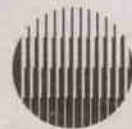


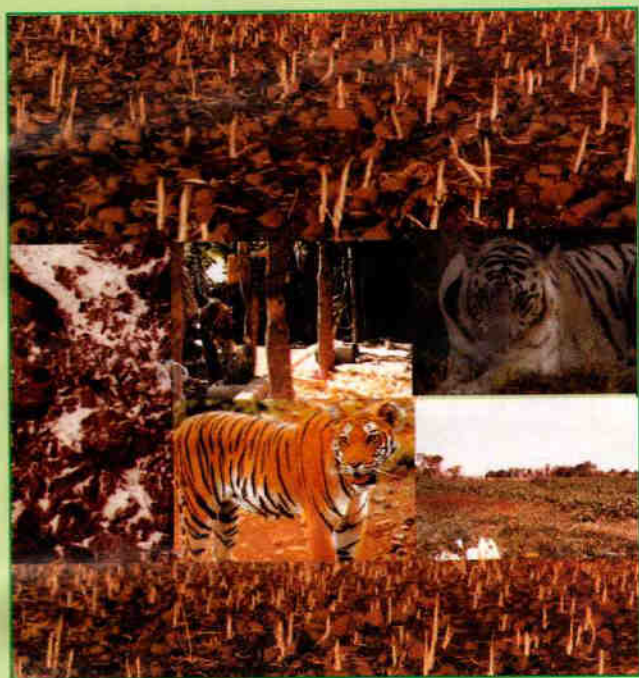
FIFTH STATE OF THE ENVIRONMENT REPORT



Madhya Pradesh
2006



State of the Environment Report



Madhya Pradesh, 2006



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Shiv Raj Singh Chauhan



**Chief Minister
Government of Madhya Pradesh**

Foreword

The philosophy of conservation is interwoven in our tradition and culture since time immemorial. Indian culture has endorsed the fact that life owes its existence and obtains its sustenance from environment. Our ancient tradition of love and reverence for nature still prevails in Indian society, but development driven anthropogenic pressures have led to negative impacts. It is a universal fact that technology alone can not offer any total solution for environmental problems. There is need to integrate technological interventions with tradition and culture to achieve sustainable development goals.

It has now been acknowledged world wide that there is no conflict between environment and development. Both are essential for socio-economic well-being and long-term progress of a developing nation like ours. Thus, it becomes imperative to mainstream environmental concerns in development planning. The State Environment Policy is a reflection of the commitment of the State Government for integrating environmental concerns in the development process. Documentation of the status of natural resources, trend of their demand and supply scenario and identification of key environmental concerns are a necessity of the planning process. This Vth State of Environment (SoE) report is, therefore, an important document both for planners and academicians. Environmental Planning and Coordination Organisation (EPCO) - an autonomous environmental advisory/coordinating body of the State Government has prepared this SoE report through consultation with stakeholders within and outside the government. We appreciate the support of Government of India - Ministry of Environment and Forests and complement EPCO for preparation of this significant document. I am sure this SoE report will be useful for sustainable development planning of the state.

Shiv Raj Singh Chauhan

Jayant Kumar Malaiya



**Minister
Housing & Environment Department
Urban Administration & Development
Govt. of Madhya Pradesh**

Madhya Pradesh has been at the forefront of environmental actions. This was, probably, first state to adopt State Environment Policy way back in 1982 and revised it in 1999. The preparation of State Environment (SoE) Report has been one of the key agenda of the state environment policy. The SoE report aims at facilitating integration of environmental concerns in the process of economic development. The state is passing through an accelerated pace of development to enhance the quality of life of its citizen. At the same time we are committed to ensure quality of environment too through judicious use of its natural resource base. This V State of Environment (SoE) report will provide valuable inputs to this process, since with a higher rate of economic development, it becomes imperative to document the health of natural resources/environment vis-à-vis impact of development activities.

I wish to acknowledge the support of MoEF-GOI received through Development Alternative (Delhi). I also wish to complement the Environmental Planning & Coordination Organisation which has been entrusted with the responsibility of preparing SoE reports.

This document will, undoubtedly, be useful for development planners to conceive of the practices for managing resources which enhance the capacity of the present as well as future generations to meet their needs.

JK. Malaiya

Jayant Kumar Malaiya

Rakesh Sahni
Chief Secretary



Govt. of Madhya Pradesh

Brundtland Commission which is the World Commission of Environment and Development has defined Sustainable Development as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Falling in line with the global concept, 'Sustainable Development' is the key of the State Environment Policy (1999) of Madhya Pradesh. The policy also envisages preparation of State of Environment (SoE) Reports on a periodical basis. Madhya Pradesh, as per its first State Environment Policy – 1982, started SoE reporting about two decades back and brought out four SoE reports in 1987, 1991, 1996 and 2000 from its own resources. However, recognizing the vital role of SoE Reports in the planning process, Planning Commission, Government of India have, recently, initiated SoE reporting as a continuing process for all the states and UTs of India. Ministry of Environment & Forests (MoEF) was made responsible for this task. Development Alternative (Delhi) facilitated the process of SoE reporting in Madhya Pradesh. The State Government appreciates the financial support and process facilitation by Govt. of India for this V SoE Report of Madhya Pradesh.

Interdisciplinarity has gradually gained priority, both, in policy planning and in research funding. Since most of environmental problems involve interaction between social and ecological processes, the interdisciplinary input seems to be strongest in environmental sciences. The multidisciplinary environmental team of Environmental Planning & Coordination Organisation (EPCO) has, therefore, been assigned the task of preparation of this V SoE Report for Madhya Pradesh. Data and information, used in this SoE Report on various aspects of environment are mainly from government sources but published research documents have also been used.

Madhya Pradesh is endowed with an abundance of natural resources, viz., watersheds, forests, minerals and a glorious cultural heritage. At the same time the state is taking a quantum jump in developmental activities. The SoE Report will provide vital inputs for the common goal of sustainable development

This report, besides serving as a resource base for identification of critical areas for priority attention in planning processes, will also serve as an integrated data bank for a variety of users, including academicians, scientists, professionals, administrators, environmental managers etc. EPCO -the principal environmental advisory agency of the State Government deserves to be complimented for their effort in bringing out this V SoE Report.

Rakesh Sahni

P.D. Meena
Principal Secretary,
Director General, EPCO



**Housing & Environment Department
Urban Administration & Development
Govt. of Madhya Pradesh**

The current global concept of linking quality of life with quality of environment is the recapitulation of our ancient philosophy of nature conservation. There has been tremendous environmental awareness throughout the world during last four decades. As a result, it has been universally accepted that there is no conflict between development and environment. Integration of environmental concerns with development planning has, therefore, become priority agenda. Documentation of status of the natural resources and trend of their demand & supply becomes imperative for environmental planning. The V State of Environment (SoE) report is an attempt to address this issue.

The Government of India, Ministry of Environment & Forests have supported the preparation of this document through Development Alternative, New Delhi. We are thankful for this gesture. The Environmental Planning & Coordination Organisation (EPCO) - an autonomous environmental advisory agency of the State Government has accomplished the task of preparation of this V SoE Report as part of the mandate assigned to them under State Environment Policy 1999. The multi disciplinary team of EPCO professionals has been doing the job since about last two decades, resulting into production of five SoE Reports. EPCO deserves commendations for their input in periodically bringing out SoE Report of the State.

I am sure this document will be useful in interlinking Environment & Development besides serving as environmental resource book for a variety of users.


(P.D. Meena)
08/06/06

J.S. Mathur
Executive Director



**Environmental Planning &
Coordination Organisation**
Bhopal

Preface

Nature has a limited carrying capacity to accommodate anthropogenic changes. There has been unprecedented industrial development worldwide during post war period. India has also witnessed an accelerated process of development during the post – independence period, resulting in the country achieving self reliance in food grains despite more than a three fold increase in population and has now an advanced industrial base. Madhya Pradesh, as a state of the Indian Union is on its way to harmonize with the national development goals to provide a better quality of life to its people.

The world community is becoming increasingly aware that development induced environmental degradation in the desire for rapid economic growth, calls for sustainable development strategies. Such strategies underline need for evolving a deliberate synchronization for a balance between environment, development and conservation.

As a result of enormous environmental understanding, it is now a well-acknowledged fact that planned & coordinated methodologies can ensure that there is no conflict between environmental conservation and economic development. The natural resource base and health of environment are continuously under pressure to cope with the accelerated pace of development to provide better quality of life to growing population of the state. Environmental planning, is therefore a priority agenda for addressing the environmental issues to minimize the adverse impact of development activities. Documentation of the status of natural resources, and trends of their demand and supply is, probably, the first and foremost important step towards addressing this critical agenda with the necessary priorities.

Planning Commission, Govt. India, having realized the importance of State of Environment (SoE) reporting, initiated the process as a continuous activity for all states and UTs of India through Ministry of Environment & Forests (MoEF). A National Host Agency (NHA) Development Alternative, Delhi have facilitated the process of preparation this Vth SoE report of Madhya Pradesh. This SoE report prepared by the multidisciplinary team of professionals of Environmental Planning and Coordination Organisation (EPCO) covers natural resource accounting as well as development driven environmental aspects. The report is intended to present a clear picture of the vital components of the environment of the State to serve as a resource base for identification of critical areas. Data and information available on various aspects of environment have been collected mainly from various State government departments and Central government agencies.

Relevant research documents have been studied alongwith the consultative process with a wider range of experts, academicians also those working in the field. The consultative process has also been adopted. The SoE report is based on authentic secondary data since collection of primary data would have been duplication of efforts requiring tremendous resources with possibilities of contradiction. The Vth SoE report, also presents responses and initiatives taken in addition to descriptions as to status and pressures.

Under the State Environmental Policy commitment EPCO has been bringing out SoE reports on a periodical basis beginning from 1987 when two bilingual volumes were published. The IInd SoE report was also brought in two volumes in 1991. The IIIrd SoE report was published in one volume, each in English and Hindi in 1996. The IVth report brought out in the year 2000 was the last SoE report of an undivided Madhya Pradesh. The Vth SoE report is the first report after the carving out of the state of Chhatisgarh from erstwhile Madhya Pradesh. Hence it has required more inputs in terms of trends analysis.

The Vth SoE report includes altogether ten chapters broadly covering natural resource scenarios, anthropological aspects and development driven environmental aspects. Though the document in hand is based on past experience of preparing four SoE reports and methodological inputs from the National Host Agency there still has been an effort to put in information and analysis as per suggestions of users and availability of additional information/data.

The financial and facilitation support from MoEF- Govt of India through Development Alternatives (D.A.) is greatly acknowledged. The appreciable efforts of **Dr. U.R. Singh**, Director (Research & Training) EPCO, his team and **Dr. Anand Kumar** of D.A., Delhi needs to be underlined for bringing out this Vth SoE report of Madhya Pradesh. The document will hopefully cater to the need of our esteemed users.

J.S. Mathur

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Executive Summary

Climate

- The World Meteorological Organisation (WMO) has observed 1990s as the warmest decade of 20th Century. The rate and duration of warming of 20th Century were larger than at any other time during the last 1000 years. The year 1998 was the warmest on record, with 2001 being the second highest. The warming observed is directly linked to the relative increase of green house gases in the atmosphere resulting global warming in addition to local climatic changes.
- The extreme heat during summer and moderate cold in winters are experienced in the climate of state because Tropic of Cancer passes through the Narmada river. The northern part experiences both the extremes, viz. hottest summer & coolest winter. The Plateau of Malwa, enjoys very pleasant climate throughout the year, probably because of predominant black cotton soil.
- The average temperature fluctuated during 1960s to till the end of last century, however average temperature observed is comparatively lower than the average normal temperature during the last decade (1990-2000).
- Annual rainfall in north-western M.P. is very low as compared to southern and south eastern region.

Trend analysis of rainfall during the last century indicates some interesting facts. During Indian Independence (forties), rainfall in the state was slightly lower than the normal. However in the next decade the monsoon trend was again positively inclined but overall trend of rain in the decade is considered as normal. Above average rainfall was recorded during the early 1970s in contrast the state has recorded second lowest rainfall in country during 1980s. In the last two decades of the century the state has received below than average rainfall.

Land Resources

Land is the basic resource of human society and land use study is of prime importance for the economic development, resource planning and cultural advancement of people.

In comparison to the national figures of recorded forest area, of 24.97%, figures for Madhya Pradesh are 30.88% quiet high. The state stands IVth in country. A steep increase under forests cover is observed 1998 to 2000 (area considered as divided M.P.). This may be attributed to participative approach in forest management through joint forest management.

The total increase under land not available for cultivation was 1,15,124 ha from 1998-99 to 2002-03. Overall pattern of barren land in the state (divided) has decreased to 3,01,696 ha. from 1998-99 to 2002-03. Permanent pastures and grazing land has been constantly decreasing from 1998-99 till 2002-03. It was 16,98,484 ha in 1999-2000 and remained 13,94,500 ha. in 2002-03.

The state has highest 37% ravenous area of the country, mostly extend around the border of Rajasthan ranking second with 24% ravines. Tjis is one of the greatest environmental problem of north-west part of state coupled with socio-economic issues.

In 1998-99 (divided M.P.) the total cultivable wasteland area was 11,75,349 ha. and increased 12,13,500 ha. by 2002-03. Fallow land which is not in use for agriculture purposes because of infertility; increased from 4,98,614 to 9,96,500 ha from 1998-99 to 2002-03, i.e., 3 to 5%. The detailed analysis of Landuse figures from 1998-99 to 2002-03 shows decline of 5,09,412 ha in net area sown, reducing from 49% in 1998-99 to 47% in 2002-03. Similarly the gross cropped area also decreased by 23,00,498 ha. during same period. Such trends are also indicative of the change in socio-economic pattern which is primary a shift towards urbanization inspite of strong Panchayati Raj System in the state.

Agriculture

Agriculture holds the key to all round growth and rapid reduction in rural poverty levels in a country like India and states like Madhya Pradesh. Agriculture provides more than food. It contributes to economic growth, better livelihood, provisions of environmental services, it is important for poor people both in urban and rural areas.

This chapter on Agriculture looks at a subject that can play a vital role in tackling poverty and hunger and also attempts to understand the impact of agricultural activities on environment. It also tries to understand the trends in agriculture sector and how it is affected by technological and market pressure. The chapter attempts to discuss the important role of agriculture in livelihood promotion and poverty alleviation.

Madhya Pradesh is primarily an agricultural State. Agriculture contributes about 45% of state domestic product (SDP). With 19.8 million hectare i.e. 48.65% of geographical area is under cultivation (higher than national average). More than 70% of rural labour force finds employment in this sector. A 60% of landholders are marginal and small farmers having only 19% of land, whereas 40% of landholders are big farmers having 81% of land.

The State has broadly been divided into 11 Agro Climatic Zones (ACZ). These zones have special cropping patterns, soil types and varying degrees of rainfall. Agriculturally Malwa and Central Narmada Valley (CNV) are more advance ACZ. The cropping pattern shows a significant presence of cash crops and horticultural crops in Malwa and CNV, zone. The average productivity of land in these regions is also higher than the state average.

Madhya Pradesh is predominantly Kharif crop growing State. Kharif crops occupy about 54.25 % whereas Rabi crops occupies about 45.75 % area out of the total cropped area in the State. The State is at present producing about 16.0 million tones of food grains. It contributes about 7.7 % food grains (6.5 % Cereals and 24.29 % Pulses) in national kitty. The State is the highest producer of oilseed and pulses in the country. Major crops grown in the State are Paddy, Wheat, Maize and Jowar among Cereals, Gram, Tur, Urad and Moong among Pulses, while Soybean, Groundnut and Mustard among Oilseeds.

Fertilizer plays king pin role in augmenting agricultural production in combination with irrigation, and high yielding varieties of seed. The area under assured irrigation in M.P. is now 34.7% almost comparable with the national average of 37.1%, but still the fertilizer consumption in M.P. is less than half of the national average. States average fertilizer consumption of NPK is 46.33 Kg/ha during 1999-2000 as against all India consumption of 97 Kg./ha. But during 2002-03 it has come down to 39.20kg./ha.

The Soil in the State are deficient in nitrogen and phosphate nutrients. Soils of about 36 districts out of 48 have shown nitrogen deficiency while 31 have shown phosphate deficiency and 23 district out of 48 districts have shown potash deficiency.

It is evident that the sustainable development of Madhya Pradesh is dependent on sustainability of livelihoods based on natural resources.

Despite the high dependence of people on primary sectors of the economy, only 48.65 of land area of Madhya Pradesh is under agriculture which is substantially lower than most large states.

The tradition of building small check dams and storage ponds in low lying land, though wide spread earlier in some parts of the state, has declined in the last 50 years. Rajiv Gandhi Mission for Watershed Development (RGMWD) was introduced to improve degraded land in MP through improving land and water resources. On observing the good response from the community on RGMWD, the Pani Roko Abhiyan (PRA) was introduced recently to improve the water resources.

Though climate change and economic globalization are the two main processes of global change, their impacts are rarely studied in conjunction. An ongoing research project- pooling the expertise of TERI (India), Center for Development (Canada)- analyses the double exposure of Indian agriculture to these phenomena. The findings suggests high social vulnerability in districts of Andhra Pradesh, Bihar, Haryana, Madhya Pradesh. High technological vulnerability in districts of Bihar, central Maharashtra, Madhya Pradesh, the northeastern states, and western Rajasthan.

When The climate change and globalization vulnerability profile were superimposed to identify the double exposed districts in Madhya Pradesh, Maharashtra, northern Andhra Pradesh, Northern Karnataka, Western Rajasthan, southern Gujarat and southern Bihar. Policy interventions may be needed climate change in the context of economic globalization.

Agriculture is the main stay of the state's economy. The main responsibility of the Department of Agriculture is therefore to optimize the agricultural yield, through use of advanced agricultural equipment, improved certified seeds, massive soil and water conservation measures, rationalization of cropping, rain-fed horticulture, fodder cultivation and fuel wood planting, organic farming etc. integrated pest management.

Though almost all these issues are being addressed but integrated watershed development and organic farming have got tremendous response from farmers.

Forests

Anthropogenic activities coupled with human & cattle population pressure poses great threat to the forests. There has also been rapid increase in the incidence of head loading. These have resulted into a wide gap between demand and supply of forest produces.

The recorded forest area of the State is 30.89% of its total geographical area against average National figure of 23.38%. Reserve Forest alone constitutes 61.68% of the total forests in the State. The per capita forest in Madhya Pradesh is 0.21 ha as against the National average of 0.07 ha. The district-wise analysis of recorded forests area of 45 districts of the State show that in 4 districts, the recorded forest area are even less than 5.00 %, thus can be said to be in very critical stage. The situation in 8 districts, where forest area ranges from 10-20%, is also not very satisfactory. There are 11 districts where the forest area ranges from 20-30%, can be said to be satisfactory. The recorded forest area in 22 districts is more than State average of 31 %, while it is more than national average in 31 districts. In 12 districts the forest area is said to be nearer to 33% envisaged in National Forest policy, while in 19 districts it is more than National Forest Policy. A comparison of RF, PF and unclassified forests to their total reveals that there are 29 districts where the RF is more than 50% of total forests, out of which 9 districts have more than 75% RF.

Based on species composition, there are three important forest formation, viz., teak, Sal and miscellaneous forests. About two third of the

area of the State is covered under miscellaneous forests. The average growing stock (volume of timber/ wood) of recorded forest is estimated to be about 500.00 lakhs, which is worth Rs 2.50 lakh crore.

The actual forest cover of the State is 25.07 % of its total geographical area. Thus the State is having 4.50 % more forest cover as compared to average national figure. The contribution of the State to all India forest cover is 11.42 and that of recorded forest is 12.39 %. The dense forest cover of the State is 14.40% of its geographical area while the open forest cover is 10.17%. The scrubland is lesser (1.12 of total geographical area) than all India figures (1.44%).

The total tree cover area of the State is 5751.00 sq. km. This is about 1.87 % of the total geographical area of the State. Thus the forest cover and tree cover of the State together constitutes 83,016.00 sq. km or 26.9 % of the State's geographical area, as against national figure of 22.73 %.

The physio-graphic distribution of the forests cover indicates that Northwestern part covering entire/parts of 32 districts comes under Central Highlands. The southern parts covering entire/parts of 17 districts come under Northern Deccan, while only a small area covering entire/parts of 4 districts falling in eastern part of the State comes under East Deccan.

Change in forest cover based on the estimates of 1997 and 2001 assessment as constraints mentioned in the report, indicates that there seems to be constant increase in forest cover in the State as well as in the country. The net gain in the State during four years is 3.35% as against national figure of 6.65%. The overall forest cover assessment of 2001 is much higher (2.8% for M.P and 6.0% for India) than the 1999 assessment.

The district-wise forest cover analysis reveals that 9 districts of the State is in very critical stage where the forest cover is less than one third of the State average and half of the National average. The situation in 10 districts, where forest cover ranges from 10-20% is also said to unsatisfactory. There are 18 districts where the forest cover is more than average state of 25.07% and 26 districts where the forest cover is more than national average. In 12 districts the forest cover is nearer to 33%, while in 12 districts it is even more than 33%. There are two districts, where the forest cover is more than 50%. The dense forest cover alone is more than the average national figure (20%) in 12 districts.

Forest produce plays an important part in the socio-economic development of the State. Important forest produce includes timber, small timber, fuel wood and bamboo. The teak and Sal are most important timber produced in the State. More than one third of the total produce is exported to other States. The second grade timber is found in small quantities. The State is also rich in bamboo forests, timber and bamboo harvesting is carried out departmentally in selected coupes annually as per the provisions laid down in the Working Plans in force. Disposal of forest products like timber, poles, fuelwood, bamboo etc. is done through auction in **commercial depots** and through sale on notified rates in the **Nistar depots**.

Tendu, Sal seed, Harra, Gum, Chironji, flower and seeds of Mahua, Mahul and flowers, seeds/bark and roots of various plant species etc, are important non-wood forest produce (NWFP) found in the forest of the State. Tendu leaves, Sal seeds, and gums are nationalized forest produce. Other NWFP being non nationalized which can be collected and traded freely. According to survey nearly 500 species of medicinal plants have been identified from forests of the State.

Of the total 52,739 villages in the state, 22,600 villages are located in or near forest areas. Being away from the mainstream of development, most of the villagers are directly or indirectly dependent on forests for their livelihood. In addition to these, there are a host of items like leaves, flowers, fruits, bark, seeds, roots etc. commonly referred to as non-wood forest products (NWFP), which contribute significantly in

socio-economic development of the rural communities.

Forest (Conservation) Act 1980 restricts diversion of forests lands for non-forestry purposes. Analysis reveals that a total of 121024.07 ha forest area relating to 561 cases approved by GOI has been diverted since 1980. While diverging forests land the condition of compensatory forestation either on equal area of non-forest land or on double the degraded forestland is imposed. The Govt of MP has also regularized eligible encroachers prior to 31st December 1976. Conversion of 925 Forest Villages into revenue villages in 28 districts of M.P. is under progress. Sanction of conversion of 310 forest villages into revenue villages has been received from MoEF by 21st January 2004. Fire policy and guidelines have been prepared for controlling forest fires.

Madhya Pradesh has a long history of scientific forest management through documented planning. These plan documents are called "Working Plans". Working plans are prepared for management of natural forest areas for a period of ten years after which it is revised.

In the State of M.P., there are large number of small patches of private tree clad areas and forests. They have not been yielding any income to the owners. Such private land holdings of the thousands of farmers are small, generally ranging from 0.5 ha to 15 ha. The forest produce also play significant role in socio-economic development of the local rural communities.

The MP Lok Vaniki Act, 2001 aimed at boosting scientific management of privately owned 'forests' and other 'tree clad areas' in the state. The Act provides an opportunity to the willing landholders to take up management of their tree-clad holdings for optimizing economic returns to themselves and simultaneously ensuring environmental benefits to the society.

Bio-diversity

As a result of conservation efforts of Madhya Pradesh, the status of wildlife population in state has projected an overall encouraging trend with tiger as flagship component of forest eco-system. With only 12.5% of forest area of country, M.P. supports 19% of tiger population of India. Madhya Pradesh, at present, supports 5 out of 25 Tiger Reserves and 2 out of 14 Biosphere Reserves (Pachmarhi BR 1999 and Achanakmar-Amarkantak BR, 05) in the country as against 2 out of 15 Tiger Reserves in 1983. This indicates the positive efforts of State for *in-situ* conservation of biodiversity. The conservation efforts are well reflected in Tiger population, which increased from 457 in 1972 to 965 in 1989. Decrease in Tiger population to 912 in 1993 was probably due to poaching and territorial in-fighting among Tigers. This again increased to 927 in 1997-98 in erstwhile-undivided Madhya Pradesh. The tiger population in M.P. (excluding Chhatisgarh area) increased from 700 in 1998 to 712 in 2003.

The mixed tropical forests dominates the State which is supposed to be rich in bio-diversity. Sub-tropical hill forest eco-system found in Pachmarhi and Amarkantak are considered as one of the richest gene pool. These are being conserved under Biosphere Reserve category. The Wildlife Institute of India have classified Madhya Pradesh in following two Biogeographic Zones;

- i) Semi-arid bio-geographic zone (4.B) covering about one fourth area of the State consisting of western districts without much forest. This zone has only one National Park (NP) and nine Wildlife Sanctuaries (WLS).
- ii) Deccan Peninsula bio-geographic zones (6C,D,E) covering about three fourth area of the state spread over in three biotic provinces, viz, Eastern plateau (6C), Chhota Nagpur (6D), and Central highlands (6E). Rest of the NPs and WLS are located in this zone. All 5 Tiger Reserves and two Biosphere Reserves are also located in this zone indicating biodiversity richness of the zone.

As per latest data, about 10.40% of total forest area and about 3.52% of geographical area of State is covered under Protected Area (PAs) network as against the recommended norms (by State wildlife board) of 15% and 5%, respectively. There has been remarkable

development in wildlife reserves between 1980-1983 in the State recording about 500% increase in number of N Ps. Similarly, WLS increased from 19 (7049 sq.km) in 1980 to 31 (10566 sq.km) in 1983. There has not been remarkable addition of National Parks or Wild life Sanctuaries after 1983.

The Amarkantak and Pachmarhi region are supposed to be genetic Exress highway linking to biodiversity hot spots of the country i.e. Western Ghat and Eastern Himalaya and cougluence points of Northen and Southern tye of Vegetation. Majority of plant diversity is located in these forests.

The case studies for floristic inventory for Pachmarhi regions indicated that the region is exceptionally rich in flora. About 1244 species found belongs to angio-sperms, bryophytes, pteridophytes. The Pachmarhi Satpura hill ranges area is one of the 26 endemic centers identified by GOI. The studies on flora of Amarkantak region reveal approx. 1000 species of angiosperms. Some areas of unique plant of Mandla Patakot valley, Supkhar chir pine, Garhkota-Ramma reserve, plant fossils of Mandla, Rukhad nature reserve, Bori nature reserve etc.

Madhya Pradesh is one of the state that had large agro-bio-diversity status. Conservation plans of agro-biodiversity has recently been initiated through NBPGR. Variation of 12 agro- climatic zone, 6 crop zones and 28 prominent soil- types are driving factors of richness of agro-biodiversity. A number of scheduled tribe races spread all over the state, have helped to conserve the agro-biodiversity in their traditional way.

The state has a total of 467 lakh animals out of which cattle and buffaloes constitute 79%, goat 17% and remaining 4% animals include pig, sheep and other animals. Important recognized breeds of cattle considered as native breeds of Madhya Pradesh are "Malwi" and Nilmari". "Gaolao" breed found all over Vidarbh region of Maharashtra and adjoining areas of Madhya Pradesh (Chhindwara distt.) and "Kankattha: breed of cattle in Panna district. Similarly, "Bhadawari" breed of buffalo is found in abundance at Bhind and Gwalior districts. "Jalauni" breed of sheep is found in Tikamgarh and Shivpuri which form the border with Jhansi and Jalaun districts of Uttar Pradesh. "Jamnapari" breed of goat is found in various villages of Bhind district situated near Chambal river. Berari Goats are in the Nimar districts of M.P. "Malwi camel" are also found in Mandsaur district of Madhya Pradesh. In the poultry sector, "Kadakhath" is the native breed of Madhya Pradesh found in Jhabua.

The state of M.P. has taken several initiative for better management of *in-situ* biodiversity conservation in Protected Areas. Some of these initiatives are as follows;

- Eco-development of villages in and around protected areas to eradicate forest dependent livelihood pattern and ensure their sustainable development.
- Voluntary village relocation spending upto Rs. 1.00 lakh per family, compensation for damage caused by wild animals, conflict resolution and inoculation of domestic cattle.
- Training of personnel's and monitoring population estimation of wild animals with voluntary participation of educational institutions.
- Asiatic Lion reintroduction project at Kuno-Palpur Sanctuary
- Establishment of Wildlife health monitoring disease diagnostic and research cell, (Jabalpur) and intelligence bureau/anti-poaching squads.

- Addition of a chapter on inclusion of bio-diversity conservation principles in the management of Forests to the book of guidelines for Working Plan preparation to ensure bio-diversity conservation outside Protected Area Network.
- *Constitution of State Bio-diversity Board*
- Active participant in National Bio-diversity Strategy and Action Plan (NBSAP) concluded in 2002-03. The State Bio-diversity Strategy and Action Plan (SBSAP) prepared as part of NBSAP has six broad Strategies. The key elements and action points of these six strategies are elaborated in SBSAP.

Water Resources

- Besides being vital for sustenance of life water has become a limiting factor for economic development too. By the year 2050 approximately 2 billion population shall be adversely affected due to water scarcity (UNEP). Water experts have warned that by 2050 about half a dozen states in India shall face serious water problem. Owing to its physiography Madhya Pradesh is also facing water crises. Hence, assessment of available water resources, their optimum development and judicious use is imperative
- The important concerns/issues pertaining to water resources and their management include seasonality of most of its rivers facing reduced flow due to withdrawal for irrigation; lack of sewage collection, and treatment facilities in urban areas causing eutrophication; excessive exploitation of ground water; negatively effected ecology of riverine system due to damming etc.
- There are five major river systems in M.P. viz., Ganga, Narmada, Tapti, Mahi and Godavari. The Physiography of the state is such that the majority of the rivers originates in the state and flow outwards to the neighbouring states.
- The Ganga basin is the largest basin in the state, spread over an area of 202070 Km² in M.P. covering 32 districts. The major tributaries include Sone, Tons, Chambal, Betwa, Kunwari-Sindh, Ken etc. Narmada basin is the second largest basin covering an area of 85930 km² in M.P. and covers 20 districts. Important tributaries include Shakkar, Dudhi, Tawa, Barna, Hathini, Tenduni etc. Tapti river basin in M.P. is 9800 km². It originates near village Multai (Betul district) flows for 332 km in the state. Godawari Basin has a total area of 63360 km². The river itself does not flow through M.P. but part of its catchment area falls in the southern part of the state. Its major tributaries that drain the state are Wainganga and Wardha. Mahi originating in Dhar district west has catchment area of 6700 km² in M.P. The main tributaries of Mahi is Anas which originates in Jhabua district.
- Upto December 2003, there were 07 major 99 medium and more than 3000 minor completed irrigation schemes while 13 major, 12 medium and 586 were under different stages of construction. The irrigation potential created is 20.80 lakh ha. According to fisheries department 2.93 lakh ha. of standing water area in the form of irrigation reservoirs, village ponds and tanks is available. Of this 79% is in the form of irrigation reservoirs and 21% is in the form of village ponds. About 2.13 lakh ha irrigation reservoirs 0.37 lakhs ha. village ponds tanks has been brought under fisheries.
- Water quality monitoring in the state is carried out by M P Pollution Control Board through their regional offices under the programmes GEMS & MINARS sponsored by Central Pollution Control Board. The significant observations regarding water quality criteria for major rivers/tributaries are as follows:-
- The existing class of water in Chambal river at Nagda upstream and down stream is D and E, respectively against desired level of

C class. Dissolved Oxygen, pH & total Coliform are found to be within the desired levels of C class. BOD is quite high exhibiting organic pollution. The Khan river water at Kabit Kehdi near Indore is highly polluted showing very high values of pollutants. The desired class for Kshipra at Ujjain is C while the existing class is D. The existing water quality of river Sone at Chachai and Amlai is of B class. The values of BOD, total Coliform and D O indicate fairly good water quality. The water quality of River Tons at Chakghat station is observed to be fairly good (B class) as against the desired class C.

- The desired class of water quality in Narmada River is A at Amarkantak near origin, B at Mandla, at Sethanighat, Hoshangabad u/s & d/s, Omkareshwar d/s and Maheswar and C class at rest of the stations. The existing class of water at Amarkantak, Sethanighat and Hoshangabad u/s & d/s do not meet the desired class. The BOD and Total Coliform values are high. The desired class levels in the stretch from D/s of Omkareshwar till the end of the stretch upto Badwani are maintained.
- The existing water quality of Tapi at Burhanpur broadly meet the class B criteria as against the desired class A. The desired class of water of Wainganga River is class C. The existing class at Chhindwara and Ashti is D while at Balaghat it is B. The D O, pH and Total Coliform values through out the stretch are meeting the desired class levels.
- Majority of the rivers of M.P. being seasonal, exploitation of ground water is considered to be more reliable water source. Besides being important source for irrigation, about 70% rural and 30% urban water supply is from ground water creating a tremendous pressure on unevenly distributed ground water resources. The net ground water availability in M.P. (excluding Chhatisgarh) is 3.11 m.ha.m. while total utilisable ground water resources are 2.175 m.ha.m. The net ground water draft in 1998 was 1.44 m.ha.m. leaving a balance groundwater resource for future use as 0.735 m.ha.m.
- The average percentage of ground water development in M.P. is 46.23 with respect to net ground water availability and 66.07 % with respect to utilisable ground water. The level of ground water development in M.P. varies from as low as 3.74.% in Dindori district to as high as 103.47% in Ujjain, followed by 102.00% in Ratlam district. In general, the western part of the state is in the over exploitation and critical category. In M.P. out of 313 blocks 17 Nos. of blocks are under over exploited category, 12 Nos in critical and 38 Nos. in semi critical categories ..
- During the year 2002, rainfall was deficient in 66% stations, normal in 32% stations and only 2 rain gauge stations in Betul showed excess rainfall. However long term behavior of groundwater levels (phreatic zones) by comparing the average water level data for May (premonsoon) of last ten years (1992-2001) with current water level for May 2002 indicates that there is fall in water level upto 2 m b.g.l and is seen in entire state area and noted in almost 50% of the hydrograph stations while fall between 2 m b.g.l and 4 m b.g.l is observed in 12.9% stations in entire state area except eastern most parts and more than 4.0 m b.g.l is noticed in 7.4% stations in small pockets in Seoni, Damoh, Chhatarpur and Raisen districts.
- Rise in ground water level upto 2.0 m b.g.l noted in 24.8% hydrograph station and 2-4 m b.g.l in small pockets in parts of Dhar, Betul, Jabalpur, Shahdol, Umaria, Sidhi and Shivpuri districts in 3.4% .
- Ground water quality is monitored by Central Ground Water Board (CGWB) at 805 hydrograph stations located all over M.P. During May 2002, the results of chemical analysis reveals that ground water in phreatic aquifers is in general fit for human consumption and agriculture use. However high values of electrical conductivity is observed in certain localized pockets, Nitrate pollution is wide spread. Fluoride concentration is higher in deep aquifers (Handpumps) at some places.

- The distribution of Electrical Conductivity (EC) at 25°C (indicator of salinity) ground water show normal in most part, moderate to high in pockets of north, central and western parts of the state and, high to very high in parts of Bhind, Sheopur, Chhatarpur, Rajgarh, Ratlam, Ujjain and Sehore districts. In general Fluoride concentration is low, but 47 locations spread in Northern, Western, Central, South-eastern and Eastern parts of the state show fluoride concentrations in excess of 1.5 mg/l (Permissible limit). Nitrate pollution in ground water is harmful to human beings in particular to the infants as it causes disease called "Blue baby syndrome" total 285 water samples out of 805 showed Nitrate concentration above permissible limit. The concentrations of most of elements were below permissible limits.
- Water resources management is the prime concern of the central as well as state government and number of initiatives have been taken up for protection/conservation of water resources. The National and state water policies have been adopted to address issues like, safe drinking water supply integrated water resources planning with participatory approach, conjunctive use., special measures for rainwater harvesting and ground water recharge.
- Major intervention in Water Sector gained momentum with the launch of Rajiv Gandhi National Mission. New initiative in Water Sector started through sector reforms project in 1999 which was later on scaled up as Swajaldhara 2002. Total Sanitation Campaign was launched with emphasis on public participation and demand driven approach. In order to provide safe drinking water as per standards of 40 liters per capita per day in rural areas of the state number of Rural Water Supply and Sanitation Schemes are being implemented.

Geology & Mining

- Madhya Pradesh ranks third next only to Jharkand and Chhatisgarh in terms of the country. Madhya Pradesh is the sole producer of diamond and major producer of the pyrophyllite, copper-ore coal, limestone and diaspore.
- India's largest open-cast copper mine is at Malanjhand-Balaghat-M.P. The thickest coal seam of Asia is in Singrauli (M.P). Beside being leading producer of manganese, dolomite, rock-phosphate, glass and fireclay, the state is fast emerging as dimensional stone producer
- Mining activities generally exerts adverse impact on environment and affect the immediate surroundings. The major environmental impact of mining in the State are deforestation, land degradation, disruption/pollution of water system, air quality deterioration, noise pollution, vibration, displacement of local community and their socio-economic problems etc.
- Out of a total reserve of over 240748 million ton of hard coal in country possesses over 16000 million tonnes. Singrauli is the biggest coalfield of the State, spread over 220 sq.k m (U.P. &M.P) and encompassing about 11,000 million tonnes of coal reserves, making it the fourth largest coalfield in the country after Raniganj, Jharia and north Karanpura. The growth of coal production will have to continue to keep pace with demand for energy and chemical products. The recurrence of Coal Bed Methane (CBM) has been identified in three blocks viz. Sohagpur east Sohagpur west and Satpura in Madhya Pradesh out of 7 blocks identified by the Ministry of Petroleum and Natural Gas, Govt. of India.
- Madhya Pradesh is also popular for cement production and ranks second in the country. The rich and extensive deposits of limestone mainly in the districts of Jabalpur, Mandasaur and Satna made it the leading producer of limestone. Unplanned mining of limestone is creating environmental problems like disposal of solid waste, air pollution (dust nuisance), altered hydrogeology, visual pollution and land degradation.
- In Madhya Pradesh, the occurrences of bauxite reserves are mainly found in Shahdol, (Anuppur) and Mandla districts. The mining of

bauxite in Amarkantak has denuded large areas of Sal rich forests on the hills. The stripping of these hills has resulted in huge loss of forests besides destruction of the aesthetic beauty of the area. The mining activities have been restricted in Amarkantak area due to environmental consideration.

- The State, is foremost in the production of copper and manganese in India from Balaghat mines. The impact of mining is clearly visible in this natural resource rich area.
- India produces about 84000 carat of diamond every year from its main source in Panna as against the world production of more than 50 million carat annually. In the diamond mine at Panna district of the State, one carat of diamond requires handing of about 18 tonnes of diamondiferous gravel. The production of 84000 carat per year requires processing of 1.5 million tonnes of gravel every year.
- Panchayat have been made partner in exploitation and benefit sharing of minor mineral while Van Suraksha Samiti have been associated to check illegal mining. These are part of social initiatives. The state environment policy envisages integrated EIA and EMP of mining project with public participation.

Pollution and Environmental Health

Pollution is primarily caused by various anthropogenic activities. Air pollution adversely affects to human health and causes various types of diseases. The air quality status of major urban centres in the State is no better than the adjoining industrial areas, mainly because of increased use of automobile vehicles by rapidly increasing population. The growing economy of the state has brought the changes in the life style of inhabitants in the state resultantly the vehicular pollution has aggravated the problem. The traffic movement has tremendously increased in the major cities of Madhya Pradesh viz. Bhopal (3142 vehicle/hour) and Gwalior (2316 vehicle/hour). The vehicular emission study conducted by MPPCB between 2000 to 2003 shows that in the year 2000-01, about 30% of the vehicles have exceeded the permissible limit while the percentage in the year 2001-02 and 2002-03 was about 28% and 26% respectively. This has happened due to awareness generation and Pollution Under Control (PUC) checking program by transport authorities in the major cities of the state.

The combustion of fossil fuel, power generation and industrial processes are the principal source of pollutants in urban and industrial areas in the state. The data generated by Madhya Pradesh pollution Control Board (MPPCB) under the Industrial Air Pollution Monitoring (IAM) programme shows the total number of air polluting industries was estimated to be 610, out of which 420 were in red category. This shows that about 65% industries falls under highly polluting category. The trend of air quality monitoring analysis by MPPCB under NAAQM programme reveals that SPM and RSPM are generally exceeding the permissible limits at majority of the monitoring stations. At Indore the SPM level in residential areas was recorded 278 mg/m³ and 219 mg/m³ in the year 2000 and 2002 respectively, which is beyond the permissible limit. The SO₂ and NO₂ level recorded were also higher at Nagda industrial area.

In Madhya Pradesh, the main sources of noise are commercial/industrial activities, automobiles, loud speakers etc. High noise levels are deleterious to human being as well as animals. Under the noise level monitoring programme by MPPCB the noise level of 10 major cities were monitored in the year 2002-03. Bhopal city was on the top for percentage of value exceeding limits which was 90.0% followed by Jabalpur 78.93%, Gwalior 77.35%, and Ujjain 68.42%. During Diwali lot of fireworks are used and the market is bugging with lot of activities. The ambient noise level monitoring conducted at 7 urban centres in the state during Diwali festival revealed that values in commercial and residential areas were invariably beyond the permissible limit as against the permissible limit of 65 (day time) and 55 (night time). The highest value 142.2 dB (A) leq was recorded at Bhopal (Commercial area) followed by Ujjain 107.2. dB (A) leq. The data shows that situation is becoming alarming during Diwali festival.

Due to industrializations, and urbanisation the problem of water pollution is aggravating. The MPPCB under IEM programme have monitored 588 water polluting industries, out of which about 65% (380 industries) have been categorised under red category. Pollution of water is probably responsible for more human illness than any other environmental influence. Diseases transmitted are mainly due to micro-organism and parasites e.g. Cholera, Meningitis, Jaundice etc.

The analysis of deaths due to diarrhea shows that despite of increasing number of cases the number of deaths have decreased, while in the case of meningitis the cases and deaths both are showing the reducing trend. This may be due to effectiveness of mosquito control practices. Regarding jaundice the cases of death incidents are showing the fluctuating trend. The general trend of water borne diseases shows that community awareness and health facilities in the state are gradually increasing.

Out of 753 hazardous waste generating industries 169 are located at Dhar and 168 at Indore district followed by Ujjain (89), Bhopal (79) and Gwalior (73).

The generation of MSW garbage is directly proportionate to the population. The highest garbage was generated in Indore (638.97 T/day) followed by Bhopal (573.55 T/day), Jabalpur (380.58 T/day) and Gwalior (350.76 T/day). This indicate that the composition of MSW has direct relation with magnitude of urbanisation. A comparative analysis of compostable matter in the solid waste shows that the Indore (42%) is at par with metros (41.8%) while Jabalpur it is about 54% .

Hospital waste generated in four major cities indicate that the highest waste is generated from Indore (1953 kg/day), followed by Bhopal (1512 kg/day), Jabalpur (1274 kg/day) and Gwalior (931 kg/day).

Prevailing policies and regulations mentioned at relevant places of each section shows the readiness and response of the state govt. towards this vital issue.

ENERGY

- The power development scenario in India and Madhya Pradesh, after Indian independence, has been quite encouraging. There has been gradual increase in electricity production capacity of the country from 1362 MW (at the time of independence) to more than a lack in 2005. The corresponding figure for Madhya Pradesh were 39.28 MW in 1951 and 2940 MW in 2005. In spite of such a glorious development in electricity production capacity, the gap between demand and supply has also increased to 25000 MW for India as against 1000 MW in Madhya Pradesh. This may directly be attributed to rapidly growing human numbers and energy dependent life style.
- The state is gradually moving towards cleaner technology by way of enhancing its share of hydel power generation which is about 3.1% in total power generation of the country as against 2.6% of thermal power generation of India. However, fossil fuel which is the main culprit for environmental degradation from energy sector still has lion's share. The increasing number of vehicles add to catalytic effect of the problem.
- The green revolution has also direct bearing on power consumption, mainly because of irrigation sector development. And as such the agriculture sector consuming 31.79% of total power is the second largest consumer after industrial sector (38.80%). This is interesting that bulk of electricity in agriculture sector is consumed in the western part of the state while major electricity generation facilities are located in eastern part of the state. These facts are based on data available for 2003-04.

- The research studies of R.G. Technical University suggest that there is large gap between wind energy potential and its harnessing both at national and state level. The state has been able to harvest 28.00 MW against the wind power generation potential of 5,500 MW. Similarly country has harvested only 1427 MW out of the potential of 45000 MW. The situation for other non-conventional energy sources are not better than that of the wind energy. This is evident from the fact that at national level bio-mas plus co-generation is only 30 MW out of the potential of 1427 MW, while state is harnessing only 6 MW out of a potential of 28 MW.
- Having analysed the problems and perspective of energy sector vis-à-vis environmental conservation, the tremendous gap between available potential and actual harnessing of renewable energy is quite noticeable. This calls for priority attention with decentralized approach. Moreover, the energy conservation measures need be addressed on a massive scale with public participation.

Human Settlement

- Madhya Pradesh a landlocked state having an area of 308245 sq km, is surrounded by five states, viz, Uttar Pradesh, Rajasthan, Gujrat, Maharashtra and Chhatisgarh. It has a population of 60.38 million, which is 5.87% of the Indian population according to the 2001 census. The decadal growth rate (1991-2001) of the State was 24.34%, against the all India average of 21.34%. The sex ratio in the State in 2001 works out to be 920 femal/1000 male as against the ratio of 932 in 1991. The all India ratio in 2001 was 933.
- The birth and death rates in Madhya Pradesh remain high. The percentage of literate to the total population in the State was 43.4% in 1991, which increased to 64.08% in 2001 against the all India average of 64.8%. The State rural literacy was 58.1% against 79.67 urban literacy in 2001.
- According to the 2001 Census, more than one third of the population in the State belongs to Scheduled Castes and Scheduled Tribes, against the all India average of 24.4%. The general workers participation rate (% of workers to the total population) in the State was 42.93% in 2001. The participation rate among the females has shown an upward trend from 32.53% in 1991 to 33.2% in 2001. A high female participation rate is a symptom of backwardness in the rural areas of the State, whereas a higher female participation rate in the urban areas is due to an increase in female literacy. The rice-growing tract of the State has generally shown a relatively higher participation rate. There has been a State level shift of the overall main workers from the agriculture to non-agriculture sectors.
- Madhya Pradesh is still preponderantly a rural State having 73.5% rural population in total population. Urban population of State is below the all India average of 27.78%. Bhopal district has the largest component of the urban population, i.e. 80.53% while Dindori district has the lowest urban population of 4.64%. Madhya Pradesh has recorded a decadal growth rate of 22.02% in its rural population and 31.19% in its urban population during the decade 1991-2001. The number of towns in the State from 1901-2001 grew from 97 to 368 towns as per provisional figure 2001. The level of urbanization in MP has gone up from 10.49% in 1901 to 26.67% in 2001.
- There are 26 class I towns out of total 368 towns. The Indore, Bhopal and Jabalpur are urban agglomerations with a population of 1.63 million, 1.45 million and 1.11 million respectively. Most of our urban centers are experiencing rapid growth of slums at an alarming rate. Slums may be an environmental curse to an urban area, they are important and essential components of economic life which serves the urban population directly or indirectly. Half of the urban population of the State resides in Class 1 urban agglomerations/towns. All these UAs /towns registered quite a high growth rate of population, which has resulted in an enormous increase in the number of slums. The State has identified 10 metropolitan areas, which are seriously affected by the slum problem. These include

Bhopal, Jabalpur, Indore, Ujjain, Gwalior, Neemuch, Ratlam, Sagar, Katni and Burhanpur. The State Government takes up various means of environmental improvement of urban slums, employment-generating programmes for the urban poor, fencing of government land building of shelters for the homeless etc.

- The economy continues to be predominantly agrarian, the agriculture and allied sectors still contribute to about half of the State Domestic Product (SDP). The Net State Domestic Product of Madhya Pradesh, at Constant Prices (1993-94) in 1998-99 was Rs. 43,81,487 which was increased to Rs. 52,76,561 in 2003-04. Achieving higher growth is not an end in itself. The growth of the economy has to result in increased socio-economic standards of all the people of the State. The outlay for social sector constitutes one third of the total outlay and thus still continues to be the priority sector. However, the proportion of the social sector outlay has come down from 42.37% in the Ninth Plan to 29.68% in the Tenth Plan. This is mainly because areas like education and health are being funded from outside the budgetary resources. The infrastructure sectors - irrigation, power and roads are thrust areas of the Tenth Plan. Poverty alleviation is most important agenda of the State Government.
- The scheme of Environment Improvement of Urban Slums (EIUS) has improved the basic amenities. The scheme of Integrated Development Plans of Small and Medium Town is being implemented in the State covering 40 medium & small towns during this plan period. Agriculture is backbone of state economy and also for employment generation. The Plan would aim at increasing the productivity through improved inputs like better irrigation, higher seed replacement, increased fertilizer consumption and better credit facilities. The plan also aims at developing agriculture infrastructure like market yards, storage, handling & transportation and food / agro parks. Forestry is another important area in the primary sector.
- A capacity addition of 835.4 MW is proposed during the Tenth Plan. Transmission losses at present are 47 percent is much higher than the national averages. As part of the infrastructure development, the road sector is given priority. Madhya Pradesh ranks among the lowest in the country in terms of nearly all health related indicators. The state's persistent effort to improve the quality of life of its people rendered difficult by the continued high levels of fertility and mortality
- As a part of revitalization of Panchayati Raj Institution and Urban Local Bodies, the District Planning Committee (DPC) has also been constituted in every district. A core group consisting of one resource person from education, economics, sociology, statistics and a social worker who is fully conversant with development of the district was created to prepare the district plan. The State has decided to implement decentralized district planning process from the year 2002-03. The DPC have prepared district plan proposals for the year 2002-03.
- It is imperative to give a new dimension to the environmental conservation programme incorporating action plans in compliance of national and international commitments. The State Environment Policy seeks to lay down guidelines that will facilitate development while ensuring environmental conservation yet without hampering the present and future development imperatives.
- With an area of 3.08 Lac square K.M. and density of population 196 per kilometer, it makes the State a difficult terrain, hard to reach and inaccessible. In terms of Human Development Index (HDI) with an index value of 34.8 the state lags behind the all India average of 45. The State's population doubled during the period of 30 years, between 1951 and 1981 from 26 to 52 million. At the present pace, it will double again in the succeeding 34 years, that is, up to 2015. The state has taken the initiative of adopting a state specific population policy. District Poverty Initiative Programmes (DPIP), which focused its activities in over 2908 villages in 14 northern districts of MP, will alleviate poverty by improving the capacity and opportunities for poor and disadvantaged people with special focus on women. It aims at poverty alleviation using a judicious development strategy that is sustainable both economically and environmentally.

- The Government of Madhya Pradesh intends to implement a livelihoods project for creating and strengthening sustainable livelihoods in predominantly 22 tribal districts of the state. Already a district poverty initiative project (DPIP) funded by the World Bank is in operation in 14 districts where populations are mainly non-tribal. Aims to augment conserve and optimize the utilization of soil and water resources in rain fed areas. This would reduce the vulnerability to droughts and stabilize the fluctuations in agricultural production. Watershed Management Mission has grown to cover all 45 districts, all 313 blocks, 6253 watersheds and 8692 villages to become India's largest watershed management programme currently in operation with 110970 User Groups, 23176 Self Help Groups and 11130 Women's Thrift and Credit Groups. The total area selected for treatment is 39.49 lakh Ha.

Key Environmental Concerns of the State of Madhya Pradesh

A few decades back, economic development and environmental quality were thought of as independent entities, but we now find them closely linked. The concept of sustainable development, indeed, carries with it the premise that economic, environmental and social well-beings are interrelated. It highlights the need to use the resources and services of the environment to improve the quality of people's lives in a manner that it does not diminish or compromise the environment's capacity to cater to the needs of future generations.

Some of the key environmental concerns in Madhya Pradesh being discussed here includes human settlement, forest, bio-diversity, water resource management, energy, mining, agriculture, pollution and environment health, land use and climate. The natural resource scenario, anthropological aspects and development driven environmental aspects are the usual broad concerns. These concerns have been classified on the basis of an inventory of issues followed by prioritisation.

- 1.1 Madhya Pradesh is second largest state (3.08 lakh sq.km.) in the country. This land-locked state surrounded by 5 states accounts for only 5.8% of the total population of India but decadal growth rate (1991-2001) of state (24.34%) is higher than Indian average (21.34). Sex ratio in M.P. was not only lower than national average (2001) but also came down from 1991 census. There has been quantum jump in literacy rate from 1991 census to 2001 (64.08%) coming almost parallel to national average of 64.8%. The faster rate of female literacy compared to male literacy is positive indicator but lower rate of literacy in tribal districts and rural area is cause of concern because state has 35.5% SC/ST in total population as against 24.4% national average. In term of human Development Index (HDI) with an index value of 34.8% the state lags behind the all India average of 45. This is also cause of concern.
- 1.2 The urbanisation in the state has been quite fast recording 31.19% decadal growth rate against only 22.02% in rural population. This has posed enormous problem of slums, waste and infrastructure. Problem of domestic solid waste has become severe with increasing trend of urban population and use and throw culture. A large number of hazardous chemicals like chlorine, Ammonia, Hexane, pesticides are being used in large quantities.
- 2.1 Madhya Pradesh has maximum forest cover (77,265 sq.km) of all states followed by Andhra Pradesh and Chhatisgarh. With only 9.38% of the geographical area of country, M.P. has 12.5% of the recorded forest area of India. As per 2001 assessment by Forest Survey of India (FSI) recorded forest area of M.P. is 30.5% (25.7% cover) of geographical area of state as against 23.3% (20.55% forest cover) recorded forest area in India. As far as the issues of forest are concerned, the state has witnessed an overall increase in the forest cover; nevertheless, there has been decline in the same in some of the districts.
- 2.2 Forest has experienced comparatively higher rate of degradation in two pockets of state, viz (i) western M.P. including Khargone, Ratlam, Jhabua, Ujjain, Dhar, Shajapur, Indore, Vidisha, Guna and Rajgarh, and (ii) northern M.P. including Rewa, Satna, Panna, Damoh, Tikamgarh and Shahdol. The dependence on fuel wood in urban areas of the state is substantially higher than all India average. The practice of carrying head-load of fuel wood for sale and allowing the cattle to graze in forest are the two main factors putting pressure on forest health. Forest Conservation Act- 190 has checked the diversion of forest land but this has also prevented the development of modern agriculture in the tribal areas of the state.
- 2.3 Here there is a need to make a conscious effort to study the major threats to forest ecosystem and increase in the forest cover. The decline in forest cover also leads to the consequent bio-diversity loss and care should be taken to curb this situation too. Large-scale awareness about deforestation, its implications is warranted. Popularization of alternative and renewable sources of energy to reduce dependence on fuel-wood and resultant pressure on forest is equally important.
- 3.1 The scenario of wildlife conservation in the state underlines quite remarkable efforts. With only 12.5% of forest area of country, M.P. supports 19% of tigers in India. The State has 5 out of 15 tiger reserves and 2 out of 14 Biosphere reserves of the country. Pachmarhi and Amarkantak regions are supposed to be genetic highway linking western ghats and eastern Himalaya. However, as against 15% of forest area and 5% of geographical area recommended by state wildlife board, the state has only about 10.4% forest area and 3.5% geographical area under protected area network. The effort are required to bridge this gap.

- 3.2 Six points strategy is indicated in State Bio-diversity Strategy and Action Plan (SBSAP). Serious efforts are needed to address the issues indicated in SBSAP prepared for Madhya Pradesh as part of National Bio-diversity Strategy and Action Plan (NBSAP).
- 4.1 Water is vital for life. It is one of the precious resource for economic development and day-to-day living. Our growing population and rapidly diversifying and expanding needs make water an increasingly scarce resource. This is a challenging situation and calls for the best and most stringent conservation measures. What is crucial is generating awareness of the manner in which water is used today; This will determine, to a large extent, its availability for the future. The health of riverine eco-systems of the state are adversely effected due to increasing withdrawal of water for domestic, agricultural and industrial purposes and discharge of industrial and domestic waste into rivers. Urban water bodies are the worst victim of domestic waste and encroachment.
- 4.2 Rural water bodies are potential source of fisheries. The bulk of fish production in the state comes from village ponds but the productivity of these village ponds in state is much lower than the national average. However, fish productivity of reservoirs is well comparable with national average. This is because of organised approach.
- 4.3 The excessive exploitative of ground water for irrigation and domestic use has resulted into decline in water table in major part of the state. However, as a result of watershed approach rise in water table has been observed in some areas.
- 4.4 Large quantities of water that is used for agriculture is wasted and results in problems, such as water logging and salinisation. The demand for non-agricultural uses is also increasing rapidly. At the same time, more food has to be produced to meet the demands of the increasing population and its burgeoning consumption levels. To counter these issues, there is a need for using the available water very efficiently – by using less of it to produce more.
- 4.5 Also, there is a need to study the problem of water pollution and water borne diseases in the state in order to provide remedial measures. Rapidly deteriorating water quality is one of the most serious environmental problems not only of Madhya Pradesh but of whole in South Asia. High population densities, unsuitable agricultural practices, rapid urbanisation, increasing industrialisation and a general lack of pollution control facilities are exerting growing pressure on the water resources.
- 5.1 The agriculture and allied sector of economy still contribute to about half of the state domestic products (SDP). The state has taken several initiatives for rural development through Panchayati Raj System. But agricultural productivity still needs to be boosted.
- 5.2 More than six fold increase in area under irrigation after 1956 has mainly benefited wheat, mustered, gram and cash crops. However, area under traditional coarse cereals like maize, barley, kudo-kutki, and jowar has been substantially decreased. Rapid expansion of area under soyabean and irrigated gram has resulted into expansion of area under nitrogen fixing crops reducing demand on chemical fertilizer.
- 5.3 Expansion of irrigation facilities has resulted into substantial increase in rate of fertilizer application, but it is still much lower than the national average. However, even despite the modest application rate of fertilizer in the state, the nitrate level in the ground water of few area has been reported to be in excess of the normal level. The Central Ground Water Board has identified the some deeper aquifers with high concentration of fluoride in more than half a dozen districts.
- 5.4 The substantial increase in net sown area after 1956 has come about from the conversion of the Common Property Resources (CPR), earlier available for grazing and forest land. Reduction in CPR has increased the pressure on forest and adversely affected the rural poor.
- 6.1 Mineral potential of M.P. is worthy of rich geological succession of the area. The endearments include abundant mineral reserves of bauxite, coal, diamond, copper, manganese, limestone etc. But the mining activities generally lends to offset the stability of environment of the area, resulting to deforestation, land degradation, pollution/disruptive of water system, air quality deterioration, vibration, noise, solid waste and socio-economic problems. The bauxite mining has to be restricted because of its impact ore origin place of Narmada and bio-rich Amarkantak. NMDC diamond mines of Panna being role producer of diamond also generates enormous amount of diamond ferrous waste affecting Panna National Park and Ken river.

- 6.2 Singrauli with fourth largest coal field of the country is developing as future energy capital with maximum number of super thermal power plants in this area. But, Madhya Pradesh is at receiving end from environmental point of view. This is because major mining areas and flyash disposal areas fall in M.P.
- 7.1 Energy is a crucial determinant of development. The major electricity generation facilities are located in eastern part of state but bulk of the electricity in agriculture is consumed in western part of state. Of all human activities, the production and use of energy has perhaps the largest impact on the environment. Increasing utilisation of energy by burning fossil fuels has been the major contributor to environmental degradation at local, national and trans-national levels. While its extraction disrupts terrestrial and aquatic ecosystems, conversion and combustion for producing energy are the principal sources of greenhouse gases and other air pollutants. At the household level, indoor air pollution from the use of traditional fuels is a major health hazard. Thus, the need to use energy, while keeping its adverse environmental effects minimal, is a major challenge that faces countries at all levels of development.
- 7.2 During the mid-1970s to mid-1980s, the concerns about energy were related to its availability, resulting in significant increase in prices. At present the concern has shifted to considerations of environmental impacts of energy production and use. The widening gap between demand and supply of energy calls for development of clean-energy sources like hydro-electric, wind energy, biogas etc.
- 8.1 Any discussion of priorities for ensuring greater income security – for better environmental management in the state – would have to take into consideration the importance of generating awareness in large volumes. At the policy level, the issue of ensuring stability of income is still seen as a political issue and not as an environmental one. The fact that falling income levels or rising population levels would eat into the amount of resources available is still far from being perceived, as it should be. Both in terms of primary resources (such as electricity, water supply and sanitation), income insecurity would mean greater pressure on the state exchequer to provide the basic amenities to the people at affordable rates, or for free. In India, for example, electricity is free for much of the agricultural populace. The rationale for this is that farmers need to cut down on production costs so that they may be able to retain enough earnings to sustain themselves. However, the root of all evil is the lack of awareness, at all levels, and about the severity of the poverty problem, and what is its possible repercussions on the environment.
- 9.1 The concern at hand is that as the numbers are too high presently, there is a need to curb population growth rates even more to ensure that the overall figure at a future date would be less alarming. Madhya Pradesh has adopted population policy. This state specific policy reiterates a commitment for a renewal momentum to population stabilization efforts. It also intends to address family welfare issues. However, it needs to be addressed with missionary zeal.
- 9.2 The positive lesson learnt from participate watershed management approach in the state need a sustained efforts and large scale replication of success stories. Low waste and no waste technologies in processing sector and green procurement needs to be promoted.
- 9.3 Awareness generation is the most potent tool for environmental conservation. The state is doing awareness programme as active partner of National Environmental Awareness Campaign (NEAC) and National Green Corp (NGC) Scheme of Government of India. More such programmes may help in bringing about pro-environment attitudinal changes. Over and above all mainstreaming of environment in all public policies and programmes will be an effective mode of addressing environmental concerns.

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Overview

Madhya Pradesh (including what is now Chhattisgarh) was constituted on recommendations of the State Re-organisation Commission on 1st November 1956. The Mahakoshal and Chattisgarh part of the Old Central Provinces (CP) and Berar, Vindhya Pradesh, Madhya Bharat and Bhopal were merged to form the new state. Some districts of CP and Berar were transferred to Maharashtra and there were a few minor adjustments with Rajasthan, Gujarat and Uttar Pradesh. Chhattisgarh was carved out of Madhya Pradesh and became the 26th state of India (Figure 1) from 1st November 2000.

At present, Madhya Pradesh consists of 9 divisions and 48 districts with 8 national parks and 25 wild life sanctuaries. Madhya Pradesh is a leading mineral producing state with deposits of 25 different minerals. It is the only diamond producing state in India.

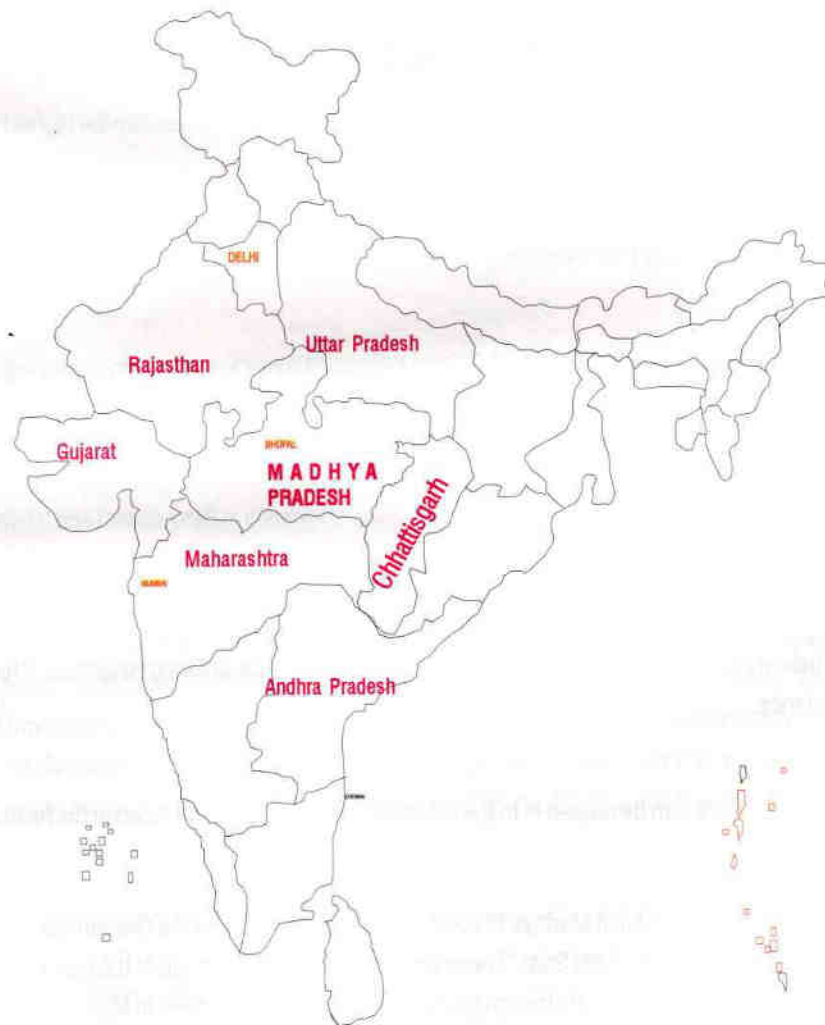


Fig. 1: Madhya Pradesh in India

Physiography

Geographical Boundaries

Madhya Pradesh lies between latitude 21°6' and 26°54' N and longitude 74° and 82°47' E. It covers a geographical area of 308,245 sq. km., which is about 9.38% of the total area of India. The State is land-locked and at no point is the sea less than 300 kms away. Uttar Pradesh, Chhattisgarh, Andhra Pradesh, Maharashtra, Gujarat and Rajasthan surround it.

Most of the State lies on the tableland of Central India bounded by the Upper Gangetic plains in the north; the Godavari valley in the south; the plains of Gujarat in the west; and plateau of Bundelkhand and Chhattisgarh in the east. The State is traversed by the Vindhya, Satpura and Maikal hill ranges running east west. The highest point is at Dhupgarh near Panchmarhi in Hoshangabad district, at 1,350 m. Most of the State has an elevation of between 305 to 610 m above MSL. Low-lying areas are in the narrow Narmada valley in the central and southern parts. In general, the State stretches across a geographically elevated position.

The Aravallies

This range runs along the border between Rajasthan and Madhya Pradesh and extends to the Mandsaur, Ratlam and Jhabua districts.

The Vindhyas

This range runs from east to west just north of the Narmada river with its highest point at Amarkantak. The Bhandar and Kymore hills are a part of this range.

The Satpuras

This range also runs east to west and separates the Narmada valley from the Tapi. These are the highest hills of Madhya Pradesh and the highest point in the State (Dhupgarh) lies here.

The geographical configuration of Madhya Pradesh is such that all major rivers flow outwards from the State as shown in the figure. The State is drained by the following major river systems:

The Narmada

Amarkantak is the source of this river, which flows for 1079 km through Madhya Pradesh before entering Gujarat. It is the fifth largest river in the country and drains almost 19% of the State. Revered as a sacred river, it is often referred to as the poor man's Ganga.

The Tapi

South of the Narmada, the Tapi is a comparatively much smaller river, originating in Betul district and flowing through Gujarat before joining the Arabian Sea.

The Chambal

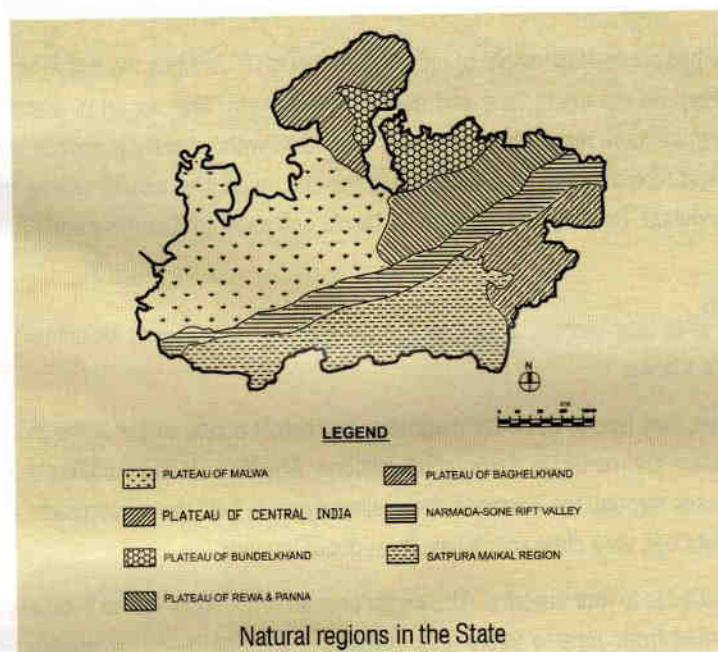
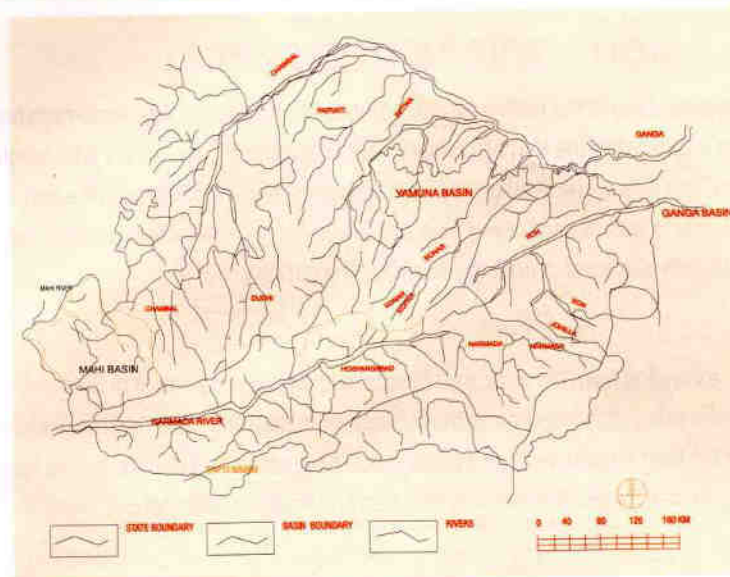
This river starts near Indore and flows north in the western part of the State before entering Rajasthan, it forms the north-west boundary of the State for some distance.

Natural Regions

Based on its topography, the State can be divided into the following natural regions as shown in the forthcoming figure.

The Plateau of Malwa

Covering almost the entire western region of Madhya Pradesh, the plateau, formed by the Deccan trap rocks, starts north of the Narmada and Betwa rivers and covers 18 districts of the State. The capital Bhopal lies on one edge of the plateau. The average annual rainfall in the plateau is over 900 mm. The climate is moderate though the temperature reaches 42-43°C in May. While the northern portion of the plateau has almost no forests, the southern portion consisting of Dewas, Raisen and Hoshangabad has a good deal of teak forest.



The Plateau of Central India

This region covers the northern part of the lower basin of Chambal river. It is formed by the Vindhayan rock groups with the deccan trap in the south and the Bundelkhand gneiss rocks in the east. The Bundi and Karauli hills form its western boundary. The region presents an amalgam of low land and upland topography. The area is marked by deep ravines of the Chambal, Kalisindh and Parvati rivers. The plateau is 200-300m high but is close to the Yamuna River on its northern side. The average rainfall is less than 750 mm and the temperature ranges between 42.5°C and 5.2°C. The region has no mineral resources. The districts of Bhind, Morena and Gwalior lie in this region.

The Plateau of Bundelkhand

It lies to the east of the Central India Plateau and is bound on the northeast by the Rewa – Panna plateau. The area consists of granite rocks of the Arabian era. Generally, the plateau is flat with marginal slopes and the topography is smooth and undulating. One third of the northern plain area is monotonously flat and is in strong contrast to the Vindhyan tableland, which rises in three well – marked escarpments roughly delineated by the Betwa, Dhasan, Kan and Sindh rivers. The average rainfall is 750-1030 mm and the temperature ranges between 42.5°C and 7.5°C. The region consists of Datia, Chhatarpur and Tikamgarh districts and is poor in mineral resources.

The Plateau of Rewa and Panna

This is also known as Vindhyan plateau and lies to the northeast of the Bundelkhand plateau. The maximum height of the plateau is 750m. The Bhandar hills of the Vindhya State group and the Kymore ranges have a number of waterfalls with heights up to 450m. The area is drained by the Ken, Sonar, Berma and Tons rivers. The average rainfall is between 1125-1250 mm and the temperature ranges between 42.5 °C and 12.5°C. The region has thick forests with abundance of bamboo and is rich in mineral resources. Rewa, Panna, Satna and Damoh districts lie in this region. Panna is the only diamond-producing district in the country.

The Narmada – Sone river Valley

This is the largest valley in the State, extending from the northeast to west with an average height of 300m. It is bounded by the Vindhyan, Bhandar and Kymore hills in north of the valley; the Satpura and the Maikal hills in the south; and the Bhagelkhand highlands in the east. The valley is narrow, and the trap falls in the Narmada River do not allow much navigation. It is drained by the Narmada and Sone rivers. The Narmada valley contains limestone and coal mines. The districts included are Jabalpur, Narsinghpur, Hoshangabad, Khandwa, Khargone, Shahdol and Sidhi.

The Satpura and Maikal Region

The region south of Narmada Valley has an average height of only 300 m though it contains the highest point in the State, the peak of Dhupgarh. The Satpura slope is sharp on the south face and gentle on the north. The region is drained by Tawa, Johila, Denwa, Banganga and Vardhan rivers. The temperature ranges between 39°C and 10 °C with an average rainfall between 1250 and 1500 mm. The area abounds with dense teak and mixed forests. It is also rich in mineral resources, which include limestone, fire clay, dolomite and copper. The area includes Chhindwara, Betul, Seoni, Balaghat, Mandla and parts of Khandwa and Khargone districts.

Climate

Madhya Pradesh has been divided into four climatic zones, which are the Northern Plains; Mountainous Regions of Vindhya; Narmada River Valley; and Plateau of Malwa,

As the northern plains are far from sea, they tend to be hotter in summer and cooler during winter. In the mountainous Vindhyan regions, it is not very hot in summer and winters are moderate. Famous hill stations, Amarkantak and Pachmarhi, are situated in the Vindhyan regions. As the Tropic of Cancer passes through the Narmada river valley, extreme heat during summers and moderately cold winters are experienced. The Plateau of Malwa has very pleasant climate throughout the year.

Climatologically, the year may be divided into four seasons. The winter season from December to February is followed by the summer season from March to May. The period from June to September constitutes the South-west monsoon season and the period from October to December forms the post-monsoon season.

Summer begins in March and remains until the arrival of monsoon i.e. Mid-June. The months of April and May are hot, very dry and generally uncomfortable. Due to lower temperatures, the plateau regions are comparatively less uncomfortable in summer. The weather tends to be oppressive during June due to high humidity and temperature. The temperature increases from the month of March to touch 40°C in May. The temperature rises in the north-west, as it is drier and lacks vegetation. In Gwalior, Morena and Datia districts, the temperature reaches 44°C.

Rainfall occurs between mid June and October. Steamy monsoon winds in June flow towards south and south-west directions and these cause heavy rainfall. In the west, monsoon winds from the Arabian Sea and in the east, winds from Bay of Bengal cause heavy rainfall. Most rains occur during July and August. Monsoon winds from Bay of Bengal and Arabian Sea cause rainfall in the Vindhyan region. Annual rainfall in the north-west is very low as compared to the south and southeastern regions. The rainfall in the east varies in between 1400 mm and 1650 mm where as in the west it is approximately 800 mm. The quantity of rainfall varies each year in the State.

The next three months (July, August, September) are fairly comfortable due to reduced day temperatures, although humidity continues to be very high.

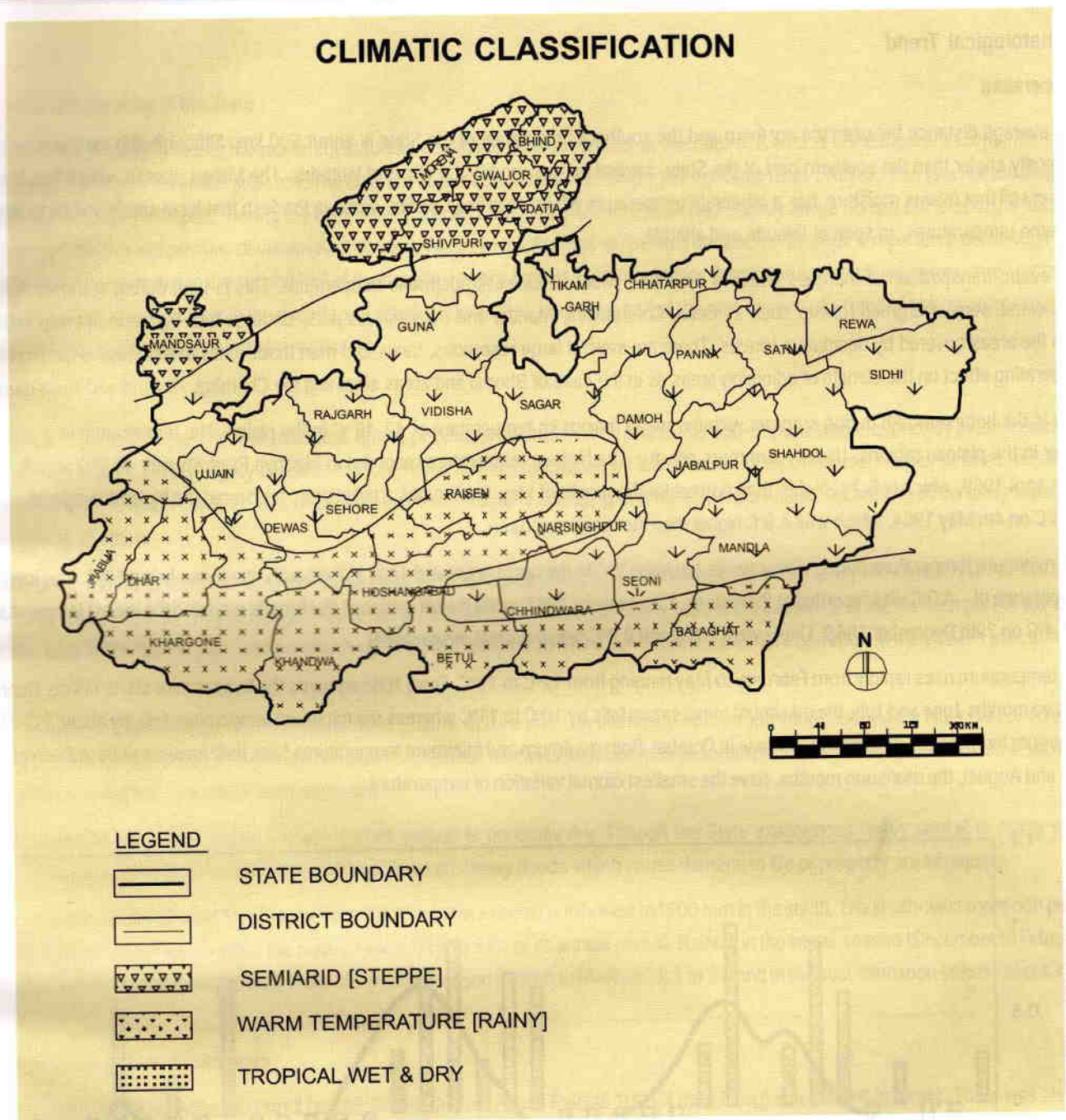


Fig: Climatic Classification of Madhya Pradesh

Winter starts in November each year and the temperature gradually falls, with December and January being the coldest months. The southern parts of State are colder than northern regions. The weather in winters is usually dry, with clear skies and wind. The period from November to March is generally pleasant over the entire State except when severe cold waves associated with the Western Disturbances affect northern parts of the State. As the temperature declines gradually, fog occurs at night in mountains and high lands. Cyclones cause light rainfall in the north-west during December and January. Cyclonic rain is very good for winter crops like wheat, channa and masoor. The coldest place in State is Shivpuri town.

Climatological Trend

Temperature

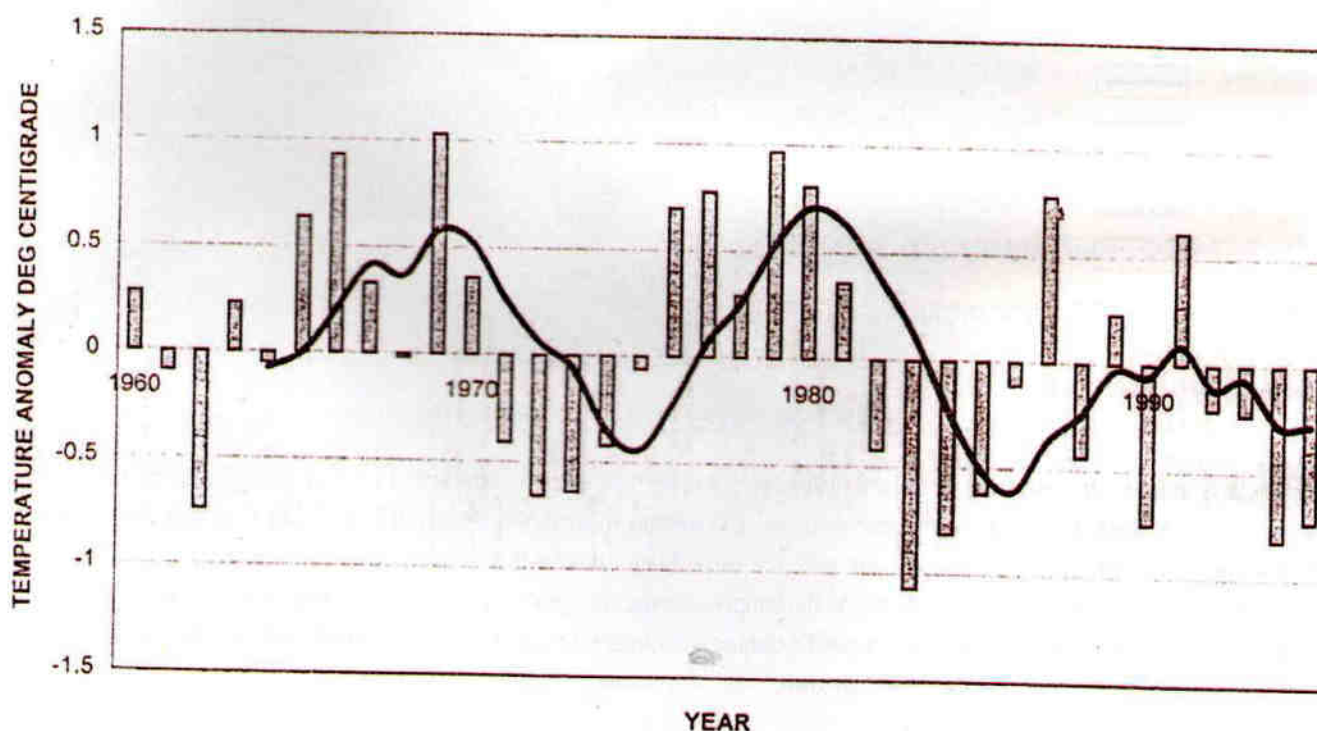
The average distance between the northern and the southern boundaries of the State is about 500 km. Although, the northern part is generally cooler than the southern part of the State, several factors modify the effect of latitudes. The Malwa plateau, which has black cotton soil that retains moisture, has a moderate temperature while areas like Gwalior, Vindhya Pradesh that have sandy soil experience extreme temperatures, in spite of latitude and altitude.

The evapo-transpiration of the trees releases moisture, which reduces atmospheric temperature. This is high during summer. Areas with dense semi-evergreen forests such as Betul, Chhindwara, Mandla and Balaghat districts, undergo less variation in temperature than the areas covered by deciduous forests. There are several large reservoirs, tanks and man made lakes in the State, which have a moderating effect on the climate of adjoining areas as in the case of Bhopal and areas adjoining the Chambal, Hirakud and Tawa dams.

May is the hottest month during summer with the mean maximum temperature of 47-48°C in the plains. The temperature is 2 to 5°C lower in the plateau regions. Usually summers are dry. The highest temperature recorded in Madhya Pradesh was 48.8°C at Sidhi on 10th April 1969, which is 6.7°C higher than normal for the month of May. Pachmarhi, a hill station, registered the highest temperature of 40.6°C on 4th May 1954, which was 4.6°C higher than the mean maximum.

The minimum temperature during winter varies between 7°C in the north-west and 14°C in the south, the mean being 10°C. The lowest temperature of - 4.0°C was recorded at Shivpuri on 13th January 1967, while the hill station of Pachmarhi recorded the lowest temperature of 1.4°C on 29th December 1968. These were 9.1°C and 8.9°C below normal, respectively.

The temperature rises rapidly from February to May ranging from 12°C to 19°C. From June onwards the temperature starts falling. During the two months June and July, the maximum temperature falls by 10°C to 11°C whereas the minimum temperature falls by about 3°C. The maximum temperature registers an increase in October. Both maximum and minimum temperatures have their lowest values in December. July and August, the monsoon months, have the smallest diurnal variation of temperature.



Yearly variation of temperature over Madhya Pradesh 1960-1995 5 year moving average

Trend of temperature in the State

Temperature is among one of the major constituents of climate as well variants of the nature. It affects contemporary crops, life style, economy, culture and even literature too. The diagram represents variation in temperature of State from 1960 to 1995 (source the diagram collected from IMD, Bhopal). During the early sixties, the average temperature of State was slightly above normal but later in the decade, it rose and the highest positive deviation was noticed. Again, in the first half of the next decade the average temperature declined, it was below normal. However, in the second half of the decade average temperature was higher. During the early eighties, temperature recorded was the lowest, whereas later in the decade, temperature fluctuated. In the first half of the next decade, the trend of temperature observed was lower than the average normal temperature.

Rainfall

Rainfall characteristics are difficult to assess due to peculiar problems in the tropical and sub-tropical areas, especially in the Indian and Sri Lankan region. This is largely because of topographical features created by the direction of the mountain ranges besides the erratic nature of the monsoon currents. It is often claimed, that climate is changing and rainfall in particular, decreasing at certain places and increasing at others.

Most of the rainfall is received from the south-west monsoon originating from the Arabian Sea. However, the eastern part of the State receives rainfall from the Bay of Bengal. The onset of the monsoon varies from early June in the eastern and the western part of the State to late June in the central part, and continues up to early October. Pre-monsoon showers are more common in the eastern part than the western.

The intensity of rainfall varies from month to month. Rains, in June and July are heavy, with strong winds. During the latter part of July and early August, rainfall is mild though continuous. In September, rainfall is sporadic though sometimes heavy. During winters, some showers are also received from the north-west monsoon.

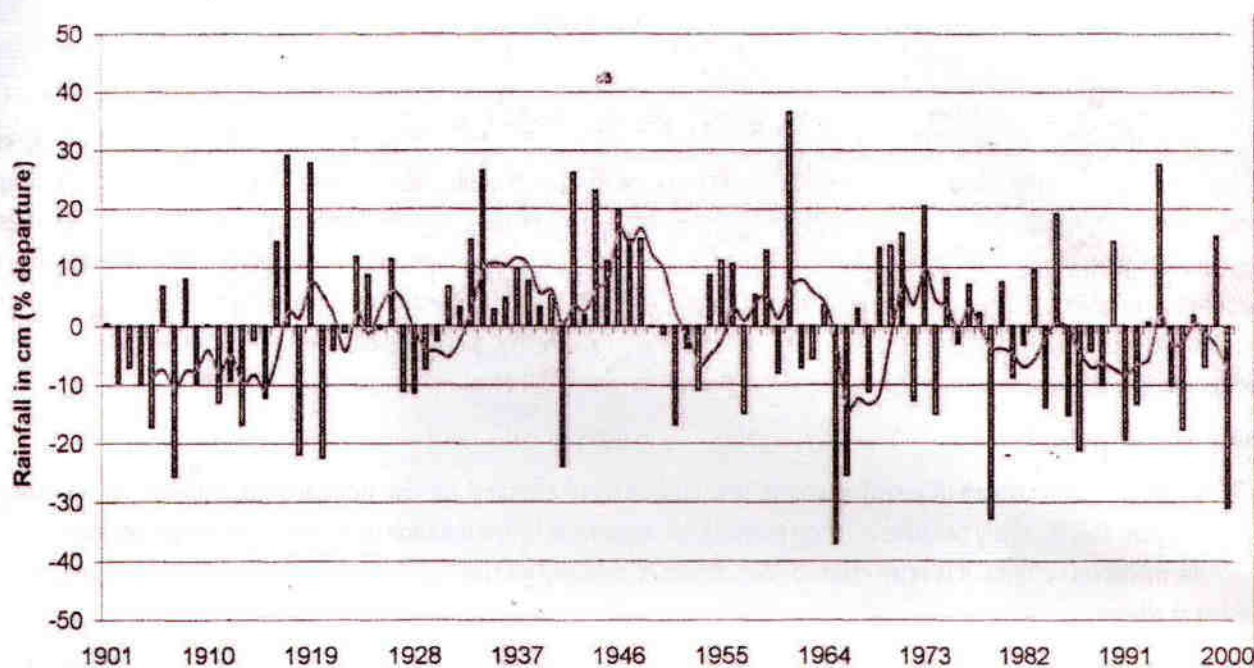
Rainfall during summer is negligible and the hot season is generally dry. Though the State experiences heavy rainfall in many years because of forests and favourable topographical features, heavy floods which cause damage to life or property are infrequent.

The total annual rainfall in the State varies from 700 mm in the extreme north-west to 1600 mm in the south. The south-west monsoon period is the principal rainy season when the State receives 84% to 94% of its annual rainfall. Rainfall in the winter season (December to February) is about 1% to 4% of the annual total, in the hot weather season (March to May) about 1 to 3% and in the post-monsoon season about 3% to 7%.

Status of Rainfall over past years

During the year 2002, Badwani district had 48% more rainfall (Actual Rainfall 1003.4 mm) than the normal (6792 mm). There was also an increase of 40% (1063 mm) in rainfall over Shahdol from the normal (rainfall of 634.5mm). However, 14 districts concentrated in the south Dhar (794.2mm), Khandwa (742.4 mm), Betul (920.4mm), Hoshangabad (1395.3 mm), Sehore (924.2mm), Raisen (952.3mm), Jabalpur (1044.9 mm), Seoni (1083.3mm), Balaghat (1449.0 mm) and some districts are from northern side (Tikamgarh, Chhatarpur, Panna, Satna and Umariya) received normal rainfall. About 27 districts received less than normal rainfall and are under the category of deficient rainfall. Two districts Neemuch and Sheopur received scanty rainfall during the year.

During 2003 excess rainfall in Chhatarpur (1348.5mm), Panna (1803.7mm), Damoh (1379.1mm), Satna (1592.1mm), Rewa (1441.6mm), Katni (1605.9mm), Jabalpur (1605.9 mm), Umariya (1479.4 mm), Shahdol (1320.6mm) districts in the eastern part of the State caused floods. Some districts in the southern part of the State also received more than normal rainfall. These are Jhabua, Indore, Badwani, Khargone, Chhindwada and Balaghat. Out of 24 districts only 5 (Neemuch, Morena, Gwalior, Tikamgarh and Harda) received less than normal rainfall.



Source: India Meteorology Department, Bhopal Fig : Variability of monsoon rainfall over Madhya Pradesh from 1901-200

During 2004, most districts received normal rainfall. Only 19 districts are in the category, which have deficient rainfall. These are Sheopur, Morena, Bhind, Datia, Shivpuri and Tikamgarh in the northern parts, Sidhi Umari and Shahdol in the eastern part and Khandwa, Harda, Betul, Chhindwada, Seoni and Balaghet in the southern part. No district falls in the category of districts with scanty rainfall.

Trend of Rainfall during the last Century (from 1901- 2000)

Each year rains in the State vary as per geo-climatic conditions and other intervening elements of nature. The figure represents variability of monsoon rainfall over the State in last century. The figure shows deviation of actual rainfall from normal rainfall.

- ❖ It is very clear from the diagram that the departure trend of rainfall is more negatively inclined especially during the first decade.
- ❖ During the second decade, rainfall in the State fluctuated, which means, the trend in each year differed in terms of quantity of rains in the State.
- ❖ For four consecutive years after 1928, rains were not very scarce.
- ❖ The monsoon trend in next seventeen years has been observed as very high, as the trend in the diagram is positively inclined during the decade except for one year.
- ❖ During the period when India became independent, rains in the State were slightly lower than the normal and drought occurred in some places. In 1955, the monsoon trend was again positively inclined but the overall trend of rain in the decade is considered as normal.
- ❖ The highest deviation from normal or the highest rainfall recorded in whole decade in the State occurred between 1955 and 1964. During the same decade, the lowest rainfall in the century was also recorded.
- ❖ During the early seventies, above than average rainfall was recorded all over the State.
- ❖ During the early eighties, the second lowest rainfall in whole century was recorded which leads to the drought in the State.
- ❖ In last two decades of the century, below average rainfall was recorded.

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The rainfall trend over the past hundred years may be briefly defined, as more negatively deviated and in last two decades of the century, it was below average. The post independence era has seen continuous monsoon fluctuations. In the last two decades, fluctuations in rainfall were recorded, and these were more negatively inclined.

Cloudiness

The period from November to March is mainly cloudless, though a few clouds may be seen in the afternoon. This continues in April and May, over west Madhya Pradesh but clouds over the east, increase and about 3-4 Oktas of the sky remain covered during the evenings. During the monsoon season (June-September), skies are heavily clouded especially during July and August, when more than five Oktas of the sky are covered with clouds. On an average, in each of these two months, the sky remains overcast for more than 15 days per month and is clear very seldom. During October, cloud density decreases over the entire State, particularly in the northwest.