Missing the Woods for the Ore: Goa's Development Myopia

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A recent report by the National Council of Applied Economic Research comparing benefits and costs of mining and forest services finds that mining benefits outweigh the costs they impose. A scrutiny of the methodology of the report suggests an overvaluation of social benefits and undervaluation of social costs. The report also deviates from received practices in environmental valuation of forest benefits. Its conclusions therefore are inaccurate and state policy must be cautious while allowing activities that may cause irreversible damages to Goa's natural wealth.

1 Introduction

The ongoing debate on conservation and development invariably revolves around alternative uses for natural resources raising a basic question between the need for industrial growth and hence the demand for sub-soil resources on the one hand, and the need for maintaining and increasing our natural capital (Dasgupta 1982). Fossil fuels, coal, minerals, etc, are all nature's bounties which are typically sub-soil resources that are extractable now or in the future. This extraction is not a neutral process because it causes irreversible damage to the surface environment consisting of forests, water and river bodies, arable lands, oceans and biodiversity, apart from damaging the sub-soil organic chemical properties, water and biodiversity (Kadekodi 2010).

In this paper we critically examine the developmental role claimed for the mining industry by the National Council of Applied Economic Research (NCAER) (2010) for Goa. The mining industry provides employment, contributes to gross domestic product (GDP) by production and has been the engine of growth for many economies. With growing domestic and international demand for metals, the expansion of the mining industry has been quite dramatic, especially in states where large mineral deposits exist. However, since these are sub-soil deposits, their extraction imposes a cost on the environment, other natural resources like water, and local human populations. The debate, therefore, involves a comparison of costs and benefits of this industry in the larger social context (World Bank 1998).

NCAER (2010) provides a social cost-benefit analysis (CBA) of mining and forests in Goa and argues that the gross benefits from mining outweigh the losses that may be incurred from the loss of forests. The net gain from such a strategy is calculated to be Rs 1,842.2 crore per year (ibid: 50). Using a 12% social discount rate (SDR) and a time frame of 25 years it finds that the opportunity cost of mining is Rs 14,449 crore measured as net present value (NPV) of losses to be incurred if mining was disallowed.[1] The values used by NCAER (2010: 29, 55) suggest that out of the 1,424 square kilometres[2] of dense forest area, about 296 square kilometres (8% of geographical area or about 20% of dense forest area) is under mining;[3] and the corresponding deforestation cost due to mining is estimated to be worth Rs 468 crore (at 2008-09 prices), which amounts to Rs 1.58 lakhs per hectare of forest area. This figure is rather small when compared with the range of ecosystem services that are derived from tropical natural forests (Kumar 2011).[4]

We argue that this report undervalues the environmental costs of mining and overvalues the benefits when examined in the light of received practices in environmental valuation. Its conclusions

therefore are inaccurate. The needs of development often force policymakers to make difficult choices but state policy must be cautious while allowing activities that may cause irreversible damage to Goa's natural wealth.

The question we raise is whether the benefits from forests currently outweigh the benefits from an alternate land use.[5] The NCAER (2010) report attempts to lay the economic justification for permitting further land use change of Goa's forests in favour of mining. This paper fundamentally questions this wisdom, based on CBA of mineral extraction, apart from suggesting a comprehensive study on valuation of ecosystem services of forests, rivers and biodiversity in Goa.[6]

2 Issues in Valuation and Evaluation of Mining Activity

The Western Ghats region in Goa, a biodiversity hotspot, contains dense tropical forests with one national park at Mollem and six wildlife sanctuaries (FSI 2009). This is the watershed for important water bodies such as the Kushawati, Kalay, Uguem, Khandepar, Advoi, Bicholim, Zuari, and Mandovi rivers. These rivers feed the world famous Goan ocean front with fresh water, and provide life support to aquatic and ocean biodiversity.

Without a complete assessment of the value of these resources, a decision on alternate land use and the opportunity costs thereof would be imprudent. Thankfully, the techniques of valuation are constantly improving and economists have at their disposal a set of tools which allow them to make some reliable estimates (Freeman 2003; Kumar 2011).

The Total Economic Value (TEV) method is a point for discussion in this context (Krutilla and Fisher 1975; Pearce and Turner 1990). The logic of TEV is that resources have multiple "use" (direct and indirect) and "non-use" benefits. If all these items could be added up then we would arrive at a composite value for one or more natural resources.[7]

A complete valuation of forest resources would require inclusion of timber and non-timber values (fuels and food from forests, non-timber forest products or NTFPs), the biodiversity values (including ecotourism, bioprospecting, flagship species non-use values) and ecological services (water augmentation and regulation, climate regulation, mitigation of flood damage and soil erosion, pollination, waste absorption, etc). This is now a well established methodology in Natural Resource Accounting (Pagiola et al 2004).[8]

Evidently, the TEV refers to the ecosystem functions performed by the natural resources. The ecosystem functions provide ecosystem services. Examples such as fish in the Zuari or Mandovi rivers (an ecosystem function) providing food (an ecosystem service or good) can be given. Another example is regeneration and conservation of forests in Goa (an ecosystem function) enabling flood control for the downstream towns (an ecosystem service). Keeping human welfare as the basis of analysis, ecosystem services therefore are to be understood and measured as part of the CBA for mineral extraction.

Social costs of mining would include the loss of an entire spectrum of ecosystem services while social benefits would include the value of minerals (both export and other processing values), employment generation, etc. One does not find such a methodology in the NCAER (2010) report. Only direct environmental costs such as air pollution, deforestation and damage to landscape due

to mining are accounted for, ignoring the loss of an entire set of ecosystem services (ibid: 43).

The denudation of forest resources in Goa could have dramatic effects on the hydrological cycle of the state which relies largely on perennial flow of fresh water from Mandovi and Zuari and other watersheds that lie in the Western Ghats (and are not fed by glacial melt as in the Gangetic system). If the moisture retention capacity of these watersheds declines, the entire life cycle of the state would be aggravated dramatically – increased floods in all urban and rural areas alongside the rivers during the monsoons, salinity ingress upstream in the non-monsoon period, and the drying of the rivers and closure of river navigation, loss of marine life, among other impacts. These impacts are over and above the known damages that mining causes – contamination or destruction of groundwater table, inundation of fields with mining waste and health problems associated with air and dust pollution (Nayak 2002).

Forests services are typically classified as (i) direct use value; (ii) indirect use value; (iii) option value; and (iv) non-use value. The first three (i-iii) are the "use values" and all four components must be added to get the TEV (Adger et al 1995). With this methodological approach, we now examine some of the findings of NCAER (2010).

3 All About Forest Values

Over the last decade, various monetary estimates for Indian forests' stocks and flows have become available with increasing levels of sophistry. This is not the occasion to review that literature but we pick on some of the key estimates to demonstrate that the NCAER methodology is not in conformity with established procedure in this genre of economics.

NCAER (2010: 61) claims to have adapted forest values generated by IRADE (2008) using Verma (2000) methodology. But curiously, both IRADE and NCAER deduct most of the benefits in their computation of the economic value of forests, whereas Verma and Verma et al (2006) have attempted to bring these into the NRA accounting framework. The IRADE and corresponding NCAER estimates are presented in Table 1. Both these studies arrive at much smaller values for Goa's forests than estimates by the Green Accounting for Indian States Project (GAISP), namely, Gundimeda et al (2005, 2006, 2007) and Kumar et al (2006) as well as the ones from Supreme Court (2008).[9]

Table 1: Comparative Estimates of Forest Values (NPV in Rs crore)

	IRADE (2008) Tables 4.23 and 4.25 (2004-05 Prices)	NCAER (2010) Tables A7.1 and A7.2 (2004-05 Prices)	GAISP Values Higher Bound (2001-02 Prices)	GAISP Values Lower Bound (2001-02 Prices)
Total economic value (TEV, of which)	4,430	2,926	16,988[10]	10,878
Timber	74	48.87	1,638.16[11]	1,638[11]
NTFP	9	5.94	31[12]	31[12]
Fodder	32.7[13]	14.53	70[14]	70
Fuelwood	3	1.98[15]	Computed as part of "Timber" above	Computed as part of "Timber" above
Ecotourism	600	396.29	836[16]	114
Watershed benefits	3,033	2,003.24	2,631.6[17]	2,631.6
Carbon sink	225	148.6	903.05[18]	903.05
Bioprospecting	452[19]	298.5	5,912[20]	525
Non-use values			4,965.5[21]	4,965
Economic value[22]	550	363.26[23]		

Additionally, based on the TEV norms prescribed by the Supreme Court of India (Supreme Court 2008), as shown in Table 3 ahead, the estimated TEV of Goa's forest values are Rs 18,606 crore. Since all these estimates refer to different time periods (2001-02, 2004-05, 2008) for purposes of fair comparison, they are adjusted to 2009-10 prices using the consumer price index (CPI) for urban non-manual employees.[24] As shown in Table 2 (last row), in comparison to the other estimates (namely, Supreme Court or SC 2008 and the GAISP), the estimates from NCAER (2010) and IRADE (2008) are much lower. The Supreme Court values lie in between the high and lower bound TEV values obtained from the sensitivity analysis using the GAISP estimates.

Table 2: Comparative TEV (Rs Crore) Valued at 2009-10 Prices (Using CPI UNME indices)

	IRADE (2008)		NCAER (2010)			GAISP Values	
	Total Economic Value	Economic Value	Total Economic Value	Economic Value	SC (2008)	Higher Bound	Lower Bound
2001-02 prices						16,988	10,878
2004-05 prices	4,430	550	2,925	363			
2008-09 prices					18,606		
2009-10 prices	5,454	677	4,067	505	21,027	27,617	17,684

CPI UNME is the consumer price index for urban non-manual employees. Figures for IRADE are from p 88; figures for NCAER are from p 42.

Evidently, IRADE (2008) and NCAER (2010) forest values are substantially smaller than those estimated by Gundimeda et al (2005, 2006, 2007) and Kumar et al (2006). The reasons for this are not hard to find. Some of the benefits from forests have been undervalued while some others have not entered the computation by NCAER. We next compare some of the individual item values estimated by NCAER with others available in the literature.

3.1 Ecotourism

The NCAER report (2010) follows the IRADE report (2008) in establishing ecotourism benefits. Even though these reports estimate the values for ecotourism benefits in Goa, they do not add them to the total forest benefits claiming that these values reflect the beach-based ecotourism benefits.

There is a problem with such an argument. There is 755 square kilometres of forestland under parks and sanctuaries in Goa (FSI 2009: 78). There is a reasonable amount of forest tourism and a number of ecotourism resorts have established themselves around these sanctuaries. Gundimeda et al (2006: 34) record that the NPV of ecotourism benefits of forests in Goa is Rs 73,710 per hectare (at 2001 prices) which aggregates to Rs 556.5 crore for 755 square kilometres under parks and sanctuaries, whereas IRADE (2008: 84) ignores this contribution.

3.2 Valuing Biodiversity

Gundimeda et al (2006: 34) estimate the biodiversity benefits to be Rs 5,20,932 per hectare for Goa (at 2001-02 prices) aggregating to Rs 5,912 crore considering only the dense and very dense forest areas of Goa (at 2001-02 prices). IRADE (2008: 85) on the other hand estimates the biodiversity value in the range of Rs 20,964.74 per hectare (all forests) to Rs 36,015.93 per hectare (moderate dense forests). Their estimate of biodiversity value at Rs 452 crore is extrapolated from Verma (2000) at Rs 0.21 lakh per

hectare for the entire forest area in Goa (2,156 hectare for their assessment).

3.3 Omission of Other Benefit Values

Other than the problem of undervaluing ecotourism benefits, there are two significant benefit omissions in the computation matrix of NCAER (2010) for forests.

Non-Use Values: Gundimeda et al (2006: 39) further suggest that the presence of tigers and elephants (or similar keystone species) add to the non-use value of forests by Rs 4,37,488 per hectare (at 2001-02 prices). There have been regular sighting of leopards and elephants (and occasional tiger sighting reports) in Goa's forests and its buffer zones (Sarma and Easa 2006). The forest non-use benefits accordingly add up to Rs 4,965.5 crore (see Table 1, col 3).

Resilience Value: The second component is "resilience", which has been defined as the ability of a system to revert to its earlier state of equilibrium, if perturbed. Mäler et al (2008) have argued that "resilience" of a system is an inalienable component of natural capital and must form part of the ecosystem assessment. There is no available estimate of resilience value for Goa's forests and this needs to be addressed by future research.

We next present a thumb-rule alternative estimate of TEV that can be inferred from a landmark order of the Supreme Court (2008) that has relevance to the discussion at hand.

3.4 The Supreme Court and Forest Valuation

In what has become known as the T N Godavarman case, the Supreme Court of India established NPV values for alteration in forestland (Supreme Court 2008). These are the NPVs based on the benefits that are derived from India's forests which would be forgone if forestland use was changed and are therefore compensatory payments for benefits forgone.

Based on the recommendations of the Central Empowered Committee (CEC), the Kanchan Chopra Expert Committee, and the Supreme Court order, we recalculate the NPV of Goa's forests to be Rs 18,605.89 crore at 2008-09 prices (see Table 3 for calculations).

Table 3: Amounts of Compensation Payable for Goa's Forests as Per Supreme Court Mandated Values[25]

Type of Forests	Amount (Rs) Per Hectare[a]	Area (Sq Kms)[b]	In Rs (Crore)[c]
Very dense forest	10,43,000	511	5,329.73
Dense forest	9,39,000	624	58,593.6
Open forest	7,30,000	1,016	7,416.8
Total		2,151	18,605.89

Source: [a]: Supreme Court (2008); [b]: FSI (2009); c: Values of "a" multiplied by "b".

The valuation of forests by this method is significantly larger than the economic value of forests at Rs 468 crore (at 2008-09 prices) calculated by NCAER (2010).

Having demonstrated that the valuation of forests by NCAER is inaccurate and a gross underestimate, we next establish the there has been an overvaluation of benefits from mining activity and an undervaluation of costs imposed by it.

The entry point for this discussion is the SDR which is supposed to be the rate at which society discounts the future benefits and costs.

4 Appropriate Social Discount Rate

NCAER (2010) has chosen a SDR of 12%. This is an outlier as far as environmental valuation is concerned where SDRs used typically range between 0% and 5% (see illustrative and non-exhaustive list of SDRs in Table 4, and Arrow et al (1996) for a detailed discussion).

The problem with using a large SDR is that it makes future values look very small in the present and therefore prejudices choices in favour of the present belying the needs of the future. Environmental damage typically is found to have long-term consequences and therefore the need for a small SDR. We use 5% SDR for some of our alternate estimates discussed here (even this is considered to be high as demonstrated by the values given in Table 4).

Table 4: SDRs Used in Some Studies (non-exhaustive list)

SDR	Reference
0%	Ramsey (1928),[26] Cline (1992)
1.4%	Stern (2007)
0–2%	Experts views to CEC for forest valuation (CEC 2007)
4%	Gundimeda et al (2006), Kumar et al (2006), Nordhaus (1994)
5%	Kanchan Chopra committee recommendation to CEC and Supreme Court for forest valuation (CEC 2007; Verma et al 2006; Kula 2004)

5 Overvaluation of Mining Benefits

In order to enhance the social benefit estimates of mining, NCAER has listed various claims (Table 5) which on scrutiny we find ineligible to be counted as social benefits.

5.1 Transport of Ore

The first in this list are the claims that pertain to the transport of ore. Iron ore in Goa is largely exported by sea and is transported from the mines to the Mormugao Port Trust (MPT) by barges by way of river navigation. NCAER (2010) has claimed carbon credits worth Rs 10.9 crore for the mining industry due to use of barges for transporting iron ore from the mines and Rs 30.6 crore due to reduced diesel subsidy for the same means of transport. The basis of this claim is that these benefits accrue because barges are a clean and more efficient transport alternative to trucks. We argue that these are false claims on the following counts.

Table 5: Benefit Calculation by NCAER (2010)

Item	Benefit Attributed (in Rs Crore)
Carbon credit	10.9
Subsidy on diesel	30.6
Forex benefits	908
State Tax	
Royalty	300
Barge	12
Road infra cess	50
Central tax	
Export duty	250
Corp tax difference	748
Total	2309.5

Source: NCAER (2010: 43).

Carbon Credit: The carbon credit claim is invalid as the use of barges is the least cost-efficient alternative for the mining firms and no additional expense has been incurred by way of use of an eco-friendly alternative (to a polluting) transport option (NCAER 2002). Had the industry switched from polluting trucks to clean barges and in the process incurred an additional cost, a claim for social compensation would arise which is the basis for carbon credits. Industry experts opine that it is not possible for trucks to transport the ore from the mines as efficiently and as cheaply as the barges do in any case. Therefore, the mining industry is

experiencing no cost escalation due to use of barges for which it needs to be compensated.

Similarly, the benefits claimed for reduced subsidy for lower diesel consumption stands invalidated for the same reason. In fact, what needs to be added to the cost side of the calculation instead is the subsidy for diesel (which is a social cost) provided for use of barges (which provide a private benefit).

Barge Tax: There is a claim of social benefits due to the annual barge tax of Rs 12 crore. Barges, when they travel down the river with their loads of mining ore, lead to quicker "wear and tear" of embankments. This imposes increased maintenance expenses and reduced productivity for the farmers near the river banks. It is not clear whether or not these damages are sufficiently compensated for by the amount of the barge tax and therefore whether or not this barge tax is efficient or not.

Road Cess: A similar argument holds for the road infrastructure cess. Mining trucks are the main users of the roads in the forest areas and their heavy load on the major tarred roads of the state cause considerable damage. This cess payment needs to be treated as a compensation for the creation of road infrastructure for the industry and for the "wear and tear" the trucks cause on existing roads. Once again, it needs to be checked whether the road cess covers the entire damage cost.

Foreign Exchange: The major item claimed as a benefit is a bonus for (10% of) foreign exchange earnings by the industry, Rs 908 crore.[27] The import tax according to this claim supposedly reflects the scarcity value of foreign exchange.

There are many reasons why import taxes are imposed and forex scarcity may be only one of the factors that may determine import tax rates, say, for example, the infant industry argument. In a flexible exchange rate system, the scarcity value of a currency is meant to be captured by the market price for that currency. In India, the scarcity of dollars does not seem to be the defining constraint in the economy any more. In fact, the increasing amount of forex deposits lying with the RBI is a reason for worry and is also a potential drain on our surplus (Sen 2005).

We next look at the issue of royalty and the manner in which it should be included into the CBA.

5.2 Royalty

The issue of royalty needs to be seen from a resource compensation principle. The equilibrium price for an exhaustible resource is:

Exhaustible resource price = Marginal cost of ore extraction + Exhaustibility rent (same as royalty rent in theory).

NCAER (2010: 43) claims that the royalty paid by the firms is a net benefit to society (Rs 300 crore). This is an accounting fallacy since the royalty paid is supposed to be the resource rent for consuming a sub-soil asset – it is the opportunity cost of depletion of natural capital (see, for example, Fisher 1981: 14).

The *efficient* royalty rate paid by the mining firms is *not* a net benefit to society, but actually a compensation for depleting its natural capital. Further, the royalty amounts currently being

paid are likely to be an underestimate of the true depletion value of natural capital since the mining licences were not auctioned and therefore are probably inefficient prices. By using the "first come first serve" principle for allotment of mining leases the state may have actually underpriced a social asset and allowed private firms to be subsidised.

5.3 Double Counting

NCAER (2010) claims a number of central and state taxes as social benefit. However, all these taxes have already been added in the firms' price of the ore. So the taxes and cesses should not be added to social benefits as it would lead to double counting.

On the benefit side, what is relevant is only the net value added or net profit plus employment benefit by the industry that accrue to the state. In order to compute the present value of these private benefits we need a sense of the size of the resource since it is exhaustible. We discuss this in the next section.

6 Mineral Deposits and Recalculated Present Value

Goa has numerous varieties of mineral deposits of which iron ore is probably the most valuable currently. NCAER (2002: 69) mentions that the estimated iron ore deposits from private sources is 2000 mega tonnes. However, the Geological Survey of India (GSI 2002) records iron ore reserves in Goa to be 712 mega tonnes of which 268 mega tonnes is proven reserves, 190 mega tonnes (probable) 254 mega tonnes (possible) as on 1 April 2005 (IBM 2009: 47-42).

In 2008-09, Goa produced 33 mega tonnes of iron ore for an estimated value of Rs 38.8 billion (ibid: 47-16). Simple arithmetic suggests that for 712 mega tonnes of ore to be extracted at an annual rate of 33 mega tonnes would take only 21 years for the reserves to end. Given that two-thirds of these reserves are "probable" or "possible", the industry may be looking at a much shorter time horizon of eight to nine years when "proven" reserves will exhaust. It may be noted that NCAER (2010) bases its CBA with a 25-year horizon which is an overly optimistic estimate given the current state of information on deposits. So if the ore is only going to last for a shorter time period, then the NPV must change accordingly.

NCAER calculates the annual gross benefit from mining to be Rs 2,309.5 crore per year. However, if mining were to last until 2017, as inferred above, then the gross present value of benefits (i e, gross revenue) (in 2008) for the mining sector would be Rs 17,833 crore (with a 5% SDR) or Rs 13,049 crore (for 12% SDR, which NACER [2010] has used).

As we argued above, we should compare the private net benefits against the externality costs to arrive at the net social gain from mining. Since the accounts of all the firms in the mining sector in Goa are not accessible we will rely on a rule of thumb to make guesstimates of the private net revenues.

We assume that the industry incurs a cost of production which is 80% of the gross revenue, leaving 20% profit margins.[28] It is easy to do a sensitivity analysis on this but even large variations in profit margins will not affect the CBA. The gross output of the iron ore sector in Goa for 2008-09 (P) was reported as Rs 3,888.482 crore (IBM 2009: 47-15). This, in a scenario of a 20% profit margin, implies the net annual private benefit would be Rs 777 crore. We further assume that this benefit accrues every year till the ore is exhausted. The discounted sum of revenues (at 5% SDR) over nine years gives us the NPPV (net private present value of benefits) of Rs 5,527 crore (with a nine-year production frame).

We next focus on the social costs that mining imposes.[29] We need to check whether there are any costs attributable to mining other than what the firms have already internalised in their calculation of net revenues. If they have, then the private profit figure is not a good proxy for net social benefit.[30]

7 Undervaluation of Costs

There seem to be two issues as far as social cost computations are concerned – items that have been included as costs but have been undervalued, and items that have not been included at all.

7.1 Health Cost: Air Pollution

NCAER claims that mining occupies less than 3% of Goa's land area. Therefore, the cost of air pollution attributable to the mining industry should be no more than 10% of the total air pollution costs in the state. This projection is based on the assumption that pollution caused by industries in an area cannot exceed more than three times the area occupied by it (2010: 42).

There are two reasons why such an assumption may be invalid: (a) First, the size of the industry or the area occupied by it need not have any link to the amount of pollution it causes (there are numerous examples, the UCC's Bhopal gas leak, the Exxon Valdez oil spill, and the more recent Gulf of Mexico oil spill by BP). (b) Second, the area occupied by mining in Goa spreads across 700 square kilometers in four talukas. The 318 valid mining leases add up to 234 square kilometres (RPG 2011: 42). The NCAER report does not specify how it arrived at the estimate of 3% (land being occupied by mining) but one presumes this is the area under the 99 active mining leases (ibid: 42). Air pollution from mining is not limited to the area around the mines, it also spreads during transportation and so the effective area of air pollution may be much larger than recorded in NCAER (2010).[31] Further, the area occupied by other industries currently is a small fraction of the area occupied by mining. Therefore, the share of air pollution attributable to mining may far exceed 10%.

7.2 Cost of Loss of Forests

We have already indicated that the cost of forest loss caused by mining is substantial. The estimates of such losses (NPV) at 2009-10 prices range from Rs 17,684 (GAISP with low vales for biodiversity), Rs 21,027 crore (Supreme Court 2008), to Rs 27,617 crore (GAISP with high values for biodiversity). In comparison, the TEV estimates of IRADE (2008) and NCAER (2010) are Rs 5,454 and Rs 4,067 crore, respectively. But they attribute only Rs 677 crore and Rs 505 crore (respectively) as the "economic value" of the forests.

As we have explained earlier, NCAER (2010) has grossly undervalued the benefits from (a) watershed, (b) ecotourism benefits, (c) biodiversity, (d) carbon sink, and (e) fodder benefits. Importantly, it has not added benefits from (a) the non-use values, and (b) resilience, which could be substantial by themselves.

8 Conclusions

Today, the mining industry is certainly very important for a state such as Goa. Being an exhaustible resource, however, the industry also faces a situation of redundancy as and when all the sub-soil minerals are extracted. The minerals of Goa may soon approach such a situation. Under such conditions, it is time to think of alternatives for the development of the state, especially as the state also undertakes a process of regional planning.

Goa's forests are not only the lifeline of the state, they may also have large global benefits as an unexplored biodiversity repository. Short-run private interests must not overshadow inter-generational social needs in the decision-making processes.

The NCAER (2010) study makes a case for expediting the extraction of iron ore from the state. However, alternative strategies based on sustainable use of the natural capital, such as marine, forest, watershed or biodiversity resources, could be more socially beneficial. Therefore, it is necessary to weigh the mining options against the other alternatives of development using opportunities of ecotourism, recreation, fishing, aquaculture, traditional medicines and bioprospecting.

Our limited exercise in this article shows that the NCAER study grossly underestimated the natural capital of the state while overestimating the value of mineral resources. Since the mineral industry is going to have a very short lifespan, a long-term perspective for the state asks for proper valuation of natural resources such as forest, land, water bodies, marine and biodiversity resources, and a better designed development perspective for the state. A more detailed study would be able to provide a superior cost-benefit model of forestland-water-marine-biodiversity based development alternatives.

NOTES

1 It is not clear why a time frame of 25 years has been chosen unless the expectation is that the mining deposits would exhaust in that period at current rates of extraction. Our computations below do not confirm this.

2 Forest size used by NCAER (2010).

3 According to CSE (2008) about 825 mining leases are pending as applications covering an area of 678 square kilometres. The department's website states that there are "334 mining leases in existence" (http://www.goadmg.gov.in/).

4 Supreme Court judgment on NPV (dated 28 March 2008) for tropical forests is in the range of Rs 7.3 to Rs 10.4 lakh per hectare; see judgment of Supreme Court, 3-Member Bench Comprising Chief Justice of India, K G Balakrishnan, Arijit Pasayat and S H Kapadia in Writ Petition (Civil) 202 of 1995 in the Supreme Court by Petitioner: T N Godavarman Thirumulpad against Respondent: Union of India and Ors (3 March 2008). http://www.Fedmin.Com/Html/Npvo8.Pdf, http://www.Forests.Tn.Nic.In/Graphics/Judgement%20case%20202.Pdf (henceforth referred to as Supreme Court 2008). We discuss this in greater detail ahead.

5 The NCAER report states: "The opportunity cost of not having the iron ore mining industry in terms of employment would be very significant with unemployment levels hitting 13.8% of population" (2010: 49). Its objective is to "…. provide a comparison or the opportunity cost of not having the iron ore mining industry in terms of its contribution to state GDP, employment generation and present value of net benefits with the social costs of pollution and deforestation due to this industry" (ibid: Preface).

6 There has been a protracted debate on Goa's development-environment interface (see Alvares 2002; Anonymous 2006; Goswami 2008).

7 Costanza et al (1997) in a much discussed paper put the value of the earth's resources at $18-33 trillion. However, it is quite well known that such measures are not free from methodological limitations (Bockstael et al 2000); value of resources changes with the stock of natural wealth (Mäler et al 2008). The valuation of a resource in the presence of (i) limited information, (ii) thresholds, and (iii) irreversibility, needs careful consideration (Dasgupta 2009), must be done with the caveat that such values are a gross underestimate, what Toman (1998) called the "lower bound of infinity".

8 The Millennium Ecosystem Assessment too recognises that "Ecosystem services are the benefits people obtain from ecosystems (which) …. include *provisioning services* such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling" (MEA 2005: v). The recent notable work on this is the series of studies under *The Economics of Ecosytems and Biodiversity* (see Kumar 2011).

9 Gundimeda et al (2006, 2007) rightly include the expected benefits from bioprospecting which gives them a higher valuation of forests.

10 This is arrived at by aggregating individual benefits listed in that column (the same applies to the 2001-02 lower bound price of Rs 10,878 crore for timber). The authors of these different estimates have not indicated that these benefits are mutually exclusive and exhaustive and therefore can be added up as they exist. We find that the TEV thus derived would be of the order of Rs 16,740 crore (at 2001-02 prices) if we use the high value estimates of Gundimeda et al (2006).

It should be noted that Gundimeda et al (2006) have done sensitivity analysis for biodiversity and ecotourism. If we use the lowest values (after adjusting for errors in computation in their monograph) for bioprospecting and ecotourism, then the TEV works out to Rs 10,636 crore (at 2001-02 prices) as the lower bound (authors' calculations). Even this value is an underestimate since water-recharge benefits have not been accounted for in Kumar et al (2006).

11 Gundimeda et al (2005, Table 10, p 22). The same source applies for the 2001-02 lower bound price of Rs 2,631.6 crore for watershed benefits.

12 Ibid, Table 12, p 24. The same source applies for the 2001-02 lower bound price of Rs 114 crore for ecotourism.

13 The NCAER (2010), Table 4.25 in its calculation of EV only uses 30% of this value. The same applies to the 2001-02 lower bound price of Rs 903.05 crore for carbon sink.

14 Gundimeda et al (2005, Table 8, p 18) and authors' calculations. The same applies to the 2002-03 lower bound price of Rs 70 crore for fodder.

15 NCAER (2010) Table A7.1 does not include this amount. We have added it here so that the TEV calculated by NCAER matches the sum of the line items in the same table and also conforms to IRADE (2008) calculations from where these estimates are borrowed.

16 Gundimeda et al (2006, Table 14, p 35) and authors' calculations.

17 Kumar et al (2006, Table 19, p 27) and authors' calculations. The estimate of Kumar et al did not have any values for water recharge and his estimate of watershed benefits was Rs 2,389 crore which accounts for nutrient and flood control benefits but fails to account for water recharge benefits of Goa's forests. In order to fill this gap we have extrapolated from the benefits derived by other states in this region, namely, Maharashtra, Karnataka and Kerala.

18 Gundimeda et al (2005, Table 11, col 16, p 23).

19 IRADE (2008: 85-86) reports this as biodiversity value.

20 Gundimeda et al (2006, Table 14, p 35).

21 Ibid, Table 14, p 35.

22 EV = TEV (Ecotourism) – (Watershed) – (Carbon sink)-70% Fodder = (Timber) + (NTFP) + (Fuelwood) + (Bioprospecting) + (30% Fodder).

23 The value of this is estimated to be Rs 467.62 crore at 2008-09 prices by NCAER (2010: 42). Inadvertently, they have also referred to this as Total Economic Value which must be a typing error (see p 33).

24 These have not been adjusted for changes in stocks or relative price that may have occurred in the interim period.

25 The area under forests stated by FSI (2009) differs from the figure of 1,424 square kilometres used by NCAER (2010) in their calculations.

26 The logic of 0% SDR is that societies may value each generation equally and therefore any positive SDR tends to discount the welfare of future generations, which is not ethically acceptable (for a detailed recent discussion on discounting see Dasgupta 2009).

27 Ten per cent of the foreign exchange revenue of

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the industry has been claimed as social benefit.

28 The profit margins assumed here are generous. See Balakrishnan and Babu (2003) for a discussion on profit trends in the 1990s.

29 We also would need to add any benefit that society derives (like a positive externality) other than what has been already included as part of the private benefit. Education is a well recognised case where there are significant positive externalities generated over and above the private benefit of education. However, such spillovers are not obvious in resource extraction industries.

30 We do not discuss private costs as these have already been accounted for while calculating net private benefit.

31 See also TERI (2000) and NCAER (2002).

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