Directions, Innovation, and Strategies for Sustainable Development in Goa

EXECUTIVE SUMMARY

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Executive summary

1. Introduction

The State of Goa stands on the crossroads of development. Economic growth in recent times, largely driven by industries, mining and tourism, has put ever increasing pressures on the state's natural resources and environment. The degradation of ecosystems and environmental conditions has far-reaching adverse implications on the well-being of human societies. There is growing concern in the government as well as civil society of Goa that the state is facing a major sustainability challenge. In addition to this is the possibility of future climate change introducing new risks to the region and increasing the vulnerability of both socio-economic and natural resource systems.

Goa 2035, a vision document for the state, highlights, "Goa should stand out globally as a model of development without destruction." This is a laudable goal and illustrative of the recognition in Goa's policy circles that there is a need for alternative development pathways to meet the sustainability challenge. The current DISHA study by TERI aims to support this effort by the Government of Goa, and for this purpose has carried out both baseline assessments and a priori evaluations of possible future trends and transformations in the core development activities and processes in the state. The study draws from TERI's own experience in the past of conducting similar assessments at the national level*.

The main objectives of the DISHA study are (a) to assess the current state of environmental and socio-economic development in Goa; (b) to assess the likely impacts on environmental and socio-economic development, under different growth scenarios over the next two decades; and (c) to develop strategies to avert the likely negative impacts for the state's environmental resources, without compromising on improved overall socio-economic development. The focus of the study is on key economic activities in the state and the resulting environmental pressures.

The analytical framework used in the DISHA study provides an integrated analysis of social, economic, and environmental dimensions of development. The framework enables a clearer understanding of the context within which the impacts occur, the reason for their occurrence, and the possible alternative routes that can be taken to avoid the pressures created by the driving sources. Figure 1 presents the framework used in the current study.

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* TERI, 1998, Looking back to change track: GREEN India 2047
TERI, 2001,Directions, innovations, and strategies for harnessing action for sustainable development
TERI, 2009, Looking Back to Change Track, Green India 2047 renewed

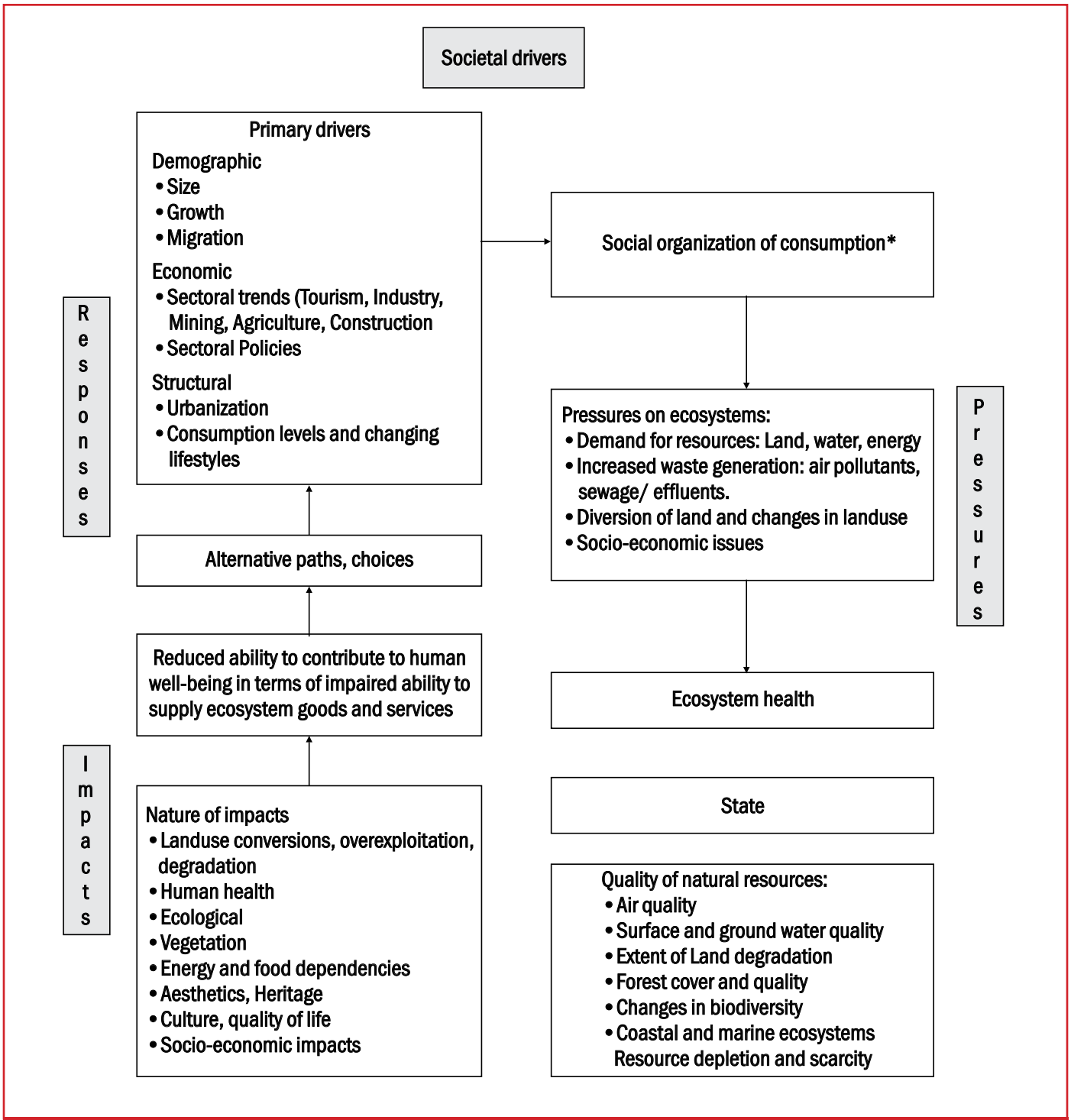

Figure 1 Framework of the study

Note: * Drivers pertaining to social organization of consumption in this integrated framework could be shaped by rules, property rights, resource characteristics, technology and practices, knowledge and perception of ecosystems, time horizons, aspirations, political institutions, markets, and access to capital. However, these are beyond the scope of this study and are not discussed.

Noronha et al (2003), *Coastal tourism, environment, and sustainable local development*, The Energy and Resource Institute

The components of the integrated framework are as follows:

- **Primary drivers of environmental change:** These can be broadly categorized as demographic, economic, structural, and institutional. Demographics in Goa have witnessed a significant change in the last two decades, with high degrees of in-migration, both temporary such as tourists, and permanent such as those migrate in response to their employment. Moreover, the population growth is skewed towards the coastal and urban regions of the state. These have had an impact at several levels, in terms of adding to the total numbers of people who will be using the resources of the state;, as well as in terms of changing cultural practices, as those who out-migrate may have different perceptions of coastal ecosystems compared to the in-migrants. Also, rising per capita incomes and demonstration effect of the tourism sector, combined with structural changes such as the consumptive patterns and lifestyles that are resource-intensive and polluting have an impact upon the state. There have been sectoral trends linked to the growth in major economic sectors of the state such as tourism, industries, mining, construction, but at the expense of other sectors including agriculture and aquaculture which can also be identified as important sectors.
- **Pressure on the environment:** As a result of discharge of emissions, waste water, solid wastes, and other driving forces, there is tremendous pressure on the limited resources and pristine ecological environment of Goa. Be it emissions of pollutants from industrial stacks, vehicular tail pipes, discharge of domestic sewage and industrial effluents, or diversion of forest/agricultural land for economical purposes, drivers of growth have left their significant footprints over the environment of Goa. Hence, the three legs of sustainable development have not been properly balanced. Unsustainable practices in the economic sectors have adversely impacted the environmental front and may eventually affect the social development in the state as well.
- **State of the environment:** Pressures exerted through various driving forces in the state are also defining the condition of environment. While deterioration of air quality, polluted water bodies, dumps of solid wastes, and degraded lands depict the quality of environmental resources, issues related to scarcity of water and energy highlight the state of resource depletion in the state.
- **Impact:** The state of environment in a region impacts not only human health but also affects its ecology, vegetation, aesthetics, and cultural heritage. It is important to evaluate the impact caused by degradation of environmental quality in Goa. It is expected that the impact will affect both those who are, and those who are not its major contributors. For example, the tourism sector which is mainly driven by the exotic environmental beauty of the place may face a decline once the impacts are visible on the environmental quality of Goa. Impacts of tourism activity may alter the biophysical environment, natural spaces and agrarian landscapes, and alter the spatial distributions of population, labour, and income.

- **Response of the society:** This refers to the decision-making process towards issues like watershed protection and air quality management planning. It is essential to understand the measures taken for abatement of impacts caused by degradation of environmental quality in Goa. Evaluation of effectiveness of these interventions will help in drafting policies for the future and shift the development pathways towards sustainable development.

2. Methodology

The overall approach was based on a baseline assessment and a consultative process with different stakeholders. This process helped not only flag the issues and concerns but also establish the baseline, project the future, and suggest policies for sustainable development of the state. The study involved numerous stakeholder groups representing civil society, environmental groups, industry, and the policy community. Two consultative workshops — August 2010 and September 2011 — were held at the inception and mid-term stages of the project. Other than the workshops, individual consultations were also carried out with different stakeholder groups.

Baseline assessment for the State of Goa was carried out for the year 2009–2010 to assess the social trends (population, urbanization, health, work participation, and poverty pressures), economic activities (tourism, mining, industries, agriculture, and construction), and the condition of environment (air, water, forest and biodiversity, energy). Secondary data were collected from authentic government or published sources in the state and compiled and analysed using various statistical techniques. Primary surveys were also carried out to supplement the secondary data at various instances. Trend analysis is carried out for the time-series data and the results of this analysis are compared with relevant guidelines, standards, and benchmarks. Finally, the data collected was fed into various indicators for establishing the baseline state of the various social, economic, and environmental dimensions in Goa.

After establishing the baseline, sector-specific developmental plans and polices of the state were studied and growth scenarios were developed based on the past trends and existing ground realities. This scenario is termed as 'Business As Usual' (BAU) scenario which illustrates the trajectory of growth in Goa for the next 20 years (2010–2030) as well as its implications over various resources and sectors.

Based on the *Goa 2035* vision, road map 2035 and our own assessment of the issues, an alternate pathway to sustainable development is proposed. Innovative strategies are assessed in terms of their potential to mitigate negative impacts on the environment and to improve human well-being. This forward-looking analysis is expected to help create sectoral, institutional, and policy preparedness to cope with likely developments and also to help prioritise interventions.

Results of the baseline assessment, future scenario analysis, and stakeholder consultations are used to outline actionable interventions through various stakeholders. It also highlights the required policy, governance, legislative and regulatory provisions needed to abate adverse

impacts. The agencies responsible for implementation of actions suggested are also identified.

3. Baseline assessment: key findings

The baseline assessment carried out for Goa depicts a mixed picture of development. While the state is doing well in socio-economic indicators, the environmental leg is lagging behind. The population is growing at a rate slower than the country average along with rapid urbanization and high literacy rates but at the same time, there still exists a skill-mismatch resulting in unemployment. Again, while the IMR and MMR indicators show improvements in the health sector, there is also significant rise in various health problems such as cancer, heart diseases, etc. Higher economic growth and the demonstration effect of the tourism sector are leading to consumerist lifestyles in the Goan society. Many social evils have also risen with the growing economy.

Industry, tourism, mining, agriculture, and construction are the key economic sectors in the state. Over the years, the pattern of economy has shifted from agrarian-based to manufacturing and tertiary forms. The sector-wise assessment of the baseline conditions is presented in the subsequent sections.

Agriculture is losing its lucrativity against competing demands from other sectors

3.1 Agriculture

With traditional crops like paddy losing value, there is a shift of work force from agriculture to industrial and tourism sectors. The value added from agriculture in Gross State Domestic Product (GSDP) has declined from 16.5% in 1960 to less than 7% in 2000-01 and 4.2% in 2008-09. The production of paddy has been decreasing over the last five years and the area under paddy production has gone down by 11% during 2004-2010. There are more than 30 salinity-resistant, traditional, domestic rice varieties which have not been preserved or are threatened by the high-yielding varieties. High imports of agri-products from neighbouring states have resulted into inflation.

The agriculture sector has also borne the ill-effects of rapid urbanization. Unplanned urban development is making agriculture more and more difficult in the areas around cities and towns as it is altering natural water courses resulting in water-logging or shortages in prime agricultural lands. With growth in real estate, tourism or industrial development, agricultural lands are most prone to be converted into alternate usages.

There are other issues linked to the agriculture sector including the loss of traditional varieties, ill-effects of the mono-culture system, rising cost of cultivation, inabilities to link to local markets, etc. The agriculture sector has also been affected by the mining sector due to land degradation by the flow of mining silt and water shortages.

However, on a positive note, there is also a trend towards shifting from conventional crops to other lucrative options like cashewnut, coconut, and organic farming. Considering the competing pressures from other sectors, agriculture could strengthen its situation by shifting towards high-end agri-products.

Mining activities severely impact the ecology and resource base of the region

3.2 Mining

The production of iron-ore in Goa has been growing at a faster rate than in the late 20th century. In 2001, the production was at 15.8 million tonne (MT) which has grown in 2009 to 41 MT with a compounded annual growth rate of 11.1%. Mining is closely linked with several forestry and environment issues as it interferes with the ecology and environment and has the potential to disturb the ecological balance of an area.

The key environmental problems arising out of mining activities are degradation of land and forest, loss of biodiversity, soil contamination, air pollution, surface and ground water pollution, noise and vibrations, and deterioration of natural drainage system.

Mining activities in Goa are linked with permanent alteration of land use impacting the watersheds, surface water regimes, forest, and bio-diversity of the region. There is special concern about the five wildlife sanctuaries that line the eastern border of the state, and coexist with the mineral-bearing areas. There are several reports of diversion of forest land for mining leases. The total forest area affected by mining during 1988-97 has been estimated at about 2,500 ha.

The high overburden to ore ratio in the region makes waste disposal a problem and coupled with scarcity of land this becomes a major problem. About 123 MT of waste is generated annually which through surface run-offs affect the agricultural lands nearby.

Mining activities in Goa contribute to problems related to water mainly due to dewatering of the mining pit water (to enable mining below the ground water level). A pre-monsoon ground water declining trend of 40% and 16% and post-monsoon declining trend of 40% and 50% has been recorded in Bicholim and Sattari *talukas*, respectively, which can be attributed to dewatering activities in mining regions. Mining areas have always been linked with very high levels of dust generated during mining and ore-transportation activities. The level of suspended dust in mining areas has been found to be exceeding air quality standards. Estimates of emissions from different sectors in Goa show that the mining sector contributes to 38% of the particulate matter (PM) emissions. Other than these, the sector also exhibits other concerns such as illegal mining, mine closure plans, and boundary issues with eco-sensitive zones.

3.3 Industries

Undoubtedly, the industrial sector has contributed the most in the overall economic growth of the state, but not without a significant environmental footprint. The registered units in the state have provided employment to around 0.75 lakh people. However, usage of migrant labour and skill-mismatch has limited the social benefits to the local population.

The industrial sector in Goa is the most water-intensive sector. Industries in Goa account for 52% of the total water consumption by different sectors, excluding agriculture. Ninety-two per cent of industrial water demand is met through groundwater withdrawals by private borewells which could result in lowering of the groundwater table. The pharmaceutical industries

consume the largest amount of water (22% of total), followed by the beverages sector (16%). Owing to this, many industrial estates face water supply shortages and conflicts with the surrounding villages.

Industry is the most resource intensive sector in the state

The sector is also ill-equipped with infrastructural arrangement for control of environmental pollution. None of the industrial estates have common effluent treatment plants or hazardous waste disposal facilities. Many units use soak pits for wastewater disposal or store hazardous wastes on site which leads to contamination of soil and ground water resources.

Industries have a substantial share in the air pollutant emissions, accounting for 24% of the total PM_{10} emissions and 31% of the total SO_2 emissions in Goa. There are around 509 Goa State Pollution Control Board (GSPCB) authorized hazardous waste generating units in Goa, which generate approximately 56,498 tonnes per annum of waste. There has been concern in the past regarding significant quantities of hazardous wastes being stored on-site by industries for long periods of time, causing soil and groundwater pollution.

3.4 Tourism

Goa has the right blend of history, culture, natural beauty, and climate to attract tourists, who have put it on both the international and national tourist map. Tourism has significantly contributed to the economic development of the state in terms of employment generation, infrastructure development, intra-sector competition, and valuable foreign exchange earnings. Total tourist arrivals in Goa have increased from 4.4 lakh in 1981 to almost 25 lakh in 2009. The tourist arrivals are biased towards coastal *talukas* and specific seasons, generating tremendous pressures at specific locations and during specific time spans.

Coastal tourism's affinity to the sea and sand has resulted in development of tourist infrastructure along the coast. As a result of these developments, sand dunes, *khazans*[1] and mangrove ecosystems have been severely impacted. Development of shacks, lawns, and recreational activities on the beach itself is a major cause for the destruction of sand dunes and its vegetation along the coast. The destruction of nature's first line of defence against the action of the tide, waves, and wind makes coastal areas susceptible to threats from sea level rise.

Spatial and temporal biased tourism leading to deeper environmental footprints

Tourism-related infrastructure is also an important source of pollution generation in terms of solid wastes and waste water. Increasing waste generation in tourist regions and inefficient waste collection, transportation, and disposal facilities is contributing to poor waste management. During a survey conducted in the study, very high rates of water consumption were observed in all categories of hotels. The mismatch in infrastructure services too has contributed to poor management of waste and water resources. As per the survey conducted during the study, only 30% – 35% hotels were segregating their waste in different treatable categories.

[1] *Khazans* are saline flood plains in the tidal estuaries, which have been reclaimed over centuries with an intricate system of bunds and sluice gates.

Tourism sector generates a water demand of 8 million cubic metres (MCM) yearly; 60% of which is met through groundwater, further depleting the ground water tables. About 56% hotels use septic tanks for waste water disposal which is not the best technology available and could contaminate ground water. Tourist establishments, especially the high end and luxury budget hotels are high consumers of electricity. It is estimated that around 210 million units of electricity is consumed by the hotel sector in Goa, which has significant potential of reduction.

The tourism sector has also been linked to some ill-effects on the culture and society of Goa. Social evils are seen to be on the rise with growth in tourism. Due to the 'demonstration effect', ill-effects such as changing culture, occupational shifts, increased drug use, prostitution, and paedophilia, have been observed.

3.5 Construction

Construction sector in Goa has recorded a Net State Domestic Product (NSDP) growth rate of 12.6% in 2009-10-the highest in the decade. At this rate, Goa is among the top five fastest growing states in 2009-10 when compared to the all-India figures. The construction sector is presently catering to huge demand for housing (including second homes) and basic infrastructural requirements of different sectors like tourism. Significant data constraints have been felt which needs to be rectified in the near future for better assessment of the sector.

Increasing housing gap is observed in the state, amounting to an estimated housing shortfall of 0.25 lakh dwelling units in the year 2001 which is likely to increase to 1.44 lakh by 2021. Some of the existing challenges faced by the housing sector in Goa include scarcity of land available in settlements with marketable titles, rising land prices, construction of second homes which lie vacant for most part of the year, etc. Conversion of agricultural lands for real estate is increasing though no data are available to follow the exact trends. Also, the sand used for construction — sand mining in water bodies has serious impact on the shoreline causing erosion, destroying the flora and fauna.

Conventional buildings in Goa are climate resilient, compared to the new upcoming ones.

There is a distinct visible change in the architectural style of house buildings. Goa was yet untouched with the 'Glassbox' style architecture blindly followed in rest of the country. However, gradually, there is a distinct visible change in the architectural style of house buildings. There is increasing glass area, absence of shading devices, use of energy intensive materials such as glass, aluminium, aluco bond, etc. This results in an inefficient envelope with lot of heat build-up inside the building and resultant high air-conditioning requirement. Adoption of energy efficiency measures in buildings can reduce the energy consumption significantly. Green buildings and environmental assessment systems — rating like GRIHA — are not very popular presently though the conventional building style of Goa is climate responsive. The only building registered with the LEED and GRIHA rating systems is the new *Yojana Bhawan* that is being constructed by the Goa State Infrastructure Development Corporation (GSIDC).

Goa is a state with a lot of privately owned heritage buildings which are often centres of attraction for the tourists. However, currently there are no provisions to aid these private owners to maintain their buildings. As a result, a lot of these heritage structures have become dilapidated.

3.6 Environment

Environment has borne the major burden of the developmental activities that have happened in Goa in the last few decades. Growth in industries, mining, construction, and the tourism sector had significant impacts on the local environment. While mining and industries have impacted the environmental quality through generation of wastes and air pollutant emissions, tourism has its impacts over the coastal ecology and demand for natural resources. Land which could easily be the most precious commodity in Goa has come under enormous strain due to competitive demands. The analysis of the environmental issues assessed during the project is presented below.

3.6.1 Energy demands

The electricity demand in Goa is growing with peak demand shooting up to 453 MW in 2009–10. During this period, Goa's peak power deficit has been within a range of 35 to 60 megawatts (MW). The current power sourcing is heavily dependent on central capacity allocations.

There is huge potential for energy savings in industrial and building sectors

The present energy situation in state clearly points to the need for power-generating sources for future. Given the ecologically sensitive nature of the state, it would not be easy to build a coal-based power station within the state boundaries. Nuclear power again would require large tracts of land not just for the plant facility, but also for the buffer zone to meet disaster mitigation requirements, which would be difficult to get in Goa. A gas-based power plant might work well as it would be more compact in its footprint thus requiring relatively small amounts of land.

Assessing the renewable energy options, it was felt that currently, the Direct Normal Irradiance (DNI)[2] levels in the state are not sufficient for economical generation of solar thermal power on a large scale, i.e., grid connected. Roof-top solar photo-voltaic (SPV) and solar water heating systems will definitely help in offsetting certain amount of energy demand. Wind energy potential in the state has largely failed to attract developers because of insufficient wind speeds required for wind power generation. A few small renewable hybrid systems (SPV and wind, 20 to 35 m mast height) of 206 kilowatt (kW) of cumulative capacity have been installed by Goa Energy Development Agency (GEDA) at various institutional levels. However, specific feasibility studies are required for assessment of potential of solar and wind power at specific sites in the state.

[2] DNI is a synonym for beam radiation which is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky.

The use of biomass in the state has largely been at the decentralized level for thermal applications like heating, cooking, etc. In Goa, the average surplus biomass from forest tree species like teak, eucalyptus, cashew, etc., is available at a rate of approximately 119.3 tonnes per year,[3] which can be used for either thermal application or power generation through gasification technology. Hydropower in the state is currently untapped. There are currently five dams in the state which can be used for power generation. The status of hydropower potential (above 25 MW) in the state of Goa as published by Central Electricity Authority is 55 MW.[4]

Goa also has great potential for energy saving through demand-side energy efficiency measures. A study by the Bureau of Energy Efficiency (Ministry of Power) in 2009 revealed that there was a potential of saving 291 MUs (based on 2007–08 consumption levels). Overall, assessment of power consumption in the state reveals that the industrial sector (including mining) is the largest consumer of energy in Goa (Figure 2), which demands attention towards improvement of energy efficiency. Domestic (buildings) sector is also identified as the sector which has significant potential of reducing the energy demands and thereby requirements of generating extra power.

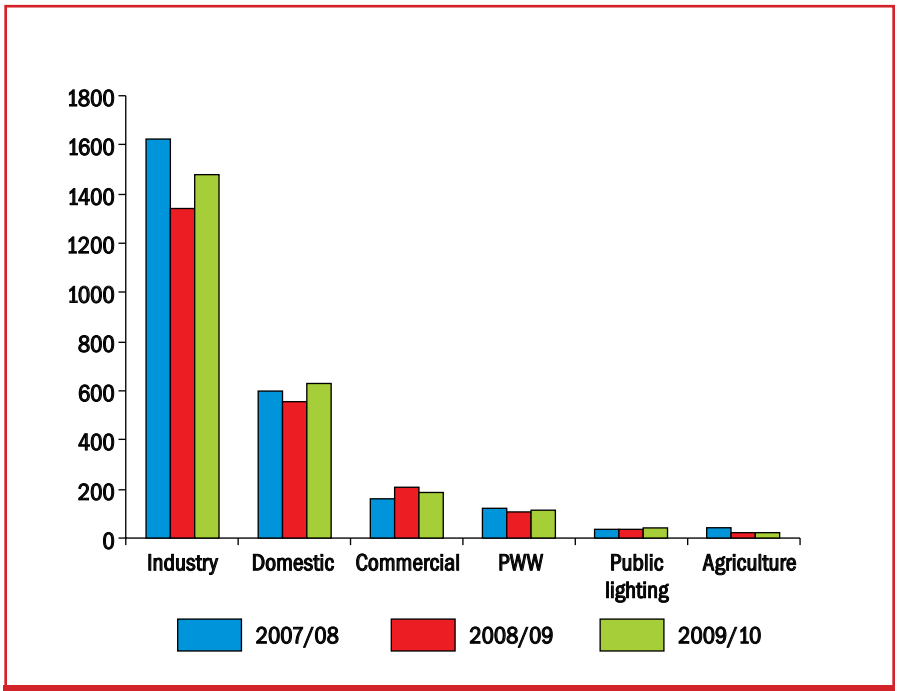

Figure 2 Sectoral electricity consumption (in million units) for 2007–10

[3] Source: Available at http://lab.cgpl.iisc.ernet.in/atlas/Tables/Tables.aspx (accessed on 23 June 2011).

[4] Source: Central Electricity Authority. Available at http//www.cea.nic.in/reports/hydro/he_potentialstatus.pdf (accessed on 4 August 2011).

3.6.2 Air pollution

Mining, industries and the transport sectors are the major contributors to air pollution

Urban air quality was not such a very big issue in the past, but now has started to become a concern in many parts of Goa. Goan cities like Panaji and Vasco have already started showing instances of violation of National ambient air quality standards in terms of ambient air pollutant concentrations. The rural regions of Goa have to deal with indoor air pollution in the households caused by biomass burning. Dust generation has been identified as a key issue in the regions around mining and handling of iron-ore in Goa. The GSPCB has also started monitoring in different industrial zones of the state which shows concentrations of the pollutants especially PM_{10} and $PM_{2.5}$ above the annual average standard (60 g/m^3). Higher levels of pollutants are observed in Usgao and Bicholim areas.

The source-wise emission inventory prepared for different pollutants in Goa depicts mining (38%), industries (24%), and transport (10% tail-pipe and 15% road dust) as the major contributors to the PM_{10} emissions in the state. Fire-wood burning in households (7%) and agricultural burning of waste residues (2%) also contribute marginally. NO_x emissions are dominated by the high temperature combustion of fuels in the transport sector (77%), and DG sets (14%). Sectoral shares and *taluka*-wise distribution of PM_{10} emissions per km^2 area is presented in Figure 3, which shows higher emission intensity in the coastal *talukas* and mining dominated *taluka* of Sattari.

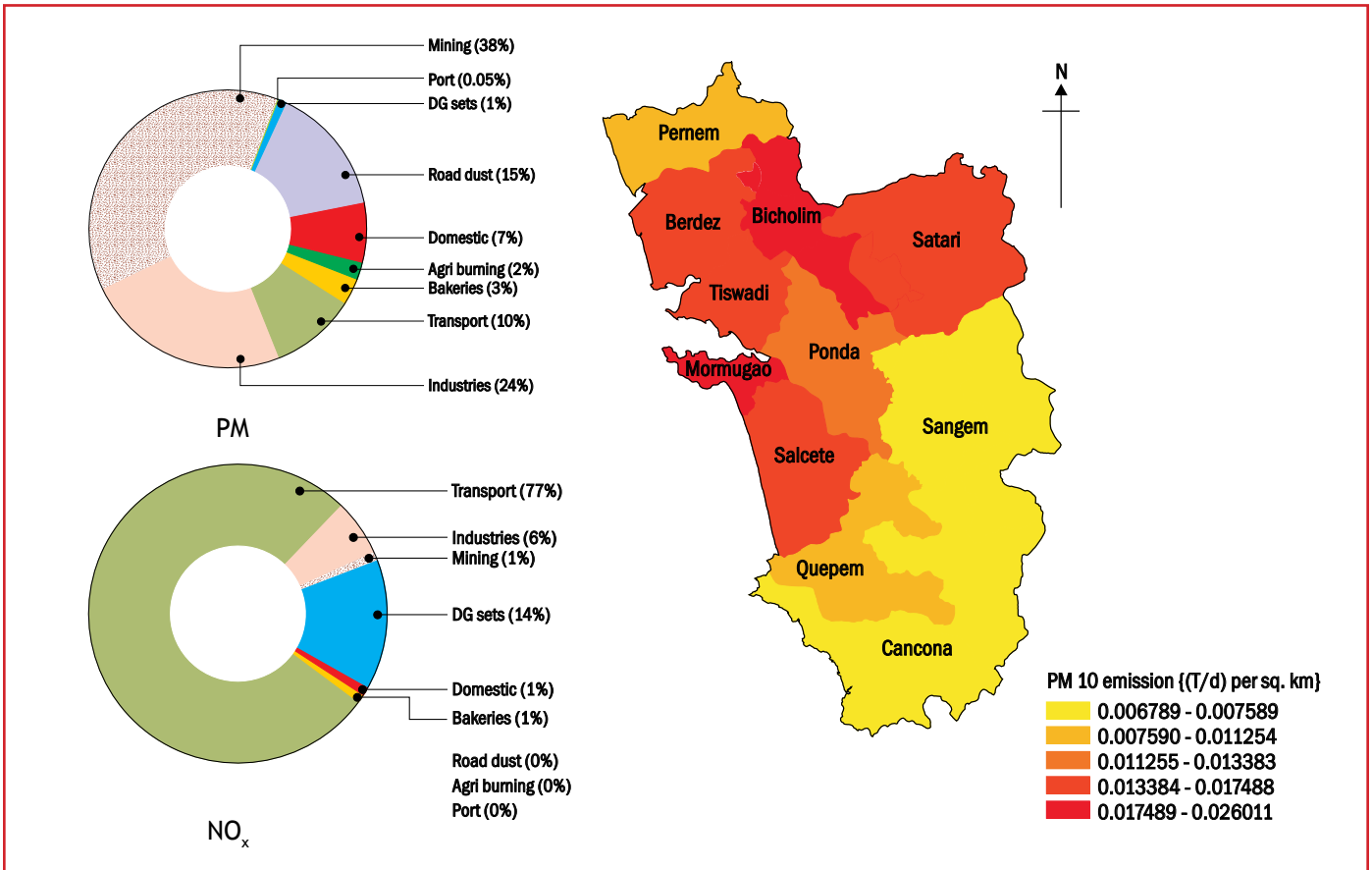

Figure 3 Share of different sectors in the emission loads for PM and NOx and spatial distribution of PM emissions in Goa

3.6.3 Water resources and quality

Water use efficiencies need to be improved in agriculture, industries, and domestic sectors

Competing demands from domestic, agricultural, tourism, industrial, and mining activities have exerted tremendous pressure on water resources of the state. Being a coastal state, most of the rivers in Goa are influenced by tidal waves and are affected by salinity up to a distance of about 20-40 km upstream.[5] Forty-nine per cent of the river length in the state is within the saline zone, which affects the total potable water availability. Furthermore, 50% of the rivers except the Baga and Sal have their catchments in the *ghats*, thus, limiting water availability. The ground water potential that can be exploited in the entire state is about 132.7 MCM and the current stage of ground water development in north and south Goa districts is about 33% and 34%, respectively, which is considered generally safe, but with exceptions in specific regions.

From the current supply data, it is observed that around 42% of treated water is lost owing to leakages and other minor losses at the treatment plants. The other issues related to water treatment and supply include: (i) shortage in the availability of raw water as the water level from sources declines during summer months from mid-February to mid-June, (ii) process design deficiencies leading to bottlenecks and imbalances in process loading, (iii) malfunctioning of instruments, (iv) lack of flow measurements and flow control systems, and (v) lack of operational, maintenance manuals and plans.

The share of different sectors in overall water demand in the state is shown in Figure 4. It is observed that the agriculture sector (63%) is the most water-intensive sector followed by industries and the domestic sector. Excluding the agricultural sector, industries have the largest share of 52% followed by the domestic (21%) and mining (17%) sectors. Larger dependence on groundwater is also seen in the industrial and mining sectors.

According to the Census India 2001, only 13% of Goa's urban population is served by the sewerage system, much lower than the all-India average

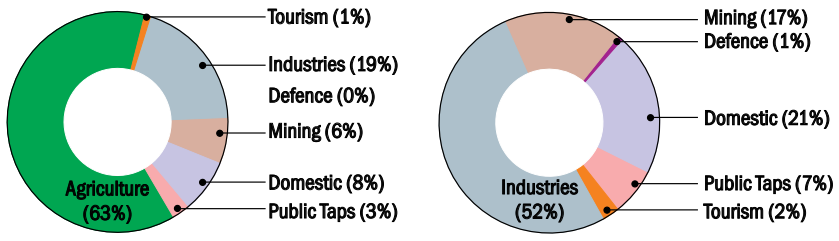

Figure 4 Share of different sectors in the total water consumption in the state

[5] Available at http://www.goaenvis.nic.in/water.htm (accessed on 29 September 2010).

of 28%. Further, according to the Eleventh Five Year Plan of the Planning Commission, Government of India,[6] 15.2% of the households in the urban areas of Goa do not have toilets. The slums concentrated in few pockets practice open defecation which may have ill-effects on public hygiene and health. Only, the major municipalities like Panaji, Margao, and Vasco have a sewerage system. There exists a sewage treatment capacity of about 35.5 million litres per day (MLD) as against a generation of about 158 MLD of sewage from the domestic sector.

Hence, the state is presently dealing with a situation of high water demands — due to ineffective efficiencies in supply and consumption of the resource — and limited infrastructure for management.

3.6.4 Land, forest, and bio-diversity

Forests and biodiversity are severely impacted by changing land-use and degradation

Due to the phenomenal growth of population, coastal tourism, and industries, the state is witnessing distinct changes in its land use which is responsible for environmental stress in the coastal landscapes. Around 43% of the total geographical area is suffering from various kinds of land degradation. It includes, degraded and wastelands accounting for 1,22,000 ha, which is about 33% of total geographical area of the state. Acid soils (pH <5.5), a major problem, accounts for 1,03,000 ha, which is about 28% of Goa. Mining is one of the major concerns causing land degradation as about 12,000 ha have been rendered wastelands due to mining (3% of total geographical area). The recoded government-owned forest area in the state is 1224 km^2, which is 33.06% of the geographical area. Out of this, the reserved forest constitutes 20.67%, protected forest 69.04%, and un-classed forests 10.29% of the total forest area. About 1,232.97 km^2 of forests of Goa is concentrated in Sanguem, Satari, Canacona, and Quepem *talukas*. In addition to mining activities, other developmental activities for which forest land has been diverted under the Forest Conservation Act are drawing power lines, road construction, irrigation, and others. The total forest area involved is about 146 ha of forest land.

Tourism poses a severe threat to the fragile and dynamic coastal ecosystem of Goa. Some of the threats faced by the coastal ecosystem of Goa are loss of biodiversity, adverse effects on beaches, dunes, mangroves, reduction marine and inland fishes population, impact on sea turtles nesting, etc. Reclamation of mangrove and *khazan* lands near the estuaries has impacted the food chain in the estuaries and the breeding cycles of fish and shellfish.

The sacred groves, which are patches of forests protected by the local communities as part of their religious faith, are an integral part of the Western Ghats ecosystem. The state of Goa is also not an exception.

The state is extremely rich in the terrestrial as well as aquatic biodiversity. But, the conservation of these biodiversity resources has been a challenge due to issues like habitat fragmentation, human-wildlife

[6] Planning Commission. 2007. Eleventh Five Year Plan, 2007-2012. 54th NDC Meeting, Government of India, p. 32.

conflict with elephants entering the habitations, identification of important locations for biodiversity conservation outside protected areas, etc.

3.6.5 Solid waste generation

Despite Goa's emergence as one of the most progressive states in the country, its waste management scenario is more or less similar to other Indian states. Urbanization and changing lifestyles is steadily increasing the quantities and altering the nature of solid waste being generated in the state. Further, being a tourist hub, the situation gets accentuated as the necessary infrastructure and institutional mechanisms rendering waste-management services are placed under increased pressures.

Changing lifestyle is increasing the quantities and altering the nature of solid waste

The total municipal solid waste generated in 14 municipal councils (MCs) of Goa is 191 tonnes per day (T/d). The per capita waste generation rate in municipal councils of Goa works out to be approximately 0.45 kg/day. The tourism sector contributes significantly to the solid waste generation in the state, i.e., about 18% of the total municipal solid waste (MSW) generated in 14 MCs. Few municipal bodies have initiated a door-to-door collection (DTDC) system for MSW and chosen decentralized composting as the method of treatment. On the other hand, most village panchayats have not been able to set up DTDC. It is found that most composting units across these municipal areas are non-functional and are able to treat only 18%–20% of the total biodegradable waste generated.

On a positive note, there are some good case studies like Panaji and Bicholim to showcase. The capital city of Panaji has been somewhat successful in achieving the status of a bin-free city and with 100% coverage of DTDC. However, the problem area for Panaji is its inability to dispose the collected waste safely due to lack of adequate land for ultimate disposal. Bicholim is the first municipal town to have its own waste treatment plant and landfill site. Generally, identification of garbage disposal sites in the state has been a very contentious issue.

Biomedical Waste (BMW) although lesser in quantity in Goa but due to its hazardous nature, it has to be dealt differently and with utmost care. There are 288 health care units in the state registered with the GSPCB which generate around 2,438 kg/day of Biomedical waste.[7] Almost 50% of this originates from Goa Medical College (GMC), and about 25% of it comes from the two district hospitals in Goa (Hospicio and Asilo). However, there is only one BMW incineration facility at GMC and there is a need for another facility to dispose waste from all BMW generating health care facilities.

In 2009, 236 tonnes of e-waste is estimated to be generated in Goa; 58% from the industries, 26% from the residential areas, and, 15% from the commercial sector. The total WEEE (Waste from Electronic and Electrical Equipment) that includes waste from television sets, washing machines, and refrigerators has been estimated to be 708 tonnes. For management of e-waste in Goa, there are approximately 300 authorized scrap dealers,

[7] Dr Simon Pereira, 'Environmental Pollution in Goa'. DISHA Inception workshop, 27 September 2010, Panjim, Goa, India.

however, none who collect and treat e-waste exclusively. Only 10-15 tonnes of e-waste (maximum) is collected from all over Goa every year which suggests a good amount of e-waste entering the grey market. In many cases, e-waste components like wires and cables end up in the MSW stream too.

Another very important form of the waste which is generated in Goa is industrial waste. There are 509 industrial units registered under the hazardous waste act in Goa which generate around 56,498 Metric Tonnes Per Annum (MTA) of hazardous waste,[8] out of which 23% is recyclable. Moreover, mining activity is linked with humongous quantities of rejects or waste material as about 123 million tonnes of mining rejects is generated annually.

3.7 Environmental Health

Environmental contamination and emerging infectious diseases are a growing concern

Public health problems caused by environmental contamination and emerging infectious diseases are a growing concern and decision-makers worldwide are realizing the importance of environment-health linkages. Major global assessments such as the World Health Organization's burden of disease project have examined linkages between environmental risk factors with various kinds of diseases. For Goa, Figure 5 depicts cases related to the key health-environment markers and also the cases that can be attributed to environmental risks.

It can be seen that 55,545 cases in Goa state can be attributed to environment-related risks. Goa as a tourist destination would have to

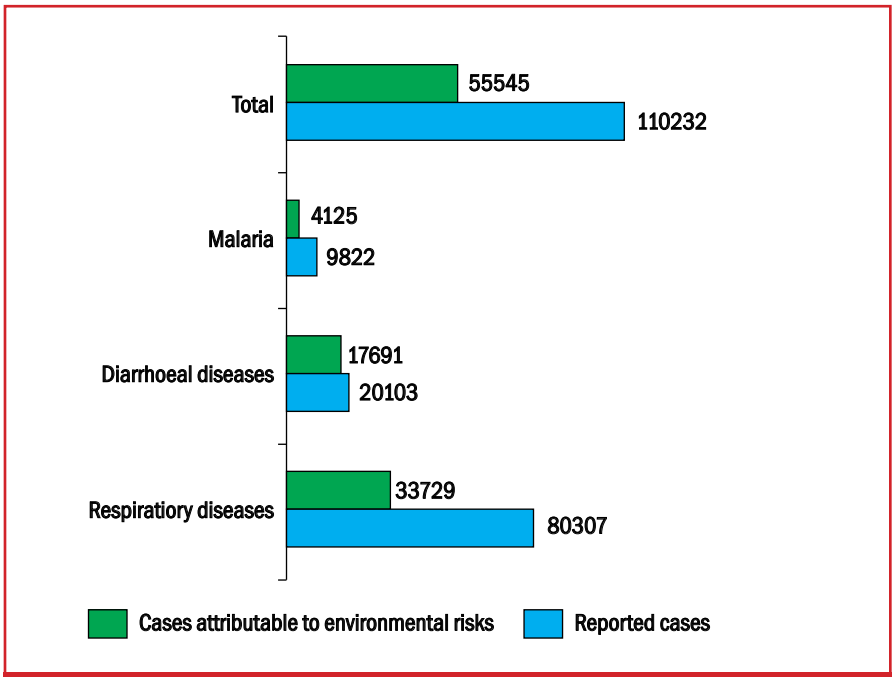

Figure 5 Summary of cases attributable to environmental risks in Goa[9]

[8] Source: Goa State Pollution Control Board (GSPCB), *Hazardous Waste Annual Report 2009-2010*.

[9] Based on Prüss-Üstün and Corvalán (2006). Preventing disease through healthy environments, World Health Organization, Geneva.

consider these in public provision of health infrastructure in the state. Studies confirm that respiratory communicable diseases (RCD) across the state, especially in the mining *talukas* had increased annually between the years 2000 and 2004. Consultation with respiratory health experts in Goa Medical College indicate that behavioural factors like smoking could also impact the number of cases reported. It was concluded that there is still dearth of micro-level studies that could make environment-health linkages for respiratory conditions like Siderosis for the state of Goa.

In case of diarrhoeal infection, key factors include quality of drinking water and hygiene. Annually in Goa, diarrhoea causes estimated 17,000-20,000 cases. In case of malaria, cases reported are high for endemic states that include Goa and the north-eastern states. There has been an increase in reported cases for malaria as well as mortality figures for malaria from 2000 to 2008. There has been focal rise of cases reported at the sites of constructions with high-risk populations comprising of migrant workers and labour force.

3.8 Climate change

Goa is primarily vulnerable to an increase in mean sea level and an increase in the frequency and intensity of extreme events such as tropical cyclones and storm surges. Being located in the West coast, Goa is under the influence of the north Indian Ocean. Several studies carried out on sea-level variability along the west coast of India suggest that the variations in sea level during the winter monsoon are linked to the coastal currents around India and to the circulation in the southern Arabian Sea as a whole. A rise in sea level and other human causes such as ground water pumping can reduce fresh water flow towards coastal discharge areas and cause saltwater to be drawn towards the fresh water zones of the aquifer. A study observed that even under a 0.5 m SLR (sea-level rise) and assuming even 10 km^2 of coastal area being affected, nearly 250 wells in Goa would be affected by salt-water intrusion. Additionally, the studies have estimated that under a 1 m SLR scenario, Goa could potentially lose as high as 4.34% of its total land area, impacting land use patterns and cultivated land in the state.

Goa is primarily vulnerable to mean sea level rise

Agriculture will be adversely affected by increase in temperatures, increase or decrease in the overall amounts of rainfall, and also shifts in the timing of the rainfall. Agriculture will be worst affected in the coastal regions of Goa where agriculturally fertile areas are vulnerable to inundation and salinisation. Additionally, rise in temperatures under a climate change scenario can impact agriculture due to increase in pest infestations. The incidence of other crop diseases like fungal and bacterial infection is also likely to increase if the climate gets warmer. With participatory meetings with farmers of Goa, it was understood that there has been increasing infestation of wide variety of pests on horticultural crops and there has been increase in the pathogens in the soil.

SLR can also alter the ocean currents and the food chains operating in the marine ecosystems, thereby affecting fisheries to varying levels.

SLR could increase the vulnerability of coastal areas to flooding during storms as they now build on a higher water level. Furthermore, eroding of the shoreline removes natural protective structures along the coast. Loss of wetlands and mangroves can cause storm surges to dissipate slower and increase coastal flooding. There are some instances of extreme events that have taken place in Goa, e.g., 271 mm rain in a day in Canacona leading to floods, but there are no studies currently, linking such abrupt events to long-term climate change.

When coupled with temperature rise, SLR can create favourable range and conditions for vectors such as mosquitoes to thrive. The sea water also harbours several disease causing agents and SLR could expose the coastal population to these pathogens.

The IPCC projects that by 2080s, SLR could potentially convert 33% of the coastal wetlands globally, to open water. Loss of wetlands will impact the goods and services provided by them including maintaining species diversity, providing breeding sites for fishes, purification of wastes, recycling of nutrients, and acting as a natural shield from coastal extreme events.

The vertical rise in the water column due to the predicted SLR, and the limitation of landward margins, may result in water logging and ultimately the death of mangroves as well as other dependent and associate biota.

Table 1 Key findings of the baseline assessment

S. No	Sector	Findings
1	Social	
	Rising population densities	High population density of 394 persons/km² (North Goa: 471 persons/km² and South Goa: 326 persons/km²). Uneven distribution, migration, floating population
	Increasing urbanization	62% population residing in urban areas in 2011
	Health	Good coverage of medical facilities (compared to other states): IMR and MMR low and further coming down
		Rapid rise in chronic diseases such as cancer, heart disease, and mental health problems
	Literacy	Census 2011 : 87.4% (4th in India)
	Employment	Unemployment rate higher than country average with gender differences; Lack of jobs and skill mismatch
	Economy	Highest SGDP per capita (2.5 times the country average)
	Poverty	Population BPL has constantly been lower than the national average; Lesser slums
	Agricultural products dependency	Decreased agricultural yields and changed consumption patterns
	Security	Social evils on the rise
2	Economy	
	Tourism	Tremendous growth (6 times in 3 decades) In 10 years, 792 new hotels; rent back facilities Foreign exchange earnings from Goa is about 700 million US$ per year Environmental Impacts: CRZ violations leading to destruction of sand dunes and coastal ecology; pressures on sewerage, waste disposal facility, electricity supply, water supply, transport, roads, etc.; Occupational shifts and social-economic issues, inflation

Table 1 Key findings of the baseline assessment

S. no	Sector	Findings
	Industries	Significant contributor to SGDP (1/3rd) Most resource intensive and polluting sectors in the economy Water consumption share– 52% [a]- mainly ground water Major contributor to air emissions (24% in PM)
	Mining	40% of the total exports of iron ore from India Environmental issues: Land degradation, degradation of forest and loss of biodiversity, air pollution, surface and ground water pollution, noise pollution, etc. Conflict between mining and agricultural sectors Governance issues: illegal mining, enforcement of mine operating and closure laws
	Agriculture	Decline in agriculture: contributes 3%-4% to the NSDP, employs 7% Less lucrative to workforce: land diversion for other land uses (land price increase) Infrastructure constraints: supply chain, efficient irrigation, and information systems Impacted by mining and unplanned urban development
	Construction	Increasing rate of construction similar to other urban centres of the country is observed in Goa. Bye-laws do not provide for continuation of architectural facades relevant to historical places. Bye-laws do not provide for energy-efficient and resource-efficient buildings Conflict of interest for hoteliers and CRZ/ecology. Green buildings are not very popular Housing supply gap; rising prices
3	Environment	
	State of Environment	Air pollution: High PM emissions from mining (38%), industries (24%), and transport (10%) sector Surface water: Deterioration due to domestic sewage and industrial effluents. Limited sewage treatment infrastructure Ground water exploitation – Mining, tourism, industries Forest: 1,100 ha of land diverted to other land uses, deterioration of quality Coastal degradation due to new resorts, settlements, infrastructure for tourist activities, sand mining, reclamation of shallow water bodies, shoreline constructions, sea walls, beach shacks, etc. Waste management: Decentralized form of MSW management, cess on mining waste, no major facility of common hazardous waste management
	State of resources	**Water** Water requirement in rural areas is like a medium-class town All 334 villages have been covered with water supply Water shortages are seasonal and user-segment specific. Densely populated areas (high tourist concentration) tend to face maximum shortage 13% of urban population served by sewerage system (India 28%) **Land** Competing demands for land from different sectors Land use changes from agriculture to other sectoral uses Land degradation due to mining and industrial wastes **Energy** Growing power deficit

Note: [a] In the total water consumption other than irrigational purposes.

Table 2 Comparative analysis of economic, environmental, and social aspects of different sectors in the State (2009/2010)

Sector	Economic	Environment	Social	Inter-linkages
Tourism	Contribution to NSDP**: 5346.1 crore NSDP share : 32%	Water demand: 8 MCMY[a] Energy demand: 187 MKWH[b] Air pollutant[c]: 399 T/yr[d] Effluent: 6.6 MCMY Solid waste: 12323 T/yr	Demonstration effect Social evils rise	Backward linkage to other sectors like construction
Mining	Contribution to NSDP : 672.7 crore NSDP share : 4%	Water demand: 58.8 MCMY Energy demand: 673[e] MKHW Air pollutant: 7107 T/yr (PM_{10} -38%) Effluent : 49.4 MCMY Solid waste: 123000000 T/yr Forest land diverted : 1100 Ha	Conflict between mining and mining impacted communities	Backward linkage to agriculture and forward linkage to transport
Industries	Contribution to NSDP : 4302.7 crore NSDP share : 26%	Water demand:176.7 MCMY Energy demand: 680 MKWH Air pollutant: 5784 T/yr (24% PM_{10}) Effluent : 141 MCMY Solid waste: 56498 T/yr	Skill mismatch	Impact on agriculture, tourism, power, transport
Construction	Contribution to NSDP : 1709.07 crore NSDP share : 10% Major factor in land price increase in the State	Solid waste: 5475 T/yr[f]	Land price increase	Negative effects on agriculture
Agriculture	Contribution to NSDP : 497.0 crore NSDP share : 3% Declining NSDP share	Water demand: 570 MCMY[g] Energy demand: 18.7 MKWH Air pollutant: 292 T/yr	Occupational shift towards other option Less lucrative option Absence from the educational system	Forward linkages to tourism

Notes:

** NSDP figures are the advance estimates for the year 2009-10 at the constant prices (base year 2004–2005) -Economic survey 2010-11 (pg 96); tourism includes trade, hotels & restaurant and transport, storage & communication

a MCMY: Million cubic meter per year

b MKWH: Million units

c PM, SO2, and NOx emissions

d T/yr : tonnes per year

e Estimated based on sp. Energy consumption of 0.059 Gj/ton

f for Panjim only

g Estimated based on water demand of various crops

4. Future projections: key findings

Future projections for business as usual scenario were carried out for various economic sectors of the state based on the growth of population, past trends, and market demands. It is projected that the resident population of Goa will grow from 14.5 in 2011 to around 16 lakh in 2030. However, the tourist population – which has been linked to the economic conditions in the major tourist countries like EU, Russia for international tourists, and India for domestic tourists – is projected to increase at a much higher rate and is expected to reach 50 lakh by the year 2030. The industrial sector in Goa will tend to shift towards orange and green industries in future and the

With growth in economic activities environmental stressors are going to increase manifold

state gross domestic product (SGDP) from the sector is assumed to grow at the rate of 6.5% to reach 25,000 crore in 2030. Mining sector growth has been linked with iron-ore demands from China, and if no intervention is taken the mining of iron ore should grow to 132 MT/year. Past trends of agriculture sector suggest a shift from paddy to other lucrative options such as cashew, coconut, or other organic farming products.

The sectoral estimates of growth were also translated into additional environmental pressures on the fragile environment of Goa. Table 3 presents the projected increase in environmental pressures from different sectors during 2010-2030.

It is quite evident that with growth in economic activities, environmental stresses are also going to increase. Many environmental indicators — air quality and water quality — show that they are either violating or on the verge of violation of prescribed standards. Limited land availability has already made waste management a key issue in the state. All this only suggests a grim future, if we move on the same path of development. The subsequent section highlights the need of various sectoral interventions which could lead to reduction in the growth of environmental stressors without impacting the overall social and economic development of the state.

Table 3 Projected increase in environmental pressures from different sectors during 2010–2030

Sector	Environmental pressure	Baseline 2010	2020	2030
Tourism	Water demand: MCMY[a]	8	12	15
	Energy demand: MKWH[b]	187	286	380
	Air pollutant: T/yr[c]	399	504	911
	Effluent : MCMY	7	9	12
	Solid waste: T/yr	12323	17194	22788
Mining	Water demand: MCMY	59	135	191
	Energy demand: MKWH	673	1547	2118
	Air pollutant: T/yr	7107	7588	7975
	Effluent : MCMY	50	113	161
	Solid waste: T/yr	123000000		396000000
Industries	Water demand: MCMY	177	259	342
	Energy demand: MKWH	680	1252	2170
	Air pollutant: T/yr	5782	8472	11195
	Effluent : MCMY	141	207	273
	Solid waste: T/yr	56498	82749	109347
Agriculture	Water demand: MCMY	570	634	696
	Energy demand: MKWH	19	17	16
	Air pollutant: T/yr	292	168	102
	Effluent : MCMY	-	-	-
	Solid waste: T/yr	-	-	-

Note: [a] MCMY: Million cubic meter per year; [b] MKWH: Million units; [c] T/yr: tonnes per year

5. The alternate pathway to sustainable development

Goa is one of the better-performing states in India. However, the current pattern of economic growth may not only be detrimental to its ecology but in the long run could eventually impact the overall development of the region. The challenge of sustainable development requires that policy-making is driven by sustainability goals, recognizes the inter-linkages between the sectors and resources, and is backed up by effective implementation. The alternate pathway proposed in this study is based on a set of 'sustainability goals' with strong cross-sector linkages as explained in Figure 6.

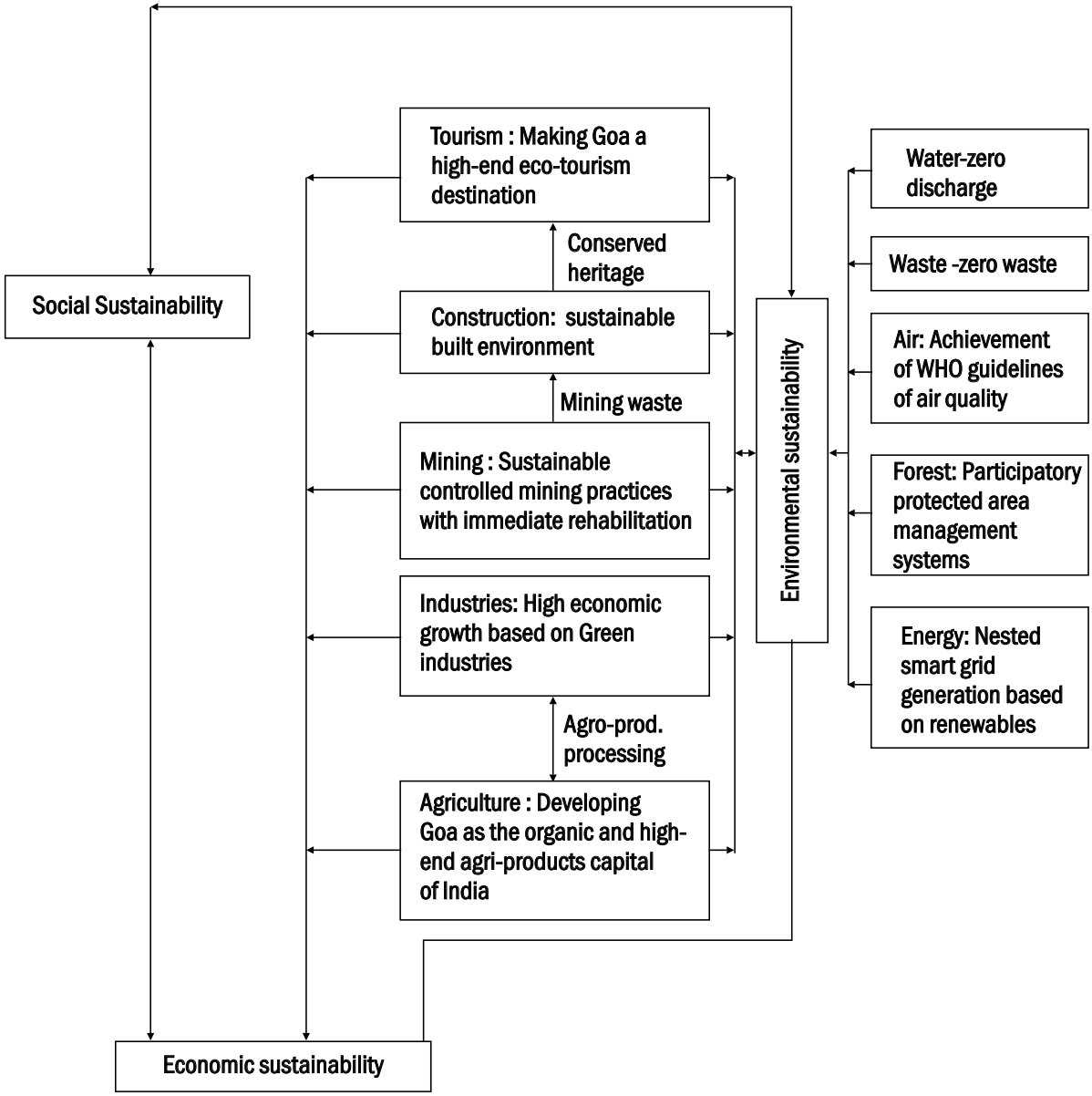

Figure 6 Sustainability goals with cross-sector linkages for Goa

5.1 Socio-economic

Restrict unequal development and revitalize the rural economy

The key challenge related to socio-economic sustainability in Goa is to restrict the unequal development of the different areas of the state and promote a more structured and balanced development across its various *talukas*. The problems arising from changing land use patterns, congestion, health, etc., that have accompanied the high levels of urbanization need to be addressed. The decline in agricultural activity and employment needs to be checked and revitalizing of the rural economy needs to be encouraged through fiscal and financial support. The pace of mining activity should be slowed down considerably as it is generating severe environmental and social problems and responsible mining needs to be encouraged. The relatively better health conditions and infrastructure in the state as compared to rest of India needs to be maintained and improved further so that the state could become a model state for its health achievements. Also, there appears to be a gap between the educational policy in the state and the industrial requirement which leads to unemployment. With high literacy levels already prevailing in the state, what is needed now is upgradation of the education infrastructure in the context of the new demands by the industry. There should be a vision for Goa that emphasizes training (based on the industry demand) and skills development through creation of domain-specific training institutes/programmes, industrial training institutions and centres.

5.2 Tourism

Promoting high-end environmentally conscious tourism which is economically benefiting and environment friendly

Since the onset of tourism in Goa, it has grown drastically where in the average annual growth of tourist arrivals to the state is 7 % from 1981 to 2009. This phenomenal growth has resulted in a mismatch between the supply of tourism services and infrastructure and the demand. Tourism is an extremely resource intensive activity, wherein it can impact both, the resource-base of an economy, as well as the ecological functions performed by that resource. Socially, tourism has often contributed to the demonstration effect wherein the host population imitates the high consumptive lifestyle and culture of tourists.

Given this scenario, it is imperative that the tourism sector in Goa, while fulfilling its huge growth potential, should do so in a sustainable and socially responsible manner. Thus, the vision for tourism in Goa is "Sustaining Economically Viable, Ecologically Bearable and Socially Responsible and Culturally Equitable Tourism in Goa". This will involve:

1. Promoting high-end environmentally conscious tourism which is economically benefiting and environment friendly;
2. Spreading tourism across temporal and spatial scale; and
3. Reducing environmental footprint of the tourism industry through legislative, regulative, and fiscal-based instruments.

5.3 Mining

Mining in Goa has been a contentious issue. However, as one of the strongest drivers of ecological degradation in the state, the policy response needs

Adopting controlled and environmentally sustainable mining

to be comprehensive in its substance and effective in its implementation. From the sustainable development perspective, the goal for the mining activities in the state should be to shift towards sustainable and controlled mining with limited environmental impacts.

The *Goa 2035* vision document emphasizes on empowering and involving local stakeholders in environmental monitoring and reporting the offences associated with mining operations. The document also suggests setting up of a fund derived from royalty received in mined out ore that would be used for development of area including provision of alternative employment to the population affected by mining. In addition to such measures, our study proposes the following strategies:

- **Cancellation of mining licenses:** The mining licences given prior to 1980 need to be reconsidered. Similarly, sacred groves and other sensitive ecosystems should be declared as ecologically sensitive areas and no mining should be permitted in these areas. Mining should also be discontinued in the catchment of water bodies to preserve and conserve these. Progressive targets need to be set for providing cap on mining activities in future.
- **Conservation of groundwater**: The pumped-out groundwater has to be treated and used either for recharging the aquifer to tackle depleting groundwater levels or supplied as drinking water/irrigation supply in that order of priority to nearby habitation.
- **Use of eco-friendly mining practices**: The use of rippers and dozers should be made mandatory of all the leases. In certain deposits, where underground mining is an option should be explored; the environmental impacts are much less in that case than in open-cast mining. Possibility of pursuing mining for other minerals with lesser environmental footprint needs to be pursued.
- **Upgradation and maintenance of civil infrastructures**: There is need to upgrade the road infrastructure to take to load and prevent trucks from overloading. There should be heavy penalty levied for overloaded trucks.
- **Need to landscape and rehabilitate mined-out areas**: Mine decommissioning should be planned at the commencement of operations or at the least to be integrated with the final year of mine operation. Final rehabilitation should be influenced by the long-term post-mining land use and environmental condition of the site determined in partnership with the local community. This would include either restoration of native ecosystems or pre-mining land use, or development of new landforms and land uses, which bring about a greater community benefit.
- **Addressing illegal mining**: Legislative provisions would be required to control illegal mining, transportation, and storage. Also, the penalty on the illegal mined out ore needs to be higher than the market value of the ore.

5.4 Industries

Industrial growth in Goa must ensure that there is minimal impact over environmental resources. In terms of a sustainability goal, the state may work towards a 2030 scenario in which two-thirds of the industrial contribution to its SGDP is sourced to the 'green' category of industries. By mandating a lower environmental footprint for its industries, the alternate pathway for Goa is expected to create green jobs while ensuring the preservation of environmental quality. The 'greening' of Goa's industrial sector in the alternate scenario is consistent with the sustainability goals proposed for agriculture and tourism.

Improving resource efficiency and promoting green growth

The present study proposes the following strategies for the sustainable development of the industrial sector in Goa:

- **Promotion of selected categories of industries** which are clean, resource-efficient, and based on carrying capacity studies for the region.
- **Improving energy efficiency in the existing units** through energy auditing, use of efficient process technologies and appliances, and improved maintenance of the energy infrastructure.
- **Improving water use efficiency in existing units** through water auditing, use of improved efficient process technologies and appliances, reuse or recycling of wastewater, proper operation and maintenance of existing infrastructure, minimizing the leaks and losses, and rainwater harvesting.
- **Clean technology** interventions in small-scale industries.
- **Development of infrastructure for environmental pollution control and inventorization** of the effluents and hazardous and non-hazardous wastes from industries.
- **Fiscal incentives** for clean technologies.

5.5 Agriculture

Promoting high-value organic farming, improvised cultivation practices with supportive infrastructure and incentive

Goa has the potential of being a global leader in high-value organic farming and being an example of enterprise-led agriculture. The goal should be to evolve as a leading producer and exporter of fresh and processed indigenous/exotic fruits and vegetables through the use of modern technologies customized for Goa. This requires improvising on methods of cultivation for local cultivators to create new standards along with supportive infrastructure and incentives. An immediate step that may be considered is the establishment of a germplasm bank for collection of valuable genes in the region.

5.6 Construction

The construction sector in Goa has shown phenomenal growth in the last decade. The sustainability goal for the sector could be to allow all new construction only on the principles of green buildings. Moreover, to the extent possible (say 50%) of existing buildings should be retrofitted so as to make them resource-efficient and environment-friendly. This is also recommended to implement the findings of the regional plan and do

Conserving old patterns of resource efficient buildings

proactive landuse planning to avoid conflicts due to competing demands of land and emerging environmental issues. There is a need to conserve and manage the old heritage buildings in the state by provision of fiscal incentives. This will help to reduce the environmental footprint of the sector and reduce its share in the demands of natural resources. This will also help in conservation of old heritage buildings, which in turn will help in keeping the culture of the state intact, and will act as an added feature for tourism sector to grow.

5.7 Energy

Focus on sustainable and smartly managed energy system with minimal dependence on external supplies

Goa's electricity demand is primarily met through power supplied by central allocations and due to the delicate state of environment, it is difficult for the state to have its own power-generating plant based on conventional fuels. However, with rising demands from various sectors, Goa needs to have a pragmatic approach towards augmenting its power capacity so as to keep abreast with its plans of enlarging economic development.

The goal in this regard for the state of Goa is to supply the power demanded while looking at opportunities to produce its own dispatchable power using cleaner fuels such as natural gas, or to use renewable energy.

In either way, the focus is to have a totally sustainable and smartly managed system (e.g., nested smart grid generation based on renewables) with least future dependence on external supplies. A lot also needs to be done for improvement on demand side management. Improving efficiencies in industrial production and buildings sector will lead to substantial decrease in the energy demands. GRIHA compliance in the tourism sector will definitely reduce its share in the energy consumption.

5.8 Air pollution

To achieve the NAAQS in the shorter time frame (2020) and WHO guidelines by the year 2030

Goa is a state which depends on mining, industries, and tourism for its major economic activities. These sectors are also the main ones responsible for deterioration of air quality in many regions of the state which affects human health. Considering the future growth trajectories of the economic sectors in Goa, there is a need to take proactive measures for control of air pollution so that there are negligible impacts of these activities on air quality. The WHO has specified guidelines for air quality which suggest minimal impact of air pollutant concentrations over human health. National Ambient Air Quality Standards — NAAQS (though little above the WHO guidelines values) — have also been specified to benchmark the air quality in a particular region. To strengthen the environmental leg of sustainability, the goal is kept ambitiously to achieve the NAAQS in the shorter timeframe (2020) and WHO guidelines by the year 2030. This will not only reduce the health costs of the existing population but will also be positive for attracting high-end tourism and boosting the overall economy. For this, energy efficiencies need to be improved across different sectors; old closed mines needs to be rehabilitated for reducing fugitive dust emissions; road construction, maintenance and cleaning needs to be of highest standards; emphasis should be laid on restrictions or inspection

and maintenance of older polluting vehicles and diesel generating sets; and public transport systems and e-services need to be enhanced for discouraging the use of private vehicles.

5.9 Water

Improving water use efficiency in agriculture and industries

Considering the future growth trajectory of economic sectors, the water consumption patterns are set to rise manifold. With this will also rise the waste water generation which may lead to severe impact over the water bodies of the state. Hence, the sustainability goal for the water sector in Goa is to provide equal access to the safe water while ensuring environmental sustainability of the resource through state-of-art conservation techniques, wastewater recycling, and treatment methods. This will require implementation of Integrated Watershed Management Plan to restore ecological balance by preventing soil run-off, rainwater harvesting, and groundwater recharge. The strategies to improve the state of water resource in state include:

- Reduction in Unaccounted-for-Water (UFW) by fixing leakages.
- Promotion of decentralized sewage treatment to reduce load on the central facility.
- Increasing the water-use efficiency of all the economic sectors.
- Introducing market-based instruments, water pricing mechanisms that encourage resource conservation, reuse or recycling.
- Adoption of water saving fixtures, retrofitting should be encouraged, rebates/financial incentives should be given.

5.10 Waste management

Making Goa zero-waste state by ensuring extensive reuse and recycling

The sustainability goal for Goa should be to make the state waste free by the year 2030. This will encourage the remodelling of product life cycles ensuring reuse and recycling of all resources consumed. The concept of zero waste can be inclined to being idealistic, however, the employment of selective consumerism, minimum usage and consumption of resources, decentralized composting, and the recovery — reuse and recycling — of materials is very much possible in the long term.

It will initially be requiring a paradigm shift in people's mindsets and attitudes on elimination and reduction of waste right at its points of generation and can be achieved by extensive awareness programmes. Next will be the management of wastes, starting from source segregation, and composting of bio-degradable fractions, while assuring sufficient markets for the manufactured manure. On the other hand, recycling of non-biodegradable waste should be formalized by bringing in the scrap/junk dealers and rag-pickers into the working arm of local governing body in charge of waste management. The supporting infrastructure relating to recycling and recovery needs to be upgraded and vastly improved in order to move towards a zero-waste state. There is a need to enforce regulations to reduce consumption of plastic to discourage littering and open dumping of waste, management and disposal of other waste streams such as

biomedical and hazardous waste. EPR (Extended Producer Responsibility) needs to be extensively promoted for reducing e-waste generation.

5.11 Forests and biodiversity

Initiate systems of participatory forests management and biodiversity conservation

The state of Goa is important from the point of view of biodiversity conservation due to its location amidst the Western Ghats, rich coastal biodiversity including mangroves, fishes, etc., and large expanse of the forests beyond the administrative boundaries of the State Forest Department. The state already has one national park and six wildlife sanctuaries but certainly the requirement of protection and safeguarding of the biodiversity is much larger due to the importance of the region in terms of conservation, to avoid people-wildlife conflicts, to strengthen the traditional conservation practices, and so on. To address such requirements, there is a need to have participatory biodiversity conservation systems for the state. There are three specific existing provisions which could be suggested to develop a participatory biodiversity conservation system for Goa such as (a) Conservation Reserve (Wild Life [Protection] Act 1972), (b) Community Reserve (Wild Life [Protection] Act 1972)' and (c) Biodiversity Heritage Site (Biological Diversity Act, 2002). There are several potential sites in Goa such as more than 100 known sacred groves, numerous lakes important for fishery and bird conservation, areas adjacent to protected areas, and so on, which could be identified for community-based conservation system using the three provisions.

Amendments to the Wildlife (Protection) Act 1972 have opened up new opportunities to involve the community in the conservation efforts by declaring community and conservation reserves (on government and private/community land respectively). These amendments will recognize (the largely isolated) community conservation efforts and integrate these with the mainstream conservation strategy. However, while conservation reserves have received increasing attention, very few community reserves[10] have been established so far, largely due to communities' inhibition to share ownership and conservation stakes with the government. Besides, the Declaration and Management of a Conservation Reserve and the Declaration and Management of Community Reserve, the provision of declaring Biodiversity Heritage Sites in Biological Diversity Act, 2002, generates an opportunity to recognize community initiatives like Sacred Natural Sites. It also provides an institutional mechanism at the national, state and local levels for conservation of these sites. All three provisions provide an institutional mechanism of management and conservation with the help of the local communities. There is a need for the state government to effectively utilize these provisions. At the same time these legal provisions have yet to have an on-ground impact largely due to limited documentation of sacred natural sites, important corridors for

[10] Community reserves can be established by the government on the land owned by the private or by the community.

wildlife, locations of wildlife conflict, etc. Similarly policy perspective of compatibility of institutional mechanisms of these provisions at various levels is not explored adequately to maintain the balance of stake between government authorities and the local communities. But having the national policy provisions provide an excellent opportunity for the state governments to initiate the systems of participatory biodiversity conservation.

5.12 Creative economy

Excessive dependencies on mining and coastal tourism has probably led to the neglect of other sectors which could be less resource intensive, environmental friendly and more sustainable. Futuristically, Goa needs to transform its economy and adapt its core businesses, which are natural resource dependent, to new sources of growth built on knowledge, skill and creativity. The "creative economy" (UNCTAD, 2010) "is an evolving concept based on creative assets potentially generating economic growth and development. It is a set of knowledge-based economic activities with a development dimension and cross-cutting linkages at macro and micro levels to the overall economy. It is a feasible development option calling for innovative, multidisciplinary policy responses and inter-ministerial action. Goa being a tourist destination, a cosmopolitan multi-cultural state, having good infrastructure could transform its economy towards the creative industries like entertainment, handicrafts – embroidery, jewelry, architecture design, cultural sites, software, literature, fashion and design, visual arts, pictorial traditions into animation, food preservation etc

transform the economy to new sources of growth built on knowledge, skill, and creativity

Investments has been inadequate in building these types of creative economical activities. There are huge possibilities of integrating the power of ICT to making possible more "smart" development choices. A flagship University Program on media, film, design, fashion in collaboration with Colleges of International repute institutions could be launched. There is also a need to revisit the University undergraduate/vocational courses to build competencies in design, fashion, creative writing, languages, communication, digital technology, graphics, and animated films. These also needs to be focused on entrepreneurship and enterprise development.

6. Conclusion

Despite the multitude challenges to its sustainable development, Goa has a major opportunity to transform itself as a role model for other states in India in the pursuit of green growth. Although, this report explains the current scenario and presents a glimpse of the future, there are still many areas of research which are directly relevant to the sustainable development of the state, and need further attention. The development of comprehensive green accounts for the state would be greatly enabling for decision-makers for pursuing the goal of economic growth while not compromising on environmental sustainability. Good governance and people's participation would have a transformative effect on effective implementation of policies that is crucial to achieving sustainable development.

Directions, Innovation, and Strategies for Sustainable Development in Goa is a project conducted by TERI supported by FUNDAÇÃO CALOUSTE GULBENKIAN. The project aims to assess the current state of environmental and socio-economic development in Goa. It aims to understand the likely impacts on environmental and socio-economic development, under different growth scenarios over the next two decades, till 2030. The project finally recommends strategies to avert the likely negative impacts for the state's environmental resources, without compromising on overall socio-economic development.

This study involved numerous stakeholder groups representing civil society, environmental groups, industry, and the policy community to seek perspectives, inputs, data, and information on various aspects on socio-economic development and environmental protection.

The study encompasses social issues of population growth, migration, employment, urbanization, poverty; addresses sustainability concerns of key economic sectors of the state — tourism, mining, industries, construction, and agriculture; and impacts on the natural resources — air, water, land, forest, and biodiversity. The study also considers climate change as an additional stressor on the resources of Goa.

The project highlights the required policy, governance, and legislative and regulatory provisions needed to abate the adverse impacts with improved socio-economic development.

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