been the basis of good scientific studies.

Regretfully, IMD is an exception. Other Governmental agencies exhibit a number of shortcomings (Gadgil, 2006b):

- *Failure to Maintain Records*: Some such as Department of Mines in Goa have utterly failed to maintain proper records of operational mines. Much sand mining and stone quarrying throughout the country is illegal and never brought on proper records. Similarly, Fisheries Departments and Pollution Control Boards maintain no records of major events like large scale fish mortalities. Even scientific organizations like the Indian Council of Agricultural Research have failed to maintain records of significant parameters such as changes in soil organic content of farmland, development of pesticide resistance amongst insect pests, and spread of introduced genes from GM crops.

- *Very Patchy, Incomplete Information*: Rapidly plunging groundwater levels are a very significant issue. Very limited information is available on this score. Remarkably, information on ground water level for Goa is available for talukas not affected by mining, but completely lacking in talukas affected by mining.

- *Suppression of Accurate Information* : Pollution Control Boards are culpable in many cases of suppressing information on levels of pollution greatly exceeding permissible limits, e.g. in the case of Vashishti river in Ratnagiri district of Maharashtra.

- *Deliberately Falsified Information* : Forestry establishment's records of tiger populations are clearly exaggerated in many areas. On the other hand, it has been claiming falsely that there are no tigers in Goa. A large proportion of Environmental Impact Assessments, prepared not only by private agencies, but also by CSIR labs like NEERI carry deliberately falsified information on issues like impact of mining on hill streams.

- *Failure to Make Information Publicly Available* : Significant sources of important information such as the pollution related *Zoning Atlas for Siting of Industries*, or land use related *Regional Plan for Goa 2021* that ought to be made available to the public are kept under wraps.

- *Failure to Involve Public in Generating Useful Information*: Three significant avenues for involving the public in generating useful environmental information, namely, preparation of ward-wise Environmental Status Report by Local Bodies under the 73rd and 74th Amendments to the Constitution, preparation of People's Biodiversity Registers by Local Bodies under Biological Diversity Act, and compilation of information generated through student projects under educational system-wide compulsory Environmental Education courses are being tapped very little.

- *Active Discouragement of Involving Public in Generating Useful Information* : Undue restrictions on public involvement in collection of useful environmental information are common, especially in lands under the control of Forestry establishment, which is country's major landlord controlling nearly one-fourth of the land surface.

ENVIS and Other Environmental Information Initiatives

In response to these challenges, the Ministry of Environment, Forest and Climate Change (then Department of Environment), Government of India launched an Environmental Information System (ENVIS) around 1983. ENVIS has evolved via a federated structure where selected institutions in the country have been designated as ENVIS nodes or centers tasked to collect and disseminate environmental information in specific thematic areas. Currently, the ENVIS network has 68 centers which include institutional, NGO and State Government Partners. While ENVIS has some long-term and some short-term objectives, the core idea for ENVIS is to act as a repository and disseminator of environmental information (MoEF&CC, 2015). Although ENVIS has by now completed over three decades in existence, information available from various ENVIS centers is largely document based comprising of newsletters, bibliographies, abstracts, annual reports, research papers, court orders, circulars etc. While some ENVIS centers host databases, often times these databases have either been found not to work or provide very coarse information that has little immediate practical value in environmental governance. The highly federated structure of ENVIS, imposed by its subject-centric segregation of information collation to partner institutions, makes ENVIS lack design coherence. The sum of its parts does not seem to add up to a whole capable of aiding environmental decision making. The inadequacy of ENVIS to meet requirements of environmental governance is substantiated by the fact that in spite of the its existence from 1983 till date, MOEF&CC felt the need to start and operate a new environmental information facility called the *Environmental*

Information Centre (EIC) to function as a professionally managed clearing house for environmental information in 2002 (EnviroLink, 2002; Murthy, 2005). EIC started through a digital portal (Fig. 1) aiming to fill the environmental information void by providing quality environmental information to aid environmental planning and decision making. The examination of the following genesis statement displayed on the EIC website clearly suggests that the primary objective of setting up the EIC was to cater to improving the quality of EIAs and accelerate the process of environmental clearances (EIC, 2004):

"The environmental decision making for environment clearance (as per the environment regulations in India) to a large extent, has been an over the counter operation for project proponents, the environmental regulators and other stake holders. Technical specialists are consulted by policy and decision makers, to assist in gathering information on project screening scoping and on the quality of environmental studies that have been submitted for evaluation. Because of the inaccessibility of good quality of data, the decision making is often a time-consuming, inefficient and a faulty process. If the data and analytical tools could be placed within reach of the decision makers, they would be able to consult them more readily, and would therefore be more likely to base their decisions upon more logical foundation. A committee was set up by the Cabinet Secretariat, with Shri V. Govindarajan as convener, to examine extant procedures for investment approvals and implementation of projects and to suggest measures to simplify and expedite the process of both public and private projects. The committee pointed that the Environment clearance perhaps takes the longest time and causes maximum delay to projects. Cumbersome procedures for environmental clearance and public hearing, submission of incomplete information, poor

Fig. 1: The EIC Landing Page (EIC, 2004)

quality of EIA/EMP, disproportionate details required for the application, delays in the meetings of the Expert Committees and site visits are major reasons behind delays. To ensure a speedy environmental clearance as per the environmental regulations in India, the Govindarajan committee recommended that MoEF should consider setting up a central data centre, which could serve as a one-stop source for obtaining reliable and validated data for preparing EIAs. The database will help screening and scoping for the EIA study. Experience in India indicates that lack of timely availability of reliable environmental data has been one of the major bottlenecks in scoping of EIA and for the preparation of quality EIA reports and consequent environmental decision making process. Environment being a multidisciplinary area, multitude of agencies are involved in collection of environmental data. However, there is no single organization in India that tracks the data available among the multitude of data generators and makes it available in the form and manner required by the practitioners in the field of EIA. Further, the environmental data is often not available in a processed or value added form that can possibly enhance the scoping, the quality of the EIA studies and logical environmental decision making. All this in turn affects the effectiveness of EIA process by causing delays in conducting EIAs and in reviewing the EIA reports for according timely Environmental Clearance (EC) as per the environment regulations. With this background, Environmental Information Centre (EIC) was conceived. EIC was set up to serve as a professionally managed clearinghouse of one stop environmental information".

Information available from the internet archive seems to suggest that the EIC, for reasons not immediately apparent, gradually lost traction and finally stopped functioning around 2010 and its domain name – http://www.eicinformation.org – was not renewed thereafter. In the absence of the EIC and without any successor to the facility, the problem of quality environmental information suitable for environmental governance and decision making remains unaddressed. In this situation, the role visualized for EIC has now been relegated to ENVIS via a recent office memorandum (MOEF&CC, 2014). With no fundamental structural or design changes in ENVIS in the past many years (discounting increase in membership of partner institutions), it is difficult to visualize how ENVIS can fit this role and meet specialized information requirements that it is not designed to deliver.

A Transparent, Participatory, Public Database

Evidently, in the modern information age, we need to move towards greater objectivity, transparency and participation by all segments of the society in all spheres of national activity, including generation and management of environment-related information.

Promoting Objectivity

The Environmental Clearance process is a rich source of data relating to Indian environment. Regrettably it is today a flawed process that generates little reliable information. It is vital that it be reformed to ensure objectivity and completeness of the information generated, along with promoting transparency and participation. What is needed is: [a] assigning preparation of EIA statements to a neutral competent body that does not depend on payment by project proponents. This will not only produce credible environmental information but also avoid what has been termed as 'agenda-control' in favour of the proponent (Hukkinen,2008) [b] making mandatory the involvement of local Biodiversity Management Committees in the process of EIA preparation, [c] making mandatory taking on board all information submitted and suggestions made during Public Hearings. In fact, the EIA must itself take public view into consideration at the very beginning of the process, rather than seek public view after preparing the report (Rajaram and Das, 2006). [d] making mandatory, periodic environmental clearance requirement, preferably every five years, [e] making mandatory involvement of local Biodiversity Management Committees in the process of monitoring of implementation of conditions laid down while granting Environmental Clearances (Glasson,1994), [f] making mandatory preparation of regional Cumulative Environmental Impact Analyses (WGEEP, 2011).

Promoting Transparency

Transparency is the hallmark of science and it is vital that India's Environment Information System be totally transparent. Fortunately, we have an excellent Right to Information Act which should facilitate ensuring transparency (DoPT, 2015). In this context, the most important provision is the provision for *suo motu* disclosure in CHAPTER II Right to information and obligations of public authorities (2) - It shall be a constant endeavour of every public authority to take steps in accordance with the requirements of clause (b) of sub-section (1) to provide as much information suo motu to the public at regular intervals through various means of communications, including Internet, so that the public have minimum resort to the use of this Act to obtain information.

India has also committed itself to opening up of data generated by public funds i.e. ministries/line departments by promulgating National Data Sharing and Accessibility Policy (NDSAP). The NDSAP defines a dataset as open "if anyone is free to use, reuse, and redistribute it. Open Data is machine readable and should also be easily accessible". In fact, as per the NDSAP implementation guidelines, NDSAP is applicable to all entities in the government setup and its "notification mandates government departments to proactively open up data" (NIC, 2014). While a beginning for dissemination of open data has been made through the national open data platform – data.gov.in, there are hardly any high value environmental datasets available that can be put to any serious use. Most datasets are quite old, available only as text or excel sheets and are not geo-tagged. In divergence with the NDSAP guidelines, Government departments are doing very little to share useful data via the national open data platform. Furthermore, the true value of environmental datasets would be realized only when they are current, application centric and most importantly geo-referenced to be used as GIS layers. One significant opportunity to create and disseminate such datasets would emerge if government departments, in pursuit of NDSAP and digital India mission, team up with Bhuvan (ISRO, 2015) and make high value geocoded environmental datasets available which can be used to improve the quality of EIAs.

Promoting Participation

Modern science has abundantly demonstrated that good information flows from an open, transparent process that welcomes participation from all interested parties. All over the world, citizens are a great repository of detailed information on many facets of their local environment. Our citizens, especially those strongly rooted to their local environments in their pursuit of livelihoods, the barefoot ecologists, and students and teachers, whose business it is to acquire, grow and disseminate knowledge, ought to play an important role in this process of building up a good information resource on India's environment. In this context, a great opportunity has been provided by India's Biological Diversity Act 2002 that mandates the establishment of Biodiversity Management Committees in all local bodies, ranging from Gram Panchayats and Nagarpalikas to Taluk Panchayat Samitis and Zilla Parishads and assigns to these committees the role of preparing local level environmental information in the form of "People's Biodiversity Registers (PBR)". It thus provides an excellent platform for the involvement of the barefoot ecologists along with students and teachers for generating detailed systematic documentation on the local environment. Furthermore, these PBRs are not expected to be just one time exercises of preparing written documents, but continually updated databases with provisions for maintaining certain information as confidential and other information as publicly accessible. These local level databases are expected to be linked to an Indian Biodiversity Information System (Gadgil *et al*., 2000; Gadgil, 2006c).

Regrettably, the state and central governmental authorities have failed to support this most worthwhile initiative. However, a small number of voluntary efforts by village communities collaborating with scientists have produced some excellent models of what may be achieved through this route (Gadgil and Heda, 2009). In a more specific context, the Government of Sikkim has demonstrated the power of this approach through its Sikkim Springs programme. This highly

successful programme entails mapping of the hill springs of the state with active participation of the local communities, with the data organized into a state level computerized and publicly available database (Sikkim Springs, 2015).

Environmental Education Projects

The study of environment is ideally suited to serve as a lever to get students engaged, not merely in memorizing, but instead in learning, and in building capacity for critical thinking and problem solving. In this context, the National Curriculum Framework exercise undertaken in 2005 has made two important recommendations that have been accepted by the Central Advisory Board (CAB) on education, namely:

- Involve students in first hand observation, and collection and interpretation of information on their own environment.
- Create a model system of collection of information on the status and on-going changes in various environmental parameters with the help of a decentralized network of high schools and junior colleges.

Given its intrinsic variability, each ecosystem, along with its complement of biodiversity tends to be unique. Its understanding therefore calls for extensive locality and time specific observations, careful documentation and an elucidation of the patterns and underlying processes. It is certainly feasible to initiate such careful, locality specific documentation of many facets of India's ecology and biodiversity on the basis of student projects. Furthermore, the results of such projects could be uploaded on a publicly accessible website, thereby creating a transparent, comprehensive database on India's environment. By inviting, not only experts, but all interested citizens to assess the quality of such projects and augment their results, a self-correcting system could be set up that would lead to an organic growth of our understanding of Indian environmental scenario and concrete ways of undertaking positive action. Including such knowledge generation activities as a part of the educational process would greatly enhance the quality of the educational experience as well (NCERT 2005, 2008).

It may be appropriate to mention here that the Centre for Ecological Sciences (CES) at the Indian Institute of Science (IISc), Bangalore has been engaged in experiments on such a model with a number of High Schools and Junior and Degree Colleges in Karnataka since 1993. These experiments have demonstrated that good quality data can be collected by deploying student power provided that sufficient efforts are devoted to developing proper methodology, resource material and training programmes. As an example, students of 42 Karnataka High Schools could collect data on levels and recent trends in local abundance for 172 out of 300 medicinal plant species used commercially in Karnataka. Only limited information on 27 of these species is available with Government agencies or pharmaceutical industry. This data has been organized in a Relational Database Management System (Gadgil and Rao, 1998). Regretfully, this excellent recommendation of CAB has in no way been translated into practice.

Potential of Wikipedia

The rapidly advancing tools of ICT hold much promise in facilitating a participatory process of knowledge generation. Indeed, a whole new movement of Citizen Science has developed the world over in recent decades under the impetus of the ICT revolution, in particular the Wiki software, and availability of knowledge resources such as Wikipedia. The Waterwatch programme of the state of Victoria in Australia provides an excellent model of such an approach. The Waterwatch Victoria is a successful community engagement program connecting local communities with river health and sustainable water issues and management. It was initiated in 1993 to enable the community to become involved in the monitoring and management of waterways in their catchment, with volunteers with a passion for the environment, providing water quality data from waterways spanning the entire state. The data is used to monitor waterways over time to establish their condition and whether change (positive or negative) is occurring (Waterwatch, 2015). The Biological

Diversity Act and the student level Environmental Education projects provide excellent opportunities to set up a parallel programmes in India, opportunities that are regretfully being deliberately sabotaged.

Given the very serious limitations of activating official machinery into worthwhile action as evident from the failures to deploy Biodiversity Management Committees or operationalize the CAB recommendation on Environmental Education, it is worthwhile organizing an entirely citizen driven effort. This is certainly feasible, as has been demonstrated by Wikipedia that has successfully created an outstanding, free, internet-based Encyclopedia (Reagle, 2010). Notably, this is an entirely citizen-based effort without any Governmental support or any special role for experts, and free of any commercial influences. We should now consider generating Wikipedia articles on each and every locality covered by Census of India 2011 as was done with the use of US Census data around 2002-03. Into such articles, the local citizens may then upload reliable information on issues such as mass mortalities of fish, which is invariably reported, at least in the local language newspapers but fails to be consolidated. Notably there are now Wikipedia versions of all Indian state languages. With proper use of hyperlinks, such data can be readily organized into a comprehensive transparent, participatory and dynamic dataset.

The Way Ahead

The problem of collecting, collating, validating and disseminating quality environmental datasets is indeed a complex one. It is clear that the existing environmental information practices in the country are grossly insufficient to meet the needs of environmental governance. The absence of freely available credible baseline information on various environmnetal variables has resulted in a situation which is promoting data manipulation, obfuscation and faslification. It is vital that urgent steps are taken in mission mode to fill this information void by reimagining and redesigining a multipurpose environmental information superstructure for the country. The recent launch of the Digital India intitative by the Government of India with its focus on promoting geospatial data (DietY, 2015), further necessitates that the environmnetal information architecture be revisited and realligned to serve the complex environmnetal and sustainability challenges of the new millenium.

The emergence & growth of the internet in the last two decades and the information collection and dissemination models that have evolved in its wake, have important lessons in reimagining the environmental information architecture of the country. It is imperative that the new architecture firmly keep the following key tenets in view :

I. In addition to government and non-governmental organizations like Center for Science and Environment(CSE) and Ashoka Trust for Ecology and Environment (ATREE), involvement of people, local communities should become a key component in gathering, uploading and updating environmental information. The local Biodiversity Management Committees and the people bidoversity registers framework as promulgated in Biological Diversity Act 2002 & Rules 2004 (NBA, 2013) coupled with mobile and web technologies can prove invaluable in building and maintaining information assets.

II. A national environmental researchers network be created and actively engaged to guide and contribute to the environmental information initiative.

III. In keeping with the vision of the National Spatial Data Infrastructure (NDSI,2015), there should be a sustained effort to geocode environmental information and make it available as GIS ready datasets such that environmental decision making can be informed by spatial intelligence.

IV. Environmental information, in the spirit of National Data Sharing and Accessibility Policy (DST, 2012), must be shared freely and transparently with all.

V. The environmental information architecture should incorporate national environmental data quality standards that can define procedures for ensuring credibility and validity of the information being shared.

In pursuance of the above, the following initiatives can be undertaken to build the environmental information infrastucture:

1. Starting a fresh initiative to create a new Environment Infromation Infrastructure that can act as a umbrella platform to collate and disseminate environmental information in the country. This rethinking is also vital to allign environmental information collection and dissemination with the Digital India initiative.

2. Setting up of a Environmental Information System Design Group to technically visualise the design,development,delivery and maintainence of the proposed information system infrastructure.

3. Creating partnerships with public sector and private sector digital platforms. Two notable partneships that can have considerable impact include (a) Bhuvan (ISRO, 2015) and (b) Google Public Data Explorer (Google, 2015). The Bhuvan platform developed and maintained by the Indian Space Research Organization (ISRO) has, over the years, made remarkable progress in integrating and making available high quality geospatial information and tools. The Bhuvan platform is already interfacing with many ministries and line departments (Fig. 2) and has stable and mature tools for creation of online GIS ready shapefiles via a user friendly interface. Bhuvan is easily accessible and provides information and remotely sensed data from the Indian Remote Sensing Satellite constellation free of cost. It has many useful ancillary layers which can be very useful in data visualization. Currently some state forest departments like Karnataka have put forest boundary maps on Bhuvan demonstrating the possible potential of this paltform for environmental data generation and dissemination. In view of the above, Bhuvan should play a very

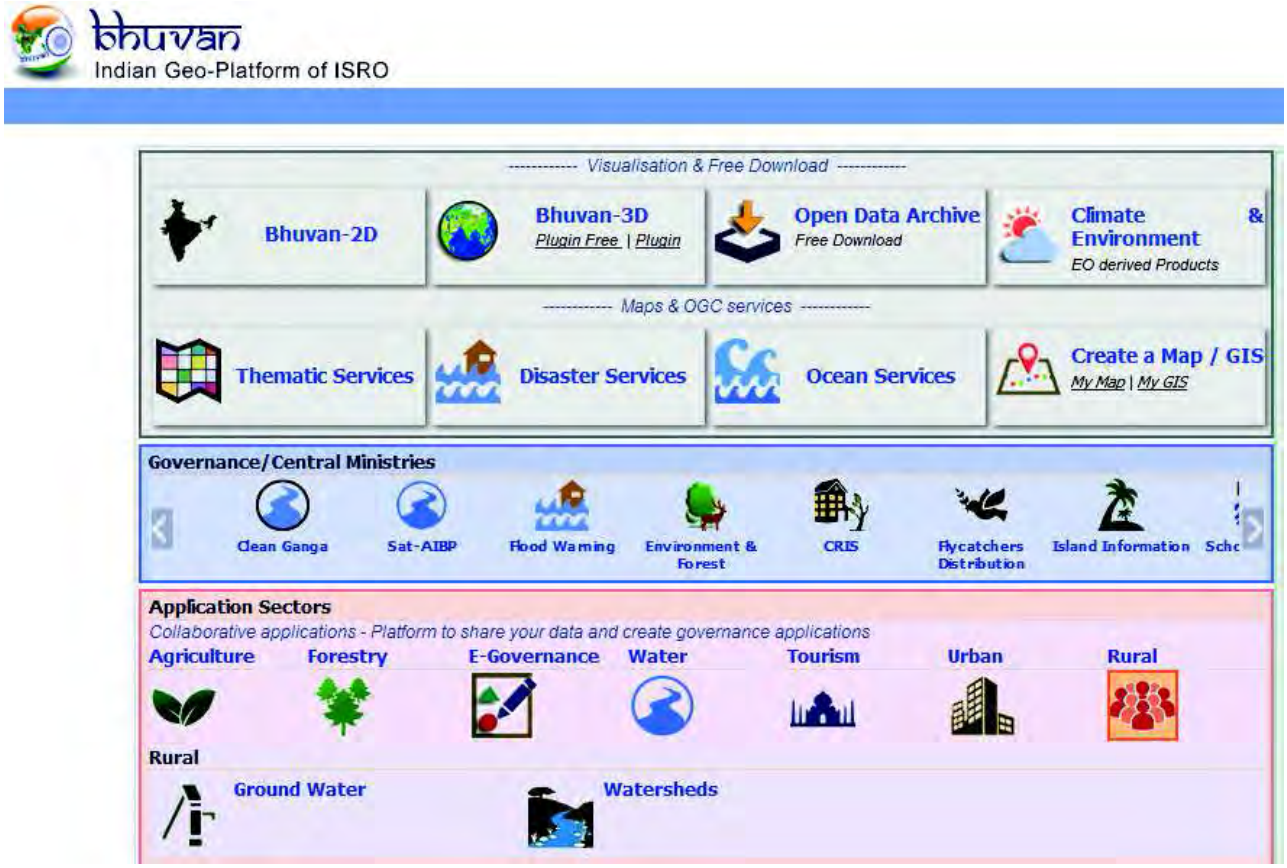

Fig. 2: The Bhuvan Platform (ISRO, 2015)

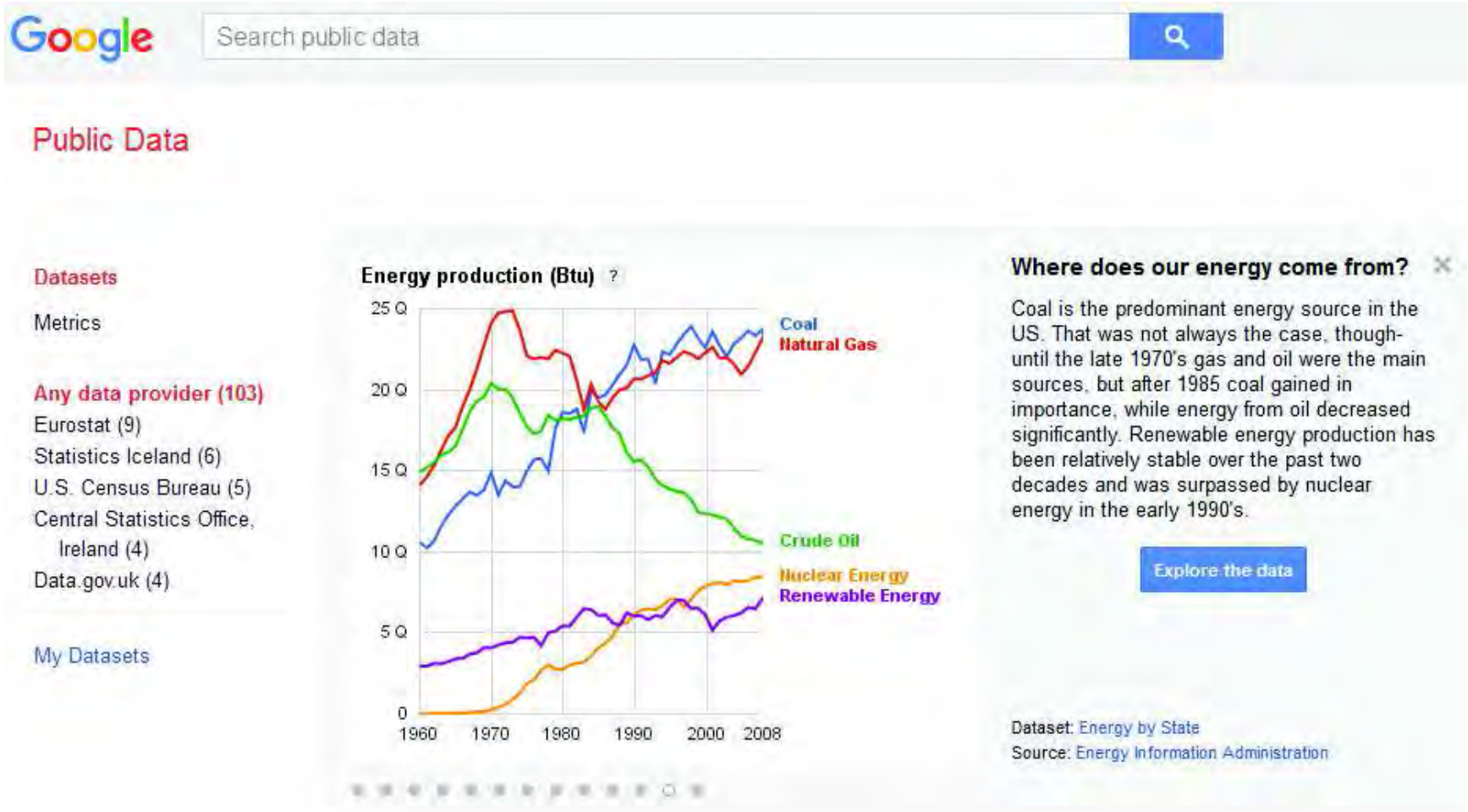

Fig. 3: Google Public Data Explorer (Google, 2015)

major role in the poposed environmental information infrastucture as there is a huge opportunity of convergence between all stakeholders via this platform.

The second platform that could make a considerable impact is the Google Public Data Explorer (Fig. 3). Leveraging the power of analytics, the Google Public Data explorer is using many sources of public data like UN, Worldbank etc. to provide powerful visualizations of data. There is a good opportunity to partner with Google by permitting Google to access publically available Indian environmental datasets and include them in the Google public data explorer directory and possibily integrate them as Google Earth and Google Maps layers. The e-Green Watch portal of the MOEF&CC for the management of processes related to plantation and other forestry works provides an initial glimpse of such integration (e-Green Watch, 2015).

4. Finally, the Indian citizens should also pursue independent crowd sourced initiatives like Wikipedia to build public repositories of environmental information that are totally independent of any Governmental involvement or control.

Conclusion

It is imperative that we transform the current opaque, exclusionary and bureaucratically controlled system of managing information relating to India's environment into an open, transparent and participatory system. Indeed, we should aim to launch it as a people's movement, a movement that should be spearheaded by the country's scientific community.

What can Science Academies do?

Our Science Academies would do well to prepare a white paper on this topic by constituting an interdisciplinary group of the Fellows representing various pertinent disciplines. This paper should also incorporate a systematic assessment of the extent of current practices violating values of science.

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