A COMPUTER BASED DECISION SUPPORT SYSTEM FOR SUSTAINABLE DEVELOPMENT OF SOUTHERN MAHARASHTRA REGION

A THESIS

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By

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Candidate's Declaration

I hereby certify that the work which is being presented in the thesis entitled **A COMPUTER BASED DECISION SUPPORT SYSTEM FOR SUSTAINABLE DEVELOPMENT OF SOUTHERN MAHARASHTRA REGION** in fulfilment of the requirement for the award of the Degree of Doctor of Philosophy submitted in the **Department of Architecture and Planning** of the **University of Roorkee** is an authentic record of my own work carried out during a period from Aug. 1995 to November 1997 under the supervision of Prof. N. K. Tayal and Dr. G. C. Nayak.

The matter embodied in this thesis has not been submitted by me for the award of any other degree.

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Abstract

Sustainable Development, which has been accepted as an all important concept in recent years, is likely to remain just that, without a strong ethical base to support it and a suitable technology to operationalise it. The operationalisation of this concept is of paramount importance at the global as well as the local levels.

This thesis endeavours to operationalise the concept of sustainable development at the regional / district level by developing a computer (spread-sheet and GIS) based visual-interactive-predictive-corrective Decision Support System which will be user-friendly and easy to understand at the grass-roots levels. It goes on to demonstrate the use of this DSS in the case of the Southern Maharashtra Region which presents a collage of diverse socio-economic and physio-climatic conditions and is currently at crucial cross-roads of developmental options.

It takes a look at the requirement of an ethical framework of "Trusteeship" (care, respect and responsibility) towards the environment and goes on to illustrate the concept of sustainable development at the regional level as an eco-developmental issue. The history of eco-developmental thought is traced up to its present ubiquitous status. The definition of a holistic human development paradigm and the need for public awareness and participation in order to achieve it is emphasised. The role required to be played by the government to improve the quality of life through assessment of the demand for and the provision of both, positive and negative public goods, in order to facilitate the attainment of this holistic development paradigm is spelt out. The technological base required for playing this role effectively is outlined.

The theories, concepts and techniques which form the substantive background for the postulations and the development of this thesis, along with the technological basis for its operationalisation are spelt out. The theories of Regional Concept,

Place - Work - Folk, Ecology and Ekistics, Corporate Management and Decision-Making, Central versus Participatory regional Planning are enunciated in brief. The present status of regional planning in India is mentioned. The changing role of the district administration in information collection, storage, management and dissemination along with the enabling technology for Sustainable Regional Development (SRD) in the form of a country-wide computer-communication and Geographical Information System network is emphasised.

The various dimensions of man - environment interactions and the conceivable approaches to the study of these have been looked at. The concept of sustainability and the limits of this concept have been examined. The constraints on development and their inherent flexibility which necessitate an anticipatory-adaptive approach in order to conform to the path of sustainable development are studied. The deductive-inductive approach adopted in this study has been out-lined. A conceptual model of Sustainable Regional Development (SRD) has been postulated and its subsystems defined along with their respective elements. The qualities required in these elements or indicators of sustainable development are specified and the selected indicators highlighted. The theoretical and statistical validity of the selected indicators has been established. The possible frameworks for development and organisation of sustainable development indicators have been examined, finally settling for the combination type of framework for this study.

A systems approach to Sustainable Regional Development (SRD) is adopted by envisaging it as a holistic concept requiring a Pareto-optimal balance to be maintained over time and space between four components of liveability (COL)s namely - social well-being, economic vitality, infrastructure availability and environmental quality.

A set of ten indicators has been selected under each COL. These indicators have been classified as positive or negative depending upon whether they contribute to or detract from the path of sustainable development. The directionality of these indicators of sustainable development has been decided by conducting a experts opinion poll. Use has been made of Multi-Variate Analysis Theory for converting these indicators into Sustainable Development Indices (SDI)s through a standardisation technique. The four Components of Liveability (COL)s have been obtained by a weighted summation of these ten Sustainable Development Indices (SDI)s each through Multi-Attribute Utility Technique. An overall sustainable development function, Composite Aggregated Development Index of Sustainability (CADIS) is worked out by aggregating the four COLs in a similar fashion. These have been used in a spatio-temporal analysis with the help of the Decision Support System developed by this research.

A computer based visual-interactive-predictive-corrective Decision Support System (DSS) for operationalising the concept of SRD has been developed. This utilises the dynamic data to data and data to graphic interlinkage and visualisation capabilities provided by a windows based spreadsheet and geographical information system (GIS) softwares. It can be used effectively by the decision makers at the grass-roots level for planning, monitoring and enlightened decision making so as to maintain the region / district on the path of sustainable development. This DSS is visual-interactive-predictive-corrective in structure and can be used gainfully to visualise the effects of tentative decisions a priori in data, chart and graphic (map) forms. The seven cyclic stages of the DSS have been described.

The use of this DSS has been demonstrated in the case of the Southern Maharashtra Region comprising of five districts. Data has been collected for all forty

indicators of sustainability for three time frames of 1971, '81, and '91. This has been converted into SDIs, COLs and CDIs by MVA techniques and extrapolated to 2001 and 2011. The bar charts and trend-lines which are dynamically linked to the data help in easy visualisation of the trends. The levels of and weightages attached to each COL can be altered interactively by the decision makers. These would lead to identification of Critical Success or failure Factors (CSF)s and the required modifications if any in these through policy interventions. Scenario building allows a priori visualisation of the financial, physical and temporal implications of these decisions. A Geographical Information System (GIS) software has been used to visualise the spatial implications of these decisions, thus giving a feed-back to sectoral policy making.

The section on conclusions and recommendations outlines the theoretical and experimental contributions of this thesis along with the efficacy and the limitations of the DSS postulated. Finally suggestions for desirable further research directions have been listed.

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Milind V. Telang

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Glossary of Terms and Abbreviations Used

Autos/LP	=	Automotive vehicles per lakh of persons
BirthRt	=	Birth Rate
Bnks/LP	=	Banks per lakh of persons
BrnLnd%	=	Barren Land percentage
CADIS	=	Composite Aggregated Development Index of Sustainability
COL	=	Component of Liveability Index
CSF	=	Critical Success or failure Factors
DeathRt	=	Death Rate
DenPop	=	Density of Population
DfrstRt	=	Deforestation rate
DifM-Flit%	=	Difference in Male-Female Literacy Percentage
EdInst/LP	=	Educational institutions per lakh of persons
ElHS%	=	Electrified Human Settlements Percentage
EmpM&Q	=	Employment in mining and quarrying
FdCrps%	=	Food Crops Percentage
FdGrnYld	=	Food Grain Yield
FPrtR	=	Female Participation Rate
FrstLnd%	=	Forest Land Percentage
FWks/LP	=	Factory workers per lakh of persons
HslessPop%	=	House less Population Percentage
HspBeds/LP	=	Hospital beds per lakh of persons
IND	=	India (nation)
InfMrtRt	=	Infant Mortality Rate
IrrAr%	=	Irrigated Area percentage
KOL	=	Kolhapur (district)
Lvstk/HP	=	Livestock per 100 persons
MAH	=	Maharashtra (state)
NAgriEmp%	=	Non-agricultural Employment Percentage
NArSwn%	=	Net sown area as percent of total area
PCIncm	=	Per Capita Income

PopGrthRt	=	Population Growth Rate
PO/LP	=	Post offices per lakh of persons
RAT	=	Ratnagiri (district)
RdKms/100Kms	=	Road kms. per 100 Sq. kms
RlyKms/LP	=	Railway kms per lakh of persons
RnfPC	=	Rainfall Per Capita
SAN	=	Sangli (district)
SAT	=	Satara (district)
SDI	=	Sustainable Development Index
SIN	=	Sindhudurg (district)
SMR	=	Southern Maharashtra Region
SRD	=	Sustainable Regional Development
SwnAr%	=	Sown area percentage
Tel/LP	=	Telephones per lakh of persons
Tlit%	=	Total Literacy Percentage
TPrtR	=	Total Participation Rate
Trcts/100H	=	Tractors per 100 hectares
UnEmp%	=	Unemployment Percentage
UrbPop%	=	Urban Population Percentage

Chapter 1.

INTRODUCTION

1.1 Background:

Sustainable Development has of late become a key concept not only for the sake of *our one and only earth*, but for the survival of mankind itself. It has been realised lately that the best way to ensure the adoption of a sustainable lifestyle and development pattern is to empower and educate the people to take charge of their own destiny. The adoption of an ethic of trusteeship towards the environment and the creation of an environment for the operationalisation of the policies of Sustainable Development at the regional level will ensure both intra-generational as well as inter-generational equity through sustainable resource use coupled with a holistic human development paradigm.

The emergence of a cost-effective electronic communications, information and computer technology has today provided the means for the deployment of sustainable development policies at the grass-roots level. A country-wide District Information System (DISNIC) is being put into place by the National Informatics Centre (NIC) of the Government of India, which will enable the easy collection, management, sharing and dissemination of data across the country. It will also facilitate the formation of national data bases which could be accessed for on-line information at the village, Panchayat, block (taluka) and district levels.

The 73rd and 74th constitutional amendments of 1992 have reversed the development and planning process from top-down to bottom-up thus putting the responsibility for this squarely on the decision makers at the grass-roots level (village panchayats and zilla parishads). But the serious shortage of planning expertise at these levels points to the requirement of a suitable Decision Support

System (DSS) or expert system to gainfully use this electronic information network and enable successful implementation and monitoring of Sustainable Regional Development (SRD) policies.

1.2 The Problem:

Sustainable Development is a multidimensional, spatio-temporal-dynamic phenomenon. It has to deal with various facets of man - environment interaction in terms of social, economic, infrastructural and environmental quality aspects. Each of these parameters has a number of criteria or elements which can be measured, but not necessarily in comparable units of measurement. The identification of these elements critical to sustainable development and the evolution of a common parameter for their measurement are the foremost requirements in attempting to develop a model of this spatio-temporal-dynamic system, so that the elements of the subsystems themselves and the interactions between the defined subsystems may be quantified. Once this task has been accomplished, one needs to be able to apply this measure to track the system through time and to compare different geographic units so as to understand the relative improvement or decline of the various criteria as related to sustainability. It is only through continuous monitoring of these movements and offering midcourse corrections that one can hope to keep the region on the path of sustainable growth. An additional requirement is that the system developed has to be uncomplicated enough to be well understood by the users who are not expected to be experts in these technical fields, yet at the same time be able to model the system adequately and accurately. It is normally found in such situations, that systems which provide a visual out-put stand a better chance of being appreciated by the laymen than highly sophisticated mathematical models which do not provide a visual out-put. The research problem therefore, is to develop such a visual - interactive - predictive - corrective decision support system for

monitoring sustainability parameters on a periodic basis and make mid-course corrections if required to maintain the region / district on the path of sustainable growth.

1.3 Objective of Research:

It is the endeavour of this thesis to develop such a visual - interactive - predictive - corrective computer based Decision Support System for easy visualisation of dynamic sustainable development parameters and their movement over time and space so as to enable informed and enlightened decision making at the regional and district levels leading to the operationalisation of the policies of sustainable development. It conceptualises a spatio-temporal and dynamic regional system which needs to be guided on to a suitable trajectory of sustainable development. It utilises the dynamic data - graphics linking capabilities of a Personal Computer (PC) based spread-sheet and Geographic Information System (GIS) softwares for achieving these objectives.

1.4 Scope and Limitations:

The objective of this study is the development of a Decision Support System for aiding decision making leading to sustainable development of regions / districts by enabling a priori visualisation of the effects of tentative decisions taken and thus arriving at compromise strategic - operational solutions. The emphasis therefore has been on using available technology in the best possible manner rather than develop new technology. As such no new computer programme will be attempted. The emphasis has throughout been placed on practical application of the conceptual spatio-temporal-dynamic model of the region based on substantive theories of regional planning and systems dynamics. Again for similar practical reasons, chiefly data normally available at the field level has been used and no special survey has

been undertaken to gather uncommon data which would not be available in field applications.

1.5 Approach and Sequence of Presentation:

1.5.1 Methodological Approaches: Three possible methodological approaches to scientific research have been identified by experts (Wolf C.P. 1974) -

1) Inductive approach, which makes general inferences from particular instances. This is the case studies approach. Here the emphasis is not on perfecting the methodology or theory, but on solving the immediate problem.

2) Deductive approach, on the other hand draws inferences from the general to the particular. Here we begin with a concept, convert it to a variable, hypothesise a relationship between variables to achieve a theoretical formulation, then develop indicators and measurement techniques to determine the direction and test the strength of association, finally arriving at a parameter estimation. In this approach the development of theory is considered most important.

3) The Inductive-Deductive or Analytic Induction, which combines both the inductive and the deductive approaches. This approach lends itself to the simultaneous examination of those things which are general and theoretical as well as the particulars of a given event. Quite apart from forging theoretical linkages, this approach has an undeniable immediacy and utility, despite acute "causal ignorance".

It is considered that the third approach that is the method of Analytic induction would be the most suitable in the present study as the problems of sustainable development have an urgency especially for the developing countries and can not therefore await the perfection of methodology and theory.

1.5.2 Sequence of Presentation: The first part of this thesis (chapters 1 to 6) deals with the theoretical development of the framework of Sustainable Regional Development (SRD) and a Decision Support System (DSS) for operationalising the same. It establishes the need for an ethic of trusteeship towards the environment, discusses the concept of SRD and the theories and techniques used in the development and operationalisation of this concept. It conceptualises a spatio-temporal-dynamic regional system and develops a computer based Decision Support System (DSS) for Sustainable Development of regions.

The second part (chapters 7 and 8) deals with the empirical application of the DSS and demonstrates the use of such a DSS for the Southern Maharashtra Region comprising of five districts.

The third part (chapter 9) gives the conclusions and recommendations. The theoretical and experimental contributions of this thesis are listed. The effectiveness of this approach and some problem areas are examined and suggestions for future research directions are given.

The thesis has been presented in the following sequence -

Chapter 1. This gives an introduction to the topic of research and sets out the objectives, scope and limitations and the order of presentation.

Chapter 2. Focuses on the need for a suitable evironmental ethic conducive to the achievement of sustainable regional development. It examines various traditional ethics and settles upon the ethic of Trusteeship (ethics of care, respect and responsibility) advocated by Mahatma Gandhi as the most appropriate. It goes on to look at the problems of regions in the light of such an environmental ethic and spells out the implications thereof.

Chapter 3. This chapter traces the history of eco-developmental thought, establishes a holistic human development paradigm and out-lines the concept of sustainable development. It also looks at the role required to be played by the government in ensuring that the nation follows a trajectory of sustainability in its endeavour to achieve this holistic human development paradigm. The technological base and other factors required for this are outlined.

Chapter 4. The theories, concepts and techniques which form the substantive background for the postulations and the development of this thesis, along with the technological basis for its operationalisation are spelt out in this chapter. The theories of Regional Concept, Place - Work - Folk, Ecology and Ekistics, Corporate Management and Decision-Making, Central versus Participatory regional Planning are enunciated in brief. The present status of regional planning in India is mentioned. The changing role of the district administration in information collection, storage, management and dissemination along with the enabling technology for Sustainable Regional Development (SRD) in the form of a country-wide computer-communication and Geographical Information System network is emphasised.

Chapter 5: This chapter takes a look at the various dimensions of man - environment interactions and the possible approaches to the study of these. The approach taken in this study has been out-lined. The concept of sustainability and the limits of this concept have been examined. The constraints on development and their inherent flexibility which requires an anticipatory-adaptive approach in order to conform to the path of sustainable development are studied. A conceptual model of Sustainable Regional Development (SRD) has been postulated and its subsystems defined along with their respective elements. The qualities required in these elements or indicators of sustainable development have been specified and the

selected indicators highlighted. The theoretical and statistical validity of the selected indicators is established.

Chapter 6: The theoretical development of a computer based interactive-iterative-predictive-corrective Decision Support System (DSS) has been accomplished in this chapter. The selection of appropriate indicators of sustainable development, their conversion into Sustainable Development Indices (SDI)s through standardisation, the methodology for aggregation of SDIs into Components Of Liveability (COL)s and Composite Aggregated Development Index of Sustainability (CADIS) is detailed out. The seven cyclic stages of the DSS have been described.

Chapter 7: In this chapter the application of the DSS to the Southern Maharashtra Region (SMR) has been described. The five districts of Ratnagiri (RAT), Sindhudurg (SIN), Satara (SAT), Sangli (SAN), and Kolhapur (KOL) comprising the SMR have been compared to each other, the region (SMR), the state of Maharashtra (MAH) and the nation of India (IND). The data on the sustainable development indicators pertaining to these geographic units has been collected for the time frames of 1971,'81, '91. The SDIs, COLs and the CADISs have been calculated for the time frames of 1971,'81, '91 and extrapolated to the years 2001 and 2011.

Chapter 8: The last two stage of the DSS have been applied to the SMR in this chapter. Identification of Critical Success or Failure factors for sustainable development of the region has been done. Thereafter, Scenario-1 has been built up through the adjustment of CADIS, COLs and SDIs. The financial, physical and spatial implications of these adjustments were studied thus giving a starting point for building up scenario -2 after decisions on value judgements through group decision making techniques.

Chapter 9: This last chapter deals with the conclusions and recommendations. The theoretical and experimental contributions of this thesis are spelt out along with the

efficacy and the limitations of the DSS postulated. Finally suggestions for further research have been listed.

Chapter 2

Ethics of Sustainability

2.1 Introduction:

> Mahatma Gandhi said - "The earth provides enough for every man's needs but not for every man's greed. The incessant search for material comforts and their multiplication is an evil. I make bold to say that the Europeans will have to remodel their outlook, if they are not to perish under the weight of the comforts to which they are becoming slaves. We cannot have an ecological movement designed to prevent violence against nature, unless the principle of non-violence becomes central to the ethos of human culture." (Khoshoo T.N. 1995)

In this chapter we will discuss some established modes of interaction with nature, and examine their merits and demerits in promoting a sustainable development. We will then look at the ethical requirements in advancement of sustainable development at various spatial scales, especially at the regional one. The problems of sustainable development at the regional scale will be briefly introduced.

2.2 Ethics of Sustainability:

Ethics may be defined as a set of unwritten codes which are established to guide community and individual action. Ethics are matters of social value and ideals built into the culture of a people. An environmental ethic includes norms, values and principles regarding the relationship of human species to nature. Sustainability refers to the capacity of a system to endure. Sustainability as pertaining to our

ecosystem may therefore be defined as the persistence of certain necessary and desired characteristics of the natural environment and the socio-political system (adapted from Robinson et al, 1989). As such it should not only be possible but desirable to formulate principles of conduct that respect the ongoing integrity of functioning ecosystems and that raise concerns for the distribution of human welfare and well-being both now and in the future. It is useful here to examine a few established environmental ethics.

2.2.1 The Ethic of Ecocentrism:

The Vedas which are the holy scriptures of the Hindus perceive the world as a family (*Vasudevkutumbakam*).The opening stanza of *Ishopanishad* which is one of the Vedas says - "The whole universe together with its creatures belongs to the lord (Nature). No creature is superior to any other and the human being should not have absolute power over Nature. Let no species encroach upon the rights and privileges of other species. However one can enjoy the bounties of nature by giving up greed." The Hindu ethic of "*Advaita*" is a thesis of indistinguishability between human and non-human nature. It postulates that Brahman or Godhead pervades all entities; arguing that all creation is a passage from the inertia of matter to the awareness of Godhead, it links humans and animals in one single continuum. Indeed, the Indian scriptures teach that all entities are destined to advance, through the cycle of birth and rebirth, towards the highest attainment of self-realisation that is God-hood. Every form of life is, therefore, a potential divinity, and has to be revered (Cherian 1997).

The rules of conduct prescribed in the *Rajyoga* for a householder reflect an ethic of ecocentrism . The five "*Yamas*" and five "*Niyamas*" or rules of conduct as specified for an individual in the "*Rajyoga*" pertain to the environment and ethics of resource use. They are -

1) *Ahimsa* (Non-violence) 2) *Satya* (Truth)

3) *Asteya* (shunning the use of materials obtained by illegitimate means)

4) *Brahmacharya* (celibacy)

5) Aparigraha (not coveting or amassing materials and wealth beyond requirement)

6) *Shaucha* (cleanliness of ones mind, body and surroundings). It also includes ridding oneself of undue lust including sexual desire (*Kama*), anger (*Krodha*) and greed (*lobha*)

7) *Santosh* (contentment) 8) *Tapas* (austerity)

9) *Swadhyaya* (introspection of the self) and 10) *Ishwar paridhan* (prayer and meditation).

But this thesis of ecocentrism fails to provide a genuine basis for environmental ethics because humans are neither apart from nature nor simply a part of nature. The mere fact of the interdependence of humans and ecological counterparts does not define a moral relationship (Passmore, 1975).

2.2.2 The Ethic of Anthropocentrism:

Western civilisations on the other hand have held a strong anthropocentric view for the last nineteen centuries. The Biblical text of Genesis, chapter 1, verses 26-28 runs: " Then God said, ' Let us make man in our image... and let them have dominion... over all the earth...'. God blessed them and said ' ...fill the earth and subdue it.' " These verses establish a dualism between humans and the non-human world, and can be sharply interpreted to encourage the most destructive tendencies towards the non-human world (Cherian 1997). To date, such a philosophy has been applied in order disassociate human beings from natural processes and to disregard any moral obligation we might have for our ecological counterparts. It is only recently that the self-destructive implications of such an ethic have been

realised through the depletion of natural resources and the dire consequences of polluting emissions.

2.2.3 The Ethic of Trusteeship:

The extremes represented by the ecocentric and the anthropocentric ethics have to be rejected in favour of an ethic which provides for benign forms of coexistence with non-human counterparts and among humans as well. Such an ethic expresses self-in-relationship. It enables the recognition of interdependence and of the relationship of continuity and difference, and the recognition of both the distinctness of nature and relationship with it. With this conception one recognises that self is embedded in a network of essential relationships with distinct others. Thus, respect for others (human or non-human) results from an expression of self-in-relationship rather than from containment or transcendence of self (Plumwood, 1991).

Mahatma Gandhi regarded human being as a trustee of all creation. He emphasised that "It is an arrogant assumption to say that human beings are the lords and masters of the lower creatures. On the contrary, being endowed with greater things in life, they are the trustees of the lower animal kingdom".

Indira Gandhi addressing the plenary session of U. N. Conference on Human Environment at Stockholm in 1972 said " One cannot be truly human and civilised unless one looks upon not only all fellow-men but all creation with the eyes of a friend."

Ethics based on care, respect and responsibility provide necessary conditions for sustainability in several ways. Such ethics do not require reciprocity by non-human counterparts, and therefore place moral obligations rightly on humans. They support collective obligations of humans towards one another, in addition to maintaining and / or preserving the integrity of nature (Reed & Slaymaker 1993).

This concept is very similar to Mahatma Gandhi's concept of Trusteeship of nature mentioned above. Therefore, it may be accepted that adoption of this ethical framework of trusteeship of ethics of care, respect and responsibility towards nature is a necessary precondition for the successful implementation of a policy of sustainable development.

2.3 Environmental Ethics as a scale-dependent problem set:

Reed and Slaymaker have suggested that the society-environment relation may be a scale-dependent problem set, with different expressions of ethics associated with each scale. They have identified four spatial scales with their respective ethical expressions -

Table No. 2.1 Environmental ethics and scale.

Scale	Definition	Ethical expression	Example
Planetary	$> 10^{10}\ km^2$	dependence	Gaia*
Global	$10^{8}\ km^2$	partnership	Antarctic treaty
Region	$10^{6}\ km^2$	partnership & stewardship	co-management
Local	$< 10^{4}\ km^2$	stewardship	land trusts

source: Reed & Slaymaker 1993
* A Greek concept roughly equivalent to "Mother-Earth" concept of *Atharva-Veda*

2.4 Environmental Ethics at the Regional Scale:

Regions may be defined as organised spatial systems at sub-national scales. Depletion of the natural regenerative capacity of renewable resources, the use of the environment to assimilate waste products, and changes in patterns of urban, rural, and hinterland development are typical problems of sustainability at the regional scale. Resource exploitation in hinterland and rural regions has provided a high level of material well-being in urban areas and resulted in environmental and

socio-economic problems in the hinterland, such as resource depletion and community instability (Marchak,1990). Efforts to redress this uneven distribution of material wealth and resource degradation will require a fundamental rethinking of our economic structures and decision-making processes. Generating conditions for sustainability at the regional scale will require rehabilitation of degraded environments and redistribution of material benefits. The fact that sustainability at the regional scale will likely necessitate a corresponding shift in public investment priorities from urban to rural and hinterland areas has been largely neglected. A serious discussion of ethics would place these requirements into sharper focus, resulting in a more radical rethinking of our fundamental values as a human community within a larger region.

2.5 Summary:

Ethics are matters of social value and ideals built into the culture of a people. This chapter has discussed the ethics of anthropocentrism and eco-centrism and found that the environmental ethics of **"Trusteeship"**, that is, ethics of care, respect and responsibility are essential prerequisites for a policy of sustainable development to be effectively implemented in any region. The operative word in such a policy of sustainable development at the regional scale is co-management. The problems of sustainable development at the regional scale include global - local and urban - rural disparities and over-exploitation of the supportive and assimilative capacity of the eco-system. These will in the near future require a fundamental rethinking of our economic structures and decision-making processes.

Chapter 3

PLANNING FOR SUSTAINABLE DEVELOPMENT

3.1 Introduction:

> "We may utilise the gifts of nature as we choose, but in her books, the debits are always equal to the credits." - Mahatma Gandhi (Khoshoo T.N. 1995)

This chapter will study the history of eco-developmental thought, concepts of holistic development, quality of life parameters, sustainability of development and planning for sustainable development.

Planning for development is not a new phenomenon in our country. Ever since gaining independence in 1947, we have had a series of plans all aimed at development and improvement of the conditions of our people. Our earliest plans have tended to follow the path of industrialisation which the more advanced countries had traversed earlier. But there is an increasing realisation that the human race is at cross-roads regarding the options it must choose in the area of environment and development. "The industrial countries which have had more than their share of development have achieved a certain standard of living. This has given to the earth, pollution and eco-degradation, which is the result of affluence and greed of the people of these countries."(Khoshoo T.N. 1995). It is now clear that such a pattern of development , life-style and quality of life are all unsustainable (Cook E. 1977). On the contrary people in the developing countries are still struggling for minimum sustenance. They have also contributed to the eco-degradation and pollution, which is essentially need - and - poverty based. These countries need abundant material growth to fulfil their basic needs, but must not repeat the

mistakes of the industrially developed countries. More-over, as far as possible, the developing countries must follow the sustainable path of development from the very beginning (Brotchie J.1997).

3.2 History of Eco-Developmental thought:

i) In 1950's concern for the endangered species like the large cats and public health engineering aspects were emphasised.

ii) 1960's saw the publication of the book "Silent Spring" by Rachel Carson focus attention on pollution aspects of air and water.

iii) In the 1970's Donella Meadows "Limits to Growth" theory pointed out that the natural resources are finite and therefore could not be exploited without restraint.

iv) In 1972 - Smt. Indira Gandhi addressed the United Nations Conference on Human Environment at Stockholm to emphasise that poverty and need were the greatest polluters thus introducing social, economic and ethical issues into the environmental debate.

v) 1973 - The petroleum crises focused the world's attention on the energy issues and their impact on the environment and development (Cook E. 1977).

vi) 1976 - The Vancouver declaration on Human settlements emphasised the existing unjust international economic order and its effects on the social-economic-environmental conditions in the developing countries.

vii) 1980's - The global implications of evironmental degradation and unrestrained energy use became clear. Global warming, ozone depletion and sea-level rise were discussed (Holdren J. 1977).

viii) 1987 - Publication of the World Commission on Environment and Development's report spelt out the need for sustainable development that

would meet the needs of the present generation without jeopardising those of the future generations.

ix) 1992 - The U N Conference on Environment and Development (known as The Earth Summit) adopted the Agenda 21, a comprehensive blue-print for action to reverse the trend of environmental degradation and to promote sustainable and environmentally sound development in all countries.

x) 1996 - The agenda for the second United Nations Conference on Human Settlements (Habitat-II) addressed two themes of equal global importance: "Adequate shelter for all" and "Sustainable Human settlement development in our urbanising world"(Centre for Environmental Studies 1997).

3.3 The Fourth Revolution:

Ecology and economy are two powerful words linked by the Greek *oikos* meaning house. The root meaning of ecology is a knowledge of the house; economy means management of the house. Modern usage doubles the impact: ecology being the study of mutual relations between organism and environment, economy the management of expenditures. Are these not the operative concepts in planning for a world with diminishing resources and increasing populations (Goodman P. 1977)

The 1992 "State of the World" report by Lester Brown (Khoshoo1995) talks of a fourth (the environmental) revolution in the offing, the first being the tool-making revolution at the dawn of civilisation, the second - the agricultural revolution and the third - the industrial one.

Mr. T.N.Khoshoo an eminent environmentalist defines the fourth revolution as the eco-developmental revolution wherein economic development will be based on ecological principles like environmental harmony, economic efficiency, resource

(including energy) conservation, local self-reliance and equity with justice. There has to be a healthy blend of environmental, social, economic and developmental imperatives. A sustainable society has faith in science and technology as an instrument of environment friendly social and economic change. Economic growth would not be at the cost of ecological assets. There has to be a working partnership with nature. We have to conserve non-renewable resources and energy, produce only recyclable goods, reduce waste and avoid degradation of renewable resources. Maintain a constant and sustainable level of people, livestock, and quantity of goods produced. These should be within the carrying capacity of the natural ecosystems, agro-ecosystems, or industrial-economic systems. Soil and water conservation, bio-fertilisers, biological control of pests, extensive use of bio-technology and minimal use of non-renewable energy - all these should be emphasised. The basic needs of people are to be met without any serious detriment to the environment. Lastly, attempts have to be made at paraphrasing sustainability in concrete terms by identifying specific indicators and thereafter periodically refining and updating them (.Khoshoo T.N. 1995).

3.4 Holistic Human Development Paradigm:

The objective of development is to create an enabling environment for people to enjoy long, healthy and creative lives. Philosophers like Aristotle (384-322 BC), Emanuel Kant (1724-1804) and Adam Smith (1723-1790) have shaped the idea that human beings are the ultimate end of development and not convenient fodder for the materialistic machine (Haq M. 1996). The basic purpose of development is to enlarge peoples choices. It might well be argued that expansion of income can enlarge all other choices as well. But that is not necessarily so. Many human choices extend far beyond economic well-being. Knowledge, health, a clean physical environment, political freedom and simple pleasures of life are not

exclusively or largely, dependent on income. High incomes do not automatically translate into better human lives. Economic growth is essential in poor societies for reducing or eliminating poverty, but the quality of this growth is just as important as its quantity. According to Mahbub-ul-Haq (the architect of the United Nations Development Programme's Human Development Index) - "The concept of human development has four important components - productivity, equity, sustainability and empowerment. It is concerned with the rate of economic growth as well as equitable distribution of this growth. It deals not only with the choices of the current generation but also with the sustainability of these choices for the future generations. And it empowers people as both the means and the ends of development. In other words, human development is a holistic concept; economic growth is only one component in such a comprehensive development paradigm." (Mahbub-ul-Haq 1996)

The second United Nations Conference on Human Settlements (Habitat-II) has emphasised that sustainable human settlements depend on the creation of a better environment for human health and well-being, which will improve the living conditions of people and decrease disparities in the quality of their lives (Centre for Environmental Studies 1997). The liveability of the built environment had an important bearing on the quality of life in human settlements. Quality of life implies those attributes catering for the diversified and growing aspirations of citizens that go beyond the satisfaction of basic needs. Liveability refers to those spatial, social and environmental characteristics and qualities that uniquely contribute to people's sense of personal and collective well-being and to their sense of satisfaction in being the residents of that particular settlement. The aspirations for liveability vary from place to place, and evolve and change with time: they also differ among the diverse populations that make up communities. Therefore, conditions for liveable human settlements presuppose a working democracy in which processes of

participation, civic engagement and capacity-building mechanisms are institutionalised.

The Technology Information Forecasting and Assessment Council of the Department of Science and technology has released a set of ten reports in August 1996 describing a "Vision of India for the year 2020" (Indiresan P.V. 1996). Having accepted that growth in the Gross National Product (GNP) is a very unreliable indicator of the quality of life, the vision is expanded beyond mere economic growth in two ways: it includes a) need-based socio-economic development as well as b) control of disparities of several kinds. Thus the socio-economic vision aims at the universal fulfilment of the following needs:

Physical - safe drinking water, domestic fuel, primary education

Security - land for housing, vocational training, computer literacy

Social - connectivity (roads, public transport)

Autonomy - personal transport, telecommunications

Ecology - de-congestion, sanitation and

Self actualisation - recreational and cultural facilities.

As to disparities, six such disparities as mentioned below have been identified in the above report for minimisation: 1) urban - rural, 2) forward - backward caste, 3) rich - poor, 4) private - public, 5) man - woman, 6) forward region - backward region.(Ibid.)

3.5 Concept of Sustainable Development:

The concept of Sustainable Development especially as applicable to the developing countries therefore involves marrying the concept of sustainability with that of development. Sustainable Development would involve raising the quality of

life of the present generation without sacrificing the right of the future generations to a similar quality of life.

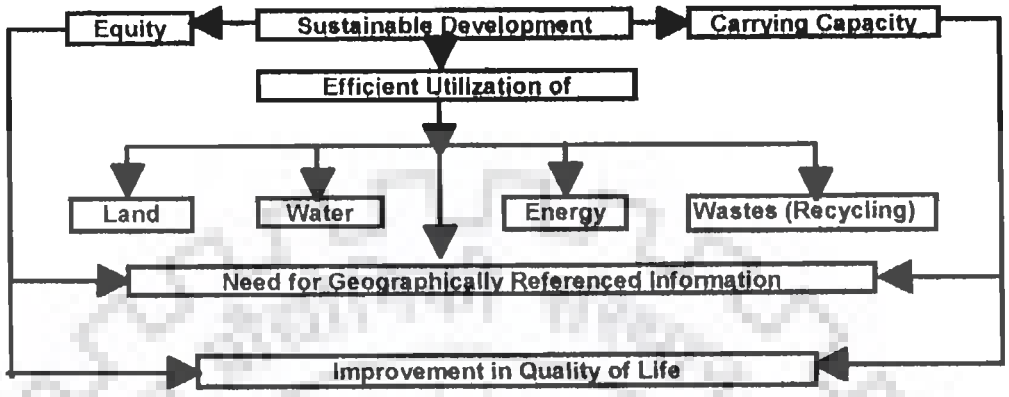


Figure No. 3.1 Issues Raised By Sustainable Development

Sustainable Development would aim at improvement in the quality of life of the present as well as the future generations. This raises questions of equity - both intra-generational as well as inter-generational , efficient utilisation of natural resources - land, water, energy and wastes (recycling of) and ecological carrying capacity-in terms of human population, bio-diversity, etc. (Figure 3.1)

3.6 Quality of Life Parameters:

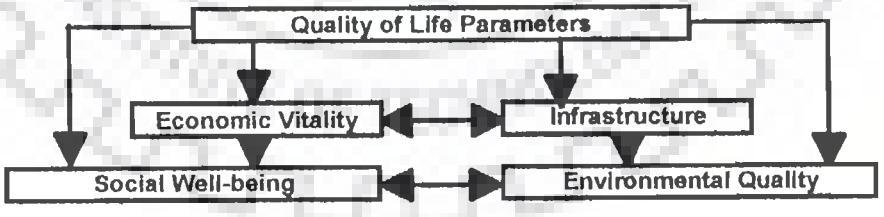


Figure No. 3.2 Quality of Life Parameters

When we talk of Sustainable Development as a holistic concept aiming at the improvement of the overall quality of life, it becomes necessary to find some variables which would adequately describe the quality of life enjoyed by a people. Whilst the Human Development Index of the U.N.D.P. (UNDP 1993,94) gives one third weightage to real income (adjusted GDP per capita) and two thirds to

education (adult-literacy rate, mean years of schooling, educational attainment), and life expectancy at birth, the Asian Development Outlook (Asian Development Bank 1994) gives equal weightage to six variables namely; life-expectancy, infant mortality, access to safe drinking water, index of real per capita GDP, male-female gap in literacy levels, and the adult literacy rate. Whilst the Habitat-II agenda mentions infrastructure availability as an important ingredient of quality of life, the World Development Report 1994: Infrastructure for Development (World Bank 1994) gives overwhelming emphasis to infrastructure provision (safe drinking water, sanitation, paved roads, electricity, and telephone main-lines etc.). Differences in weightages apart, they all concentrate on three broad categories of variables namely - social, economic, and Infrastructural. To this list one feels (based on the foregoing discussion), should be added another category, namely Environment, the quality of which would undoubtedly have a large bearing on the quality of human life. Each of these however, is a complex parameter composed of a set of variables which have proactive and interactive inter-relationships amongst themselves and with the elements of the other three parameters mentioned above (Figure 3.2). The details of the constituents of each of these main components of liveability will be presented and discussed in later chapters.

3.7 Planning for Sustainable Development:

Simply defined, sustainable development would mean development that ensures a reasonable level of welfare both at present and in future without jeopardising the long-range ecological and environmental goals. It thus requires that a dynamic balance be maintained amongst the ecological, social and economic systems. Planning for such a sustainable development would involve a constant stock taking of the quality of life parameters already defined in 3.6 so as to keep a

watch on the achievement of sustainability goals. It will therefore be a cyclic process and will include the following stages -

I	Data acquisition	II	Data storage and retrieval
III	Data processing and Analysis	IV	Decision making & action plan
V	Monitoring and review of plan implementation		

i) **Data Acquisition:**

Various characteristics of the population under study will be gathered first. This data will be referenced to time (when), and geography (where). It may be in a tabular form (attribute data) or in a graphic form (mapped data). The data may have to be gathered from varied sources such as Census of India, numerous central and state government departments, other specialised or sectoral agencies etc. With increasing types and sources of data, data registration becomes a complex affair. As this multi-source data may not be in a compatible format, proper format for storage of data becomes important.

ii) **Data storage and Retrieval:**

The multi-source data has to be put in a proper format so that it will not only match when combined, overlapped or compared but it should also be possible to produce different combinations of the basic data sets on demand from the user, efficiently and speedily. With increasing complexity and quantity of data and user needs, the only way to manage the vast quantity and quality of data, is by the use of computerised systems. A normal Data Base Management System (DBMS) cannot fulfil this task efficiently. It requires the use of a Relational Data Base Management System (RDBMS) because only RDBMS allow the easy handling and recombination of various data sets.

iii) Data Processing and Analysis:

Raw data cannot be directly very useful unless it can be used to answer certain questions or queries. The queries may be either statistical or spatial. For example sums, averages, trends are all examples of statistical queries whereas patterns, iso-lines, 'distance from' relationships are examples of spatial queries. These two kinds of queries could also be combined to do "what-if" studies or impact analysis studies including scenario building exercises.

iv) Decision Making and Action Plan Preparation:

After analysing the data and fixing up the goals and objectives, alternative plans of action have to be prepared. These alternatives have to be weighed against each other to decide the optimum course of action leading to sustainable development. This decision making may be helped by simulation and gaming techniques which can help the decision maker to visualise a priori the consequences of alternative courses of action.

v) Monitoring and Review of Plan Implementation:

After the plan of action has been finalised through a process of optimisation and informed decision making, the finally approved alternative will be implemented. During implementation, the unforeseen effects on the population, economy and environment have to be monitored and necessary changes made to the policy. This review requires continuous updating of data after receiving feed-back from the field teams, thus leading to another round of the entire planning process.

3.8 Role of Government in Sustainable development:

The Habitat-II conference held at Istanbul in 1996 has rightly pointed out the importance of peoples participation in planning and implementation of sustainable development plans and programmes. No plan, however well intentioned, can hope

to succeed without the active support and participation of the people themselves. Mahatma Gandhi had realised this long ago and advocated the expedient execution of the Panchayat raj model of governance.

3.8.1 The Gandhian Model of Development:

Gandhiji had set for himself two objectives. A near-term objective of political independence following the path of *ahimsa* and *satyagraha*, and a long-term objective of economic independence for India's teeming millions based on social, economic, environmental, equity, cultural and ethical considerations. He wanted the development effort to be concentrated in the villages where 76% of India's population lived in abject poverty. He was for a proper, legally binding empowerment of the poor and the women in our society. His model of development envisaged that the governance should be from the bottom upwards and not top downwards. The goals should be self-defined and not stranger-defined. Independence should begin at the bottom. It follows therefore that every village has to be self-sustained and capable of managing its own affairs. The government of the village will be conducted by the Panchayat (village council). These will have all the authority and jurisdiction required to do so. The greater the power of the Panchayat the better it is for the people (Khoshoo 1995).

But it has taken us fifty long years after independence to realise this dream of Panchayat-raj. It was only in 1992 that the required legislation could be enacted to make the Panchayat raj a reality. The 73rd constitution amendment act of 1992 will endow the Panchayat raj institutions with adequate powers, authority and autonomy in order to - "1. Enable them to effectively function as institutions of local self-governance, and 2. Discharge their constitutional responsibilities regarding

preparation and implementation of programmes for economic development with social justice." (Sharma S.K.1996)

3.8.2 The principal function of government:

The principal function of government is to improve the quality of life of its citizens by providing public goods, both positive, in terms of employment, infrastructure, social amenities etc. and negative, in terms of control measures like laws, regulations etc. The demands for public goods (both positive and negative) can be assessed, and attempts made to satisfy them through strategic, well informed and co-ordinated decision making at various levels of administration at various time frames so that a dynamic balance is maintained between requirements of development on one hand and sustainability of the same and of nature itself on the other. All this requires geographically referenced information on where, how much and what type of public goods are required. This requires the use of a computer based Decision Support System which can help the decision makers at various levels in the government and administration to assess, compare, analyse, visualise, predict and monitor the effects of their policies and changes required therein. It also requires a computer based Geographical Information System (GIS) which can produce, capture, store, update, manipulate, organise, analyse and display geographically referenced information.

3.8.3 Trends at global and national levels: (Figure 3.3)

Several trends at the global and national levels emerging at the turn of the century are also pointing towards requirement of a geographically referenced data management system and a computer based decision support system -

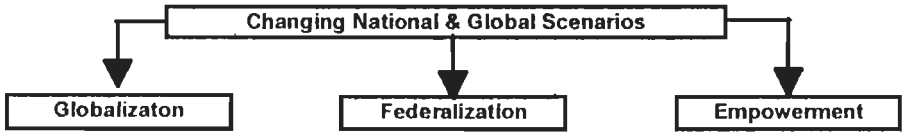


Figure No. 3.3 Trends at Global & National levels

i) Globalisation:

Due to the information technology revolution, the world has today become a small place. Ease of transmission and management of large amounts of data almost instantaneously makes it possible to make informed decisions and strengthens the local - global linkages.

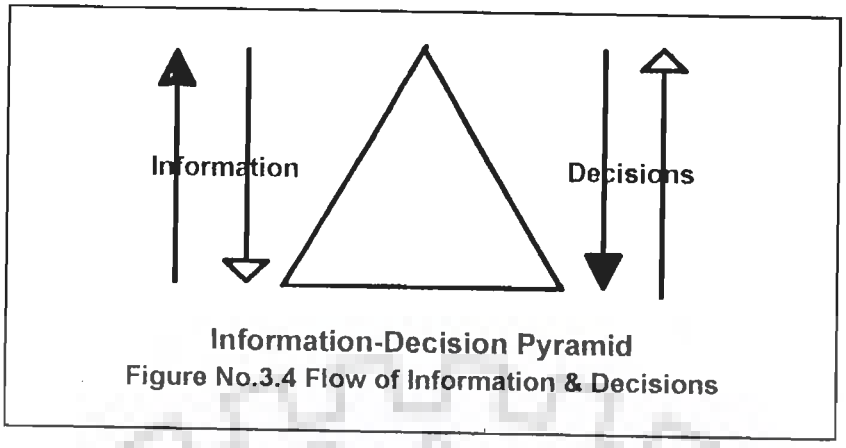
Decisions to produce, sell or hold commodities can now be taken in response to the world markets thereby avoiding waste.

ii) Federalisation:

At the global and the national levels, today the trend is towards dissolution of gigantic, monolithic governments into an increasingly federal structures, which makes co-ordinated planning, implementation and monitoring of development a pressing need.

iii) Empowerment:

The trend of devolution of power down to the grass roots level all around the world and especially in India is very evident today. The 73rd & 74th constitutional amendment of 1992 makes planning, monitoring and implementation of development the duty of the local self governments. To effectuate this, the present one way flow of information (bottom upwards) and of decisions (top-downwards) needs to be corrected and replaced by a two way flow (Figure 3.4).



Information-Decision Pyramid
Figure No.3.4 Flow of Information & Decisions

To enable our nation to fit into the emerging world and national scenarios, it becomes imperative to establish a networked geographical information system at the panchayat, taluka, district, state and national levels, so that informed and decentralised but co-ordinated decision-making is made possible.

3.9 Sustainable Regional Development:

A region is a geographical area that meaningfully may be regarded as a coherent entity from the viewpoint of description, analysis, administration, planning, or policy. Various types of regions are distinguished in the literature - for example, homogeneous or functional regions, natural or ecological regions, economic regions, and administrative regions. A regional system is more amenable to policy management, examination, and control than a global system. In this context, planning regions may allow for the attainment of certain planning objectives in the most efficient way. From a welfare point of view it makes sense to define Sustainable regional Development as development that ensures that the regional population can attain an acceptable level of welfare, both at present and in the future, and that this regional development is compatible with ecological circumstances in the long run while it also tries to accomplish a globally sustainable development.

Sustainable development calls for trade-offs between the desired production-consumption levels through the utilisation of the supportive capacity and environmental quality within the assimilative capacity of regional ecosystems. The utilisation of carrying capacity, thus, requires a series of adjustments to reconcile competing aspirations in developmental process (Khanna P. 1995).

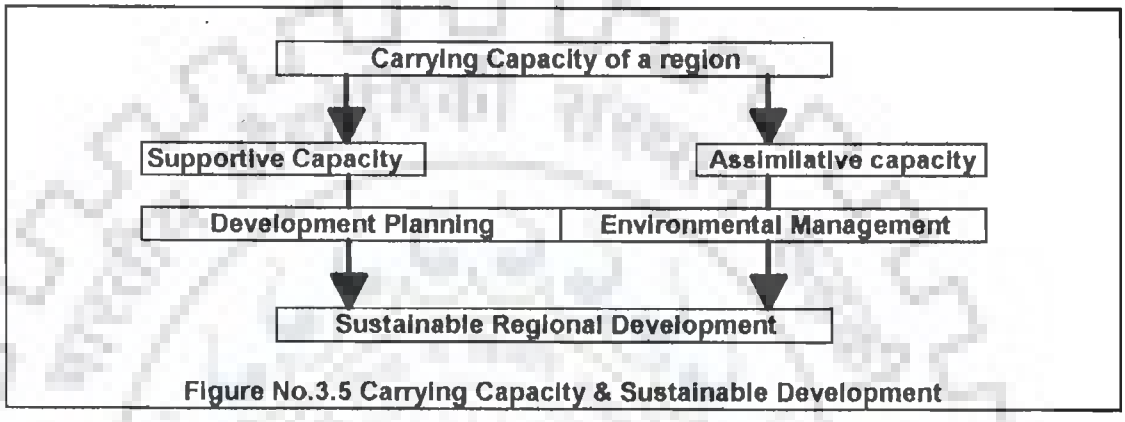


Figure No.3.5 Carrying Capacity & Sustainable Development

Implementation of sustainable development policies at the regional level would therefore consist of the following steps (based on Nijkamp et al 1990)-

1. Delineation and characterisation of a region
2. Potentials for and constraints on the future growth
3. Assess probable and uncertain developments (possible deviations from extrapolated path)
4. Identify and evaluate alternative developmental scenarios
5. Finalise the optimum path of development

In evaluating the different developmental paths for any selected region, a set of sustainability related performance indicators and an evaluation method must be decided upon. In case of multiple indicators, use of multicriteria techniques for the evaluation of alternative development scenarios with respect to sustainable regional development seems logical.

3.10 Summary:

This chapter has dealt with the historical development of eco-developmental thought from simple conservation of the endangered species to an all-encompassing stature. The argument for equal weightage to environmental as well as economic aspects is today well accepted. The addition of social and infrastructure equity to developmental requirements completes the desired quality of life parameters. People's participation in the planning and development process is a vital consideration today. The role of the government in providing the required support to enable effective people's participation through legislative, institutional and infrastructural provisions is also important for attaining sustainability goals. Information technology in the shape of data bases, hardware, software and trained personnel are the prerequisites for Sustainable Regional Development (SRD). Finally, developing and monitoring a set of sustainable development indicators through multicriteria techniques is a crucial step in the path to SRD.

Chapter 4.

CONCEPTS, THEORIES AND TECHNIQUES

4.1 Introduction:

This chapter surveys the theories, concepts and techniques which have influenced this author and form the essential underpinning of this thesis. Sustainable regional development being an interdisciplinary subject, it naturally has to draw from diverse disciplines such as regional planning, systems analysis, public participation, corporate decision making, multicriteria analysis and decision making, ecology and environmental impact assessment. Each of these disciplines has a vast scope and therefore one finds it necessary to accept an eclectic approach in choosing only those theories which have a direct bearing on the formation of this thesis. The treatment of each topic has again to be very limited for similar reasons. This chapter therefore does not go into the depths of these topics but picks and chooses only those facets which will help in developing the thesis for operationalising the concept of sustainable development of regions.

4.2 Regional Planning theory:

4.2.1 Regional Concept: Dickinson defines regional concept as "The regional concept is concerned with the models of spatial association of phenomena over the earth's surface (Dickinson R. E. 1970). Its first task is to develop procedures of analysis, both quantitative and qualitative. This means procedures of analysing and synthesising spatial systems of earthbound phenomena, both as unique units, and as members of generic world-wide (or continental) systems." He goes on to say that the acid test of the regional approach is to determine and explain and recommend action upon the regional variants of socio-economic conditions of agricultural workers (poorest sections of the society), whether in cash, work, food or access to

civilised amenities in villages and towns. He provides a number of such instances in different countries and then states "All these cases reveal clearly the great regional variations in socio-economic structure, that demand thorough assessment and remedial action with high priority to provide all people within the state with a socially accepted standard of living."

4.2.2 Place, Work and Folk: Sir Patric Geddes a biologist by training but a Town and Country planner by vocation is credited with the most enduring theory of regional and town planning (In the 1st quarter of the 20th century). He conceived Town and Country planning as the study of Place, Work and Folk. Place signifies the environment, Work the economic aspects and Folk the social and cultural aspects of mankind. These aspects are further imagined as having inter-linkages and interactions as shown in the following diagram -

PLACE (Environment)	Place WORK (natural advantages)	Place FOLK (natives)
Work PLACE (pasture, mine, workshop)	**WORK** (Economics)	Work FOLK (Industrial)
Folk PLACE (village, home, etc.)	Folk WORK (occupation)	**FOLK** (Sociology)

Fig.No. 4.1

As is clear from the above diagram, the inter-actions between Folk and Place produce the study of Human Settlements and Infrastructure. It is also clear that he considered the study of regions in an integrated fashion, that is, he envisages a systems approach to regional planning.

4.2.3 Ecology and Ekistics: C.A. Doxiadis an architect-town planner in the 2nd and 3rd quarters of the 20th century, has described the interactions between Ecology (the science of relations between living organisms and their surroundings) and Ekistics (the science of human settlements) (Doxiadis 1977). He has defined five elements of human settlements and five forces acting on them. The five elements are Nature, Man, Society, Shells (Buildings), and Networks (Communications, Transport and Services). The five forces are Economic, Social, Political, Cultural and Technical. He defines Ekistics as the study of the interactions of these elements and forces. It can be seen that he advocates the systems approach to study of human settlements and sees shells and networks (that is infrastructure) as an important element and technology as an important force shaping the human settlement pattern. He postulated the Ekistics logarithmic scale of communities relating communities at all scales to population and area. He also propounded the Ekistics grid which can be used for summation of all information relating to human settlements and identifying any gaps in our knowledge. He recognises the need for reconciling the aspirations of mankind with the limitations of the finite world.

4.2.4 Corporate Management and Decision Making:

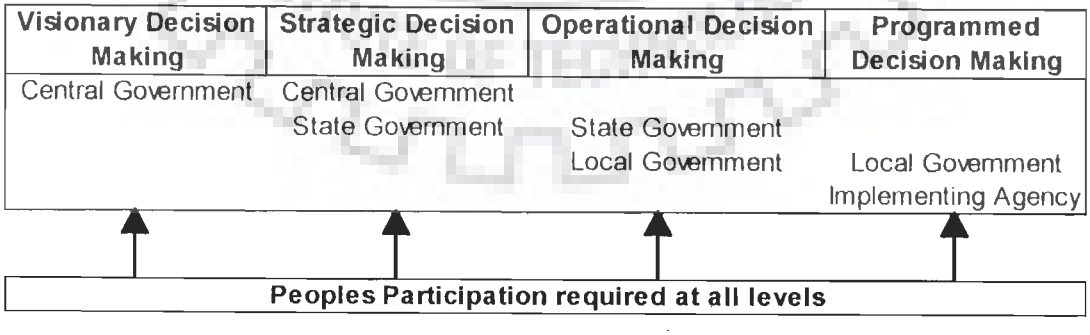


Fig. No. 4.2 Levels of Decision Making and Administraton

In Corporate Management theory, four levels or types of decision making are referred to - Visionary Decisions, Strategic decisions, Operational decisions and

Programmed decisions. These correspond to various descending levels of decision makers or management (Rangnekar S. 1996).

Translated to public sector planning function, these decision making levels and the corresponding administrative levels could be postulated as shown in the above diagram (Fig. 4.2).

4.2.5 Centralised versus Participatory Regional Planning: As per Shri. S.K.Sharma (Sharma S.K. 1997), centralised planning being presently practised in many developing countries is largely based on practices followed in the erstwhile Soviet Union. It aggregates the financial resources and, based on incremental economic models, packages them as schemes for various social and economic programmes. It then allocates them to various regions without studying the environmental resources and infrastructure needs in spatial dimensions. It also does not take the local context and requirements adequately into consideration.

Centralised planning leads to wasteful expenditure on plan programmes to fulfil plan financial targets and neglects upkeep. It promotes financial irresponsibility in plan expenditure and encourages pilferage, wastage and corruption along the long route from the centre to the field.

Centralised planning is non-participatory, unscientific, undemocratic, anti-environment, anti-people, wasteful and prone to corruption. It is one of the major reasons for the social and environmental degradation in the developing countries (Sharma S.K. 1997).

The only scientific and democratic method of planning is participative regional planning. Regional planning is initiated by the district governments with full involvement of the local governments and the people. It expresses planning not merely in descriptive and quantitative but also in spatial plans integrating in them the

socio-economic, infrastructure and environmental issues. The higher levels of government need to intimate availability of funds without any pre-conditions, well in advance, to enable the district and local governments to initiate the planning process. The local plans are consolidated as draft district or county plans during which the sharing of the resources and infrastructure between the urban and rural areas can be negotiated. The district governments should normally engage regular planning staff for administration, co-ordination and approvals only and engage consultants for plan preparation. Concurrently, regional planning at various levels, namely, identified resource regions, state and national, should be initiated to take a macro view of the socio-economic and natural resources and the infrastructure need to support their sustainable development. The draft district or county plans forwarded to the higher levels of government for approval, should be collated with the higher levels of infrastructure leading finally to the emergence of a national plan (ibid.).

Regional planning is the only accepted form of scientific planning . It is based on the science of study of behaviour of multivariate systems. It draws on the tools of the science of cybernetics, systems analysis and regional analysis for studying the behaviour of people and resources. It develops and designs the interventions needed to take the on desired sustainable paths. Regional planning functions as the cybernetic control over development channelling it along predetermined paths. It tries to introduce minimum controls and allows human systems to naturally respond to social, environmental and entrepreneurial initiatives of the people and nature to regenerate itself. Regional planning monitors the development process by periodically updating the status quantitatively as well as on spatial plans and offers mid course corrections wherever needed. Regional planning is thus an ongoing

process of studying behaviour of human and natural systems and maintaining them up a sustainable growth path (Ibid.).

4.2.6 Regional Planning In India: Some sporadic attempts at regional planning are of and on made in India. The central planning commission has, in every five year plan, stressed the need for regional planning. In pursuance of this, some regional plans were prepared but they could never, for reasons given below, create any impact -

Viewing a region as a large area covering several districts, macro-level regional plans were generally prepared. While they provided useful insights, they did not have the depth of detail nor the effective participation of the people. Furthermore, the plans had to be implemented by the local bodies under the umbrella of centralised planning. The co-ordination between various implementing agencies was missing as is evident from the study of the implementation of several regional plans prepared in India. The central planning commission while emphasising regional planning did not realise that the two could not coexist (Ibid).

4.3 Systems Approach to Regional Planning:

A system can be defined as an organised or connected group or set of objects, principles, or ideas related by some common function or belief (Dickey and Watts 1978).

The first step in trying to understand and analyse the people, physical entities, and activities that comprise a region is to view them as an interrelated set of components or factors. In a broad sense, this means that the important social, political, economic, and artificial and natural environmental elements must be identified along with the relevant physical and behavioural connections between them. It is then possible in many situations to analyse these elements and

connections quantitatively to establish more precise relationships and to use these to help determine how to guide the system towards a more desirable state. This approach generally is referred to as systems analysis. Any system can be divided into subsystems. The reasons for doing so are mainly simplicity of understanding and ease of management. The idea is to break the system into parts that display a certain richness of intercommunication. This is done to the point where the subsystem elements are clearly identified and their main interactions reduced to a manageable number. Practically all systems are exceedingly complex. To be able to work with such complicated entities, we must make use of models, or abstractions of real-world systems so that one can comprehend and deal with it (ibid.). Models then represent idealised parts of systems, just as systems represent an arbitrarily separated segment of the real world.

4.4 Supporting Technology for Sustainable Regional Development:

4.4.1 Information Technology: The rapid development and dispersal of the information technology in the form of tele-communication, tele-vision, tele-banking, tele-shopping and many more forms is nothing short of a revolution and is changing our patterns of living and working very rapidly (Brotchie J. 1985). In order to effectuate the concept of Sustainable Regional Development (SRD), the role required to be played by modern information technology is extremely important. Efficient data collection, storage, manipulation and transfer is undoubtedly the linchpin of SRD. With the advent of extremely cost effective electronic media and computers, it is today possible to cover a vast country like India with a information net work, which will be of immense help in the decentralised but co-ordinated planning, monitoring and decision making for SRD.

4.4.2 Network of GIS Centres: In order to ensure that our country follows a path of sustainable development, it will be necessary to set up a electronically

connected network of GIS centres at the Panchayat, Taluka, District, State and National levels. This will enable the sharing and transfer of data across the country. It will also provide feed-back to the decision makers at all five levels thus leading to a close monitoring and effective implementation of an enlightened policy of Sustainable Development (Fig. No. 4.3).

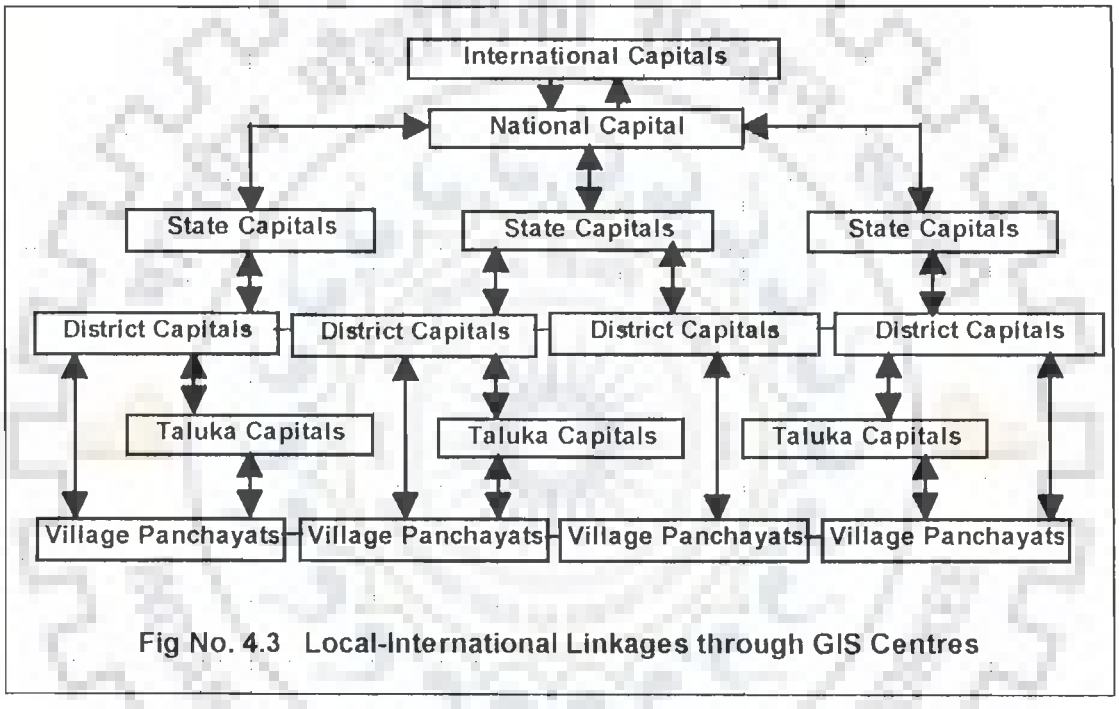


Fig No. 4.3 Local-International Linkages through GIS Centres

A decision support information system for the Indian government has been evolved on a nation-wide computer - communication net-work, NICNET set up by the National Informatics Centre (NIC). The objectives of this net-work are -

i) To develop the necessary information system / data bases in various sectors of the economy for planning and decision - taking at the district level.

ii) Promote informatics culture at the district level.

iii) Improve the analysis and presentation of statistics utilised for national, regional and district planning.

iv) Develop modelling and forecasting techniques required for decision making for socio-economic development.

4.4.3 Changing Role of the District Administration: At present the Directorate of Economics and Statistics is the main agency for the collection and dissemination of statistics on various sectors of the economy. District is at present the lowest unit for data compilation. Now the focus having shifted to block and village level planning, data availability at this level has to be improved. A good amount of information is available at the district level. Presently information flows from the district to the state and onwards to central governments for planning purposes. In view of the increasing number of schemes, departments and agencies operating at the district level, effective means of monitoring and co-ordinating the developmental effort is required at this level. The DISNIC (District Information System) launched by the NIC at the district level will rationalise the flow of information both upwards and downwards from the district level. The DISNIC will thus pave the way for easy collection, compilation, dissemination and on-line accessibility of information on several sectors of the economy at the district level with availability of qualitative and quantitative information at all possible levels such as the taluka, block, panchayat and village. The DISNIC will provide the means of achieving the above. DISNIC will also facilitate the building up of data bases of national importance through the active co-operation of the central, state and the district administrations (Sheshagiri N. 1991).

4.4.4 A Geographic Information System (GIS): A Geographic Information System may be defined as a computer based technology for producing, capturing, storing, updating, management, organising, analysing and displaying spatial or geographically referenced information (Clarke 1986). GIS combines elements of CAD (Computer Aided Design), Data Base Management Systems (DBMS),

mapping, image processing, and statistical analysis. The distinguishing feature which separates spatial analysis from traditional information systems is the use of locations for referencing information as an important variable in quantitative analysis. By exploiting the spatial dimension, spatial analysis introduces a new perspective which can greatly enhance decision making and problem solving.

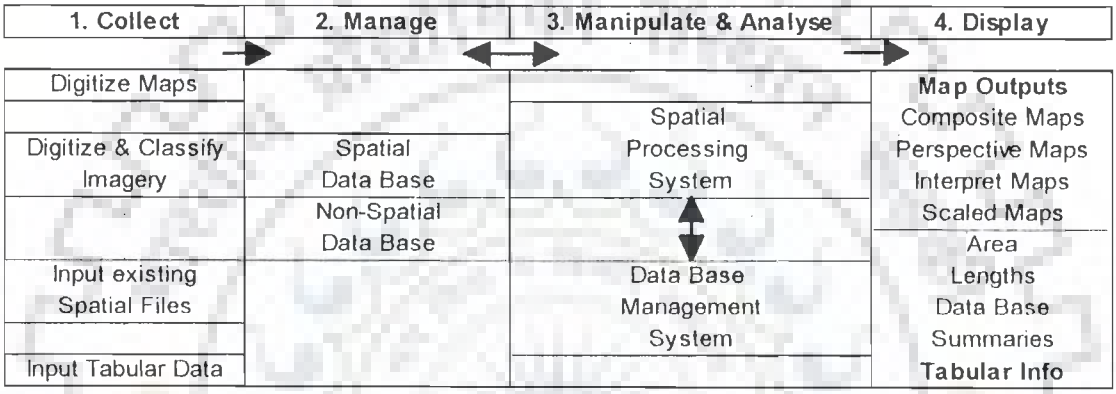


Fig. No. 4.4 A GIS Schematic

It may be clear from the above that GIS is a general purpose computerised planning tool which can be customised for various specific types of planning and monitoring functions. For example GIS may be used in diverse fields such as climatology, wild-life habitat management, hydrological studies, environmental analysis, geological exploration, network planning, urban management and of-course human resource development. It all depends on the nature and components of the database developed.

4.4.5 Components of a GIS: A GIS has five basic components, namely -

i) Hardware: The hardware requirements for running a GIS software may vary with the particular commercially available software. Some softwares are Unix and workstation based whereas others are windows and PC based. At the panchayat and taluka / block levels a PC based system would be more suitable whereas at the

district level the workstation and Unix based system will be most appropriate. However the PC / windows based system could also be used at the district level especially with PCs becoming more and more powerful in the last few years.

ii) Software: There are a number of commercially available GIS softwares like ARCINFO, SPANSGIS, MAPINFO, PAMAP, ISROGIS, MGE, THEMAPS, ILWIS, GISNIC etc. The selection of a particular software suitable to the situation would require a special study and does not form a part of this research.

iii) Data-base: A number of data bases are in the process of being set up especially in the public sector. Prominent among these are the DISNIC by the National Informatics Centre, Natural Resources Data Management System (NRDMS) by the Department of Science and Technology, NISSAT (National Information System for Science and Technology) by the Dept of Sc. and Tech. The Census of India has made the1991 census data available on floppies. The Digital Mapping Centre of the Survey of India is in the process of making the survey maps available in a digital format. The ISRO has made the satellite imagery commercially available in digital form. Essential data in conventional hard copy format is available from the Directorate of Economics & Statistics at the state level and a plethora of implementing agencies at the district level.

iv) Trained Operators: This an important component of the proposed network. At present this is a major constraint for operationalising this system. The lack of general awareness of computer culture, and trained personnel in GIS needs to be urgently attended to. The combination of knowledge of regional planning and GIS is rarer still and therefore the importance of an expert system or a Decision Support System for Sustainable Development cannot be over stressed.

v) An Expert System: The data which is available from diverse sources and in different forms needs to be co-ordinated into a useful format. The knowledge of the

regional system and insight for analysing and synthesising the plethora of information into a meaningful base for decision making is woefully absent at the district and regional levels. These are sufficiently strong reasons for the development of a Decision Support System for Sustainable Regional Development.

4.5 Multi Criteria Analysis Technique:

Multicriteria analysis approach can be said to be a set of statistical techniques which serve to investigate a number of choice possibilities in the light of multiple criteria and conflicting priorities (Voogd H. 1985). These choice possibilities can be alternative plans or strategies, administrative zones or regions, potential residential areas, urban renewal neighbourhoods, and so forth. The hard-core of this analysis consists of a (at least) two dimensional matrix, where one dimension expresses the various alternatives and the other dimension the criteria by which the alternatives must be evaluated. Various forms of weighted summation technique are used for the aggregation of the information in these matrices.

A multicriteria analysis method can serve to inventorise, classify, analyse and conveniently arrange the available information concerning choice possibilities in regional planning. A characteristic feature of these multicriteria methods is that they start from a number of explicitly formulated *criteria* (or standards of judging). The criteria can show considerable mutual differences in nature. Consequently, they are not measured in one single unit, like for instance in cost-benefit analysis, but in a variety of units which reflect as well as possible the nature of the criteria concerned. Another important feature of multicriteria methods is that they are able to take explicit account of *political priorities*. This makes the approach pre-eminently suitable to incorporate differences in political views expressed. The salient characteristics of multicriteria methods can be summarised as follows -

1. Multicriteria methods are a means to arrive at a surveyable classification of factual information.
2. Multicriteria methods are a means to get a better insight into the various value judgements or priorities.
3. Multicriteria methods are a means to incorporate differences in interests and / or political views in an analytical research framework.
4. They are a means to give more substance to the notion of openness of a planning process.
5. They are a means to arrive at a reduction of the available information.
6. Multicriteria methods are a means of arriving at substantially better considered decisions.
7. They are a means of arriving at a better (i.e. more controllable) position of the planner.
8. Multicriteria methods are a means to account for or justify policy decisions.
9. They are a means to structure research contributions in a planning process.

4.5.1 Functions of a Multicriteria Analysis Method: MCA methods can be used in situations where taxonomic units (i.e. choice possibilities) must be appraised and / or classified. Four different functions of MCA methods can be distinguished -

a) The use of MCA methods for an (descriptive) analysis of the spatial system.
b) The use of MCA methods to select options (e.g. strategies) from a predefined set of alternative options in order to limit a decision area.
c) The use of MCA techniques to account for a proposed line of action or policy line.
d) The use of MCA methods to test the likely appropriateness of a certain policy.

4.6 Summary:

The concepts, theories, techniques and technology which form the necessary backdrop for thesis and for the operationalisation of Sustainable Regional Development have been surveyed in this chapter. These include regional planning, systems analysis, public participation in decision making and governance, information technology and GIS, and multicriteria analysis technique. These will be utilised in the development of this thesis in the following chapters.

Chapter 5

Sustainable Regional Development

5.1 Introduction:

In this chapter the ideas set out in the previous chapter will be synthesised and built upon to effectuate the concept of sustainable development at the regional level. Various possible dimensions of man - environment interactions and alternative approaches for studying these are looked into and the boundaries for this study are set out. The problems in defining the concept of sustainable development and the constraints on the achievement of the same are spelt out. Possible alternative scenarios arising out of these are studied, and the need for adopting a learning, adaptive attitude is emphasised. A conceptual model of the sustainable regional development system is postulated. The interactive subsystems of this system are spelt out including their elements. The requirements of good indicators of sustainable development and the need for a statistical technique for transforming these to a common range of measurement is set out.

5.2 Dimensions of Man-Environment Interactions:

Man as an element of the environment around him both acts upon and in turn is acted upon by it. From the time man first set his faltering steps on this earth, as a nearly powerless element of the environment, to today's seemingly all powerful and dominant constituent, the man - environment interactions have undergone tremendous qualitative and quantitative changes. Man - environment interactions seem to be all pervasive and multi-dimensional. Social, cultural, technological, economic and political are only some of the possible dimensions of study. Many possible themes and levels of study of man - environment interactions are

generated since these are all pervading. It is therefore necessary to delineate our field of study. It has been the endeavour of man since time immemorial to develop himself by interacting with his environment. It is from this developmental perspective that the man - environment interactions could be studied in the following format

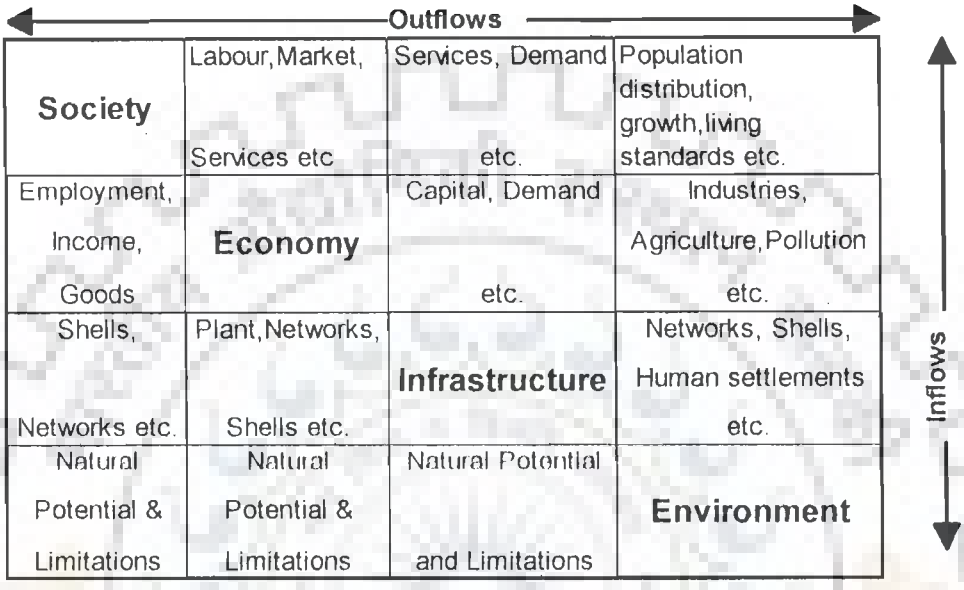


Fig. No. 5.1 Man-Environment Interaction Matrix

5.3 Social Aspects of Development:

The role of human capital formation in national development is frequently not appreciated to the fullest extent. Denison, a well known economist in the US has calculated the factors that contributed to the economic growth there between 1929 and 1983. According to him, the contribution made by technology and R & D in the economic growth of the US was as much as 64%, followed by education which accounted for 30%. In contrast the share of capital was barely 10% and that of land negative. This should come as a revelation to the developing countries, where human population is more often than not considered as a liability. India has an abysmal record on the human development index published annually by the UNDP. After 50 years of independence, nearly half of India's population is illiterate. Women are even worse off with only 28% average literacy level. The position is no better on

the health front with infant mortality rate of 90 per thousand live births, 60 years of average life expectancy and a death rate of 9.8 per thousand and a 135th rank on the overall Human Development Index (HDI). (Human Development Report - UNDP 1994). Many of the countries in Asia have much better records (refer Table No. 5.1).

Table No. 5.1 Comparative Indicators of Social Development

Country	HDI* Rank	Life Exp at birth Yrs	Infant Mort.Rt/1000	Adult Lit.Rate %
India	135	59.7	89	49.8
China	94	70.5	27	80
Sri Lanka	90	71.2	24	89.1
Low HDI* Av		55.8	98	47.4
High HDI* Av		74.1	30	97.3

Source: Human Development Report, UNDP 1994 * Human Development Index

This table indicates how far India has to go before it can hope to be called socially developed.

5.4 Economic Development:

Table No. 5.2 Comparative Indicators of Economic Development

Country	HDI* Rank	GDP / Capita in $	Labour Force % of Ttl Pop	% Lbr Force in Agri
India	135	1,150	38	62
China	94	2,946	59	73
Sri Lanka	90	2,650	41	49
Low HDI* Av		1,170	38	64
High HDI* Av		14,000	44	17

Source: Human Development Report, UNDP 199 * Human Development Index

In economic terms also India with a per capita Net National Product (NNP) of only 2,226 Rs. ranks among the poorest countries with more than 30% of population living below the poverty line (Economic Survey, Govt. of India 1994-95). With 62% of labour force engaged in agriculture, this sector is producing only 31% of Gross Domestic Product (GDP). Our exports to imports ratio was 87% and the annual growth rate of GDP per capita was only 3.2% during 1980-'90 (UNDP 1994). This is a gloomy picture indeed as many of our neighbouring countries including China and Shri Lanka have shown a much better performance on the economic front. (See

Table No. 5.2). The rate of growth or GDP per capita was sluggish at 3.2 % during 1980 -'91 and the income distribution shows wide disparities with the highest 20 % of population garnering 41.3% of the income whereas the lowest 20% was left with only 8.8%.

5.5 Infrastructure Development:

India is lagging far behind in providing its people with basic infrastructure like safe drinking water, sanitation, health services, roads and many others. This has repercussions not only on human resource but also on economic development. Table No. 5.3 gives some salient comparative figures on this account.

Table No. 5.3 Comparative Indicators of Infrastructure Availability

Country	HDI* Rank	% of Population with access to			Road Kms
		Health Services	Safe Water	Sanitation	/ M Pop
India	135	**	**	15	193
China	94	90	83	97	**
Sri Lanka	90	90	71	60	536
Low HDI* Av		62	45	30	311
High HDI* Av		92	86	76	11,792

Source: Human Development Report, UNDP & World Dev Report World Bank 1994

* Human Development Index ** Not available

5.6 Environmental Quality:

The natural resources balance sheet does not speak in favour of India either. The per capita availability of land, water, and forests is not very encouraging and combined with a birth rate which shows no sign of let up at 2.2% annually, the future seems to be even more bleak.

Table No. 5.4 Comparative Indicators of Environmental Quality

Country	HDI Rank	Pop / Km Sq.	WaterRes/capita	Forests %
India	135	268	2.2	22
China	94	124	2.5	14
Sri Lanka	90	268	2.5	27
Low HDI Av		59	9.4	30
High HDI Av		32	15.8	*

Source: Human Development Report, UNDP 1994 *Not available

5.7 Limits of Sustainability:

The question "How many people can the earth support?" has no straight answer. It depends as much on social, cultural, economic and political choices as it does on the constraints imposed by nature, as rightly shown by J.E. Cohen (Cohen 1995). He points out that this question leads to a host of thorny issues such as -

1) How many people at what average level of material well-being?
2) How many people with what distribution of material well-being?
3) How many people with what technology?
4) How many people with what domestic and international political institutions?
5) How many people with what domestic and international economic arrangements?
6) How many people with what domestic and international demographic arrangements?
7) How many people in what physical, chemical and biological environments?
8) How many people with what variability or stability?
9) How many people with what risk or robustness?
10) How many people for how long?
11) How many people with what fashions, tastes, and values?

He points out that without settling the above issues it is not possible to attempt an answer to the question of sustainability. "Definitions of a human carrying capacity referring to the size of a population that can be supported indefinitely are operationally meaningless. The concept of indefinite sustainability is a phantasm, a diversion from the difficult problems of today and the coming century."(ibid.) It follows, that rather than engage in futile theoretical issues, we have to concentrate on making the right choices leading to the goal of sustainability here and now.

5.8 Constraints on Development:

It is now well appreciated that development can not operate without any restraint and that there are definite constraints on it. These constraints may be political, economic, legal, technological, social or natural. Looked at from the quantity versus quality point of view, the relation between the number of people and the attainment of a better quality of life may be expressed in the following diagram -

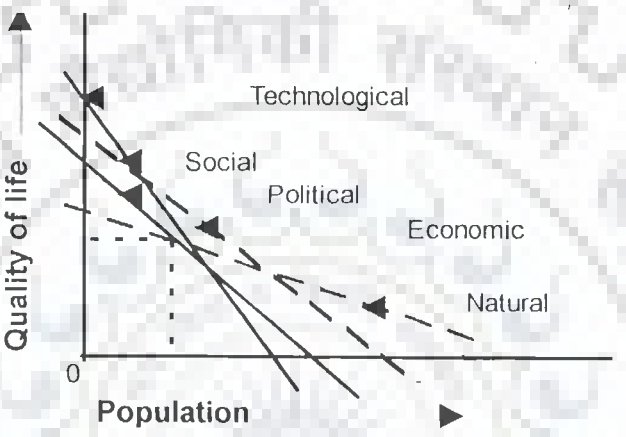


Fig. No. 5.2 Constraints on Development

The search for a better quality of life is bounded by the solution space defined by these constraints. But these constraints are not fixed or rigid. They not only vary over time but can substitute each other to a certain extent. For example natural constraints can be countered to an extent by importing goods or by improving technology. In view of this flexibility, it is a extremely hazardous task to forecast the future. On the whole, three types of long range alternative futures have been forecast by experts -

1) Technological optimist, with minimum social change necessary.
2) Limited technology, with effective social change toward a steady state.
3) Limited technology, limited social change, leading to a decline.
4) Rapid deterioration and collapse.

"Whether the present represents the apex in the growth-maturity-decay theory of social change or the period of challenge just before creative response and the

next step in social evolution, only the future will tell. The important thing for the individual designer and planner is to be observant of the course of things so as to respond as effectively as possible, to look with a dispassionate eye on changes that are inevitable, and to try and live with them as successfully as possible."(Johnson W.A. 1974). It is thus imperative to adopt a adaptive (learn and change over time) approach to not only survive but develop in this era of rapid change. Development planning has therefore to be like a game of chess, learning from the past and anticipating the near future simultaneously in order to make the best possible move in the allotted time.

5.9 Sustainable Regional Development :

A region can be seen to be a system. Various subsystems operate within this system to produce the set of circumstances that comprise the quality of life in that region. Man both acts upon and is acted upon by the eco-system in a number of ways. Man's social, economic and infrastructural activities affect the environment. Though these activities are essential components of man's standard of living, they cannot be allowed to impinge upon the quality of the environment, because that itself is an important component of man's life, not just as a economic resource but also as an aesthetic asset in itself. None of the four components of a regional system namely Social Well-being, Economic Vitality, Infrastructure Availability, and Environmental Quality can therefore be said to be more important than the others. This then is the essential condition for sustainability; that each of these four components of liveability (COL) should be tried to be improved, but not at the cost of any of the others. This condition has been described as a Pareto-optimal balance in economic literature.

5.10 A Systems Approach to Sustainable Regional Development :

A system can be defined as an organised or connected group or set of objects, principles, or ideas related by some common function or belief. Practically all systems are exceedingly complex, especially those social systems of concern to urban and regional analysts. To be able to work with such complicated entities, we must make use of models, or abstractions of real-world systems and treat them as if they were reality. The purpose of a model thus is to simplify a system so that one can comprehend and deal with it. A model for Sustainable Regional Development can therefore be conceptualised by envisaging Economic vitality, Social well-being, Infrastructure availability, and Environmental quality as four subsystems within the overall system of the region. They are dynamically interlinked and interdependent parameters of the quality of human life (Fig. 5.3)

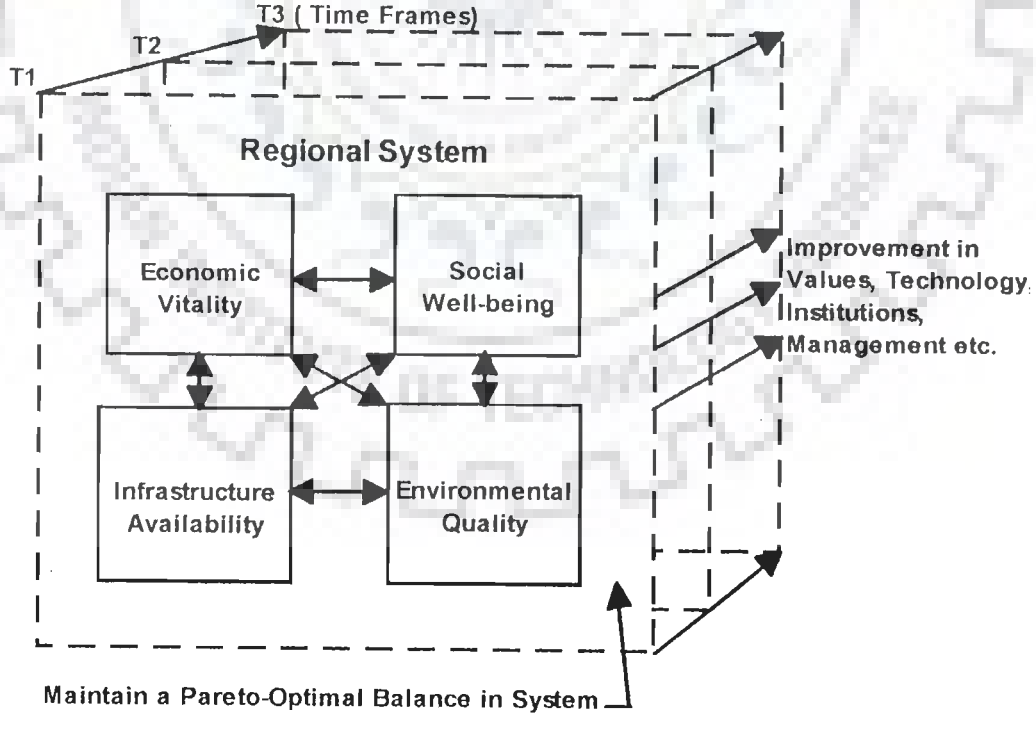


Fig.No. 5.3 Conceptual Model for Sustainable Development of Regions

A Pareto-optimal balance has to be maintained between these sub-systems. That is, we may try to optimise each of these without jeopardising any of the others. The path to Sustainable Development of a region lies in trying to achieve higher levels of balance in this dynamic interdependent system through improved inputs in terms of better technology, values, institutional framework, implementation and management practices etc. over future time frames.

5.11 Components of Liveability (COL)s:

5.11.1 Social Well-being: This indicator of the quality of life deals with human content or the profile of human development. How healthy, educated, productively employed are the people? How well are the women, the aged and children in the society treated? What is the rate of population growth? What about equity of income and infrastructure availability? These and such other questions are relevant to this component of quality of life.

5.11.2 Economic Vitality: This deals with the economic quality of life in the region. Questions like - What is the income per capita? What is the percentage of population gainfully employed? What is the sectoral break-up of employment? What is the productivity of the different sectors of the economy? are to be dealt with here.

5.11.3 Infrastructure Availability: Quality of life of the people is to a large extent dependent on adequate availability of shelter, water, access to various community facilities like post offices, telephones, hospitals, educational institutions, electricity, banks etc.

5.11.4 Environmental Quality: The quantity of land and water available per capita, and the quality of land, water and air have become questions of vital importance. Growing urbanisation and industrialisation and consequent rapid de-forestation, pollution of land, air and water are matters of deep concern and affect the quality of life of the citizens.

Each of these four Components of Liveability is composed of a number of elements or indicators which can be identified as contributing to or detracting from sustainability. These indicators of sustainability could be many, but in the interest of simplicity and manageability we will restrict them to ten each, the selection being based on heuristic knowledge of experts in this field (refer annexure A). Practical considerations of availability of data have also influenced the selection of these indicators as the objective of the entire exercise is to make the system useable at the grass-roots level. Therefore data available at the district level or that published by the state Directorate of Economics and Statistics and in various Central Government Publications has been used. This has some times resulted in use of proxy variables, for example number of automotive vehicles and number of factories in a district have been used as a proxy for air and water pollution as no data was directly available on this variable.

5.12 Role of Sustainable Development Indicators :

Indicators serve many purposes; to monitor existing conditions, to measure performances of policies and programmes, to raise awareness of the public, to define targets, to set planning objectives, to compare localities horizontally (that is across space) or longitudinally (over time), to raise red flags in an early warning system, to guide strategic investment choices, to challenge conventional wisdom, and so forth (Banerjee T. 1996). It must however be remembered that indicators are simplifications of complex phenomenon and provide only an indication of conditions or problems. Moreover, aggregations over time or space always hide some of the detail. Non the less, indicators have an extremely important role to play in the planning profession in general and planning for sustainable development in particular. The sustainable development indicators have a descriptive, predictive, comparative and prescriptive role to play in the planning process.

5.12.1 Descriptive Inputs of Indicators: The indicators of sustainable development serve to describe cultural, political, social, economic, infrastructural or environmental conditions in the study region. They help us to measure not only inter-generational but even intra-generational equity, that is, the conditions may vary across geographic regions or over time. This description of conditions may be with respect to 'before and after' studies for illustrating successes or failures of planning and development programmes or for detailing out the various alternative courses of action available for selection.

5.12.2 Comparative Inputs of Indicators: The measurements of conditions can be used to compare sections of populations, or localities to each other. The conditions in an individual locality or group of people may be compared to a minimum, maximum or average level amongst the set, or may be compared to some ideal condition either minimum or maximum. In the former case it is called a target, or desirable minimum to be achieved and in the latter case as a threshold or maximum level not to be exceeded. This comparison enables analysis of existing conditions as well as evaluation of proposed alternatives.

5.12.3 Predictive Inputs of Indicators: Once the existing conditions have been described, we would want to know how these are likely to vary in future. Provided past or time series data is available, this can be used for trend projection into the future. The trend projection may either be simple or conditional. Given the interactive or pro-active nature of the factors involved, the trend projection for a particular factor may take the form of a statistical model or a linear equation or be conditional to other factors being assumed to be so and so. The indicators may be used to predict the effects of alternative development proposals in future thus helping in deciding on the final choice of proposal.

5.12.4 Prescriptive Inputs of Indicators: Having described analysed and predicted conditions, it may be felt that certain actions need to be taken to set right

existing conditions or achieve certain targets or thresholds. Indicators may also be used to decide on the measures to be taken or alternative plans of action to be adopted.

5.13 Requirements of good Indicators:

There could be a wide range of indicators depending on the different dimensions or aspects of a situation. The more the number of indicators, the more detailed and accurate is the description of the situation. But on the other hand ease of manipulation and decision making demand that these numbers be kept within cognizible limits.

As contrasted with simple social, economic or environmental indicators, which are amenable only to straightforward interpretation or projection, the indicators of sustainable development have to fulfil the following conditions -

They should be,

i) **Interactive Indicators:** The interactive nature of the subsystems under study, namely social, economic, infrastructural and environmental systems dictate that the indicators selected should be able to portray this interaction. For example, rate of unemployment is both an economic as well as a social stress indicator. Rate of urbanisation, on the other hand, is economically and socially desirable but a stress on the environment. Several indicators could be combined to form what are called composite indices. For example, the Human Development Index of the UNDP is a composite index which aggregates four indicators. Despite methodological problems such as weightages of individual indicators, standardisation of different measurement units, and choice of a aggregation technique, composite indicators have become popular because they are able to condense vast

information contained in several individual indicators down to a single number.

ii) **Comparative Indicators:** The comparison of conditions both horizontally that is across space and longitudinally that is over time gives sense to the indicators. So does comparison with a standard, average, threshold or target. It is only through such comparison that progress achieved towards a desirable state or a worsening situation can be identified.

iii) **Predictive Indicators:** The indicators chosen should be amenable to projection into future. For this, time series of values of particular indicators are required. Prediction of indicators can be more useful when used in conjunction with comparison, that is, with reference to certain thresholds or targets to be achieved. The inherent ambiguity or uncertainty associated with such predictions can be reduced through use of statistical correlation tests or conditional indicators.

iv) **Distributive Indicators:** The differences in the quality of life within the same generation, that is variation of social, economic, infrastructural and environmental conditions within a population or across geographic units should be taken into account by good indicators. Six such disparities; forward - backward caste, rich - poor, urban - rural, private - public, man - woman, and across regions have been identified by the 'Vision of India - 2020' prepared by the Technology Information Forecasting and Assessment Council of the department of science and technology (Indiresan P.V. 1996).

v) **Scientifically Valid Indicators:** The indicators chosen must be objective, scientifically measurable and unambiguous. They should be relevant to the stated goals, objectives and issues of concern, responsive to the changes

in the environment and flexible enough to incorporate new scientific information.

vi) **Accurate Indicators:** The field data upon which the Indicators are based should be fairly accurate. Inaccurate data will lead to ambiguous indicators which in turn will give vague or inaccurate results.

vii) **Cost Effective and Easy To Use Indicators:** the amount of time and money spent in collecting data to be used in the indicators should be justified. Easily collected and used indicators are naturally to be preferred to costly, obscure and time consuming ones.

viii) Popular Indicators: The indicators should be popular in the sense that instead of highly technical or jargonistic indicators, simple ones, the impact of which can be easily grasped by the common people are to be preferred. Therefore, inputs from a wide range of participants representing various sections of the community are to be valued from the earliest stages of indicator development. This is especially true about sustainable development indicators since they are so value laden and context sensitive.

ix) **Comparable to Other Contexts:** Though certain indicators may be more appropriate to particular communities or regions, some core or fundamental indicators may be useful at the state, national or even global scale, thus making cross comparison possible.

x) **Indicators Attractive to the Media:** The question of community awareness is extremely important for sustainable development issues and therefore if the SD indicators are attractive to the media and get more coverage, the chances of the entire programme being successful are increased multifold.

5.14 Possible Frameworks for Development of S D Indicators:

A review of current practice in state of the environment reporting, quality of life reporting, healthy city reporting and urban sustainability reporting, points to six general frameworks that can be used for developing Sustainable Development Indicators (SDI)s. These are, domain-based frameworks, goal-based frameworks, issue-based frameworks, causal frameworks, and combination frameworks (MacLaren V.W. 1996). They are -

5.14.1.Domain-based Frameworks: In such cases the indicators are developed based on domains such as economy, society, population and resources, environment, etc. (e.g. Sustainable Seattle 1993). A domain based framework is most effective for enduring coverage of the dimensions of sustainability but an important weakness is that it does not directly link indicators with sustainability goals. It is also weak on integrative aspect of sustainable development. Examples of this type of framework are - Environment, Economy, Society, etc.

5.14.2 Goal-Based frameworks: Goals of sustainable development are first defined and then indicators are developed for each goal or combination of goals. (e.g. for local government management function). The advantages of this framework are its explicit characterisation of sustainability and ease of evaluation of the indicators. The weakness is that being fairly simple it does not capture the complex inter-relationships among the various dimensions of sustainable development. Examples of this type are Carrying Capacity, Basic Human Needs, Social Well-being, Economic Prosperity, Participation in Governance etc.

5.14.3 Sectoral frameworks: This is based on typical sectoral responsibilities of municipal or state government departments such as housing , transportation, waste management, land use control etc. Though this has the advantage of identifying and monitoring targets for each department, it is too compartmentalised and is not responsive to inter-sectoral linkages. Examples of this kind of indicators are -

Housing, Welfare, Recreation, Transportation, Environment, Economic development etc.

5.14.4 Issue Based Frameworks: Key issues of sustainability are identified and then indicators are developed to show the movements within these key issues. This type of framework suffers from arbitrariness and lack of coverage of all dimensions of sustainable development. Some examples of this type of indicators are - Urban Sprawl, Solid Waste Management, Crime and Safety, Job Creation, Industrial Pollution etc.

5.14.5 Causal Frameworks: These are based on cause and effect relationships and are known as condition-stress-response frameworks. Mainly used for state of the environment reporting. Examples are Air Quality-automobile use-Bus lanes, Unemployment-Inadequate Education-Special training Programmes, Human health-Air quality-Pollution warnings etc. The difficulty in using this type of framework in Sustainable Development Indicators is that the distinction between social-economic stressors and socio-economic conditions is not always clear.

5.14.6 Combination Frameworks: Many of the disadvantages of individual types of frameworks can be removed whilst simultaneously consolidating the advantages, by using a combination framework. The Community Oriented Model of the Lived Environment (COMLE) developed by Murdie et al (1992) is an example of this. This model contains three main segments - 1) Sectoral policies and programmes, 2) Components of liveability, and 3) Monitoring of indicators.

The Decision Support System developed in this study is based on this combination type of framework.

5.15 Selection of Sustainable Development Indicators:

The following four sets of SDIs were selected keeping in view the above stated requirements of good indicators -

5.15.1 Selected Indicators of Social Well-being:

1. Population Growth Rate: India is one of the most densely populated countries. This places high stress on the region's supportive capacities. This fact coupled with continued high fertility rates is indicative of unsustainable development and therefore needs close monitoring. The unit of measurement for this indicator is Average annual growth rate of population in percentage.

2. Infant Mortality Rate: A high mortality rate of infants induces couples to refuse the small family norm. It is also indicative of lack of access to health services. Consequently a high rate of infant mortality contributes to unsustainability. The unit of measurement here is Infant mortality per 1000 live births.

3. Death Rate: A high rate of deaths is a sign of many social ills such as poverty, malnutrition, lack of health facilities etc. A low death rate on the other hand would lead to lower birth rates besides being indicative of a healthier population and therefore sustainability. This is measured by annual deaths per 1000 people.

4. Birth Rate: A high birth rate contributes to high rates of population growth and therefore unsustainability in the context of the already densely populated developing countries. A measure of this indicator is births per 1000 people annually.

5. Total Literacy Percentage: Besides indicating low levels of human development, low literacy leads to low economic productivity, higher birth rates, dependence on subsistence activities etc. This is measured by percentage of literate population.

6. Difference in Male - Female Literacy Percentage: This is a measure of gender disparities. It has repercussions in economic productivity, human fertility, and education levels of the next generation. The measure of this indicator is difference in percentage of literate male and female population.

7. Female Participation Rate: Measured in terms of the percentage of total females that actively engage themselves in economically productive activity. A

higher participation rate of females is considered a signal of the equality of the genders besides contributing to economic productivity.

8. Percentage of Urban Population: Urbanisation is a dual edged sword so to say, as on one hand it increases the social standards and economic productivity in a region but on the other hand leads to higher consumption and pollution levels. This is measured in terms of the percentage of total population of the region that lives in urban areas.

9. Unemployment Percentage: Unemployment is a dual loss, as on one hand it means waste of human and economic potential and on the other hand it is a social scourge leading to loss of human dignity and crime. It is measured in percentage of people in the workable age group who are without economically gainful employment.

10. Percentage of House-less Population: Percentage of the total population without a proper shelter are a social, economic, infrastructural and environmental problem.

5.15.2 Selected Indicators of Economic Vitality:

1. Total Participation rate: The more the percentage of total population engaged in economic production, the better it is as it means higher productivity and less drag on the economy in terms of non-productive members or dependants.

2. Percentage of Non Agricultural Employment: This indicator shows the sectoral break up of total employment. Because of the notoriously low productivity of the agricultural sector, it is considered better for the economic development of a region if a larger percentage of the labour force is engaged in non-agricultural sectors.

3. Unemployment Percentage: As already discussed, this is both a social as well as a economic problem.

4. Percentage of Food Crops: Cash crops are obviously more paying and so economically speaking, better for the region. But socially this may create a problem

as food is also a social amenity. This is measured in percentage of cultivated land which is under food crops as against cash crops.

5. Food Grains Yield per Hectare: Agricultural productivity is an important indicator, as higher the yield per hectare, the more people that can be fed from the same piece of land. Economically too, higher yields are more desirable.

6. Per Capita Income: Annual income per capita is a sign of the relative prosperity or penury of the region. Though it may hide intra-regional disparities, it is a good inter-regional measure of economic development. This is simply measured in rupees per year.

7. Tractors per Hectare: Tractors are a sign of rural prosperity. They also mean a higher yield per hectare and thus higher agricultural income.

8. Live-stock per Hundred Persons: This is a measure of diversified agricultural practices. It also means higher income levels.

9. Net Area Sown As Percentage of Total Cultivated Area: In economic terms, the more the area under cultivation, the more is the income. But environmentally land allowed to lie fallow regains its productivity and is therefore pro-sustainability.

10. Percentage of Urban Population: Productivity being more in the urban sectors, in economic terms, the greater the percentage of urban population, the better.

5.15.3 Selected Indicators of Infrastructural Availability:

1. Road Kilometres per lakh of Population: Roads are an important means of transport and communication. Increased accessibility by road not only means better social life but also higher economic productivity.

2. Railway Kilometres per Lakh of Population: Along with roads, railways also form an important facet of transport and so has to be attended to.

3. Post Offices per Lakh of Population: Letters and telegrams are an important means of communications and play a vital role in the economic and social development of the region.

4. Telephones per Lakh of Population: Modern electronic communications are the backbone of regional economic activity. They help not only by ferrying messages faster but even by obviating some of the business trips thus reducing the load on the transport network.

5. Educational Institutions per Lakh of Population: The role of education in the economic and social development has been stressed by many experts. Educational institutions per lakh of population are a measure of access to education.

6. Hospital Beds per Lakh of Population: Access to health is an important social necessity and therefore the number of hospital beds available to the people is an important indicator of infrastructural availability.

7. Percentage of Electrified Human Settlements: Electricity has today become not only an important infrastructural facility but also a vital social amenity. Therefore the percentage of human settlements provided with electricity is a vital statistic of regional progress.

8. Banks per Lakh of Population: In this age of trade and commerce banking is of utmost importance not only for industry and trade but also for agriculture.

9. Irrigated Area as a Percentage of Total Cultivated Area: Irrigation boosts agricultural productivity and also induces cash crops and is therefore a fundamental infrastructure. The increase in irrigated land is therefore extremely important development from economic point of view.

10. Percentage of House-less Population: Housing is not only a essential infrastructure but also a social necessity. Percentage of population without housing is consequently an indicator of regional underdevelopment.

5.15.4 Selected Indicators of Environmental Quality:

1. Percentage of Urban Population: Urban areas though economically desirable, place a lot of strain on the environment both in terms of the higher per capita consumption of natural resources (due to a more energy intensive lifestyle), and pollution load (due to industries, automobiles etc.). Hence, the higher the percentage of urban areas in a region, the greater the stress on the environment and lower its quality.

2. Percentage of Barren and Waste land: Here too, as opposed to the economic view, waste land from the point of view of the environment, constitutes a reservoir of potential environmental regeneration. It is said that land allowed to lie fallow for a couple of years regenerates itself through natural processes.

3. Percentage of Sown Area: This indicator is also similar to the above in the sense that land allowed to remain fallow for some time regenerates itself. Hence, the lesser the percentage of sown area, the better the state of the environment.

4. Population Density: The higher the density of population, the greater is the stress placed on the environment, as humans depend on the use of natural resources for practically all their activities and give off their waste products into the environment thus making demands on its assimilative capacity. This indicator is measured in persons per square kilometre.

5. Percentage of Land under Forests: It is well known that forests constitute an important part of the natural environment. They not only harbour wild life but also form a significant constituent of the assimilative capacities of the environment.

6. Rate of Deforestation: Forests are disappearing rapidly due to the onslaught of man's multifarious and ever multiplying activities. The pace of this disappearance is to be monitored closely as it indicates the deteriorating state of the environment. This is measured in terms of the percentage of annual reduction in the land under forests in a region.

7. Employment in Mining and Quarrying: This indicator is used as a proxy variable for amount of degraded land in a region, as direct data on this indicator was not available. Obviously, the more is the employment in this sector, the more is the quantum of degraded land. This is measured in number of persons employed in mining and quarrying per hundred square kilometres of area of the region.

8. Rainfall per capita: As no data on amount of fresh water availability per capita was available, this variable was calculated by multiplying the average annual rainfall for the last thirty years in the region by the geographical area of the region and dividing this by the population of the same region.

9. Number of Factory Workers per Lakh of Population: This was used as a proxy variable for the quality of air and water in the region. The reasoning being that the more the number of factory workers, the more will be the number of factories and consequently, more will be the air and water pollution and the worse the quality of air and water available to the people.

10. Number of Automobiles per Lakh of Population: It is well known that automobiles are one of the worst polluters of air. It is consequently important to monitor the number of automotive vehicles in the region. The more the relative density of automobiles, the worse will be the quality of air being breathed by the people in the region.

5.16 Validation of the Indicators:

The issue to be considered was whether the variables chosen represent the concepts to be represented adequately or not. This was sought to be achieved in two ways. Firstly, several experts in the planning and related fields were consulted for taking advantage of their heuristic knowledge. Secondly, correlation tests were conducted on each set of variables and it was found that they were having a high

correlation with each other thus showing that they were measuring the same concept. The results of these tests may be seen at annexures A and B respectively.

5.17 Summary:

In this chapter we have looked at the dimensions of Man-Environment interactions and examined some possible approaches to the study of these. The approach taken in this study has been out lined. A conceptual model of Sustainable Regional Development has been postulated and its sub-systems defined along with their respective elements. The qualities required in these elements or indicators of Sustainable Development were specified and the selected indicators highlighted. The validity of the selected indicators was established. In the next chapter we shall detail out the need and method for converting the indicators into indices and use of these indices in a Decision Support System (DSS) for achievement of sustainable development of regions.

Chapter 6

A Computer Based Decision Support System

6.1 Introduction:

Having identified the sets of indicators of sustainable development in the last chapter, the task now is to try and use these, firstly to find out the present conditions of sustainability in the regions of our interest and secondly to try and project these conditions into the future and identify the problem areas and solutions if any. These objectives can be achieved by comparing the indicators across space and time. That is comparing the region of our interest to other regions over several time frames. It will then be possible to monitor the comparative improvement or decline of these indicators as related to sustainability and consequently the policy interventions required to maintain the region on a path of sustainable development. In this Chapter, we will examine the need for conversion of the indicators into indices and their use in a computer based Decision Support System for analysis, forecasting, identification of critical success or failure factors and visualisation of the effects of possible alternative strategies employed. The dynamic data and graphics linkage capabilities of a computer based spread-sheet software will be used for this interactive decision making.

6.2 Spatio-Temporal Analysis:

As stated earlier, the intra-generational or spatial equity or disparities could be investigated by comparing the region under study to other regions such that the disparities across space or amongst geographic units are highlighted. In this research, the study region i.e. the Southern Maharashtra Region comprising of five districts namely Ratnagiri, Sindhudurg, Satara, Kolhapur, and Sangli was compared

to the state of Maharashtra and the nation i.e. India. On the other hand the inter-generational or temporal inequities are sought to be studied by observing the movements of the indicators of sustainable development over time. The collection and study of data over past time frames helps in visualising the future through trend projection. Figure number 6.2 below symbolises the Spatio-temporal analysis employed in this research.

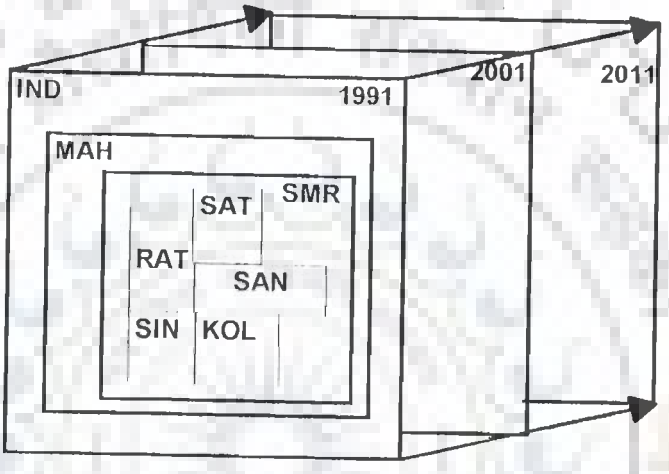


Fig. 6.1 Spatio-Temporal Analysis of Sustainable Development Indices

The movement of the forty indicators and four components of liveability for the eight geographical units were charted for the periods of 1971, '81,'91 with the help of a commercially available, p.c. based spread - sheet software. The same software was used to extrapolate the trends to the time frames of 2001 and 2011. The incorporation of trend lines into these bar charts helped in easy visualisation of dynamic scenarios, the slopes of these trend-lines indicating the rate of improvement or deterioration of these indicators in relation to each and to sustainability. This has been further elaborated in chapter 7.

6.3 Development of Sustainable Development Indices:

Having selected the forty indicators of sustainable development in four sets, it can be seen that their units of measurement vary tremendously. One indicator might

be expressed, for instance, in number of houses, whereas another indicator is measured in hectares. The areas of the geographical units too may be vastly differentiated. If we are to use them to any fruitful purpose of measuring and comparing the overall quality of development in various regions to each other and its relationship to sustainability, then they have to be necessarily transformed into a comparable form. This has been achieved in two ways. Firstly, the effect of areas of the regions was eliminated by using parameters such as percentages, per capita, per hectare etc. Secondly by using a statistical technique of multicriteria analysis, the raw data on all these forty variables which was collected over the time frames of 1971, '81, '91 was transformed into ranges of 0 to1 scores. This kind of transformation is called standardisation. These standardised scores were named as Sustainable Development Indices (SDIs). This enabled the evaluation, comparison, correlation, and forecasting of these diverse parameters (Fig. No. 6.2).

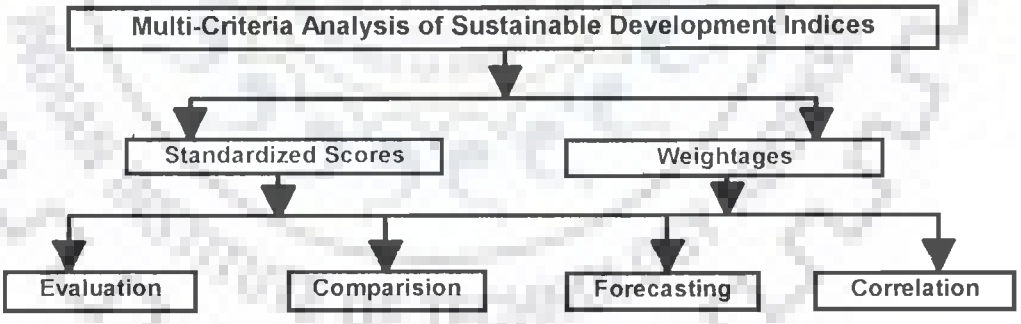


Figure No. 6.2

The use of techniques of multicriteria analysis also helped by allowing the use of weightages or value judgements in the later stages of the process of deciding on alternative policy interventions leading to sustainable development.

6.3.1 Alternative Measures of Standardisation: Four kinds of standardisation methods can be distinguished (Voogd H. 1983) -

a) The normalisation approach most often used in the statistical literature, which implies a transformation to units of standard deviation. This kind of standardisation can be written as -

$$\bar{e}_{ji} = \frac{S_{ji} - \bar{S}_j}{\sqrt{\{\sum_i (S_{ji} - \bar{S}_j)^2\}}}$$

A standardised score according to the above is thus the deviation of a criterion score from the mean criterion score divided by the standard deviation. It implies that the distribution of the e_{ji} - scores has a mean of zero and a standard deviation of 1: two characteristics which are not of a specific use to us.

b) A transformation of 'raw' scores to scores within a range from 0 to 1 with a *additivity constraint* -

$$\text{standardised score i} = \frac{\text{'raw' score i}}{\sum \text{'raw' scores}}$$

or each 'raw' score is divided by the sum of all 'raw' scores. This kind of transformation is especially appropriate in standardising various sets of different criterion weights, since an application of the above formula implies that all those weight sets will then add up to unity. This will be used in our work a little later.

c) A transformation of 'raw' scores to scores within a range from 0 to1 for which its *ratio-scale properties* may be further used -

$$\text{standardised score i} = \frac{\text{'raw' score i}}{\text{maximum 'raw' score}}$$

or each 'raw' score is divided by the highest 'raw' score of the criterion. This is very useful in standardising an evaluation matrix that will be analysed by a weighted summation technique or any other technique which utilises the magnitude of the individual scores.

d) A transformation of 'raw' scores to scores within a range of 0 to 1 for which its *interval scale properties* may be further used. This type of standardisation is especially appropriate where a technique is used which performs a pairwise comparison of the criterion scores. This kind of standardisation can be written as -

$$eji = \frac{s_{ji} - \min_i s_{ji}}{\max_i s_{ji} - \min_i s_{ji}}$$

The above formula implies that the lowest 'raw' score for a particular criterion is subtracted from the 'raw' score of the i^{th} element, after which the result is divided by the highest 'raw' score minus the lowest 'raw' score of the criterion concerned. This kind of transformation means that the worst criterion score will always be given a standardised value of 0, whereas the best criteria score will always have a standardised value of 1. Evidently, instead of the highest 'raw' score, a hypothetical maximum score may be used in the above formula. Such a hypothetical score may be seen as some kind of an *target* or achievement level.

6.3.2 Standardisation of raw scores: In our study, the raw data of sustainable indicators has been converted to standardised scores or Sustainable Development Indices by the formula (d) mentioned above, specifically for the standardised score (SDI) of the i^{th} region on the j^{th} indicator -

$$SDIji = \frac{score(i_{th}\ region)_j - min\ score_j}{max\ score_j - min\ score_j}$$

This formula converts the raw data into scores ranging from 0 to 1, making it possible to compare, analyse, predict and correlate the variables under the four components of liveability.

6.3.3 Directionality of Scores: Value judgements are necessary in deciding the vector qualities (that is the direction) of the indicator scores (Voogd H.1983). That is, whether a particular variable is contributing to sustainability or detracting from it. For some of the indicators a higher criterion score implies a 'better' score, whereas for other criteria a higher score might imply a 'worse' score. The first kind of criteria are called 'benefit-criteria', whereas the second type can be denoted as 'cost-criteria'. An example of a benefit criteria is 'the increase in the amount of natural areas', and an example of cost criteria is 'the increase in the amount of unemployment'; the first kind of increase will undoubtedly be received as positive, while the second kind of increase will be seen as a negative development. This illustrates that each standardisation should be accompanied by a consideration of the direction of the scores, i.e. the scores of the cost criteria should receive the same direction as the benefit-criteria or vice-versa. This may be done by substracting the standardised score, whose direction has to be changed, from one. For example, if all scores have to be formulated according to the direction 'the higher the better', the following transformation should take place:

i) directed standardised score = standardised score (for benefit-criterion)

ii) directed standardised score = 1 - standardised score (for cost-criterion)

The benefit and cost criterion were decided in our study by using the heuristic knowledge of experts. An expert's opinion survey was conducted on this issue (refer annxure A). In the first case, the SDI was calculated as (i) and in the second case, as per (ii) above.

6.4 A Decision Support System :

To enable the decision makers at the grass-roots levels (regional, district, taluka and village levels) to make well-informed decisions and to visualise the effects of such decisions a priori, a computer based Decision Support System (DSS) has been developed. This consists of seven cyclic but interactive stages (See Fig. No.6.3) which have to be continuously monitored over time, namely -

i) Identification of Sectoral Policies and Programmes (SPP) or the lack of such in a region.

ii) Identification of indicators of sustainable development and collection of data on these over several time frames for the region under study and other comparable regions and transformation of these indicators into Sustainable Development Indices (SDIs).

iii) Identification of four sets of Components Of Liveability (COL)s namely Economic Vitality, Social Well-being, Infrastructure Availability, and Environmental Quality. Grouping and aggregation of ten (or more) SDIs into each of the COLs by using Multi-Attribute Utility Theory (MAUT) techniques.

iv) Aggregation of the four COLs into an overall sustainable development function named Composite Aggregated Development Index of Sustainability (CADIS) through MAUT.

v) Analysis, comparison, forecasting, correlation of CADIS, COLs, and SDIs. through the use of the dynamic data-and-graphics linking capabilities of the computer.

vi) Identification of Critical Success and failure Factors (CSFs) for sustainable development. This would cover the political, institutional, managerial, technical and financial aspects.

vii) Scenario Building through interactive-sequential-iterative-manipulation of weights and levels of CADIS, COLs and SDIs. considering - a) Financial and quantitative

implications and b) Spatio-physical (distributive) implications of the scenarios through Geographical Information Systems (GIS)..

This will result in feed-back to Sectoral Policies and Programmes (SPP).

These seven stages are described in detail below -

6.4.1 Sectoral Policies and Programmes (SPPs): It is the effectiveness of sectoral policies and programmes that is in a large measure responsible for the quality of life of the people of a particular region. Policies and programmes of such sectors as employment, housing, public services (water supply, sanitation, electricity and garbage disposal to name a few), communications (postal service, telephones and recently E-mail and Internet), transport (railways, roads, airways of people and goods), landuse (optimisation of residential, industrial, agricultural etc.), use of natural resources (over, under and above ground), produce levels of satisfaction or dissatisfaction for the people. They also ultimately contribute to or detract from sustainability. Therefore, in the interest of sustainability of development, they need to be closely monitored. Indicators of sustainable development should therefore reflect the effects of these sectoral policies and programmes and be able to monitor their performance over time, thus giving feed-back for mid course corrections if any required. On the other hand indicators strictly partitioned into sectors of implementing agencies fail to account for the linkages across departmental boundaries and hence are not very useful as SDIs.

6.4.2 Sustainable Development Indicators and Indices (SDIs): As mentioned above these should on the one hand be derived to reflect the sectoral performances but on the other hand should be able to be aggregated into the identified components of liveability. The process of conversion of indicators into indices and the reasons thereof have already been elaborated in sufficient detail.

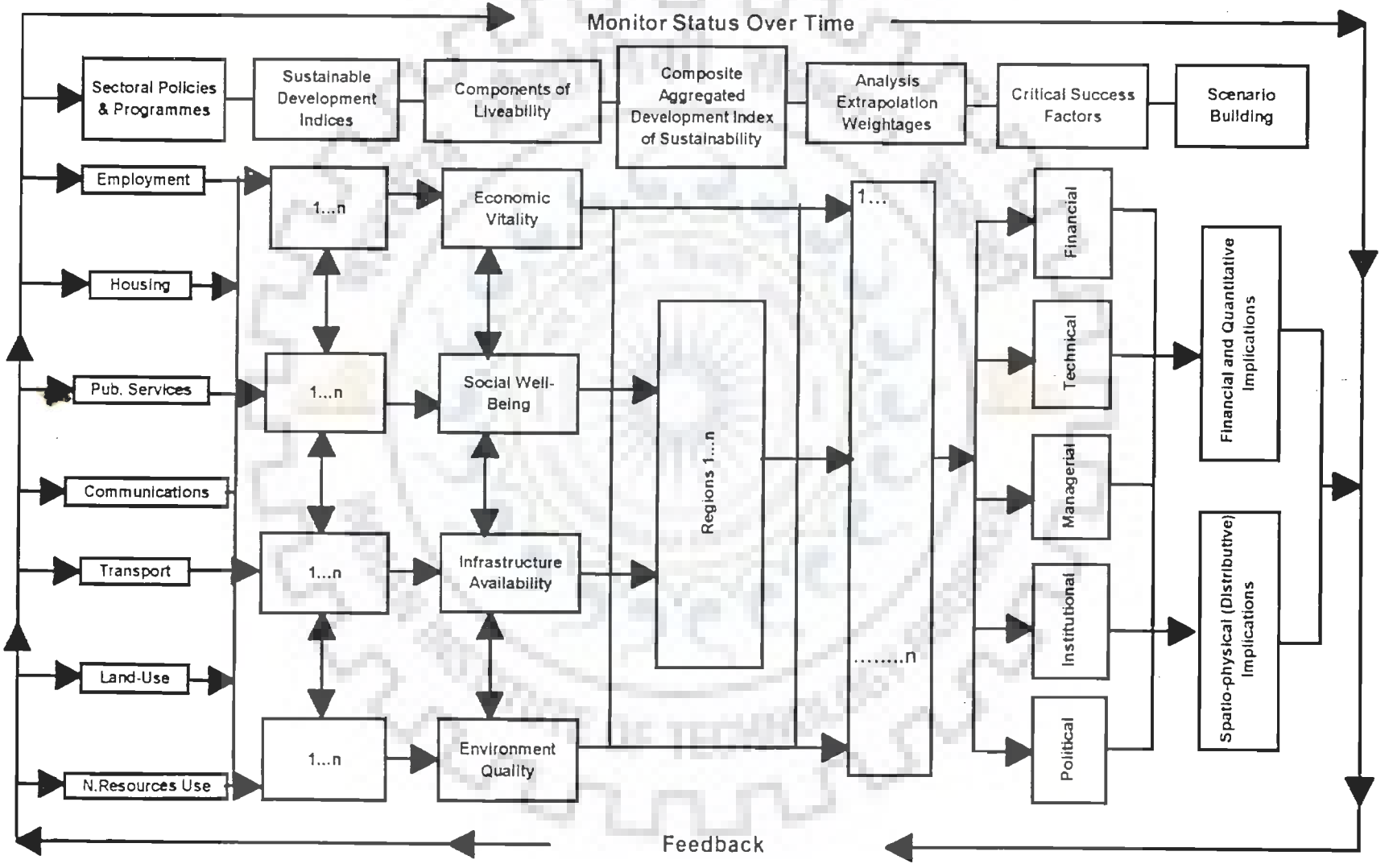


Fig. No. 6.3 A Decision Support System for Sustainable Development of Regions

6.4.3 Components Of Liveability (COL)s: The satisfaction of certain basic aspirations of people is the main goal of any government, but not at the expense of the environmental quality. At the same time the distributional aspects of inter and intra-generational equity have to be kept into view. The various dimensions of the quality of life can be partitioned for ease of understanding into several Components of Liveability (COL)s. We have divided the quality of life into four components namely - Economic vitality, Social Well-Being, Infrastructure Availability, and Environment Quality. Ten sustainable development indices (SDI)s have been selected and grouped under each of these. The aggregation of these SDIs into a single index number for each of these COLs leads to easy comprehension of these factors of the overall goal of sustainable development and their monitoring and comparison over time and across space. This aggregation has been accomplished by the use of rules derived from the Multi-Attribute Utility Theory (MAUT) which are detailed out below. (This digression at this point is essential in the interest of easy elucidation of the procedure followed in our study.)

6.4.3.1 Multi-Attribute Utility Theory (MAUT):

MAUT is by far the most popular method for scoring, evaluating and aggregating systems. The reason for the popularity of MAUT is its simple yet systematic approach to evaluation (and aggregation) that overcomes the problems of ad hoc approaches. MAUT lends itself to automation, is intuitive in its approach to decision making, and is consistent in its advice. It has been shown that MAUT is often superior to humans in its decision-making capacities (McCrary et al 1996).

In MAUT, the elements of a decision-making problem are broken down into a hierarchy of objectives, sub-objectives, and attributes. An objective is the desired direction or goal of the decision maker or organisation, and is placed at the top of the hierarchy. That objective is broken down into specific sub-objectives as the hierarchy is developed from top to bottom. The sub-objectives are further broken

down into attributes that provide a detailed description of the sub-objective with which it is associated (refer Fig.No.6.4)

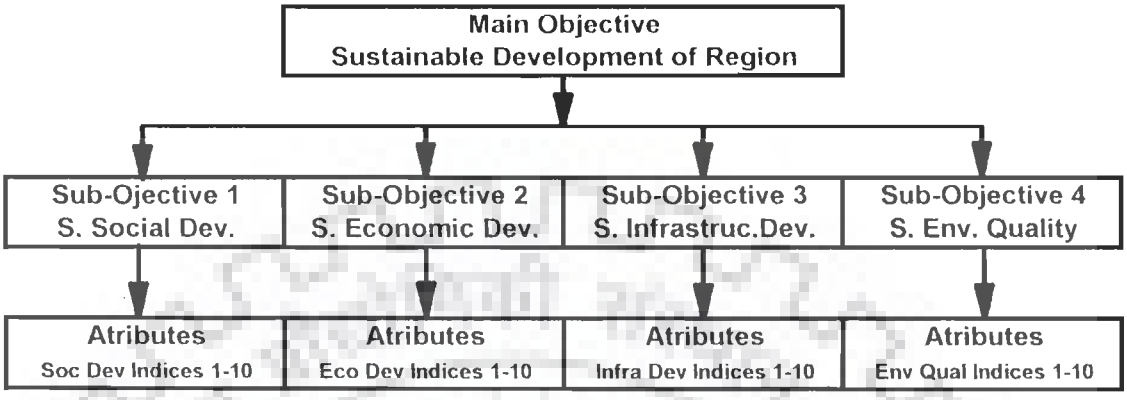


Fig. 6.4 Methodology for obtaining CADIS
(Composite Aggregated Development Index of Sustainability)

The aggregation of the attributes and sub-objectives is an additive problem; to be useful, an attribute and sub-objective must be quantifiable and additive with other attributes and sub-objectives. Each set of attributes is added to form a value for the sub-objective, then the values for the sub-objectives are added together to form a value for the overall objective. This aggregation can be mathematically represented as follows -

$$S = \sum_{i=1}^{N} W_i \left[\sum_{j=1}^{M} (w_j \times a_j) \right]_i \quad \text{.....(1)}$$

where S = summation total, the objective value, or score
N = number of i subobjectives
M = number of j attributes in the i th subobjective
W_i = weight on the i th subobjective
w_j = weight on the j th attribute
a_j = value on the j th attribute

Based on the foregoing, a mathematical equation for aggregating or scoring CADIS can be defined in terms of four factors namely; Social Well-Being (Sc),

Economic Vitality (Ec), Infrastructure Availability (In), and Environmental Quality (En) as follows:

$$\text{CADIS (overall obective)} \approx f(Sc, Ec, In, En) \quad \text{.....(2)}$$

where **Sc** = $\mathbf{W}_{sc}$ x sc, **Ec** = $\mathbf{W}_{ec}$ x ec, **In** = $\mathbf{W}_{in}$ x in, **En** = $\mathbf{W}_{en}$ x en
and sc, ec, in, en = values of the COLs. Here they have values ranging 0 to 1
W_{sc}, W_{ec}, W_{in}, W_{en} = weights of the COLs. They too have values 0 to 1, such that the sum of the weights equals 1.

Combining these factors, based on the structure of **(1)**, yields the following model structure -

$$\text{CADIS} = W_{sc}.sc + W_{ec}.ec + W_{in}.in + W_{en}.en \quad \text{....(3)}$$

such that the value of CADIS will always be a number between 0 to 1. Further definition of the variables **sc**, **ec**, **in** and **en** using **MAUT** nomenclature, is required as follows -

$$sc = \frac{\sum_{k=1}^{p} w_{sc_k}.sc_k}{p\left[\max(w_{sc_k})\right]}; \quad \text{.....(4)} \qquad ec = \frac{\sum_{m=1}^{q} w_{ec_m}.ec_m}{q\left[\max(w_{ec_m})\right]}; \quad \text{.....(5)}$$

$$in = \frac{\sum_{n=1}^{r} w_{in_n}.in_n}{r\left[\max(w_{in_n})\right]}; \quad \text{.....(6)} \qquad en = \frac{\sum_{o=1}^{s} w_{en_o}.en_o}{s\left[\max(w_{en_o})\right]} \quad \text{.....(7)}$$

where $\mathbf{w}_{sck}$, $\mathbf{w}_{ecm}$, $\mathbf{w}_{Inn}$, $\mathbf{w}_{eno}$ are all weights of the attributes in each of the COLs whose values range from 0 to 1 such that the sum of the weights equals 1.

sc_k, ec_m, in_n, en_o are all values of attributes of the respective COLs ranging from 0 to 1

p, q, r, and s are the number of attributes which have in our case have been kept uniformly at 10 each.

Substituting (4), (5), (6) and (7) into (3), completes the framework for the multivariate Composite Aggregated Development Index of Sustainability (CADIS):

$$CADIS = W_{sc}\frac{\sum_{k=1}^{p} w_{sc_k}.sc_k}{p[\max(w_{sc})]} + W_{ec}\frac{\sum_{m=1}^{q} w_{ec_m}.ec_m}{q[\max(w_{ec_m})]} + W_{in}\frac{\sum_{n=1}^{r} w_{in_n}.in_n}{r[\max(w_{in_n})]} + W_{en}\frac{\sum_{o=1}^{s} w_{en_o}.en_o}{s[\max(w_{en_o})]}$$

Though here initially the weights of the attributes and the COLs have been taken as all equal, in the later stages the decision-maker can alter these weights and even the number of the attributes to see the effects of such variation on the values of COLs and CADIS. The decision of these weights is a value laden task and if there are more than one decision maker, then a separate exercise will have to be carried out as per MAUT to decide upon these weights.

6.4.4 Composite Aggregated Development Index of Sustainability (CADIS): The CADIS as is evident from the name, is a composite index of the overall goal of sustainable development derived by the aggregation of the four COLs. This index combines the effects of all four COLs and therefore of all the forty SDIs into a single number. This facilitates the easy visualisation, comparison, and forecasting of progress of different regions towards the goals of sustainable development. This has again been accomplished through the use of the MAUT techniques mentioned above.

6.4.5 Analysis of SDIs, COLs and CADIS:

Comparison: The comparison of CADIS for different regions under study gives the overall standing of the individual regions as compared to each other which may be converted into rankings. The comparison of COLs shows the comparative

development on each of the components of liveability amongst the regions. The comparison of SDIs gives the comparative development on that particular indicator of sustainability. All this gives a picture of the distribution of these phenomenon over space or across regions but this static comparison does not yield substantial results until the movement of these indicators can be compared over a span of time and into the future as well.

Extrapolation: This can be done by training the model by entering data for past time frames into the computer. For being able to project the trends into the future, past data for atleast three time frames is required to be fed into the computer. It can then train itself on this data and generate equations and best-fit curves to project the trends into the future. It also gives the R^2 (coefficient of determination), so that alternative curves may be interactively tried out giving the best R^2. Bar charts can be generated and tend-lines can be incorporated into them to give a visual feel of the dynamic comparative movement of the SDIs, COLs, and CADIS. This is especially helpful in visualising the future and deciding on the corrective measures required to be initiated.

Weightages: The computer software also generates comparative weightages of COLs from the past data. This is useful in making corrections for the future. Alternative weights may be tried out interactively to see how much improvement in the levels of COLs can be made with the same.

6.4.6 Identification of Critical Success and failure Factors: The spatio-temporal analysis of the SDIs, CDIs and the CADIS will be useful for identifying critical gaps if any in the sectoral policies and programmes thus giving a feed back for the betterment of the same in order to achieve the objective of development without damaging the environment. There could be political, managerial, institutional, technical and financial blocks to the sustainable development path which will have to be removed.

6.4.7 Scenario Building or 'What-if' Studies: Through the interactive-sequential-iterative manipulation of the CADIS, COLs and SDIs an alternative scenario of the future can be built up. The proposed SDIs can be converted back into respective indicators, thereby indicating the physical and financial implications of the scenario. That is to say, how much financial allocation would be required to achieve that particular scenario and what sort of physical targets would have to be met. The scenario can then be altered interactively to either upgrade or downgrade the targets keeping in view the practicality.

6.5 Feed Back To Sectoral Policies and Programmes (SPP):

Once the scenario for the future has been finalised, the SPP can be provided with firm targets and time frames for fulfilling them. The performance towards fulfilment of these targets can then be actively monitored by going through another cycle of the whole process of the Decision Support System.

6.6 Summary:

In this chapter, the theoretical development of a computer based interactive - predictive - corrective Decision Support System (DSS) has been highlighted. The selection of appropriate indicators of sustainable development, their conversion into Sustainable Development Indices (SDI)s through standardisation, the methodology for aggregation of SDIs into Components of Liveability (COL)s and Composite Aggregated Development Index Of Sustainability (CADIS) was detailed out. The details of the working of the DSS have been supplied. In the next chapter the practical application of the DSS to the Southern Maharashtra region will be reported.

Chapter 7

Application of DSS to Southern Maharashtra Region

7.1 Introduction:

The Decision Support System (DSS) has been applied to the study of Southern Maharashtra Region (SMR) consisting of five districts namely Ratnagiri, Sindhudurg, Satara, Sangli and Kolhapur, which are a part of the state of Maharashtra and the nation of India. This region was selected for study as it offers a wide range of variations - natural, social, economic and infrastructural. Though they form a part of the progressive state of Maharashtra, the development is by no means uniform over the state and each of the districts has a particular physico-cultural and socio-economic profile and presents a unique set of developmental and sustainability related problems. These variations are compounded by the different trajectories of growth displayed by each of these regions. Whereas some of them are growing at a tremendous rate thus posing a problem to the carrying capacity of the environment in those districts, others are languishing in the backwaters of political and economic neglect, thereby imposing another set of socio-economic problems on its people. Given the assumption that the past developmental trends continue into the future, then the problems faced and therefore the solutions required in each of these districts will be unique. It follows, that though the human aspirations of a reasonable quality of life are common to all the people of the region, the path to their achievement is likely to be different in the various districts of the region. Therefore, the planning for sustainable development in each of these districts requires the application of the DSS to monitor the components of liveability parameters over time and take corrective measures if any as and when required.

In this chapter we will first briefly study the historic, climatic, social and economic background of this region, moving on to the details of the present conditions and the trends of development displayed in each of the five districts as compared to the region, state and the nation. This is accomplished by identifying four sets of sustainable development indicators, each with ten variables and conversion of these into Sustainable Development Indices (SDIs), Components of Liveability (COL)s, and finally Composite Aggregated Development Indices of Sustainability (CADIS). These indices are analysed in relation to each other over a period of 1971 to '91 and then extrapolated to 2001 and 2011. Thereafter, we will use the DSS to examine the likely future development of these districts, and identify a set of Critical Success or failure Factors (CSF)s for achievement of sustainable development. This will lead us to a set of revised policy guidelines for this region in order to maintain it on the path of sustainable development. Thus the first six stages of the DSS are applied to SMR in this chapter, leaving it to the chapter 8 to build alternative scenarios, and find out the financial, physical and spatial implications thereof.

7.2 Background of Southern Maharashtra Region (SMR):

7.2.1 location: The Southern Maharashtra Region (**SMR**) comprising of the five districts of Ratnagiri (**RAT**), Sindhudurg (**SIN**), Satara (**SAT**), Sangli (**SAN**), and Kolhapur (**KOL**) is the southern most tip of Maharashtra state, bounded by Karnataka in the south, the Arabian sea in the west, Raigad and Pune districts in the north and Solapur district in the east. The two coastal districts of Ratnagiri and Sindhudurg (called the Konkan) on the one hand, and the three districts of Kolhapur, Satara and Sangli located on the Deccan plateau (the so called Ghats) on the other, form natural partners and have had age-old ties through give and take of not only goods but even people and culture.

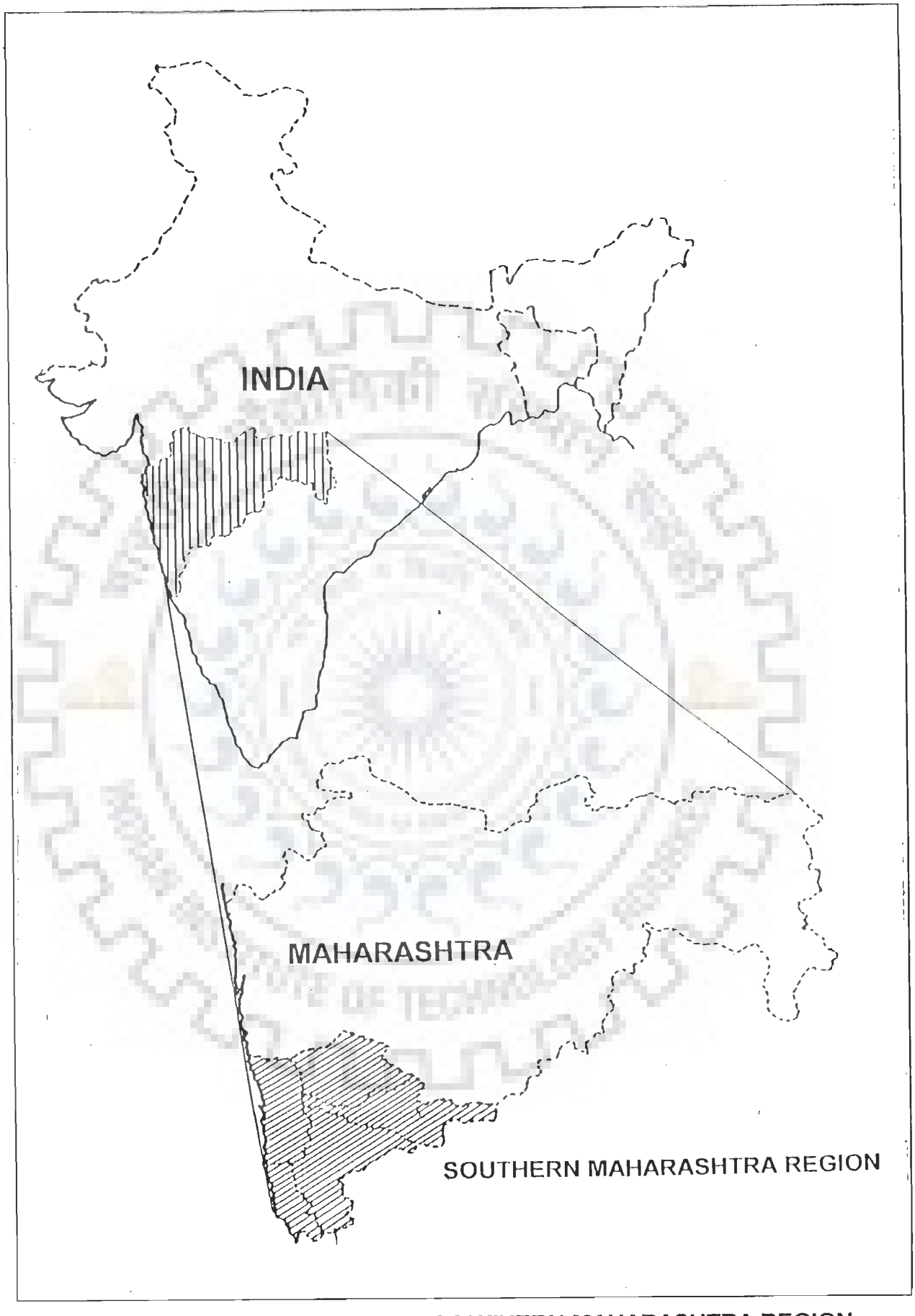


Fig. No. 7.1 LOCATION MAP OF SOUTHERN MAHARASHTRA REGION

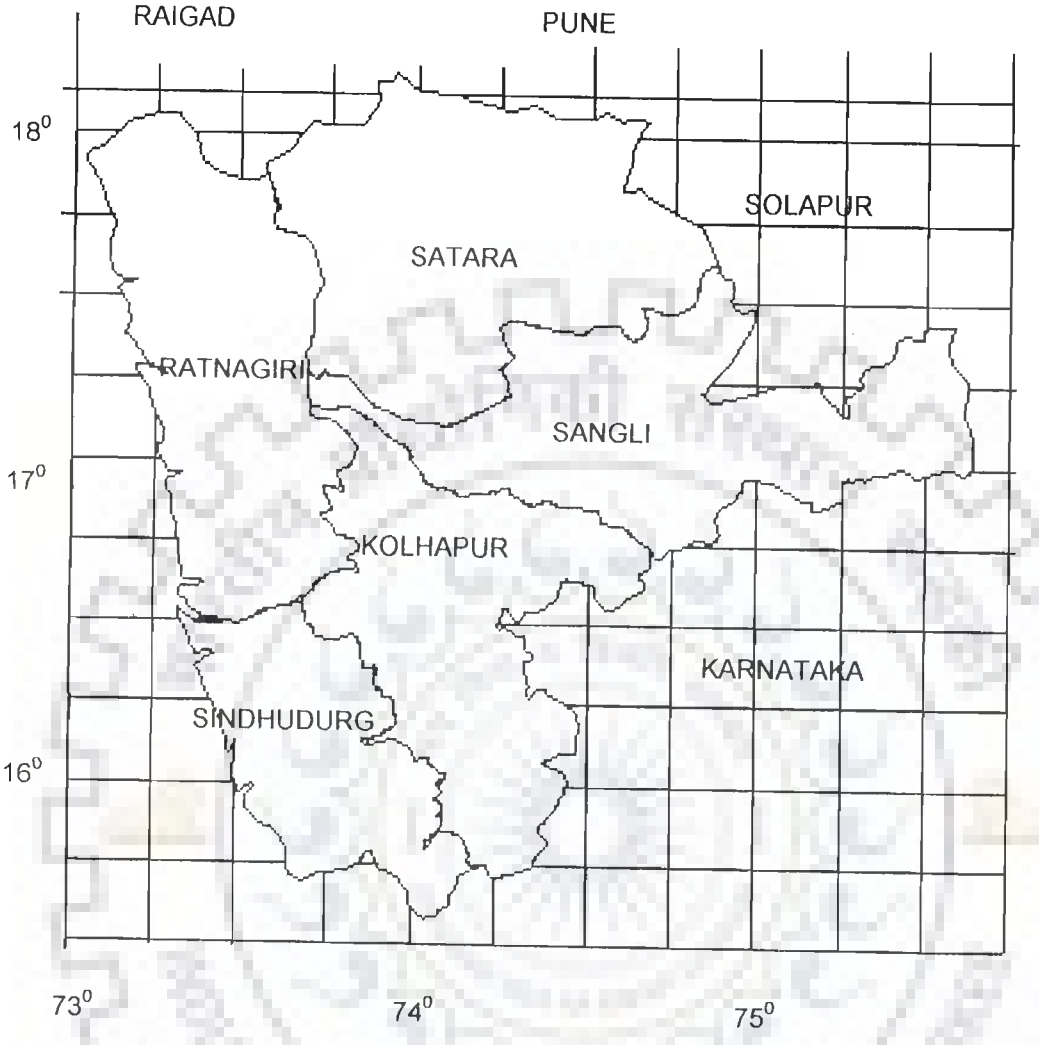


Fig. No. 7.2 Southern Maharashtra Region

7.2.2 History: As per the *puranas*, this area was known as the *Kuntal* region and is said to have been a part of the Virat kingdom where the Pandavas spent their 13th year in wilderness (*Adnyatvas*). Thereafter in the ancient historic period, it was ruled at different periods by various Hindu dynasties such as the Mauryas, the Shilaharas, the Satvahanas, the Chalukyas and the Rashtrakutas. During the early middle ages, the muslim dynasties of Bahamani and Adilshahi governed it till it came under the rule of the Marathas, though parts of the coastal regions were occupied by the Portuguese and the Abisinians (*Habshis*). In the late 19th century, most of it came under the British rule except the princely states of Kolhapur, Satara and Sangli. In

1947, along with the rest of the country, this region became a part of independent India.

7.2.3 Physiography and Climate: Whereas the Ratnagiri (RAT) and Sindhudurg (SIN) districts are coastal with mostly lateritic soils, the other three districts are part of the Deccan plateau, have a higher elevation with generally black cotton soils. The Western Ghats which are called the Sahyadri range, run north - south, roughly forming a water-shed and a climatic boundary between these two zones. The rainfall is maximum on these ghats (4000 to 6000 mm) and tapers off on both sides to 1200 mm on the coastline and just 500 mm in the eastern parts of Satara (SAT) and Sangli (SAN) districts. The climate is warm-humid in the two coastal districts, temperate in most parts of Satara (SAT) and Kolhapur (KOL) and hot-dry in Sangli (SAN) district.

7.2.4 Economy: Ratnagiri and Sindhudurg produce rice and are known for their quality mangoes whereas Kolhapur, Satara and Sangli produce sugar-cane, jowar, and cotton and are famous for their sugar and jaggery. Sangli district has recently made a name as a grapes producer. Kolhapur and Sangli are industrial, commercial and educational centres whereas the beautiful coast-line and a number of historic sea-forts make Ratnagiri and Sindhudurg excellent tourist attractions. The two coastal districts are lagging behind in industrial development and therefore young people from these districts migrate to Mumbai for employment.

7.2.5 Social and Cultural: Better literacy levels and equality of gender make the two coastal districts socially more advanced than the three districts on the ghats. Each of the two zones have their own distinct culture with the 'Lavani' of the ghats and the 'Koli' dance of the Konkan being famous.

7.2.6 Infrastructure: Sangli and Satara are well served by railways, Kolhapur has limited access to railway and the two coastal districts were totally lacking in this until the recent construction of the Konkan Railway. Road accessibility in Kolhapur district is less than the other four districts.

7.3 Past Trajectories and Present Conditions:

In order to understand the present and to be able to project the trends into the future, it becomes imperative to look at the past. Data for ten indicators of sustainable development each under the four Components Of Liveability (COL)s was collected over three time frames - 1971, 1981 and 1991 (refer table Nos. 1-A,B,C to 4-A,B,C on page nos.) (based on the publications of the Directorate of Economics & Statistics, Government of Maharashtra, the Census of India, and other publications of the Government of India). The indicators selected under the four Components of Liveability (COL)s, their directionalities (this has been explained in detail in the previous chapter) and their present conditions respectively are as follows -

7.3.1 Social Well-being:

1) Average annual growth rate of population (PopGrthRt(-)): (Population Growth Rate): KOL (2.1) is the fastest and SIN (0.66) the slowest growing of the five districts in terms of population, but the average for SMR (1.58) is much lower than the growth rates of both MAH (2.57) and IND (2.35).

2) Infant mortality rate per 1000 live births (InfMrtRt(-)) (Infant Mortality Rate): is highest in KOL (26) and lowest in RAT(10). The average infant Mortality in SMR (20) is much lower than MAH (60) and IND (79).

3) Death rate per 1000 persons (DeathRt(-)): This is lowest in RAT (6.35) and highest (10.39) in SIN, the average for SMR (7.03) is again lower than MAH (8.2) and IND (9.8).

4) Birth rate per 1000 Persons(BirthRt(-)) : is lowest in SIN (19.8) and highest in SAT (24.6). But this is still lower than MAH (26.2) and IND (29.5).

5) Percentage of total literacy (Tlit%(+))(Total Literacy percentage): SIN at 75.81% is the most literate district and SAN the least (62.61%). The average literacy level for SMR (66.95) is better than MAH (64.87) and IND (52.11).

6) Difference in male-female literacy percentage (DifM-Flit%(-)): SIN has the least score on this indicator (19.36 %) i.e. it is the best, whereas SAT and KOL (both 27.25 %) are the worst districts. The average for SMR (24.76 %)is almost the same as that of MAH (24.24 %) and IND (24.84 %)

7) Female workers as % of total female population (FPrtRt(+)) (Female Participation Rate):is highest in SIN (44.25 %), and lowest in SAN (34.67 %), but the average for SMR (39.66 %) is better than MAH (33.11 %) and IND (22.73 %).

8) Urban population as percentage of total population (UrbPop%(+)): KOL is the most urbanised at 26.32 %, and SIN the least at 7.57 %. The average for SMR (15.69 %) stands much lower than either MAH (38.69 %) or IND (25.71 %).

9) Percentage of unemployment excluding non-working females(UnEmp% (-)) (unemployed percentage): Only 14.56 % are unemployed in KOL whereas 17 % are unoccupied in SIN. Unemployment in SMR (15.88 %) is almost same as MAH (15.21 %) and lower than IND (16.68 %).

10) Percentage of houseless population (HslessPop%(-)): is lowest in SAN (2.81 %) and highest in SIN (9.14 %). The average for SMR (5.24 %) is slightly better than IND (5.38 %) but inferior to MAH (3.82 %).

7.3.2 Economic Vitality:

1) Main workers as percentage of total population (TPrtRt(+)) (Total Participation Rate): KOL has the highest participation rate at 39.13 % and SAT the lowest at 36.57 %. SMR on the whole is better off than IND at 34.12 % but not doing as well as MAH at 39.22 %.

2) Percentage of non-agricultural employment (NAgriEmp%(+)) (Non-agricultural Employment Percentage): KOL has the best score on this variable (37.09 %) and SIN the worst (27.33 %) in the region. SMR on the average is not doing as well as either MAH (40.38 %) or IND (35.10 %).

3) Percentage of unemployment excluding non-working females(UnEmp%(-)) (Unemployment Percentage): Only 14.56 % are unemployed in KOL whereas 17 % are unoccupied in SIN. Unemployment in SMR (15.88 %) is almost same as MAH (15.21 %) and lower than IND (16.68 %).

4) Percentage of cultivated land under food crops (FdCrps%(-)), (Food Crops Percentage): This is lowest in KOL (54 %) and highest in SIN (74.6 %) meaning thereby that KOL is having more cash crops and is therefore more prosperous whereas SIN is more dependent on food crops or one may say on subsistence farming. SMR at 67.26 % has more area under food crops than MAH (63.7 %) but less than IND (69.03 %).

5) Average food grains yield in Kgs. per hectare (FdGrnYld(+))(Food Grain Yield): Productivity of food crops is highest in RAT (1777 kg. per Hect.) and lowest in SAN (651 Kg. per Hect.). The average for SMR works out to 1332 Kg. per Hect. Which is higher than MAH (839 Kg. per Hect.) but lower than IND (1369 Kg. per Hect.)

6) Average Per-capita income at 1981 constant prices(PCIncm(+)), (Per Capita Income): RAT has the lowest per capita income at Rs. 2417/- as compared to KOL which has the highest at Rs. 3232/-. SMR has an average per capita income of Rs. 2686/- which is more than the IND average of Rs. 2223/- but less than MAH (Rs. 3438/-).

7) Tractors per 100 hectares sown (Trcts/100H(+)): KOL has the highest score at 0.77 and RAT and SIN have the lowest scores at 0.01. SMR on an average (0.40) does much better than MAH (0.19) but much lower than IND (0.55).

Table No. 7.1-A INDICATORS OF SOCIAL WELL-BEING 1971

AdUni	PopGrthRt(-)	InfMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	Dif M-F Lit%(-)	F Prt Rt (+)	UrbPop%(+)	UnEmp%(-)	HslesPop%(-)
RAT	1.50	43	9.4	22.2	39.8	22.88	29.96	8.99	41.8	20.45
SIN	0.46	43	9.4	22.2	39.8	22.88	28.45	6.89	41.8	20.45
SAT	2.08	57	10.8	28.5	38.32	27.61	30.03	13.16	45.6	7.97
SAN	2.51	43	9.4	25.70	37.48	27.74	14.05	18.63	45.00	4.96
KOL	2.83	49	9.9	26.80	35.37	29.44	20.73	21.50	42.00	17.81
SMR	2.07	48	9.88	25.8	37.74	26.93	24.64	13.83	43.24	45.88
MAH	2.75	105	12.3	32.2	39.13	24.57	28.15	31.37	40.5	14
IND	2.48	137	15.2	36.9	29.46	20.75	15.25	20	42.79	5.09

Table No. 7.1-B INDICATORS OF SOCIAL WELL-BEING 1981

AdUni	PopGrthRt(-)	InfMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	DifM-FLit%(-)	F Prt Rt (+)	UrbPop%(+)	UnEmp%(-)	HslessPop%(-)
RAT	0.79	29.5	8.88	22.58	47.75	21.47	36.35	8.73	28.9	12.45
SIN	0.30	29.5	8.88	22.58	47.75	21.47	36.35	6.54	29.4	12.45
SAT	1.8	37.5	8.54	26.55	48.15	25.72	34.68	13.04	31	2.83
SAN	1.89	33.5	7.9	25.05	46.87	26.1	24.36	21.52	30.26	4.32
KOL	2.24	37.5	7.83	24.55	45.36	28.66	29.02	25.22	28.28	2.89
SMR	1.4	34.5	8.28	24.68	47.18	24.69	32.15	15.01	29.56	5.62
MAH	2.45	80	9.6	28.5	47.18	24	30.63	35.03	27.86	6
IND	2.47	108	12.5	33.9	36.23	22.1	18.99	23.3	29.74	5.68

Table No. 7.1-C INDICATORS OF SOCIAL WELL-BEING 1991

AdUni	PopGrthRt(-)	IntMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	DifM-FLit%(-)	F Prt Rt (+)	UrbPop%(+)	UnEmp%(-)	HslessPop%(-)
RAT	1.16	10	6.35	26.1	62.7	25.03	42.74	9.12	16	8.66
SIN	0.66	22	10.39	19.8	75.81	19.36	44.25	7.57	17	9.14
SAT	1.99	18	6.28	24.6	66.67	27.25	39.33	12.89	16.33	3.29
SAN	1.98	24	6.4	24.4	62.61	24.89	34.67	22.72	15.51	2.81
KOL	2.1	26	5.75	22.44	66.94	27.25	37.31	26.32	14.56	5.36
SMR	1.58	20	7.03	23.44	66.95	24.76	39.66	15.69	15.88	5.24
MAH	2.57	60	8.2	26.2	64.87	24.24	33.11	38.69	15.21	3.62
IND	2.35	79	9.8	29.5	52.11	24.84	22.73	25.71	16.68	5.38

Table No. 7.2-A INDICATORS OF ECONOMIC VITALITY 1971

AdUt	TPrtRt(+)	NAgriEmp%(+)	UnEmp%(-)	FdCrps%(-)	FdGrnYld(+)	PCIncm(+)	Trcts/100H(+)	Livstk/HPop(+)	NtArSwn%(+	UrbPop
RAT	30.83	25.71	41.8	67.97	991	809	0.005	48	27	8.99
SIN	29.85	25.27	41.8	67.97	1101	810	0.005	48	34.1	6.89
SAT	31.33	28.26	45.6	81.3	478	1216	0.033	61	51.2	13.16
SAN	31.08	27.24	45	79.4	547	991	0.04	61	66.3	18.63
KOL	33.99	27.71	42	62.9	941	1427	0.12	41	49.35	21.5
SMR	31.41	26.84	43.24	72.9	755.2	1252	0.05	53	46.84	13.83
MAH	38.2	36.02	40.5	71.5	515	2065	0.02	50	61.4	31.37
IND	32.78	31.86	42.79	77.13	695	1037	0.49	63	45.93	20

Table No. 7.2-B INDICATORS OF ECONOMIC VITALITY 1981

AdU	TPrt Rt(+)	NAgriEmp%(+)	UnEmp%(-)	FdCrps%(-)	FdGrnYld(+)	PCIncm(+)	Trcts/100H(+)	Livstk/HPop(+)	NtArSwn%(+	UrbPop
RAT	34.06	26.3	28.9	64.7	1244	1613	0.01	46	27.8	8.73
SIN	34.06	26.3	29.4	64.7	1358	1613	0.01	45	27.8	6.54
SAT	33.56	28.7	31	72.5	690	1762	0.13	61	54.1	13.04
SAN	34.16	29.8	30.26	63.7	599	1872	0.09	58	69.5	21.52
KOL	36.76	32.4	28.28	53.2	1327	2101	0.33	39	50.6	25.22
SMR	34.52	28.7	29.56	63.76	1043.6	1796	0.18	50	45.96	15.01
MAH	38.71	38.2	27.86	67.6	677	2435	0.07	47	59.5	35.03
IND	33.45	33.48	29.74	73.08	1032	1630	0.52	58	46.28	23.3

Table No. 7.2-C INDICATORS OF ECONOMIC VITALITY 1991

AdU	TPrt Rt(+)	NAgriEmp%(+)	UnEmp%(-)	FdCrps%(-)	FdGrnYld(+)	PCIncm(+)	Trcts/100H(+)	Livstk/HPop(+)	NtArSwn%(+	UrbPop
RAT	37.29	26.89	16	57.6	1777	2417	0.01	51	28.6	9.12
SIN	38.27	27.33	17	74.6	1615	2452	0.01	66	21.5	7.57
SAT	36.57	29.14	16.33	73.1	902	2575	0.44	68	55	12.89
SAN	36.87	32.36	15.51	77	651	2753	0.37	58	68.3	22.72
KOL	39.13	37.09	14.56	54	1713	3232	0.77	41	52	26.32
SMR	37.63	30.56	15.88	67.26	1332	2686	0.4	57	45.08	15.69
MAH	39.22	40.38	15.21	63.7	839	3438	0.19	43	57.6	38.69
IND	34.12	35.1	16..68	69.03	1369	2223	0.55	53	46.63	25.71

Table No 7.3-A INDICATORS OF INFRASTRUCTURE AVAILABILITY 1971

Adm Unit	RdKms/100SKms(+)	RlyKms/LP(+)	PO/LP(+)	Tel/LP(+)	EdInst/LP(+)	Hbeds/LP(+)	El HS % (+)	Bnks/LP(+)	IrrAr%(+)	HslsPop%(-)
RAT	252	0	35	67	149	52	23.31	4.7	3.37	20.45
SIN	252	0	35	67	149	52	23.31	4.7	3.37	20.45
SAT	221	7.3	25.5	122	126	51	42.68	6.9	17.6	7.97
SAN	267	10.2	24	141	101	82	41.5	7.8	10.97	4.96
KOL	172	1.7	18	196	106	48	69.44	7.1	12.25	17.81
SMR	228	1.9	25.6	132	121	58	44.22	6.6	11.05	15.88
MAH	151	9.5	18	415	106	122	47	6.1	7.3	14
IND	140	10.4	24.6	138	91	67	23	4.8	25.46	5.09

Table No 7.3-B INDICATORS OF INFRASTRUCTURE AVAILABILITY 1981

Adm Unit	Rd Kms/100SKms (+	RlyKms/Lpop	P O /L Pc	Tel / Lpo	EdInst/Lpop	Hbeds/Lpop	El HS % (+)	Bnks/Lpop	IrrAr%(+)	HslsPop%(-)
RAT	252	0	47	182	175	85	53.5	8.1	4.3	12.45
SIN	269	0	46	154	180	85	53.5	2.2	4.3	12.45
SAT	199	6.4	32	270	121	89	73.5	5.7	17.4	2.83
SAN	202	8.9	24	350	87	142	72.8	7.7	11.2	4.32
KOL	158	1.5	23	427	92	91	81.1	6.5	14.1	2.89
SMR	216	3.4	34	277	131	98	6.9	6.0	10.3	5.62
MAH	159	8.3	21	795	95	143	73.5	6.2	10.5	6
IND	172	8.89	20.2	405	100	82	52	6	27.7	5.68

Table No 7.3-C INDICATORS OF INFRASTRUCTURE AVAILABILITY 1991

Adm Unit	Rd Kms/100SKms (+	RlyKms/Lpop	P O /L Pc	Tel / Lpo	EdInst/Lpop	Hbeds/Lpop	El HS % (+)	Bnks/Lpop	IrrAr%(+)	HslsPop%(-)
RAT	362	0	46	376	182	128	100	8	2.3	8.66
SIN	421	0	57	323	218	144	100	9.1	20.4	9.14
SAT	429	5.5	31	371	121	169	100	6	28.5	3.29
SAN	430	7.6	23	521	96	176	100	7.8	15.8	2.81
KOL	229	1.3	21	655	93	125	100	7.2	18.7	5.36
SMR	374	4.8	36	449	142	18	100	7.6	17.1	5.24
MAH	280	7.1	18	1328	94	164	100	7	13.7	3.82
IND	204	7.4	17.9	672	129	97	81.3	7.2	24.5	5.38

Table No. 7.4-A INDICATORS OF ENVIRONMENTAL QUALITY 1971

Adm Unit	UrbPop%(-)	BrnLnd%(+)	SwnAr%(-)	PopDen(-)	FrstLnd%(+)	DfrstRt(-)	EmpM&Q(-)	RnfPC(+)	FWrk/LPop(-)	Autos/Lpop(-)
RAT	8.99	28.52	27	155	2.96		18.7	26.41	127	560
SIN	6.89	28.52	34.1	145.6	2.96		18.7	26.24	127	560
SAT	13.16	10.9	51.2	164.8	14.14		20.29	7.54	495	686
SAN	18.63	5.1	66.3	179.65	5.63		7.37	6.89	575	686
KOL	21.5	5.34	49.35	266.49	20.52		26.42	5.51	822	921
SMR	13.83	12.47	46.84	182.31	10.81		18.2	14.52	496	683
MAH	31.37	5.84	61.4	164	20.21		14.69	8.54	1787	679
IND	20	25.52	45.93	178	24.14		19.18	7.95	1058	371

Table No. 7.4-B INDICATORS OF ENVIRONMENTAL QUALITY 1981

Adm Unit	UrbPop%(-)	BrnLnd%(+)	SwnAr%(-)	PopDen(-)	FrstLnd%(+)	DfrstRt(-)	EmpM&Q(-)	RnfPC(+)	FWrk/LPop(-)	Autos/Lpop(-)
RAT	8.73	28	27.8	167	0.64	7.6	19.29	24.48	240	836
SIN	6.54	28	27.8	148	3.5	-1.82	19.29	26.38	310	836
SAT	13.04	9.42	54.1	195	15	-0.61	25.67	6.38	505	810
SAN	21.52	4.69	69.5	213	5.7	-0.12	8.31	5.81	687	1245
KOL	25.22	6.54	50.6	323	20.3	0.11	35	4.5	1276	1964
SMR	15.01	12.16	45.96	209.2	9.6	1.12	2.08	13.51	603.6	1340
MAH	35.03	5.71	59.5	204	19.9	0.15	19.42	7.46	1693	1491
IND	23.3	19.46	46.28	216	22.41	0.72	22.8	6.88	1036	853

Table No. 7.4-C INDICATORS OF ENVIRONMENTAL QUALITY 1991

Adm Unit	UrbPop%(-)	BrnLnd%(+)	SwnAr%(-)	PopDen(-)	FrstLnd%(+)	DfrstRt(-)	EmpM&Q(-)	RnfPC(+)	FWrk/LPop(-)	Autos/Lpop(-)
RAT	9.12	27.67	28.6	188	0.7	-0.09	42.57	21.94	564	1642
SIN	7.57	24.8	21.5	160	7.78	-12.23	88.66	24.76	325	1425
SAT	12.89	7.93	55	234	15.12	-0.08	27.96	5.23	1051	2955
SAN	22.72	4.29	68.3	258	5.74	-0.07	12.36	4.86	872	3529
KOL	26.32	7.73	52	389	21.6	-0.64	35.02	3.62	1382	4413
SMR	15.69	14.48	45.08	245.8	10.22	-0.65	41.31	12.08	838.8	2793
MAH	38.69	5.58	57.6	257	19.8	0.05	37.22	4.82	1599	3632
IND	25.71	13.4	46.63	267	20.68	0.77	23.65	5.3	1014	2541

8) Livestock per 100 persons (Lvstk/HP(+)): SAT with 68 is leading in this indicator as against KOL which is lowest with 41. The SMR with 57 is dominating both MAH with 43 and IND with 53.

9) Net sown area as percent of total area (NArSwn%(+)), (Net Area Sown percentage): SAN with 68.3% top scores and SIN with 21.5% is the lowest. The average for SMR (45.08%) is lower than MAH (57.6%) but higher than IND (46.63%).

10) Urban population as percentage of total population (UrbPop%(+)): KOL is the most urbanised at 26.32 %, and SIN the least at 7.57 %. The average for SMR (15.69 %) stands much lower than either MAH (38.69 %) or IND (25.71 %).

7.3.3 Present Infrastructure Availability:

1) Road length kms. per 100 Sq. kms. (RdKms/100Kms(+)): SAN with 430 is the first and KOL with 229 is the last. The SMR with 374 Kms does better than both MAH with 280 Kms and IND with 204 Kms.
2) Railway line kms per lakh of persons (RlyKms/LP(+)):SAN has the most (7.6 Kms) and RAT and SIN have least at 0 (Konkan Railway was not completed in 1991). SMR has 4.8 Kms as compared to MAH (7.10) and IND (7.4). KOL with 1.3 is also deficient in this indicator.
3) Post offices per lakh of persons (PO/LP(+)): SIN has the highest number at 57 and KOL has the lowest at 21. SMR with 36 has a much better score than MAH (18) and IND (17.9).
4) Telephones per lakh of persons (Tel/LP(+)): KOL top scores with 655 and SIN brings up the tail with 323. The average for SMR at 449 is much lower than IND with 672 and very low as compared to MAH with a figure of 1328. This is due to the fact that most of the telephones are concentrated in Mumbai and Pune.

5) Educational institutions per lakh of persons (EdInst/LP(+)): SIN has the most (218) and KOL the least (93). SMR with 142 does better than both MAH (94) and IND (129).

6) Hospital beds per lakh of persons (HspBeds/LP(+)): SAN with 176 tops the list and RAT with 128 has the least. SMR with 148 does better than IND (97) but not MAH (164)

7) Electrified Human Settlements as percentage of total number of Human Settlements(ElHS%(+)): This indicator was meaningful in the past with electrification progressing gradually all over India, but now it has almost lost significance with 100% electrification in all the districts of SMR and of MAH. But IND is still lagging with only 81.3% of towns and villages electrified by 1991.

8) Banks per lakh of persons (Bnks/LP(+)): SIN is leading in this with 9.1 and SAT has the least with 6. SMR with 7.6 is doing better than MAH (7) and IND (7.2).

9) Irrigated Area as percentage of total net sown area(IrrAr%(+)): SAT stands first with 28.5% whereas RAT with just 2.3% is last. SMR (17.1%) does better than MAH (13.7%) but not as well as IND (24.5%)

10) House-less population as percentage of total population (HslessPop%(-)): SIN has the worst housing shortage with 9.14% of the population being without shelter whereas SAN with 2.81% does the best on this indicator. SMR with 5.24% is worse off than MAH (3.82%) but does better than IND (5.38%).

7.3.4 Present Environmental Quality:

1) Urban population as percentage of total population(UrbPop%(-)) (Urban Population Percentage): KOL is the most urbanised at 26.32 %, and SIN the least at 7.57 %. The average for SMR (15.69 %) stands much lower than either MAH (38.69 %) or IND (25.71 %).

2) Barren and uncultivated Land as percentage of total (BrnLnd%(+)): RAT has most with 27.67% and SAN has least with 4.29%. SMR average stands at

14.48% as against MAH (5.58%) and IND (13.4%). Environmentally RAT has more potential to generate more forests and therefore better off on this indicator.

3) Sown area as a percentage of total area (SwnAr%(-)): This is the opposite of (2) above. SIN has the least sown area % of 21.55 and is environmentally better off than SAN which has 68.3%. SMR has 45.08% which is better than IND (46.63%) and MAH (57.6%).

4) Density of Population per Sq. Kms. (DenPop(-)): SIN is the least densely populated with 160 persons per S.Kms. and KOL is the most dense with 389. SMR (245.8) is less dense than MAH (257) and IND (267).

5) Percentage of forest land to total (FrstLnd%(+)): RAT has the least amount of forests at 0.7% of total land and KOL has the most with 21.6%. SMR with an average of 10.22% has proportionately less forests than MAH (19.8%) and IND with 20.68%.

6) Average annual rate of deforestation in % (DfrstRt(-)): All the districts in SMR seem to be on a afforestation programme as they all have negative deforestation rates for the 1981-91 decade. SIN is leading with -12.23% and the least is SAN with 0.07%.

7) Employment in mining and quarrying per 100 S.Kms (EmpM&Q(-)): SIN has the most persons engaged in mining and quarrying (88.66/100 S.Kms.) and SAN the least (12.36). SMR with 41.31 has more than either MAH (37.22) or IND (23.65).

8) Average annual rainfall (in mm x area of district in S. Kms) per capita (RnfPC(+)) (Rainfall per capita): SIN has the most rainfall per capita with 24.76 and KOL the least (12.08). SMR with 12.08 is better than both MAH (4.82) and IND (5.3).

9) Factory workers per lakh of persons (FWks/LP(-)): Here this variable is used as a proxy for air and water pollution. SIN is the least polluted with just 325 as

against KOL which has a high figure of 1382. SMR with 538.8 is better off than MAH (1599) and IND(1014).

10) Automotive vehicles per lakh of persons (Autos/LP(-)): KOL has the most with 4413 and SIN the least (1425). Therefore KOL is the most polluted and SIN the least. SMR with 2793 is worse than IND (2541) but better than MAH (3632).

7.3.5 Over-view of Present Conditions (Sectoral Policies and Programmes):

The present (1991) problems and prospects in each of the districts are highlighted below. The stacked bar charts (Refer Fig. Nos. 7.3, 7.4, 7.5. 7.6, 7.7) produced by the computer show the relative proportion or weight of each Component of Liveability (COL) in the overall quality of life in the district (CADIS). Where available, these have been compared to the relative financial allocations made in these districts by the government bodies.

1. RATNAGIRI (RAT): (Refer Fig. No. 7.3)

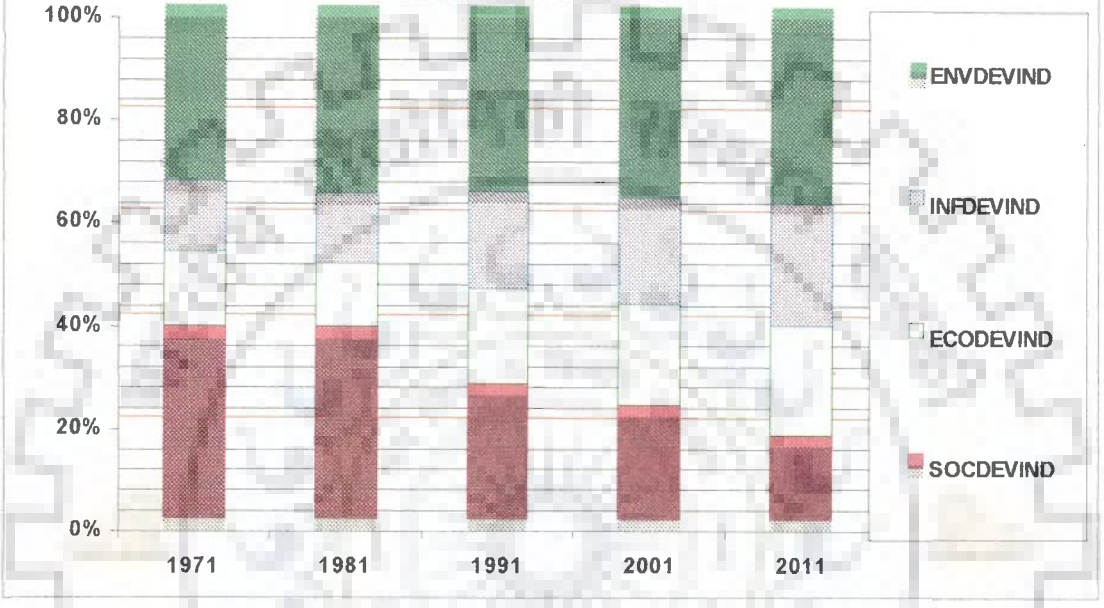
Social Well-being is high in RAT (weight 26.5% in 1991), but decreasing sharply. The main problems are - the urbanisation is lagging and the difference in the male - female literacy levels is increasing.

Economically the growth in per capita income and percentage of non-agricultural employment is slow and the net area sown is very less (weight = 18.5% in 1991).

Infrastructure-wise (weight = 19.0% in 1991), there is a slight improvement over the period 1971 to '91, but there are deficiencies in roads, railways (the Konkan railway has not been considered), telephones, number of hospital beds, and percentage of irrigated area.

Environmental Quality is fairly high (weight = 36.0% in 1991), and maintaining the same level, basically because of lack of developmental pressures. But there are problem areas such as the forest land being very less, barren land being more.

Fig. No. 7.3 WEIGHTS OF COMPONENTS OF LIVEABILITY INDICES : RATNAGIRI



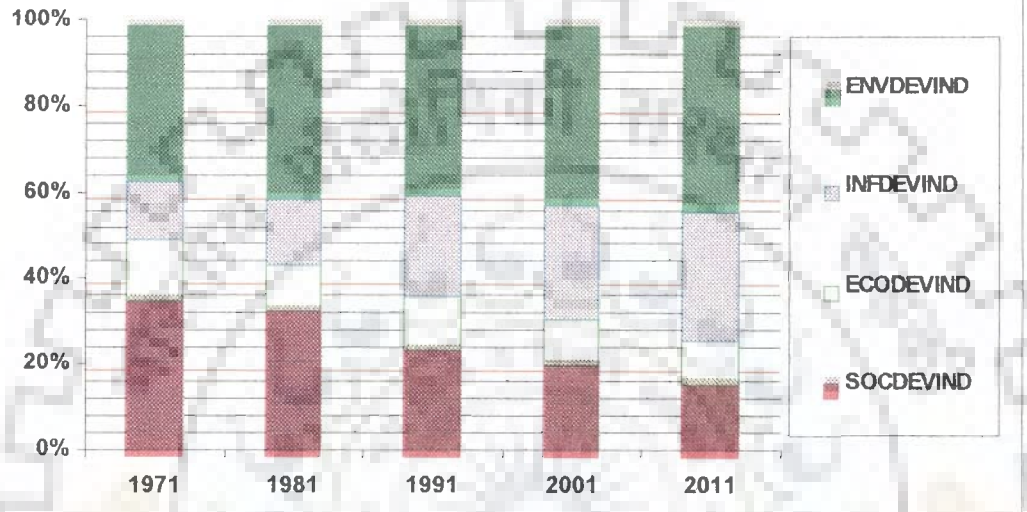
1. **SINDHUDURG (SIN):** (Refer Fig.No.7.4)

Social Well-being: This has a tradition of high social well-being, but this tradition is gradually being eroded. From a weight of 36% in 1971 this COL has gone down to 24.5% in 1991. On the other hand, the district plan (District Social and Economic Report, Directorate of Economics and Statistics, Government of Maharashtra 1991-92) does not take this into account and allocates only 10% of the budget to schemes under this head.

Economic Vitality: this COL maintains its level at approximately 12.5% from 1971 to '91. That indicates that there is a economic stagnation in spite of a financial allocation of 40% to this sector by the district plan. The problem areas are Total participation rate is low, the Non-agricultural employment is not picking up, the food crops % is very high, urbanisation is too slow and so is industrialisation.

Infrastructure Availability: in SIN has improved from a weight of 12% in '71 to 24% in'91. Almost all the indicators have improved. The plan allocations are however much higher at 43%. This may be amounting to neglecting other sectors.

Fig. No. 7.4 WEIGHTS OF COMPONENTS OF LIVEABILITY INDICES SINDHUDURG



Environmental Quality: is very good and rising further in this district, but this is more due to the lack of developmental pressure than any conscious effort to improve the same (Weight = 39.5% in '91). The allocation for this sector in '91 plan is only 7%. The problem in this sector is that the employment in mining and quarrying is comparatively high and may be a environmental disaster in the near future if not kept in check.

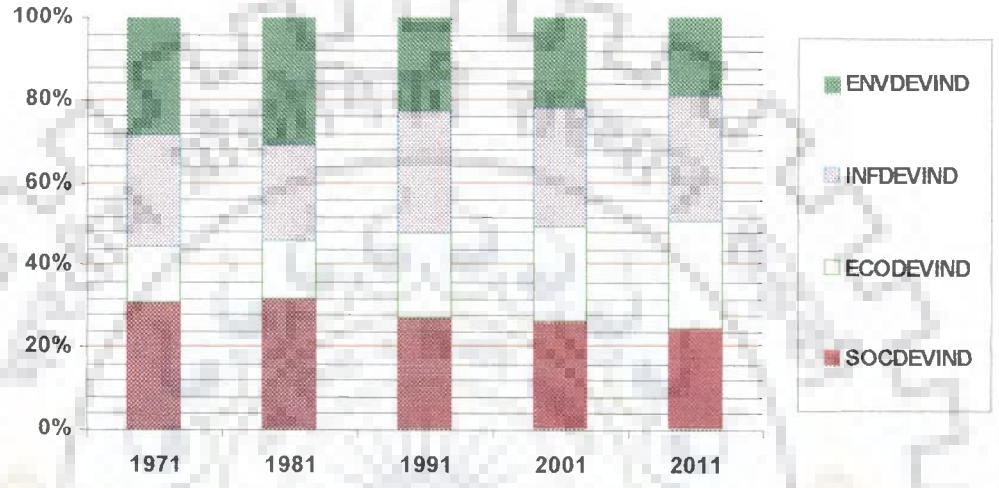
2. SATARA: (Refer Fig. No. 7.5)

Social Well-being: is reasonable high in this district (26.5% in '91), but is not improving as it should. The problems are, the urbanisation is not fast and the difference in the male-female literacy rate remains high.

Economic Vitality: The economic development is fairly high in this district (21.5% in '91) but is not improving further. The reasons are, the non-agricultural

employment is not growing fast, the percentage of cash crops and the food grains yield both are low, the urban population percentage is not increasing, the number of live-stock is low.

Fig. No. 7.5 WEIGHTS OF COMPONENTS OF LIVEABILITY INDICES SATARA



Infrastructure Availability: There is uneven progress on this COL. After declining in '81 this has picked in '91 (weight = 29.5%).

Environmental Quality: is not very high and is going down further (weight = 22.5% in '91).

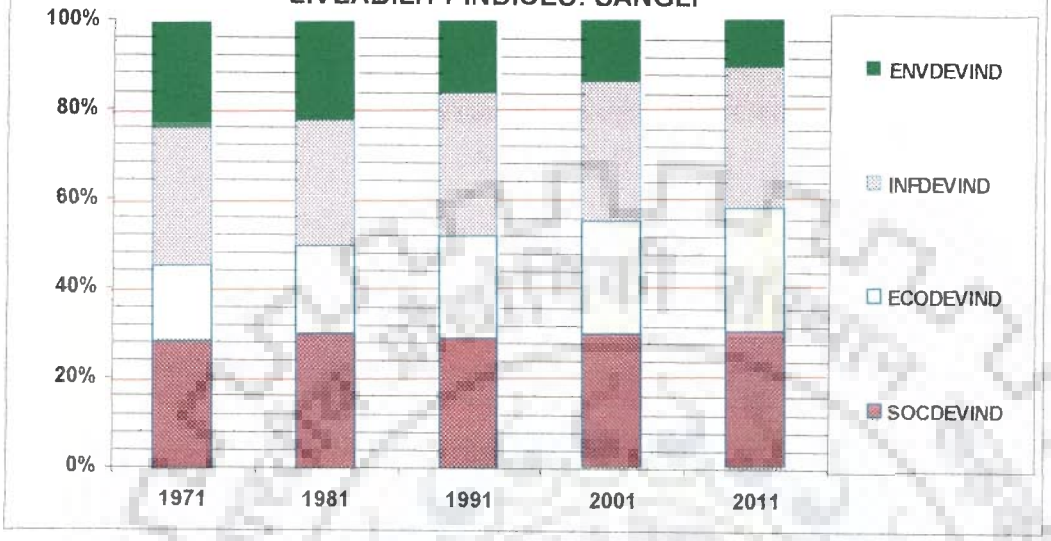
3. **SANGLI:** (Refer Fig. No. 7.6)

Social Well-Being: This COL has steadily improved in this district (weight = 29% in '91). Whereas the district plan allocation was just 4% for this sector in '91.

Economic Vitality: Even this COL has made a good improvement (weight = 22.5% in '91). The allocation in the district plan is 46% for this sector in 1991.

Infrastructure Availability: Availability of infrastructure has been good and improving in SAN. The weight in '91 for this COL is 32% and is expected to further improve with district plan providing as much as 50% allocation to this sector in '91.

Fig. No. 7.6 WEIGHTAGES OF COMPONENTS OF LIVEABILITY INDICES: SANGLI



Environmental Quality: The quality of environment is the real cause for worry in SAN. This COL which was already low in '71 has further declined in '91 to 16% only. The reasons are the high rate of growth of urbanisation, industrialisation and automotive vehicles. But the district plan allocation is just 0.74% for this sector.

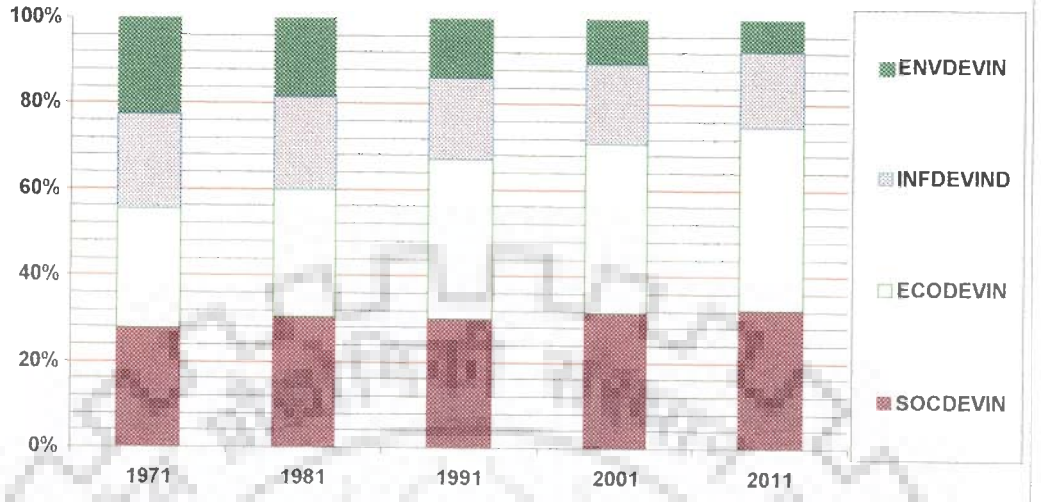
5. KOLHAPUR: (Refer Fig. No. 7.7)

Social Well-being: Social development in KOL has been rather uneven. The weight of this COL has remained constant at about 28% to 30%. The problematic area is the difference in male - female literacy rate. The financial allocation has matched the computer generated weight at 30%.

Economic Vitality: This COL has shown excellent progress from 28% to 37% weight. Almost all SDIs have improved and are likely to improve further. The financial allocation has almost matched the computer generated weight at 40%.

Infrastructure Availability: This is medium in KOL (weight = 19% in '91). The problematic areas are road and railway accessibility, number of post offices, and educational institutions. The plan allocation at 28% is realistically trying to improve this situation.

Fig. No. 7.7 WEIGHTS OF COMPONENTS OF LIVEABILITY INDICES KOLHAPUR



Environmental Quality: A sharp decline in the quality of environment in this district has accompanied the rapid urbanisation and industrialisation. (1991 weight = 14%. The plan allocations fall far short of the requirements at just 2.0%.

7.4 Analysis of Sustainable Development Indices (SDIs):

(Table Nos. 7.5-A,B,C to 7.8-A,B,C on page nos. to) The raw data has been converted to standardised scores or Sustainable Development Indices by the formula given at 6.3.2. for ease of further analysis as already explained in chapter 6.

This formula converts the raw data into scores ranging from 0 to 1, making it possible to compare, analyse, predict and correlate the variables under the four components of liveability. Value judgements are necessary in deciding the vector qualities of these scores. That is, whether a particular variable is contributing to sustainability or detracting from it (+ve or -ve). An expert's opinion survey was conducted on this issue (refer annexure A) . In the first case, the SDI was calculated as above but in the second case, the reciprocal of the above standardised score (1- standardised score) was taken as the SDI.

Table No. 7.5-A Standardised Social Well-being Indices: 1971

Adm Unit	PopGrth Rt(-)	InfMrt Rt(-)	Deat hRt(-)	Birth Rt(-)	T Lit % (+)	DifM-FLit%(-)	F Prt Rt (+)	UrbPo p%(+)	UnEm p%(-)	HslessPop%(-)	COL	Rank
RAT	1	1	1	1	1	0.75	0.99	0.09	0.75	0	0.76	1
SIN	1	1	1	1	1	0.75	0.9	0	0.75	0	0.74	2
SAT	0.39	0.85	0.75	0.57	0.85	0.21	1	0.26	0	0.81	0.57	5
SAN	0.19	0.80	0.67	0.43	0.80	0.20	0.97	0.29	0.12	1.08	0.55	6
KOL	-0.12	0.72	0.54	0.21	0.72	0.00	0.98	0.37	0.71	1.49	0.56	7
SMR	0.39	0.95	0.92	0.75	0.8	0.29	0.66	0.28	0.46	0.3	0.58	4
MAH	0.04	0.34	0.5	0.32	0.93	0.56	0.88	1	1	0.42	0.60	3
IND	0.18	0	0	0	0	1	0.08	0.54	0.55	0.99	0.33	8

Table No. 7.5-B Standardised Social Well-being Indices: 1981

Adm Unit	PopGrth Rt(-)	InfMrt Rt(-)	Deat hRt(-)	Birth Rt(-)	T Lit % (+)	DifM-FLit%(-)	F Prt Rt (+)	UrbPo p%(+)	UnEm p%(-)	HslessPop%(-)	COL	Rank
RAT	0.78	1	1	1	0.97	1	1	0.08	0.67	0	0.75	1
SIN	1	1	0.77	1	0.97	1	1	0	0.51	0	0.73	2
SAT	0.31	0.9	0.59	0.65	1	0.41	0.9	0.23	0	1	0.60	6
SAN	0.27	0.95	0.69	0.78	0.89	0.36	0.31	0.53	0.24	0.86	0.59	7
KOL	0.11	0.9	0.7	0.83	0.77	0	0.58	0.66	0.87	0.99	0.64	4
SMR	0.49	0.94	0.63	0.81	0.91	0.55	0.76	0.3	0.46	0.72	0.66	3
MAH	0.01	0.36	0.43	0.48	0.91	0.65	0.67	1	1	0.73	0.62	5
IND	0	0	0	0	0	0.91	0	0.59	0.4	0.72	0.26	8

Table No. 7.5-C Standardized Social Well-being Indices: 1991

Adm Unit	PopGrth Rt (-)	IntMrt Rt(-)	Deat hRt(-)	Birth Rt(-)	T Lit % (+)	DifM-FLit%(-)	F Prt Rt (+)	UrbPo p%(+)	UnEm p%(-)	HslessPop%(-)	COL	Rank
RAT	0.74	1	0.87	0.35	0.45	0.28	0.93	0.04	0.41	0.08	0.52	6
SIN	1	0.83	0	1	1	1	1	0	0	0	0.58	3
SAT	0.3	0.88	0.86	0.51	0.61	0	0.77	0.17	0.27	0.92	0.53	5
SAN	0.31	0.8	0.86	0.53	0.44	0.3	0.55	0.49	0.61	1	0.59	2
KOL	0.25	0.77	1	0.74	0.63	0	0.68	0.6	1	0.6	0.63	1
SMR	0.52	0.86	0.72	0.62	0.63	0.32	0.79	0.26	0.46	0.61	0.58	4
MAH	0	0.28	0.47	0.34	0.54	0.38	0.48	1	0.73	0.84	0.51	7
IND	0.18	0	0.13	0	0	0.31	0	0.58	0.13	0.59	0.19	8

Table No. 7.6-A Standardised Economic Vitality Indices: 1971												
Adm Unit	T Prt Rt(+)	NAgriEmp%(+)	UnEmp%(-)	FdCrps%(-)	FdGrn Yld(+)	PCInc m(+)	Trcts/100H(+)	Livstk/Pop(+)	NtArSwn%(+)	UrbPop%(+)	COL	Rank
RAT	0.12	0.04	0.75	0.72	0.82	0	0	0.32	0	0.09	0.29	7
SIN	0	0	0.75	0.72	1	0	0	0.32	0.18	0	0.3	6
SAT	0.18	0.28	0	0	0	0.32	0.06	0.91	0.62	0.26	0.25	8
SAN	0.15	0.18	0.12	0.1	0.11	0.14	0.07	0.91	1	0.48	0.33	5
KOL	0.5	0.23	0.71	1	0.74	0.49	0.24	0	0.57	0.6	0.51	3
SMR	0.19	0.15	0.46	0.46	0.44	0.19	0.09	0.55	0.5	0.28	0.33	4
MAH	1	1	1	0.53	0.06	1	0.03	0.41	0.87	1	0.69	1
IND	0.35	0.61	1	0.23	0.35	0.18	1	1	0.48	0.54	0.57	2

Table No. 7.6-B Standardised Economic Vitality Indices: 1981												
Adm Unit	T Prt Rt(+)	NAgriEmp%(+)	UnEmp%(-)	FdCrps%(-)	FdGrn Yld(+)	PCInc m(+)	Trcts/100H(+)	Livstk/Pop(+)	NtArSwn%(+)	UrbPop%(+)	COL	Rank
RAT	0.12	0	0.67	0.42	0.85	0	0	0.32	0	0.08	0.25	7
SIN	0.12	0	0.51	0.42	1	0.02	0	0.27	0	0	0.23	8
SAT	0.02	0.2	0	0.03	0.12	0.18	0.24	1	0.63	0.23	0.27	6
SAN	0.13	0.29	0.24	0.47	0	0.32	0.16	0.86	1	0.53	0.4	4
KOL	0.63	0.51	0.8	1	0.96	0.59	0.48	0	0.55	0.66	0.63	2
SMR	0.2	0.2	0.46	0.47	0.59	0.22	0.33	0.5	0.44	0.3	0.37	5
MAH	1	1	1	0.28	0.1	1	0.12	0.36	0.76	1	0.66	1
IND	0	0.6	0.4	0	0.57	0.02	1	0.86	0.44	0.59	0.47	3

Table No. 7.6-C Standardised Economic Vitality Indices: 1991												
Adm Unit	T Prt Rt(+)	NAgriEmp%(+)	UnEmp%(-)	FdCrps%(-)	FdGrn Yld(+)	PCInc m(+)	Trcts/100H(+)	Livstk/Pop(+)	NtArSwn%(+)	UrbPop%(+)	COL	Rank
RAT	0.62	0	0.41	0.84	1	0.16	0	0.37	0.15	0.04	0.36	7
SIN	0.81	0.03	0	0.1	0.86	0.19	0	0.93	0	0	0.29	8
SAT	0.48	0.17	0.27	0.17	0.22	0.29	0.57	1	0.72	0.17	0.41	5
SAN	0.54	0.41	0.61	0	0	0.44	0.47	0.63	1	0.49	0.46	4
KOL	0.98	0.76	1	1	0.94	0.83	1	0	0.65	0.6	0.78	1
SMR	0.69	0.27	0.46	0.42	0.6	0.38	0.51	0.59	0.5	0.26	0.47	3
MAH	1	1	0.73	0.58	0.17	1	0.24	0.07	0.77	1	0.66	2
IND	0	0.61	0.13	0.35	0.64	0	0.71	0.44	0.54	0.58	0.4	6

Table No 7.7-A Standardised Infrastructure Availability Indices: 1971

Adm Unit	RdKms/ 100SKms (+)	RlyKms/Lpop (+)	P O /L Pop (+)	Tel / Lpop (+)	EdInst /Lpop (+)	Hbeds/Lpop (+)	El HS % (+)	Bnks/ Lpop (+)	IrrAr %(+)	Hsls Pop %(-)	COL	Rank
RAT	0.65	0	1	0	1	0.05	0	0	0	0	0.28	6
SIN	0.65	0	1	0	1	0.05	0	0	0	0	0.28	6
SAT	0.5	0.7	0.44	0.2	0.6	0.04	0.42	0.71	0.64	0.81	0.50	2
SAN	1	0.98	0.35	0.2	0.17	0.46	0.39	1	0.34	1	0.59	1
KOL	0.81	0.16	0	0.4	0.26	0	1	0.77	0.4	0.17	0.40	5
SMR	0.74	0.18	0.45	0.2	0.52	0.14	0.45	0.62	0.35	0.3	0.40	5
MAH	0	0.91	0	1	0.26	1	0.51	0.45	0.18	0.42	0.48	3
IND	0.35	1	0.39	0.2	0	0.26	0	0.03	1	0.99	0.41	4

Table No 7.7-B Standardised Infrastructure Availability Indices: 1981

Adm Unit	RdKms/ 100SKms (+)	RlyKms/Lpop (+)	P O /L Pop (+)	Tel / Lpop (+)	EdInst /Lpop (+)	Hbeds/Lpop (+)	El HS % (+)	Bnks/ Lpop (+)	IrrAr %(+)	Hsls Pop %(-)	COL	Rank
RAT	0.56	0	1	0	0.95	0.05	0.33	1	0	0	0.40	6
SIN	0.44	0	0.96	0	1	0.05	0.33	0.5	0	0	0.34	7
SAT	0.34	0.72	0.44	0.2	0.37	0.11	0.74	0	0.56	1	0.44	4
SAN	0.57	1	0.14	0.3	0	0.98	0.71	0.83	0.3	0.86	0.56	1
KOL	1	0.17	0.1	0.4	0.05	0.15	1	0.33	0.42	0.99	0.46	3
SMR	0.58	0.38	0.53	0.2	0.47	0.27	0.69	0.14	0.26	0.72	0.42	5
MAH	0	0.93	0.03	1	0.09	1	0.74	0.21	0.27	0.73	0.50	2
IND	0.71	0.998	0	0.4	0.14	0	0	0.13	1	0.72	0.40	6

Table No 7.7-C Standardised Infrastructure Availability Indices: 1991

Adm Unit	RdKms/ 100SKms (+)	RlyKms/Lpop (+)	P O /L Pop (+)	Tel / Lpop (+)	EdInst /Lpop (+)	Hbeds/Lpop (+)	El HS % (+)	Bnks/ Lpop (+)	IrrAr %(+)	Hsls Pop %(-)	COL	Rank
RAT	0	0	0.72	0.1	0.71	0.41	1	0.65	0	0.08	0.37	6
SIN	0.03	0	1	0	1	0.62	1	1	0.69	0	0.54	4
SAT	0.71	0.72	0.34	0.1	0.22	0.95	1	0	1	0.92	0.58	2
SAN	1	1	0.13	0.2	0.02	1	1	0.58	0.52	1	0.64	1
KOL	0.45	0.17	0.08	0.3	0	0.37	1	0.39	0.63	0.6	0.40	5
SMR	0.44	0.63	0.45	0.1	0.39	0.67	1	0.52	0.57	0.61	0.54	4
MAH	0.29	0.93	0	1	0.01	0.88	1	0.32	0.44	0.84	0.57	3
IND	0	1	0	0.4	0.29	0	0	0.39	0.85	0.59	0.34	7

Table No. 7.8-A Standardised Environmental Quality Indices: 1971

Adm Unit	UrbPop%(-)	BrnLnd%(+)	SwnAr%(-)	PopDen(-)	FrstLnd%(+)	DfrstRt(-)	EmpM&Q(-)	RnfPC(+)	FWrk/Pop(-)	Autos/Pop(-)	COL	Rank
RAT	0.91	1	1	0.92	0	0	0.41	1	1	0.66	0.69	2
SIN	1	1	0.82	1	0	0.5	0.41	0.99	1	0.66	0.73	1
SAT	0.74	0.25	0.38	0.84	0.52	0.9	0.32	0.1	0.8	0.43	0.52	5
SAN	0.52	0	0	0.72	0.13	0.89	1	0.07	0.73	0.43	0.44	6
KOL	0.4	0.01	0.43	0	0.83	0.85	0	0	0.58	0	0.31	8
SMR	0.72	0.31	0.5	0.7	0.37	0.75	0.43	0.43	0.77	0.43	0.54	4
MAH	0	0.03	0.13	0.85	0.81	0.82	0.62	0.14	0	0.44	0.38	7
IND	0.46	0.87	0.52	0.73	1	0.85	0.38	0.12	0.44	1	0.63	3

Table No. 7.8-B Standardised Environmental Quality Indices: 1981

Adm Unit	UrbPop%(-)	BrnLnd%(+)	SwnAr%(-)	PopDen(-)	FrstLnd%(+)	DfrstRt(-)	EmpM&Q(-)	RnfPC(+)	FWrk/Pop(-)	Autos/Pop(-)	COL	Rank
RAT	0.92	1	1	0.89	0	0	0.59	0.91	1	0.98	0.72	2
SIN	1	1	1	1	0.13	1	0.59	1	0.95	0.98	0.86	1
SAT	0.77	0.2	0.37	0.73	0.66	0.87	0.35	0.09	0.82	1	0.58	4
SAN	0.47	0	0	0.63	0.23	0.81	1	0.06	0.69	0.62	0.45	6
KOL	0.34	0.08	0.45	0	0.9	0.8	0	0	0.29	0	0.28	8
SMR	0.7	0.32	0.5	0.65	0.41	0.69	0.5	0.37	0.75	0.54	0.54	5
MAH	0	0.04	0.24	0.68	0.88	0.79	0.58	0.14	0	0.41	0.37	7
IND	0.41	0.63	0.56	0.61	1	0.74	0.46	0.11	0.45	0.96	0.59	3

Table No. 7.8-C Standardised Environmental Quality Indices: 1991

Adm Unit	UrbPop%(-)	BrnLnd%(+)	SwnAr%(-)	PopDen(-)	FrstLnd%(+)	DfrstRt(-)	EmpM&Q(-)	RnfPC(+)	FWrk/Pop(-)	Autos/Pop(-)	COL	Rank
RAT	0.96	1	0.85	0.88	0	0.12	0.6	0.87	0.81	0.93	0.70	2
SIN	1	0.88	1	1	0.33	1	0	1	1	1	0.82	1
SAT	0.83	0.16	0.28	0.68	0.68	0.06	0.8	0.08	0.43	0.49	0.44	5
SAN	0.51	0	0	0.57	0.24	0.06	1	0.06	0.57	0.3	0.33	6
KOL	0.4	0.15	0.35	0	1	0.11	0.7	0	0.17	0	0.28	7
SMR	0.74	0.44	0.5	0.62	0.46	0.11	0.62	0.4	0.6	0.54	0.50	3
MAH	0	0.06	0.23	0.58	0.91	0.06	0.67	0.06	0	0.26	0.28	8
IND	0.42	0.39	0.44	0.53	0.96	0	0.85	0.08	0.46	0.63	0.47	4

7.5 Summary of findings on SDIs:

7.5.1 Social Well-being: Ratnagiri district deteriorates from 1st rank in '71 and '81 (0.76) to 6th rank (0.52) in '91, whereas Kolhapur improves it's position from 7th in '71 (0.56) to 4th in '81 (0.64) and 1st in '91 (0.63). Maharashtra goes down from 3rd rank in '71 (0.60) to 7th in '91 (0.51). India maintains the lowest position throughout (0.33 in '71 to 0.19 in '91). Other districts maintain intermediate positions over the same period.

7.5.2 Economic Vitality: Kolhapur district improves its position from 3rd in '71 (0.51) to 1st in '91 (0.78). India goes down from 2nd rank in '71 (0.57) to 6th in '91(0.40). Satara and Sangli maintain in between positions whereas Ratnagiri and Sindhudurg are languishing throughout at the bottom of the pile.

7.5.3 Infrastructure Availability: Sangli has excellent infrastructure availability right through - 1st rank in '71,'81 and '91. India deteriorates from 4th to 7th rank and other districts maintain their intermediate status.

7.5.4 Environmental Quality: Sindhudurg holds top rank throughout (0.74 in '71 to o.82 in '91). Ratnagiri too maintains 2nd rank. India goes down slightly from 3rd rank in '71 (0.64) to 4th rank in '91 (0.48). All other units keep their positions in-between.

7.6 Calculation of the Components of Liveability (COL)s:

The SDIs for the ten variables were then weighted (as equal initially) and aggregated to give the final score for each of the Components Of Liveability (COL)s by the formula given at 6.4.3.1 Ranking was done based on these for each of the eight geographic units under study for '71, '81, '91 (refer table nos. 7.9-A to 7.9-C on page nos. to).

These historic trends of the COLs were extrapolated to the time frames of 2001

Table No 7.9-A Composite Aggregated Development Indices of Sust.: 1971						
Adm Unit	Social Dev	Econ Dev	Env Dev	Infra Dev	Average	Rank
RAT	0.76	0.29	0.69	0.28	0.50	3
SIN	0.74	0.30	0.74	0.28	0.51	2
SAT	0.57	0.25	0.53	0.50	0.46	6
SAN	0.55	0.33	0.35	0.59	0.45	5
KOL	0.50	0.51	0.41	0.40	0.45	7
SMR	0.58	0.33	0.54	0.40	0.46	6
MAH	0.60	0.69	0.38	0.48	0.54	1
IND	0.38	0.57	0.64	0.41	0.50	4

Table No 7.9-B Composite Aggregated Development Indices of Sust.: 1981						
Adm Unit	Social Dev	Econ Dev	Env Dev	Infra Dev	Average	Rank
RAT	0.75	0.25	0.73	0.28	0.50	2
SIN	0.73	0.23	0.87	0.34	0.54	1
SAT	0.60	0.27	0.59	0.44	0.47	4
SAN	0.59	0.40	0.35	0.56	0.47	3
KOL	0.64	0.63	0.39	0.46	0.53	3
SMR	0.66	0.37	0.54	0.42	0.50	3
MAH	0.62	0.66	0.38	0.50	0.54	1
IND	0.26	0.47	0.59	0.40	0.43	5

Table No 7.9-C Composite Aggregated Development Indices of Sust.: 1991						
Adm Unit	Social Dev	Econ Dev	Env Dev	Infra Dev	Average	Rank
RAT	0.52	0.36	0.70	0.37	0.49	4
SIN	0.58	0.29	0.92	0.54	0.58	1
SAT	0.53	0.41	0.45	0.58	0.49	4
SAN	0.60	0.46	0.23	0.64	0.48	5
KOL	0.63	0.78	0.29	0.40	0.52	2
SMR	0.57	0.47	0.50	0.54	0.52	2
MAH	0.51	0.66	0.28	0.57	0.50	3
IND	0.20	0.40	0.48	0.34	0.35	5

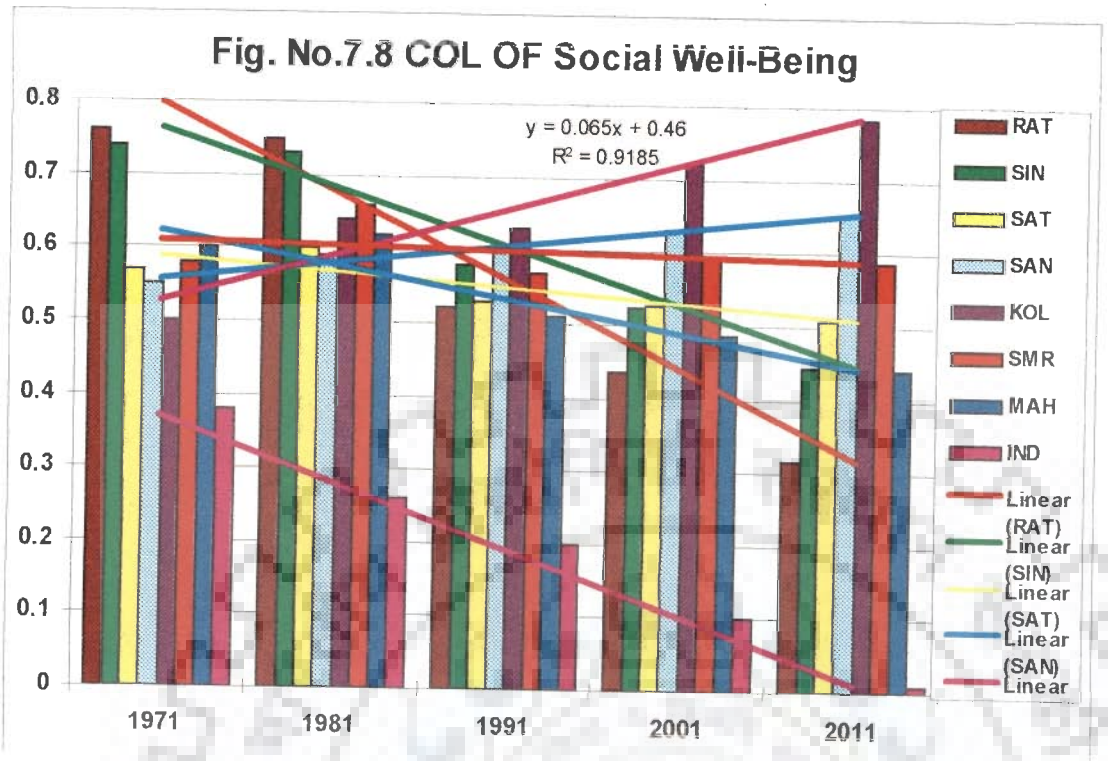


Fig. No.7.8 COL OF Social Well-Being
y = 0.065x + 0.46
R² = 0.9185
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1971
1981
1991
2001
2011
RAT
SIN
SAT
SAN
KOL
SMR
MAH
IND
Linear
(RAT) Linear
(SIN) Linear
(SAT) Linear
(SAN) Linear

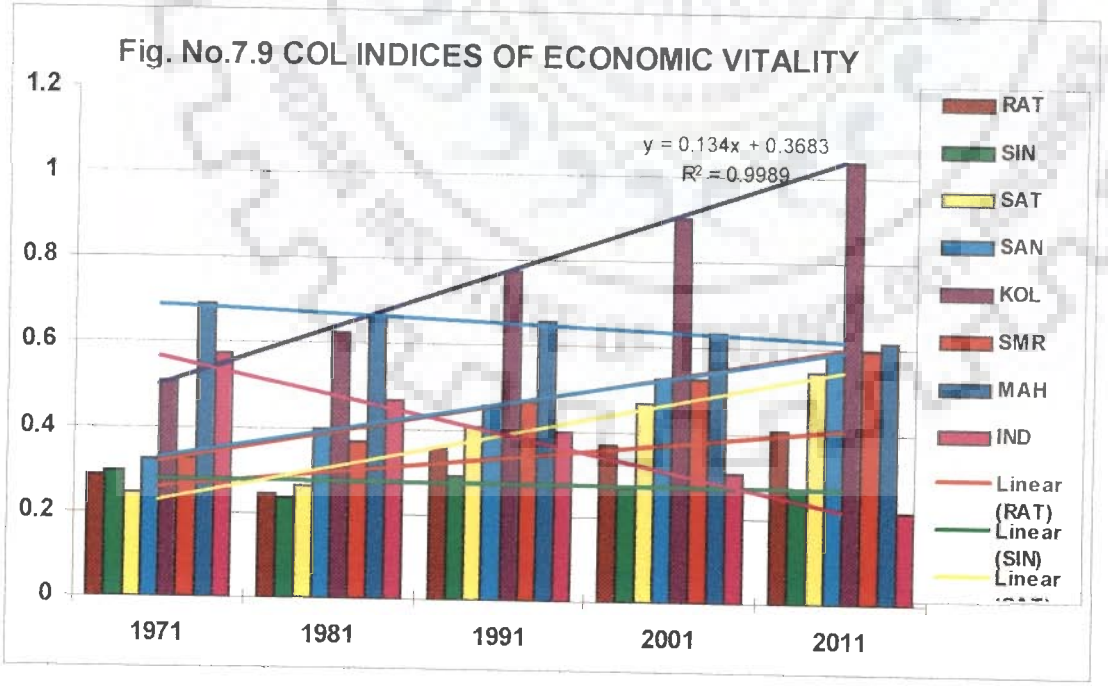


Fig. No.7.9 COL INDICES OF ECONOMIC VITALITY
y = 0.134x + 0.3683
R² = 0.9989
1.2
1
0.8
0.6
0.4
0.2
0
1971
1981
1991
2001
2011
RAT
SIN
SAT
SAN
KOL
SMR
MAH
IND
Linear
(RAT) Linear
(SIN) Linear

Fig. No.7.10 COL INDICES OF INFRASTRUCTURE AVAILABILITY

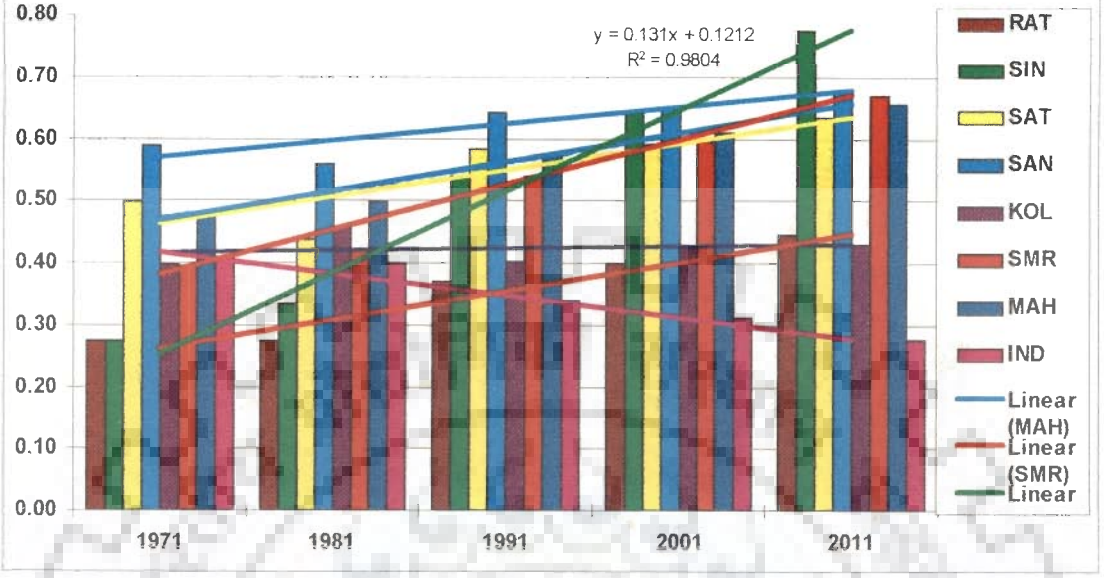
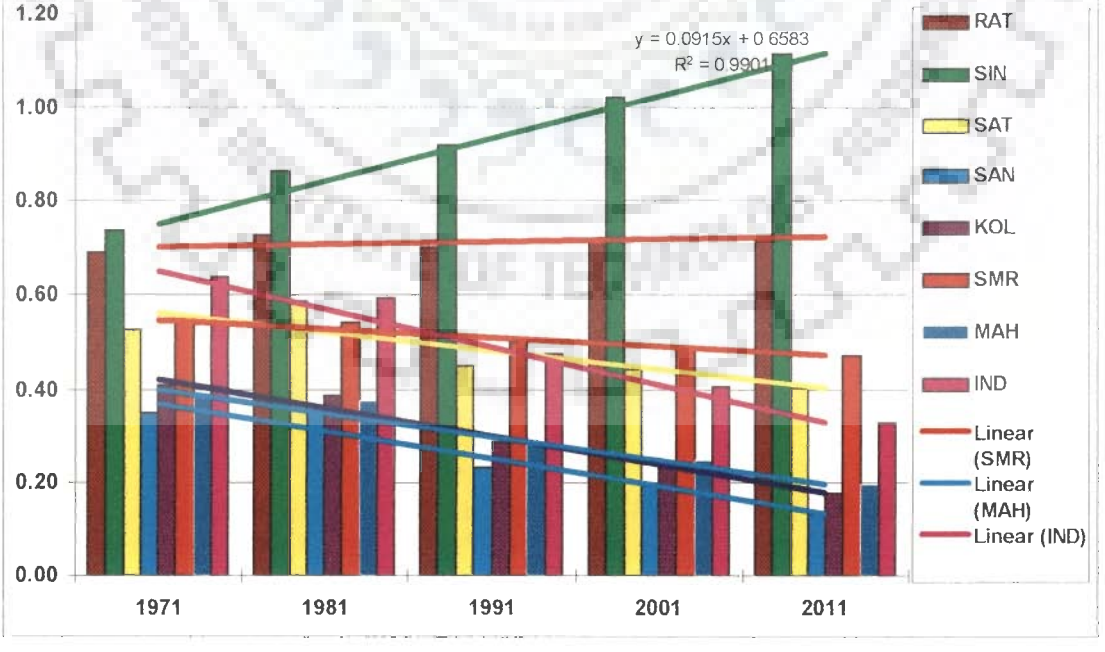
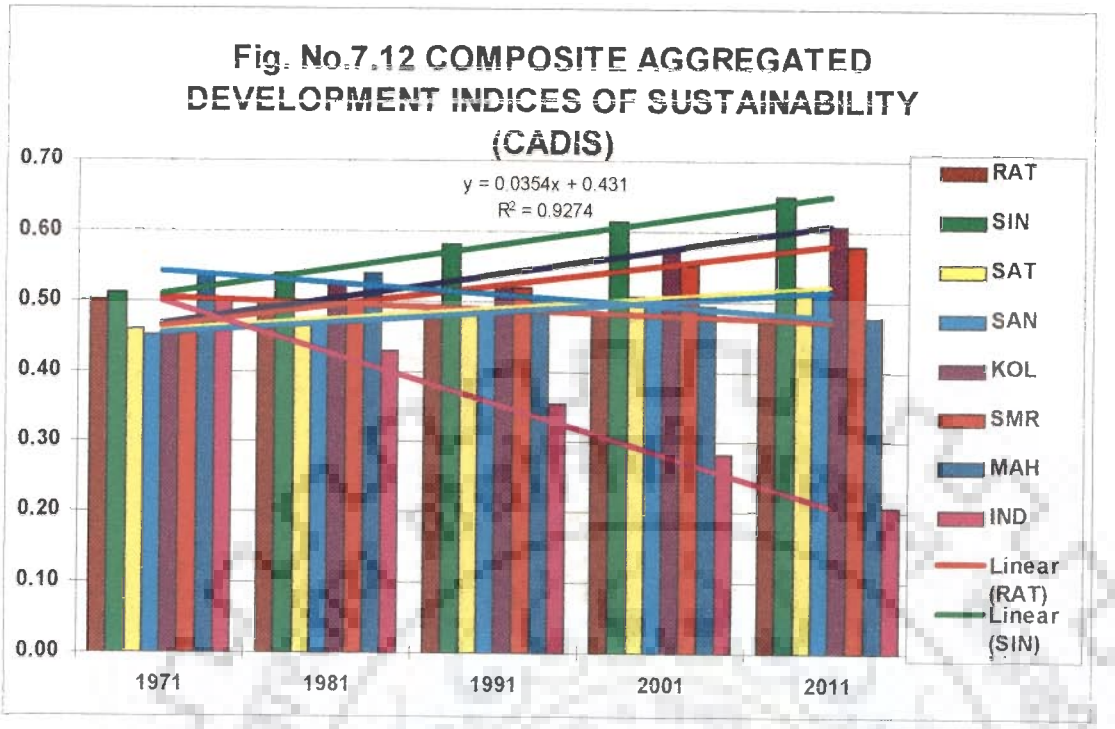


Fig. No.7.11 COL INDICES OF ENVIRONMENTAL QUALITY





and 2011 with the help of a computer and a spread-sheet software. The data tables are displayed as bar-charts and trend-lines in Fig. Nos. 7.8 to 7.12. The data tables and the bar charts are dynamically linked. That is, any change in the data is reflected automatically in the charts. This capability has been utilised effectively in the later stages of the DSS for 'What If' studies and scenario building.

7.7 Summary Of Findings On COLs And CADIS:

The comparative improvement or deterioration in each of the four components of liveability namely- Social Well-being, Economic Vitality, Infrastructure Availability and Environmental Quality for each of the eight regions under study has been visualised for the time frames of 2001 and 2011. The over-all quality of life in these regions at those time frames has been projected through the respective Composite Aggregated Development Indices of Sustainability (CADIS).

7.7.1 Social Well-Being Index: Kolhapur is making most rapid progress in this index too. SMR is maintaining a status-quo and Sangli is making moderate

progress, Satara and Maharashtra are going down slowly but Sindhudurg and Ratnagiri are worsening rapidly. However, the fastest degeneration is that of India.

7.7.2 Economic Vitality Index: Kolhapur district is making rapid progress whereas Sangli and Satara are not far behind. Ratnagiri is making a moderate progress. Maharashtra is steady at a high level of development whereas Sindhudurg is languishing. India's position is going down rapidly as compared to SMR.

7.7.3 Infrastructure Availability Index: Sindhudurg makes the most rapid progress followed by Sangli, Maharashtra, SMR and Satara in that order. Ratnagiri also makes reasonable progress. Kolhapur maintains a status-quo and India is losing rapidly.

7.7.4 Environmental Quality Index: Sindhudurg improves its position further, whereas Ratnagiri maintains a status-quo. The environmental quality in all other units deteriorates gradually, Sangli being the worst case.

7.7.5 Composite Aggregated Development Index of Sustainability: Kolhapur district makes rapid progress followed by Sindhudurg, Sangli, Satara and Ratnagiri. SMR also makes good progress as compared to Maharashtra and India.

7.8 Summary:

In this chapter we have applied the first five stages of the Computer Based Decision Support System out-lined in chapter 6 to the Southern Maharashtra Region. The five districts of Ratnagiri, Sindhudurg, Satara, Sangli and Kolhapur have been compared to the region (SMR), the state (Maharashtra) and the country (India). The indicators of sustainability, Sustainable Development Indices (SDIs), Components of Liveability (COL)s and the Composite Aggregated Development Index of Sustainability (CADIS) have been calculated, and extrapolated over a

period of 1971 to 2011.Identification of certain Critical Success Factors (CSFs) and further study of these CSFs and scenario building for SMR will be taken up with the help of the computer based DSS in the next chapter.

Chapter 8
Critical Success Factors and Scenario Building or 'What-If' Studies

8.1 Introduction:

In the previous chapter we had applied the first five stages of the DSS to the study of the five districts comprising SMR, and SMR itself. In this chapter we will derive a set of Critical Success or Failure factors (CSFs) in relation to the sustainability of the development trends in the SMR. The application of the next stage of the DSS to SMR consists of interactive decision making in an iterative way by deciding target values for the CADIS and then changing the values and weights of COLs and SDIs in order to reach the target. The weights can be decided by group decision making techniques such as DELPHI or the Nominal Group Technique (NGT) in case of multiple decision makers. Through a formula for reverse calculation, the values of SDIs can then be converted into revised values of the indicators concerned and thus lead to the next round of iteration. The physical, financial, and spatial implications of the decisions are visualised a priori by the use of the computer based spread-sheet and GIS soft-wares. The ultimately accepted scenario will constitute the objectives and provide a feed-back for sectoral plan and programme making.

8.2 Identification of Critical Success and failure Factors (CSF)s:

A CSF is a necessary condition for balanced regional development that can be guided by policy intervention (Nijkamp et al 1990). Five aspects which are crucial for the success or failure of any sustainable development policy or programme are, Financial, Technological, Managerial, Institutional and Political (Ramachandran 1996). Improvement in any of these will lead to overall improvement in the region. Certain Critical Success or failure Factors (CSF)s for successful implementation of

the sustainable regional development have been identified under each of the aspects as follows -

8.2.1 Financial CSFs: Infrastructure availability which is a crucial input not only for improving the quality of life, but also to other sectors such as economic vitality and social well-being is lacking in SMR. Financial interventions with government-private partnerships in the form of BOT (Build, Operate and Transfer) or BOLT (Build, Operate, Lease and Transfer) or variations of these will be needed to tackle these imbalances.

8.2.2 Technological CSFs: Sustainability oriented technological inputs are required especially in the fields of energy, transport, information and communication technology in all the districts. Alternative, non-polluting and renewable forms of energy need to be developed. Less energy intensive and lesser polluting forms of transport need to be encouraged. Modern electronics based information and communication technology will speed up dissemination of knowledge and reduce the demand for travel and transport and migration to the urban areas. Air, water and land pollution abatement and waste recycling technology is urgently required especially in KOL, SAT and SAN which are getting highly urbanised.

8.2.3 Managerial CSFs: Lack of trained manpower in the field of co-ordination of the developmental efforts towards sustainability, through the use of systems approach is a serious handicap at the district administration level. Professional planners with knowledge of engineering, statistics, economics, sociology, finance and management are needed at the policy formulation, programme, and implementation stages to ensure provision of basic services such as health, shelter and education, especially to the poorer sections of the society. This is a matter of priority for sustainable regional development.

8.2.4 Institutional CSFs: Educational and training institutions, health and population control institutions, institutions to provide financial support, legislative,

administrative and co-ordinating institutions are all required at the grass-roots level. These should be people oriented and seek to operate in close co-operation with the community based and non-governmental organisations.

8.2.5 Political CSFs: Public awareness and acceptance of sustainability oriented developmental policies and programmes is crucial to their success. People's participation in public policy formulation and decision making is similarly imperative.

8.3 Scenario building or "What-If" studies:

Use has been made here of the dynamic linkage provided by the computer between the data tables and the visual display (charts). A feed-back to policy and programme making is given by scenario building or "what-if" studies. This is done in three stages.

Stage I: The Composite Aggregated Development Index of Sustainability (CADIS) (which is a weighted aggregation of the four COLs) for a particular district is made to reach a target figure by changing the weightages and values of four components of liveability (COL) in an interactive way. This constitutes scenario 1. The slope of the CADIS trend-line is an important visual aid in guiding the orchestration of the COLs. The financial implications in terms of increase in the budget size, and the percentages of sectoral allocations required are also studied thus aiding in the decision making process.

Stage II: The new COLs (which are weighted aggregations of the SDIs) are taken as target figures and some of the ten Sustainable Development Indices (SDI) under each COL are changed so as to reach the target figure. Here again the slopes of the individual COLs are vital visual guides in doing this. The spatial implications (distributive effects) of the trends are studied and corrective interventions suggested .

Stage III: The new SDIs are converted back to actual scores or indicators by a reverse calculation process. Thus the actual targets to be achieved in each of the ten indicators of sustainable development in order to reach the scenario 1 are found out. If these are found to be unachievable (or too low) due to practical considerations, then the scaled down (or upgraded) indicators are taken as the starting point and scenario 2 is built up bottom-upwards through stages III to stage I. This process may be repeated iteratively a number of times to arrive at the ultimately accepted scenario which forms the basis for a planned action at the grass-roots level.

This Decision Support System can also be used to co-ordinate planning efforts at higher levels of Govt. in an identical fashion by taking the plans and programmes of the lower levels as a starting point. This process has been demonstrated for the South Maharashtra Region.

8.3.1 Stage I - (A) Fixing CADIS targets: Tables 8.1-A,B & 8.2-A,B and Fig. Nos. 8.1-A,B and 8.2-A,B show how the COLs and the weights can be changed interactively to achieve certain target figures of CADIS and the planning and financial implications thereto are worked out in Fig. Nos. 8.3-A,B. This is termed scenario 1.

There is gradual improvement in the overall quality of life in this region as shown by the rise of the CADIS from 0.46 in 1971 to 0.52 in 1991. This can be made to climb more sharply to 0.57 in 2001 and 0.67 in 2011 (target figures) by making improvements in all the four COLs as shown in the table No. 8.1-B. and 8.2-B.

TABLE NO.8.1-A COL VALUES: S M R - TREND					
	1971	1981	1991	2001	2011
CADIS	0.46	0.50	0.52	0.55	0.58
SOC W-B	0.58	0.66	0.57	0.59	0.59
ECO VIT	0.33	0.37	0.47	0.53	0.60
INF AVA	0.40	0.42	0.54	0.60	0.67
ENV QUA	0.54	0.54	0.50	0.49	0.47

TABLE NO.8.1-B COL VALUES: S M R - SCENARIO 1					
	1971	1981	1991	2001	2011
CADIS	0.46	0.50	0.52	0.57	0.67
SOC W-B	0.58	0.66	0.57	0.64	0.75
ECO VIT	0.33	0.37	0.47	0.54	0.67
INF AVA	0.40	0.42	0.54	0.62	0.71
ENV QUA	0.54	0.54	0.50	0.50	0.53

Fig. No. 8.1-A CADIS and COLs S M R: Trend

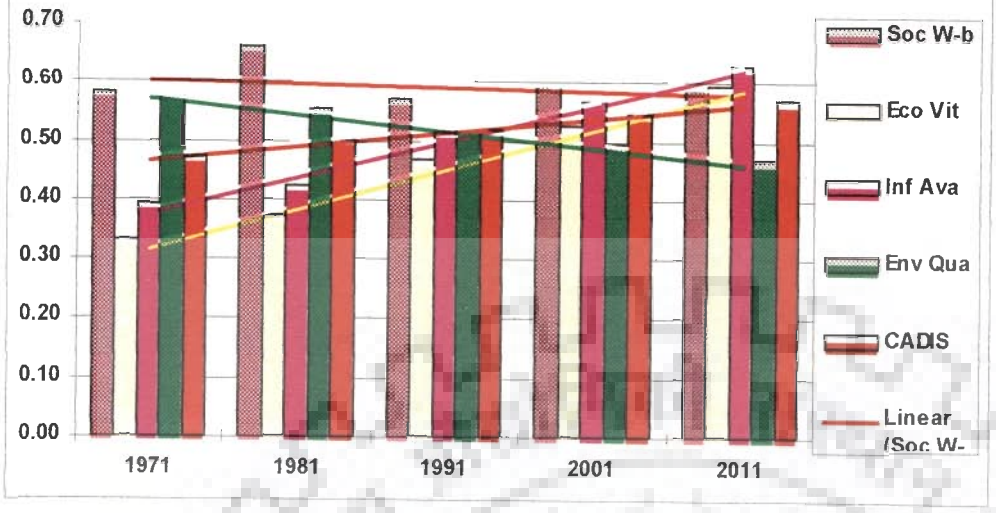
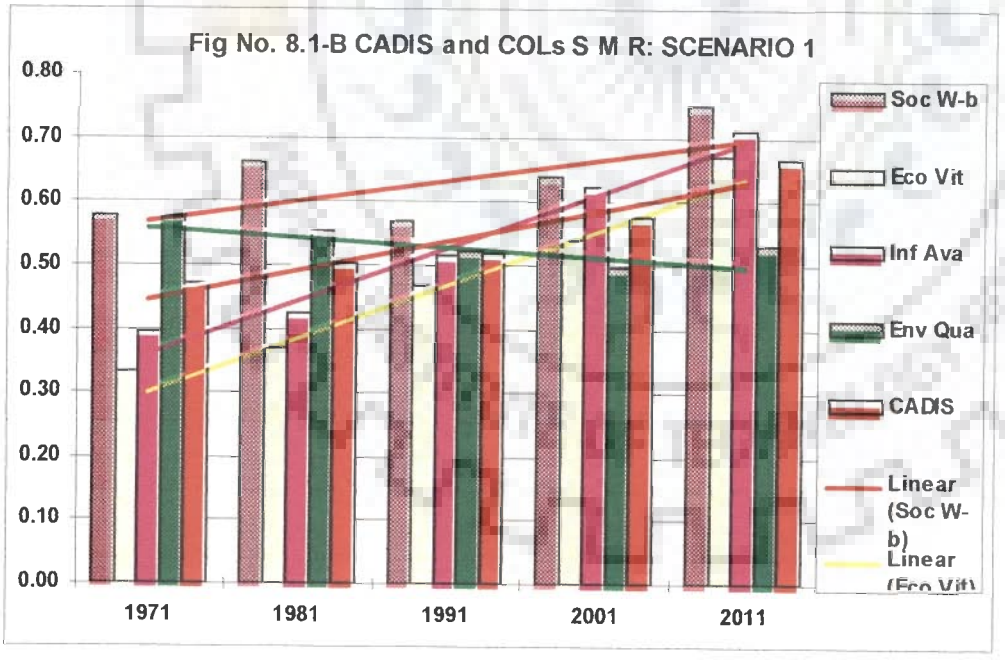


Fig No. 8.1-B CADIS and COLs S M R: SCENARIO 1



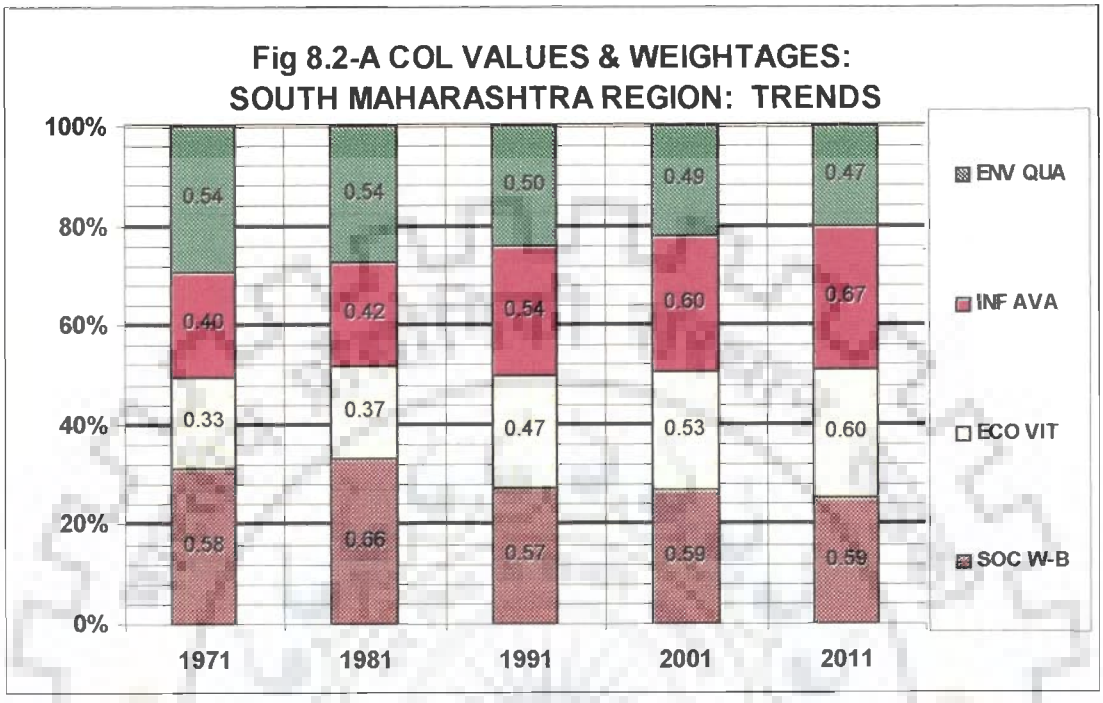


Fig 8.2-A COL VALUES & WEIGHTAGES:
SOUTH MAHARASHTRA REGION: TRENDS
100%
80%
60%
40%
20%
0%
0.54
0.40
0.33
0.58
0.54
0.42
0.37
0.66
0.50
0.54
0.47
0.57
0.49
0.60
0.53
0.59
0.47
0.67
0.60
0.59
1971
1981
1991
2001
2011
ENV QUA
INF AVA
ECO VIT
SOC W-B

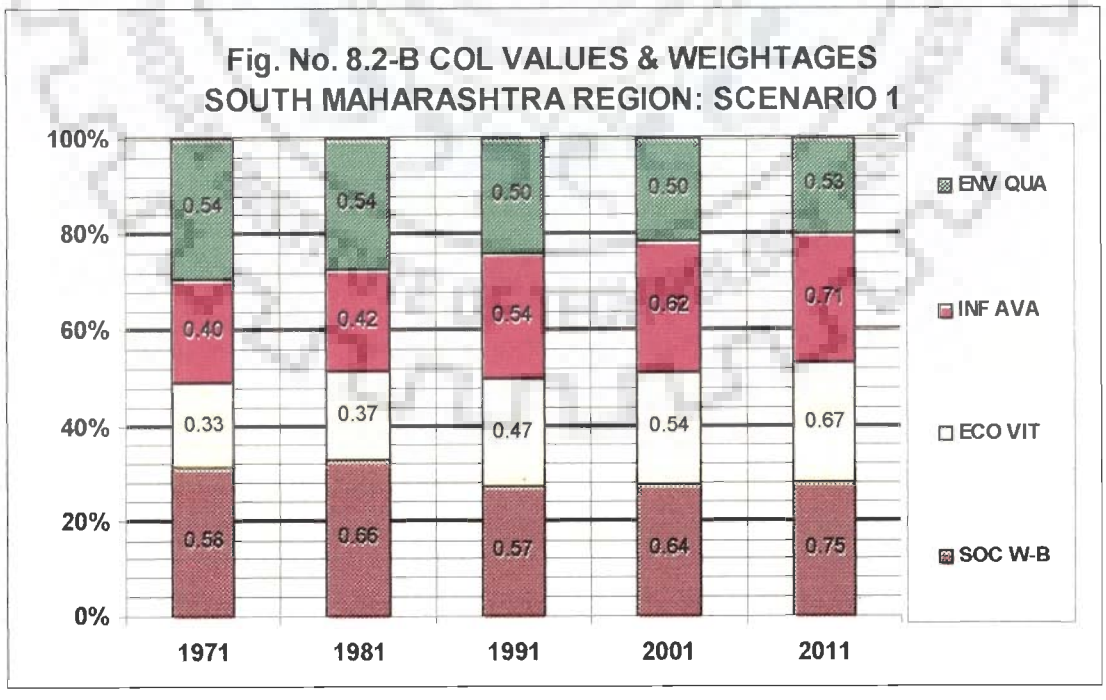


Fig. No. 8.2-B COL VALUES & WEIGHTAGES
SOUTH MAHARASHTRA REGION: SCENARIO 1
100%
80%
60%
40%
20%
0%
0.54
0.40
0.33
0.56
0.54
0.42
0.37
0.66
0.50
0.54
0.47
0.57
0.50
0.62
0.54
0.64
0.53
0.71
0.67
0.75
1971
1981
1991
2001
2011
ENV QUA
INF AVA
ECO VIT
SOC W-B

Table No. 8.2-A WEIGHTS & VALUES OF COL / CADIS: SMR TREND										
Year	Soc W-B		Eco Vit		Inf Ava		Env Qua		C A D I S	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Σ Wi	Σ Wi Vi
1971	0.31	0.58	0.19	0.33	0.2	0.4	0.3	0.54	1	0.46
1981	0.33	0.66	0.19	0.37	0.21	0.42	0.27	0.54	1	0.5
1991	0.27	0.57	0.23	0.47	0.26	0.54	0.24	0.5	1	0.52
2001	0.27	0.59	0.25	0.53	0.26	0.6	0.22	0.49	1	0.55
2011	0.26	0.59	0.26	0.6	0.28	0.67	0.2	0.47	1	0.58

Table No. 8.2-B WEIGHTS & VALUES OF COL / CADIS: SMR SCENARIO 1										
Year	Soc W-B		Eco Vit		Inf Ava		Env Qua		C A D I S	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Σ Wi	Σ Wi Vi
1971	0.31	0.58	0.19	0.33	0.2	0.4	0.3	0.54	1	0.46
1981	0.33	0.66	0.19	0.37	0.21	0.42	0.27	0.54	1	0.5
1991	0.27	0.57	0.23	0.47	0.26	0.54	0.24	0.5	1	0.52
2001	0.28	0.64	0.24	0.54	0.26	0.62	0.22	0.5	1	0.57
2011	0.28	0.75	0.26	0.67	0.26	0.71	0.2	0.53	1	0.67

8.3.2 Stage I - (B) Planning and financial implications: Table no.8.2-A above, shows the values and weights for 2001 and 2011 obtained by extrapolation of trends, whereas table no. 8.2-B shows the adjusted values and weights which constitute scenario 1. Similarly Fig. No. 8.3-A and fig. no. 8.3-B show the financial implications of these adjustments. Considering 1991 as base year (100%), the allocations have to be increased to 110% in 2001 and 128.8% in 2011 so as to achieve all the above targets. The share of social sector has to be increased from 26% to 28% in 2011, that of economic sector kept constant at 26%, infrastructure sector reduced from 28% to 26% and environment sector kept constant at 20% of total budget in order that respective targets fixed for the four COLs may be achieved.

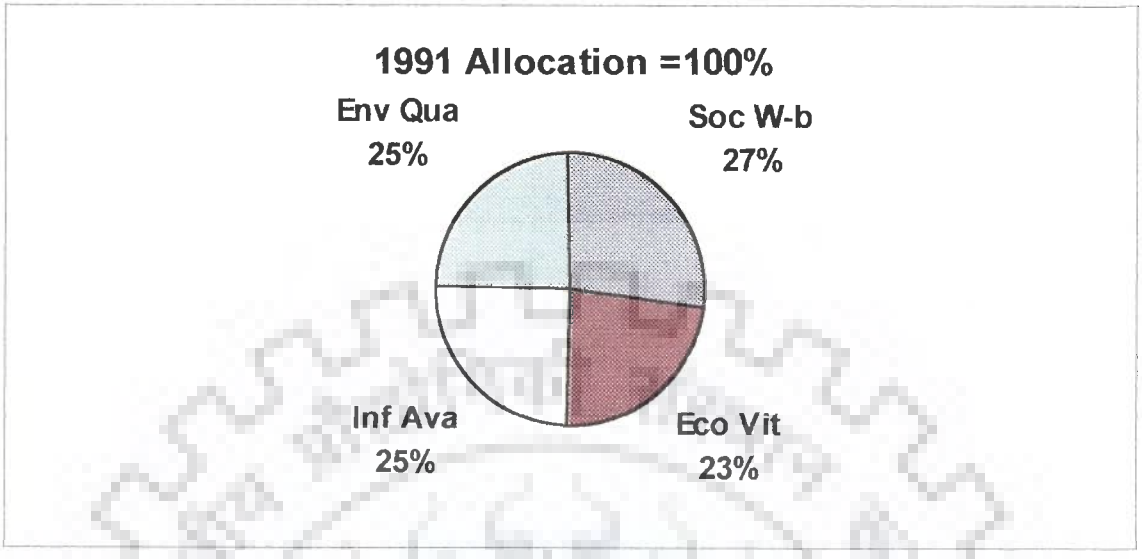


Fig. No. 8.3-A Sectoral Plan Allocations SMR 1991

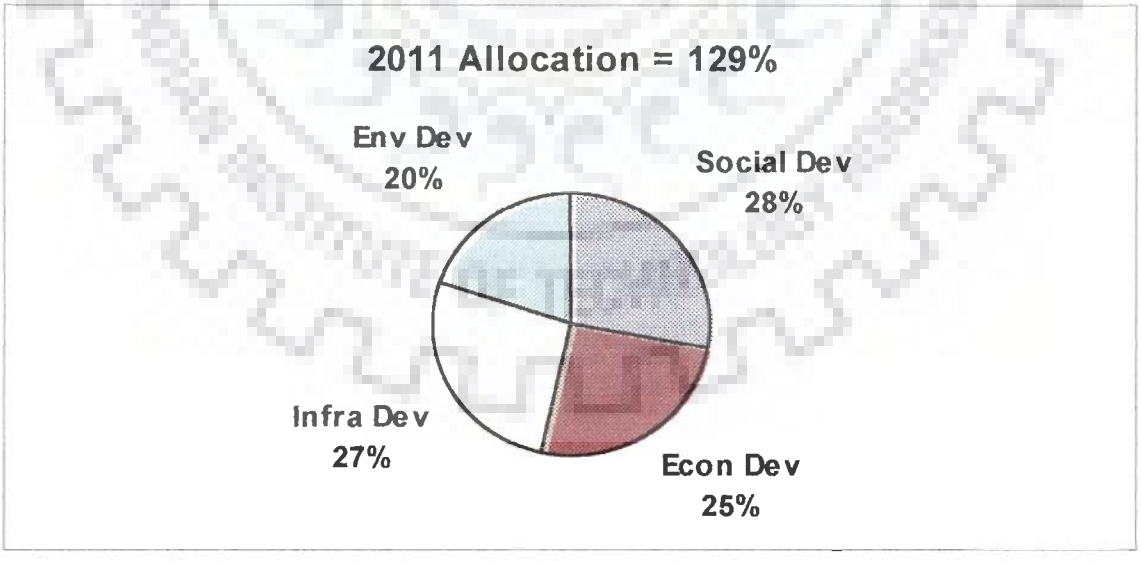


Fig. No. 8.3-B Sectoral Plan Allocations Required SMR 2011

8.3.3 Stage II - (A) Adjustment of SDIs: The changed values of COLs in turn requires changes to be made to the respective SDIs as follows -

i) Social Well-being Index: (refer table no.8.3-A,B)The infant mortality rate, death rate, birth rate, total literacy rate, difference in male-female literacy rate and unemployment rate, all these have to be improved to enable the social development index to rise from 0.59 in 1991 to 0.64 in 2001 and 0.75 in 2011 as shown in the table.

ii) Economic Vitality Index: (refer table no. 8.4-A,B)This index can be improved from 0.47 in 1991 to 0.54 in 2001 and 0.67 in 2011 by improving employment percentage, land under cash crops, food grain yield per hect., live-stock per lakh or population, and net sown area percentage as shown.

iii) Infrastructure Availability Index: (refer table no. 8.5-A,B) This can be made to improve from 0.52 in 1991 to 0.62 in 2001 and 0.70 in 2011 by improving road kms per 100 sq kms, railway kms per lakh of population, post and telegraph offices, telephones, educational institutions and banks per lakh of population as shown in the table.

iv) Environmental Quality Index: (refer table no. 8.6-A,B)This is likely to improve to0.53 in 2011 from 0.50 in 2001 by improving scores on percentage area sown (ve), population density (-ve), percentage of forest land, employment in mining and quarrying (-ve), rainfall per capita (through population control), factory workers and automotive vehicles per lakh of population (-ve) as shown in table.

TABLE NO.8.3-A SOCIAL WELL-BEING S D INDICES S M R: TREND

YEAR	PopGrthR	InfMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	DifM-FLit%	F Prt Rt (+	UrbPop%(	UnEmp%(-	HslessPop	COL
1971	0.39	0 95	0 92	0.75	0.8	0.29	0.60	0.28	0 40	0.3	0.58
1981	0.49	0.94	0.63	0.81	0.91	0.55	0.76	0.3	0.46	0.72	0.66
1991	0.52	0.94	0 72	0.62	0.63	0.32	0.79	0.26	0.46	0.62	0.59
2001	0.60	0.93	0.56	0.60	0.61	0.42	0.87	0.26	0.46	0.86	0.62
2011	0.66	0.92	0.46	0.53	0.53	0.43	0.93	0.25	0.46	1.02	0.62

TABLE NO.8.3-B SOCIAL WELL-BEING S D INDICES SMR: SCENARIO 1

YEAR	PopGrthR	InfMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	DifM-FLit%	F Prt Rt (+	UrbPop%(	UnEmp%(-	HslessPop	COL
1971	0.39	0.95	0.92	0.75	0.8	0.29	0.66	0.28	0.46	0.3	0.58
1981	0.49	0.94	0.63	0.81	0 91	0 55	0.76	0.3	0 46	0.72	0.66
1991	0.52	0 94	0.72	0 62	0.63	0.32	0.79	0 26	0.46	0 62	0 59
2001	0.60	0.93	0.60	0.65	0.7	0.50	0.87	0.26	0.46	0.86	0.64
2011	0.66	0.95	0.70	0.75	0.85	0.65	0.93	0.25	0.9	0.90	0.75

TABLE NO.8.4-A ECONOMIC VITALITY S D INDICES S M R: TREND

YEAR	T Prt Rt(+)	NAgriEmp	UnEmp%(-	FdCrps%(	FdGrnYld(	PCIncm(+)	Trcts/100H	Livstk/LPc	NtArSwn%	UrbPop%(	COL
1971	0 19	0 15	0.46	0.46	0.44	0.19	0.09	0.55	0.50	0.28	0.33
1981	0.20	0.20	0 46	0.47	0.59	0.22	0.33	0.50	0.44	0.30	0.37
1991	0.69	0.27	0 46	0.42	0.60	0.38	0.51	0.59	0.50	0.26	0.47
2001	0.86	0.33	0.46	0.41	0.71	0.45	0.73	0.59	0.48	0.26	0.53
2011	1.11	0.39	0.46	0.39	0.78	0.55	0.94	0.61	0.48	0.25	0.60

TABLE NO.8.4-B ECONOMIC VITALITY S D INDICES S M R : SCENARIO 1

YEAR	T Prt Rt(+)	NAgriEmp	UnEmp%(-	FdCrps%(	FdGrnYld(	PCIncm(+)	Trcts/100H	Livstk/LPc	NtArSwn%	UrbPop%(	COL
1971	0.19	0.15	0.46	0.46	0.44	0.19	0 09	0 55	0 50	0.28	0.33
1981	0.20	0.20	0.46	0.47	0.59	0.22	0.33	0.50	0.44	0.30	0.37
1991	0 69	0 27	0 46	0 42	0 60	0.38	0.51	0.59	0.50	0 26	0 47
2001	0.86	0.33	0.46	0.45	0.75	0.45	0.73	0 60	0.55	0.26	0.54
2011	1.00	0.39	1.00	0.50	0.80	0.55	0.94	0.65	0.60	0.25	0.67

TABLE NO.8.5-A INFRASTRUCTURE AVAILABILITY S D INDICES S M R: TREND

YEAR	Rd Kms/1(	RlyKms/Lp	P O /L Pop	Tel / Lpop	EdInst/Lpc	Hbeds/Lpc	El HS % (+	Bnks/Lpop	IrrAr%(+)	HslsPop%	COL
1971	0.74	0.18	0.45	0.19	0.52	0.14	0.45	0.62	0.35	0.3	0.39
1981	0.58	0.38	0.53	0.19	0.47	0.27	0.69	0 14	0.26	0.72	0.42
1991	0.44	0 38	0 45	0.13	0 39	0 67	1	0.52	0.57	0.61	0.52
2001	0.29	0 51	0.48	0 11	0.33	0.89	1.26	0 33	0.61	0.85	0 57
2011	0.14	0.61	0 48	0 08	0 265	1 16	1.54	0.28	0.72	1 01	0.63

TABLE NO.8.5-B INFRASTRUCTURE AVAILABILITY S D INDICES S M R : SCENARIO 1

YEAR	Rd Kms/1(	RlyKms/Lp	P O /L Pop	Tel / Lpop	EdInst/Lpc	Hbeds/Lpc	El HS % (+	Bnks/Lpop	IrrAr%(+)	HslsPop%	COL
1971	0.74	0.18	0.45	0 19	0.52	0 14	0.45	0.62	0.35	0 3	0 39
1981	0.58	0 38	0 53	0 19	0 47	0 27	0.69	0 14	0 26	0 72	0 42
1991	0 44	0 38	0 45	0.13	0 39	0.67	1	0.52	0 57	0.61	0.52
2001	0 45	0.51	0.50	0.25	0.45	0.89	1.00	0.45	0.61	0.85	0 62
2011	0.55	0.65	0 60	0.35	0 55	1.00	1 00	0.55	0 72	1 00	0.70

TABLE NO.8.6-A ENVIRONMENTAL QUALITY S D INDICES S M R: TREND

YEAR	UrbPop%(	BmLnd%(	SwnAr%(-)	PopDen(-)	FrstLnd%	DfrstRt(-)	EmpM&Q(	RnfPC(+)	FWrk/LPo	Autos/LPc	COL
1971	0.72	0.31	0.50	0.70	0.37	1.08	0.43	0.43	0.78	0.43	0.58
1981	0.70	0.32	0.56	0.65	0.41	0.69	0.48	0.41	0.75	0 56	0.55
1991	0.74	0.44	0.50	0.62	0.46	0.29	0.62	0.40	0.60	0.54	0.52
2001	0.74	0.49	0.52	0.58	0.50	-0.11	0.70	0.38	0.53	0.62	0.50
2011	0.75	0.55	0.52	0.54	0.55	-0.50	0.79	0.37	0.44	0.68	0.47

TABLE NO. 8.6-B ENVIRONMENTAL QUALITY S D INDICES S M R : SCENARIO 1

YEAR	UrbPop%(	BmLnd%(	SwnAr%(-)	PopDen(-)	FrstLnd%	DfrstRt(-)	EmpM&Q(	RnfPC(+)	FWrk/LPo	Autos/LPc	COL
1971	0 72	0 31	0 50	0 70	0.37	1 08	0.43	0.43	0.78	0.43	0.58
1981	0.70	0.32	0.56	0.65	0.41	0.69	0 48	0.41	0.75	0 56	0.55
1991	0 74	0.44	0 50	0 62	0.46	0 29	0.62	0 40	0.60	0.54	0 52
2001	0.74	0 49	0.55	0.58	0.50	-0.11	0.70	0.38	0.55	0.65	0.50
2011	0.75	0.55	0.60	0 65	0.65	-0.50	0.85	0.40	0.65	0.75	0.53

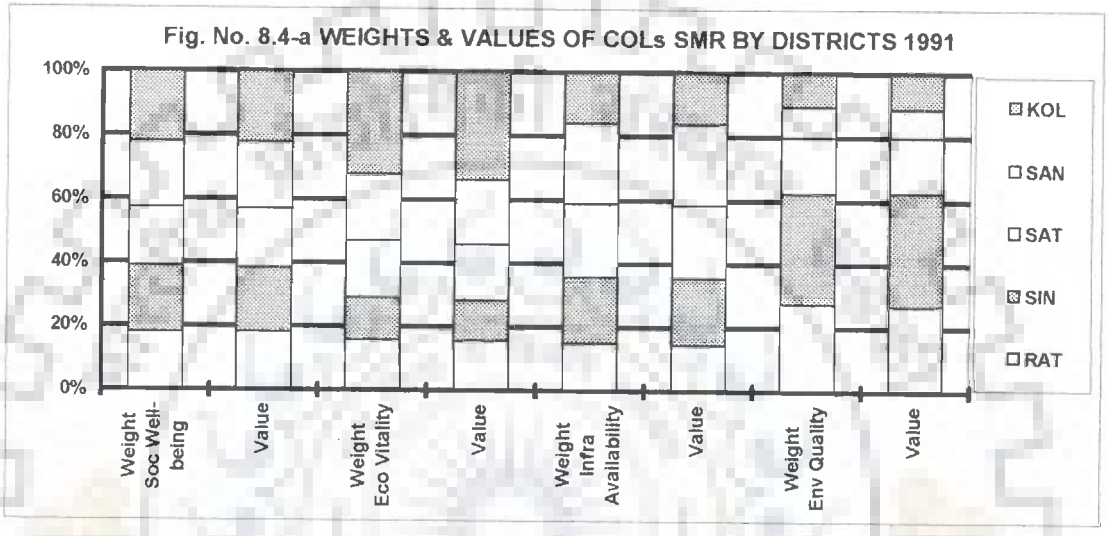
8.3.4 Stage II - (B): Spatio-physical (Distributive) Implications: One of the main objectives of regional planning in a socialistic state is the reduction of intra-generational or inter-regional disparities in the quality of life. This has been studied by examining the trends of comparative development in the five districts of SMR from 1971 to '91 and projecting the same to the time frames of 2001 and 2011. (refer table Nos.8.7, 8.8, and Fig. Nos. 8.4, 8.5) The corrective interventions required to restore sustainable and balanced development are shown in the scenario 1 detailed out in table no. 8.9 and Fig. Nos. 8.6

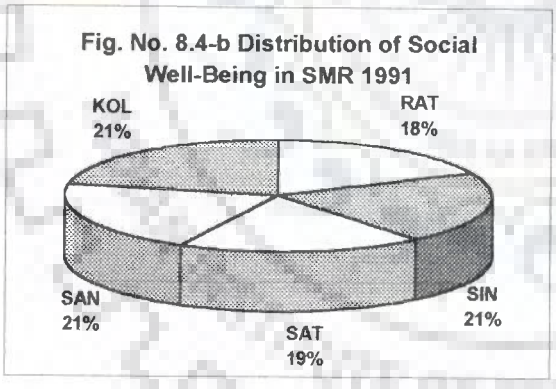
a) Social Well-Being: In 1991 there is more or less even distribution of social well-being (Fig. 8.4-b) with only RAT (18% weight) lagging a little behind the other districts. But if the trends of development continue, then a very distorted picture would emerge with RAT having only 13%, SIN 17% and SAT only 18% weightage in 2011. Therefore corrective intervention is needed as shown in scenario 1 (Table 8.9) where raising of the values of all the above mentioned districts results in a fairly even distribution of social well-being with all the districts having nearly 20% weight.

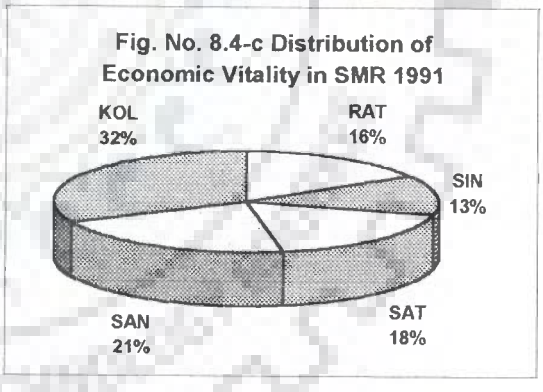
b) Economic Vitality: SIN (13%) and RAT (16%) are lagging behind in 1991 and KOL (32%) is dominant (Fig. 8.4-c). the trends indicate that this polarisation will further increase in 2011 (Fig. 8.5-c) with KOL garnering 35% weight whereas RAT having 14% and SIN just 10%. Corrective policies are needed as indicated in scenario 1 (table No. 8.9) which will result in a less imbalanced picture with SIN 16%, RAT 18%, SAT 18% and the dominance of KOL reduced to 27%.

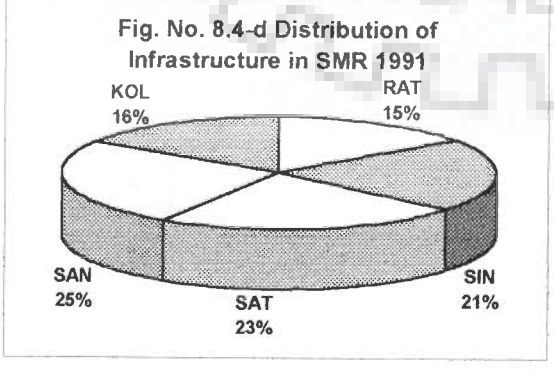
c) Infrastructure Availability: In 1991 (Fig. 8.4-d) RAT (15%) and KOL (16%) were lacking in infrastructure. The trends indicate further increase in the distortions with KOL going down to just 14% and RAT 16% weight, whereas SIN will have 26% weight in 2011. With corrective intervention policies, the scenario 1 (table 8.9 and Fig. 8.6-d) seeks to amend this imbalance to almost equal weight of 20% to all the districts.

Table No.8.7 Weights and Values of COLs in SMR: 1991								
Adm Unit	Soc Well-being		Eco Vitality		Infra Availability		Env Quality	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
RAT	0.18	0.52	0.16	0.36	0.15	0.37	0.275	0.70
SIN	0.21	0.58	0.13	0.29	0.21	0.54	0.35	0.92
SAT	0.185	0.53	0.18	0.41	0.23	0.58	0.175	0.45
SAN	0.205	0.60	0.21	0.46	0.25	0.65	0.095	0.23
KOL	0.22	0.63	0.32	0.78	0.16	0.40	0.105	0.29
SMR	1	0.57	1	0.46	1	0.51	1	0.52









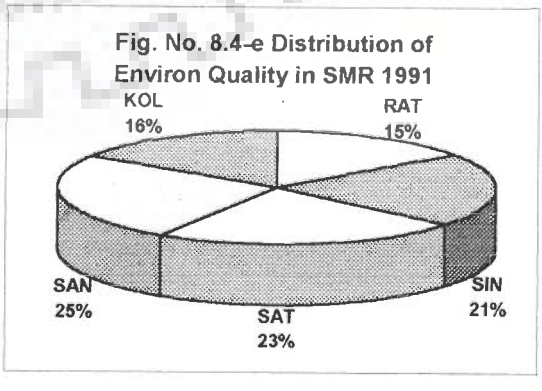
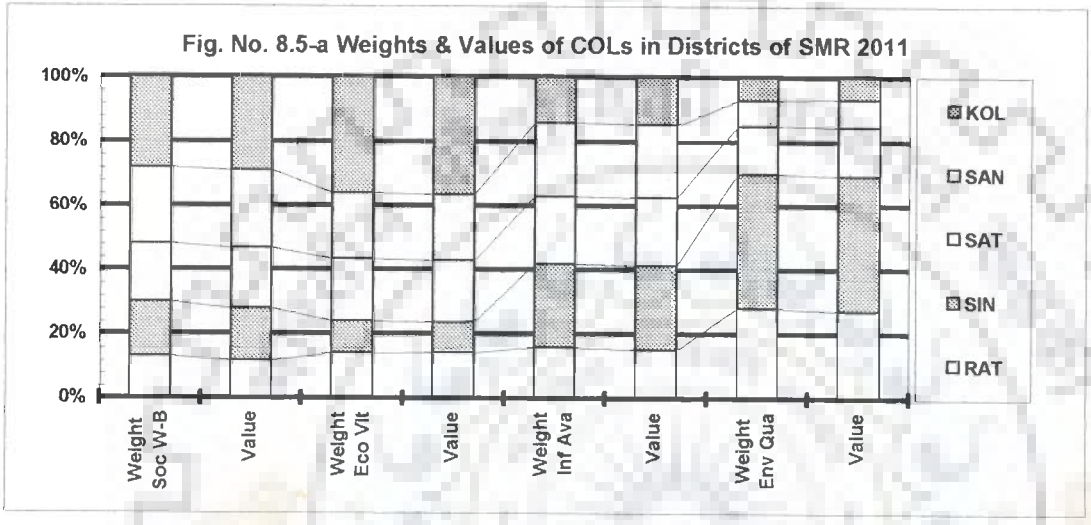
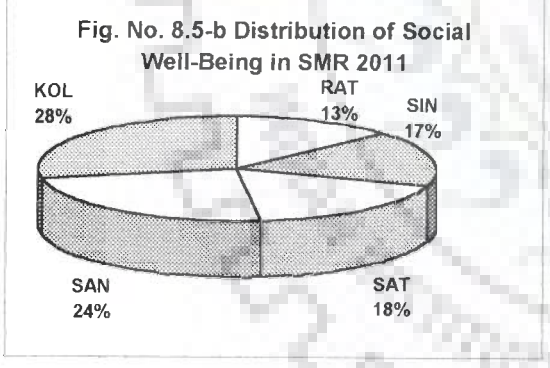
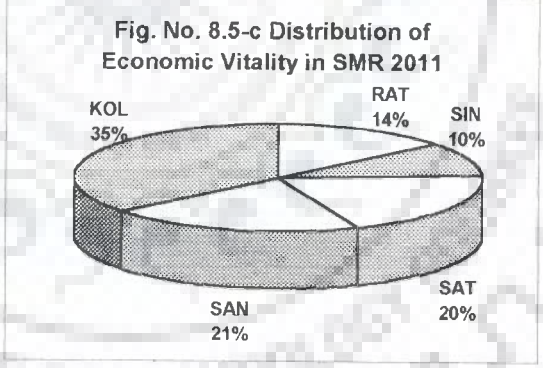


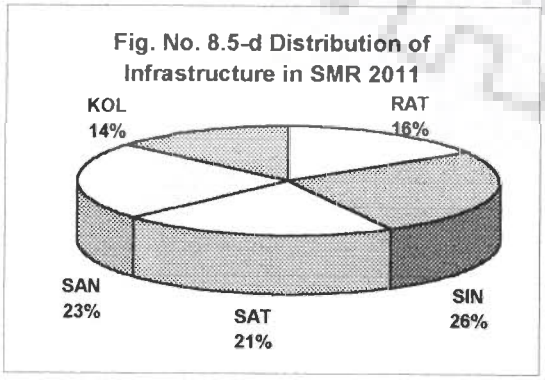
Fig. Nos. 8.4-a,b,c,d,e Intra-regional Distribution of COLs - SMR 1991

Table No.8.8 Weights and Values of COLs in SMR: 2011 Trend								
Adm Unit	Soc W-B		Eco Vit		Inf Ava		Env Qua	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
RAT	0.13	0.32	0.14	0.41	0.16	0.45	0.28	0.72
SIN	0.17	0.44	0.1	0.27	0.26	0.78	0.42	1.12
SAT	0.18	0.51	0.195	0.55	0.21	0.63	0.15	0.40
SAN	0.24	0.66	0.205	0.59	0.23	0.68	0.08	0.23
KOL	0.28	0.79	0.36	1.04	0.14	0.43	0.07	0.18
SMR	1	0.54	1	0.57	1	0.59	1	0.53









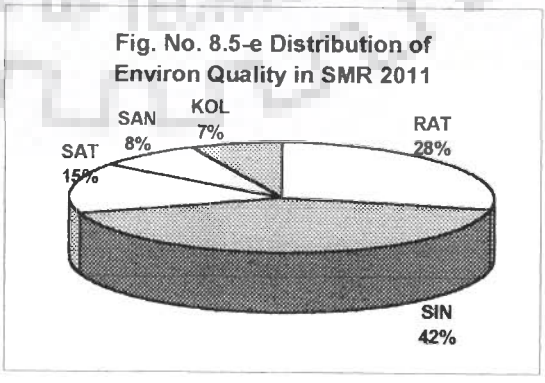
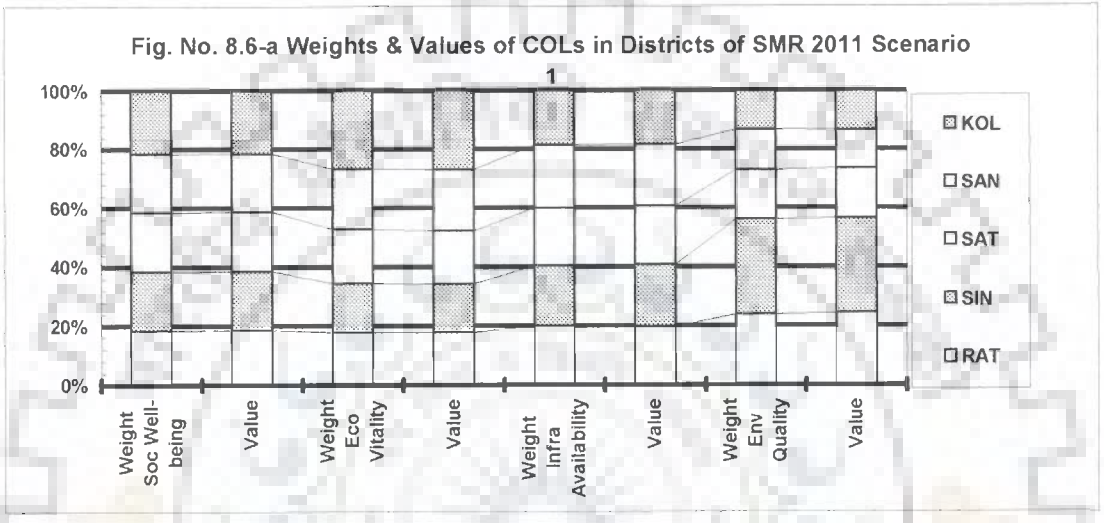
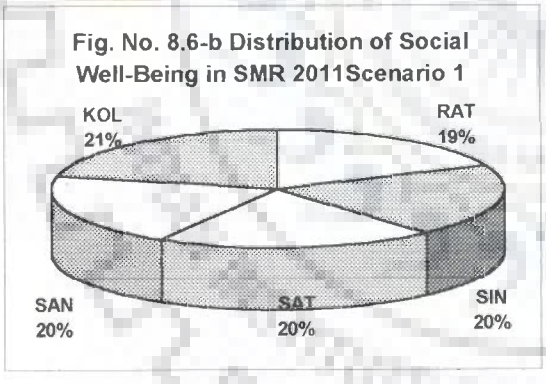
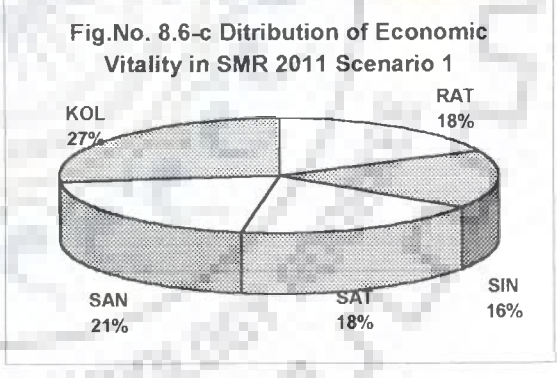


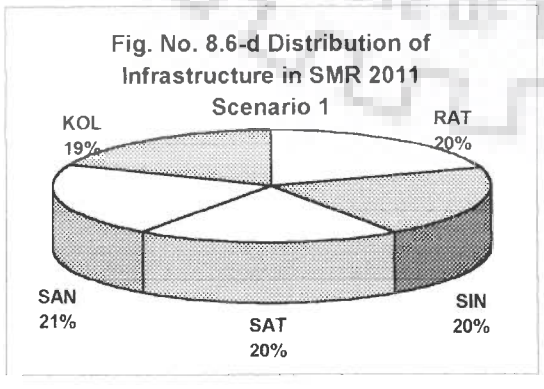
Fig. Nos. 8.5-a,b,c,d,e Intra-regional Distribution of COLs - SMR 2011

Table No.8.9 Weights and Values of COLs in SMR: 2011 Scenario 1								
Adm Unit	Soc Well-being		Eco Vitality		Infra Availability		Env Quality	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value
RAT	0.185	0.70	0.18	0.60	0.205	0.70	0.24	0.65
SIN	0.2	0.75	0.164	0.55	0.21	0.75	0.32	0.85
SAT	0.2	0.75	0.183	0.60	0.2	0.70	0.17	0.45
SAN	0.2	0.75	0.206	0.70	0.22	0.75	0.14	0.35
KOL	0.215	0.80	0.267	0.90	0.19	0.65	0.13	0.35
SMR	1	0.75	1	0.67	1.025	0.71	1	0.53









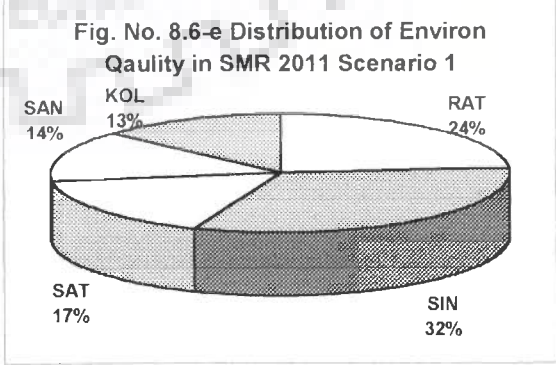


Fig. Nos. 8.6-a,b,c,d,e Intra-regional Distribution of COLs - SMR 2011 Sc-1

d) Environmental Quality: (Fig. 8.4-e and table 8.7) In 1991, KOL (16% weight) and RAT (15%) already have a low quality of environment which is likely to worsen in 2011 (table 8.8 and Fig. 8.5-e) with KOL just 7%, SAN 8% and SAT only 15% weightage. This has to be improved to KOL (13%), SAN (14%) and SAT (17%) as shown in table No. 8.9 and Fig. No. 8.6-e duly initiating corrective measures as required.

8.3.5 GIS Studies: The spatio-physical or distributive implications of the trends and scenario 1 can be appreciated better through the use of a GIS soft-ware. The following maps (Fig. Nos. 8.7 to 8.10) illustrate some of these aspects as follows -

a) Social Well-being: Fig. No. 8.7 shows the distribution of urban areas in SMR with their zones of immediate influence along with the district wise values (1991) of the Social Well-Being Index. The darker the shading, the better is the performance of the district in this index. This figure brings out the relationship between urbanisation and social well-being. It can be observed clearly that the districts which have more urban areas are doing better on this index. On the other hand, the predominantly rural districts are lagging behind.

b) Economic Vitality: Fig. No. 8.8 shows the zones of heavy, medium and low average rainfall along with the dependence level of each district on the agricultural sector. It may be seen that though RAT and SIN are heavily dependent on agricultural employment, they have adequate rainfall, so that the problem in these areas is one of encouraging good agricultural practices and construction of small check dams to reduce soil erosion and to increase the availability of water during the non monsoon months. Whereas in the case of the eastern parts of SAT and SIN which get very scanty rainfall and are fairly dependent on the agricultural sector, the need is for larger irrigation schemes which could tap the potential of the Krishna river and bring water to these draught prone areas. Simultaneously, structural

adjustments in the economy in order to reduce the dependence of these areas on the agricultural sector through encouragement of industrial and as well as commercial activities are required in these areas.

c) Infrastructure Availability: Fig. No. 8.9 shows the areas served by the railways and the national and state highways along with the population density in each of the districts of SMR (1991). The zones of low road and rail accessibility with low population density like RAT and SIN probably will have to depend on the public sector investments whereas the areas of high population density but low accessibility like the southern parts of KOL and the eastern parts of SAT and SAN can be opened up for private investments in these infrastructure sectors.

d) Environmental Quality: Fig. No. 8.10 shows likely values of the Environment Quality Index in 2011 along with the distribution of the urban areas (1991) in the districts of SMR. On one hand these are the areas of economic affluence, on the other they are also the centres of air, water and sound pollution. The areas outside these influence zones are rural areas which are pockets of economic backwardness but environmental superiority. This indicates the need to balance these conflicting requirements by encouraging further urbanisation in RAT and SIN but discouraging the same in KOL and SAN while simultaneously enforcing anti-pollution policies in both the zones.

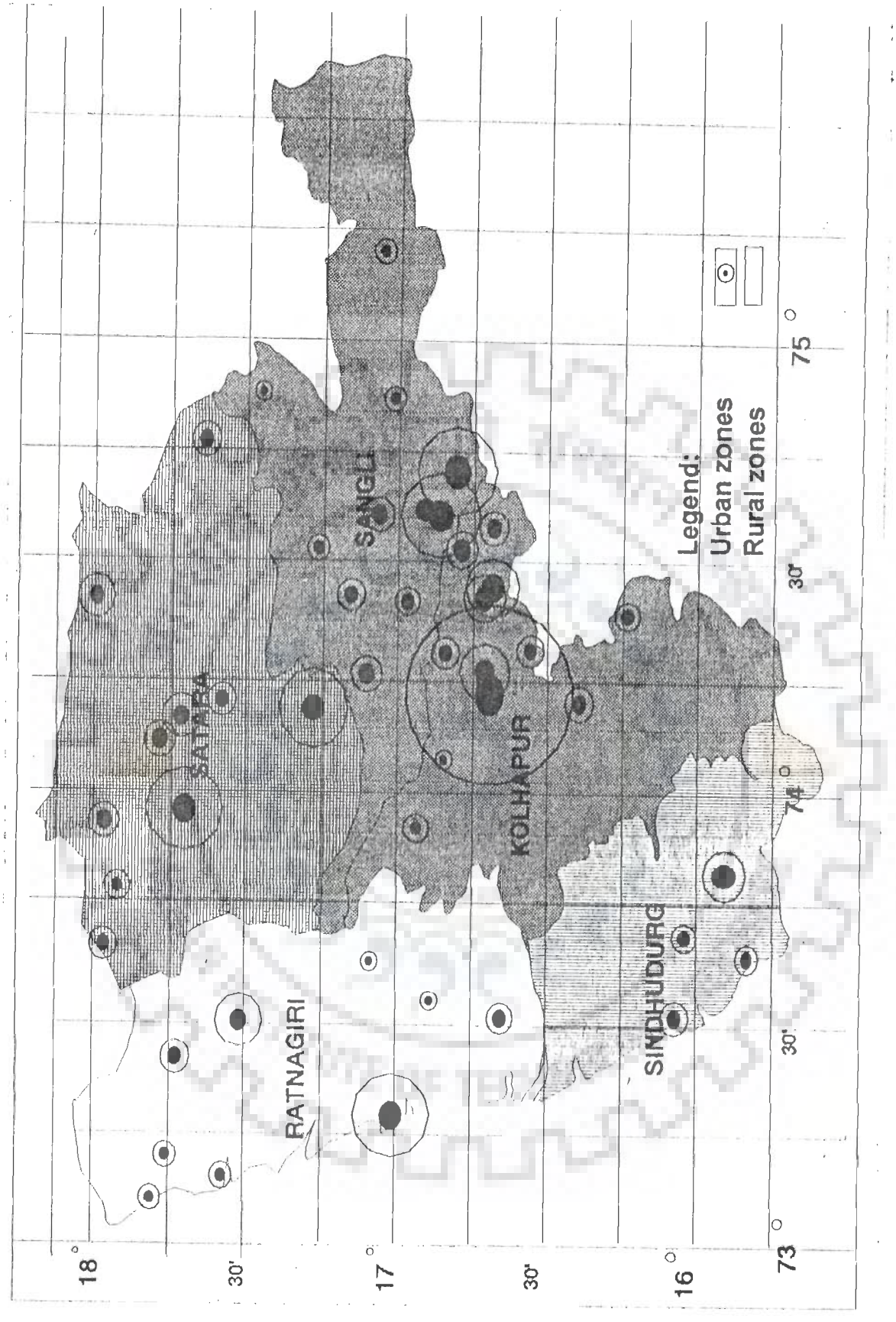


Fig. No. 8.7 Urban Zones and Social Well-Being in the Districts of SMR

1991

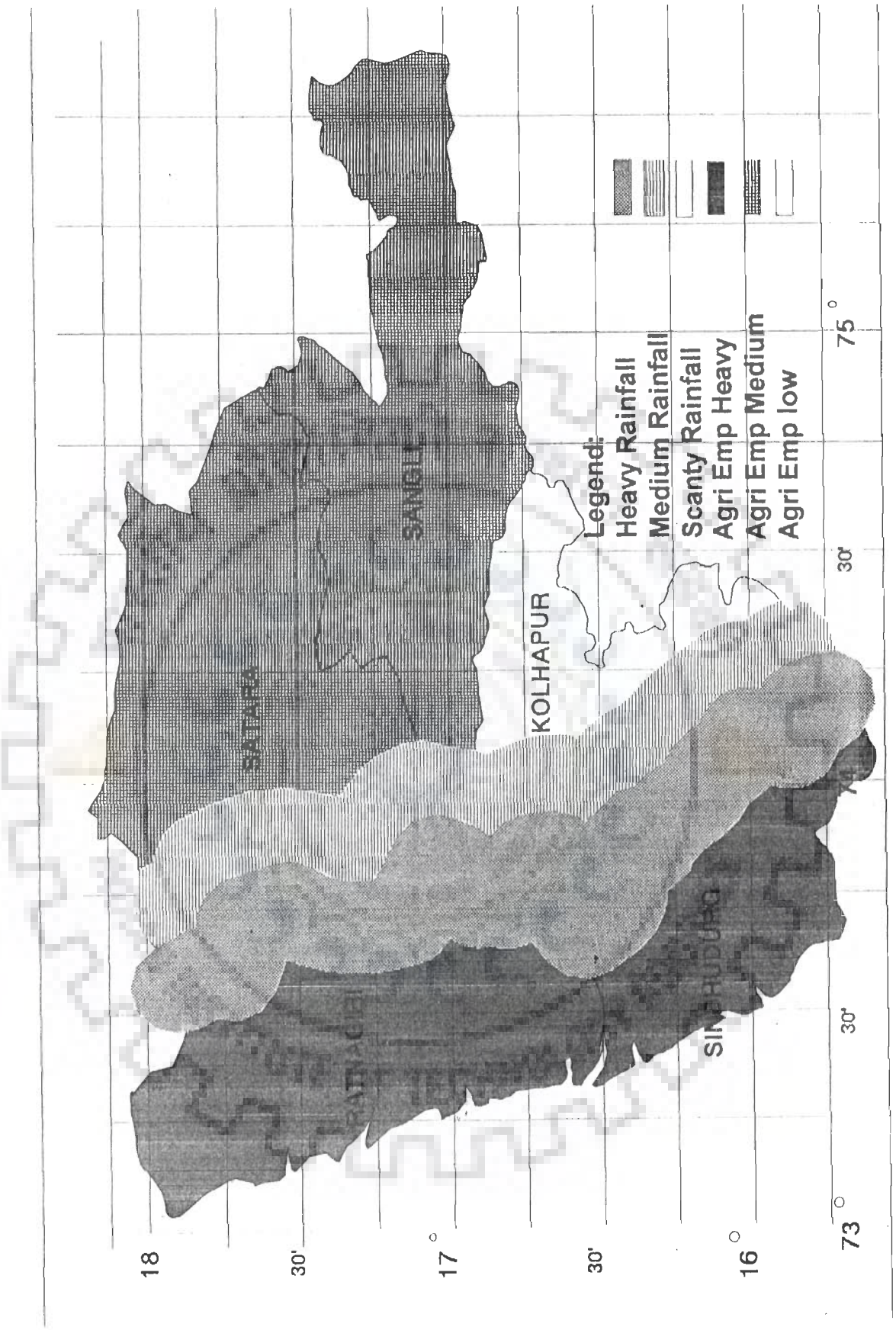


Fig. No. 8.8 Rainfall & Dependence on Agriculture in the Districts of

SMR 1991

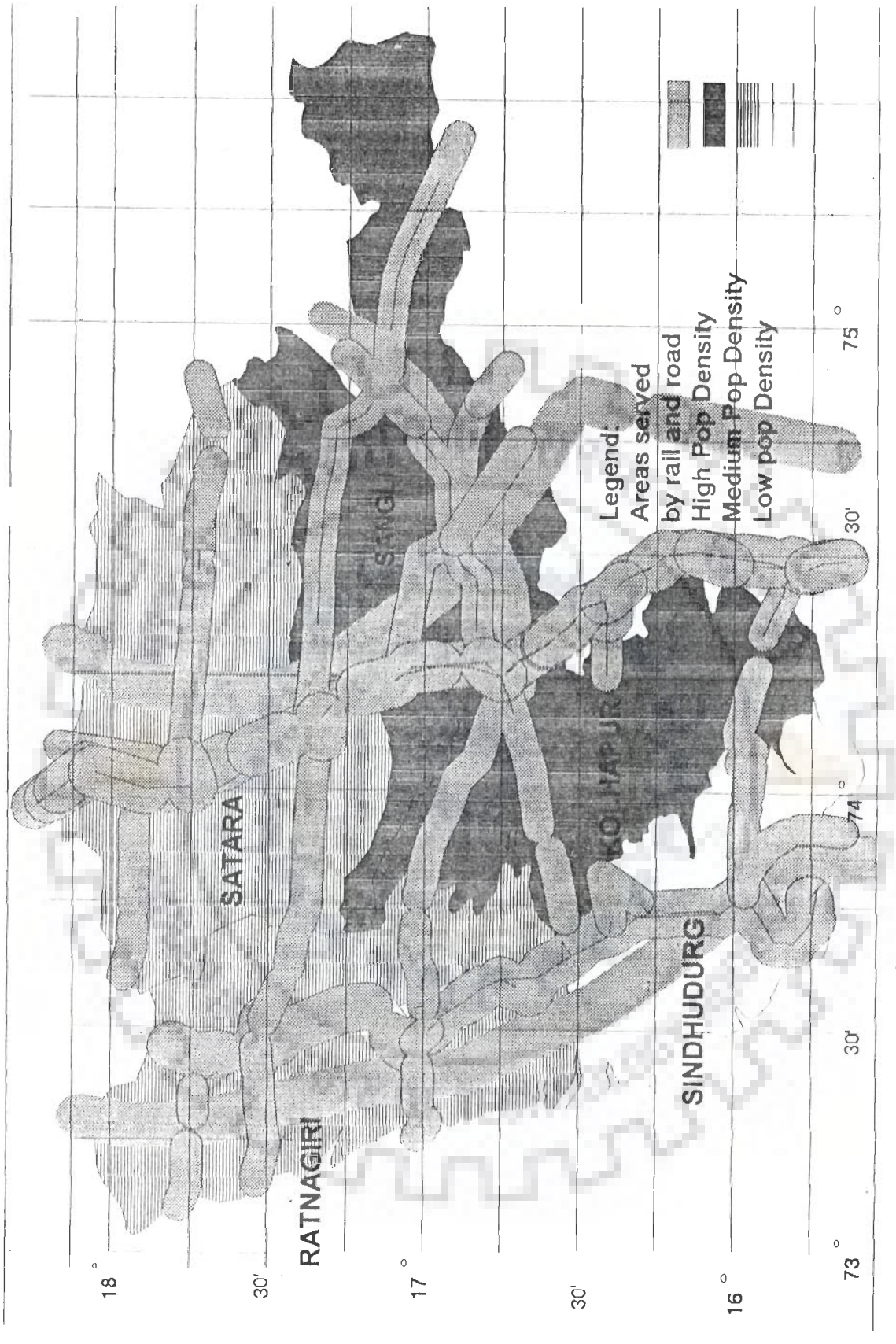


Fig. No. 8.9 Population Density & Road and Railway Accessibility in SMR 1991

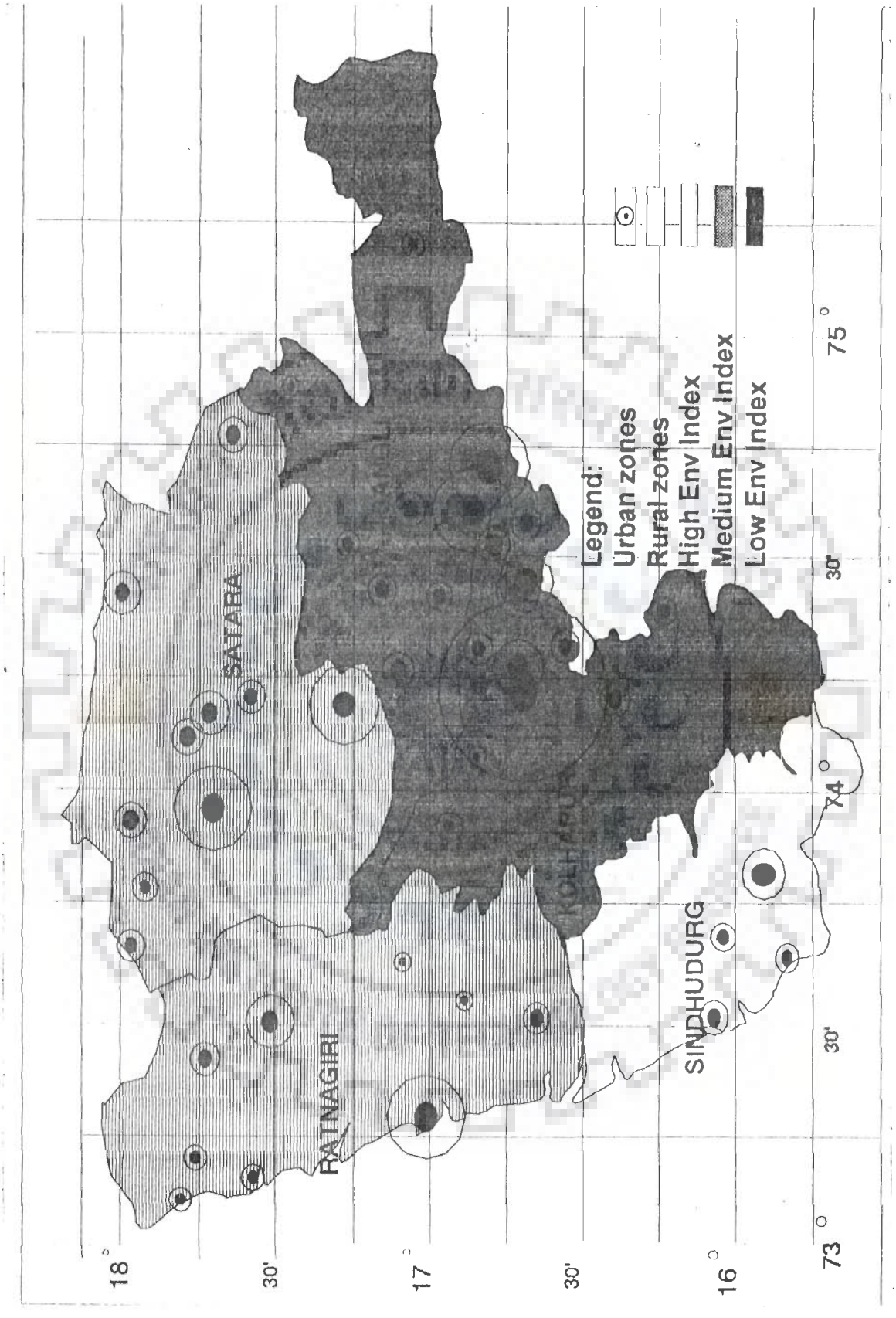


Fig. No. 8.10 Environmental Quality and Urban Zones in the SMR

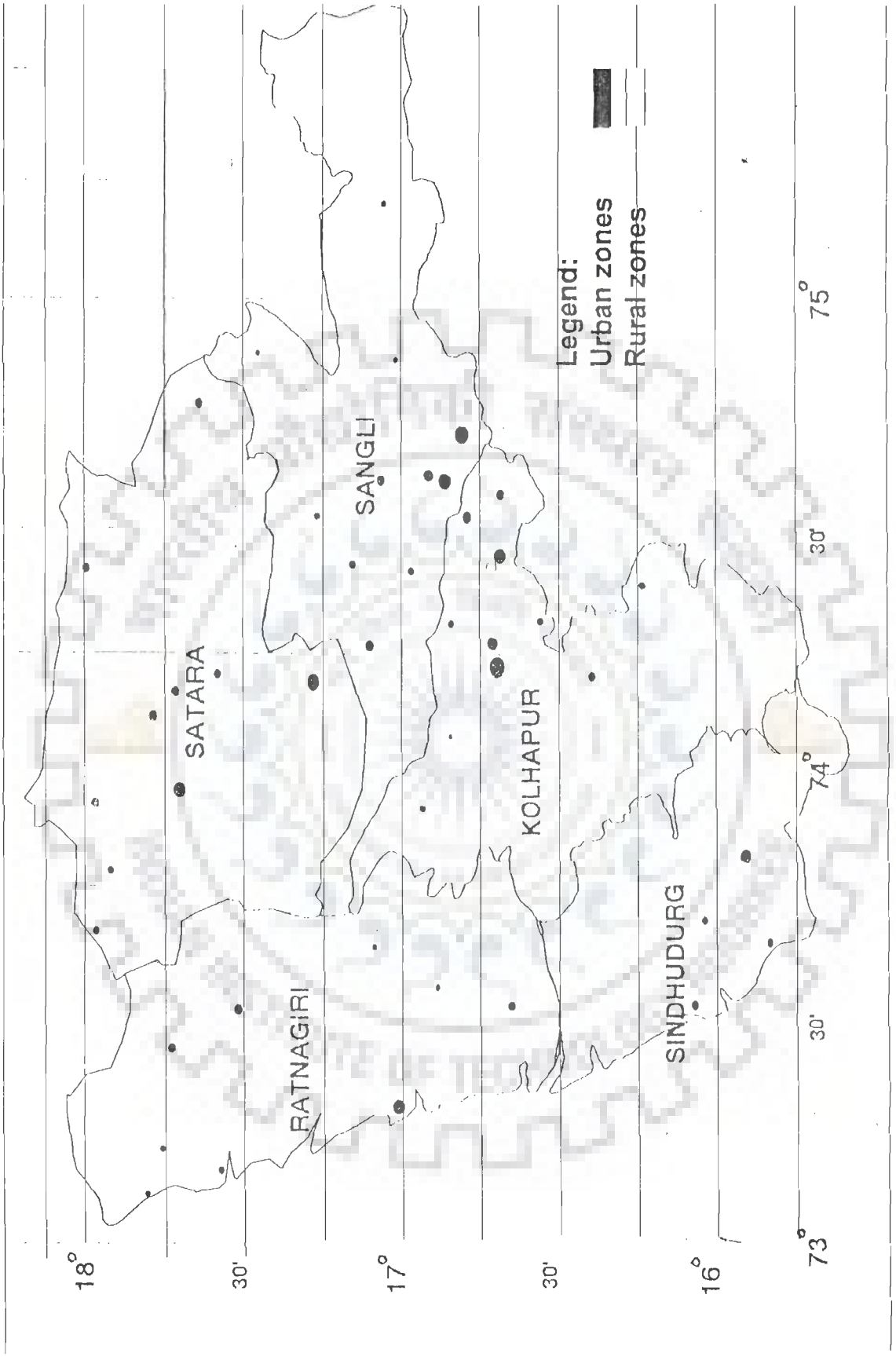


Fig. No. 8.11 Urban centres and rural areas in the SMR

8.3.6 Stage III: Reconversion of SDIs to Indicator Values:

The adjustment of SDIs to reach the target values of respective COLs have to be tempered by practical considerations. For this the changed indices have to be reconverted to respective indicators. This is done through a reconversion formula which gives the respective indicator value at a particular index value. This reconversion gives clues for readjustment of the indices as follows -

a) Social Well-Being: (refer table no. 8.10-A,B) This COL was adjusted from 0.62 (trend) to 0.75 (scenario 1) in 2011 by adjusting SDIs / Indicators as follows -

i) Infant Mortality Rate: The actual score on this indicator can at the best be 0 per 1000 live births and not -10 as given by the trend projection. The value of this indicator is therefore readjusted to reflect this reality thus giving an SDI of 0.95.

ii) Death Rate: This indicator value was improved (reduced) from the trend value of 3.67 in 2011 to 2.71 thus improving the SDI from 0.46 to 0.70

iii) Birth Rate: The trend projection was indicating a reduction in birth rate to 19.99 by 2011. This can be further improved (reduced) to 19.03 thus improving the SDI from 0.53 to 0.75.

iv) Total Literacy %: Average literacy level in SMR was predicted to be 91.78% in 2011 by the trend. This could be further improved to 95.98% thus improving the SDI from 0.53 to 0.85

v) Difference in Male-Female Literacy %: The predicted value of 22.85% was improved (reduced) to 21.78% thus improving the SDI from 0.43 to 0.65.

vi) Unemployment %: The SDI value was improved from 0.46 (predicted) to 0.90 by reducing the indicator value to 0% (minimum possible).

vii) House-less population %: This indicator can also have a minimum possible value of 0 %. Therefore the SDI was readjusted to .90 from 1.02 as shown by the trend.

TABLE NO.8.10-A SOCIAL WELL-BEING INDICATORS S M R

YEAR	PopGrthRt(-)				InfMrtRt(-)				DeathRt(-)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.39	0.89	2.07	2.83	0.95	43	47.70	137	0.92	9.4	9.86	15.2
1981	0.49	0.3	1.41	2.47	0.94	30	34.68	108	0.63	5.82	8.28	12.5
1991	0.52	0.66	1.58	2.57	0.94	16	20.00	79	0.72	5.75	7.05	10.39
2001	0.60	0.39	1.18	2.36	0.93	2.67	6.04	50	0.56	3.34	5.35	7.89
2011	0.66	0.27	0.94	2.23	0.92	-10.83	-8.35	21	0.46	1.515	3.67	5.48

TABLE NO.8.10-B SOCIAL WELL-BEING INDICATORS S M R : SCENARIO 1

YEAR	PopGrthRt(-)				InfMrtRt(-)				DeathRt(-)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.39	0.89	2.07	2.83	0.95	43	47.70	137	0.92	9.4	9.86	15.2
1981	0.49	0.3	1.41	2.47	0.94	30	34.68	108	0.63	5.82	8.28	12.5
1991	0.52	0.66	1.58	2.57	0.94	16	20.00	79	0.72	5.75	7.05	10.39
2001	0.60	0.39	1.18	2.36	0.93	2.67	6.04	50	0.60	3.34	5.16	7.89
2011	0.66	0.27	0.94	2.23	0.95	0.00	1.05	21	0.70	1.515	2.71	5.48

TABLE NO.8.11-A ECONOMIC VITALITY INDICATORS S M R

YEAR	Total Participation Rate(+)				Non Agricultural Emp % (+)				UnEmployed labour % (-)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.19	29.85	31.44	38.2	0.15	25.27	26.88	36.02	0.46	40.5	43.25	45.6
1981	0.20	33.45	34.50	38.71	0.20	26.3	28.68	38.2	0.46	27.86	29.56	31
1991	0.69	34.12	37.64	39.22	0.27	26.89	30.53	40.38	0.46	14.56	15.88	17
2001	0.86	36.74	39.31	39.73	0.33	27.77	32.60	42.56	0.46	1.7	2.19	2.6
2011	1.11	38.88	40.39	40.24	0.39	28.58	34.83	44.74	0.46	-11.27	-11.50	-11.7

TABLE NO.8.11-B ECONOMIC VITALITY INDICATORS S M R : SCENARIO 1

YEAR	Total Participation Rate(+)				Non Agricultural Emp % (+)				UnEmployed labour % (-)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.19	29.85	31.44	38.2	0.15	25.27	26.88	36.02	0.46	40.5	43.25	45.6
1981	0.20	33.45	34.50	38.71	0.20	26.3	28.68	38.2	0.46	27.86	29.56	31
1991	0.69	34.12	37.64	39.22	0.27	26.89	30.53	40.38	0.46	14.56	15.88	17
2001	0.86	36.74	39.31	39.73	0.33	27.77	32.60	42.56	0.46	1.7	2.19	2.6

TABLE NO.8.12-A INFRASTUCTURE AVAILABILITY INDICATORS S M R

YEAR	Road Kms / 100 S Kms (+)				Railway Kms / Lakh Pop(+)				Post Offices / Lakh Population (+)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.74	26.8	42.49	48	0.18	0	1.87	10.38	0.45	18	25.65	35
1981	0.58	33.6	44.50	52.4	0.38	0	3.38	8.9	0.53	20.21	34.41	47
1991	0.44	61	74.64	92	0.38	0	2.88	7.6	0.45	18	35.55	57
2001	0.29	74.67	84.26	108.13	0.51	0	3.16	6.18	0.48	18.74	42.38	68.33
2011	0.14	91.77	97.01	130.13	0.61	0	2.93	4.79	0.48	18.74	47.62	79.33

TABLE NO.8.12-B INFRASTUCTURE AVAILABILITY INDICATORS S M R : SCENARIO 1

YEAR	Road Kms / 100 S Kms (+)				Railway Kms / Lakh Pop(+)				Post Offices / Lakh Population (+)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.74	26.8	42.49	48	0.18	0	1.87	10.38	0.45	18	25.65	35
1981	0.58	33.6	44.50	52.4	0.38	0	3.38	8.9	0.53	20.21	34.41	47
1991	0.44	61	74.64	92	0.38	0	2.88	7.6	0.45	18	35.55	57
2001	0.45	74.67	89.73	108.13	0.51	0	3.16	6.18	0.50	18.74	43.54	68.33
2011	0.55	91.77	112.87	130.13	0.65	0	3.11	4.79	0.60	18.74	55.09	79.33

TABLE NO.8.13-A ENVIRONMENTAL QUALITY INDICATORS S M R

YEAR	% Urban Population (-)				% Barren & Waste Land (+)				% Net Sown Area (-)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.72	6.89	13.74	31.37	0.31	5.1	12.36	28.52	0.50	27	46.84	66.3
1981	0.70	6.54	15.09	35.03	0.32	4.69	12.15	28	0.56	27.8	45.96	69.5
1991	0.74	7.57	15.66	38.69	0.44	4.29	14.58	27.67	0.50	21.5	45.08	68.3
2001	0.74	7.68	16.69	42.35	0.49	3.88	15.24	27.21	0.52	19.93	44.00	70.03
2011	0.75	8.02	17.52	46.01	0.55	3.48	16.34	26.79	0.52	17.18	43.03	71.03

TABLE NO. 8.13-B ENVIRONMENTAL QUALITY INDICATORS S M R : SCENARIO 1

YEAR	% Urban Population (-)				% Barren & Waste Land (+)				% Net Sown Area (-)			
	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score	St Score	Min Score	Actual Scor	Max Score
1971	0.72	6.89	13.74	31.37	0.31	5.1	12.36	28.52	0.50	27	46.84	66.3
1981	0.70	6.54	15.09	35.03	0.32	4.69	12.15	28	0.56	27.8	45.96	69.5
1991	0.74	7.57	15.66	38.69	0.44	4.29	14.58	27.67	0.50	21.5	45.08	68.3
2001	0.74	7.68	16.69	42.35	0.49	3.88	15.24	27.21	0.55	19.93	42.48	70.03
2011	0.75	8.02	17.52	46.01	0.55	3.48	16.34	26.79	0.60	17.18	38.72	71.03

TABLE NO.8.10-A SOCIAL WELL-BEING INDICATORS S M R (contd)

YEAR	BirthRt(-)				T Lit % (+)				DifM-FLit%(-)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.75	22.2	25.88	36.9	0.8	29.5	37.74	39.8	0.29	19.36	26.91	30
1981	0.81	22.58	24.73	33.9	0.91	36.23	47.08	48.15	0.55	21.47	24.71	28.66
1991	0.62	19.8	23.49	29.5	0.63	52.11	67.04	75.81	0.32	19.36	24.90	27.5
2001	0.60	19.13	21.91	26.03	0.61	61.89	79.40	90.60	0.42	20.06	23.65	26.22
2011	0.53	17.93	19.99	22.33	0.53	73.20	91.78	108.60	0.43	20.06	22.85	24.97

TABLE NO.8.10-B SOCIAL WELL-BEING INDICATORS S M R : SCENARIO 1 (contd)

YEAR	BirthRt(-)				T Lit % (+)				DifM-FLit%(-)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.75	22.2	25.88	36.9	0.8	29.5	37.74	39.8	0.29	19.36	26.91	30
1981	0.81	22.58	24.73	33.9	0.91	36.23	47.08	48.15	0.55	21.47	24.71	28.66
1991	0.62	19.8	23.49	29.5	0.63	52.11	67.04	75.81	0.32	19.36	24.90	27.5
2001	0.65	19.13	21.54	26.03	0.7	61.89	81.98	90.60	0.50	20.06	23.14	26.22
2011	0.75	17.93	19.03	22.33	0.85	73.20	95.98	100.00	0.65	20.06	21.78	24.97

TABLE NO.8.11-A ECONOMIC VITALITY INDICATORS S M R (contd)

YEAR	Food Crops % of Total Cropped Area (-)				Food GrainYield / Hect (+)				PerCapita Income 1981 Rs (+)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.46	62.9	72.84	81.3	0.44	478	755.20	1101	0.19	809	1050.00	2065
1981	0.47	53.2	63.74	73.08	0.59	599	1043.60	1358	0.22	1613	1796.00	2435
1991	0.42	54	67.34	77	0.60	651	1332.00	1777	0.38	2223	2686.00	3438
2001	0.41	47.8	62.57	72.83	0.71	749	1693.02	2088	0.45	2962	3442.46	4019
2011	0.39	43.35	60.02	70.68	0.78	835.5	2083.96	2426	0.55	3669	4238.17	4705.5

TABLE NO.8.11-B ECONOMIC VITALITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Food Crops % of Total Cropped Area (-)				Food GrainYield / Hect (+)				PerCapita Income 1981 Rs (+)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.46	62.9	72.84	81.3	0.44	478	755.20	1101	0.19	809	1050.00	2065
1981	0.47	53.2	63.74	73.08	0.59	599	1043.60	1358	0.22	1613	1796.00	2435
1991	0.42	54	67.34	77	0.60	651	1332.00	1777	0.38	2223	2686.00	3438
2001	0.45	47.8	61.56	72.83	0.75	749	1753.25	2088	0.45	2962	3442.46	4019
2011	0.50	43.35	57.01	70.68	0.80	835.5	2107.90	2426	0.55	3669	4238.17	4705.5

TABLE NO.8.12-A INFRASTUCTURE AVAILABILITY INDICATORS S M R (contd)

YEAR	Telephones / Lakh Population(+)				Educational Inst / Lakh Population(+)				Hospital Beds / Lakh Population(+)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.19	67	132.00	415	0.52	91	121.16	149	0.14	48	58.36	122
1981	0.19	154	276.60	795	0.47	87	130.71	180	0.27	82	98.47	143
1991	0.13	323	449.20	1328	0.39	93	141.75	218	0.67	97	147.92	173
2001	0.11	437	578.31	1759	0.33	92	144.80	251	0.89	125	189	197
2011	0.08	565	690.84	2215.5	0.265	93	144.35	286	1	149	234	223

TABLE NO.8.12-B INFRASTUCTURE AVAILABILITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Telephones / Lakh Population(+)				Educational Inst / Lakh Population(+)				Hospital Beds / Lakh Population(+)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.19	67	132.00	415	0.52	91	121.16	149	0.14	48	58.36	122
1981	0.19	154	276.60	795	0.47	87	130.71	180	0.27	82	98.47	143
1991	0.13	323	449.20	1328	0.39	93	141.75	218	0.67	97	147.92	173
2001	0.25	437	767.75	1759	0.45	92	163.88	251	0.89	125	189	197
2011	0.35	565	1142.89	2215.5	0.55	93	199.21	286	1	149	223	223

TABLE NO.8.13-A ENVIRONMENTAL QUALITY INDICATORS S M R (contd)

YEAR	Density of Population (-)				% Forest Area (+)				Annual Deforestation rate (-)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.70	145.6	181.87	266.49	0.37	2.96	10.80	24.14	1.08	-24.28	-38.45	144.28
1981	0.65	148	209.25	323	0.41	0.64	9.57	22.41	0.69	-18.24	11.20	76
1991	0.62	160	247.02	389	0.46	0.7	10.31	21.6	0.29	-12.2	1.92	7.72
2001	0.58	165.6	285.43	448.67	0.50	-0.83	9.75	20.18	-0.11	-6.16	-66.29	-60.56
2011	0.54	172.8	329.00	509.93	0.55	-1.96	9.48	18.91	-0.50	-0.12	-193.42	-128.84

TABLE NO. 8.13-B ENVIRONMENTAL QUALITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Density of Population (-)				% Forest Area (+)				Annual Deforestation rate (-)			
	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.70	145.6	181.87	266.49	0.37	2.96	10.80	24.14	1.08	-24.28	-38.45	144.28
1981	0.65	148	209.25	323	0.41	0.64	9.57	22.41	0.69	-18.24	11.20	76
1991	0.62	160	247.02	389	0.46	0.7	10.31	21.6	0.29	-12.2	1.92	7.72
2001	0.58	165.6	285.43	448.67	0.50	-0.83	9.75	20.18	-0.11	-6.16	-66.29	-60.56
2011	0.65	172.8	290.79	509.93	0.65	-1.96	11.60	18.91	-0.50	-0.12	-193.42	-128.84

TABLE NO.8.10-A SOCIAL WELL-BEING INDICATORS S M R (contd)

YEAR	F Prt Rt (+)				UrbPop%(+)				UnEmp%(-)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.66	14.05	24.60	30.03	0.28	6.89	13.74	31.37	0.46	40.5	43.25	45.6
1981	0.76	18.99	32.18	36.35	0.3	6.54	15.09	35.03	0.46	27.86	29.56	31
1991	0.79	22.73	39.73	44.25	0.26	7.57	15.66	38.69	0.46	14.56	15.70	16.68
2001	0.87	27.27	47.92	51.10	0.26	7.68	16.69	42.35	0.46	1.7	1.96	2.17
2011	0.93	31.61	56.39	58.21	0.25	8.02	17.52	46.01	0.46	-11.27	-11.82	-12.29

TABLE NO.8.10-B SOCIAL WELL-BEING INDICATORS S M R : SCENARIO 1 (contd)

YEAR	F Prt Rt (+)				UrbPop%(+)				UnEmp%(-)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.66	14.05	24.60	30.03	0.28	6.89	13.74	31.37	0.46	40.5	43.25	45.6
1981	0.76	18.99	32.18	36.35	0.3	6.54	15.09	35.03	0.46	27.86	29.56	31
1991	0.79	22.73	39.73	44.25	0.26	7.57	15.66	38.69	0.46	14.56	15.70	16.68
2001	0.87	27.27	47.92	51.10	0.26	7.68	16.69	42.35	0.46	1.7	1.96	2.17
2011	0.93	31.61	56.34	58.21	0.25	8.02	17.52	46.01	0.9	0	0.00	0.00

TABLE NO.8.11-A ECONOMIC VITALITY INDICATORS S M R (contd)

YEAR	Tractors / 100H Sown (+)				Livestock / 100 Population (+)				Net Area Sown % of Total Area (+)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.09	0.005	0.05	0.49	0.55	41	53	63	0.50	27	46.84	66.3
1981	0.33	0.01	0.18	0.52	0.50	39	50	61	0.44	27.8	45.96	69.5
1991	0.51	0.01	0.40	0.77	0.59	41	57	68	0.50	21.5	45.08	68.3
2001	0.73	0.01	0.64	0.87	0.59	40	57	69	0.48	19.9	44.00	70.0
2011	0.94	0.02	0.95	1.01	0.61	40	59	72	0.48	17.2	43.03	71.0

TABLE NO.8.11-B ECONOMIC VITALITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Tractors / 100H Sown (+)				Livestock / 100 Population (+)				Net Area Sown % of Total Area (+)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.09	0.005	0.05	0.49	0.55	41	53	63	0.50	27	46.84	66.3
1981	0.33	0.01	0.18	0.52	0.50	39	50	61	0.44	27.8	45.96	69.5
1991	0.51	0.01	0.40	0.77	0.59	41	57	68	0.50	21.5	45.08	68.3
2001	0.73	0.01	0.64	0.87	0.60	40	58	69	0.55	19.9	47.49	70.0
2011	0.94	0.02	0.95	1.01	0.65	40	61	72	0.60	17.2	49.49	71.0

TABLE NO.8.12 -A INFRASTUCTURE AVAILABILITY INDICATORS S M R (contd)

YEAR	Electrified H S % (+)				Banks / lakh Population (+)				Irrig Area % Of Net Sown Area (+)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.45	23	43.88	69.41	0.62	4.7	6.62	7.8	0.35	3.37	11.10	25.46
1981	0.69	52	72.08	81.1	0.14	6	6.29	8.1	0.26	4.3	10.37	27.66
1991	1	81.3	100.00	100	0.52	6	7.61	9.1	0.57	2.3	17.98	29.8
2001	1	110	115.07	114	0.33	6.87	7.77	9.63	0.61	2.25	20.49	31.98
2011	2	140	123.90	129	0.28	7.52	8.28	10.28	0.72	1.72	25.18	34.15

TABLE NO.8.12 -B INFRASTUCTURE AVAILABILITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Electrified H S % (+)				Banks / lakh Population (+)				Irrig Area % Of Net Sown Area (+)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.45	23	43.88	69.41	0.62	4.7	6.62	7.8	0.35	3.37	11.10	25.46
1981	0.69	52	72.08	81.1	0.14	6	6.29	8.1	0.26	4.3	10.37	27.66
1991	1	81.3	100.00	100	0.52	6	7.61	9.1	0.57	2.3	17.98	29.8
2001	1	110	115.07	114	0.45	6.87	8.11	9.63	0.61	2.25	20.49	31.98
2011	1	140	129.39	129	0.55	7.52	9.04	10.28	0.72	1.72	25.18	34.15

TABLE NO.8.13-A ENVIRONMENTAL QUALITY INDICATORS S M R (contd)

YEAR	Employment in Min & Quarr (-)				Rainfall Per Capita (+)				Factory Workers / Lakh Pop (-)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.43	7.37	18.20	26.42	0.43	5.51	14.50	26.41	0.78	127	496.00	1787
1981	0.48	8.31	22.08	35	0.41	4.5	13.51	26.38	0.75	240	603.60	1693
1991	0.62	12.36	41.32	88.57	0.40	3.62	12.08	24.76	0.60	325	838.80	1599
2001	0.70	14.34	43.64	112.15	0.38	2.65	10.93	24.2	0.53	429	937.72	1505
2011	0.79	16.83	42.79	143.22	0.37	1.71	9.70	23.38	0.44	528	1025.38	1411

TABLE NO.8.13-B ENVIRONMENTAL QUALITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Employment in Min & Quarr (-)				Rainfall Per Capita (+)				Factory Workers / Lakh Pop (-)			
e	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor	St Scor	Min Scor	Actual Score	Max Scor
1971	0.43	7.37	18.20	26.42	0.43	5.51	14.50	26.41	0.78	127	496.00	1787
1981	0.48	8.31	22.08	35	0.41	4.5	13.51	26.38	0.75	240	603.60	1693
1991	0.62	12.36	41.32	88.57	0.40	3.62	12.08	24.76	0.60	325	838.80	1599
2001	0.70	14.34	43.64	112.15	0.38	2.65	10.93	24.2	0.55	429	913.02	1505
2011	0.85	16.83	35.79	143.22	0.40	1.71	10.38	23.38	0.65	528	836.83	1411

TABLE NO.8.10 -A SOCIAL WELL-BEING INDICATORS S M R (contd)

YEAR	HslessPop%(-)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.3	4.96	15.80	20.45	0.58	19.08	24.76	38.92
1981	0.72	2.83	5.52	12.45	0.66	17.26	22.32	34.85
1991	0.62	2.81	5.24	9.14	0.59	16.14	22.04	33.35
2001	0.86	1.38	1.57	2.70	0.62	14.55	20.57	30.14
2011	1.02	0.31	0.37	-2.95	0.62	13.08	19.33	27.36

TABLE NO.8.10 -B SOCIAL WELL-BEING INDICATORS S M R : SCENARIO 1 (contd)

YEAR	HslessPop%(-)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.3	4.96	15.80	20.45	0.58	19.08	24.76	38.92
1981	0.72	2.83	5.52	12.45	0.66	17.26	22.32	34.85
1991	0.62	2.81	5.24	9.14	0.59	16.14	22.04	33.35
2001	0.86	1.38	1.57	2.70	0.64	14.55	20.72	30.14
2011	0.90	0.31	0.38	1.00	0.75	15.29	21.57	28.12

TABLE NO.8.11 -A ECONOMIC VITALITY INDICATORS S M R (contd)

YEAR	Urban Population % (+)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.28	6.89	13.83	31.37	0.33	152.04	209.34	352.83
1981	0.30	6.54	15.01	35.03	0.37	242.62	310.72	414.00
1991	0.26	7.57	15.69	38.69	0.47	307.37	428.75	556.44
2001	0.26	7.68	16.62	42.35	0.53	389.33	539.06	644.70
2011	0.25	8.02	17.39	46.01	0.60	466.99	656.65	746.50

TABLE NO.8.11 -B ECONOMIC QUALITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Urban Population % (+)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.28	6.89	13.83	31.37	0.33	152.04	209.34	352.83
1981	0.30	6.54	15.01	35.03	0.37	242.62	310.72	414.00
1991	0.26	7.57	15.69	38.69	0.47	307.37	428.75	556.44
2001	0.26	7.68	16.62	42.35	0.54	389.33	545.37	644.70
2011	0.25	8.02	17.39	46.01	0.67	468.12	660.66	747.67

TABLE NO.8.12 -A INFRASTUCTURE AVAILABILITY INDICATORS S M R (contd)

YEAR	% Housing Shortage (-)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.3	4.96	15.80	20.45	0.39	28.68	45.89	90.25
1981	0.72	2.83	5.52	12.45	0.42	44.19	68.23	135.56
1991	0.61	2.81	5.28	9.14	0.52	68.44	98.28	202.36
2001	0.85	1.38	1.58	2.70	0.57	86.86	118.69	254.84
2011	1.01	0.31	0.34	-2.95	0.63	106.74	137.43	310.90

TABLE NO.8.12 -B INFRASTUCTURE AVAILABILITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	% Housing Shortage (-)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.3	4.96	15.80	20.45	0.39	28.68	45.89	90.25
1981	0.72	2.83	5.52	12.45	0.42	44.19	68.23	135.56
1991	0.61	2.81	5.28	9.14	0.52	68.44	98.28	202.36
2001	0.85	1.38	1.58	2.70	0.62	86.86	140.23	254.84
2011	1.00	0.31	0.31	-2.95	0.70	106.74	189.96	310.90

TABLE NO.8.13 -A ENVIRONMENTAL QUALITY INDICATORS S M R (contd)

YEAR	Motor Vehicles / Lakh Pop (-)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.43	371	683.00	921	0.58	67.42	143.89	332.19
1981	0.56	853	1340.00	1964	0.55	127.52	228.24	427.23
1991	0.54	1425	2793.00	4413	0.52	194.78	401.98	667.83
2001	0.62	1937	3445.83	5925	0.50	257.28	474.29	811.39
2011	0.68	2464	4149.16	7671	0.47	320.96	544.90	979.21

TABLE NO. 8.13-B ENVIRONMENTAL QUALITY INDICATORS S M R : SCENARIO 1 (contd)

YEAR	Motor Vehicles / Lakh Pop (-)				COL			
e	St Score	Min Score	Actual Score	Max Score	St Score	Min Score	Actual Score	Max Score
1971	0.43	371	683.00	921	0.58	67.42	143.89	332.19
1981	0.56	853	1340.00	1964	0.55	127.52	228.24	427.23
1991	0.54	1425	2793.00	4413	0.52	194.78	401.98	667.83
2001	0.65	1937	3332.68	5925	0.50	257.28	460.36	811.39
2011	0.75	2464	3765.67	7671	0.53	320.96	483.02	979.21

b) Economic Vitality: (refer table no. 8.11-A,B) The target value for this COL for the year 2011 fixed as per scenario 1 (0.67) as against (0.60) as predicted by extrapolation was achieved by adjusting the following indicators and SDIs -

i) Total Participation Rate: The SDI was pegged down to 1.0 (maximum possible) by restricting the indicator value to 40.24% (maximum predicted for 2011).

ii) Unemployment Rate: The SDI was raised to 1.00 from 0.46 (predicted) to give a minimum possible unemployment rate of 0%.

iii) Percentage of Food Crops: The raising of SDI from 0.39 to 0.50 means that the area under food crops will have to be reduced to 57% from 60% (predicted) by increasing the area under cash crops proportionately.

iv) Food Grain Yield: Average food grain yield will have to be raised to 2108 Kg. per Hect. from 2011 Kg. as predicted thus raising the SDI from 0. 78 to 0.80.

v) Livestock / 100 persons: The SDI can be raised from 0.61 to 0.65 by improving the number of livestock from 59 per hundred persons to a figure of 61 per hundred.

vi) Net Area Sown %: This will have to be raised to 49.5% from 43% (predicted) to raise the SDI from 0.48 to 0.60.

c) Infrastructure Availability: (refer table no. 8.12-A,B) This COL was increased from 0.63 (predicted) to 0.70 (targeted) by modifying the SDIs and indicators as below -

i) Road Kms. Per 100 S. Kms.: Raising the SDI from 0.14 to 0.55 is possible by raising the road Kms. Per hundred Sq. Kms from 97 (predicted value) to 113.

ii) Railway Kms. / lakh Persons: The raising of the SDI from 0.61 to 0.65 would require the raising of this indicator from 2.93 Kms. to 3.11 Kms. per lakh persons.

iii) Post Offices / Lakh persons: This SDI can be raised from 0.48 to 0.60 by increasing the number of post offices per lakh person from 43 to 55.

Iv) Telephones / Lakh persons: The raising of this SDI from 0.08 to 0.35 implies increasing the number of telephones from 691 per lakh persons to 1143 .

v) Educational Institutions / L. P.: To raise the SDI from 0.27 to 0.55 requires increasing the number of educational institutions from 144 to 199 per lakh persons.

vi) Banks / L. P.: The SDI can be raised from 0.28 to 0.55 by increasing the number of banks per lakh persons from 8.28 to 9.04.

d) Environmental Quality: (refer table no. 8.13-A,B) This COL was raised from 0.47 to 0.53 in scenario 1 with the help of changing SDIs and indicators as follows -

i) Net Area Sown %: has to be reduced from 43% (predicted) to 38% to raise the SDI from 0.52 to 0.60. This requirement is in direct contrast to the economic vitality requirement to raise the percentage of area sown to 49.5% . Such conflicting requirements will have to be resolved through group decision making as detailed out later.

ii) Density of Population: This has to be reduced from the predicted value of 329 persons per S. Kms. to 291 to improve the SDI from 0.54 to 0.65. This has to be achieved by reduction in the rate of population growth.

iii) Forest Area %: Percentage of land under forests which is predicted to go down to 9.48% in 2011 has to be pegged at-least at 11.6% so as to keep the SDI at 0.65 and not 0.55 as per trend.

iv) Employment in Mining and Quarrying: The number of persons employed in mining and quarrying has to be reduced from a projected figure of 43 per 100 S. Kms. to 36 in order to raise the SDI from 0.79 to 0.85.

v) Rainfall per Capita: The present value of this indicator is 12.08 (1991), which predicted to go down to 9,70 by 2011. This has to be kept at 10.39 (target value) to improve the SDI from 0.37 to 0.40. This requires a policy of restriction of population growth rate.

vi) Factory Workers / Lakh persons: The number of factory workers per lakh persons has to be restricted to 837 and not allowed to grow to 1025 so as to raise

this SDI from 0.44 to 0.65. This may be achieved by a structural adjustment of increasing the percentage of employment in the commercial sector.

vii) Motor-vehicles / Lakh persons: Reduction in this indicator from 4149 (predicted) to 3768 will help in raising this SDI from 0.68 to 0.75.

8.4 Resolution of Conflict:

It may be observed from the above that certain indicators and SDIs are in conflict with each other. This is to be expected since the same indicators have a positive effect in one COL and a negative in another one. For example percentage of urban population is a positive indicator in Social Well-Being and Economic Vitality but a negative one in Environmental Quality. Similarly the percentage of area sown is economically a positive indicator but environmentally a negative one. Resolution of such conflicting requirements can be attempted through group decision making theory. Techniques such as DELPHI and NGT (Nominal Group Technique) may be used effectively along with Multi-Criteria Evaluation (MCA) or Multi-Attribute Utility Theory (MAUT) to quantify the value judgements. This matter will not be elaborated here as it falls outside the scope set out for this thesis.

Once decisions have been reached on the values to be accepted for individual indicators and SDIs, then this can be taken as the beginning of scenario 2 which can be built up bottom upwards from SDIs to COLs and finally on to the CADIS.

8.5 Feed-back to Sectoral Policy and Programme making (SPP):

Assuming that consensus has been reached on the finally accepted scenario, this will provide a feed-back to the SPP.

a) Social Well-being: In order to bring down the infant mortality, death rate and the birth rate, special health and family welfare programmes aimed at specific age groups programmes will have to be launched. These would include not only

infrastructure in the form of hospitals, dispensaries and medicines but also trained medical and para-medical personnel to be positioned at requisite places in the region. The improvement in literacy and difference in male-female literacy require educational institutions, teachers and mass awareness programmes to be promoted in a co-ordinated manner. The reduction in percentage of unemployment needs programmes for encouragement of non-agricultural employment opportunities especially in the rural areas. The housing shortage can be eliminated by promoting house construction and financing institutions along with encouragement of the use of local as well as waste material in the house construction.

b) Economic Vitality: Improvement of the participation rate and unemployment rate requires policies aimed at increasing the employment opportunities as well as the education and training facilities of workers. The reduction of area under food crops and increased food grain yield needs development of irrigation facilities to ensure a uninterrupted water supply, increase in the storage and marketing facilities and improved agricultural productivity through increased use of modern farm machinery and fertilisers. The increase in the number of live-stock requires improved policies and programmes in the animal husbandry and dairy sectors.

c) Infrastructure Availability: Policies and programmes aimed at improving the availability of infrastructure in all the fields mentioned are required as these not only constitute an important component of liveability but also affect the other parameters of the quality of life.

d) Environmental Quality: Reduction in the net area sown requires increased agricultural productivity through policies and programmes already mentioned above. Holding down the population density requires population control measures already mentioned under Social Well-Being. Increase in the forest areas needs attention to afforestation programmes and preventive measures to avoid deforestation. Community based programmes have of late proved to be effective in this. The

reduction of air, water and land pollution all require special attention to monitoring and prevention of these especially in the urban areas.

8.6 Summary:

In this chapter we have completed the application of the computer based DSS to the SMR by going through the last two stages of identifying Critical Success or failure Factors for sustainable development of the region and then building up scenario 1 through adjustment of CADIS, COLs and SDIs. The financial, physical and spatial implications of these adjustments were studied, thus giving a starting point for building up scenario 2, after decisions on value judgements through group decision making.

Chapter 9

Conclusions and Recommendations

9.1 Contributions of thesis:

This thesis has dealt with the subject of operationalising the concept of Sustainable Regional Development by developing a computer based Decision Support System (DSS). The functioning of the DSS has been demonstrated by applying the same to the task of Sustainable Development of Southern Maharashtra Region. The main contributions of this thesis are -

9.1.1 Theoretical contributions:

a) This thesis has established a need for the adoption of an ethic of ***trusteeship*** or an ethic of care, respect and responsibility towards the environment as a necessary basis for operationalising the concept of Sustainable Regional Development.

b) After tracing the history of eco-developmental thought it has set out the concept of sustainable regional development in the perspective of global and national trends and spelt out the role of the government in planning for sustainable development.

c) It has examined several theories in regional planning, the changing scenario at the district administration level and the role which information technology can play in enabling the adoption of sustainable development policies at the district and regional levels through a net-work of GIS centres established all over the nation.

d) The dimensions of man - environment interactions and some possible alternative approaches to the study of these have been looked into. The limits of the sustainability concept, the constraints on development and the

approach to sustainable development adopted in this thesis have been set out. A conceptual model of sustainable regional development has been postulated along with its sub-systems and their respective elements. Possible frameworks for the development of Sustainable Development Indicators were examined and the combination type of framework was selected for this study. The qualities required in these elements or indicators were specified and the indicators for this study were selected in view of these.

e) Theoretical development of a computer based interactive-iterative-predictive-corrective Decision Support System for Sustainable Regional Development was accomplished. The selection of appropriate indicators of sustainable development, their conversion into Sustainable Development Indices (SDIs) through standardisation, the methodology for aggregation of SDIs into Components of Liveability (COLs) and Composite Aggregated Development Index of Sustainability (CADIS) were elaborated. The details of the working of the various stages of the DSS were explained.

9.1.2 Experimental Contributions:

The DSS postulated in this thesis was applied to the Southern Maharashtra Region for operationalising the concept of sustainable regional development as indicated in the following -

i) The back-ground and present conditions in the region were examined under four sets of Components of Liveability (COLs), each consisting of ten sustainable development indicators with a view to identifying the problems and prospects or the existing sectoral policies and programmes in the region. These indicators were converted into Sustainable Development

Indices (SDIs), and analysed through Spatio-temporal comparison, and aggregation into COLs and CADIS.

ii) Certain Critical Success or failure Factors (CSFs) essential for the successful implementation of sustainable development policies in the region were identified. Scenario building or 'What-If' study was demonstrated for SMR through the interactive-iterative-predictive-corrective process of the DSS. The financial, physical and spatial (distributive) implications of this scenario were studied through the use of a spread-sheet and a GIS software. The possibility of resolving conflicting value judgements through group decision making techniques was indicated. Feed-back for adjustment of sectoral policies and programmes was obtained.

9.2 Efficacy of the Decision Support System:

The use of the proposed DSS has been effectively demonstrated in the case of the Southern Maharashtra Region. The DSS possesses the following advantages -

i) Unlike the traditional master plan or regional plan approaches to town and country planning, the DSS is process oriented and not product oriented. This makes it dynamic and responsive to changing ground situations, so that it can be used over and over again in a live context, its frequency of use being limited only by the frequency of the data input.

ii) The DSS possesses very good adaptability. It can be applied to various types of regions ranging from village, city, district, region, state up to the nation the only condition being that data for lower and higher levels of regions besides the one under consideration has to be available.

iii) The DSS can be applied to as many geographical units as one may like, that is, the number of regions being compared to each other is theoretically unlimited.

iv) The indicators, SDIs, COLs may be changed in quantity or quality to suit local conditions without affecting the efficiency of the DSS.

v) Though numerical or quantitative data has been used in this demonstration, the DSS is also amenable to use of qualitative or mixed data. However, an additional step of conversion of such data to ordinal or ratio scale will be a necessary preparation.

vi) The DSS can be made more physical planning oriented than has been attempted in this thesis by emphasising the use of GIS provided ofcourse that detailed spatial data is available either in hard copy form or in the form of satellite imagery.

vii) The DSS can be used in conjunction with target and threshold values fixed exogenously.

9.3 Limitations of the DSS:

i) The performance of the DSS is data dependant. The better the quantity, quality and frequency of the available data, the better will be the results obtained. But presently such data especially in comparable format is not available in sufficient quantity and frequency at various levels (nation, state, district, taluka and village). The establishment of a network of GIS centres (DISNIC) in the near future will go a long way in solving this difficulty.

ii) The DSS is technology dependent to a certain extent, that is, it requires the availability of a personal computer (preferably an Intel chip based one) with spread-sheet and GIS soft-wares.

iii) The DSS requires a computer analyst and a planner or the same person doubling as both to operate it, that is, it is not very simple and will require specially trained man-power to understand and operate it and to interpret its output.

9.4 Suggestions for further research:

i) The validity of the DSS needs to be tested in different situations and at various levels, that is at village, city, district, state and national levels.

ii) The use of qualitative data could be tried out in the DSS.

iii) The present study has used administrative regions in the DSS. The use of physio-climatic regions may be tried instead.

iv) The under-lying correlation between the various SDIs and COLs may be probed to find out the causal relationships among them.

v) The use of continuous data instead of discrete data as has been used in the present study may be tried in the DSS.

vi) The use of neural network theory and / or fuzzy logic theory in the DSS may be examined.

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Appendixes

Appendix A-1: Proforma for Value Judgement on Directionality of SDIs

Sustainable Development of Southern Maharashtra:
A PC based Decision Support System

A Ph.D. research by Shri. M.V.Telang

Expert Opinion Poll on Sustainability Indicators

Please give your opinion whether the following indicators contribute positively or negatively to Sustainable Development

Social Well-being

1 Pop Growth Rate ( )
2 Infant Mortality Rt. ( )
3 Death Rt. ( )
4 Birth Rt. ( )
5 Total Literacy % ( )
6 Diff in M-F Lit % ( )
7 Female Part.Rate ( )
8 Urban Pop % ( )
9 UnEmp % ( )
10 Houseless Pop % ( )

Infrastructure Availability

1 Rd Kms / 100 SKms ( )
2 Rly Kms / L pop ( )
3 P.O. / L Pop ( )
4 Tel / L pop ( )
5 Ed Inst / L pop ( )
6 Hosp. beds / L pop ( )
7 Electrified H.S. % ( )
8 Banks / L pop ( )
9 Irrigated Area % ( )
10 Houseless Pop % ( )

Economic Vitality

1 Total Part. Rt. ( )
2 Non Agri Emp % ( )
3 UnEmp % ( )
4 Food Crops % ( )
5 FoodGrainsYld / H( )
6 Per Cap Income (+)
7 Tractors / 100 H ( )
8 Livestock / H pop ( )
9 Net Area Sown % ( )
10 Urban Pop % ( )

Environmental Quality

1 Urban Pop % ( )
2 Barren Land % ( )
3 Sown Area % ( )
4 Population Density( )
5 Forest Land % ( )
6 Deforestation Rt. ( )
7 Emp in M&Q ( )
8 Rainfall / Capita ( )
9 Fact.Work./L Pop ( )
10 Autos / L Pop ( )

Remarks if any:

Name of the Expert:

Signature & date:

Appendix A-2: Aggregation of Value Judgements on SD Indicators

Sustainable Development of Southern Maharashtra:
A PC based Decision Support System
A Ph.D. research by Shri. M.V.Telang

Aggregation of Expert Opinion Poll on Sustainability Indicators						
	EXP 1	EXP 2	EXP 3	EXP 4	EXP 5	AVERAGE
Social Well-being						
1 Pop Growth Rate	(-)	(-)	(-)	(-)	(-)	(-)
2 Infant Mortality Rt.	(+)	(-)	(-)	(-)	(-)	(-)
3 Death Rt.	(-)	(-)	(-)	(-)	(-)	(-)
4 Birth Rt.	(-)	(-)	(-)	(-)	(-)	(-)
5 Total Literacy %	(+)	(-)	(+)	(+)	(+)	(+)
6 Diff in M-F Lit %	(-)	(-)	(-)	(-)	(-)	(-)
7 Female Part.Rate	(+)	(+)	(+)	(+)	(-)	(+)
8 Urban Pop %	(-)	(-)	(+)	(+)	(+)	(+)
9 UnEmp %	(-)	(-)	(-)	(-)	(-)	(-)
10 Houseless Pop %	(-)	(-)	(-)	(-)	(-)	(-)
Infrastructure Availability						
1 Rd Kms / 100 SKms	(+)	(+)	(+)	(+)	(+)	(+)
2 Rly Kms / L pop	(+)	(+)	(+)	(+)	(+)	(+)
3 P.O. / L Pop	(+)	(+)	(+)	(+)	(+)	(+)
4 Tel / L pop	(+)	(+)	(+)	(+)	(+)	(+)
5 Ed Inst / L pop	(+)	(+)	(+)	(+)	(+)	(+)
6 Hosp. beds / L pop	(+)	(+)	(+)	(+)	(+)	(+)
7 Electrified H.S. %	(+)	(+)	(+)	(+)	(+)	(+)
8 Banks / L pop	(+)	(+)	(+)	(+)	(+)	(+)
9 Irrigated Area %	(+)	(+)	(+)	(+)	(+)	(+)
10 Houseless Pop %	(-)	(-)	(-)	(-)	(-)	(-)
Economic Vitality						
1 Total Part. Rt.	(+)	(+)	(+)	(+)	(+)	(+)
2 Non Agri Emp %	(+)	(+)	(+)	(+)	(+)	(+)
3 UnEmp %	(-)	(-)	(-)	(-)	(-)	(-)
4 Food Crops %	(+)	(+)	(-)	(-)	(-)	(-)
5 FoodGrainsYld / H	(+)	(+)	(+)	(+)	(+)	(+)
6 Per Cap Income	(+)	(+)	(+)	(+)	(+)	(+)
7 Tractors / 100 H	(+)	(+)	(+)	(+)	(+)	(+)
8 Livestock / H pop	(+)	(+)	(+)	(+)	(+)	(+)
9 Net Area Sown %	(+)	(+)	(+)	(+)	(+)	(+)
10 Urban Pop %	(+)	(-)	(+)	(+)	(+)	(+)
Environmental Quality						
1 Urban Pop %	(-)	(-)	(-)	(-)	(-)	(-)
2 Barren Land %	(-)	(+)	(-)	(+)	(+)	(+)
3 Sown Area %	(-)	(+)	(+)	(-)	(-)	(-)
4 Population Density	(-)	(-)	(-)	(-)	(-)	(-)
5 Forest Land %	(+)	(+)	(+)	(+)	(+)	(+)
6 Deforestation Rt.	(-)	(-)	(-)	(-)	(-)	(-)
7 Emp in M&Q	(-)	(+)	(+)	(-)	(-)	(-)
8 Rainfall / Capita	(+)	(+)	(+)	(+)	(+)	(+)
9 Fact.Work./L Pop	(-)	(+)	(-)	(-)	(-)	(-)
10 Autos / L Pop	(-)	(-)	(-)	(-)	(-)	(-)

Appendix B-1: Correlation between SDIs - SMR

	INDICATORS OF SOCIAL WELLBEING SMR									
	PopGrthR(	InfMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	DifM-FLit%	F Prt Rt (+	UrbPop%(	UnEmp%(-	HslessPop
1971	2.07	48	9.88	25.8	37.74	26.93	24.64	13.83	43.24	45.88
1981	1.4	34.5	8.28	24.68	47.18	24.69	32.15	15.01	29.56	5.62
1991	1.58	20	7.03	23.44	66.95	24.76	39.66	15.69	15.88	5.24

	CORRELATION COEFFICENT MATRIX SOCIAL WELLBEING SMR									
	PopGrthR(	InfMrtRt(-)	DeathRt(-)	BirthRt(-)	T Lit % (+)	DifM-FLit%	F Prt Rt (+	UrbPop%(	UnEmp%(-	HslessPop
PopGrthRt	1	0.801829	0.754846	0.885498	-0.55072	0.972497	-0.70057	-0.80674	0.700587	0.903585
InfMrtRt(-)		1	0.995026	0.990902	-0.9837	0.840982	-0.99979	-0.9848	0.999787	0.859718
DeathRt(-)			1	0.994991	-0.98318	0.886856	-0.9975	-0.99654	0.997496	0.902749
BirthRt(-)				1	-0.98523	0.836225	-0.99957	-0.98324	0.999569	0.855225
T Lit % (+)					1	-0.72999	0.979786	0.937513	-0.97979	-0.75386
DifM-FLit%(-)						1	-0.85196	-0.92218	0.851957	0.999366
F Prt Rt (+)							1	0.98817	-1	-0.87006
UrbPop%(+)								1	-0.98817	-0.93537
UnEmp%(-)									1	0.870064
HslessPop%(-)										1

	INDICATORS OF ECONOMIC VITALITY SMR									
	T Prt Rt(+)	NAgrlEmp	UnEmp%(-	FdCrps%(-	FdGmYld(	PCIncm(+)	Trcts/100H	Llvstk/HPo	NtArSwn%	UrbPop%(
1971	31.41	26.84	43.24	72.9	755.2	1252	0.05	53	46.84	13.83
1981	34.52	28.7	29.56	63.76	1043.6	1796	0.18	50	45.96	15.01
1991	37.63	30.56	15.88	67.26	1332	2686	0.4	57	45.08	15.69

	CORRELATION COEFFICIENT MATRIX ECONOMIC VITALITY SMR									
	T Prt Rt(+)	NAgrlEmp	UnEmp%(-	FdCrps%(-	FdGmYld(	PCIncm(+)	Trcts/100H	Llvstk/HPo	NtArSwn%	UrbPop%(
T Prt Rt(+)	1	1	-1	0.61151	1	0.990436	0.989158	0.569495	-1	0.98817
NAgrlEmp%(+)		1	-1	-0.61151	1	0.990436	0.989158	0.569495	-1	0.98817
UnEmp%(-)			1	0.611506	-1	-0.99044	-0.98916	-0.56949	1	-0.98817
FdCrps%(-)				1	-0.61151	-0.49649	-0.48868	0.302146	0.611506	-0.72562
FdGmYld(+)					1	0.990436	0.989158	0.569495	-1	0.98817
PCIncm(+)						1	0.99996	0.677461	-0.99044	0.957558
Trcts/100H(+)							1	0.684032	-0.98916	0.954934
Llvstk/HPop(+)								1	-0.56949	0.436692
NtArSwn%(+)									1	-0.98817
UrbPop%(+)										1

Appendix B-2: Correlation between SDIs - SMR

	INDICATORS OF INFRASTRUCTURE AVAILABILITY SMR									
	Rd Kms/1(	RlyKms/L	P O /L Pop	Tel / Lpop	EdInst/Lpc	Hbeds/Lpc	El HS % (+	Bnks/Lpop	IrrAr%(+)	HslsPop%(-)
1971	220	1.9	25.6	132	121	58	44.22	6.6	11.05	15.88
1981	216	3.4	34	277	131	98	6.9	6.0	10.3	5.62
1991	374	4.8	36	449	142	18	100	7.6	17.1	5.24

CORRELATION COEFFICIENT MATRIX INFRASTRUCTURE AVAILABILITY SMR										
	Rd Kms/1(	RlyKms/L	P O /L Pop	Tel / Lpop	EdInst/Lpc	Hbeds/Lpc	El HS % (+	Bnks/Lpop	IrrAr%(+)	HslsPop%(-)
Rd Kms/1(	1	0.82972	0.535809	0.857055	0.844747	-0.89763	0.942363	0.952373	0.999333	-0.467525
RlyKms/Lpop (+)		1	0.915865	0.998704	0.999622	-0.49876	0.595135	0.252822	0.837672	-0.881334
P O /L Pop (+)			1	0.894243	0.904485	-0.10881	0.222418	0.252822	0.504625	-0.996883
Tel / Lpop (+)				1	0.999725	-0.54223	0.635267	0.659126	0.837672	-0.856143
EdInst/Lpop (+)					1	-0.52239	0.616996	0.641323	0.824645	-0.868016
Hbeds/Lpop (+)						1	-0.99336	-0.90928	-0.91312	0.030044
El HS % (+)							1	0.99951	0.953951	-0.144806
Bnks/Lpop (+)								1	0.962871	-0.175701
IrrAr%(+)									1	-0.434939
HslsPop%(-)										1

	INDICATORS OF ENVIRONMENTAL QUALITY SMR									
	UrbPop%(	BrnLnd%(	SwnAr%(-)	PopDen(-)	FrstLnd%(	DfrstRt(-)	EmpM&Q(	RnfPC(+)	FWrk/LPo	Autos/Lpop
1971	13.83	12.47	46.84	182.31	10.81		18.2	14.52	496	683
1981	15.01	12.16	45.96	209.2	9.6	1.12	2.08	13.51	603.6	1340
1991	15.69	14.48	45.08	245.8	10.22	-0.65	41.31	12.08	838.8	2793

CORRELATION COEFFICIENT MATRIX ENVIRONMENTAL QUALITY SMR										
	UrbPop%(	BrnLnd%(	SwnAr%(-)	PopDen(-)	FrstLnd%(	DfrstRt(-)	EmpM&Q(	RnfPC(+)	FWrk/LPo	Autos/Lpop
UrbPop%(	1	0.696028	-0.98817	0.97085	-0.61569		0.454791	-0.96816	0.933888	0.932894
BrnLnd%(+)		1	-0.79791	0.847838	0.137253		0.95601	-0.85361	0.906749	0.9079141
SwnAr%(-)			1	-0.99612	0.487553		-0.586	0.995098	-0.97768	-0.9770922
PopDen(-)				1	-0.40087		0.654998	-0.99994	0.992369	0.9920238
FrstLnd%(+)					1		0.421774	0.398821	-0.29323	-0.2905758
DfrstRt(-)						1				
EmpM&Q(-)							1	-0.66320	0.743171	0.7450215
RnfPC(+)								1	-0.99366	-0.9933486
FWrk/LPop(-)									1	0.999996
Autos/Lpop(-)										1