सत्यमेव जयते

Government of Rajasthan

Rajasthan State Environment Policy 2010

including

Rajasthan Environment Mission & Climate Change Agenda for Rajasthan (2010-2014)

Department of Environment
Government of Rajasthan, Jaipur

Contents

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Rajasthan Environment Mission

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2010

CHAPTER 1. Preamble

In the six decades since India's independence, Rajasthan has shown steady progress in most economic and human development indicators. Until the early 1980s, though, Rajasthan was considered one of the most backward states in India (In 1981-82 Rajasthan ranked 25th among 28 Indian states in terms of per capita NSDP, whereas by 1991-92 it ranked 18th among the 28 Indian states. The literacy rates in Rajasthan increased from 8.95% in 1951 to 30.9% in 1981, to 61.03% in 2001, as against literacy rates in India of 16.67% in 1951, 53.56% in 1981 and 65.38% in 2001). Harsh climatic conditions, abject poverty, low literacy levels, and an economy heavily dependent on rainfed agriculture contributed to poor economic performance. Besides social factors, the poor natural resource base played an important role in determining the development of the State economy.

Rajasthan is the largest state in the country. The Aravali range, running from northwest to southeast, divides the state diagonally into two distinct regions, the western arid region and the eastern semi-arid region. Over 61 percent of the State, mostly in the western part, is desert. The State has only 1.1 percent of India's total water resources as against 10.5% of the country's geographical area and 5.5% of the country's population. Except for the Chambal, the 13 other rivers of the state are non-perennial. Precipitation is scanty, and constitutes the only source of annually renewable water supply. As such, the State is prone to frequent droughts.

Beginning 1980s, increased abstraction of surface and groundwater for irrigation resulted in large areas to be brought under irrigation (Gross irrigated area in the State increased from 37 lakh ha in 1980 to 67 lakh ha in 1996). The State began to register real GSDP that was among the highest in the large Indian states during 1980-97. This surge in economic growth continued until the late 1990s, and was induced primarily by a robust agricultural growth. Diversification of crop varieties, and a price policy which supported crops suitable for the agro-climatic conditions of the State, also helped improve agricultural performance during this period.

With improvements in economic performance, the State began to display significant improvements in its human development indicators. Poverty proportions reduced substantially, literacy rates improved, consumption inequalities declined, and regional disparities in economic growth within the State decreased. The percentage of population below the poverty line fell from an estimated 50 plus percent in the early 1970s, to 15.4 percent in 1999-2000. However, the rapid growth in agriculture decelerated during the late 1990s due to repeated droughts, depleting groundwater reserves, unfavourable agriculture trade policies, and crop support prices that pushed crops suitable for the State's agro-climatic features to the marginal areas, as a result of which the State lost its advantages.

The lack of opportunities in rural areas and small towns also saw an increase in rural to urban migration, and increasing urban growth in the larger cities, which could be attributed to population growth as well as migrants in search of better livelihoods. This trend has continued to date, however the urban labour market has apparently not been able to fully integrate the migrant population, and a unique feature of Rajasthan is that the State has larger proportions below the poverty line in urban areas as compared to the rural areas. Short-term out-migration is another adaptive mechanism which is particularly significant in the western desert, where upto 40 percent of the workers out-migrate at one time or the other in a year.

The State's planning process also sought to broad base the economy by diversifying into non-agricultural sectors, especially the industrial and service sectors. Several industrial policies, promulgated over the past few decades, aim to minimize regional imbalances within the State, improve infrastructure, and generate employment. Given Rajasthan's vast mineral reserves, and the fact that majority of the rural population still subsist on agriculture, industrial development has focused mainly on mineral-based and agro-based industries. However, Rajasthan still ranks low among Indian states in terms of industrial production.

Rajasthan has vast mineral reserves of metallic and non-metallic minerals, such as zinc, lead, copper, limestone, marble, granite, gypsum, and also lignite, petroleum and natural gas reserves. The State industrial policies have progressively sought to exploit these resources by promoting mining and mineral-based industries. The total revenue value of minerals received was Rs. 48.02 crores in 1950-51, which increased to Rs. 349.43 crores in 1999-2000, and further to Rs. 748.98 crores in 2008-09.

In the industrial sector, the small-scale industries have shown significant growth and the number of registered units increased from 70,100 in 1980-81 to 3.2 lakhs by 2008-09. The SSIs include primarily textile dyeing and printing, small mining leases, stone crushers, cement kilns, and agro-processing units. Despite the robust growth in the sector, employment averages four persons per unit, and investment per unit has remained very low.

Rajasthan has also placed a major focus on the promotion and development of tourism, given its rich cultural heritage, forts and palaces, vast desert, wildlife sanctuaries, and traditional fairs and festivals. The fastest growing segment of the tertiary sector has been trade, hotels, and restaurants, which alone account for 15 percent of the NSDP. Tourism also has immense potential for employment generation in urban as well as rural areas. As a result, Rajasthan today offers a well developed mix of tourism products, such as the Golden Triangle (the Delhi-Jaipur-Agra circuit), Palace on Wheels, Desert Triangle (the Jodhpur-Jaisalmer-Bikaner circuit), and numerous heritage hotels as well as national parks and wildlife sanctuaries, and tourist destinations of special value such as Pushkar, Udaipur and Mount Abu.

Despite these developments, for the majority of the rural population, agriculture and animal husbandry still remain the main source of livelihood. Animal husbandry in Rajasthan is a major economic activity. Rajasthan has 12 percent of the cattle population in the country, which is nearly equal to the human population in the State. The human population of the State was 5.65 crores according to the 2001 census. The

livestock population of the State as per 1997 Livestock Census was 5.44 crores. Animal husbandry contributes nearly one fifth of the State GDP and income from livestock accounts for one third to half the income of the rural poor. This sector also has a major share in rural employment as compared to agriculture and other sectors. However, the sector faces problems of low productivity due to feed and fodder problems, and lack of backward and forward linkages with livestock-based industry. For example, in absence of a well developed leather goods industry, 60 percent of the hides and skins are sent out of the State for curing and tanning.

With the diversification of the economy, the need for power has emerged as an extremely important infrastructure for economic development. Various thermal, hydel and nuclear power stations have been installed and are operating within the State to serve as the primary source of electricity. The total installed capacity of these leave a sizeable power deficit, and to bridge this gap, coal based thermal power remains the major option despite long haulage and environmental concerns. The availability of coal from CIL coalfields is highly inadequate, therefore Rajasthan has resorted to use of imported coal to augment depleting coal stocks at the power plants. The State has also started exploring its considerable lignite and oil and gas reserves.

Tracing the development trajectory of Rajasthan, it is evident that any environmental policy for the State must weave in with the State-specific issues in key sectors such as agriculture and animal husbandry, mining and industry, tourism, energy, and basic urban services and infrastructure. Furthermore, elements of environmental management are contained in many of the sectoral policies of the State, and the environment policy must build upon these policies and provide a coordinated response. Lastly, the state environment policy should be in line with the objectives and underlying principles of the National Environment Policy, 2006.

This policy document is therefore based on an analysis of the state-specific issues, the natural resource constraints from which these emerge, and their overall implications for the environment. The document identifies the key environmental challenges and outlines strategies and actions to address them. Above all, it is intended to be a guide to action, and accordingly provides inputs for a State Environment Mission, supported by Task Forces with specific agenda and action plan, and institutional arrangements for implementation of the proposed measures.

CHAPTER 2. Key Environmental Challenges

Rajasthan faces several environmental challenges that it must address to ensure continued economic growth that is sustainable and equitable.

The foremost challenge is to ensure that development activities do not erode the natural resource base on which these are dependent. For example, irrigated agriculture, industrialization, and urbanization have placed an **increasing demand for water** in the State. At the same time, there are gross inefficiencies and inappropriate management practices which result in large systemic losses, overuse and wastage. As a result, the groundwater table in many parts of the State has been depleting at an alarming rate, the lakes and wetlands have diminished, and the already limited resources are becoming polluted with agricultural chemicals, and municipal and industrial effluents, to the point of causing extreme water stress, especially for the economically vulnerable in rural and urban areas. This has ended in a vicious cycle, with water now emerging as a key limiting factor for economic growth (the per capita water availability in Rajasthan is 780 cum as against a minimum requirement of 1000 cum).

The second set of challenges is to reconcile the sometimes conflicting policy objectives among different sectors so that resources are allocated rationally and equitably. Rajasthan has considerable **mineral reserves in forest areas which the forest policy has restricted from being exploited.** While expansion of mining areas could bring in revenues, and support employment and income generation, preservation of a certain forest cover in the State is also crucial for maintaining the stability of the ecosystems, including soil and water conservation, and protecting the livelihoods of the communities that depend on them. Traditionally, mining development in Rajasthan has left a long track of environmental degradation. The threats from mining are not just to loss of forest cover, but also loss of soil fertility, altered surface drainage, and wide-scale pollution from stone slurry, mine tailings and mining overburden. Especially the small-scale mining units often use outdated technology which causes significant wastage and pollution. Rehabilitation of abandoned mines has often not been carried out, despite mandatory mine closure plans. On the other hand, some forest areas with sparse tree cover could be considered for diversion for mining. The award of mining leases in the forest areas should, however, be done only after approval of the competent authority for diversion of forest land to non-forest use under the Forest Conservation Act. This along with technology modernization and pollution control could enable some level of convergence between the goals of mining, forestry, agriculture, and environment.

Abatement of pollution in the face of industrialization and rapid urban growth is another major challenge before the State today**.** The geometric growth in the number of small scale industries has given rise to a quite significant source of pollution, which the present regulatory tools (civil and criminal sanctions) are unable to adequately address. Serious pollution from SSIs, especially when located in industrial clusters, has led to a number of public interest litigations, as a result of which many of the SSIs have been shut down or are facing threat of closure. Likewise, the pollution

standards with respect to the large and medium enterprises and hazardous waste generating units need to be better enforced. Better environmental management practices also need to be enforced in respect of utilization of certain wastes, such as fly ash from the thermal power plants.

Population growth and the continual flow of migrants to the cities has generated increasing pressure for the provision of basic urban services, which have not been able to keep pace with the demand. As a result, most cities face water and power shortages to various degrees, and are unable to cope with the increasing levels of vehicular emissions, wastewater discharges and uncontrolled dumping of solid wastes, eventually leading to pollution of air, water and soil. Groundwater abstraction for domestic and commercial use in many cities has already exceeded recharge levels. There are also a growing number of slum areas in the bigger cities, where pollution and unhygienic conditions further accentuate poverty. Expansion of major cities has changed land use patterns and led to substantial conversion of agricultural land for housing development and industrial use.

Another major challenge for the State is to **strike a balance between the exploitation of forests for products of economic value** (such as food, medicines, timber), **and conservation efforts which seek to maintain the natural processes that sustain biodiversity**. At the same time, forests and biodiversity need to be protected from encroachments for marginal agriculture, tourism, mining, industry and urbanization. Depletion of forests and biodiversity has significant potential to impact livelihoods and cause impoverishment of people depending on them in many direct and indirect ways. For example, the water table in many agricultural watersheds of the State has lowered significantly due to denuded hills upstream, thereby affecting rural livelihoods. Lack of forage in forests has led to reduction in size of herds or sometimes even change in livelihoods of herders. Loss of forest cover has also caused scarcity of fuelwood for the rural communities.

There is a need to evolve an **innovative strategy for providing cooking and lighting energy for the rural population**, so that environment and human health are not adversely affected. About 65% of the total households and 85% of the rural households in the State use biomass fuels for cooking, which results in loss of vegetation, deforestation and significant burden of disease from indoor air pollution. Even while the State plans for an expansion in thermal power generation capacity, it is unlikely to improve the energy situation in large parts of the State which remain so sparsely populated that any centralized power supply option may not be economically feasible.

The development of **the tourism industry also poses a challenge, as it exerts considerable pressure on civic amenities** (including water and sanitation and transport), land use, wildlife and forests, and the socio-economic fabric of the State. Therefore, tourism should be developed within the carrying capacity of the region, and address the potential conflicts between resource use for tourism and livelihoods of the local population, as well as the need for preservation of the unique architectural heritage of the State.

Climate change is of increasing concern not only at the national level but for the State governments as well. The Fourth Assessment Report of the Inter-

governmental Panel on Climate Change (IPCC) points out that the frequency and intensity of extreme events are likely to increase. This would have implications for the States like Rajasthan, which experience extreme climatic conditions. The impacts will be most felt on the vulnerable and poor sections of the society, therefore vulnerability assessment and adaptation measures must be taken in the vulnerable socio-economic sectors like water and agriculture.

When addressing these challenges, it is necessary to recognize the centrality of environmental concerns in the development process. **While overexploitation of natural resources and polluting activities may be the proximate drivers, development processes result in environmental degradation only through deeper causal linkages**. As brought out in the National Environment Policy, 2006, these may pertain to institutional failures, inappropriate fiscal regimes (such as implicit and explicit subsidies) shortcomings in regulatory regimes, governance constraints, and lack of policies that incentivize environmental conservation. Improving environmental governance and building capacity therefore need to be part of any strategy aimed at conserving and enhancing environmental resources.

There is also a need to recognize **the nexus between poverty and environment**. Environmental degradation perpetuates poverty by taking away the time and resources needed for engaging in gainful livelihoods. For example, environment-related health factors (such as lack of access to water and sanitation) result in a significant burden of disease among the poor, which in turn reduces their earning capacity. At the same time poverty itself exacerbates environmental degradation, for example cutting of fuelwood for cooking in absence of alternative energy sources leads to deforestation and indoor air pollution. Therefore, programs for economic development and poverty alleviation have the potential to improve environmental conditions. However, measures to arrest this downward spiral require public awareness and information dissemination at the grass roots level.

Lastly, **the environment policy must support research and development activities that promote innovation** and provide technological alternatives, as well as insights for policy making and regulation. The State must also build partnerships and seek to involve the range of stakeholders who can collectively help find solutions to the State's environmental problems.

CHAPTER 3. Objectives and Principles of the State Environment Policy

The objectives and principles of the State Environment Policy are the same as those on which the National Environment Policy, 2006 is founded. Broadly, the SEP aims to:

(i) **Conserve and Enhance Environmental Resources** by protecting critical ecosystems and natural and man-made heritage, ensuring equitable access to environmental resources for all sections of society, ensuring judicious use of these resources to assure inter-generational equity, and ensuring their efficient use to maximize productivity and minimize environmental degradation.

(ii) **Assure Environmental Sustainability of Key Economic Sectors** by integrating environmental concerns into policies, plans, programs, and projects for economic and social development, so that these do not erode the very resource base on which they are dependent

(iii) **Improve Environmental Governance and Build Capacity** by assuring transparency, rationality, accountability, time and cost effectiveness, participation, and regulatory independence in the process of environmental management and regulation. The policy should also ensure higher resource flow for environmental conservation and promote beneficial multi stakeholders partnership.

In order to realize these objectives, a set of strategies and actions are detailed in the subsequent sections. The basic principles guiding these strategic interventions are the same as those documented in the National Environment Policy, 2006, that is:

(i) Human beings are at the center of concerns for sustainable development and are entitled to a healthy and productive life in harmony with nature.

(ii) The right to development must be fulfilled with equity for present and future generations across all sections of society.

(iii) Environmental protection is an integral part of the development process and cannot be considered in isolation from it.

(iv) Where there are credible threats to key environmental resources, the 'precautionary approach' shall be followed and lack of full scientific certainty will not be used as a reason for not taking mitigatory action.

(v) Production and consumption activities will aim for economic efficiency by assigning economic value to the cost of environmental services, ensuring that polluters pay for the cost of pollution, minimizing wasteful use and consumption of natural resources, and minimizing institutional costs and delays in environmental management.

(vi) Entities with 'Incomparable' value (such as unique historical monuments, charismatic species of fauna and flora, unique landscapes) must be preserved at any cost as damage to these cannot be compensated in terms of money or conventional goods and services.

(vii) The environmental policy must be guided by the principles of equity in all its facets, i.e. 'procedural equity' relating to fair rules for allocation of entitlements and obligations, 'end-result equity' relating to fair distribution of outcomes, 'intra-generational equity' within societies, and 'inter-generational' equity relating to justice between generations.

(viii) Civil liability may be used in addition to criminal liability as a deterrent to environmentally harmful actions, and for compensation to the victims of environmental damage.

(ix) The State is the trustee of all natural resources, and must enable their public use while protecting the legitimate interest of a large number of people.

(x) Decentralization of powers from a Central Authority to State and Local Authorities could empower the public authorities to more effectively address local environmental concerns.

(xi) Environmental concerns must be integrated into sectoral policy making and policy research, and linkages must be strengthened among the various agencies charged with implementation of environmental policies at the central, State, and Local Self-Government levels.

(xii) Environmental standards must reflect the economic and social development situation in which they are to be applied, and must be based on considerations of risk to human health, risks to other environmental entities, technical feasibility, costs of compliance, and other strategic considerations.

(xiii) It is preferable (and often cheaper) to prevent environmental damage from occurring, rather than attempting to restore after degradation.

(xiv) If endangered species and natural ecosystems of special importance to sustaining life, providing livelihoods, and general well being are threatened by a developmental activity, environmental offsetting measures must be undertaken to restore as nearly as feasible the lost environmental services to the affected populations.

CHAPTER 4. Strategies and Actions

The set of strategies and actions **to redress** the key environmental problems of the State are covered under three broad areas:

(i) conserving and enhancing environmental resources;

(ii) assuring sustainability of key economic sectors; and

(iii) improving environmental governance and building capacity.

4.1 Conserving and Enhancing Environmental Resources

Water, land, air, forests and biodiversity are key resources that must be conserved and enhanced. At the same time, vulnerability assessment and adaptation measures should be undertaken in the vulnerable sectors to mitigate the impacts of climate change, especially on the poor sections of society.

4.1.1 Water Resources in Rajasthan

Water Availability: Rajasthan is the largest state in India covering an area of 34.271 million ha, which is more than 10% of the total geographical area of the country, and sharing only about 1% of the total surface water resources of the country. The rivers of the state are rainfed and are classified into 14 major basins and 59 sub basins. Chambal River is the only perennial river in the state which traverses the South Eastern part and the rest are rainfed. The Western Rajasthan is arid to semi-arid with low and erratic rainfall, high summer temperatures, low humidity and high-velocity winds causing an average annual potential evapotranspiration of 2,000 mm, a negative water balance and acute water deficit. The state average rainfall is 531 mm against national average of 1200 mm. There is a large area in Western part of the State, which does not have any defined drainage basin. In the eastern part of the state, the climate is semi-arid to sub-humid with relatively better rainfall, low velocity wind and higher humidity. The surface water resources in the state are mainly confined to south and south-eastern part of the State. Thus the water resources in the state are not only scarce but have highly uneven distribution both in time and space. The state has a large dependence on water received from different states under inter-state agreements and a large share of ground water in the total water supply.

The per capita annual water availability in the State is about 780 cubic meter (Cum) against minimum requirement of 1000 Cum. With increasing population, the scarcity will increase further and the per capita water availability in the state is expected to go down. Total surface water available in the State is 21.71 BCM, out of which 16.05 BCM is economically utilizable. State has so far harnessed 11.55 BCM, which is 72% of economically utilizable portion. In addition 17.89 BCM is allocated through Inter-State agreements. The available water is not enough to cater to the needs of the drinking, agriculture and non- agriculture demands. Demand for water from industry, tourism and recreation, as well as sanitation and environmental purposes, has been growing apace. There has also been a sharp increase in drinking water demand with increase in population and greater consciousness about sanitary facilities. The projected non-

agricultural demand for water is to increase from 3.29 BCM per year (the 1995 level) to 5.05 BCM per year in the year 2015. The supply, however, has remained unchanged. Thus there is a growing imbalance between demand and supply of water in the state. The primary source is the scanty and uncertain precipitation, confined to just two months of the year.

Resource Degradation: Causes and Impacts: Exponential growth recorded in population over the past five decades has subjected the states' water resources to tremendous pressure and exploitation. A special feature in Rajasthan is its large livestock population (18.70% of total livestock population in India), which consumes a major share of state's water resources. Inter-sectoral policies and developmental projects also have led to degradation of water resources in the state.

Water pollution: Natural contaminates such as fluoride, nitrate, and chloride salts are increasing in ground water making it unfit for drinking and posing risk to health. As per BIS, desirable limits in Fluoride, Nitrate and TDS are 1.0, 45 & 500 mg/l and maximum permissible limits are 1.5, 100 & 200 mg/l respectively. Based on these norms about 56% of the water sources in the state are non-potable. While the WHO norms permit only 1.5 mg/l as a safe limit of fluoride in drinking water for human consumption, people in several districts in Rajasthan are consuming water with fluoride concentrations of up to 24 mg/l. High fluoride groundwater is distributed in all the 33 districts in Rajasthan and is influenced by the regional and local geological setting and hydrological conditions for the fluoride contamination. Fluorides in drinking water of Rajasthan have been found to originate from indigenous rocks, and the geological distribution of rocks reveals that fluorotic ores occupy large areas of eastern and southeast parts of the state.

Continuous drought and low/highly variable rainfall in the state in the last decade has resulted in over- exploitation of 91% of water supply sources i.e., ground water, reducing water table, and yield of water or no water in tube well or hand pump and increase in concentration of dissolved salts making it unsuitable for drinking, thereby making already covered habitations either not covered or quality problematic. The fully covered habitations have reduced to only 32.6%, partially covered habitations to about 14% leaving about 53.4% habitations as not covered or quality problematic (about 21190 having salinity problem, 23297 fluoride problem, 20659 nitrate problem). Nearly 90% of the drinking water and 60% of the water required in the agriculture sector is extracted from ground water reservoirs. Thus, not only has the ground water depleted to alarming levels but the quality of ground water has progressively deteriorated leading to serious health problems. Due to over exploitation of ground water in the state around 80% of the State is now witnessing ground water depletion and the water table in some areas is going down even at the rate of 3 meter per year.

Intensive surface water irrigation many a times causes water-logging and increased salinity, which are major environmental threats. The incidence of water logging and salinity depends upon factors such as quantity of water used, intensity of irrigation, soil drainage characteristics, depth of water table, etc. Where surface irrigation is provided, the dynamics of ground water exploitation varies with a tendency of not using ground water for agriculture, which creates problem of water table rise and even water logging threatening urban and rural infrastructure and land. Large scale developmental projects like canal irrigation through Indira Gandhi Nahar Pariyojona (IGNP) in the western

region of Rajasthan has brought about problems such as water logging and soil salinity, which not only degraded the good irrigated agricultural lands but also devastated many of the village hamlets. As a consequence, most part of the areas around the main canal where water delivery is comparatively high, experienced high water tables and water stagnation, particularly in the low-lying flats and depressions. Canal seepage, surface irrigation practices, sandy soil texture and the presence of hard impermeable layer at shallow depth are found to be among the several factors responsible for the development of water ponding, high water table and secondary salinization in the command area. The soils are heavy in the Chambal Command area and intensity and quantity of water used for irrigation are such that artificial drainage is necessary to reclaim the lost arable land.

The river Jojari in Jodhpur and river Bandi in Pali are severely affected by industrial activities in their basins. Waste water discharge from textile units has caused degradation of water quality in Luni and Bandi river basins. The industrial cluster in Bhiwadi is listed among the top 10 polluters in India. Mining industry contributes to water pollution and degradation in Rajasthan. Most often no effort has been made for stabilisation of waste dumps. Washouts from waste dumps and slurry dumps are contaminating soil and ground water resources in the immediate vicinity of waste dumps.

Another major concern is the allocation of water for maintaining ecosystem services. For example, optimal environmental flows need to be maintained during the critical drought periods in the perennial Chambal river system, considering the fact that Chambal river and the National Chambal Sanctuary is the only 'Landscape Level Riverine Protected Area' in the country and also the only Tri-State Managed Riverine Protected Area.

Floods in urban areas during monsoons also are a major cause of concern which occurs due to faulty planning, choking of drainage systems and unplanned growth of settlements. Rajasthan has faced such situations in the past. The flash floods in Jaipur, Loonkransar and many other places caused heavy damage. Flood prone management should be planned at the time of sanction of the project so that no unplanned growth in the flood plain zones so earmarked could take place during and after construction of the project.

Lakes and reservoirs: The human settlements and public effluent sources are the chief factors for the degradation of lakes, particularly the urban lakes in Rajasthan. The anthropogenic pressures in the catchment itself has resulted in degradation of the catchment area due to deforestation, extensive agricultural use and consequent erosion and increased silt flows, which have vitiated the quality of water stored in the lakes. Infrastructure development, housing pressure and encroachments have resulted in converting all urban lakes into hyper eutrophic state. For instance, Udaipur is dependent on its lake system, which is directly, or indirectly the life source of the city in terms of surface water resources, tourism, and the ecosystem at large. Lakes thus form the backbone of the city's economy which is however under imminent danger of irreparable degeneration. Water resources in Udaipur city are polluted due to disposal of sewerage directly into surface drains or surface water bodies. Ground water contamination occurs due to absence of septic tanks in the city, leakages and overflowing of sewerage pipelines, and mixing of water and sewerage due to faulty lines.

Heavy siltation after deforestation has reduced the depth of the lakes to a quarter of which it used to be 40 yrs ago. With the uncontrolled increase of the density of habitation around the lakes, they have become a substitute for a sewage system. The Municipal sewerage lines open directly into the lakes and thereby increase the bacterial material and organic load. The 73 ghats situated on the banks of the lakes are traditionally used for bathing purposes and for washing clothes. This releases large amount of detergents in to the lake, which increases its phosphate content. Similarly, increased commercial activity, especially of hotels in the vicinity of the lakes, has also contributed considerably to water pollution. In the catchment area of Fateh Sagar Lake, chemical effluents from synthetic fiber mills are discharged every day in a drain, which carries water to Fateh Sagar. The Udaipur lake bottom is covered with a thick mat of submerged vegetation, presence of floating micro algae which are detrimental to the public health, and also harbour varieties of harmful organisms. This degree of pollution makes chlorination and treatment by other chemicals ineffective to render the water potable.

Institutional and policy impacts: Sectoral policies like subsidies for irrigation (power, pumps) and other inputs in agriculture sector indirectly leads to environmental degradation. The environmental cost arising out of wasteful water use practices are not internalised. The farmers at the head end region of irrigation projects tend to over irrigate and also shift their cropping patterns towards water intensive crops causing land degradation. To mitigate these, water tariff must account for the opportunity costs associated with its use. The demand for increase in production has led to increased use of chemical /inorganic fertilizers, pesticides, high yielding varieties and mechanization of agriculture. The use of chemical fertilizers has been steadily increasing. These chemicals are causing water quality problems which affect the health of the people. To check the use of pesticides Government has banned the use of harmful pesticides like DDT. Biofertilizer use is encouraged under soil conservation and watershed development programs. Agriculture department promotes Integrated Plant Nutrients Management (IPNM) and Integrated Pest Management (IPM) to combat the problem of Pesticides/ fertilizer use. Fertilizer application through sprinkler saves labour in fertilization and helps in optimum uptake of plant nutrients, and thus, enhances agricultural productivity. Subsidy has been offered on water saving devices, sprinklers system and drip irrigation. Besides, strategies for promoting sustainable organic agriculture also may be promoted.

The pace of development has led to construction of dams, industries, roads, public facilities and townships in Rajasthan. The construction activities extend pressure on water resources. The rapid growth of population in urban centres has resulted into unauthorized constructions. Such growth has taken in the urban centres specifically in big towns of Jaipur, Kota, Ajmer, Jodhpur, Udaipur, Bikaner, Bhilwara, Sriganganagar, Pali and Bharatpur. Impacts of construction activities on water bodies are: 1) the construction of dams involves submergence of land, clearing of land, displacement of inhabitants. Downstream water requirement is affected in operation phase, 2) local drainage is affected during construction phase, 3) water pools formed which give foul odour and provide breeding ground for mosquitoes, 4) turbidity of water bodies rises, 5) irrigational canals are affected during construction phase and 6) pollution of surface and groundwater occur due to seepage and runoff from construction site. The State Pollution Control Board is the regulatory body taking care of the quality aspect and has provided norms for water quality monitoring during construction phase. Besides quality

aspect the construction activities require lots of water which is met from ground water in Rajasthan. Policy guidelines on minimizing the impacts are to be developed.

Water use efficiency is very low in the state and unaccounted for water loss (ULW) through losses in public distribution system for drinking water (10-11% of the total use) is of the order of 30-40 per cent. About 83 per cent of the water is used for irrigation and of this, 65 per cent is surface water; losses in surface water irrigation are much higher as compared to those in ground water irrigation. Thus, about two-thirds of the water used for irrigation is affected by inefficiency. High cost of service, low cost recovery and low level of expenditure on O&M reduce the water use efficiency. The water rates do not convey a sense of scarcity among the stakeholders as such there is a need to rationalize the O&M charges to move towards full recovery of opportunity costs for sustainable development of water resources. The increase in water use efficiency through involvement of Water User's Association, at least in the tertiary canal network, is necessary. Efforts are needed to inculcate Water Users Association culture in the Water Resources Department.

The Rajasthan state policy for rural drinking water and sanitation (2005) states that community needs to be made aware of the linkages between proper use of safe drinking water and sanitation facilities by encouraging health and hygiene promoting practices in order to break the disease transmission chain towards ensuring good health benefits to all by 2015. In view of this, concerted effort on promoting environmental consciousness through advocacy and implementation programs on water supply and sanitation is necessitated. The coverage of rural areas under sanitation and hygiene education is only 14% as per 2001 Census. Therefore, massive effort is required to attain full coverage. With this end, the programme has now been transferred to Public Health Engineering Department (PHED) so as to bring both water supply and sanitation and hygiene education under one authority.

For management of environmental issues, the State Water Resources Planning Department (SWRPD) functions as an apex department by coordinating the environmental issues related to water with other departments. Many policies relevant for water sector viz., draft sector policy for rural drinking water and sanitation (2005) and draft ground water use and regulation bill (2004) are to be finalized yet. The State Water Policy has recently been finalised. The relevant state acts like Rajasthan Irrigation and Drainage Act and Rules (1954), Participation in Management of Irrigation (PIM) Act, 2000 need to be revisited given the current water scenario in the state. Besides, there is a need for integrating sectoral policies with the water sector policies as all the activities directly or indirectly impact the water resources.

Strategies: The environmental policies for water sector should have focus on ensuring the water security of the region which recognize that sufficient good quality water is needed for social, economic and cultural uses while, at the same time, adequate water is required to sustain and enhance important ecosystem functions. The six pronged strategy given below for good governance of water sector in Rajasthan would help ensure environmental, ecological, economic and social sustainability.

- *Ensure water security at sub state and regional levels through integrated water resource management*: Maintaining economic, social and ecological integrity by providing strategies for ensuring sustainable water allocation for

consumptive uses and maintaining minimum ecological/environmental flows in rivers and other natural water bodies in the state

- *Restoration and regeneration of already damaged water ecosystems:* Financial outlays for restoring the ecosystem through a balanced approach integrating top-bottom and bottom-top approaches
- *Precautionary strategies:* Strategies formulated through internalizing the associated risks and uncertainties
- *Water equity*: inter-generational and intra-generational : Strategies which ensure equitable distribution of water resources through good governance
- *Environmental and economic valuation of water:* Internalizing the externalities while conducting valuation of resources.
- *Formulate sectoral policies through integration of water sector sustainability strategies*

The following measures shall be taken:

Surface water: rivers

- Comprehensive inventory of potential and actual water resources, perennial and ephemeral; mapping and inventorisation of agricultural activities, human influences, industrial activities, confluences of water bodies and discharges on upstream and downstream of location using GIS and Remote Sensing techniques
- Integrated waste management of industrial waste with potential for water contamination, and prevention of point and diffuse pollution through discharge of contaminated effluent to rivers
- Integrated river basin management programmes through a designated Nodal Authority and involvement of impacted stakeholders
- Conjunctive use of surface and ground water
- Community driven water pollution monitoring programme shall be initiated to monitor water quality on regular intervals
- Effective flood forecasting system on high discharge rivers shall be established
- Flood-plain zoning and emergency plan for flood control and management for each flood-prone basin/area shall be prepared.

Surface water: lakes, reservoirs and other wetlands

- A regulatory system shall be set up for regulation of lakes at district levels to regulate withdrawals, non-consumptive use, discharges, and conversion of wetlands to other uses. Panchayati Raj Institutions (PRIs) shall be empowered to regulate village ponds
- Lake restoration and desiltation activities shall be undertaken
- Enforcement mechanism for preventing discharge of pollutants to lakes shall be strengthened

Water supply augmentation

- Preservation of traditional water harvesting structures and sources shall be encouraged.
- Rain water harvesting, storm-water harvesting, recycling and reuse of waste waters shall be promoted. In drinking water deficit areas, especially where presently there are no water and sanitation facilities or water is being supplied through tankers, rain water harvesting in such pockets shall be taken up on a community basis so that local needs could be met or supplemented.
- Investigations shall be undertaken to quantify the potential for evaporative suppression in storage structures. Studies will be conducted to evolve methods to suppress evaporative losses and projects shall be implemented accordingly.

- The potential for inter-basin water transfer, wholly within Rajasthan, from any areas with surplus water to water deficit areas, shall be investigated. Local participation and environmental impact assessment shall be undertaken as part of such investigation.
- Re-use of irrigation drainage water shall be encouraged
- Waste water recycle and reuse shall be promoted in all sectors; the re-use of treated sewage effluent shall be promoted, with appropriate levels of treatment applying to municipal usage, industrial usage, other horticultural usage, beneficial surface discharge (e.g. for irrigation) and recharge of groundwater. Water intensive industries shall be required to recycle their water.

Water demand management

- Water conservation methods shall be implemented to minimize salinization and water logging. New irrigation projects, comprising over 2000 ha command area, shall be required to consider the possible effects and extent of drainage whilst deciding the cropping pattern and to plan appropriate responses to incipient salinization and water logging as an integral part of the project.
- Water auditing shall be undertaken for all industries large and small, to compile a register of industrial water usage; install water meters, and undertake ground water recharge activities;
- Use of treated sewage for non-food crops; Saline water for tolerant crops shall be promoted.

Ground water

- Groundwater shall be better utilized by encouraging and facilitating pressure irrigation methods such as drip and sprinkler irrigation technique. Re-use of irrigation drainage water shall be encouraged.
- Desalination of saline and/or brackish groundwater shall be explored: Wherever feasible, large waste-heat sources such as power and other industrial plant may be mandated to install desalination facilities
- Water User Groups (WUGs) shall be set up to regulate groundwater extraction by all users dependent on the aquifers under the WUG jurisdictions
- While allowing mines, the impact on ground water table shall be estimated.

Water and health

- A review of basic water quality and/or analytical public health facilities shall be undertaken at district level in collaboration with urban local bodies
- Providing defluoridated water for drinking purposes to be integrated into National Drinking Water Mission
- A phased program of improved domestic water quality shall be undertaken, in order of prioritized health risks involving implementation of filtration, chlorination, de-fluoridation.
- Basic water and sanitation services for all urban areas and localities shall be planned and implemented.

Water governance: policies and institutions

- Water tariffs to progressively move towards full cost recovery of operation and maintenance, with lifeline rates for slum dwellers cross-subsidized by others. This shall be matched by a rigorous program of improvement in the efficiency of operation and maintenance. Differing stepped water rates may be charged for agricultural, industrial, commercial, and municipal purposes. In all cases, the highest rate shall be a strong disincentive for profligate water usage.
- A program of water metering for water management purposes shall apply to all significant water users irrespective of source and water ownership.

Capacity building and advocacy

- Mass-media campaigns shall be conducted, particularly through sponsored TV programmes to raise awareness about responsible water use by all
- A program shall be prepared and initiated to heighten public awareness of the need for sewerage, STP and public health infrastructure in all urban areas, and to promote responsible water use.

4.1.2 Desertification and land degradation

Desertification is defined as land degradation in the arid, semi-arid and dry sub-humid areas, resulting from various factors including climate variations and human activities. It is a slow and less perceptible process that gradually leads to the decline of production potentials of the land and affects the socio-economic fabric of the people who make a living from those lands.

In Rajasthan 67% of area is affected by desertification and/or land degradation where the wind erosion (44.2%) is the maximum contributor followed by water (11.2%), vegetal degradation (6.25%) and salinization (1.07%).

Land degradation and desertification occur due to: (i) Wind erosion – Sand dunes and other sandy landforms in Thar desert are most vulnerable to wind erosion especially in the western part of the State. High human pressures along with the historical dry climates also contribute to the localized wind erosion or soil reactivation. The practice of mechanized deep ploughing and increase in the net sown area are accelerating the Aeolian processes; (ii) Water erosion – parts of Aravali hill ranges, eastern margin of Thar desert are experiencing accelerated rill and gully erosion; and (iii) Water logging and salinity – excess irrigation and wrong drainage planning have caused water logging and salinity build up in canal command areas of Ganganagar and Hanumangarh districts.

The following measures shall be taken:

- Scientific assessment of desertification: Standardized methodology based on a sound and unbiased assessment framework shall be developed for the assessment of the desertification. The role of GIS and Remote Sensing is essential for monitoring and modeling of the information.
- Integrated approach for implementation of the schemes to combat the desertification: Integrated approach from planning to implementation for more than 30 centrally sponsored schemes shall be undertaken. The implementation of these schemes shall also be linked with the process of periodic assessment of desertification with defined criteria and indicators.
- Participatory sand dune stabilization programme shall be encouraged to involve the private land under sand dunes.

4.1.3 Forests and biodiversity

(i) Protected Areas

The state has two national parks (NP), 25 wildlife (WL) sanctuaries and two Conservation Reserves created under the provisions of the Wildlife (Protection) Act, 1972. There are also two critical wildlife habitats.

The main causes of conflict in the Protected Areas (PAs), which comprises nearly a third of Rajasthan's forests, are undefined boundaries, inadequate relocation packages for the displaced communities, non-settlement of rights of fringe villages, and crop damage by wild life. Lack of tenural rights, ad hoc arrangements (for example, annual grazing receipts, share of forest resource use), also dissuades local communities to participate actively in the conservation programmes. The state's PA network is not comprehensive, adequate or representative of the different ecosystem types in the state. There are many

unique ecosystems that do not occur in present PAs, such as the *magras* of the desert, saline wetlands, or freshwater lakes.

The following measures shall be taken:

- Complete the legal process of boundary demarcation after quick and fair settlement of rights of communities living in as well as on the fringes of protected areas. Relocation of villages close to Protected Areas in a phased time bound manner shall be done expeditiously.
- Appropriate relocation packages for the displaced communities in terms of livelihood, shelter, cropping and grazing needs, besides education, health-care, provision of electricity and cooking fuel, drinking water and sanitation shall be designed by involving all relevant stakeholders. Lessons from relocation of Sariska forest dwellers shall be considered. Communities shall be involved in the consultative process of designing the relocation packages so that they do not feel alienated.
- Confer heritable but non-transferable rights to the relocated communities to provide defined ecotourism services.
- Scientific Management Plans with short and long term strategies for improving biomass productivity, habitat improvement, sustainable tourism and meeting livelihood needs of the community shall be designed and implemented.
- Site-specific, people friendly eco-development programmes in fringe areas of PAs shall be undertaken; Ranthambhor Tiger Reserve has such a programme ongoing
- All relevant stakeholders, especially local communities that have traditionally been associated with natural resources shall be consulted in framing policies that would have an impact on their lives.
- Effective use of Community Reserves and Conservation Reserve provisions according to Wildlife (Protection) Act shall be made while increasing the area under PA network, developing corridors, etc.
- Conservation efforts both within and outside the existing Protected Area Network shall be strengthened and the unrepresented unique ecosystems like the *magras* of the desert, saline wetlands, or freshwater lakes shall be included in the existing network.

(ii) Biodiversity outside PAs

Introduction of improved plant and animal breeds has led to erosion of local breeds, such as the land races of grains and the local animal, which are better adapted to agro-climatic condition of the region. Spread of weeds and invasive alien species like *Prosopis juliflora, Lantana camera* and *Parthenium histophorum,* has caused loss of natural vegetation in fallows, and impoverishment of forests. Lately preference is given to local native species in government plantation programmes, and the trend of monoculture might be reversing, but it is difficult to eradicate invasive exotic species that are widespread in the state.

Loss of traditional entitlements, unequal access to public resources and poverty has weakened the relationship between poor people and natural resource leading to indiscriminate extraction of forest produce, and illegal trade in rare and endangered animals.

The following measures shall be taken:

- Proper research shall be undertaken before introduction of exotics, and cultivation of traditional crop varieties and locally adaptive native species that are more suitable to the agro-climatic condition of the state shall be encouraged in the conservation programmes.

- Technically sound programme of eradication / control of unwanted invasive alien species particularly the *Propospis*, including their use as biofuels for rural power generation shall be developed.
- Legal recognition shall be given to the traditional entitlements of forest dependant communities taking into consideration the provisions of the Panchayat Extension to the Scheduled Areas (PESA). Similarly recognition of customary rights for management of resources would provide an important incentive to reduce possibilities of conflict and to secure livelihoods and engage communities to conserve the forests.
- E*x-situ* conservation of genetic resources, especially threatened species of flora and fauna shall be enhanced by creating gene banks.
- Project Great Indian Bustard shall be initiated with participatory approach of conservation especially focusing the habitats owned privately along with the habitat owned by the forest department.
- The biodiversity of drylands and desert shall be documented and protected along with the habitat.
- Bamboo cultivation shall be encouraged in a participatory manner by involving JFMCs.

(iii) Diversion of forests for development projects

Clearing of native vegetation for agriculture, pasture and other development purposes like, mining, construction of roads, canals, dams, expansion of urban sprawls and industrial centres is causing fragmentation of forest areas and thereby impacting the biodiversity of the state.

The following measures shall be taken:

- All efforts shall be directed towards curbing illegal mining in forest areas by enforcing strict surveillance mechanism, including the use of satellite imagery.
- Compensatory afforestation and product-life-cycle management approaches shall be enforced in authorised areas for mining and sand stone quarrying to prevent adverse impacts of mining activities on the environment and ensure accountability.
- Rationalize the process of diversion of forest lands for non-forest purposes through ensuring proper enumeration, scientific assessment, and streamlining of procedures at the State level, with defined task descriptions for all steps and mandatory timelines.
- Proper implementation of MoEFs EIA Notification 2006 shall be ensured.

(iv) Traditional ecological knowledge and domesticated biodiversity

The traditional agricultural practices, crop varieties, animal breeds, livelihood practices are based on the management of agri-pastoral resources. With changes in technologies, markets, etc. the use of traditional knowledge is getting reduced, increasing the stress over the ecosystems and ultimately impacting the livelihoods of the local people. But even today traditional knowledge has potential to assist the disaster management strategies in a participatory and decentralized manner. It is an important source of revenue once the IPR systems are in place for safeguarding the knowledge and ensure the equitable benefit sharing to the knowledge holders.

Local communities of the state have traditional knowledge on range of aspects such as ethno botanical and ethno medicinal use of plants and animals for treating ailments, agricultural practices, traditional eco-friendly technologies, traditional nature conservation practices, coping strategies for sustaining the natural resources and

livelihoods and so on. The domesticated biodiversity such as traditional crop varieties and animal breeds may provide very important livelihood support system in adapting to the impacts of climate change.

The following measures shall be taken:

- Focus shall be given on indigenous domesticated animal diversity for developing the improved breeds having adaptive abilities in deserts such as *Tharparkar* cow, etc.
- Research on traditional crop varieties shall be promoted so as to understand their adaptation potential against climate change.
- Traditional knowledge associated with domesticated breeds of animals and traditional cultivars shall be documented in order to facilitate grant of IPRs for traditional knowledge (TKs) when the system is nationally/ internationally operationalized.
- Effective outreach strategy shall be developed to communicate various traditional systems of conservation of natural resources.
- Documentation and demarcation of *oran*s and other biodiversity rich sacred natural sites shall be done
- The traditional techniques of seed banks, fodder bank, grain bank shall be effectively used for decentralized storage of resources for disaster management.
- Organic-farming agriculture technologies shall be promoted and proper incentives shall be provided to the users by way of setting up certification schemes and promotion of marketing channels
- The technologies such as deep ploughing tealers shall be discouraged in the state.
- Effective implementation of Biological Diversity Act, 2002 shall be done so as to safeguard the traditional knowledge of medicinal plants, etc., notify Biodiversity Heritage Sites.
- Effective implementation shall be done for Protection of Plant Varieties and Farmer's Rights Act so as to recognize and conserve the traditional crop varieties.

4.1.4 Air

Rajasthan is growing at a rapid rate. The population has grown from 44 million in 1991 to 56 million in 2001 at a decadal rate of 28%. Urbanization in the state has been about 23% during the decade. Ambient air pollution has been a problem in the major urban centers of the state, while indoor air pollution has remained a concern in rural households using biomass for cooking.

The results of monitoring conducted under the National Ambient Air Quality Monitoring Program (NAMP) in 5 major towns namely Alwar, Jaipur, Jodhpur, Kota, and Udaipur shows that particulate matter (PM) concentrations have remained consistently well above the annual average ambient air quality standards in all the cities during 1995-2007. During the same period, oxides of nitrogen (NOx) have also shown instances of violation at some locations. With rising vehicular fleet this could be a pollutant of concern in future. 80% households in Rajasthan are using biomass as fuel for cooking and impacted by problems related to indoor air pollution.

The major causal factors associated with the deterioration of air quality in urban regions are rise in vehicular fleet, rapid industrial growth, coal based power generation, dust re-suspension, and construction activities. Vehicular fleet in Rajasthan is growing at the

rate of 17% in last decade (1998-2008) and has gone upto about 65 lakhs in 2009. Major share is of private vehicles, and the public transport system has not grown at the required pace. Industrial growth of the state is evident in the index of industrial production (an annual growth of about 11%).

More than 60% power generation installed capacity is thermal mainly based on coal, and thereby having substantial impact on air quality. Shortage in electrical energy has led to growth of captive power generation using D.G. sets which has led to even more emissions.

A study in Jaipur finds that significant share of population was affected by air and noise pollution.

There are several measures taken at city, state and central level to control the air pollution levels, especially in urban centres. National level measures include evolution of NAAQS (National Ambient Air Quality Standards), notification of emissions standards for air polluting industries, improving the fuel quality (reduction of lead, sulphur and benzene content), adoption of improved vehicular emission norms (BS-I, BS-II), improvement of roads (especially the national highways- National Quadrilateral project), enhancing power generating capacity etc. However, at the state and city level various measures have been taken up such as enhancing public transportation (BRT for Jaipur, consideration of Metro rail project for Jaipur) , inspection of in-use vehicles, traffic management, constructions of flyovers and improving infrastructure.

The following measures shall be taken:

Urban

- Landuse planning keeping in view the environmental issues: Environmental concerns shall be integrated in the urban planning at a very initial stage. Settlements shall be planned with a view to minimize energy consumption in transportation, power supply, water supply etc. Siting of industries, provision of appropriate road space , demarcation of residential and commercial zones, decentralization of services, maintenance of appropriate green cover shall be looked upon while planning a city. Prior to commencing the Master Plan exercise, an evaluation of the two alternative models (High rise, high density, mixed Landuse and intensive public transport v/s Low rise, low density, segregated landuse relying primarily on private vehicles) shall be carried out.
- Preparation and implementation of action plans for major cities: Action plans shall be prepared based on scientific studies clearly identifying the major sources of air pollution, taking into account city development plans and other future development plans.
- Enhancement of public transport: A strategy shall be formulated for urban transport to ensure adequate investment (public and private) in low pollution public transport systems. JNNURM (Jawaharlal Nehru National Urban Renewal Mission) has provided a platform for channelling significant financial support from the Central Government.
- Greater and widespread promotion and use of cleaner fuels such as ULSD/CNG/Electric vehicles: National auto fuel policy has suggested to introduce BS-III fuel across the country by 2010 (except 11 cities where BS-IV fuel to be provided). A future road map for provision of BS-IV fuel in the state shall be prepared. Initially, the critically air polluted cities of the state shall be shifted to BS-IV fuels, followed by other regions. Public transport in the state has to be based on cleaner fuels such as ULSD/CNG/Electric vehicles. CNG fuel may be considered as an option for public transport (public buses and autos), especially in the bigger cities (divisional headquarters and NCR).

- Controlling air pollution from older vehicles: As an immediate measure, restrictions shall be imposed on the movement of old commercial vehicles in the congested zones of major cities of the state. On a short to medium term, there I&M system in the state for controlling the emissions from all vehicles shall be strengthened. On a longer term, fleet modernization program shall be initiated in which subsides/direct cost benefits need to be provided to the old commercial vehicles owners to switch from old to new vehicles.
- Managing travel demand and growth of private vehicles: Measures in major cities shall include: staggering of office, school, and factory hours; minimum rider ship requirements in peak hours; encouraging private bus service provision for public use, etc.
- Industrial air pollution control: While considering industrial activities as an integral part of state's developmental path, appropriate siting of the new industries becomes important. For control of pollution from industries, strengthening of enforcement mechanisms shall be undertaken. Thrust shall be given to cleaner technologies and the use of cleaner fuels and energy efficient devices shall be encouraged. Major thrust shall be given to building capacity and generating awareness in the industrial community (especially in the small scale sector)
- Power: Emphasis shall be placed on adoption of renewable energy technologies. Energy demand management by promotion of energy efficient technologies and devices and awareness generation is the key to reduce power consumption and thereby reducing emissions.

Rural

- Greater penetration of LPG and relook at kerosene subsidies: Given that kerosene subsidies are not reaching the targeted population, measures shall be taken to promote the use of LPG as a cooking fuel instead of kerosene.
- Replacing kerosene with renewables for lighting: Measures shall be taken to redirect kerosene subsidies towards the provision of solar lanterns in the rural areas.
- Acceleration of programmes of improved fuelwood stoves: Use of fast growing species in wastelands for fuelwood, including by harvesting of existing *Prosopsis growth,* shall be promoted.

General

- Strengthening of air quality monitoring network: The air quality monitoring network of the state which is too small for an urban population of around 132 lakhs (Census 2001) shall be enhanced. Possibilities of implementing PPP models for effective air quality monitoring across the state by involving the private sector, as well as research and academic institutes shall be explored.
- Better construction, maintenance and cleaning of the roads: Strict adherence to the pollution prevention measures suggested in the MoEF construction manual is required. Regular maintenance and cleaning of roads shall be undertaken by strong enforcement of norms through quality checks and heavy disincentives for defaulters.

4.1.5 Climate change: adaptation and mitigation

Climate change is an additional stressor that will exacerbate existing vulnerabilities across the state of Rajasthan. Nearly 61% of the geographical area falls under arid/ semi arid zone. Apart from receiving low amounts of rainfall annually, the state also experiences high inter-annual temporal and spatial variation in rainfall. The vagaries of the climate have had a detrimental impact on the state's economy, with water, livelihood security and protection of livestock becoming critical concerns. On June 30th 2008, the first National Action Plan on Climate Change (NAPCC) for India was released, outlining

eight National Missions encompassing mitigation and adaptation priorities for India. These include Missions on Solar Energy, Enhanced Energy Efficiency, Sustainable Habitats, Water Mission, Himalayan Ecosystem, Green India, Sustainable Agriculture and Strategic Knowledge for Climate Change. In view of the criticality of poverty alleviation and economic growth for the country, the NAPCC "identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively". The NAPCC provides a roadmap for states to identify their specific vulnerabilities and opportunities and develop a set of strategies of priority for the state. These strategies include **Adaptation**- that is adapting to the likely long-term impacts of climate change and tapping potential opportunities that may arise; and **Mitigation** that is reducing greenhouse emissions from different sectors. Apart from consideration of the role of technology in adaptation and mitigation, the role of traditional knowledge and practices in enhancing and buttressing adaptive capacities at the community level needs to be valued. The discussion of climate change strategies within the State Environment Policy holds critical importance, because good environmental practices can yield several co-benefits for climate adaptation and mitigation in the state of Rajasthan and vice-versa.

Water resources: The quality and quantity of ground water and surface water resources in Rajasthan has deteriorated rapidly in last two decades. Changes in the climate will have profound effect on hydrological cycle viz. precipitation, evapo-transpiration and soil moisture. Preliminary assessments as part of the Second National Communication (NATCOM) of India to be submitted to the United Nations Framework Convention on Climate Change (UNFCCC) indicates that river Luni along with the west-flowing rivers Kutch and Saurastra are likely to face acute water stress conditions, while the river basins of Mahi and Sabarmati are likely to experience constant water shortage. In the light of these projected changes and current vulnerabilities in the water sector, an integrated strategy for rainwater harvesting and drought management needs to be developed for the state. An Integrated Water Resources Management strategy should be adopted at different levels (from household level to watersheds and catchment level). To enable the optimum utilization of water resources, demand side management should be promoted. Options to enhance water availability by combining new infrastructure with other supply-oriented measures such as desalination, re-use and water marketing need to be identified.

Traditional practices and structures of water harvesting in the form of tanks, bawris and village ponds need to be revived and maintained. An example of co-benefits of good environmental practice in the state for adaptation in the water sector is through rainwater harvesting for ecological restoration of mine- spoils. Artificial recharge of groundwater along with policy to regulate groundwater utilization in the state needs to be addressed. A real-time database for monitoring groundwater and surface water needs to be developed to assess water levels and flow changes over time and enable planned adaptation strategies for the state. Integrated impacts assessment using regional climate model scenarios applicable at the basin level should be developed.

Agriculture: The agriculture sector is likely to face several challenges in the light of increasing competition for resources from non-agricultural sectors along with increasing food demand due to the rising population. With changes in climatic variables such as temperature, precipitation, increased incidence of droughts and intensification of water scarce conditions could impact agricultural production drastically. Rajasthan is

largely an agrarian State, with 27 % of State Domestic Product being derived from agriculture. Nearly 70 % of the population in the state depends on agriculture- based livelihoods. This sector stands to be severely affected due to short-term and long-term changes in climatic variables as agriculture in the state is primarily rain-fed, with bulk of rainfall (nearly 90%) being received during the monsoon season. Furthermore, the state has a short monsoon period and often witnesses a late onset and early withdrawal compared to other states. The state of Rajasthan faces many pressures that directly impact the agriculture sector like high population growth rate, increased use of fertilizers due to increased production demand, increased pressure on canals, wells and tube wells for irrigation, etc.

Steps are necessary for the adoption of sustainable agriculture and agro-forestry practices in the rural areas to reduce the risk and livelihood threats to likely climate change impact in Rajasthan. Specific areas of intervention include seed development, research and marketing, technology development and on-ground demonstrations, improvement in agri-extension services, crop insurance, improvement in reclamation of saline/alkaline soils and efficient irrigation practices. Planned adaptation strategies in the agriculture sector will essentially need to be multi-sectoral in nature in order to improve the adaptive capacity of farming communities. Some long-term adaptations include changes in sowing dates, crop type and cropping pattern depending on the agro-climatic conditions to improve crop yields under new climatic conditions, application of new technologies, new land management techniques and water use efficiency related techniques including judicious use of water in paddy fields in order to reduce methane emissions from water-logging cultivation conditions. Impacts of climate change on livestock health also need to be assessed in different parts of the state. As strategies towards risk management in the agriculture sector, insurance based on weather-based derivatives with the help of Automatic Weather Stations is underway.

Apart from adaptation, the agriculture sector also contributes to carbon emissions from the livestock sector. The livestock sector in the state contributes to nearly 16% of greenhouse gas emissions in the state. Promotion of integrated crop-livestock management, efficient fodder development, improved animal feeding technologies and organic animal farming practices are some strategies suggested for controlling emissions from the livestock sector. Soils as a resource should be considered while exploring mitigation options through carbon sequestration. The silt of traditional water harvesting practices through ponds and tanks are among the best soil improvement practices in the country. Improvement of land can also contribute towards exploring the carbon sequestration potential in the soils of the state.

Forests and biodiversity: There is a need to maintain adequate forest cover in the state to mitigate climate change effects. Out of the total area of Rajasthan, only 9.56% is forest land. Out of the total forest land, 38.16% is categorized as reserved forests and 53.36% is categorized as protected forest in the state. The remaining 8.48% is categorized as unclassified forests. The forest ecosystems of Rajasthan are characterized by arid and scanty vegetation. Land use patterns have been showing a decrease in forest land cover and increase in desert land Increasing pressure from human and livestock population and indiscriminate and illegal exploitation of forest resources are among factors that have lead to further intensification of the problem. A trend of forests turning into open scrubs has been observed. Degradation of forest lands that hold the fertile soil together has exacerbated the already existing problem of desertification. As

more and more forest land is being sanctioned for mining, not only is the forest cover reducing but the habitat of the species is also being destroyed. There is a need to engage communities for forest protection and conservation and explore the mitigation potential of protected forests. The potential of forest species to adapt to long-term changes in climate needs to be assessed.

Sustainable Habitats: Major problems of the urban areas in Rajasthan are poor infrastructure, management of increasing waste, traffic and transportation due to increasing population and number of motor vehicles, growth of slum areas, degradation of built heritage, urban poverty, pollution, depleting ground water resources, multiplicity of agencies engaged in development of urban areas, colonies set up on agricultural land etc. Strategies for the urban areas should be adopted to reduce the GHGs emitted from automobiles. The Green buildings concept should be promoted in Rajasthan, along with formulation of detailed norms and policy for the same. As the buildings sector is the largest consumer of energy, the state government should enforce Energy Conservation Building Codes. Green Certification, for example GRIHA rating may be made mandatory. There is also a need for an intensive awareness campaign for architects, town planners and private sector. Increasing the efficiency of public transport system shall be undertaken.

The state of Rajasthan is undertaking many initiatives in the direction to reduce its energy consumption and improve the living standard of the people of the state. Setting up of urban infrastructure development scheme, increasing the number of transport facilities, augmenting the urban transport system with the introduction of BRTs, CNG using vehicles, MRTS are some of the very significant efforts that are being undertaken by the Government of Rajasthan.

Management of Municipal Solid Waste especially in tourist places such as Jaipur, Udaipur and Jodhpur should be explored. Sustainable landfills concept with capture of methane from landfills needs to be taken up along with effective MSW treatment plants.

Renewable Energy and Enhanced Energy Efficiency

The state lacks water and other conventional sources of energy: however there is a vast potential for utilization of non-conventional energy sources like wind, solar and biomass for power generation. There is a need to setup energy consumption benchmarks for energy-intensive industry sectors in the state. There is a need to develop a time-bound programme for energy conservation and energy-efficiency in these sectors. Since many of the MSME clusters in the state use either diesel or furnace oil or use woody biomass in an inefficient manner the focus should be on encouraging the use of environment-friendly options such as biomass gasification based systems in MSME sectors such as guar-gum plants, dyeing units, food processing units etc. Nearly 65% of the households in the state use fuelwood that is inefficient and contributes to carbon emissions. RREC may launch a comprehensive programme of efficient cookstoves taking into account specific socio-cultural needs. This would have to be done at two levels- at the household level and at the community level. Biomass gasification based cooking systems and solar cooking may also be explored for mid-day meal schemes. Considering that Jaisalmer, Jodhpur and Bikaner have very high solar energy resources they may be exploited fully for utility-scale, large solar power generation. The state government may set up Solar Parks along with solar manufacturing units to bring down power costs.

One of the many challenges that the state faces is of low energy efficiency. Low efficiency means more energy consumption and hence more consumption of non-renewable resources. In order to improve energy efficiency and address these concerns, Rajasthan Renewable Energy Corporation (RREC) has, under the guidelines of Bureau of Energy Efficiency (BEE), been conducting a survey of government buildings for energy efficiency, energy auditing, energy conservation measures for designated consumers, 'installing solar water heating systems in private establishments, etc. Further the Rajasthan Discoms are promoting the use of Compact Fluorescent Lamps (CFLs) for street and domestic lighting; energy efficiency pump sets; providing tariff concession on solar water heaters; minimizing distribution losses; using new and efficient technologies like super critical boiler technology and integrated gasification combined cycle for thermal power projects. With such a progressive beginning there is a need to strengthen the ongoing programs and policies which would not only address the developmental objectives of the state but climate change mitigation.

Human health: Weather conditions determine malaria transmission to a considerable extent. Heavy rainfall results in puddles, which provide good breeding conditions for mosquitoes. In arid areas of western Rajasthan, malaria epidemics have often followed excessive rainfall. Presently, the transmission window (based on minimum required conditions for ensuing malaria transmission) is open for 4-6 months for the state of Rajasthan. Considering a 3.8°C increase in temperature and a seven per cent increase in relative humidity by the 2050s (with reference to the present), the transmission window for Rajasthan will be open for only 3 months indicating a likely decrease in the transmission period as compared to the base year.

In light of the National priorities and unique vulnerabilities and opportunities in the state with respect to climate change, the following shall be undertaken:-

Water resources
Integrated water resources management strategy at different levels
Supply side and demand side management
Integrated impacts assessment using regional climate model scenarios applicable at the basin level
Revival and maintenance of traditional practices and structures for rainwater harvesting
Sustainable agriculture
Crop insurance based on weather-based derivatives with the help of Automatic Weather Stations
Seed development, research and marketing,
Agri-technology development and on-ground demonstrations,
Improvement in agri-extension services,
Improvement in reclamation of saline/alkaline soils
Enhancing crop productivity through climate-hardy cultivars
Promotion of efficient water use practices and better irrigation infrastructure
Promotion of rainfed agricultural techniques including soil moisture conservation, watershed management, efficient water harvesting etc.
Effective role of sharing and dissemination of agro-climatic information to reduce risks at the farm level
Assessment of impacts of climate change on livestock health in different parts of the state
Controlling GHG emissions from livestock sector through promotion of integrated crop-livestock management, efficient fodder development, improved animal feeding technologies and organic animal farming practices

Forestry and biodiversity
Engage forest communities for forest protection and conservation
Assess adaptation potential of forest species to changes in climate variables
Explore carbon mitigation potential of forest conservation
Renewable energy and Enhanced Energy Efficiency
Setup energy consumption benchmarks for energy-intensive industry sectors in the state.
Explore solar energy potential in the state
Sustainable Habitats
Enforcement of Energy Conservation Building Codes and Green Certification guidelines for the building sector
Efficient urban transport, introduction of CNG
Capturing methane emissions from landfills
Human health
Strengthening health surveillance and monitoring
Development of vector specific regional maps.
Public education, awareness and outreach

4. 2 Assuring Environmental Sustainability of Key Sectors

Certain sectors such as mining and tourism are the backbone of Rajasthan's economy. Certain others such as energy and urban sectors serve as engines of economic growth. In the rural sector, pastoral nomadism is a significant source of livelihood for a large number of people. Therefore, a comprehensive strategy of planned development coupled with improved environmental practices is critical to reduce the environmental pressure / burden on resources and assure environmental sustainability of these key sectors.

4.2.1 Mining

In terms of quantity, Rajasthan contributes to about 22% of industrial mineral production in the country including production of around 15% in metallic, 25% in non-metallic and 26% in minor mineral categories. It has vast reserves of both metallic and non-metallic resources. There are 44 major minerals and 22 minor minerals found and produced in the state. In terms of the total value of India's mineral production, the State contributes 5.74% of the total value and occupies the 5th position after Bihar (13.09%), Madhya Pradesh (9.68), Gujarat (8.55%), and Assam (7.3%). Large workable reserves of lignite have been identified.

In addition to minerals, good quality oil and gas reserves have been discovered in Barmer - Sancher basin. It is reported that Cairn India will produce 1.5 million tonnes of crude oil in 2009-10, Cairn's output will increase to seven million tonnes in the next year. The estimated reserves are reported to last for 21 years.

The mining activity has a close linkage with environment and forests and is often in conflict. Mining exerts pressure on environment at every stage of mineral processing i.e. exploration, extraction, processing, and post closure operations of mines. A significant part of state's known mineral reserves are in areas which are under forest cover.

However, the needs of economic development make the extraction of mineral resources an important priority.

Mining carried out by small lease holders having quarry licenses or very small leases (less than 5 ha) in the state is causing immense pressure on the environment. The area under mining being very small, the lease holders are unable to take all the environmental protection measures required for compliance of various environmental laws. These mine holders often face problem in having adequate plantation due to smaller lease areas. Lack of awareness is another issue with such lease holders. Absence of legal mining permits due to stringent regulation in awarding permits in forest areas also gives rise to illegal mining on forest lands.

As far as impacts of mining are concerned, the most serious impacts are related to the mining overburden. In case of base metal mining, 90 to 95% of the mined materials are wasted and dumped as overburden in adjoining areas which occupy extensive land area and if not properly rehabilitated, have potential to cause contamination of surface and groundwater, erosion, and dust emissions. The reported release of lead in groundwater in these areas is damaging to health and environment. In case of non-metallic mining, the key environmental problems are land degradation including scarring of landscape, deforestation, spread of wind blown particulates on agricultural fields, gully erosion, soil contamination and pollution of surface and groundwater sources. The critical mining areas are identified at Bijolian, Ramganj mandi, Jhalawar, Karauli, Dholpur, Bansi, Paharpur, Fedusar, Alawar and Tonk. Cases of silicosis and bronchitis are often reported from mining sites for slates, sandstone and asbestos indicating hazardous nature of these operation and poor occupational health standards.

To address these environmental and ecological issues, the draft mineral policy for the state focuses on adoption of mechanized and scientific mining with due regard to conservation of minerals, mine safety and environmental aspects including maintaining ecological balance, utilization of stone waste and spreading environmental awareness.

The Aravali Notification dated 1992 has put restriction on mining in the Aravali Range. No development activity can be undertaken without prior consent in the Alwar District. Further to it and in compliance to High Court order dated October 2003, it has been made compulsory for all the mining leases, including those of minor minerals, to obtain consent to operate from RSPCB. An insertion of rule 23 A in MCDR (Mineral Conservation and Development Rules) 1988, mine reclamation and rehabilitation works at mines was made part of the mine closure plan. The reclamation and back filling of the worked out pits has been the part of mine plan which are approved by the Competent Authority and the compliance of which is regulated by the financial assurance furnished by the lessee.

The following measures shall be taken:

- With a view to address the environmental problems caused by the small mining leases, cluster based environmental management of small mining leases shall be implemented. In order to carry out environment friendly mining operations in the cluster, Special Purpose Vehicle (SPV) will be set up. The SPV will prepare environment friendly mining action plan, provide suitable technical guidance to individual entrepreneurs and will carry out concurrent evaluation of mining operations in the cluster areas.

- Environmental monitoring in critically mined areas shall be improved so as to assess the damage and arrest the degradation of mined areas through multi-institutional interventions including Department of Mines and Geology. Comprehensive inventory of mines shall be carried out including assessment of the environmental quality for prioritizing interventions for environmental improvements.
- Holistic strategy for restoration of mine spoil, including pre-mining soil removal and proper storage, protection to adjacent vegetation and trees as seed source, post-mining restoration of overburden, treatment to adjacent farmlands and streams affected by mining operations, and preventive measures for mine-induced groundwater pollution.
- Rehabilitation of closed and abandoned mines. As reported by the state Mines and Geology Department, there are around 1100 mines which have been declared abandoned. Reclamation of such abandoned mines shall be pursued vigorously not only as statutory requirement but also for the possibility of putting this reclaimed land to productive use like agriculture, forestry, water storage, and recreational purposes.
- Alternate uses of marble slurry and dust shall be incorporated in State Government programmes for roads and building construction.
- Specific ToR for conducting EIA shall be framed for mining leases to ensure proper environmental safeguards
- Special conditions shall be incorporated under Consent to Establish and Operate issued by RSPCB for mining leases (it should not be considered under same category as other industrial permits). These conditions would make regulation by concerned RSPCB office easier.
- Land use mapping of mining areas shall be undertaken to demarcate them from forest areas to resolve the conflict between mining and forest interests. Award of mining leases in the forest areas shall be done only after approval is received from the competent authority for diversion of forest land to non-forest use under the Forest Conservation Act.
- Forest areas shall not be leased for low value minerals, and leased only for minerals of strategic importance
- Adoption of mechanized mining processes shall be promoted and also open cast mining for building materials and dimensional stones and use of blasting shall be avoided as far as possible.
- Demonstration of best management mining practices and their replication to operating mine leases in the state shall be undertaken.
- Appointment of Environmental Coordinators at the Departmental level, build their capacities in planning and implementing projects related to environmental management plan. This has been done in past for project evaluation in sectors like road sector with fair degree of success.

4.2.2 Industry

The major industrial sectors in Rajasthan include – cement, dimensional stones, textile and chemical. Being rich in mineral resources, mineral based industry forms the major component of the total industrial production in the state. Despite having arid to semi-arid climate and general water shortages due to prolonged drought periods, the state has been able to make substantial investment in development of industrial infrastructure across the state.

The industrial growth in the state is dominated by small scale industries which are both employment and pollution intensive. The industrial statistics reveal that while the numbers of large and medium scale industrial units have more or less remained constant (378 units in 2001 and 384 units in 2006-07), small scale units have increased from 221,045 in 2001-02 to 275000 in 2006-07. As per data compiled by RIICO for the

registered industrial units, only 10% of them are located in notified industrial areas, the rest are set up in non-notified areas lacking the necessary industrial infrastructure, making it difficult for the regulatory agencies to monitor them for their performance. The Ministry of Environment and Forests has recently released a report based on assessment of 88 industrial clusters in the country analysing comprehensive environmental pollution index (CEPI) for industrial units in these clusters. Though none of the industrial clusters in the state figure in top ten of the report, four industrial clusters – Bhiwadi (ranked 6th), Jodhpur (ranked 23rd), Pali (ranked 31st), and Jaipur (ranked 58th), and find place in the list. These clusters need to have long terms environmental management plan to improve their environmental performance.

The two major rivers of Rajasthan are Chambal and Mahi. As no major industrial estate/are located on their banks except at Kota, significant pollution of these rivers has not been reported. As reported by RSPCB, there are numerous instances however of groundwater being contaminated by discharge of wastewater from industries like steel re-rolling, textile dyeing and printing units mostly belonging to SSI sector.

The industrial policy of 1998 lays special emphasis on accelerating the overall pace of industrial growth, increasing employment opportunities, improving productivity, ensuring sustainable development and strengthening the SSI, tiny and cottage industry sectors. To manage pollution by these units, the following key measures are suggested:

- Widening the scope of activities of RSPSB and RIICO and addressing impact assessment and pollution control at regional level and strengthening the environmental monitoring capability of RSPCB laboratories
- Proper siting of new units and relocating problematic units in the state
- Simplifying the process of issuing NOC (no objection certificate) to SSI and tiny units

Apart from these measures, 100% sales tax and octroi exemption for the period of 10 years has been announced for the projects based on fly ash utilization and management of stone slurry waste to maximize waste recycling in these sectors. The recent trend indicates increased utilization of fly ash in cement units for production of ash based cement.

To address various PILs and concerns of Hon'ble High Court in the state regarding groundwater pollution by SSI units, CETPs (common effluent treatment plants) have been established with central and state government assistance in industrial clusters at Pali, Jodhpur, Balotra, Jasol, Bithuja and Sanganer. Six new CETPs have been sanctioned to improve the wastewater treatment in these clusters. Regular operation and maintenance of these CETPs however still remains an issue of concern.

Similarly to deal with problems of hazardous waste disposal, Udaipur Chamber of Commerce and Industry (UCCI) has established a common TSDF (common treatment, storage and disposal facility) at village Gudali near Udaipur. At present around 50% of disposable hazardous waste generated in the state is disposed off at this facility. This TSDF however is not adequate to cater to entire hazardous waste generated in the state including that generated from SSI units and CETPs as they have to transport their waste long distances apart from paying disposal charges. This puts additional financial burden

on the SSIs and gives rise to tendency of illegal disposal of waste. Additional secured landfill sites are needed to cater to the state's requirements.

The following measures shall be taken:

- A study shall be commissioned to a competent research institution on mapping of industrial clusters in the state and developing technical assistance packages and guidelines for conversion of some of the most critical clusters into eco-industrial parks (e.g. by promoting efficiency and waste recycle and reuse, improving/installing common environmental infrastructure, and relocation of problematic industries/cluster). Preparation and implementation of action plans for the four clusters identified in assessment of industrial clusters report by MoEF shall be given priority.
- Operate existing and planned CETPs in SPV mode to improve the operational efficiency and ensure year around operation
- Initiate separate study by competent research organization to find solutions for addressing pollution from industrial sectors for which presently no financially viable solutions exist, for instance, addressing high TDS in effluent generated from ETPs of textile dyeing and printing units. Profiling of surface and groundwater pollution in areas where these industries are concentrated to facilitate the action to be taken for environmental regulation and management.
- Facilitate waste reduction and recycling in existing units for processes such as:
  - Marble slurry from cutting and polishing operations
  - Chemical sludge generated from CETPs
  - Waste generated from steel re-rolling operations
- Retrofitting existing SSIs with cleaner technologies and facilitating consulting services to these units. Adoption of cluster based ISO 14001 certification
- Invest in environmental monitoring capability especially in industrial clusters and prepare action plans for pollution hot spots

4.2.3 Tourism

The state of Rajasthan is a major tourist destination in India promoting culture and nature based tourism through the opening of forts, architectural and heritage sites, temples, festivals, fairs and cultural events, wild life safaris, nature parks and forests, mountains etc. Rajasthan attracts around 25% of the total international tourists coming to India, and about 5% of the total domestic tourists' arrivals in India, which in terms of numbers for 2008, was 2,98,36,564.

As tourism has a very high ratio of labour to capital needed for investment when compared to other sectors, it becomes a major source of employment. It provides a boost to the local economy as it helps in encouraging many other ancillary (economic) activities and has a multiplier effect in terms of employment and income. In Rajasthan too, tourism has been instrumental in the promotion of local handicraft and culture, wherein 90% of the household income of artisans is attributed to sales from tourism. Further, it contributes to the development /improvement of infrastructure and facilities such as roads, transportation services and infrastructure, communication facilities, etc which are also utilized by locals.

The social and environmental impacts of tourism have been well documented. The environmental impacts of tourism can be positive on account of the financial

contribution from tourism towards conservation / preservation of both natural and man made resources as well as spreading of environmental awareness amongst tourist, host population, and tourism industry. Planned tourism development coupled with improved environmental practices and mechanisms will contribute to reducing the environmental pressure / burden on resources and environment degradation and thus counteract the criticism of tourism being a resource intensive activity.

In the context of tourism in Rajasthan, environment plays a dual role, one of being a resource provider for tourism in the form of land, water, etc for its development and sustenance and the other as a tourist 'site' which is the main selling point for tourism in the form of lakes, forests etc. Hence, the very sustainability of tourism hinges on the quality and availability of natural resources it is dependant on. An examination of the manifestation of tourism in Rajasthan has highlighted the following environmental concerns:

- Conservation of flora and fauna
- Demand /pressure on resource use (both natural and man made)
  - Energy
  - Water
  - Land use and land cover
  - Solid waste, sewage and grey water disposal facilities
- Resource usage and its access to the host population

Conservation of flora and fauna: Several sanctuaries and nature parks of Rajasthan are now promoted for eco-tourism, wildlife safaris and adventure tourism. Unplanned development at these sites and improper use of these parks has contributed to fragmentation of forests and disturbance to the wildlife feeding and breeding patterns due to vehicular/tourist noise, littering etc. Less emphasis on protection and conservation of biodiversity by field staff due to their engagement with tourists (RSPCB, 2007), has further accentuated the problem of conservation of flora and fauna.

Resources use and its access to the host population: Some of the resources (natural and man made) are used by the host population, tourists and tourism related stakeholders. Access to these resources can become an issue of contestation when local/host population is deprived or has limited access to these resources. Further, traditional access to resources such as lakes, forest produce etc. may be hindered when these resources are developed into tourist sites without taking the local stakeholders into consideration. Such situations can cause disaffection towards tourism, and are not conducive for the long-term sustenance of tourism.

Demand /pressure on natural and man made resources:

The increasing tourist inflow to Rajasthan causes demand for tourist infrastructure, which exerts pressure on natural and man made resources. Additionally, there is an inflow of migrants (intra-state and inter-state migration) to support the tourism industry who indirectly exert pressure on both these resources for housing and other basic amenities. Hence tourist sites are often littered with plastic, PET bottles, dumping of waste and at times overflowing with grey water which all contribute to stench and reduces the aesthetic value of the tourist site. Growth of the tourism sector needs to correspond with growth in allied infrastructure needs such as sewage, waste disposal facility, electricity supply, water supply, transport and roads etc.

When there is a mismatch between the growth in the tourism sector and support infrastructure, negative environmental impacts in terms of environmental degradation is witnessed, which then affects the aesthetic value of the environment for tourism. Further, when natural resources are converted for tourism related activities, the economic goods and ecological services provided by that resource are either reduced or lost. This impacts the host population and accentuates their vulnerability.

These environmental issues highlight the need for tourism development to be sensitive to the environment, so as to sustain tourism in Rajasthan.

The scope for policy enhancement can be achieved through

a. Fine-tuning the State Tourism Policy to emphasize on environmental sustainability of tourism with concrete programmes/schemes to translate the same into action.

b. Strengthening the institutional capacity to deliver and implement the objectives of the policy.

(a) Environmental sustainability of tourism

Although the Rajasthan Tourism Policy incorporates environmental sustainability of tourism, the same is not implemented through its programmes. A review of the Rajasthan Tourism Unit Policy 2001, and 2007; and the programmes of the Department of tourism, emphasize on promoting the growth of the tourism industry in terms of tourist arrivals and corresponding infrastructure development and services. Some of these schemes are: the land bank scheme, adopt a monument, home away from home, and relaxation of fees and provision of subsidies to promote growth of tourism related infrastructure. These programmes do not proactively address the above environmental concerns, which can impact the sustainability of tourism.

The following measures shall be taken:

- Carrying capacity studies shall be undertaken to determine the sustainable level of tourist visitation and preparation of integrated tourism development plan for major tourist destinations. The carrying capacity studies shall emphasize how tourist visitation levels can be enhanced and built up by adoption of environment friendly practices and technology.
- Incentives/ subsidies shall be provided to tourist establishments for investing in environmental management technologies.
- Environmental conservation and remediation fund shall be set up through a fixed contribution from hotels and rationalized entry fees.
- Environmental certification for the tourism sector infrastructure shall be provided by the Rajasthan State Pollution Control Board. The development of various certification criteria shall be outsourced to a competent agency.
- Develop and institutionalize a monitoring system for the tourism sector infrastructure.
- Develop a “Code of best management practices” for eco-tourist and heritage sites to address issues related to sanitation and wastewater and solid waste management. Additionally, ensure that all tourism establishments (existing and future) are compliant with the Green Building Code. CNG may be considered as an option for transport in sanctuaries and national parks.

- The matters of hospitality in sanctuaries and national parks shall be looked after by the Tourism Department.
- Tourism demand management initiatives to be taken up to spatially and temporally spread out tourist arrivals to the state.
- Promote Rajasthan as an environment friendly tourist destination to attract environmentally conscious and sensitive tourists.

(b) Strengthening institutional capacity

For policy objectives and programmes and schemes to be implemented there is a need to strengthen the institutional capacity.

The following measures shall be taken:

- Environment cell shall be set up within the tourism department with appropriate devolution of power and funds to be made available.
- Provide mandatory training to all tourism service providers to ensure environmentally responsible behaviors by themselves and the tourists.
- Regular awareness and sensitization programmes shall be conducted by the environment cell for tourists and owners and workers of tourist establishments.
- Monitoring committees of local stakeholders may be set up to report violations of environmental management requirements to the concerned authorities to facilitate action.

4.2.4 Energy

The major issues that the state is facing in the power sector is that in the year 2008-09 there was a supply deficit by around 23%. The installed capacity of the State up to October 2009 was 7323.83 MWe whereas according to the 17th EPS Report, by the end of XII Plan (2016-17), the state will have an electricity demand of around 11400 MWe. To meet continuously growing power demands of the state, the Rajasthan Power Generation Company has planned / identified new power plants in the State. Despite the environmental concerns, coal remains the major option to enhance power availability in the State. Mainly indigenous coal which contains around 35% to 50% ash is used in the power plants. Fly and bottom ash generated as a result of coal burning raises major environmental threats if not properly handled, utilized or disposed of. Pollutants like oxides of carbon, nitrogen, sulphur, and suspended particulate matter are also emitted from the thermal power plants which impact the environment.

In order to make up the electrical energy demand, captive power plants using D.G. sets are employed in many places such as small industries, offices, hotels etc. The total captive power plants capacity is estimated to be about two-third of the total generation capacity of the State. This means excess use of petroleum based fuels, inefficiency as well as increased air pollution.

The use of devices with low energy efficiency is a major concern in the State. This is generally related with the inefficient devices, technologies, components, improper instrumentation, poor maintenance etc. Low efficiency results in more consumption of fuel resources.

The following measures shall be taken:

- The transmission and distribution losses which account for a large fraction shall be reduced by integrating affordable best available technologies.
- Energy efficiency measures, efficient lighting (such as CFLs to be mandatory in government buildings), water pumping etc. shall be employed. Banning of high energy consuming devices shall be considered.
- Cleaner coal technologies shall be employed to reduce the environmental impact.
- Greater attention shall be paid for the development of renewable energy based power projects like wind, biomass and solar etc.
- Decentralized renewable energy based power projects based on Wind, Biomass and Solar shall be promoted for the remote house holds/villages and small and medium scale industries which will reduce the load on diesel based captive power production. The solar off grid/ stand alone plants for power generation in remote areas may be promoted under relevant State Sector Plan Scheme
- Conducive environment shall be created to harness large fraction of the proposed National Solar Mission.

4.2.5 Traditional Animal Husbandry and Pastoral Nomadism

In Rajasthan, Animal Husbandry is not merely a subsidiary to Agriculture but it is a major economic activity especially in arid and semi-arid areas, thus providing the much needed insurance against recurring scarcity conditions. Income from live stock accounts for 30 to 50% of the rural household income, with wide variation in region and households. Live Stock Sector tops in rural employment with 4.5 percent growth against 1.75 for all other Sectors and 1.1 for Agriculture. This Sector also has the highest potential for rural self-employment generation at the lowest possible investment per unit. Development of Livestock Sector therefore, is critical to rural prosperity. Animal husbandry contributes 13 percent of the State's net domestic product. As against twenty five well defined breeds of cattle and seven buffaloes breeds in the country, the state is endowed with seven breeds with finest drought hardy milch breeds (*Rathi, Gir and Tharparkar*), dual purpose breeds *(Kankrej and Haryana*) and the famous draught breeds *of Nagauri and Malvi.*

The following measures shall be taken:

- PRIs shall be empowered to regulate grazing on all public lands in their jurisdiction, except for forest land
- A detailed study shall be commissioned to a competent institution to map and document migratory nomadic practices, with a view to developing interventions enabling sustainability of traditional practices and growth of this sector on commercial lines, as well as to provide health care and education benefits to the nomadic communities in a participatory manner.
- The research institutes and state agencies shall be encouraged to study and monitor the changes in pastoral nomadism along with emphasis on development of new animal breeds.
- Animal biodiversity promotion and conservation of local breeds shall be encouraged.
- Suitable feed formulation for reducing methane emissions from livestock shall be considered.

- Organic and eco-friendly practices for animal production to have safe milk, meat, wool, shall be promoted
- Studies shall be initiated to investigate impact of climate change on animal disease patterns, animal feed, and production aspects

4.2.6 Urban development

Rajasthan is not an exception to the country as whole, and has shown high decadal urban population growth rate of 31% during 1991-2001. The rapid population growth of the urban centres has resulted in tremendous pressures on land, natural resources and basic infrastructural facilities. The continual flow of migrants to the cities for better employment opportunities is generating pressure over the city infrastructure, land, and environment. Response measures in Rajasthan have not been able to keep pace with rapid urbanization.

The share of urban population in Rajasthan is likely to grow from 23.3% in 2001 to about 26.1% in 2020. As per the census 2001, there are 216 towns in the state accommodating 132 lakh people. While the bigger towns are growing at a rapid rate, smaller town have shown negative growth.

In absence of efficient public transport system, private vehicles have grown at a rapid pace in the state. Three lakh vehicles in 1981 has increased to about 65 lakhs in 2009. However, public transport (buses) have not grown at the pace which is required. Growing private vehicles and lack of good public transport has led to increased emission of pollution loads into the atmosphere.

With rising population in urban areas, the demand for power and other infrastructural facilities have also risen manifold. The condition of water supply in Rajasthan is not satisfactory due to scarcity of water channels as well as low rainfall. Only 23 towns get more than 100 lpcd water supply against the desired CPHEEO guideline of 135 lpcd. Actual quantity reaching the consumers in the towns is very low as compared to generation due to high Unaccounted For Water (UFW). Though, 222 towns have been covered with water supply facilities, quality of water is still not assured. Presence of fluoride, nitrates, and chlorides is quite common in water. Moreover, about 40% households do not have proper sanitation facilities.

About 6600 MT of municipal solid waste is generated per day in the state, which is not being disposed off in a scientific manner and dumped in low depressions. There is an increasing trend in the usage of plastics. Being non-biodegradable in nature, plastic materials discarded as waste are causing degradation of land, blockage of drainage systems, health effects on animals and overall environmental degradation. There is not much provision of proper sewerage, treatment and disposal system in any of the towns expect Jaipur, which has a coverage of about 50%. In other towns the sewage is conveyed through open drains and discharged untreated in to a *nala* or river which ultimately pollutes the surface and ground water.

Urban slums are growing in the state and nearly 14.5% of the urban population lives in slums which are not only economically weak but are susceptible to numerous environmental health problems.

Rapid rate of urbanization has impacted the urban regions of the state in varied manner. The major impacts of rapid urbanizaiton are air pollution, drainage, changing land-use, congestion, degradation of water bodies, decline in water table etc. There are many ongoing programs of the government for improvement of urban regions. These include Master Plan and town planning schemes, Integrated Development of Small and Medium Towns (IDSMT) project, centrally sponsored programmes such as UIDSSMT, JNNURM, and IHSDP, RUIDP, slum Improvement Programme etc.

The Department of Urban Development and Housing has formulated the Town and Country Planning Bill, which provides for preparation of Regional Plans, District Plans, Master Plans, Sector Plans, Town Planning Schemes and Village Plans in an integrated manner. The Government has also decided to create units of Town Planning Department at all district headquarters and also to establish a Centre for Urban Affairs in Rajasthan. Besides capacity building of local bodies, the Centre will undertake research to promote planned and environmentally sustainable development of urban areas of Rajasthan.

The following measures shall be taken:

- Promoting in-situ upgradation and planned urbanization: In-situ upgradation and planned urbanization shall be promoted in rural areas to reduce the pace of rural to urban migration. Moreover, in-situ upgradation in slum areas shall be undertaken to reduce burden on nearby urban localities.
- Landuse planning: Efforts underway for integrated and planned development of urban areas shall be completed. These shall include formation of land-use committees at all levels, regulation of the conversion of agricultural lands outside the Master Plan to other land-uses, and control of illegal land use in Master Plan areas. Settlements shall be planned with a view to minimizing energy consumption in transportation, power supply, water supply etc. Prior to commencing the master plan exercise, an evaluation of the two alternative models (High rise, high density, mixed landuse and intensive public transport v/s Low rise, low density, segregated landuse relying primarily on private vehicles) needs to be carried out..
- Green Buildings: Green Building norms shall be incorporated and enforced in the municipal building codes, including due implementation of the provisions of the new Building Regulations (February 2010) with respect to rainwater harvesting.

Water management

- *Water Zoning:* Urban development shall be planned with due regard to the constraints imposed by the configuration of water availability. There should be water zoning of the state and the economic activities should be guided and regulated in accordance with such zoning.
- *Conservation of water*: Efficiency of utilisation and conservation consciousness shall be promoted through education, regulation, and fiscal measures. For this, measures like reducing losses in the conveyance system, modernisation and rehabilitation of existing systems, recycling of treated sewage/effluents may be promoted, wherever feasible.
- *Improving coverage and quality of water supply*: Investments are to be made in improving the coverage and quality of drinking water across cities. Private sector participation shall be encouraged in the management of urban water supply distribution system for capital investment..

- *Ground Water:* There is a need to regulate the groundwater use in the state. Stricter laws on usage of ground water would be required to reduce groundwater depletion. Emphasis shall be placed on installing rain water harvesting structures for recharge of groundwater. All the new buildings shall have mandatory rain water harvesting facilities in accordance with the New Building Regulations, 2010.

- Sanitation: There is need to promote a change from open defecation to fixed spot defecation through awareness and provision of proper sanitation facilities.
- Sewerage and sewage: There is a need to improve sewerage networks and commission projects for sewage treatment in the urban regions to reduce degradation of water bodies due to sewage. Also, there is a need for proper operation and maintenance of built systems. Local bodies to be made more accountable for proper functioning of STPs through accountability of producing recycled water/ bio-gas from the unit. Action plans to be prepared and implemented for major cities for addressing water pollution due to sewage.
- Solid waste management: There is a need to develop and implement viable PPP models for setting-up and operating secure landfills, composting plants, waste to energy projects and other appropriate techniques for MSW treatment. Segregation of waste needs to be enhanced to improve efficiencies at the processing levels. Construction and demolition wastes should be segregated (collected separately) and recycled. Supply of compost produced through composting of MSW to be mandated with the sale of agricultural inputs. Informal sector systems of collection and recycling of various materials needs to be strengthened by giving them legal recognition and enhancing their access to institutional finance and relevant technologies. There is a need to review the municipal laws and policies to enable registration of societies of recyclers to operate within the framework of law. Local municipal bodies need to play an important role in proper implementation of the "Recycled Plastics Manufacture and Usage Rules". Proper inventories for Bio-medical waste and E-waste should be developed. Moreover, common biomedical waste treatment facilities should be developed in all the major cities and sufficient number of licenses to be issued for its operation. Finally, municipal bodies will be required to create a general public awareness for reducing, reusing and recycling of the wastes.
- Improving performance of local bodies : There is a need for capacity building (financial and technical) of local bodies. There is a need to enhance the capacities of municipalities for recovery of user charges for water, solid waste and sewerage systems. Finally, performance measurement of the urban local bodies shall be carried out for their continual improvement.
- Transport and air pollution: Capacities of the state governments and the municipal bodies need to be built for planning and implementation of urban transport system. Traffic studies in the big cities of the state to be carried out by competent agencies for providing solutions for traffic and travel demand management. Other major strategies include :

- *Major augmentation of public transport system and promotion of non-motorised transport*: There is an urgent need to build a transport system catering to the demands of all sections of society with emphasis on buses, bicycles, pedestrian traffic etc. JNNURM needs to be tapped for channelling significant financial support from the Central Government for investments in urban transport infrastructure. Rapid-transit-system or transport needs to be provided to the satellite towns/cities developed as growth centers around the main cities. Non- motorized modes of transport are environmental friendly and therefore have to be given their due share in the transport system of the city by addressing the safety concerns and construction of segregated rights of way, controlling encroachments, designating non-motorized vehicle and pedestrian lanes/zones.
- *Greater and widespread promotion and use of cleaner fuels such as ULSD/CNG/Electric vehicles*: National auto fuel policy has suggested to introduce BS-III fuel across the country by 2010 (except 11 cities where BS-IV fuel to be provided). A future road map for provision of BS-IV fuel in the state has to be prepared. Initially, the critically air polluted cities of the state can be shifted to BS-IV fuels,

followed by other regions. Public transport in the state has to be based on cleaner fuels such as ULSD/CNG/Electric vehicles. CNG fuel may be considered as an option for public transport (public buses and autos), especially in the bigger cities (divisional headquarters and NCR).

- *Controlling air pollution from older vehicles*: As an immediate measure, there is a need to pose restrictions on the movement of old commercial vehicles in the congested zones of major cities of the state. On a medium term, there is a need to strengthen I&M system in the state for controlling the emissions from all vehicles. On a longer term, there is a need to initiate a fleet modernization program in which subsides/direct cost benefits need to be provided to the old commercial vehicles owners to switch from old to new vehicle.
- *Managing travel demand and growth of private vehicles*: Measures that may be considered in major cities include: staggering of office, school, and factory hours; minimum ridership requirements in peak hours; encouraging private bus service provision for public use, etc.

Slum Improvement

In-situ rehabilitation of slums shall be carried out with provisions of infrastructural services such as safe drinking water, sanitation, solid waste management. Individual toilets to be constructed in slum areas with the upgradation of housing schemes. However, in case of shortage of land, finances or water, community toilets to be constructed under JNNURM and IHSDP schemes.

4.3 Improving Environmental Governance and Building Capacity

Elements of environmental protection are deeply ingrained in the governance system of India. Beginning mid seventies, a number of constitutional, legislative and regulatory provisions related to environment were enacted and institutionalized within the three tiers of government – the Centre, State, and local bodies. At the same time, efforts have been made to mainstream environmental concerns in developmental activities, and sectoral policies increasingly integrate the need for environmental protection as a means of sustainability. India is also signatory to several multilateral agreements, which reflect its commitment towards a better global environment.

In Rajasthan, the Rajasthan State Pollution Control Board (RSPCB) is the key enforcement agency responsible for regulating industry and overseeing environmental issues in the State. The latter was constituted in 1975 under the Water (Prevention and Control of Pollution) Act, 1974, with objectives to prevent and control pollution of water. Enactment of the Water (Prevention and Control of Pollution) Cess Act in 1977 provided financial autonomy to the State Board by conferring on it the powers to collect cess from industries and municipal bodies on the basis of water consumed by these entities. Later, it was also entrusted with the prevention, control and abatement of air pollution under the provisions of the Air (Prevention and Control of Pollution) Act, 1981.

The enactment of Environment (Protection) Act, 1986, significantly widened the scope of the State Board's activities to cover hazardous wastes and chemicals, municipal solid wastes, biomedical wastes, batteries and plastics, noise pollution and public hearings for conduct of environmental impact assessments of development activities. Currently, the State Board is engaged in implementation of the following Rules under the EPA, 1986:

- Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008
- Manufacture, Storage, and Import of Hazardous Chemicals Rules, 1989

- Environnemental Impact Assessment (Aravali) Notification dated 7-5-1992
- Environmental Impact Assessment Notification dated 14-9-2006
- Biomedical Waste (Management and Handling) Rules, 1998
- Plastic Manufacture, Sale and Usage Rules, 1999
- Noise (Pollution Control and Regulation) Rules, 2000
- Municipal Solid Waste (Management and Handling) Rules, 2000
- Batteries (Management and Handling) Rules, 2001

Besides, the State Board is also implementing the provisions of the Public (Liability) Insurance Act, 1991.

Notwithstanding this expanded mandate, the State Board remains overburdened with its consent management functions, with a disproportionate amount of resources being spent on issuing consent-to-establish (CtE) and consent-to-operate (CtO) for industries. Institutional assessment studies of the pollution control boards in general, and Rajasthan State Pollution Control Board in particular, have brought out the need for both organizational as well as process related reform. There are essentially three areas in which the Board needs to be strengthened:

Consent Management: The RSPCB uses a very long drawn process for issuance of CtE/CtOs. Further, the air and water consents and hazardous waste authorizations (if any) are processed separately, leading to different time schedules when the CtOs come up for renewal. The Board has already started addressing these issues and will benefit by innovating on the procedures for CtO and CtE so that the time in granting the approvals is reduced.

Monitoring and Enforcement: RSPCB has formulated certain norms for effective verification of compliance by the industrial units. According to these norms, the frequency of inspection and sampling range from once in six months for 17 highly polluting large/medium red category industries, to once in 36 months for orange category small scale units, to once in 10 to 15 years for large/medium and small units categorized under the 'other' category. The monitoring and enforcement capacity of the RSPCB needs to be further strengthened.

The Board may consider implementing a procedure of randomized surprise inspections in which the industries to be inspected are identified randomly through a computerized selection process and the inspections are carried out without any forewarning. Standardized approaches may then be used to deal with different levels of violations, which may be technical, minor or major violations.

Institutional Capacity: Study of the Board has reviewed in detail the staffing of the RSPCB in relation to the number of districts, population covered, area, and number of industries under consent management, and compared these with the staffing norms of other SPCB such as Karnataka, West Bengal, Maharashtra, and Andhra Pradesh. The study brought out that: the per district scientific and technical staff ratio is the lowest in RSPCB among the Boards compared; the per lakh population ratio is the lowest in RSPCB; the per 1000 sq. Km technical and scientific staff ratio is the lowest in RSPCB;

and the number of industries handled by the technical and scientific staff is the highest in RSPCB.

Recognizing these issues, a rigorous program of strengthening of the Board is already underway, including sanctioning of new posts and approval of training activities. Such a dynamic approach for further re-strengthening is required on a continued basis with high quality training using latest technologies and knowledge sources. Capacity building is essential not only in the areas of monitoring and enforcement, but also areas related to the several other Rules promulgated under the EPA, 1986, for which the RSPCB serves as the enforcement authority. The functions of the RSPCB should also be expanded to cover sensitization of relevant stakeholders and seek their inputs into the overall environmental management process.

Besides the RSPCB, another key agency at the State level is the Department of Environment (DoE), which presently carries out a three way liaison between the MoEF, the RSPCB, and the other departments of the State government. The DoE essentially performs the functions of reviewing and providing environmental inputs to various state government policies and programs. The DoE, however, has very limited technical staff.

Environmental Impact Assessment (EIA): Under the EIA Notification 2006, a State Environmental Impact Assessment Authority (SEIAA) was set up in Rajasthan in the year 2008, to oversee environmental clearance (EC) of category B projects. The SEIAA is supported by a State Environmental Appraisal Committee (SEAC). The applications are received by the SEIAA, and the SEAC carries out the appraisal of the project, and accordingly a decision is taken on the EC. The public hearings are carried out by the RSPCB

The enforcement of the EIA provisions in Rajasthan is presently overseen by the Regional Officer, Lucknow, who works under the MoEF and visits periodically to review implementation progress. The current structure with limited role of state level agencies in the enforcement of the EIA provisions is likely to result in lack of proper implementation of the Environmental Management Plans of new development projects. While the enforcement issues concerning the EIA Notification, 2006 are under consideration at the Central government level, the State could also take action, e.g. by building capacity within the SPCB to review the six monthly compliance reports submitted by the project authorities; and setting up a committee of local stakeholders to report violations of the EMPs to the SPCB or DoE.

The following measures shall be taken:

- System shall be developed to provide facility of granting consent to establish/operate (under the Water Act, 1974, Air Act 1981, and Hazardous Waste Rules 2008) in a consolidated format.
- Outsourcing some of the monitoring activities to the private sector competent institutions with adequate safeguards against collusion and conflicts of interest
- Continued efforts towards strengthening of the RSPCB through provision of on-the-job training and induction of staff with appropriate skill mix based on periodic assessment of the needs
- Web-based provision of real-time environmental information
- Randomized surprise inspections of industrial/mining facilities, and standardized operating procedures, including penalties

- Creation of a strong R&D cell to fund research and seek solutions to state specific issues, such as area-wide environmental quality management for mining areas, carrying capacity studies, clean technologies for industries, technical assistance packages for SSIs in key sectors, conversion of industrial clusters to eco-industrial parks etc.
- Capacity building for cumulative/regional EIAs and use of these in land-use planning; sensitizing local communities to the EMPs during the public hearing process and organizing them to monitor their implementation.

Management of the deteriorating common property resources (pastures, water, forests) requires effective decentralization of environmental governance to the local level. In this respect, Rajasthan took pioneering steps in the late 1950s to suggest a three-tier set up of democratic institutions at the village, block and district level. The 73rd Constitutional Amendment Act in 1992 devolved powers to these panchayati raj institutions (PRIs), the 11th Schedule specified the functions and schemes to be entrusted to the PRIs, and the State Finance Commissions were set up every five years to provide the resources to these institutions.

Similarly, the 74th Constitutional Amendment Act 1992, devolved powers to the Urban Local Bodies (ULBs), the 12th Schedule specified the functions and schemes to be entrusted to the ULBs, and the State Finance Commissions provided the resources for implementation. The enabling provisions in the 74th Amendment were further meant to empower the ULBs to take steps towards financial autonomy, and thereby improve the provision of basic urban services such as water supply, sanitation, and solid waste management.

These Constitutional Amendments also provided for the setting up of district planning committees to consolidate the plans prepared by the PRIs and the ULBs. The district planning committees were required to give consideration to issues of common interest such as spatial planning, sharing of water and other physical and natural resources, integrated development of infrastructure, and environmental conservation.

The constitutional arrangements need to be positively utilized and PRIs / ULBs need to be proactively associated for protection of environment. For this, following measures shall be taken:

- PRIs shall play a role in the management of, pastures and woodlands, and in efforts to combat desertification
- Likewise, PRIs shall play a role in the management of surface and groundwater resources, and their rational use and allocation
- The technical and institutional reform of the ULBs shall be accelerated for improving delivery of basic urban services of water supply, sewerage, and solid waste management.

Lastly, there is a need to mainstream and harmonize environmental issues across all the state level departments that impact environment in one way or another. This may need administrative reforms to assure that policies and programs of different departments are regularly reviewed by the environmental agencies for their potential environmental impacts, environmental cells are created within the sectoral departments, and a continual liaison is established between these cells and the DoE so that the latter can effectively play a facilitator's role.

CHAPTER 5. Policy Review and Implementation

As development imperatives in the State and their environmental implications change, new environmental priorities will emerge over time. Changes in national and global environmental regimes will also affect state level environmental issues. Therefore, the State Environmental Policy needs to be a dynamic document, which is subjected to periodic review and aligned with new knowledge and developments in the forthcoming years.

The following measures shall be taken:

- Consultations shall be undertaken with diverse stakeholders once in three years to re-examine the environmental issues and the strategic themes and policy directions to reflect the current state of affairs.

To assure implementation of this SEP, a State Environment Mission has been constituted, which will be supported by Task Forces with specific agenda and action plan, and institutional arrangements and resources for implementation of the proposed measures. Details with respect to the State Environment Mission are provided in a separate document.

Rajasthan
Environment Mission

2010

CHAPTER 1 Background

The State Government has prepared the **State Environment Policy (SEP), 2010.** The SEP identifies the key environmental challenges that the state must address to ensure continued economic growth that is sustainable and equitable. Overall, it is intended to be a guide to action on three fronts: (i) conserving and enhancing the State's environmental resources; (ii) assuring environmental sustainability of key sectors; and (iii) improving environmental governance and building capacity.

Separately, a **Climate Change Agenda (CCA)** has been prepared for the State to take forward the provisions of the NAPCC (National Action Plan on Climate Change) and prepare for adaptation and mitigation at the State level.

The purpose of the **Environment Mission** is to bring into focus the high priority issues emerging from the SEP and CCA, and mobilize government and non-government stakeholders to address these issues. The Mission would also identify and mobilize financial resources from possible sources for the implementation of the action plans in the key thrust areas, which include – (1) Water; (2) Industry; (3) Mining; (4) Afforestation; (5) Tourism; (6) Urban governance and sustainable habitat; (7) Human health,; (8) Agriculture and animal husbandry; (9) Enhanced energy efficiency including solar energy; and (10) Strategic knowledge for climate change.

Within the State Environment Mission, some sectors have been identified as being critical in terms of the climate change impacts on them. These include sectors such as human health, agriculture and animal husbandry, enhanced energy efficiency including solar energy, and strategic knowledge for climate change.

Where Rajiv Gandhi Missions already exist at the State level, such as in the case of water, agriculture and animal husbandry, and human health, it is recommended that the work under these missions and the Environment Mission be coordinated as deemed appropriate.

CHAPTER 2 Institutional Structure

The Environment Mission will have a three-tier structure, comprising:

(i) Environment Mission;

(ii) Steering Committee; and

(iii) Task Forces in key thrust areas.

2.1 Environment Mission

The Environment Mission is set up for the effective and timely implementation of the SEP and CCA recommendations. Since environmental issues are wide in scope and a number of departments and stakeholders are involved, a high level oversight mechanism is provided for. Also, action plans have been drawn up for Task Forces in key thrust areas, and accordingly, the same is reflected in the membership of the Mission and its subordinate bodies.

Composition

The composition of the Mission is as follows:

Chairperson : Chief Minister

Convenor : Principal Secretary, Environment

Members : Ministers of the under-mentioned departments, Chief Secretary, and Principal Secretaries/Secretaries in-charge of the under-mentioned departments:

- Environment
- Forests
- Mines and Petroleum
- Industries
- Water resources (Irrigation, SWRPD, PHED, GWD)
- Command Area Development (CAD)
- Agriculture (including Animal husbandry, and Watershed development and soil conservation)
- Urban Governance (UDH & LSG)
- Transport
- Energy, renewable energy
- Science and Technology
- Plan
- Finance
- Policy planning

Terms of Reference of the Mission

The terms of reference for the Mission are as follows:

1. Review the implementation of each of the missions' action plans in terms of physical progress (including necessary regulatory changes) and financial expenditure
2. Consider any changes that may be required in the scope of the different Task Forces
3. Review and endorse the report prepared by the Steering Committee at the end of each year on the implementation of the mission for consideration by the state cabinet/legislature

The Mission would meet twice each year.

2.2 Steering Committee

A Steering Committee is set up under the Chief Secretary, to review and coordinate the implementation of the Environment Mission by various agencies.

Composition

The composition of the Steering committee is as follows:

Chairperson : Chief Secretary

Member Secretary : Principal Secretary, Environment

Members : Principal Secretaries/Secretaries in-charge of the following departments:

- Environment
- Forests
- Mines and Petroleum
- Industries
- Water resources (Irrigation, SWRPD, PHED, GWD)
- Command Area Development (CAD)
- Agriculture (including Animal husbandry, and Watershed development and soil conservation)
- Urban Governance (UDH & LSG)
- Transport
- Energy, renewable energy
- Science and Technology
- Plan
- Finance
- Policy Planning

Other members : 1-2 representatives of NGO's actively involved in implementation of programmes related to the mission themes.

Terms of Reference of the Steering committee

The terms of reference for the steering committee are as follows:

1. Review the implementation of each of the missions' action plans in terms of physical progress (including necessary regulatory changes) and financial expenditure
2. Coordinate the work of the Task Forces as carried out by different Government departments and other agencies.
3. Consider any changes in the scope of the different Task Forces that may be required
4. Prepare a report at the end of each year on the implementation of the action plans drawn up for the various Task Forces, for consideration by the Environment Mission.

The Steering Committee would meet at least once during each quarter.

2.3 Task Forces

In addition, Task Forces related to the following themes are to be set up:

- Water
- Industry
- Mining
- Forestry and biodiversity
- Tourism
- Urban governance and sustainable habitat
- Agriculture and animal husbandry
- Enhanced energy efficiency including solar energy
- Health
- Strategic knowledge for climate change

The Task Forces are to be constituted under the concerned Principal Secretary/Secretary, with membership comprising the concerned heads of Divisions under their charge.

General terms of reference for the Task Forces are as follows:

1. Prepare detailed technical and budgetary proposals for implementation of the action plans drawn up for the Task Forces
2. Coordinate implementation by different government agencies and other stakeholders
3. Suggest additional measures or modifications based on consideration of local conditions
4. Any other work assigned by the Mission/ Steering Committee

The Task Forces would meet on a monthly basis or as needed to monitor implementation activities.

The overall institutional structure for the Environment Mission is given in Figure 1.

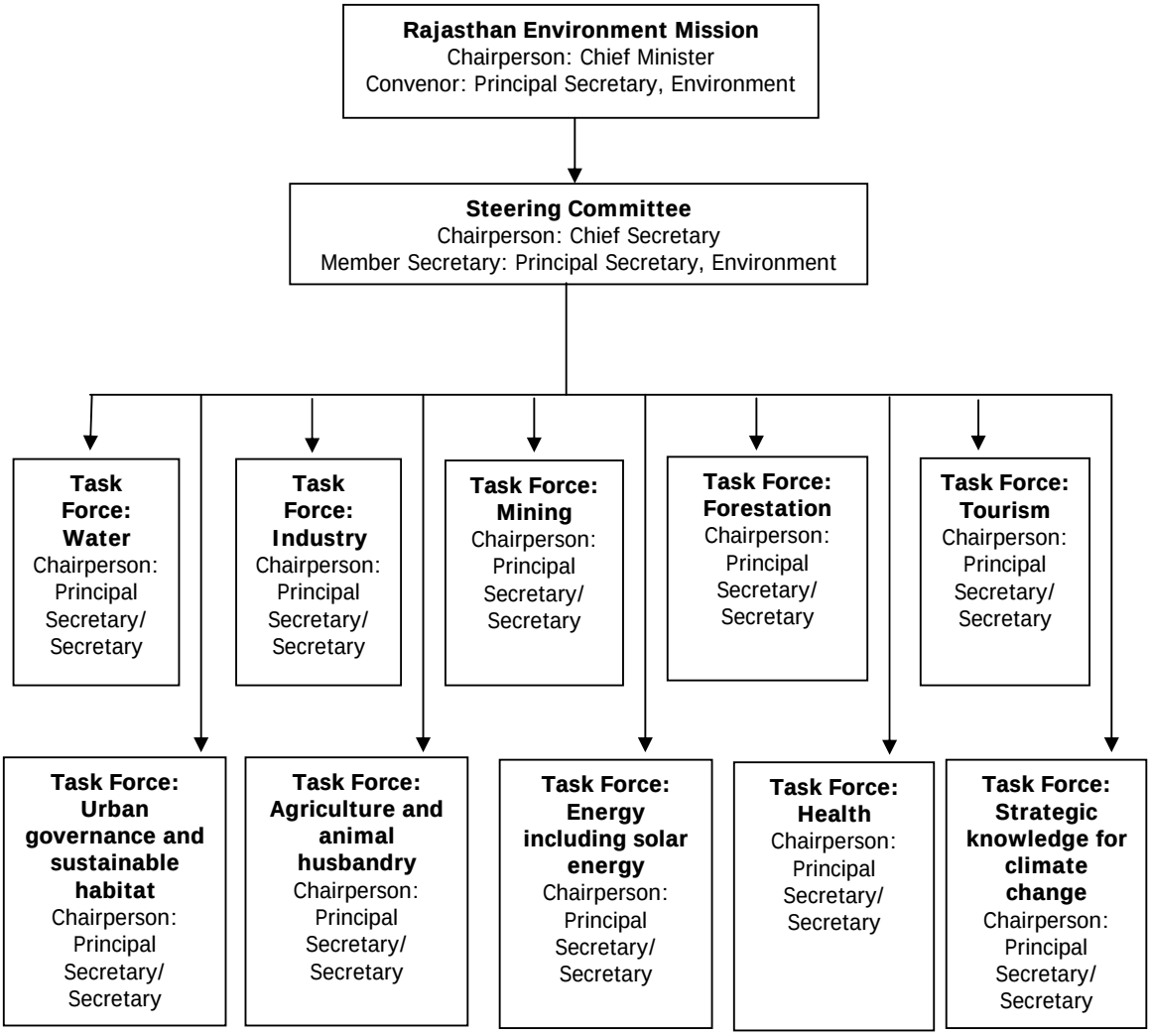


Figure 1 : Institutional Structure for Rajasthan Environment Mission

CHAPTER 3 Action Plans for Select Task Forces

Action Plans have been prepared for Task Forces in identified thrust areas. These include: (i) Water; (ii) Industry; (iii) Mining; (iv) Forestry and biodiversity; (v) Tourism; and (vi) Urban governance and sustainable habitat; (vii) Agriculture and animal husbandry; (viii) Energy, including solar energy; (ix) Health; and (x) Strategic knowledge for climate change. The action plans are detailed in the following sections and are intended to address environment and climate change issues in the State on a priority basis.

3.1 Water

The water resources in Rajasthan are highly vulnerable to natural and man made threats and there is an urgent need to address the key environmental challenges faced by the sector. Based on various reports and documents reviewed and analyzed, four key issues have been identified that need urgent attention in the Environment Mission.

Issue 1 - Water quality improvement: Natural contaminates such as fluoride, nitrate, and chloride salts in ground water are high making it unfit for drinking and posing risk to health. Intensive surface water irrigation many a times causes water-logging and increased salinity, which are major environmental threats. Specific localized cost effective measures need to be developed with proper planning and implementation strategies.

The lakes in Rajasthan are highly polluted and municipal and industrial effluents are the chief factors for the degradation of lakes, particularly the urban lakes in Rajasthan. The anthropogenic pressures in the catchment itself has resulted in degradation of the catchment area due to deforestation, extensive agricultural use and consequent erosion and increased silt flows.

A comprehensive and holistic multidisciplinary integrated research and institutional framework is required to develop strategies to address these issues and these shall be implemented through collective inter-departmental efforts.

Issue 2 - Improving water availability and water use efficiency: demand and supply side management: Water use efficiency is very low in the state and unaccounted for water (UFW) in drinking water distribution systems (10-11% of the total use) is of the order of 30-40 per cent. About 83 per cent of the water is used for irrigation and of this, 65 per cent is surface water; losses in surface water irrigation are much higher as compared to those in ground water irrigation. Thus, about two-thirds of the water used for irrigation is affected by inefficiency. The increase in water use efficiency through involvement of Water User's Association, at least in the tertiary canal network, is necessary. Efforts are needed to inculcate Water Users Association culture in the Water Resources Department. A major concern is also that where surface irrigation is provided, there is a tendency of not using ground water for agriculture, which creates problem of water table rise and water logging threatening urban and rural infrastructure and land.

High cost of service, low cost recovery and low level of expenditure on O&M ail the water use efficiency. The water rates do not convey a sense of scarcity among the stakeholders, and as such, there is a need to rationalize the water tariffs in consultation with all stakeholders to move towards full recovery of O&M charges for sustainable development of water resources.

Issue 3 - Disaster management: Drought management in Rajasthan is a key concern which needs concerted efforts from all concerned agencies. Floods during monsoons are also a cause of concern which occurs due to faulty planning, choking of damaged systems and unplanned growth of settlements. The flash floods in Jaipur, Loonkaransar and many other places caused heavy damage. Flood management should be planned at the time a project is sanctioned, so that no unplanned growth takes place in the demarcated flood plain zones during and after construction of the project.

Proper planning for containing the disasters are to be integrated in the developmental polices and programmes. The disaster management programmes should be envisaged for longer term integrating water allocation and livelihood components with appropriate fund allocation, irrespective of cost recovery.

Issue 4 - Water governance: policies and institutions: Sectoral policies like subsidies for irrigation (power, pumps) and other inputs in agriculture sector indirectly leads to environmental degradation. For management of environmental issues, the State Water Resources Planning Department functions as an apex department by coordinating the environmental issues related to water with other departments. Many policies relevant for water sector viz., draft sector policy for rural drinking water and sanitation (2005) and draft ground water use and regulation bill (2004) are to be finalized yet. The State Water Policy has recently been finalised. The relevant state acts like Rajasthan Irrigation and Drainage Act and Rules (1954), Participation in Management of Irrigation (PIM) Act, 2000 need to be revisited given the current water scenario in the state. Besides, there is a need for integrating sectoral policies with the water sector policies as all the activities directly or indirectly impact the water resources.

Issue 5 - Water stress at the river basin level and increase in evapotranspiration due to climate change. Climate change will act as an additional stressor to rising water demands in Rajasthan, from the domestic, agriculture and industrial sectors. Studies conducted as part of India's first National Communications (NATCOM) to the United Nations Framework on Climate Change (UNFCCC) indicate that the west-flowing rivers of Kutch and Saurashtra and Luni which occupy about 60 per cent of the area in Rajasthan would face acute water stress conditions. Also the river basin of Sabarmati is likely to experience constant water scarcities and shortage. Apart from augmentation of surface water and groundwater sources through revival of traditional water storage structures, rainwater harvesting and artificial recharge, there is a need to reduce evapotranspiration losses. Planning and management at the basin level under the aegis of Integrated Water Resources Management is also imperative. Hence, many of the actions to be implemented herein are also required from the perspective of addressing climate concerns in the water sector.

The detailed action plan for the water sector is presented in Table 1 along with the responsible key departments / institutional agencies. These departments, in turn, may identify sub-agencies / other organizations (NGOs, institutions etc.) and assign tasks and responsibilities appropriately. The timeframe for the action plan is defined as (a) Short term: Part of 11th plan period: 2010 onwards; and (b) Long term: 12th plan period: 2012 onwards. Research and development activities to address the key issues may be given priority and separate funds may be earmarked.

Table 1 Action Plan for Water Sector

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
I. Improving water quality				
Reduction in fluoride levels in drinking water	Providing defluoridated water for drinking purposes	2012	PHED, Department of Rural Development NGOs	The Rajasthan Integrated Fluorosis Mitigation Programme (RIFMP) Fluoride control projects in Ajmer, Bisalpur-Dudu project, Chambal-Sawaimadhopur Project has been taken up under the Accelerated Rural Water Supply Programme (ARWSP). PHED has also undertaken a fluoride mitigation project
	Fluoride rich water from the tube wells to be blended with surface water to meet the potable water quality standard as per the Indian standards, on a case by case basis	2012	PHED	Increased Allocation under ARWSP, Desert Development Programme (DDP) address drinking water problems in the desert and semi desert regions
	Upscaling of RIFMP programmes	2012	PHED	Government of Rajasthan PPP, Enhanced central assistance
	Studies on low cost de-fluoridation technologies	2010	DST	R&D funds
Salinity Management	Desalination of saline and/or brackish groundwater should be explored	2012	PHED, Department of Rural Development	Funds from drinking water quality improvement schemes
	Public private partnership model to be explored for installing desalination plants	2012	PHED, DST Private bodies	Government of India has decided to strengthen the infrastructure projects for small & medium towns under Urban Infrastructure Development Scheme for Small & Medium Towns (UIDSSMT). The Scheme is designed to cover the urban infrastructure works under Water Supply including de-salination plants Rajasthan Urban Infrastructure Development Program (RUIDP), GoR with the financial assistance from Asian Development Bank (ADB). The Investment Program is designed to cover major urban infrastructure works under Water supply, etc.

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
Industrial Pollution	Establishment/strengthening of water quality monitoring and surveillance system devising for improved monitoring, assessment and remediation strategies	2012	RSPCB, Department of Environment in consultation with CPCB	XIIth Plan funds
	Water audits be made mandatory in all Industries for achieving water use efficiency	2010	RIICO, RSPCB	Industries
Agriculture pollution	Promote organic agriculture and low external input sustainable agriculture (LEISA)	2012	Agricultural university, Department of Agriculture, Department of water Resources	Central and State Assistance
Improved Sanitation	Basic water and sanitation services for all areas and localities to be planned and implemented	2012	VWSC (Village Water & Sanitation Committee), Local bodies	Total Sanitation Campaign for rural areas The UIDSSMT Scheme is designed to cover the urban infrastructure works under Water Supply including sanitation (urban areas) The sharing of funds under UIDSSMT would be in the ratio of 80:10 between Central Government & State Government and the balance 10% share shall be raised by the concerning Municipal Board/ Council.
II. Improving water availability and water use efficiency: demand and supply side management				
Demand Side Management	Integrated water resource management (IWRM) programmes through designated nodal authority; Integrated river basin management (IRBM); Integrated lake basin management (ILBM)	2012	SWRPD/WRD (Water Resources Department) Environment Department	National River Conservation Plan RWSRP (Irrigation Department, Agriculture Department and Ground Water Department) National Lake Conservation Plan
	Conjunctive management for mitigating water logging and rising water tables	2012	Department of Water Resources, Department of Agriculture, CAD	Resources from planned outlay under irrigation and flood management
	Prepare project feasibility reports for conjunctive use of ground and surface water; Implementation of schemes zone wise in phases	2012	Ground Water Department, Department of Irrigation	Optimal conjunctive use plan to be implemented by the State agencies in co-ordination with CADA has been recommended by CGWB
Demand Side Management	A regulatory system to be set up for regulation of lakes at district levels to regulate withdrawals, non-consumptive use, discharges, and conversion of wetlands to other uses. Panchayti Raj Institutions (PRIs) to be empowered to regulate village ponds	2012	Department of water resources (SPWRD), Urban Local Bodies Department of Urban/Rural, PRIs	XIIth Plan funds , RWSRP

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
Demand Side Management	Lake restoration and desiltation activities	2012	Multi institutional initiative Irrigation Department, Command Area Development & Water Utilisation Department, PHED	National Bank for Agriculture and Rural Development (NABARD) Accelerated Irrigation Benefits Programme (AIBP) NLCP
	Groundwater to be better utilized by encouraging and facilitating pressure irrigation methods such as drip and sprinkler irrigation technique.	2010	Department of Irrigation, Groundwater department	Under XI plan: ▪ To improve overall irrigation efficiency Use of sprinkler Irrigation Command Area Development Programmes
	Deficit irrigation is another method which can be adopted where water availability is low	2010	Indira Gandhi Nahar Department	Under XI FYP: ▪ To improve overall irrigation efficiency ▪ Use of sprinkler Irrigation
	Rehabilitation of existing irrigation projects	2012	Department of Irrigation and Command Area Development & Water Utilisation Department	Existing programmes RWSRP
	Water audits to be done for canal irrigation projects	2010	Department of Irrigation, Command Area Development & Water Utilisation Department	Funds from various canal irrigation schemes
	Explore possibilities of channelising surplus ground water to deficit areas; Re-use of irrigation drainage water should be encouraged.	2012	Department of irrigation	Rajasthan Water Sector Restructuring Project (RWSRP); Irrigation Department, Agriculture Department and Ground Water Department
	Water User Groups (WUGs) to be set up to regulate groundwater extraction by all users dependent on the aquifers under the WUG jurisdictions.	2012	Department of Water Resources, NGOs, PRIs	
	Leak Detection Study and Rehabilitation Program for Water Supply System	2010	ULBs, PHED	XIth Plan funds
	Capacity building and training on water use efficiency and water use management	2010	State Government, PRIs, NGOs	RWSRP
Supply side management Supply augmentation	Preservation of traditional water harvesting structures and sources to be encouraged	2010	Irrigation department	
	Rain water harvesting mandatory for all new buildings in accordance	2010	UDH, Department of Water Resources	State water policy Construction of Roof Top Rainwater Harvesting

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
Supply side management Supply augmentation	with New Building Regulations 2010. In drinking water deficit areas, especially where presently there are no water and sanitation facilities or water is being supplied through tankers, rain water harvesting in such pockets may be taken up on a community basis so that local needs could be met or supplemented.			Structures in all government & semi government buildings under XIth plan for Groundwater recharge with funding from the concerned government department and implementation by PWD Under XI FYP 48,000 structures have been identified for water harvesting CAZRI is conducting the assessment of the potential for water harvesting technologies to combat droughts in Rajasthan. State proposals; Provision of Annual allocation under ARWSP exclusively for water harvesting/ recharging schemes so that implementation of such schemes may become mandatory Prime Minister's Gramodaya Yojana funds (PMGY) for water harvesting NREGA programmes
Supply side management Supply augmentation	Preparation of state-wise artificial recharge plan and zone wise implementation plan	2017	State Ground Water Department, Department of Water Resources	State Sector Scheme on Artificial Recharge to Ground Water through dugwells during XI Plan Central assistance; Ministry of Finance through NABARD; Implemented through State governments in association with Panchayati Raj Institutions (PRIs), Ground water department, NGOs
	Impact assessment of rainwater and artificial recharge	2010	State Ground Water Department with help from CGWB	XIth Plan funds
	Planning and implementation of Inter-basin transfer projects within the state.	2012	Department of Water Resources, Government of Rajasthan	XIIth Plan funds

Action	Timeframe (start year)	Responsible Agency	Existing policy /schemes/sources of financing
III. Natural disaster management			
Drought Management	Ongoing activity	Disaster Management group comprising of 12 departments viz. Relief, Mines, Irrigation, Industries, Home, Urban Development, Revenue, Forests, Public Works Department (PWD), Medical and Health, Agriculture and Animal Husbandry. Disaster Management & Relief Department will function as the nodal agency for the group.	Calamity Relief Fund (CRF) of the Central Govt; Prime Minister's Relief Fund; Various watershed Programmes like Desert Development Programme (DDP) Combating Desertification Programme (CDP) Drought Prone Area Programme (DPAP) Integrated Wasteland Development Programme (IWDP), National Watershed Development Programme for Rainfed areas(NWDPRA)
Prepare flood-plain zoning and emergency plan for flood control and management for each flood-prone basin/area	2012	Disaster Management & Relief Department	XII plan for Disaster Management & Relief Department
Urban storm water improvement	2010	Urban Development and Housing Department	XI FYP funds for UDH
Periodic assessment of the state of water resources ▪ Research support for GCM & RCM runs integrated with surface water flows ▪ Establishment of State Hydraulic Databank ▪ Flood forecasting system for high discharge rivers. ▪ Spatial & temporal assessment of basin-wise water availability	2010	State Water Resources Planning Department	XI FYP funds of SWRPD
IV. Improving water governance: policies and institutions			
Water tariffs to be set to progressively move towards full cost of operation and maintenance, with lifeline rates for slum dwellers cross-subsidized by others. This to be matched by a rigorous program of improvement in the efficiency of operation and maintenance.	2012	Department of Water Resources, ULBs, PHED	Various planning schemes Various PHED schemes
Control over exploitation of groundwater in dark and gray zones and to increase abstraction in areas where water table is rising through legislation or incentives/disincentives.	2012	Ground water department Various concerned departments; urban/rural/watershed/ land resource/ agriculture	Ground water department schemes (Draft Ground water bill)
Strict prohibition of direct discharge of untreated wastewater to rivers, lakes, and groundwater	2012	RSPCB	Own funding by Industries/Department of Industries for small scale sector
Form a statutory regulatory framework / body in the state for fixing water tariffs for all key sectoral users	2012	Indira Gandhi Nahar Department	XI plan mentions enhancing water tariff for irrigation, drinking & industrial use, to recover O&M cost

Action	Timeframe (start year)	Responsible Agency	Existing policy /schemes/sources of financing
A program of water metering for water management purposes should apply to all significant water users irrespective of source and water ownership	2012		State assistance
Disincentivise indiscriminate use of inorganic fertilizers and pesticides in phased manner, through multi pronged strategies targeting all stakeholders	2010	RSPCB Department of Agriculture (DoA)	Central and State assistance
R&D, extension and capacity building	2010	All concerned departments in water sector	Central and State assistance

3.2 Industry

The major industrial sectors in Rajasthan include – cement, mineral based industries, steel re-rolling, textile dyeing and printing, brick and lime kilns and chemical. Being rich in mineral resources, mineral based industries form a major component of total industrial production in the state. Despite having arid to semi-arid climate and general water shortages due to prolonged drought periods, the state has been able to make substantial investment in development of industrial infrastructure across the state.

The industrial growth in the state is dominated by small scale industries which generate employment but are also pollution intensive. The industrial statistics reveal that while the numbers of large and medium scale industrial units have more or less remained same (378 units in 2001 and 384 units in 2006-07), small scale units have increased from 221,045 in 2001-02 to 320000 in 2008-09. As per data compiled by RIICO for the registered industrial units, only 10% of them are located in notified industrial areas, the rest are set up in non-notified areas lacking the necessary industrial infrastructure, making it difficult for the regulatory agencies to monitor them for their performance. The Ministry of Environment and Forest has recently released a report based on assessment of 88 industrial clusters in the country analysing comprehensive environmental pollution index (CEPI) for industrial units in these clusters. Four industrial clusters in the State – Bhiwadi (ranked 6th), Jodhpur (ranked 23rd), Pali (ranked 31st) Jaipur (ranked 58th) - find place in the list. These clusters need to have long term environmental management plan to improve their environmental performance.

The priority environmental issues arising out of operation of industries in the state and specific actions required to mitigate them are listed below:

Issue 1 – Land and groundwater contamination in areas where small scale industrial clusters are located especially in the case of textile dyeing and printing clusters.

Issue 2 - Land degradation and loss of soil productivity: marble cutting and polishing operations generate marble slurry which is presently disposed in nearby areas. This makes the receiving soil impervious and affects soil productivity.

Issue 3 – Large number of industrial units especially tiny units located in non-conforming areas. The pollution from these units is difficult to monitor and regulate.

Issue 4 – Improper operation and maintenance of CETPs. Though there are 10 CETPs developed to serve different industrial clusters and around six new ones are planned, their regular operation and maintenance is problem thus causing soil and groundwater pollution by discharge of untreated wastewater. Also disposal of chemical sludge generated by these units is problematic due to poor access to landfill sites.

Issue 5 – Industrial units in SSI clusters using obsolete technologies due to low investment and low profit margins therefore being pollution intensive. In some industrial clusters, instances of wastewater discharge in storm water drains have been observed.

Based on the above, specific action plan is suggested in Table 2.

Table 2 Action Plan for Industry

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
I. Improving Environmental Management in Industrial Areas				
Addressing pollution in industrial clusters	Development of new and redevelopment of problematic industrial clusters into eco-industrial parks as required by industrial policy. Preparation and implementation of action plans to restore contaminated areas	2012	RIICO, RSPCB	XIIth Plan of the Department of Industry, RSPCB
	Establish CETPs for un-served clusters and operate existing and planned CETPs in SPV mode to improve operation	2010	Industry Association, RIICO	Industry owners
	Initiate studies to address pollution from industrial sectors where presently financially viable option does not exist (e.g. high TDS effluent generated from ETPs in textile dyeing and printing process). Profiling surface and groundwater pollution in areas where these industries are concentrated	2010	Industry Association, RSPCB	Industry owners, XIth and XIIth Plan funds for RSPCB
II. Cleaner Production				
Waste reduction	Facilitate waste reduction, reuse and recycling in processes such as • Marble slurry generated from processing units • Chemical sludge generated from CETPs • Fly ash from thermal power plants	2010	Industry owners, Department of Industry	No additional resources required; Draft Industrial Policy provides for octroi and sales tax exemption for waste recycling
	Retrofitting existing SSI units with cleaner production technologies and ISO certification on cluster basis	2010	Industry Association, RIICO, Department of Industry	XIth and XIIth Plan for Department of Industry. State to provide incentives for adoption of cleaner technology and ISO 14001 certification at cluster level.

3.3 Mining

Mining and mineral sector is the key developmental sector for Rajasthan. In terms of the total value of India's mineral production, the State contributes 5.74% of the total value and ranks fifth after Bihar (13.09%), Madhya Pradesh (9.68), Gujarat (8.55%), and Assam (7.3%).

Exploration of minerals, however, is an activity which has adverse impact on ecology and environment. The mining activity interacts closely with forest resources and affects associated flora and fauna. Wherever mining leases are there either in forest areas or in fringe areas, there is inevitable conflict between mining activities both environmentally and socially with forest resources. The needs of economic development, however, make the extraction of mineral resources an important priority. There is therefore a need to address conflicts arising from such interactions between the mining and forestry resources.

The priority environmental issues arising out of mining activities across the state and specific actions required to mitigate them are listed below:

Issue 1 – Inadequate environmental management in small and illegal mining leases – the mining carried out by small miners is causing immense pressure on the environment in the state. The lease area being small, the lease holders are unable to use modern mechanized mining methods and also unable to take required environmental protection measures for compliance with various environmental laws.

Issue 2 - Land degradation: removal of top soil, sub-soil, weathered rocks, overburden etc during the mining operation is leading to land degradation due to change in land geology and dumping of wastes and tailings.

Issue 3 - Water pollution: mining impacts surface water and groundwater sources either by runoff and siltation or dissolution of mine minerals while pumping out the mine water especially in the case of pyrite or sulphide containing rocks

Issue 4 – Air and noise pollution: sources of air and noise pollution are fumes emitted from various machines, movement of vehicles, drilling and blasting activities.

Based on the above, specific action plan is suggested in Table 3.

Table 3 Action Plan for Mining Sector

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
I. Integrating environmental management into mining operations				
Addressing environmental issues in small mining leases	Cluster based management of small leases through establishment of SPVs[1]	2012	Mine lease owners, Department of Mines and Geology	Mine owners, XIIth plan of Department of Mines and Geology.
Adoption of environmentally sound mining practices	Implementation of eco-friendly mining process and pilot demonstration for replication	2010	Mine lease owners under supervision of Department of Mines and Geology and RSPCB	Mine owners
	Proper management of groundwater encountered during mining either for captive use or aquifer recharge. Quality of groundwater however needs to be regularly monitored	2010	Mine lease owners under supervision of Department of Mines and Geology, RSPCB	Mine owners
Control of pollution from mining activities	Proper management of groundwater from acidic mines; the groundwater needs to be stored in ponds lined with lime bed for neutralisation	2010	Mine lease owners under supervision of RSPCB	Mine owners
	Proper maintenance and management of transport vehicles and mining equipment (silencers, exhausts, etc) to control air emissions	2010	Mine lease owners under supervision of RSPCB	Mine owners
	Use of mining tools like wire saws, hydraulic splitters and rock rippers to minimise noise and vibration caused by blasting	2010	Mine lease owners under supervision of Department of Mines and Geology	Mine owners
	Maintaining green cover to control dust and noise	2010	Mine lease owners under supervision of Department of Forestry	Mine owners
	Use of water sprays, curtains and wet drilling methods to control dust and noise	2010	Mine lease owners under supervision of Department of Mines and Geology	Mine owners
Waste minimization	Waste rocks to be used in masonry, construction work and by cement plants to the extent possible to use the waste gainfully and reduce the requirement of clay bricks and hence top soil	2010	Department of Mines and Geology /UDH/ PWD	No additional resources required; Draft Industrial Policy provides for octroi and sales tax exemption for fly ash and stone waste recycling

[1] Annual operating expenses per SPV would be around Rs 30-40 lakhs[1]. This does not include establishment cost

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
II. Mitigating post mine closure environmental impacts				
Reclamation and remediation of abandoned mines	Proper landscaping and rehabilitation and remediation of abandoned mine dumps	2010	Department of Mines and Geology	Plan funds
	Use of mined out area as water reservoir	2010	Department of Water Resources	Plan funds from Department of Water Resources. Suitable location (s) need to be identified for development of water reservoirs.
	Low-grade minerals to be stacked properly and vegetated so that they can be used at later date once the technology becomes available	2010	Mine owners under supervision of Regional Offices of Department of Mines and Geology	Mine Owners. This should be included as a mandatory component of mine plan.

Summarizing the above, two key issues emerge, which are critical to ensuring sustainability in the mining sector in the state – (1) cluster based management of small mine leases and (2) need to reclaim and remediate abandoned mines.

Institutional arrangement for selected options

(i) Cluster based management of small leases

For environment friendly mining operations in small leases, cluster based management approach would be adopted. SPVs will be formed for preparing environment friendly action plan for mining operations in the cluster area, providing technical guidance to individual lease holders and carrying out the concurrent evaluation studies of mining operations. The SPV will consist of mine lease holders and representative (s) of Department of Mines and Geology.

(ii) Reclamation and remediation of abandoned mines

The other environment problem associated with the mining activity is that of abandoned mines. In many of the old mine leases no arrangement has been made for rehabilitation and remediation of abandoned mines. This problem can be tackled by having an autonomous body/dedicated cell exclusively for rehabilitation and remediation of abandoned mines, and the operations need to be carried out in a time bound manner. The task force will have to adopt innovative measures for mobilization of resources for this purpose. The problem of rehabilitation and remediation of abandoned mines where the lease holder was duty bound to carry out this activity on the completion of mining activities, or in case of mines already operational but where mining operations are likely to be concluded in the near future, the proposed autonomous body/ dedicated cell as mentioned above may act as a monitoring body. This body may also undertake rehabilitation and remediation of closed mines through proper understanding with the lease holders.

3.4 Forestation

Forests of Rajasthan are dominated by dry deciduous type and are concentrated in the Aravali and Vindhyan hill systems.

The geography and the climate have been extremely decisive factors for the state of Rajasthan to decide the fate of the natural resources and the communities dependent on those resources. The state has 61% of the land mass of Great Indian Thar Desert mostly occupied on the western side of the state whereas the eastern part is semi-arid in nature. The state is water scarce with only 1% of the sweet water of the country. The 11% cattle population of the country is harboured by the state on the pasture land, which accounts for 1% of the country's grazing land. Forest area in the State is only 9.56% of its total geographical area, which is mostly restricted to the Aravalis and Vindhyan hill ranges on the eastern side of the state. The available ecosystem goods and services from the forests of the state are clearly not sufficient to fulfil the requirements. The state harbours a rich wildlife in the protected areas as well as outside in the areas traditionally conserved by the local communities like Vishnois.

The priority issues in connection to the afforestation programmes in the state are listed below:

Issue 1 - Currently, forest land is only 9.56% of the total geographical area of the State and vegetal cover is 7.1%. Considering the inhospitable climatic and edaphic conditions the state has to target about 20% of the area under forests. So to achieve the target additional 45000 sq. km area owned by Government, communities and private persons need to be brought under afforestation and pasture development.

Issue 2 – The plantation targets need to be identified based on the various categories of the land use and the nature of programmes such as Afforestation, Mined Area Reclamation and for Combating desertification and land degradation.

Issue 3 – Targeting community land for afforestation and pasture development is an important aspect of afforestation. Grazing lands (*Gauchars*) in 10,000 existing Panchayats needs to be taken up for silvi-pastoral treatments with active community participation. Similarly the traditional sacred woodlands *Orans* form an important landuse in the western Rajasthan but do not have enough data regarding the status.

Issue 4 – The areas outside the forest lands support extensive wildlife. The habitat for species such as Great Indian Bustard, Chinkara, Black bucks require proper management beyond the boundaries of the forests.

Issue 5 – Involving private landowners in plantation exercise, efforts of land degradation and combating desertification is an important aspect and a constructive approach is necessary for the involvement of the private landowners.

Issue 6 - Shifts in forest types and species range and diversity. Changes in climatic variables can cause shifts in forest species and forest types. This will consequently have implications on forest-dependent livelihoods and loss of biodiversity. In general, exploitation of forests coupled

with occurrence of dry climatic conditions in the state may create conditions for outbreak of forest fires, reducing the carbon sinks and releasing large amounts of GHG into the atmosphere.

The specific action plan for afforestation is given in Table 4.

Table 4 Action Plan for Afforestation

Priority Issue	Action	Time Frame (start year)	Responsible Agency	Source of financing/ Financing Mechanism
I. Increase in forest cover and density				
Increasing area under forest and tree cover	Identification of land available under various categories for plantation in Aravalis, mainly 13 districts having major forests of the state	2010	State Remote Sensing Agency (SRSA)	SRSA funds, Forest Department , ISRO funds
	The plantation models based on the indigenous species suitable to local climatic conditions need to be defined	2010	Forest Department CAZRI AFRI	Funds of responsible agencies
	The availability of quality planting material should be ensured with decentralized as well as high-tech nurseries	2010	Forest Department	CAMPA funds
Defining plantation targets according to land use	Detailed state land use map of forested and non-forested areas should be prepared based on the ground truthing of satellite imageries	2010	SRSA	SRSA funds Forest Department ISRO funds
	Contribution of areas identified for afforestation, mined area reclamation, and for combating desertification and land degradation programs should be assessed and defined so as to compensate about 11% additional forest cover for the state	2010	Forest Department	Not needed
Community involvement in afforestation activities	Collaboration with ISRO and SRSA needs to be developed for identification of Panchayat lands	2010	SRSA	SRSA funds Forest Department ISRO funds
	Necessary local institutions (JFMCs) need to be set up for involving local communities in afforestation wherever not available	2010	Forest Department	CAMPA
	Capacity building and empowerment of Panchayati Raj Institutions	2010	Forest Department Rural Development Department	CAMPA NREGA
	A status survey to prepare the action plan for strengthening/restoring the *Orans* in Rajasthan	2010	Forest Department	CAMPA
Afforestation of private land holdings	Incentive-based agro-forestry models to be developed targeting the involvement of private land owners	2010	Agriculture Department Forest Department Rural Development Department	Bank loans NABARD
Explore mitigation potential of community-forest projects	▪ Obtain carbon credits for forest conservation	2010	Forest Department	

Priority Issue	Action	Time Frame (start year)	Responsible Agency	Source of financing/ Financing Mechanism
Assessment of shifts in forest types	▪ Procure impact models (such as vegetation-response model) and use tools such as remote sensing to assess shifts in forest types with changes in the climate, for planning of adaptation strategies	2012	Forest Department	
Fire management	▪ Fire prevention, protection and management	2010	Forest Department	
II. Conservation of biodiversity				
Conservation of wildlife outside forest areas	Project Great Indian Bustard to be launched in a participatory manner so that private pasture owners can be motivated to protect the habitat and the species	2010	Forest Department	Forest Department funds for wildlife
Maintaining species diversity under climate change	▪ Assessment of shifts in forests and species habitats with changes in climate ▪ In-situ and ex-situ germplasm conservation of threatened flora and fauna	2012	Forest Dept.	

The implementation of the above action plan requires a decentralized and co-ordinated approach involving local communities. The activities also need to be co-ordinated with the programmes of watershed management wherever possible.

The Management Information Systems should be used to monitor the progress of the implementation as well as identify the possible integration of programmes at the field level.

The systems of managing Common Property Resources in Rajasthan along with new institutions like JFMCs, Panchayat level committees on natural resources, short duration project implementation committees form an important structure at the field level for involving the local communities that should be tapped effectively.

As mentioned, several activities may be funded under CAMPA and NREGA funds for which appropriate allocations can be made. The agro-forestry plantations could be implemented by involving NABARD.

3.5 Tourism

The state of Rajasthan is a major tourist destination in India promoting culture and nature based tourism through the opening of forts, architectural and heritage sites, temples, festivals, fairs and cultural events, wild life safaris, nature parks and forests, mountains etc. Rajasthan attracts around 25% of the total international tourists coming to India, and about 5% of the total domestic tourists, which in terms of numbers for 2008, was over 298 lakhs.

In the context of tourism in Rajasthan, the environment plays a dual role, one of being a resource provider for tourism in the form of land, water, etc for its development and sustenance and the other as a tourist 'site' which is the main selling point for tourism in the form of lakes, forests etc. Hence, the very sustainability of tourism hinges on the quality and availability of

natural resources it is dependent on. An examination of the manifestation of tourism in Rajasthan has highlighted the following environmental concerns:

- Conservation of flora and fauna
- Demand /pressure on resource use (both natural and man made)
  - Energy
  - Water
  - Land use and land cover
  - Solid waste and sewage disposal facilities
- Resource usage and its access to the host population

An understanding of the above environmental concerns has enabled identification of the priority areas for action to promote the environmental sustainability of tourism, which are listed below:

Issue 1 – Management of tourist arrivals: The growth trends and high number of tourist arrivals in the tourist seasons in tourism developed areas, has contributed to concentration of tourists arrivals in limited space and time which in turn exerts pressure on the natural and man made resources. When these resources are made to work beyond their capacity it can negatively impact the environment.

Issue 2 - Management of tourist destinations: The natural tourist 'sites' such as forests, sanctuaries etc. need to be managed in a way that environmental sustainability is ensured along with economic viability.

Issue 3 - Management of tourist operations: Tourism needs to be conducted in a manner that is sensitive to the environment and the natural resource base. There is a need to involve the various tourist stakeholders to review and conduct their operations in an environmentally friendly manner.

The specific action plan for promoting environmental sustainability of tourism is given in Table 5.

Table 5 Action Plan for Tourism

Priority Area	Action	Time Frame (start year)	Responsible Agency	Source of financing /Financing Mechanism
I. Environmentally sound tourism development				
Management of tourist arrivals	Carrying capacity studies for major tourist destinations in Rajasthan	2010	Dept of tourism to outsource studies to competent agency.	XIth Plan funds of the Tourism department.
	Promote Rajasthan as an	2010	Dept of tourism in consultation with	Plan financial outlay of the

Priority Area	Action	Time Frame (start year)	Responsible Agency	Source of financing /Financing Mechanism
	environment friendly tourist destination to attract environmentally conscious and sensitive tourist.		the various tourism stakeholders such as hoteliers, travel operators, travel agents, environmental NGOs, media representatives, forest dept, archaeological survey of India.	Tourism department.
Management of tourist destinations	Setting up an environmental conservation and remediation fund through a fixed contribution from hotels and rationalized entry fees.	2012	Department of Tourism, Department of Forest. Also consult Archaeological Survey of India as relevant.	XIIth plan funds
	Environment cell to be set up within the tourism department with appropriate devolution of power and funds to be made available.	2010	Rajasthan State Pollution Control Board and Tourism Department	XIth plan funds
	Regular awareness and sensitization programmes to be conducted by the environment cell for private educational institutes related to tourism, tourists, and owners and workers of tourist establishments.	2010	Department of tourism through the Rajasthan Institute of Tourism and Travel Management in collaboration with Rajasthan State Pollution Control Board.	XIth plan funds of RSPCB and Tourism department
	Monitoring committee to be set up to report environment violation to the concerned departments to facilitate action	2010	Rajasthan State Pollution Control Board and Department of Tourism	
Management of tourism operations	"Code of best management practices" to be developed for eco-tourist and heritage sites. Additionally, ensure that all tourism establishments (existing and future) are compliant with the Green Building Code with special provision for heritage buildings.	2010	Department of tourism to outsource the development of best practices to competent agency. Department of Tourism, Local bodies	XIth Plan funds
	Develop and institutionalize a monitoring system to measure environmental performance of the tourism sector.	2010	Department of tourism to outsource the development of the monitoring system to a competent agency. RSPCB & Department of Tourism to be the nodal agency.	XIth Plan financial outlay of the Tourism department. The department could also explore possibility of additional funding from the Ministry of Tourism.
	Environmental certification for the tourism sector.	2012	Department of tourism to outsource the development of the various certification criteria to competent agency. The department along with Rajasthan State Pollution Control Board to be the nodal agency.	XIIth Plan financial outlay of the Tourism department. The department could also explore possibility of additional funding from the Ministry of Tourism.
	Incentives/ subsidies to be provided to tourist establishments for investing in environmentally friendly technologies.	2012	Department of Tourism as the nodal agency along with the support of RREC and Water Resources Department.	XIIth plan funds
	Provide mandatory training to all tourism service providers to ensure environmentally responsible	2012	Department of tourism through the Rajasthan Institute of Tourism and Travel Management in collaboration	XIIth plan funds

Priority Area	Action	Time Frame (start year)	Responsible Agency	Source of financing /Financing Mechanism
	behaviours by tourists.		with the Rajasthan Pollution Control Board.	

The implementation of the above action plan requires a decentralized and co-ordinated approach involving Rajasthan State Pollution Control Board, Department of Tourism, Rajasthan Tourism Development Corporation, Forest department, Archaeological Survey of India, Water Resources department, Rajasthan Renewable Energy Corporation, Planning and Development Authority, Association of hotels (big and small hotels), travel operators and travel agents, media representation (print and electronic), environmental NGOs and local communities.

3.6 Urban Governance and Sustainable Habitat

Rajasthan has shown a high decadal urban population growth rate of 31% during 1991-2001. The rapid population growth of the urban centres has resulted in tremendous pressures on land, natural resources and basic infrastructural facilities. Response measures in Rajasthan have not been able to keep pace with the rapid urban growth.

In absence of efficient public transport system, private vehicles have grown at a rapid pace in the state. The demand for power and other infrastructural facilities have also risen manifold. Condition of water supply in Rajasthan is not satisfactory due to scarcity of water resources as well as low rainfall. About 40% households do not have proper sanitation facilities. About 6600 MT of solid waste is generated per day in the state, which is not disposed of in a scientific manner and instead dumped in low depressions. There is not much provision of proper sewerage, treatment and disposal system in any of the towns expect Jaipur. Urban slums are growing in the state and nearly 14.5% of the urban population lives in slums which are not only economically weak but are susceptible to several environmental health problems. Addressing these concerns requires investments in infrastructure as well as improved urban governance. The urban local bodies, however, lack adequate technical and financial capacity to address these issues.

There are many ongoing programs of the government for improvement of urban regions. These include Master Plan and town planning schemes, IDSMT, centrally sponsored programmes such as UIDSSMT, JNNURM, and HSDP, RUIDP, Slum Improvement Programme etc. However, significant efforts are needed for improving the urban scenario in the state.

The priority issues which need significant attention are:

Issue 1 - Integration of environmental issues in urban planning: Rapid urbanization has led to unplanned growth in urban centres which has put tremendous pressure on the limited resources of the region. There is a need for integration of environmental concerns in the process of urban planning.

Issue 2 - Management of water: Rapid urbanization has resulted in pressures over the supply and quality of drinking water in the urban regions. There is a need to put emphasis on enhancing coverage and quality, and on conservation of water.

Issue 3 - Sewage management and sanitation: Sewage management is at its inception stage in the state. Hence, there is a need to build infrastructure for proper conveyance, treatment and disposal of sewage. Moreover, urban slums are facing problems of inadequate sanitation facilities, and require significant attention.

Issue 4 - Solid waste management: With growing population and economy of the urban regions in the state, generation of municipal solid waste is on the rise. The usage of plastics is despoiling the landscape, blocking drainage systems, and affecting health of animals. There is a need to ensure proper collection, segregation, processing and disposal of solid waste.

Issue 5 - Public transport: Most of the cities of Rajasthan do not have an efficient public transport system, which has led to tremendous growth of private vehicles. An effective public transport system (based on cleaner fuels) depending on the city demand and characteristics is needed.

Issue 6 - Urban slums: Urban slums in Rajasthan are facing problems of inadequate drinking water, sanitation facilities, sewage conveyance, collection of solid waste etc. Hence, this section of society demands specific attention.

Issue 7 – Climate change risks: Climate change will be a stress multiplier in the urban environment, especially impacting sectors such as water and sanitation, health, energy and infrastructure, with the population residing in informal settlements and slums being at high risk. Urban areas are also a significant source of GHG emissions from fossil fuel consumption and solid waste generation. Hence, many of the actions to be implemented herein are also required from the perspective of addressing climate change concerns in urban development.

Table 6 lists an action plan to ensure sustainable urban development.

Table 6 Action Plan for Urban Governance and Sustainable Habitat

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
I. Integrating environmental aspects into urban planning				
Landuse planning	Formation of Land-use committees -Preparation of master plans for the upcoming towns on a proactive manner which includes : • Evaluation of 2 alternative models *(High rise, high density, mixed landuse and intensive public transport v/s Low rise, low density, segregated landuse relying primarily on private vehicles)* • Planning of settlements with a view to minimize energy consumption in transportation, power and water supply	2010	UDH to form landuse committees having members from different sectors at district levels to ensure scientific and sustainable planning of land-use	XIth plan funds from UDH
	Out of the 183 municipal towns, master plans of 62 towns have been prepared. Focus should be laid on remaining towns for proactive urban planning	2010	Town planning department, City development authorities	
	-Need to regulate the conversion of agricultural lands outside the Master plan to other land-uses and also to check illegal land use in Master Plan areas.	2010	UDH to improve vigilance for checking illegal landuse and Municipalities to enforce penalties against the same	
	Promoting in-situ urbanization through empowerment and capacity building of PRIs and provision of dedicated revenue sources.	2010	UDH and Department of Panchayati Raj needs to promote in-situ urbanization (among rural areas around the existing clusters and urban slums) to reduce the pace of rural to urban migration	Funds from UDH and Department of Panchayati Raj
	Comprehensive study of the landuse patterns that may be influenced by climate change e.g. drainage, water supply, locations of settlements.	2010	Department of Urban Development and Housing (UDH);and Local Self Government (LSG)	Commission on urbanization announced in the state budget for the year 2010-2011
Green Buildings	Incorporate and enforce Green Building norms in the municipal building codes	2010	UDH	Builders to fund. Possibility of assistance from concerned departments e.g. GWD, RREC for constructing green buildings e.g. for rainwater harvesting structures, solar based appliances
	Enhance usage of renewable energy for urban energy needs, e.g. using solar power for road traffic signals, water heating.	2010	Department of Urban Development and Housing (UDH); Dept. of LSG; Rajasthan Renewable Energy Corporation (RREC)	

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
II. Improving water management				
Water zoning	Water Zoning of the state should be carried out. Developmental activities should be guided and regulated in accordance with such zoning	2010	PHED in coordination with research institutes	XIth plan funds
Water supply	Improving coverage and quality of drinking water supply across cities	2010	UDH with PHED	-UIDSSMT, RUIDP , PPP models -recovery of investments made in the water supply infrastructure and O&M is to be made through water bill
	Reducing the losses in the conveyance system, modernisation and rehabilitation of existing systems, recycling of treated sewage/effluents (wherever feasible)	2010	PHED	Enhanced penalties for water thefts
	Conservation of water to improve the efficiency of utilisation and conservation consciousness in the state. Further, regulations and fiscal measures to be employed for the same.	2010	PHED	-XIth plan funds for capacity building and awareness -Rationalisation of tariffs
Ground water management	Ground water use in the urban areas should be strictly regulated and possibility of ground water tariff may be explored. Possibility of artificial recharge needs to be explored. A survey should be carried out to assess the potential of rain water harvesting in urban buildings and actions to be taken accordingly.	2012	Ground water department (GWD), City development authorities , UDH, Local bodies	-Special charges (disincentives) for using GW in a over-exploited zone -Incentives for buildings constructing rain water harvesting structures
III. Improving sanitation, sewerage and sewage treatment				
Sanitation	Provision of proper sanitation facilities and public toilets	2010	Municipal corporations	JNNURM and IHSDP schemes to be tapped
	Awareness generation to promote a change from open defecation to fixed spot defecation	2010	Municipal corporations	
Sewerage and sewage treatment	Improve sewerage networks and commission projects for sewage treatment	2010	UDH, PHED, Local bodies	RUIDP -Recovery of investments[1] made in the sewerage, and sewage treatment infrastructure and O&M, is to be made through water bill.

[1] @ 25 lakhs per MLD of sewage treatment infrastructure, about 200 crores is required for treating the total sewage generated in the urban centres of the state (assuming 70 lpcd water supply for urban population of 132 lakhs)

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
	Ensure proper O&M of STPs and sewerage systems	2010	Local bodies	Recovery of investments made in the sewerage, and sewage treatment infrastructure and O&M, is to be made through water bill
IV. Improving solid waste management				
Municipal solid waste	Develop and implement viable PPP models for setting-up and operating secure landfills, composting plants, waste to energy projects and other appropriate techniques for MSW treatment.	2012	Local bodies and UDH	JNNURM, RUIDP[1] The cost (capital and O&M) of solid waste management to be recovered through house tax.
	Strengthening of informal collection and recycling sector by reviewing the municipal laws and policies to enable registration of societies of recyclers to operate within the framework of law	2010	Local bodies	access to institutional finance and relevant technologies
	Proper implementation of "Recycled Plastics Manufacture and Usage Rules, 1999 and amended 2003"	2010	Municipal Corporations, RSPCB	XIth and XIIth Plan Funds
Bio-medical waste	-Inventorisation of Bio-medical waste and E-waste.	2010	RSPCB with research institute	RSPCB funds
	-Common bio medical waste treatment facilities (CBWTF) should be developed in all the major cities.	2012	RSPCB to implement the MoEF BMW rules	involvement of private sector
V. Managing air emissions from urban transport				
Public transport	Major augmentation of public transport system - By Transport Department -SPV may be formed based on PPP model where in Government, local administration, operators are involved.	2010 2012	Transport department, UDH and Development authorities	[2]Leveraging the JNNURM funding mechanism. Public-private partnership models as in case of Indore: Project outlay generation 50% : JNNURM 20%: State Govt. 30% : generated by SPV through PPP and some contribution by local administration

[1] Cost of Landfill : @ Rs 100/MT (+Rs 300/MT for SLF) Operating Cost of waste to energy projects : Rs 1000 /MT

[2] For category II cities (population 5-10 lakhs):about Rs 2000 crores for bus transport along major corridors, flyovers/under passes, pedestrian subways, off-street parking facilities, ITS, mofussil bus terminals and truck terminals, intra city road network, bye-passes, and ring-roads, traffic improvements, NMT management, Parking spaces for IPT.
For category III cities (population 10-40 lakhs): about Rs 7000 crores for development of low to medium capacity mass transit system in addition to the facilities developed under category-II. (Ministry of Urban Development)

Priority Area	Action	Timeframe (start year)	Responsible Agency	Existing policy/schemes/ sources of financing
Non-motorised transport (NMT)	Promotion of NMT by addressing the safety concerns and construction of segregated rights of way, controlling encroachments, designating non-motorized vehicle/pedestrian zones/ lanes.	2012	Transport department along with Local bodies	XIIth plan funding from Transport department and Local bodies
Cleaner fuels	Promotion and use of cleaner fuels such as ULSD/CNG/Electric vehicles -to work out a road map for provision of BS-IV fuel in the state.	2010	Directorate of Petroleum and Transport department	-Oil companies and automobile industry should plan the finances and other operational requirements.
	-Public transport in the state has to be based on cleaner fuels such as ULSD/CNG/Electric vehicles	2012	Directorate of Petroleum and Transport department	-XIIth plan funds from Transport department and Directorate of Petroleum[1]
Air pollution from older vehicles	-Immediate: Impose entry restrictions on old commercial vehicles (especially in congested zones)	2010	Transport department along with traffic police	
	-Medium term: commission an effective inspection and maintenance (I&M) system	2012	Transport department along with traffic police	Investments[2] in I&M are recoverable through revenues generated from testing of vehicles.
Travel demand management	staggering of office, school, and factory hours; minimum ridership requirements in peak hours; encouraging private bus service provision for public use, etc.	2010	Transport department along with traffic police	
	City by-passing of transit commercial vehicles	2012	Transport department along with traffic police	-Funds from XIIth plan -Capital expenditure on construction of by-passes to be recovered using toll taxes.
Efficiency in transportation of goods	Shift in pattern of transporting goods example from trucks to railways, wherever feasible	2010	Department of Urban Development and Housing (UDH) and LSG	
VI. Slum improvement				
In-situ rehabilitation	provisions of infrastructural services such as safe drinking water, sanitation, solid waste management.	2010	UDH	JNNURM and IHSDP schemes to be tapped
VII. Improving urban governance				
Reform of Urban Local Bodies	Strengthening of financial and technical capacities of local bodies	2010	Local bodies and LSG department	Reforms as per JNNURM requirements

[1] Laying of 68 km natural gas pipeline & associated facilities for Vijaipur-Kota Pipeline Project (Spread-II) at Rajasthan costs about 300 crores (i.e. Rs 4.5 crores/km. The estimates varied in between 2-4.5 crores/km for different projects

[2] 90 crores for installing I&M centers in 10 major cities of the state (Ballpark figure based on estimates of SIAM : 40 Lakh/lane for LDV and 55 lakh/lane for HDV, civil cost assumed to be additional 25%)

3.7 Human Health

Climate change is expected to affect human health in different ways, such as increased incidence of vector-borne, water-borne and food-borne diseases; malnutrition; injuries and deaths caused by extreme hydrological events, temperature extremes and heat waves. India's Initial NATCOM indicates that a 3.8°C increase in temperature and a 7% increase in relative humidity by the 2050s with reference to the present may lead to an increase in the transmission window for Rajasthan by three to five months as compared to the base year 2000. The problem is further complicated by crucial vectors like *Anopheles stephensi* forming micro-niche's which effectively reduces the chances of decrease in vector population due to increase in temperatures as is observed in the case of Rajasthan.

The key issues of concern for human health in Rajasthan with respect to changes in the climate include:

Issue 1: Weather conditions determine malaria transmission to a significant extent. In arid areas of western Rajasthan, malaria epidemics have often followed excessive rainfall and a similar strong correlation between rainfall and malaria incidences in most other districts of Rajasthan has been observed.

Issue 2: Other health impacts of climate stress in the state may manifest due to a decline in food production thus leading to malnutrition and under nourishment.

Issue 3: Temperature extremes and heat waves can also lead to mortality and exacerbating existing ailments such as heart diseases.

Table 7 lists an action plan to address climate-related human health concerns in Rajasthan.

Table 7 Action Plan on Human Health

Priority Area	Action	Time frame (start year)	Responsible agency
I. Develop high-resolution health database for climate impact studies			
Health data collection, monitoring & surveillance	▪ Study the regional pattern of climate-sensitive diseases & disease outbreaks ▪ Source high resolution climatic and regional disease pattern data Develop and maintain a digital climate-related health database at the block level	2010	IMD Department of Medicine & Health Services PHCs, hospitals
II. Develop high-resolution health impact models			
Obtain specific and integrated health impact models	▪ Source health impact modeling tools from WHO ▪ Procure/ develop/ customize health impact models ▪ Validate predictive modeling results with qualitative & quantitative assessments	2011	Department of Medical and Health Services

Priority Area	Action	Time frame (start year)	Responsible agency
Prioritization of regions based on epidemiological data & vulnerability indicators	▪ Assess regional vulnerability spatially & temporally, to diseases with respect to changes in the climate and enable adaptation & risk management in vulnerable areas ▪ Procure software such as MapInfo/ ArcInfo/ IRDIS for GIS-based analysis (vulnerability mapping and integrated impacts assessments) and image processing ▪ Assess the response of disease vectors to climate change ▪ Conduct quantitative assessment studies for malaria, dengue & chicken guinea	2012	Department of Medical and Health Services
III. Enhanced public health care			
Enhancement of primary, secondary & tertiary health care facilities	Better public health care measures including vector control, sanitation & supply of potable drinking water Effective monitoring & evaluation of endemic and epidemic areas with respect to climate change Upgradation of healthcare infrastructure to deal with emergencies during climatic extremes (such as droughts, floods, heat waves) Improving institutional capacity to undertake health adaptation in urban areas Establishment of early warning systems and evacuation plans including emergency preparedness in case of climatic extremes (such as heat waves) and anticipatory efforts	2010	Department of Medical and Health Services

3.8 Agriculture and Animal Husbandry

The agriculture sector contributes 27% to Rajasthan's Gross Domestic Product (GDP) and is critical to the economy of the state. The major land use is rainfed cropping with pearl millet as the main cereal crop and kharif legumes (clusterbean, moth bean, mung bean). Eastern Rajasthan falls in the semi-arid 500–1000mm annual rainfall zone and is intensively cultivated for pearl-millet/sorghum/ kharif pulses/maize–wheat/barley/mustard/rabi pulses. Agriculture in Rajasthan is likely to face several challenges in the light of increasing competition for resources, such as water, land and energy, from non-agricultural sectors, along with increasing food demand due to the rising population, increased use of fertilizers due to increased production demand and increased water withdrawals for irrigation from canals, wells and tube wells.

The contribution of animal husbandry to the GDP of the state is about 9.16%. Rajasthan ranks second highest in milk production in the country, amounting to nearly 17 lakh kg per day. More than 80% of the rural families keep livestock in their households. This sector provides self employment to majority of the households in rural and urban Rajasthan and supplements their

income and nutritional requirements. About 35% of the income of small and marginal farmers in the state is derived from dairy and animal husbandry; with this share being as high as 50% in the arid regions. Lack of proper feed and fodder and poor market linkages however affect the productivity in this sector. The sector has a high potential to create employment in rural areas with least investments as compared to other sectors.

Methane (CH_4) emissions from the livestock sector are mainly from enteric fermentation and manure management. With a livestock population of 49.14 million in 2003, the CH_4 emissions from enteric fermentation was 0.98 Tg and from manure management was 0.0911 Tg. Rajasthan is ranked second among all states in terms of highest methane emissions from the livestock sector. Hence there is a huge potential that exists to undertake mitigation activities in the state.

In terms of the impacts of climate change on agriculture and animal husbandry in the state some key issues have been identified.

Issue 1: Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall, but also by shifts in the timing of the rainfall. Altered rainfall patterns could affect the hydrological systems, agricultural production and productivity in the state, endangering local livelihoods and economy. Changes in precipitation patterns can also increase the likelihood of short-run crop failures and production declines.

Issue 2: Changes in temperature can affect crop yield and productivity by changes in plant physiology, soil properties (including nutrient availability), rate of evapotranspiration, pest dynamics and rate of weed proliferation.

Issue 3: Climate change poses formidable changes to the livestock sector as well. Though the vulnerability of farm animals to climate change varies with genetic composition of the livestock, type and breed, life stage and nutritional status, studies unambiguously indicate that the performance of farm animals is sensitive to the climate. The heat stress in dairy animals is likely to impact their productive and reproductive performance. Furthermore, reduction in feed and fodder availability due to changes in the climate, can also affect livestock productivity.

To address these issues in the light of climate change, Table 8 lists out the action plan for Agriculture and Animal Husbandry in Rajasthan.

Table 8 Action plan for Agriculture and Animal Husbandry

Priority Area	Action	Time frame (start year)	Responsible Agency
I. Dryland agriculture			
Promotion of rainfed agriculture techniques	▪ Boost agricultural productivity in drylands ▪ Watershed development & soil conservation ▪ Promotion of low/ zero tillage, in-situ moisture conservation, raised bed, ridge furrow, mulching etc. ▪ Development of climate-hardy cultivars ▪ Exploring collaboration with international research institutes to develop & adopt dryland techniques ▪ Improved water use efficiency	2010	Dept. of Agriculture, Dept. of Water Resources
Promotion of efficient water use practices and better irrigation infrastructure	Installation of sprinklers on all operational wells depending on region and crop-type	2012	Dept. of Agriculture, Dept. of Water Resources
Fodder development	▪ Increase and maintain green cover by reducing losses to agricultural lands due to grazing ▪ Eco-restoration of degraded lands	2010	Dept. of Animal Husbandry, Agriculture & Forests
Organic farming	▪ Use of sustainable & low-emission technologies ▪ Prepare organic farming modules to be disseminated through agri-extension, after conducting need-based studies for farmers	2010	Dept. of Animal Husbandry, Dept. of Agriculture. Forest Dept.
Soil improvement	▪ Improve land conditions for agriculture ▪ Reclamation of alkaline and saline soil ▪ Green manuring and organic farming	2010	Dept. of Agriculture
	Explore carbon sequestration potential of carbon-deficient soils	2012	Dept. of Agriculture
Promotion of energy efficient farm machinery	Reduce emissions from the agriculture sector Use of solar pump for drip irrigation	2010	Dept. of Agriculture, MNRE
II. Promoting access to information			
Providing agro-climatic information to the farming communities	▪ Harnessing potential crop productivity & allowing advance decision-making at the farm level ▪ Automated weather stations to be established at KVK level and dissemination of information to farmers on a faster mode	2010	IMD, SAUs, KVKs, Dept of IT & C
Popularization of Package of Practices upto the village level	▪ Technology development, deployment and demonstration ▪ Village adoption, development of model technology units at KVKs, knowledge centres in villages, information on suitability of cropping patterns under a changing climate	2010	IMD, SAUs, KVKs, Dept of IT
Increased efficiency of feed utilization by livestock	▪ Creating and disseminating awareness in farming community ▪ Improved animal feeding technology modules	2010	Dept of Animal Husbandry & Dept. of Agriculture

Priority Area	Action	Time frame (start year)	Responsible Agency
Assessment of relation between climate change and animal health	▪ Assessment of epidemiology of climate-sensitive diseases of livestock ▪ Conduct studies to identify linkages between climate & animal- based products production	2012	Dept of Animal Husbandry & Dept. of Agriculture
Vulnerability assessment	▪ Understanding factors that contribute to vulnerability of the agriculture sector to climate impacts ▪ Preparation of state-level vulnerability atlases	2010	
III. Use of biotechnology			
Use of biotechnology for development of climate-hardy cultivars and livestock	▪ Enhancing crop productivity and nutrition ▪ Development of climate-hardy cultivars ▪ Ensure buffer stock of Certified Seeds ▪ Providing a buffer Stock of Certified Seed by RSSC	2010	Dept. of Agriculture, Dept. of Land Resources, Dept. of Irrigation, District Horticulture Development Society Dept. of Agriculture
Livestock breeding	▪ To breed climate-hardy livestock ▪ Breeding of climate-hardy livestock and development of nutritional strategies to prevent heat stress and productivity losses	2012	Dept. of Agriculture and Animal Husbandry
IV. Risk management			
Weather-based Crop insurance	Weather-based crop insurance schemes	2010	Dept. of Agriculture
Livelihood support	▪ Maintain household incomes during lean years through livelihood diversification ▪ Enhance support to credit-linked self employment schemes	2010	Dept. of Agriculture, Dept. of Rural Development
Vulnerability and integrated impacts assessment	▪ Identification of regions at high vulnerability ▪ Conduct integrated impacts and vulnerability assessment studies in different agro-ecological regions of Rajasthan	2010	Dept. of Agriculture
Early warning	▪ Reduce risks to the agricultural sector due to droughts ▪ Develop early warning systems for drought based on weather and climate forecast	2010	Dept. of Agriculture
Drought contingency planning	▪ Risk reduction to droughts ▪ Developing and implementing region-specific contingency plans based on regional vulnerability to climatic stress	2010	Dept. of Agriculture, Dept. of Rural Development
Providing an enabling policy environment for technology deployment	▪ To support technology uptake at the farm level ▪ Providing financial support and subsidies to enable farmers to invest in and adopt relevant technologies to overcome climatic stresses	2010	Dept. of Agriculture, Dept. of Rural Development

3.9 Enhanced Energy Efficiency, including Solar Energy

One of the key priority areas to address climate change mitigation is improving the energy efficiency of the state. In this response the Rajasthan Renewable Energy Corporation (RREC) has, under the guidelines of Bureau of Energy Efficiency (BEE), been conducting a survey of government buildings for energy efficiency, energy auditing, energy conservation measures for designated consumers, installing solar water heating systems in private establishments, etc. Further the Rajasthan Discoms are promoting the use of Compact Fluorescent Lamps (CFLs) for street and domestic lighting; energy efficiency pump sets; providing tariff concession on solar water heaters; minimizing distribution losses; using new and efficient technologies like super critical boiler technology and integrated gasification combined cycle for thermal power projects. Jaipur Discom is also implementing a Lighting Energy Efficiency project for domestic consumers under the Bachat Lamp Yojna of BEE, Government of India. Further the investments made will be recovered by reducing carbon dioxide emissions and earning CERs (carbon emission reduction) credits under the CDM (clean development mechanism). In all, 10 lakh bulbs will be replaced, which shall reduce the peak demand by 60 MW and save 80 million units of electricity. The government is also in the process for establishing energy consumption benchmarks for energy-intensive industry sectors in the state by setting up time-bound program for energy conservation and energy-efficiency in these sectors.

Issue 1: Climate change mitigation presents a huge opportunity for the state of Rajasthan to exploit its solar energy potential. The state has a vast potential for power generation from non-conventional energy/ renewable energy sources like wind, solar and biomass. The state receives maximum solar radiation intensity in India. In addition the average rainfall (hence number of overcast days in a year) is least in the state as compared to the rest of the country; therefore it's best suited for solar power generation. It also has land available in abundance at a very minimal cost. Therefore, Rajasthan is likely to emerge as the preferred destination for setting up installed capacity, which may eventually exceed 100,000 MW. In order to promote solar energy in the state the Rajasthan Renewable Energy Corporation (RREC) has taken many initiatives which include, implementing rural electrification and SPV (Solar Photo-Voltaic Cell) program, remote village electrification (RVE), solar photo-voltaic power plant (grid interactive) program etc.

Issue 2: Apart from promoting renewable energy and addressing energy security concerns there is a need to tap the co-benefits by reducing GHGs. The Rajasthan Electricity Regulatory Commission (RERC) has prescribed maximum capacity to be installed from wind power projects as 1890 MW by year 2011-2012 and from biomass as 214 MW by 2011-2012. The government under it's 'Policy for promoting Generation of Electricity through Non- Conventional Energy Sources, 2004' is also taking other initiatives to promote renewable energy sources, which includes giving incentives viz. exemption from electricity duty, special incentives for industries, single window clearance., allotment of land on concessional rates etc.

To address these issues and tap potential opportunities in the light of climate change, Table 9 lists out the action plan for Enhanced Energy Efficiency and utilization of Solar Energy in Rajasthan.

Table 9 Action plan for Enhanced Energy Efficiency and utilization of Solar Energy

Priority Area	Action	Time frame (start year)	Responsible agency
I. Promotion of energy efficiency			
Survey/ audit of buildings for energy efficiency	Reduction of GHG emissions Conduct survey of residential and commercial buildings for: ▪ Energy efficiency ▪ Energy audit ▪ Energy conservation	2010	RREC, Dept. of Energy, DISCOMs, RVPN
Energy efficiency in power distribution	Energy savings and GHG reduction DISCOMs to promote use of: ▪ CFLs ▪ Energy efficient pump sets for agricultural ▪ Use of environmentally friendly solutions like biomass gasification in the MSME sector. Target MSME clusters could be that of dyeing plants, food processing units, guar gum plants etc. DISCOMs to reduce loss in distribution system by: ▪ Use of High Voltage Distribution System (HVDS) ▪ Small energy efficient transformers ▪ Strengthening distribution lines ▪ Schemes for reduction of distribution losses by using amorphous core transformers	2010	RREC, Dept. of Energy, DISCOMs, RVPN
Energy conservation	Understanding current energy situation and promoting conservation ▪ Conducting a demand assessment ▪ Capacity building and awareness amongst consumers ▪ Financial assistance for strengthening database and RREC's initiatives for energy conservation ▪ Inclusion of more categories of users for mandatory installations	2010	RREC, Energy Department
Energy conservation in buildings	Implementing the energy conservation building code (ECBC) To build capacity for implementing ECBC	2010	RREC, Energy Department
Promotion of sustainable technologies	Use of environmentally-sound and low-carbon technologies ▪ Promoting the implementation of super-critical boiler technology in thermal power plants ▪ Promoting biogas power plants for rural electrification/ decentralized electrification Deployment of Integrated Gasified Combined Cycle (IGCC) in thermal power plants	2010	Dept. of Energy, RVPN

Priority Area	Action	Time frame (start year)	Responsible agency
II. Promote solar energy utilization			
Decentralized Electrification using Solar Photo-Voltaic	▪ Installation of domestic lighting system (DLS), street lighting system (SLS) and SPV water pumping sets in remote areas with assistance from state government and MNRE(Ministry of New and Renewable Energy) ▪ Solar power generation in urban areas, promotion of Solar Cities ▪ Installation of SPV power plants in rooftops of public offices to encourage adoption of non conventional energy sources	2010	RREC, Energy dept. (GoR), MNRE
Solar Power Generation in Urban Areas	▪ Exploiting regions of high solar energy, like Jaisalmer, Jodhpur and Bikaner for utility-scale, large scale power generation. These cities are being developed under the National Solar Mission program for setting up large scale Solar Power Projects ▪ Developing Land Banks for Solar power plants for meeting the land requirement required for setting up new projects. Land Banks have been developed in Jodhpur, Barmer, Bikaner, Jalore. Land Banks are being developed in Churu and Nagaur districts	2010	Municipal Corporations, state govt., ULBs, BEE,
Energy Mix	To ensure MW scale grid Interactive electricity generation from Solar Energy MW scale solar power projects to be developed under the phase I of the National Solar Mission	2010	RREC, Department of Energy
Regulatory Measures	▪ 'Feed-in' tariffs for solar power, initially at the level of cost of generation from diesel based power, with the tariff reducing linearly each year for the new plants, to reach grid parity ▪ Solar and renewable portfolio standard for the State grid, initially at 5% of total grid supply, increasing by 1% a year till 2020, when the scheme may be reviewed. Combinations of these measures may also be considered, e.g. a renewable portfolio standard with competitive procurement, with the notified feed-in tariff applicable acting as a ceiling on bid price of renewable supply. ▪ Energy pricing for effective implementation ▪ Enable mini-grids and household systems to both draw and supply to the grid at applicable rates in each case	Long-term Long-term	RREC, Department of Energy RREC
Solar water heating	▪ Assessing the feasibility and promoting solar water heating ▪ Conducting survey for installing solar water heating system in private hospitals, resorts and nursing homes etc. ▪ Providing incentives for promoting solar water heating	2010	RREC

3.10 Strategic Knowledge for Climate Change

The National Mission on Strategic Knowledge for Climate Change identifies the need for research in specific areas of climate science to better understand the climate processes impacting the state. The key areas for action that the National Mission lists out are also very relevant for the state of Rajasthan. These include:

- Strengthening observational networks and develop a climate database, while ensuring access to historical spatial and temporal (time-series) sets of climate data
- Climate modelling tools and techniques to develop high resolution regional scenarios
- Setting essential infrastructure for high performance computation, data storing and sharing for climate scientists.

Table 10 Action plan for Strategic Knowledge on Climate Change

Priority Area	Action	Time frame (start year)	Responsible Agency
I. Climate modeling and observational database			
Data Collection and Monitoring	Access to historical spatial and temporal (time-series) sets of climate data and improvement of observational network over the state ▪ Creation of Climate database ▪ Development of observation network by employing Automatic Weather Stations(AWS) on a higher spatial grid to acquire both spatially and temporally high resolution weather data for further assessments	2010	Department of science and Technology , Department of Information Technology & Communication
Climate modelling tools and techniques	▪ Acquisition of modeling tools like RCMs and Weather forecasting models ▪ Training of state officials, research institutions and universities for capacity building ▪ Forecasting for droughts, heat-waves and extreme rainfall events		
II. Education and training			
Education and training for mass awareness	▪ Creation of knowledge hubs ▪ Facilitate national and international collaborative networks and exchange of research by conducting national and international education fairs, conferences, discussions, seminars and symposia ▪ Conduct awareness campaigns for communities, NGOs, schools, colleges, government officials, policy makers etc. through use of Information and Communication (ICT) tools	2012	Department of science and Technology , Department of Information Technology & Communication
III. Climate impact research and development			
Development of hard and soft skills	▪ Setting up dedicated facilities for climate change R&D ▪ Climate budget to provide financial resources for R&D ▪ Setting essential infrastructure for high performance computation, data storing and sharing for climate scientists. ▪ Develop regional climate projections for different socio-economic scenarios and their impact assessment for the region specific for policy implications	2012	Department of science and Technology , Department of Information Technology & Communication

Climate Change Agenda for Rajasthan (2010-2014)

2010

List of Acronyms

AR	Artificial Recharge
BCM	Billion Cubic Meter
BEE	Bureau of Energy Efficiency
BRTS	Bus Rapid Transit System
CAMPA	Compensatory Afforestation Management and Planning Authority
CCDU	Communication and Capacity Development Unit
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFLs	Compact Fluorescent Lamps
CNG	Compressed Natural Gas
CSTDF	Common Treatment, Storage and Disposal Facility
CWC	Central Water Commission
DLS	Domestic Lighting System
ECBC	Energy Conservation Building Code
ET	Evapo-Transpiration
GBI	Generation Based Incentive
GCM	Global Climate Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GRIHA	Green Rating for Integrated Habitat Assessment
GW	Ground Water
GWD	Ground Water Department
HDPE	High Density Polyethylene
HVDS	High Voltage Distribution System
ICT	Information and Communications Technology
IGCC	Integrated Gasified Combined Cycle
ILWIS	Integrated Land and Water Information System
IMD	Indian Meteorological Department
IWRM	Integrated Water Resources Management
KVK	Krishi Vigyan Kendra
LSG	Local Self Government
JFM	Joint Forest Management
NAPCC	National Action Plan on Climate Change
NATCOM	National Communications
NGO	Non Governmental Organization
NREGA	National Rural Employment Guarantee Act
NSM	National Solar Mission
MSME	Micro, Small and Medium Enterprises
MoWR	Ministry of Water Resources
MRTS	Mass Rapid Transit System
MSW	Municipal Solid Waste
O&M	Operation and Maintenance

PHED	Public Health Engineering Department
PPP	Public-Private Partnership
PRI	Panchayati Raj Institution
PVC	Poly Vinyl Chloride
R & D	Research and Development
RBO	River Basin Organization
RCM	Regional Climate Model
RERC	Rajasthan Electricity Regulatory Commission
RIICO	Rajasthan State Industrial Development & Investment Corporation
RFBP	Rajasthan Forestry and Biodiversity Project
RREC	Rajasthan Renewable Energy Corporate
RSPCB	Rajasthan State Pollution Control Board
RVE	Remote Village Electrification
RVPN	Rajya Vidyut Prasaran Nigam
RWH	Rain water Harvesting
SAU	State Agricultural University
SHGs	Self Help Groups
SLS	Street Lighting System
SPV	Solar Photo Voltaic
SW	Surface Water
SWRPD	State Water Resources Planning Department
UDH	Department of Urban Housing and Development
UNFCCC	United Nations Framework Convention on Climate Change
ULBs	Urban Local Bodies
WHO	World Health Organization

1. Background

Climate change is a global challenge with diverse implications at the national and sub-national levels, through impacts on various sectors such as agriculture, water resources, forestry and biodiversity, human health, energy and infrastructure. Such diverse impacts require a range of strategies to be deployed in response and for better preparedness. These response strategies can be broadly classified as *Adaptation*- that is adjusting to the current and likely long-term risks and impacts of climate change and tapping potential opportunities that may arise; and *Mitigation*, that is reducing Greenhouse Gas (GHG) emissions from different sources.

In 2008, a National Action Plan on Climate Change (NAPCC) for India was released, setting eight priority missions to respond to climate change; these include National Missions on Solar Energy, Enhanced Energy Efficiency, Sustainable Habitats, Water, Sustaining the Himalayan Ecosystem, Greening India, Sustainable Agriculture and Strategic Knowledge for Climate Change, covering a range of actions including adaptation and mitigation. For the realization of these actions at the state level, it is essential to place state-specific risks, impacts and opportunities juxtapose the national priorities and Missions. In this context, preparation of the Rajasthan State Climate Change Agenda is an important beginning given that Rajasthan is the largest state in the country and that there are unique vulnerabilities associated with the state, due to exposure to climatic extremes, varying capacities to effectively adapt to the climatic risks, as well as large scale opportunities that the state can tap for mitigation (for example by harnessing solar energy).

2. Objective

The objective of preparing a Climate Change Agenda for Rajasthan is to list a set of state priorities for policy, research and implementation with respect to adaptation and mitigation for the time-period 2010-2014.

The development of the Rajasthan Climate Change Agenda has been directed by three guiding principles that include:

1. Consideration of national priorities identified in the National Action Plan on Climate Change,
2. Consideration of state- specific risks, impacts and opportunities under a changing climate, and
3. Consultations with State Government officials, non-government authorities, research institutions and academia including sectoral experts.

3. Approach

The approach followed for development of the Climate Change Agenda (2010-2014) for the state of Rajasthan includes the following steps:

Step 1: **Identification of key environmental stresses, risks and sectoral impacts of climate change in Rajasthan** through:-

(a) **Literature Review** of secondary information from:

- Peer-reviewed papers from national and international journals,
- Published national and state reports (including State of the Environment Report, State Development Report, State Human Development Report, State Planning Department documents, State of Forest Report etc.) and,

(b) **Review of existing programmes, policies and plans** relevant for climate change response in Rajasthan, including

- Details of relevant ongoing programmes, policies and projects from the Annual and Five Year Plans for Rajasthan, state policies for specific sectors (such as water, livestock, forest and transport) and consultations with State officials in the Government of Rajasthan and sectoral experts (details in Annexure)
- Review of plan documents collected during consultations with officials from various State departments.

Step 2: **Framing of Climate Change Agenda for Rajasthan**

Based on the analysis of the Missions identified in the NAPCC along with an understanding of the exposure of the state to environmental stresses, climatic risks and sectoral impacts of climate change, Task Forces as relevant in the context of Rajasthan have been identified.

Step 3: **Identification of priority areas for adaptation and mitigation action in Rajasthan with targets for 2010-2014**

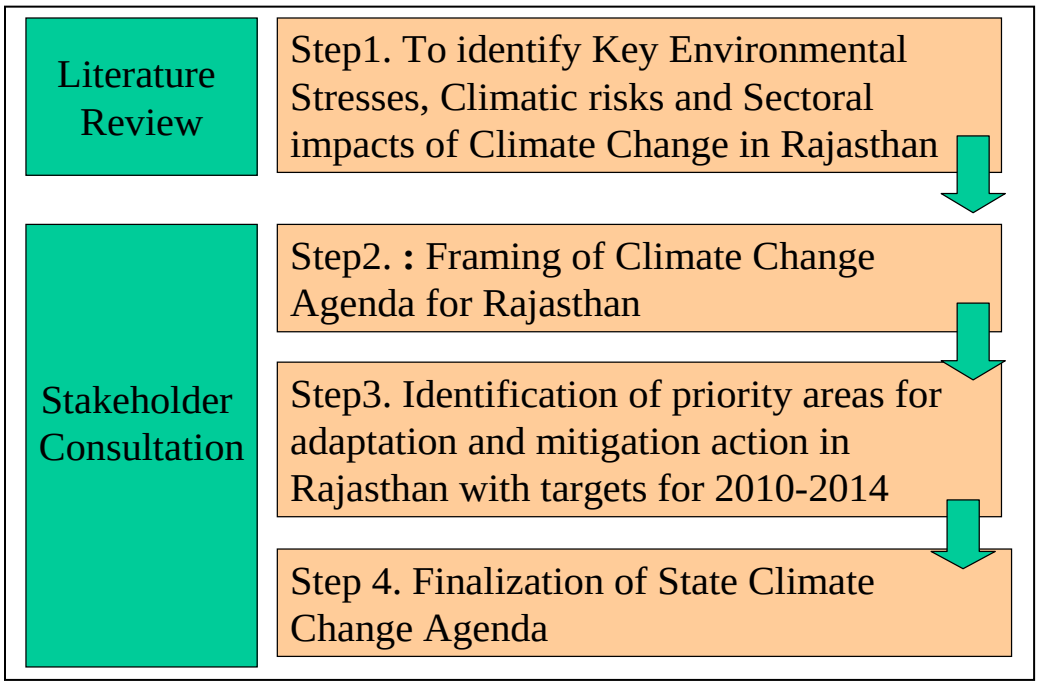
- Inputs from Step 1 and 2 have been used for identifying priority areas under each Task Force.
- Policy and regulatory measures, along with R & D needs have been specifically identified under each Task Force.

Step 4: **Finalization of the State Climate Change Agenda**

Based on inputs from steps 1, 2 and 3, State Task Forces have been formulated under the Climate Change Agenda with key strategies identified for research, policy and implementation

The preparation of the Agenda has involved an interactive and iterative process of stakeholder consultations. These include consultations with state-level government officials, non-government authorities, research institutions and academia, followed by expert inputs for review and finalization of the Agenda.

Figure 1: Summary of the approach



4. Climate change Impacts in Rajasthan

Located in the northwest part of the country, Rajasthan is the largest state in India with a geographical area of 3, 42,239 sq. km. Rajasthan has 5.5% of the country's population (56.51 million as per Census 2001), of which 77% reside in rural areas. The state has four major physiographic regions- the Western desert, the Aravalli hills, the Eastern plain and the South-Eastern plateau. The climate of the state varies from semi-arid to arid. The key sectors in which Rajasthan already faces challenges (due to pressures from a growing population, rapid economic growth and degradation of environment and natural resources) that are likely to exacerbate under conditions of change in the climate include:

- Surface and groundwater resources
- Agriculture and animal husbandry
- Forestry and biodiversity
- Human health

In the context of the state of the environment and natural resources, the sections ahead discuss the impacts of climate change on these key sectors in Rajasthan.

4.1 Water Resources

Rajasthan covers nearly 10.5 percent of the country's geographical area, with surface water resources in the state being only 1.16 percent of the country's available surface water. It is the driest state in India with nearly two-thirds of the land area classified as arid and semi arid. The average annual rainfall in the state is about 531 mm (about 318 mm in the desert areas) as compared to the national average of 1200 mm. There is only one perennial river in the state- river Chambal. Water resources in the state are not only scarce but also have a highly uneven distribution both temporally and spatially with most of it confined to the south and south-eastern parts of Rajasthan. The total surface water in the state is 21.71 BCM, out of which 16.05 BCM is economically utilizable. The state has so far harnessed 72% of the economically utilizable portion. There exists a huge deficit between water demand and supply in Rajasthan, nearly 8 BCM currently, which is likely to increase to 9 BCM by the year 2015. Droughts are rampant in Rajasthan. She Wale et al (2001) estimated the percentage area in India affected by moderate and severe drought and found (based on data analysis for a 124 year time-period, 1875- 1998) that the probability of occurrence of droughts was maximum in West Rajasthan. The probability of moderate drought in Rajasthan was found to vary between 17- 24%, and between 2-14% in case of severe drought.

Rajasthan is principally dependent on groundwater for meeting nearly 90 percent of its drinking water needs. Scanty and irregular rainfall coupled with over-exploitation of the groundwater sources has resulted in poor groundwater recharge as compared to its extraction for various purposes, leading to a decline in groundwater levels across the state. The ratio of ground water extraction to its annual replenishment was 35% in 1984 and 138% in 2008. Geological factors combined with over -extraction have brought adverse changes in the geochemistry of groundwater in Rajasthan, often concentrating naturally occurring contaminants. Natural contaminants such as fluoride, nitrate and chloride salts have been found to be increasing in ground water in different parts of Rajasthan, making it unfit for drinking and posing serious health risks to communities extracting water from these contaminated aquifers.

The water resources in Rajasthan are not adequate to meet the rising water demands from the domestic, agriculture and industrial sectors; and climate change will act as an additional stressor to water availability in the state. Studies conducted as part of India's first National Communications (NATCOM) to the United Nations Framework on Climate Change (UNFCCC) indicate that some river basins in India are likely to face an overall reduction in the quantity of the available runoff under a climate change scenario (increased GHG), projected for the period 2041- 2060. The west-flowing rivers of Kutch, Saurastra and Luni which occupy about 60 per cent of the area in Rajasthan are likely to face conditions of acute water stress. The river basin of Sabarmati is likely to experience constant water shortage. Increase in evapo-transpiration for the state of Rajasthan has been identified as one of the key impacts of climate change on water resources.

4.2 Agriculture and Animal Husbandry

The agriculture sector contributes 27% to Rajasthan's Gross Domestic Product (GDP) and is critical to the economy of the state. The major agricultural land use is rainfed_cropping with pearl millet being the main cereal crop along with kharif legumes (clusterbean, moth bean, mung bean). Eastern Rajasthan falls in the semi-arid, 500–1000mm annual rainfall zone and is intensively cultivated for pearl-millet/sorghum/ kharif pulses/maize–wheat/barley/mustard/rabi pulses. Agriculture in Rajasthan is likely to face several challenges in the light of increasing competition for resources such as water, land and energy, from non-agricultural sectors, along with increasing food demand due to the rising population, increased use of fertilizers due to increased production demand and increased water withdrawals for irrigation from canals, wells and tube wells.

The contribution of animal husbandry to the state GDP is about 9.16%. Rajasthan ranks second highest in milk production in the country (amounting to nearly 17 lakh kg per day). More than 80% of the rural families in Rajasthan keep livestock in their households. This sector is a source of self employment to majority of the households in rural and urban Rajasthan and supplements their income and nutritional requirements. About 35% of the income of small and marginal

farmers in the state is derived from animal husbandry, with this share being as high as 50% in the arid regions. Lack of proper feed and fodder and poor market linkages however, affect productivity in this sector. This sector has a high potential to create employment in rural areas with lesser investments as compared to other sectors.

Agriculture will be adversely affected not only by changes in the overall amounts of rainfall, but also by shifts in the timing of the rainfall. Changes in climatic variables such as temperature and precipitation, increased incidence of droughts and intensification of water- scarce conditions can adversely impact state agricultural production and productivity owing to changes in the hydrological cycle, changes in plant physiology, soil properties (including nutrient availability), rate of evapo-transpiration, pest dynamics and rate of weed proliferation. Changes in precipitation patterns can also increase the likelihood of short-run crop failures and production declines.

Climate change poses formidable challenges to the animal husbandry sector as well. Though the vulnerability of farm animals to climate change varies with their genetic composition, type and breed, life stage and nutritional status, studies unambiguously indicate that the performance of farm animals is sensitive to the climate. Heat stress in dairy animals is likely to impact their productive and reproductive performance. Reduction in feed and fodder availability due to changes in the climate can also affect livestock productivity. During droughts, livestock play a larger role in supporting the income and sustaining the rural population. However, under conditions of declining water and fodder availability, the contribution of this sector to household incomes of farming communities declines drastically.

4.3 Forestry and Biodiversity

Out of the total geographical area of Rajasthan, only 9.56% is forest land. Of the total forest cover, 38.16% is categorized as reserve forests, 53.36% as protected forests and the remaining 8.48% as unclassified forests. The forest ecosystems of Rajasthan are characterized by arid and scanty vegetation. Reduction in forest cover, rapid change of dense forests into open scrubs and desertification are few of the major concerns that Rajasthan faces at present. Increasing pressure from humans (including sanctioning of forest land for mining) and livestock has lead to indiscriminate exploitation of forest resources and degradation of forest lands that hold the fertile soil together, leading to desertification.

Changes in climatic variables can cause shifts in forest types, endanger livelihoods of forest-dependent communities and lead to changes in species habitats and diversity. Exploitation of forests coupled with occurrence of dry climatic conditions in the state can create favourable conditions for outbreak of forest fires, destroying the carbon sinks and releasing large amounts of GHGs into the atmosphere.

4.4 Human health

Climate change can affect human health in different ways, such as increased incidence of vector-borne, water-borne and food-borne diseases; malnutrition; injuries and deaths caused by extreme hydrological events, temperature extremes and heat waves. Weather conditions determine malaria transmission to a significant extent. In arid areas of western Rajasthan, malaria epidemics have often followed excessive rainfall and a similar strong correlation between rainfall and malaria incidences in other parts of Rajasthan has been observed.

India's Initial NATCOM indicates that a 3.8°C increase in temperature and a 7% increase in relative humidity by the 2050s may lead to an increase in the transmission window for Rajasthan by three to five months, as compared to the base year 2000. The problem is further complicated by vectors such as *Anopheles stephensi* forming micro-niche's which effectively reduces the chances of decrease in vector population due to increase in temperatures, as has been reported in Rajasthan. Other health impacts of climate change may manifest in the form of malnutrition and under nourishment due to a decline in food production. Temperature extremes and heat waves can also lead to mortality and exacerbate existing ailments such as heart diseases.

4.5 Greenhouse gas emissions in Rajasthan

The total CO_2 emitted by the state's transport sector stands at 15.17 teragram (Tg equals 10^{12} grams or equivalent to a megatonne) which is 6.22% of the total CO_2 emitted by India. Methane (CH_4) emissions from the livestock sector are mainly from enteric fermentation and manure management. With a livestock population of 49.14 million in 2003, the CH_4 emissions from enteric fermentation was 0.98 Tg and from manure management was 0.0911 Tg. Rajasthan ranks second in terms of highest methane emissions from the livestock sector in India. Hence there is a huge potential that exists to undertake mitigation activities in the state.

The next section details out seven State Task Forces for Rajasthan in response to current and likely future impacts of climate change.

5. Climate Change Agenda for Rajasthan (2010-2014)

In view of the criticality of addressing the risks posed by climate change along with the imperatives of poverty alleviation and economic growth for India, the NAPCC 'identifies measures that promote development objectives while also yielding co-benefits for addressing climate change effectively'. The NAPCC provides a roadmap that can guide states to identify their specific vulnerabilities and opportunities and prioritize a set of strategies for the state. In the context of Rajasthan, keeping in view the vulnerability of the state to climate change impacts and the potential for adaptation and mitigation needs, it becomes important for Rajasthan to address climate change issues within its developmental agenda.

The Climate Change Agenda for the state of Rajasthan will focus on the following Task Forces:

1. Water Resources
2. Agriculture and Animal Husbandry
3. Forestry and Biodiversity
4. Human Health
5. Enhanced Energy Efficiency and Solar Energy
6. Urban Governance and Sustainable Habitats
7. Strategic Knowledge for Climate Change

For each Task Force, certain Research and Development (R&D) needs as well as supporting policy and regulatory measures have been identified. Tables presented after each Task Force summarize the areas of action under each, including the start year of operationalizing these actions.

Water Resources

Rajasthan is one of the pioneer states in India exemplifying traditional ways of dealing with water scarcity through measures such as construction of *Khadins, tankas, bawris* and village ponds etc. for rainwater harvesting. Similar traditional practices and structures of water harvesting need to be revived and maintained. Artificial recharge of groundwater along with appropriate policy regime to regulate groundwater utilization in the state needs to be implemented. A real-time database for monitoring groundwater and surface water needs to be developed to assess flow changes over time and enable planned adaptation strategies for the state. Integrated impacts assessment using regional climate model scenarios at the basin level should be developed. In the light of the current vulnerabilities and projected impacts of climate change on the water sector, an integrated strategy for rainwater harvesting and drought management needs to be developed for the state. An Integrated Water Resource Management

(IWRM) strategy should be adopted at different levels. To enable the optimum utilization of water resources, demand side management should be promoted. Options to enhance water availability through infrastructural changes as well as supply-oriented measures such as desalinisation, water re-use etc. need to be identified.

The National Water Mission constituted six Sub-Committees to examine different dimensions related to water resource management, including Policy and Institutional Framework, Surface Water Management, Groundwater Management, Domestic and Industrial Water Management, Efficient use of water for various purposes and Basin level planning and Management. The priority areas for action in Rajasthan under the broader national priorities include;

1.1 Surface water management

1.2 Groundwater management

1.3 Domestic and industrial wastewater management

1.4 Basin level planning and management

1.1. Surface water management

Management of surface water is essential for maintaining water quantity and quality under a changing climate. Specific strategies include those that aim at raising the storage capacities, reducing water losses due to evaporation from agricultural and fallow lands, reducing loss of soil moisture, promoting treatment and reuse of wastewater and a better understanding of the state of the water resources to enable planned adaptation to climate change. Specific areas of action include:

1. **Augmentation and maintenance of surface water sources** through:
    a. Restoration and maintenance of traditional water storage structures such as *tankas, bawris, johads* etc.
    b. Revival and restoration of dry lakes
    c. Increasing live storage of large and minor dams through large-scale installation of gates, where feasible
    d. Promotion of drip/ sprinkler irrigation and use of High Density Polyethylene (HDPE)/Poly Vinyl Chloride (PVC) pipeline
    e. Reducing inadvertent evaporation from wastelands, fallow lands and agricultural lands through use of mulches, lining of canals etc.
    f. R & D needs
        i. Conducting studies on exploring the potential for evaporation reduction within water storage structures
        ii. Conducting studies on efficient crop-water application and utilization

g. Policy and regulatory measures

   i. Drought management while addressing equity concerns related to access to water

   ii. Managing water conflicts related to water access and sharing

   iii. Enabling community participation for management of surface water resources

2. **Periodic assessment of water resources** for a better understanding of water resources in terms of periodic data collection, assessment of the state of water resources for proactive disaster management and planned adaptation.

   a. R & D needs

      i. Setting up dedicated facilities with advanced computing systems to run Global Climate Models (GCMs) and Regional Climate Models (RCMs)

      ii. Establishment of a State Hydraulic Databank for the collection of climatic and hydrological data from a wide network of Automated Weather Stations and rain-gauge stations for climate and water research

      iii. Developing flood forecasting system for high discharge rivers.

      iv. Developing early warning systems for disaster management (droughts and floods)

      v. Flood-plain zoning to estimate relative risks and preparation of flood control and management plas for each flood-prone basin/area.

      vi. Conducting spatial and temporal assessment of basin-wise water availability

   b. Policy and regulatory measures

      i. Preparing contingency plans for drought management and flood control.

1.2 Groundwater management

Management of groundwater sources is essential to check its over-exploitation and promote natural and artificial groundwater recharge. Specific areas of action include:

1. **Demand side management** to maintain groundwater extraction to recharge balance by:

   a. Facilitating pressure irrigation methods such as drip and sprinkler irrigation

   b. Policy and regulatory measures

      i. Regulation of power tariffs for irrigation

      ii. Aquifer wise planning and setting of community organizations at the village level to plan and manage groundwater resources, with a focus on drinking water supply

2. **Augmentation of groundwater sources** to ensure groundwater availability under changing climatic conditions through:

   a. Restoration of traditional water harvesting structures

   b. R & D needs

      i. Evaluation of groundwater recharge potential with focus on water-stressed and over-exploited aquifers

      ii. Introducing automation in irrigation systems, including sensing of soil moisture in the root zone

      iii. Conducting groundwater exploration for deeper freshwater aquifers

      iv. Conducting hydro-chemical and solute transport modeling in areas facing groundwater stress

      v. Using isotope application in assessing transport of contaminants in groundwater

      vi. Development of groundwater basin models for conjunctive utilization of surface water and groundwater

      vii. Setting research institutes with state-of-the-art facilities for groundwater assessment and flow modeling with respect to changes in the climatic variables; and conducting related training and capacity building of human resources to use these models, tools and techniques.

3. **Increasing groundwater use efficiency** to promote judicious utilization of groundwater by:

   a. Water recycling

   b. Using treated wastewater for non-potable application

   c. Introduction of micro-irrigation where feasible

   d. R & D needs

      i. Assessing feasibility of conjunctive use of surface water and groundwater in major command areas to tackle problems of water logging

   e. Policy and regulatory measures

      i. Providing incentives for the construction of groundwater recharge structures,

      ii. Mandatory installation of water meters on pumped irrigation for all water users

      iii. Providing dual water supply system in all urban areas

1.3 Domestic and Industrial water management

Management of water used for domestic and industrial purposes is essential for increasing water use efficiency in the domestic and industrial sector and reducing water wastage. Specific areas of action include:

1. **Rainwater harvesting (RWH) and Artificial Recharge** (AR) in residential and commercial buildings by:
    a. Construction of rooftop RWH in all commercial and residential buildings in urban areas
    b. Promotion of AR structures
    c. R & D needs
        i. Assessing the feasibility and viability of rooftop RWH in existing and new commercial and residential buildings
        ii. Pre and post evaluation of existing AR initiatives for assessing the changes in groundwater table at a watershed level
        iii. Promoting international research collaboration for adoption and deployment of new AR technologies
    d. Policy and regulatory measures
        i. Encouraging Public-Private Partnerships (PPP) for RWH and AR
        ii. Preparation of a state-wise groundwater bill based on the model bill circulated by Central Ministry of Water Resources (MoWR) including guidelines for the implementation for RWH and AR
    e. Building awareness among all stakeholders on regular monitoring & maintenance of RWH structures, existing water conservation measures, building codes and by-laws for water conservation; including training of area *sabhas* & Self-Help Groups (SHGs) at the community level, Block Development Officers and village workers; building awareness on water-saving techniques through multi-media, school curricula and technical assistance
2. **Wastewater recycle and reuse** for non-consumptive purposes.
    a. R & D needs
        i. Creating a knowledge bank linking level of treatment and water quality for each reuse category, recommended best practices for appropriate technologies for different end uses of reclaimed wastewater
    b. Policy and regulatory measures
        i. Introducing amendments in existing bylaws making it mandatory to connect toilets to sewerage systems in residential areas
        ii. Implementation of benchmarks for use of reclaimed wastewater

iii. Providing incentives for industries and commercial establishments for reducing water consumption through use of recycled wastewater

3. **De-flouridation/ desalination** to augment water supplies in fluoride/ saline affected areas

4. **Minimization of water wastage** through

   a. Assessment of Unaccounted For Water

   b. R & D needs

      i. Procurement and installation of improved instrumentation (for monitoring pressure, leakage, flow, metering etc.) for monitoring water wastage and utilization

      ii. Explore the energy-efficiency potential of different water utilizing appliances and infrastructure

   c. Policy and regulatory measures

      i. Mandating water audit of water utilities and industries

      ii. Mandating water metering for water-intensive industries

      iii. Introducing appropriate incentives for water neutral or water positive technologies

      iv. Installing bulk revenue meters at relevant locations in the city water supply

      v. Promoting water efficient fixtures in buildings through campaigns and trainings

      vi. Encouraging PPP for labelling and marketing of water-efficient products

5. **Upgradation of infrastructure** for:

   a. water storage to increase capacity and efficiency (e.g. desilting of dams) and assess scope for additional cost-effective storage, including upgradation of drainage systems in urban areas to prevent water-logging and floods.

   b. water quality monitoring at intake, storage and delivery levels (including mobile labs) for checking contamination

   c. Building capacity of Urban Local Bodies (ULBs) to conduct comprehensive assessments of domestic water utilization and upgrade facilities in ULBs to check pressure, flow monitoring etc.

1.4 Basin level Planning and Management.

There is a need for development and management of water resources at the river basin level in Rajasthan. Specific areas of action include:

1. IWRM at the basin level through:

   a. Setting up of state-level multi-disciplinary, basin/sub-basin wise organizations

b. Creation of an information database comprising hydro-meteorological, hydrologic, socio-economic, demographic data and on parameters related to water quality and demand for integrated water resources planning and management.

c. R & D needs

   i. Development/ procurement of state-of-the-art technological tools (including Soil and Water Assessment Tool (SWAT), Integrated Land and Water Information System (ILWIS), ERDAS etc.) for preparation of basin/sub-basin level plans for assessment of flows and vulnerability at the basin level

   ii. Conduct studies on water balance along with variability in the hydro-meteorological parameters at the basin/ sub-basin level

   iii. Assessment of future scenarios of water stress with changes in water demand, land-use and flows

d. Policy and regulatory measures

   i. Creation of State River Basin Organization (RBO) and strengthening Central Water Commission (CWC) field units for basin-level data monitoring in the state

   ii. Implementation/ strengthening of community-based IWRM in drought-prone areas of the state.

The specific areas of action for Water Resources are summarized in Table 1.

Table 1: Areas of action on Water Resources

Priority Area	Action	Time frame (start year)	Responsible agency
I. Surface water management			
Augmentation & maintenance of sources	▪ Restoration and maintenance of traditional water storage bodies such as tankas & bawris, johads ▪ Revival and restoration of dry lakes ▪ Increasing live storage of large dams & minor dams through large-scale installation of gates, where feasible ▪ Promotion of drip/ sprinkler irrigation and use of HDPE/PVC pipeline ▪ Reducing inadvertent evaporation from waste lands, fallow lands, agriculture lands through use of mulches, lining of canals etc. ▪ Conduct studies on exploring the potential for evaporation reduction in storage structures	2010	WRD, IMD, GWD, PRIs

Priority Area	Action	Time frame (start year)	Responsible agency
	▪ Drought management		
Periodic assessment of water resources	▪ Research support for GCM & RCM runs integrated with surface water flows ▪ Establishment of State Hydraulic Databank ▪ Early warning for disaster risk reduction ▪ Flood forecasting system for high discharge rivers. ▪ Flood-plain zoning to estimate relative risks and preparation of flood control and management for each flood-prone basin/area. ▪ Spatial & temporal assessment of basin-wise water availability ▪ Prepare contingency plans for drought management and flood control	2010	WRD, IMD, GWD, Disaster management & Relief Dept.
	▪ Urban storm water drainage improvement	2010	Urban Development & Housing Dept.
Demand side management	▪ Facilitating pressure irrigation methods such as drip & sprinkler irrigation ▪ Regulation of power tariffs for irrigation ▪ Aquifer-wise planning for groundwater management	2010	GWD, SWRPD, Dept. of Irrigation, CAD & Water Utilization Dept.
II. Groundwater management			
Augmentation of groundwater	▪ Promote restoration of traditional water structures ▪ Evaluation of groundwater recharge potential with focus on water-stressed and over-exploited aquifers ▪ Automation in irrigation systems including sensing of soil moisture in the root zone ▪ Groundwater exploration to explore deeper freshwater aquifers ▪ Hydro-chemical and solute transport modeling in areas with groundwater stress ▪ Isotope application in assessing transport of	2010	GWD, PHED, ULBs, RLBs PRIs, SWRPD, Dept. of Irrigation

Priority Area	Action	Time frame (start year)	Responsible agency
	contaminants in groundwater ▪ Development of groundwater basin models for conjunctive utilization of surface water and groundwater ▪ Setting of research institutes with state-of-the-art facilities for groundwater assessment and flow modeling with respect to changes in the climatic variables		
Increasing groundwater use efficiency	▪ Water recycling, use of treated water for non-potable application, cultivation of salt-tolerant crops, micro-irrigation ▪ Incentives for construction of recharge structures, installing water meters on pumped irrigation for all water users, providing dual water supply in urban areas ▪ Assess feasibility of conjunctive use of SW and GW in major command areas	2012	WRD, Dept. of Irrigation, GWD
III. Domestic and Industrial wastewater management			
Rainwater harvesting	▪ Rainwater Harvesting (RWH) & Artificial Recharge (AR): Construction of rooftop RWH to be made mandatory in urban areas for all public establishments and plots covering >500 sq.m ▪ Preparation of state-wise groundwater bill including guidelines for RWH & AR ▪ Assess the feasibility & viability of rooftop RWH in existing commercial/ residential buildings	2012	CCDU, ULBs, State Development Agencies GWD, PHED, RLBs
Artificial recharge	▪ Wide scale promotion of artificial recharge structures such as anicuts, bunds, khadins, rapats and percolation tanks and devising water spreading methods in order to reduce soil erosion and gulley formations, conserve soil moisture ▪ Pre & post evaluation of existing AR initiatives to assess effect on GW table at the watershed level	2012	GWD, State Development Agencies, PRIs
Wastewater recycle & reuse	▪ Amendments in existing building by-laws making it mandatory to connect toilets to sewerage systems in residential areas ▪ Implementation of benchmarks for use of reclaimed wastewater for various purposes – irrigation, industrial use etc ▪ Providing incentives for industries and commercial establishments for reducing water consumption through wastewater recycling	2010	ULBs Ministry of Industries
Desalination/ deflouridation	Desalination/ deflouridation in water-saline areas such as Sambhar, Pachpadra & Deedwana	2010	PHED, DST, Dept of Rural Development

Priority Area	Action	Time frame (start year)	Responsible agency
Minimization of water wastage	▪ Comprehensive water audit of water utilities & industries ▪ Mandatory water metering for water intensive industries ▪ Procurement & installation of improved instrumentation (pressure gauges, leakage, flow measurement, metering etc.) ▪ Appropriate tariff and incentives for water neutral or water positive technologies ▪ Install bulk revenue meters at the relevant locations in city water supply ▪ Promote water efficient fixtures in buildings, encourage PPP in labeling and marketing of water-efficient products	2010	PHED, ULBs, WRD, RIICO, RSPCB
Upgradation of infrastructure	Upgrade capacities to undertake water quality monitoring at intake, storage and delivery levels (including mobile labs) , upgrade water drainage and storage capacities in cities	2010	ULBs
IV. Basin level Planning and Management			
Integrated Water Resources Management at the basin level	▪ Setting up of state level multi-disciplinary, basin/sub-basin wise organizations ▪ Creation of information database of data for integrated WR planning and management related to rainfall, groundwater, surface water, water demand etc. ▪ Development/ procurement of state-of-the-art technological tools (e.g. SWAT, ILWIS, ERDAS etc. for vulnerability assessment at the basin level ▪ Conduct studies on water balance at the basin/ sub-basin level along with variability in the hydro-meteorological parameters ▪ Assess future scenarios of water stress with changes in water demand, landuse and flows	2010	WR, PHED, GWD, relevant NGO partners, PRIs, IMD
	Creation of State River Basin Organization (RBO) and strengthening CWC field units for basin-level data monitoring in the state	2010	CWC, MoWR

5.2 Agriculture and Animal Husbandry

The National Mission on Sustainable Agriculture identifies four areas of research and policy action in the country. These include dryland agriculture, improving access to information, enhanced role of biotechnology and risk management in agriculture. Apart from ensuring sustainability in agriculture, Rajasthan also needs to invest in programmes that aim at increasing livestock production and enhancing livelihood support in rural areas. In this context, initiatives for infrastructure development to strengthen veterinary institutions, laboratories, diagnostic centres, education and learning are required. There is also a need to enable increased participation of Self Help Groups, Producers Cooperatives, Breeding associations and Village Committees through which extension knowledge, technologies and skills can be made accessible to local communities. The priority areas for action identified for Rajasthan under the broader national priorities include:

1. **Dryland agriculture** to tap and enhance the productivity from drylands and secure agriculture-based livelihoods. Specific areas of action for the state include:
    a. Promotion of dryland agriculture techniques such as low/ zero tillage, in-situ soil moisture conservation, raised bed, ridge furrow, mulching etc.
    b. Watershed development and management
    c. Development of efficient irrigation infrastructure to ensure judicious utilization of water
    d. R & D needs
        i. Enhancing crop productivity through development of climate-hardy cultivars i.e. crop varieties resistant to drought and heat stress
        ii. Exploring collaboration with international research institutes to develop and adopt resource-efficient dryland techniques
        iii. Exploring the carbon sequestration potential of carbon-deficient soils in the drylands of Rajasthan
        iv. Developing energy-efficient farm machinery to reduce emissions (e.g. solar pumps to replace diesel pumps for irrigation)
    e. Development of pasture lands and fodder stocks to reduce the pressure of grazing and browsing on agricultural lands. These can be developed through eco-restoration of degraded lands.
    f. Soil improvement through reclamation of alkaline and saline soil.
    g. Green manuring and organic farming can help reduce emissions from agriculture and promote judicious use of resources such as water
    h. Policy and regulatory measures

i. Providing subsidies for organic farming, purchase of energy-efficient farm machinery, climate-hardy seed varieties etc.

2. **Enhancing access to information** required to enhance productivity and reduce risks in agriculture and animal husbandry sectors. Specific areas of action include:

a. Providing agro-climatic information to farming communities, including agro-advisories, early-warning information against droughts and floods, information related to livestock health, crop prices, pasture development, agro-processing etc. Timely access to agro-climatic information can enable alterations in agronomic practices such as sowing dates, amount of agri-inputs, timing of irrigation, spacing of seeds etc. to reduce risks due to changes in climatic variables.

b. Popularization of Package of Practices (to minimize farm-level risks and improve crop productivity in response to changes in climatic variables) up to the village level

c. Providing improved animal feeding technology modules (for e.g. improving feed digestibility to reduce emissions from ruminants)

d. R & D needs

i. Establishing weather forecast stations to cover representative agro-ecological regions across the state

ii. Promoting pest and disease surveillance to capture changes in crop- pest activity with changes in climatic variables

iii. Conducting studies to assess the relation between climate change and animal health

iv. Preparing state-level vulnerability atlases integrating information on agro-climatic variables, land-use, socio-economic and demographic parameters, water resources, soil type etc. at the block level using tools such as Geographic Information System (GIS) and Remote Sensing.

e. Policy and regulatory measures

i. Conducting on-field training programmes for farmers to understand access of agro-climatic information through improved agri-extension and appropriate Information and Communication Technology (ICT) infrastructure

ii. Establish PPP between local and district level agencies, community based organizations and private sector including ICT service providers, agro-processing industries etc. to enable sharing of agro-climatic and market-based information to the farm level and reduce risks associated with climatic shocks and stresses.

3. **Enhanced role of biotechnology** in reducing risks to agriculture and allied sectors due to climate change and tapping potential opportunities under the new climatic conditions. Specific areas of action include:

    a. Development of climate-hardy cultivars that are tolerant to drought, thermal extremes, salinity and pests, and cultivars that can utilize water and nitrogen efficiently hence releasing lesser GHG emissions

    b. Breeding of climate-hardy livestock and development of nutritional strategies to prevent heat stress and productivity loss

4. **Risk management in agriculture**, including financial mechanisms such as crop insurance based on changes in weather parameters and identification of areas vulnerable to declines in agricultural productivity for the development of timely contingency plans and long-term risk reduction strategies. Specific areas of action for the state include:

    a. Delivery of weather-index based crop insurance services at the village level

    b. Enhancing livelihood support by providing alternate livelihood generation options to communities dependent on farm-based incomes.

    c. Diversification into crops that have shorter rotation period and are less water-intensive

    d. Promoting alternate cropping patterns such as Agro-forestry, mixed cropping (including horticultural and other high-value crops)

    e. Conducting vulnerability and integrated impacts assessment for agriculture and allied sectors, including assessment of vulnerability under a range of plausible future scenarios. Furthermore these assessments should be integrated with studies in sectors such as energy, water and health in order to capture the co-benefits that strategies in these sectors have for the agriculture sector.

    f. R & D needs

        i. Developing early warning systems for drought

        ii. Developing and implementing region-specific contingency plans for the agriculture sector based on regional vulnerability to climate impacts

        iii. Procuring impact models to assess the impacts of changes in climatic variables such as temperature, precipitation and humidity on crop growth and yield, pest and weed growth, water availability, soil moisture and organic matter, rate of evaporation etc.

        iv. Conducting integrated vulnerability assessments based on factors that capture socio-economic and climatic scenarios in the agriculture sector.

    g. Policy and regulatory measures

i. Providing financial support and incentives and conducting field demonstrations to enable technology adoption and deployment at the farm level.

The specific areas of action for Agriculture and Animal Husbandry are summarized in Table 2.

Table 2: Areas of action for Agriculture and Animal Husbandry

Priority Area	Action	Time frame (start year)	Responsible Agency
I. Dryland agriculture			
Enhance productivity in drylands	▪ Boost agricultural productivity in drylands ▪ Watershed development & soil conservation ▪ Promotion of low/ zero tillage, in-situ moisture conservation, raised bed, ridge furrow, mulching etc. ▪ Development of climate-hardy cultivars ▪ Exploring collaboration with international research institutes to develop & adopt dryland techniques ▪ Improved water use efficiency	2010	Dept. of Agriculture, WR
Efficient water use practices	Installation of sprinklers on all operational wells depending on region and crop-type	2012	Dept. of Agriculture, WRD
Fodder and pasture development	▪ Development of fodder stocks and pasture lands ▪ Eco-restoration of degraded lands	2010	Dept. of Animal Husbandry, Agriculture
Organic farming	▪ Use of sustainable & low-emission technologies ▪ Prepare organic farming modules to be disseminated through agri-extension, after conducting need-based studies for farmers	2010	Dept. of Animal Husbandry, Dept. of Agriculture
Soil improvement	▪ Improve land conditions for agriculture ▪ Reclamation of alkaline and saline soil ▪ Green manuring and organic farming	2010	Dept. of Agriculture
	Explore carbon sequestration potential of carbon-deficient soils	2012	Dept. of Agriculture
Energy efficient farm machinery	▪ Reduce emissions from the agriculture sector ▪ Use of solar pump for drip irrigation	2010	Dept. of Agriculture, MNRE
II. Promoting access to information			
Enabling advance decision-making at the farm level	▪ Providing agro-climatic information to the farming communities Automated weather stations to be established at KVK level and dissemination of information to farmers on a faster mode	2010	IMD, SAUs, KVKs, Dept of IT & C
Popularization of Package of	▪ Technology development, deployment and demonstration ▪ Village adoption, development of model technology units at	2010	IMD, SAUs, KVKs, Dept of

Priority Area	Action	Time frame (start year)	Responsible Agency
Practices upto the village level	KVKs, knowledge centres in villages, information on suitability of cropping patterns under a changing climate		IT
Increased efficiency of feed utilization by livestock	▪ Develop and disseminate improved animal feeding technology modules	2010	Dept of Animal Husbandry & Agriculture
Assessment of relation between climate change and animal health	▪ Assessment of epidemiology of climate-sensitive diseases of livestock ▪ Conduct studies to identify linkages between climate & animal productivity	2012	Dept of Animal Husbandry & Agriculture
Vulnerability assessment	▪ Understanding factors that contribute to vulnerability of the agriculture sector to climate impacts ▪ Preparation of state-level vulnerability atlases	2010	
III. Enhanced role of biotechnology			
Use of biotechnology for development of climate-hardy cultivars and livestock	▪ Development of climate-hardy cultivars ▪ Ensure buffer stock of Certified Seeds	2010	Dept. of Agriculture, Dept. of Land Resources, Dept. of Irrigation
Livestock breeding	▪ To breed climate-hardy livestock ▪ Breeding of climate-hardy livestock and development of nutritional strategies to prevent heat stress and productivity losses	2012	Dept. of Agriculture, Dept. of Animal Husbandry
IV. Risk management			
Weather-based Crop insurance	Weather-based crop insurance schemes	2010	Dept. of Agriculture
Livelihood support	▪ Maintain household incomes during lean years through livelihood diversification ▪ Enhance support to credit-linked self employment schemes	2010	Dept. of Agriculture, Dept. of Rural Development
Integrated vulnerability & impacts assessment	▪ Conduct integrated impacts and vulnerability assessment studies in different agro-ecological regions of Rajasthan to identify highly vulnerable regions	2010	Dept. of Agriculture
Early warning	Develop early warning systems for drought based on weather and climate forecast	2010	Dept. of Agriculture
Drought contingency planning	Developing and implementing region-specific contingency plans based on regional vulnerability to climatic stress	2010	Dept. of Agriculture
Providing an enabling policy environment for technology deployment	▪ To support technology uptake at the farm level ▪ Providing financial support and subsidies to enable farmers to invest in and adopt relevant technologies to overcome climatic stresses	2010	Dept. of Agriculture

5.3 Forestry and Biodiversity

The National Mission for Green India seeks to enhance ecosystem services including massive afforestation over 6 million hectares in the country to achieve the goal of 33% area under forest and tree cover. An initial funding of about Rs. 6000 crores has been earmarked for the programme through the Compensatory Afforestation Management and Planning Authority (CAMPA). This programme is to be taken up on degraded forest lands through Joint Forest Management (JFM) Committees. This national programme has the two-pronged objectives of increasing forest cover and density and conserving biodiversity. There is a need to focus on studies related to monitoring and management of forest fires of Indian forests. The use of satellite remote sensing in view of its synoptic view and temporal frequency is realized as one of the potential tools in identification of burnt areas and potential fire zones. Several satellite-based sensors such as like LISS-III, AWiFS, MODIS, OCM, WIFS, AVHRR and MODIS provide synergistic data sets that have potential in forest detection and monitoring (Reddy et al, 2009).

One of the major programmes under Forestry and Biodiversity in the state is the Rajasthan Forestry and Biodiversity Project which aims at afforestation of the Aravallis and biodiversity conservation, has completed its first phase. The state has recently released the Rajasthan State Forest Policy with focus on increasing the area under forest, treatment of forest areas, forest protection and conservation, afforestation on government land, community land and private land, supply and demand management of forest produce, enhancement of productivity, combating desertification and land degradation, wildlife and biodiversity conservation, conservation of sacred groves, pasture development, community participation and relevant capacity building and training of forest department and communities.

There is a need to engage communities for forest protection and conservation and explore the mitigation potential of protected forests. The potential of forest species to adapt to long-term changes in climate needs to be assessed. The priority areas for action identified for Rajasthan included under the broader national priorities are highlighted.

1. **Increasing the forest cover and density.** Joint Forest Management began in Rajasthan in 1991. Afforestation activities are being undertaken under JFM along with protection and management of forest areas with the engagement of village forest protection and management committees. Specific areas of action for the state under this national priority include:
    a. Forest demarcation to facilitate the understanding of likely shifts in forest types under a future climate, through:
        i. Survey, demarcation and notification of forest areas enabling identification of areas where buffers can be created
        ii. Data collection on the range and density of common and rare species

b. Forest development and protection for increasing and maintaining the green cover, through:

   i. Afforestation and reforestation programmes to increase forest produce and to reduce pressures on primary forests. CAMPA Fund can also provide resources.

   ii. Mined Area Reclamation and for Combating desertification and land degradation

   iii. Eco-restoration of degraded forest lands using CAMPA

   iv. Urban forestry to be promoted in major urban areas

   v. R & D

      1. In-situ and ex-situ conservation of flora and fauna

      2. Fire prevention, protection and management

      3. Procure impact models (such as vegetation-response model) and use tools such as remote sensing to assess shifts in forest types with changes in the climate

   vi. Policy and regulatory

      1. Enhanced tree and forest cover can be achieved through Multi-Stakeholder Partnerships including Joint Forest Management committees and forest-dependent communities

c. Explore mitigation potential of community-forest projects to obtain carbon credits for forest conservation

2. **Conserving biodiversity**. In Rajasthan, conservation of wildlife and biodiversity in two national parks and 25 sanctuaries covering an area of 9260.88 sq km are being conducted. Additionally, two conservation reserves spanning 104.78 sq. km have been notified in 2008. The state has world heritage sites such as the Sambhar lake, wetlands and sacred groves called '*orans*' and other biodiversity-rich sites. Specific areas of action for the state under this national priority include:

   a. Promotion of agro-forestry in order to buttress livelihoods of forest-dependent communities, through

      i. Distributing improved seedlings to farmers, panchayats, urban areas and governments and adopting site-specific agro-forestry models for productivity enhancement and reducing pressure on natural forests by maintaining buffers (plantations)

      ii. Promoting agro-forestry in private lands through extension services, distribution of improved seedlings and rationalization of felling and transit regulations

iii. Policy and regulatory

1. Enhanced tree and forest cover can be achieved through Multi Stakeholder Partnership by inviting investments for plantations on degraded lands including degraded forest land.

2. Reduce fragmentation of forests by provision of corridors for species migration, both flora and fauna.

3. Convergence of National Afforestation Programme with National Rural Employment Guarantee Act (NREGA) for taking up large-scale afforestation works.

iv. Training on silvicultural practices for growth of climate-hardy tree species

b. R & D

i. Monitoring of shifts in forest types and species diversity with changes in the climate to understand their potential to withstand changes in the climate including extremes

ii. Integrating traditional knowledge in adaptation strategies by adopting traditional crop varieties and conservation practices. Biodiversity registers should be maintained at district and local levels for documenting genetic diversity and the associated traditional knowledge (like those of *Oran, Gochar* tribes and *Bishnois*)

The specific areas of action for Forestry and Biodiversity are summarized in Table 3.

Table 3: Areas of action for Forestry and Biodiversity

Priority Area	Action	Time frame (start year)	Responsible agency
I. Increase the forest cover and density			
Forest demarcation	▪ Survey, demarcation & notification of forest areas facilitating Identification of areas where buffers can be created ▪ Data collection on the range & density of common and rare species	2010	Forest Dept., State Remote Sensing Agency (SRSA)
Forest protection	▪ Fire prevention, protection and management ▪ Communication channels & mobility of field staff should be strengthened using state of the art technology and use of data available with the State Remote Sensing Agency (SRSA)	2010	Forest Dept., PRIs
Explore mitigation potential of community-forest projects	▪ Obtain carbon credits for forest conservation	2010	Forest Dept.

Priority Area	Action	Time frame (start year)	Responsible agency
Forest development	▪ Increasing & maintaining the green cover ▪ Eco-restoration of degraded forest lands should be undertaken using CAMPA ▪ Urban forestry to be promoted in major urban centres with emphasis on aesthetic values and carbon credits	2010	Forest Dept. , State Development Authorities
Promote agro-forestry	▪ Promote livelihood support to forest-dependent communities ▪ Improved seedlings to be distributed to farmers, panchayats, urban areas & govt. institutions for planting. ▪ Promote incentives based agro-farm forestry in private lands through extension, distribution of improved seedlings, rationalization of felling & transit regulations	2010	Forest Dept.
II. Conserving biodiversity			
Understand likely shifts in forest types and species	▪ Procure impact models (such as vegetation-response model) and use tools such as remote sensing to assess shifts in forest types with changes in the climate, for planning of adaptation strategies ▪ In-situ and ex-situ conservation of germplasm, especially of threatened flora and fauna	2012	Forest Dept.
Integrating traditional knowledge in adaptation strategies	▪ Creation of biodiversity registers at district and local levels for documenting genetic diversity and the associated traditional knowledge (like those of Oran, Gochar tribes and Bishnois)	2010	Forest Dept.

5.4 Human Health

Though the NAPCC does not list out a specific National Mission on health it does suggest initiatives in the health sector focusing on enhanced health care services, and improved assessment of climate-specific burden of disease. The priority areas for action identified for Rajasthan include under the broader national priorities are highlighted.

1. Development of a **state health database** comprising of data collected at fine spatial (district/block/village) and temporal scales (monthly/weekly/daily), by
   a. Mobilising both public and private health centres/hospitals to contribute to database
   b. Training health centre staff/physicians for collection of other relevant information from both inpatient and outpatient cases (for example, with respect to sanitation practices)
2. Development of **high- resolution predictive health impact models** linking climate and disease incidence for:

a. Effective monitoring and surveillance programs for climate-sensitive diseases in order to establish their climate thresholds, understand the changing patterns and promote preventive actions to control outbreaks, for example developing vector specific graphs at the district level

b. Training of health sector staff in effectively using forecasting/ predictive modeling tools and software

c. Establishment of early warning systems

3. Integrated health vulnerability assessments

a. Conduct training of health professionals on developing and image interpretation of GIS-based maps and integrated impact assessment tools for the health sector and their application for research, intervention planning and policy

4. **Increasing coverage and accessibility to public health care** services at the primary, secondary and tertiary levels to manage cases and casualties in the light of climate change and extreme events. These include cases of malnutrition, drought, heat stress, vector-borne diseases such as malaria, dengue and water-borne diseases such as diarrhoea and cholera.

a. Policy and regulatory measures

i. Establish *synergies with relevant ongoing national health care programmes* such as those related to water and sanitation, nutrition, National Vector-Borne Disease Control Programme, Integrated Diseases Surveillance Program (IDSP) etc. and strengthening state-level initiatives such as the Rajasthan Health Systems Development Project.

ii. Development of evacuation plans including emergency preparedness and anticipatory efforts such as vaccination, distribution of mosquito repellents, bed-nets and antibiotics.

iii. Improving institutional capacity to undertake health adaptation in urban areas

iv. Promote inter-sectoral coordination with Public Health Engineering departments for improving sanitation and drinking water supply at the state, district and block level

v. Promote health education and awareness at the local level

The specific areas of action for Human Health are summarized in Table 4.

Table 4: Areas of action for Human health

Priority Area	Action	Time frame (start year)	Responsible agency
I. Develop high-resolution health database for climate impact studies			
Health data collection	▪ Study the regional pattern of climate-sensitive diseases & disease outbreaks ▪ Source high resolution climatic and regional disease pattern data ▪ Develop and maintain a digital climate-related health database at the block level	2010	IMD Department of Medical Health & Family Welfare, PHCs, hospitals
II. Procure/ Apply/ Develop high-resolution health impact models			
Integrated health impact assessment	▪ Source health impact modeling tools from WHO ▪ Procure/ apply/ develop health impact models ▪ Validate predictive modeling results with qualitative & quantitative assessments	2011	Department of Medical and Health Services, Medical colleges
Prioritization of regions based on epidemiological data & vulnerability indicators	▪ Assess regional vulnerability spatially & temporally, to diseases with respect to changes in the climate and enable adaptation & risk management in vulnerable areas ▪ Procure software such as MapInfo/ ArcInfo/ IRDIS for GIS-based analysis (vulnerability mapping and integrated impacts assessments) and image processing ▪ Assess the response of disease vectors to climate change ▪ Conduct quantitative assessment studies for malaria, dengue & chicken guinea	2012	Department of Medical and Health Services
III. Enhanced public health care			
Enhancement of primary, secondary & tertiary health care facilities	▪ Better public health care measures including vector control, sanitation & supply of potable drinking water and nutritional programmes, especially for children ▪ Effective monitoring & evaluation of endemic and epidemic areas with respect to climate change ▪ Upgradation of healthcare infrastructure to deal with emergencies during climatic extremes (such as droughts, floods, heat waves) ▪ Improving institutional capacity to undertake health adaptation in urban areas ▪ Establishment of early warning systems and evacuation plans including emergency preparedness in case of climatic extremes (such as heat waves) and anticipatory efforts	2010	Department of Medical and Health Services

5.5 Enhanced Energy Efficiency and Solar Energy

Under the guidelines of Bureau of Energy Efficiency (BEE), the Rajasthan Renewable Energy Corporation (RREC) has been conducting a survey of government buildings for energy efficiency, energy auditing, energy conservation measures for designated consumers, installing solar water heating systems in private establishments, etc. Further the Rajasthan Discoms are promoting the use of Compact Fluorescent Lamps (CFLs) for street and domestic lighting; energy efficiency pump sets; providing tariff concession on solar water heaters; minimizing distribution losses; using new and efficient technologies like super critical boiler technology and integrated gasification combined cycle for thermal power projects. Jaipur Discom is also implementing a Lighting Energy Efficiency project for domestic consumers under the Bachat Lamp Yojna of BEE, Government of India. Further the investments can be recovered by reducing carbon dioxide emissions and earning Certified Emission Reduction (CER) credits under the Clean Development Mechanism (CDM). The government is also in the process for establishing energy consumption benchmarks for energy-intensive industry sectors in the state by setting up time-bound program for energy conservation and energy-efficiency in these sectors.

Climate change mitigation presents a huge opportunity for the state of Rajasthan to exploit its solar energy potential. The state receives the maximum solar radiation intensity in India. In addition the average rainfall (hence number of overcast days in a year) is least in the state as compared to the rest of the country; therefore it's best suited for solar power generation. It also has land available in abundance at a very minimal cost. Therefore, Rajasthan is likely to emerge as the preferred destination for setting up installed capacity, which may eventually exceed 100,000 MW. In order to promote solar energy in the state the Rajasthan Renewable Energy Corporation (RREC) has taken many initiatives which include, implementing rural electrification and SPV (Solar Photo-Voltaic Cell) program, remote village electrification (RVE), solar photo-voltaic power plant (grid interactive) program etc. Further the Rajasthan Electricity Regulatory Commission (RERC) has prescribed maximum capacity to be installed from wind power projects as 1890 MW by year 2011-2012 and from biomass as 214 MW by 2011-2012. The government under it's 'Policy for promoting Generation of Electricity through Non-Conventional Energy Sources, 2004' is also taking other initiatives to promote renewable energy sources, which includes giving incentives viz. exemption from electricity duty, special incentives for industries, single window clearance., allotment of land on concessional rates etc. Such measures will not only promote renewable energy and address energy security concerns but also yield significant co-benefits by reducing GHGs.

The specific areas of action for Enhanced energy efficiency and solar energy are summarized in Table 5.

Table 5: Areas of action for Enhanced Energy Efficiency and Solar Energy

Priority Area	Action	Time frame (start year)	Responsible agency
I. Promotion of energy efficiency			
Survey/ audit of buildings for energy efficiency	Conduct survey of residential and commercial buildings for energy efficiency, energy audit and energy conservation	2010	RREC, Dept. of Energy, DISCOMs, RVPN
Energy efficiency in power distribution	DISCOMs to promote use of CFLs, energy efficient pump sets for agricultural and of environmentally friendly solutions like biomass gasification in the MSME sector. Target MSME clusters could be dyeing plants, food processing units, guar gum plants etc. DISCOMs to reduce loss in distribution system by Use of High Voltage Distribution System (HVDS), Small energy efficient transformers, Strengthening distribution lines and implementing schemes for reduction of distribution losses by using amorphous core transformers	2010	RREC, Dept. of Energy, DISCOMs, RVPN
Energy conservation	▪ Conducting a demand assessment ▪ Capacity building and awareness amongst consumers ▪ Financial assistance for strengthening database and RREC's initiatives for energy conservation ▪ Inclusion of more categories of users for mandatory installations	2010	RREC, Energy Department
	▪ Implementing the energy conservation building code (ECBC)	2010	RREC, Energy Department
Promotion of sustainable technologies	▪ Promoting the implementation of super-critical boiler technology in thermal power plants ▪ Promoting biogas power plants for rural electrification/ decentralized electrification ▪ Deployment of Integrated Gasified Combined Cycle (IGCC) in thermal power plants	2010	Dept. of Energy, RVPN
II. Promote solar energy utilization			
Decentralized Electrification using Solar Photo-Voltaic	▪ Installation of domestic lighting system (DLS), street lighting system (SLS) and SPV water pumping sets in remote areas with assistance from state government and MNRE(Ministry of New and Renewable Energy) ▪ Solar power generation in urban areas, promotion of Solar Cities ▪ Installation of SPV power plants in rooftops of public offices to encourage adoption of non conventional energy sources	2010	RREC, Energy dept. (GoR), MNRE

Priority Area	Action	Time frame (start year)	Responsible agency
Solar Power Generation in Urban Areas	▪ Exploiting regions of high solar energy , like Jaisalmer, Jodhpur and Bikaner for utility-scale , large scale power generation. These cities are being developed under the National Solar Mission program for setting up large scale Solar Power Projects ▪ Developing Land Banks for Solar power plants for meeting the land requirement required for setting up new projects. Land Banks have been developed in Jodhpur, Barmer, Bikaner, Jalore. Land Banks are being developed in Churu and Nagaur districts	2010	Municipal Corporations, state govt., ULBs, BEE,
Energy Mix	To ensure MW scale grid Interactive electricity generation from Solar Energy MW scale solar power projects to be developed under the phase I of the National Solar Mission	2010	RREC, Department of Energy
Regulatory Measures	▪ 'Feed-in' tariffs for solar power, initially at the level of cost of generation from diesel based power, with the tariff reducing linearly each year for the new plants, to reach grid parity ▪ Solar and renewable portfolio standard for the State grid, initially at 5% of total grid supply, increasing by 1% a year till 2020, when the scheme may be reviewed. Combinations of these measures may also be considered, e.g. a renewable portfolio standard with competitive procurement, with the notified feed-in tariff applicable acting as a ceiling on bid price of renewable supply. ▪ Energy pricing for effective implementation ▪ Enable mini-grids and household systems to both draw and supply to the grid at applicable rates in each case	Long-term	RREC, Department of Energy
Solar water heating	▪ Assessing the feasibility and promoting solar water heating ▪ Conducting survey for installing solar water heating system in private hospitals, resorts and nursing homes etc. ▪ Providing incentives for promoting solar water heating	2010	RREC

5.6 Urban Governance and Sustainable Habitats

Strategies for the urban areas should be adopted to reduce the GHGs emitted from automobiles. The Green buildings concept should be promoted in Rajasthan, along with formulation of detailed norms for the same. As the buildings sector is the largest consumer of energy, the state government should enforce Energy Conservation Building Codes. Green Certification, for example Green Rating for Integrated Habitat Assessment (GRIHA) rating may be made mandatory. There is also a need for an intensive awareness campaign for architects, town planners and private sector. Increasing the efficiency of public transport system should be a priority area for action.

The state of Rajasthan is undertaking many initiatives to reduce its energy consumption. Setting up of urban infrastructure development scheme, increasing the number of transport facilities, augmenting the urban transport system with the gradual introduction of Bus Rapid Transit System (BRTS), Compressed Natural Gas (CNG) vehicles, Mass Rapid Transit Systems (MRTS) are some of the very significant efforts of the Government of Rajasthan that are underway. Management of Municipal Solid Waste especially in tourist places such as Jaipur, Udaipur and Jodhpur should be explored. Sustainable landfills concept with capture of methane from landfills needs to be taken up along with effective MSW treatment plants.

The specific action steps for Urban Governance and Sustainable Habitats are presented in Table 6.

Table 6: Areas of action for Urban Governance and Sustainable Habitats

Priority Areas	Action	Time frame (start year)	Responsible Agency
I. Promoting Energy Efficiency			
Balanced and healthy urbanization	Comprehensive study of all major aspects of urbanization in the state including climatic and environmental aspects in order to promote balanced and environmentally benign and sustainable urbanization in the state	2010	Department of Urban Development and Housing (UDH);and Local Self Government (LSG)
Use of solar lighting in cities	Enhance usage of renewable energy for urban energy needs Using solar power for road traffic signals, for public buildings	2012	Department of Urban Development and Housing (UDH); Dept. of LSG; Rajasthan Renewable Energy Corporation (RREC)

Priority Areas	Action	Time frame (start year)	Responsible Agency
II. Efficient public transport systems			
Integrated Transport Planning	Promoting public transport Augmenting public transport system with CNG, BRTs & MRTs, Exploring PPP models of public transport	2010	Transport department; Department of Urban Development and Housing (UDH); Dept. of LSG
Clean fuel vehicles	Better fuel quality to reduce GHGs emissions from vehicles Use of CNG in public transport, electric cars, battery-operated cars	2010	Transport department
	Promoting use of non-motorized vehicles Providing separate tracks for non-motorized transport such as bicycles and cycle rickshaws	2010	Department of Urban Development and Housing (UDH) and LSG
Promoting efficiency in transportation of goods	Structural changes in transport of goods Shift in pattern of transporting goods example from trucks to railways, wherever feasible	2012	Department of Urban Development and Housing (UDH) and LSG

5.7 Strategic Knowledge for Climate Change

The National Mission on Strategic Knowledge for Climate Change identifies the need for research in specific areas of climate science to better understand the climate processes impacting the state. The key areas for action that the National Mission lists out are also very relevant for the state of Rajasthan. These include:

- Strengthening observational networks and develop a climate database, while ensuring access to historical spatial and temporal (time-series) sets of climate data
- Development of regional climate modelling tools and techniques of high resolution for the state government
- Setting essential infrastructure for high performance computation, data storing and sharing for climate scientists.

The specific action steps to be covered as part of this state-level Task Force are presented in Table 7.

Table 7: Areas of action for Strategic Knowledge on Climate Change

Priority Area	Action	Time frame (start year)	Responsible Agency
I. Climate modeling and observational database			
Data Collection and Monitoring	Access to historical spatial and temporal (time-series) sets of climate data and improvement of observational network over the state ▪ Creation of Climate database ▪ Development of observation network by employing Automatic Weather Stations(AWS) on a higher spatial grid to acquire both spatially and temporally high resolution weather data for further assessments	2010	Department of science and Technology , Department of Information Technology & Communication
Climate modeling tools and techniques	▪ Acquisition of modeling tools like RCMs and Weather forecasting models ▪ Training of state officials, research institutions and universities for capacity building ▪ Forecasting for droughts, heat-waves and extreme rainfall events	2010	Department of science and Technology , Department of Information Technology & Communication
II. Education and training			
Education and training	▪ Creation of knowledge hubs ▪ Facilitate national and international collaborative networks and exchange of research by conducting national and international education fairs, conferences, discussions, seminars and symposia ▪ Conduct awareness campaigns for communities, NGOs, schools, colleges, government officials, policy makers etc. through use of Information and Communication (ICT) tools	2012	Department of science and Technology, Department of Information Technology & Communication
(a) Climate impact research and development			
Development of hard and soft skills	▪ Setting up dedicated facilities for climate change R&D ▪ Climate budget to provide financial resources for R&D ▪ Setting essential infrastructure for high performance computation, data storing and sharing for climate scientists. ▪ Develop regional climate projections for different socio-economic scenarios and their impact assessment for the region specific policy implications	2012	Department of science and Technology , Department of Information Technology & Communication

6. Ways forward

Development of the Rajasthan State Climate Change Agenda has been guided by national priorities as identified in the NAPCC and cognizance of the state-specific risks, vulnerabilities and opportunities in the light of climate change. The Climate Change Agenda partially spreads across two planning periods (XI and XII) and provides a timely platform for initiating and strategizing activities necessary for climate adaptation and mitigation by the XII Plan period- both on the research as well as policy front. Specific physical and financial targets have not been indicated for 2010-2014 because:-

1. This Agenda spans two Plan periods in the state (XI and XII) hence it is difficult to estimate resource allocation in the next plan period.
2. Some activities are new and long-term and would need substantial investments into research, training and capacity building at the individual and institutional level before these can be implemented.

In order to operationalize the Rajasthan Climate Change Agenda, there is a need to conduct sector-specific and region-specific assessment of impacts, vulnerability and mitigation potential in the state. Collaboration with international and national research institutions is essential to share best practices, technologies and knowledge base and enable appropriate training and capacity building at different levels in the state of Rajasthan. In this context, the key areas for climate-related research in the state include:

- Procurement/ development of downscaled regional- level climate scenarios for Rajasthan
- Development of sectoral studies to assess both current and future vulnerability of human as well as natural systems
- Development of integrated impacts assessments for different ecological regions in the state
- Studies on mechanisms of convergence of traditional knowledge and modern technology for adaptation and mitigation
- Estimating the costs of adaptation and mitigation strategies across different sectors in Rajasthan
- Conducting studies on convergence of adaptation and mitigation
- Conducting studies to assess the co-benefits that activities in one sector can have for other sectors (for e.g. co-benefits of adaptation in water sector for agriculture and health sector)

Application of research into practice and planning requires presence of an enabling policy and regulatory environment. The key areas for policy research and action in the

state in order to implement the different strategies under the Climate Change Agenda include:

- Development of mechanisms to engage stakeholders at the state, district and local level for implementation of adaptation and mitigation strategies, a Public Private Partnership mode for implementation of the strategies in certain sectors may be considered.
- Consideration of equity issues should be central in all policy strategies and initiatives aiming at reducing the vulnerability of the poor in light of climatic shocks and stresses.
- Fostering vertical linkages between central and state level ministries and departments and horizontal linkages between relevant Govt. departments in Rajasthan for research, policy and implementation of activities under each state Task Force
- Relevant training & capacity building at all levels (institutional & individual). Capacity needs to be built in different departments to implement the strategies listed under the seven Task Forces of the Rajasthan State Climate Change Agenda.
- Specific strategies such as fuel switch would need to be supported by incentives and subsidies for technology adoption.
- Development of scenario-based approaches to enable a better understanding of decision-making under uncertainty.

Glossary of key terms[1]

Adaptation
Adjustment in natural or human systems in response to actual or expected climatic *stimuli* or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001).

Afforestation
Planting of new forests on lands that historically have not contained forests

Agroforestry
A management system that integrates trees on farms and in the agricultural landscape.

Clean Development Mechanism
Defined in Article 12 of the *Kyoto Protocol*, the Clean Development Mechanism is intended to assist Parties not included in *Annex I* in achieving *sustainable development* and in contributing to the ultimate objective of the convention; and to assist Parties included in Annex I in achieving *compliance* with their quantified emission limitation and reduction commitments.

Climate model
A numerical representation of the *climate system* based on the physical, chemical, and biological properties of its components, their interactions and *feedback* processes, and accounting for all or some of its known properties.

Certified Emission Reduction unit
Equal to 1 tonne (metric ton) of CO2-equivalent emissions reduced or sequestered through a Clean Development Mechanism project

Climate
Climate in a narrow sense is usually defined as the 'average weather' or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.

Climate change
Climate change refers to a statistically significant variation in either the mean state of the *climate* or in its variability, persisting for an extended period (decades or longer).

Deforestation
Conversion of forest to non-forest.

Demand-side management
Policies and programs designed for a specific purpose to influence consumer demand for goods and/or services.

[1] Retrieved from http://www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf

Desertification
Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities.

Emissions
The release of greenhouse gases and/or their precursors and aerosols into the atmosphere over a specified area and period of time.

Energy efficiency
Ratio of energy output of a conversion process/ system to its energy input.

Evapotranspiration
The combined process of evaporation from the Earth's surface and transpiration from vegetation.

Fuel switching
Policy designed to reduce carbon dioxide emissions by switching to lower carbon-content fuels, such as from coal to natural gas.

Greenhouse gas
Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds.

Mitigation
An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Vulnerability
The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.