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USING SCIENCE FOR DEVELOPMENT

A Possible approach for H.P.

G.M. MODI Award Lecture

by

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SYNOPSIS

Applications of Science and Technology for socio-economic development call for special care to avoid harmful effects on people and the environment. The essential parameters for Sciegce to subserve human needs are summarized. A brief review of the development of Himachal Pradesh shows that inspite of some progress of quality of life of the malority of people remains very low. A reorientation of the planning process to focns on meeting the needs of the poorest with selective application of Science and Technology can help in releasing the energies of the people and result rapid improvement in their lives. The State needs to strengthen its research base. This can be accelerated by using some of the existing national institutions and programmes.

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1. Introduction :

With the increase in population and diminishing natural resources the modern world has increasingly come to rely on Science & Technology to provide the necessities of civilized life. Developing countries like India have special socio-economic problems in overcoming the legacy of the colonial past, and also in assimilating the spirit and methodology of scientific research and technological innovation. The experience of the last 40 years has shown that inspite of sizeable public investments to establish a Science & Technology base in the country the bulk of the people remain poor and the fruits of science do not reach them. Nearly half of our population remains below the poverty line and millions have to struggle for survival. The fact is that the application of Science and Technology to socio-economic development is very strongly conditioned by complex national socio-political structures as well as international geo-political factors, which since world war II, have resulted in diversion of scarce economic resources into armaments and military establishments. It is also increasingly apparent that there are inherent dangers in the large scale application of new technologies without very careful prior planning and assessments. The technologies usually originate in the advanced countries as a result of solutions being sought to specific problems in their context. Thus new technologies often carry with them dangerous ramifications and hidden potentials for misuse. Nuclear Energy, Space Technoiogy, Automation and Computers, the Microchip and Information revolutions as well as the fast emerging Bio-technology all are subject to this quality of roles. The dangers are indeed greater when the new technologies are borrowed from abroad and applied in a poor developing country. The example of the Green Revolution in agriculture is typical. India probably would not have found it easy to attain near self-sufficiency in food grains without the application of chemical fertilizers and pesticides. However we now know that the new technology has resulted in widespread chemical pollution of land, rivers, lakes, etc., and is now threatening the food chain itself. Similarly large scale hydro-electric and irrigation projects based on big dams and extensive irrigation once thought to be a panacea, are proving to be extremely costly environmental disasters causing fertile soil to become saline, deforestation and often displacing thousands of people whose living standards get lowered rather than improve. The investments made in the industrial sector have no doubt somewhat strengthened the economy but technology is still repeatedly imported and the consumer products and market remain oriented towards the affluent. The message therefore is that while science and technology can be powerful tools for development they need to be grown and handled and applied with care to better the lives of people as a whole, and not merely used for enhancing market profits or to serve a small elite section of society.

2. Structure of Science & Technology and Development

Clearly, if Science and Technology have to sub-serve social goals certain criteria have to be satisfied. These can be summarized as follows :

(i) A high quality, viable and self-reliant base of Science & Technology must exist within the country or State.

(ii) A continuing system for accurate and timely assessment of the natural resources must be operating and used effectively. This can be accomplished at lower cost if advanced technologies like Remote Sensing and digital information processing are pressed into service.

(iii) Formulation and execution of development plans must address the real needs of the majority of the population. The plans must emerge from an extensive and decentralized discussion process and not arbitrarily decided by Government bureaucrats ane experts-however well meaning.

(iv) There must exist the political will among the leadership to remain close to the people listening to them and carrying them along in executing the complex tasks and in overcoming the many obstacles and problems which are bound to arise.

Civilized life for the average person implies availability of food and medical care, clothing and shelter and most important of all a sense of cultural expression and identity which demand a minimum level of education and the opportunity for gainful employment. The development strategy must therefore keep these as the central theme. The last 40 years have seen many examples of large scale projects which have turned out to be counter productive. The majority of them were based on imported technology and equipment not necessarily tuned to the conditions of the pootest in India. Indeed these imported introduction of S&T have often proved to be a disincentive to Indian Scientists and Engineers. Many of these projects have entailed large sums of money, time delays and cost over-runs and are proving environmentally disastrous. Essentially such projects are contractor based and run administratively in a fashion designed for waste and corruption—with no involvement of the people who are supposed to benefit.

In establishing a development strategy based on Science it is wise to recognise that S&T in the long run cannot exist and be applied effectively without the existance of an *Active and living research.* The Research System in a State has to perform several vital functions :

* it directly generates the knowledge on which applications are based and also utilises what has been done elsewhere.
* It renews the S&T base and infrastructure needed for efficient functioning of the economy—esta-

blishes standards, test and analysis facilities, health and environmental regulations.

* It provides the basis for training the innovators as well as those who would exploit the results.

* In the long term, fundamental research renews the knowledge which generates future innovations and is an essential part for the development of values and culture,

Economic development and progress *cannot* be realized without technical progress and this cannot be sustained without research. The education and training functions are central to the continuity of progress.

3. The case of Himachal Pradesh

My knowledge of Himachal Pradesh—its economy and state of development is rather sketchy and wholly second hand. It is therefore beyond the scope of this lecture to present a comprehensive and integrated plan of development for the State. What I have attempted is to sketch an approach which is illustrated by a few important features. If these remarks provoke some thought among the decision makers and scientists in the State my objective would bave been served.

Endowed with snowy mountains, extensive forests with abundant wild life, green pastures and five major river systems the State has a rich heritage of art, culture and handicrafts and an industrious and gentle people. The task is to transform an erstwhile feudal backward region into a modern reasonably advanced democratic State which can provide a civilized life for *all* its citizens.

The State's development in the last 20 years can be obtained by looking at a few selected indicators such as :

* Food
* Health

* Education
* Amenities
* Energy and Roads

It would appear that Himachal Pradesh has made reasonable progress since 1971, Fig. 1 is a summary: (Ref. 1)

* Food grain production has increased until the State is now nearly self sufficient.
* Health services and schools have grown significantly.
* Most villages have electricity and drinking water.
* Hydel projects have increased energy production by a factor of nearly 3.
* A network of roads now covers virtually all parts of the State.
* Industrial expansion has aiso taken place with nearly a 100 large factories and nearly 2000 small scale ones.

However, if we look at some need based indicators which really determine the quality of life of the mass of people we get a somewhat different picture :

* Literacy is around 40%—for women it is much lower.
* In a labour force of about 2 million nearly 2/3rd are marginally employed or un-employed.
* Per capita annual income is about Rs. 2,900-even this figure, low as it is, gives a distorted picture, as the marginally employed, unemployed and landless labour earn much less.
* On the basis of the grain and other food products produced in the State the availability of food per capita per day should be 700 gms., wheat equivalent which represents about 2800 calories. If this

were really true for every person it would be quite reasonable. Actually the purchasing power and distribution system is such that a large part of the population get less than 2000 calories per day.

* 40% of the population are children below 14 years.

* 11% of the population are above 60 years.
—it is well known that the very young and the old need special health care—which the State is not well equipped for.

* In the State of about 4.5 million people less than 5000 pay income-tax and the total revenue from this is less than Rs. 1 Crore.

* The Annual Public Expenditure of about Rs. 600 Cr/year is distributed :

  1/3rd ~ Government Administration

  1/3rd ~ Economic Services [Ag., Forest, Irrign. and energy]

  1/3rd ~ Social services [Education, Health, Welfare]

  —virtually non on Research, Science and Technology !

* Out of about 10 lakhs students at all levels only 2% are in colleges.

* The State's assessed Hydel potential is around 12000 MW—of this about 20% has been realised mainly through the Sutlej and Beas Schemes which send power out of the State.

  The State itself has developed only 1%

* The Electricity consumption pattern is also significant.

TOTAL ELECTRICAL ENERGY-GENERATED & BOUGHT 1120 Million Units

12%	Domestic	7 Lakh consumers 0.62 units/person/day
46%	INDUSTRY Commercial	83,000 consumers 21 units/person/day
2%	Agriculture	285 consumers 21 units/person/day
18%	sold out of State	

Actually the domestic users of electricity are practically all in Cities and Towns. The rural population almost entirely depends for their needs of energy for cooking on low grade fuel i.e. wood and agricultural waste which roughly give 400 million units annually. Here you see a typical situation. By not being able to use electricity and efficient means for cooking and heating the rural population's use of wood and agricultural waste adds to the pressure on the forests and deprives agriculture from using cowdung and agricultural wastes as natural fertilizers. This is an area where Science and Technology can help. Improved designs of smokeless woodstoves with high efficiency could help reduce the pressure on forests. The biogas plants of which there are 3000 in the State need research if they are to function efficiently at the low temperatures of the winter months. Another source of pressure on forests is the packing of the very sizeable apple crop in wood crates. It has been estimated that for 1 hectare under apples and other fruits about 10 hectares of forest is removed. In the mid 50's about 35% of the State's area was under forest. By the mid 70's it had come down to 25% and in another 10 years it was only 16%—it is even less now !

The picture I have painted of H.P. is not basically different for most of the other States—especially the backward ones. You do not see science being pressed into service for improving the lives of the people.

4. An approach to H.P.'s development—some suggestions.

As indicated earlier mere investments in various sectors of the economy and introduction of new technologies do not by themselves lead to an improvement in the quality of life of the bulk of the population. In fact they tend to accentuate the differences between the rich and the poor, degrade the environment and prove to be very costly. It is therefore reasonable to suggest a re-examination of the conventional models and strategies adopted for development. The conventional approach seeks to maximize economic growth and it is assumed that the benefits of economic growth would some-how trickle down to the poor and alleviate their condition. But actual experience in most of the developing countries including India, has shown that this does not happen. The only effective way to deal with poverty is to generate specific programmes to satisfy the actual human needs of the poorest and to directly allocate resources for this and take the help of S&T to solve specific problems or modify known systems to serve the needs. Only then can it be ensured that minimum standards for nutrition, shelter, clothing, health and education are met. As an added bonus a "meeting the basic needs" policy can be expected to significantly improve the workers productivity, generate confidence and enthusiasm, "releasing the peoples' energy" and hence promote faster growth. On the theoretical plane the problem has received some attention nationally as well as internationally. In the specific area of energy policy and planning Prof. A.K.N. Reddy of the Indian Institute of Science and his colleagues from Brazil, Sweden and the USA have developed an analysis which seeks to match the energy requirements to basic needs (Ref. 1) in a sustainable manner. They have developed a correlation between per capita energy use and a Physical Quality ot Life Index which varies from 0 to 100. An important finding is that the 'Physical Quality of Index' strongly correlates with three very basic measures of well being i.e.

* Infant mortality rate
* life expectancy
* literacy

In terms of energy the typical value of per capita energy use by industrialized (developed) countries is found to be between 1 KW hr and 1.2 KW hr for a quality of life index of nearly 90. It is found that in terms of basic needs, greater energy use than this value does not result in very significant improvements in the quality of life. This provides a guide and target for planning energy increases. Actually the analysis shows that the per capita energy required to meet basic needs roughly at the level of the European industrialized countries 20 to 30 years ago would be in the range roughly between 0.6 to 1.0 KW hr per capita per day. What this implies is that Himachal Pradesh which has currently a total per capita energy consumption (commercial plus non-commercial) of about 0.32 KW hr (all India figure is about 0.54) and a quality of Life Index of about 20, could in principle, attain a very much improved standard of living for all its citizens by achieving say 0.75 KW hr per capita in the next 5 to 10 years, provided of course the dtstribution is channelled into activities which satisfy basic needs. The important point is not just the increased availability of energy per person but the way it is channelled and utilized. Clearly if the "basic needs" approach is taken the present skewed pattern of energy consumption would change dramatically and the rural and small scale sector would see a shift from inefficient to efficient devices and from non-commercial energy to electricity, It is important to emphasize that it is not merely a question of greater allocation of energy inputs to the rural sector-these must be planned in a participative manner to be utilized efficiently for basic human needs. And it is here that Science and Technology inputs can play a very positive role. As an example typically the process could begin by developing new designs of the wood and agricultural waste burning stoves used in the village homes. Crude hand tools could be replaced by power tools, which incidentaliy could easily be developed and produced by small scale industry in the State. Actually this approach has been attempted by several scientists in India. Some of my colleagues at the Indian Institute of Science have developed high efficiency wood stoves with efficiencies as high as 40% and which save fuel by 40%. This work was initiated and supported by the Karnataka State Council for S&T. Some 2½ lakh wood stoves of one type and a few thousands of a second portable model are now working in the villages of Karnataka. There are of course accompanying problems such as the initial cost of the stove which with a small subsidy is currently around Rs. 135-150. Each stove is custom built in the village home by one of 4000 trained artisans. The second type of portable metal stove can be manufactured by small scale industry and costs about Rs. 100. Fig. 2 shows a "Swosthee" stove. The Technical details are discussed in Ref. 2. It is true that village stove has yet to generate a self-sustaining process on a sufficiently large scale to make a real difference. This will occur only if the State plans seriously focus on such projects.

Clearly if a well organised small scale industry could take up manufacture of standardized stove there would be benefits in economics of scale as well as ready availability of spare parts and a repair-service system. The impact on the use of wood burning is obvious. Of course parallel forest conservation and regeneration schemes would be essential for sustained development. S&T can also bring down the present high electricity distribution losses, improve the lighting by replacing incandascent lamps by efficient gas discharge lamps, and by load matching reduce losses in industry. Similar examples can be developed in the medical delivery systems as well as education and other areas. Once the thinking in the state gets oriented to plan and execute projects for meeting basic needs of the poor, much of the State's and centre's existing infrastructure cen be pressed into service.

Other areas which would bear fruit if 'needs approach' is seriously followed, would be micro and mini hydel projects with local distribution networks and locai units of industry supplying components and maintenance services. Somewhat more advanced systems such as geo-thermal, solar and wind power also have good potential for the State.

As another example I would like to draw attention to two important ongoing programmes which use Space

Technology and modern computor and information processing systems. These are the NNRMS—National Natural Resources Managing System and the NICNET—the National Informatics Centre Network. Both are located in the Planning Commission as the apex body for national planning and have units in H.P.

NNRMS seeks through application of Remote Sensing Technology to establish an accurate data base on the major natural resources such as agriculture, forests, soils, water, minerals and geological resources and maintain a monitoring system which regularly updates the information. NNRMS is based on the IRS-1 satellite and is supplemented by the data from Landsat, SPOT, & NOAA Satellites. Fig. 3 shows the IRS System. Typical examples are assessments of snow melt and water availability for the Hydel Projects Fig. 4 and for finding the degraded areas which affect siltation in the reservoirs, Fig. 5, Fig. 6 shows satellite pictures of the changes in vegetation during 3 years. This helps in meeting incidence of drought, etc. As part of national missions the waste lands and water bodies of HP have also been mapped by NRSA. However a detailed up-to-date geophysical map showing the mineral wealth of the State has yet to be made although some work is in hand. Fig. 7 shows an IRS picture over Shimla. Analysis has shown that there has been little degradation in the last 5 years—a good sign and proof that the Chief Minister's "basic needs" oriented decision is being implemented.

NICNET is a computer-communication Network providing an information bridge between the State and the Centre. The communication links are based on the INSAT System and reach not only all the State Capitals but also eventually link all district headqucrters. Fig. 8 is a schematic of NICNET. Fig. 9 shows the earth stations and satellite terminals while Fig. 10 depicts the District Planning and Information System.

Himachal Pradesh has units of both national systems and can effectively use them for planning and executing its development plans. To do so effectively the State will need to augment and strengthen its education and Science and Technology base. The State Council for Science and Technology together with the Remote Sensing Cell and the NICNET-DISNIC system could form the core of the S&T inputs for development and draw in the Universities and Government departments for planning and execution. The State's infrastructure for Science and Technology needs augmentation and strengthening. Unless there are first rate, high calibre scientists actively working for the State's development efforts little real progress can be expected. For this there must be a minimum number of State Science and Technology Centers in Life Science, Physical and Engineering Sciences with smaller active groups in each district. The critical element will be man-power. In my view by enlisting the assistance of leading national institutions, Himachal Pradesh can achieve self-reliant Science and Technology organisation in about 5 years. National Institutions such as the Indian Institute of Science, the Center for Molecular and Cellular Biology, National Aeronautical Laboratory, the National Remote Sensing Agency and other organisations would I am sure gladly cooperate in this effort.

6. CONCLUSION :

Science and Technology can effectively transform Himachal Pradesh from a relatively backward area to an advanced one if the State's leaders and scientists together make a determined effort to change the direction of the planning process from financial allocations to a decentralized efiort which first determines and quantifies the basic human needs of the bulk of the poor and then allocates resources to realize the targets. In this process the S&T base in the State would also need to be transformed. I suggest that this would be a worthwhile effort.

I thank Col. Nagrani and Officers of the State-especially Shri Grover and Shri Kailash Mahajan for the arrangements.

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by

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pp. 237-270. Published by Indian Academy of Sciences, Bangalore.
Also see
Wood heat for cooking
Ed. K. Krishna Prasad & P. Verhoart
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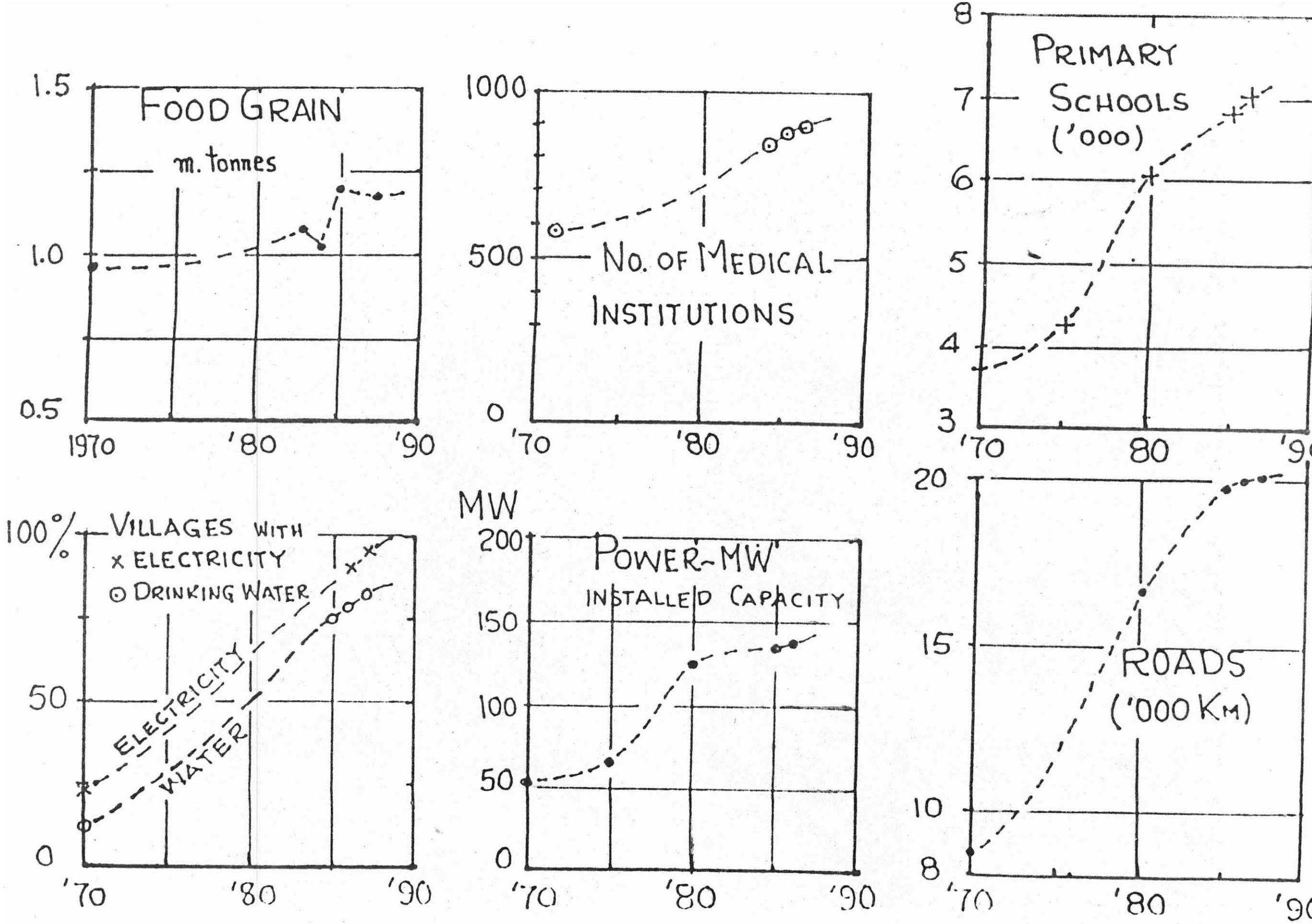


GROWTH OF HIMACHAL PRADESH

FIG - 1

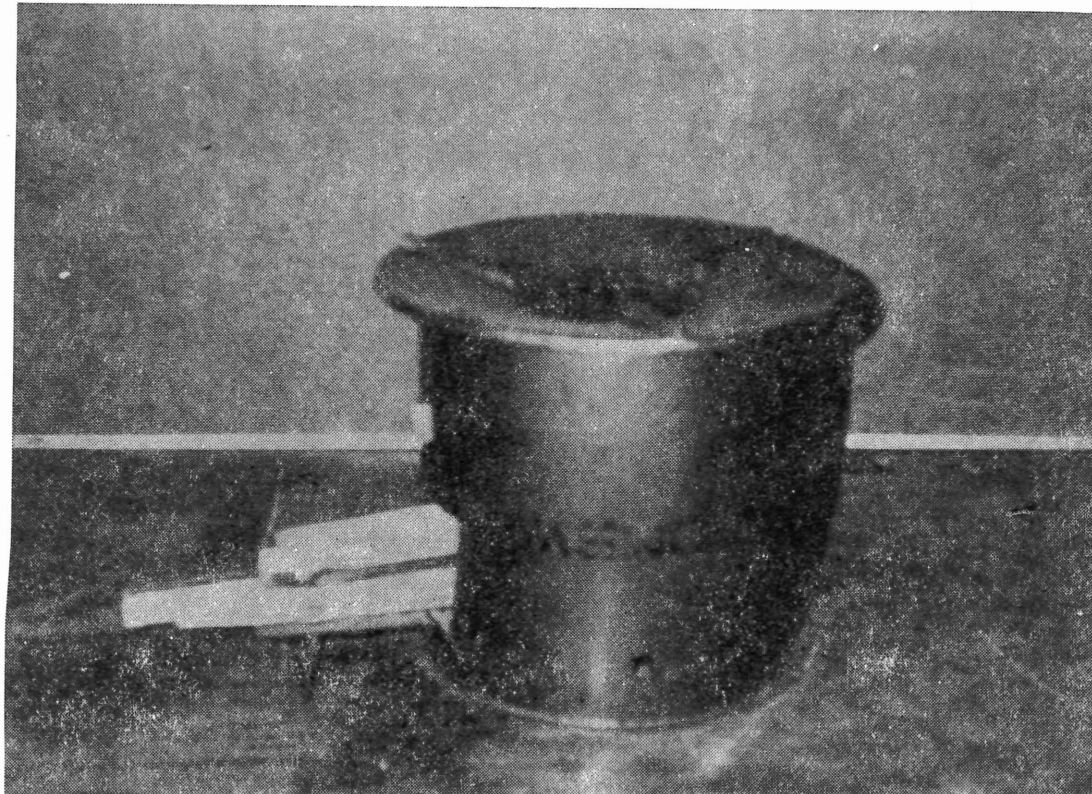


FIG. 2

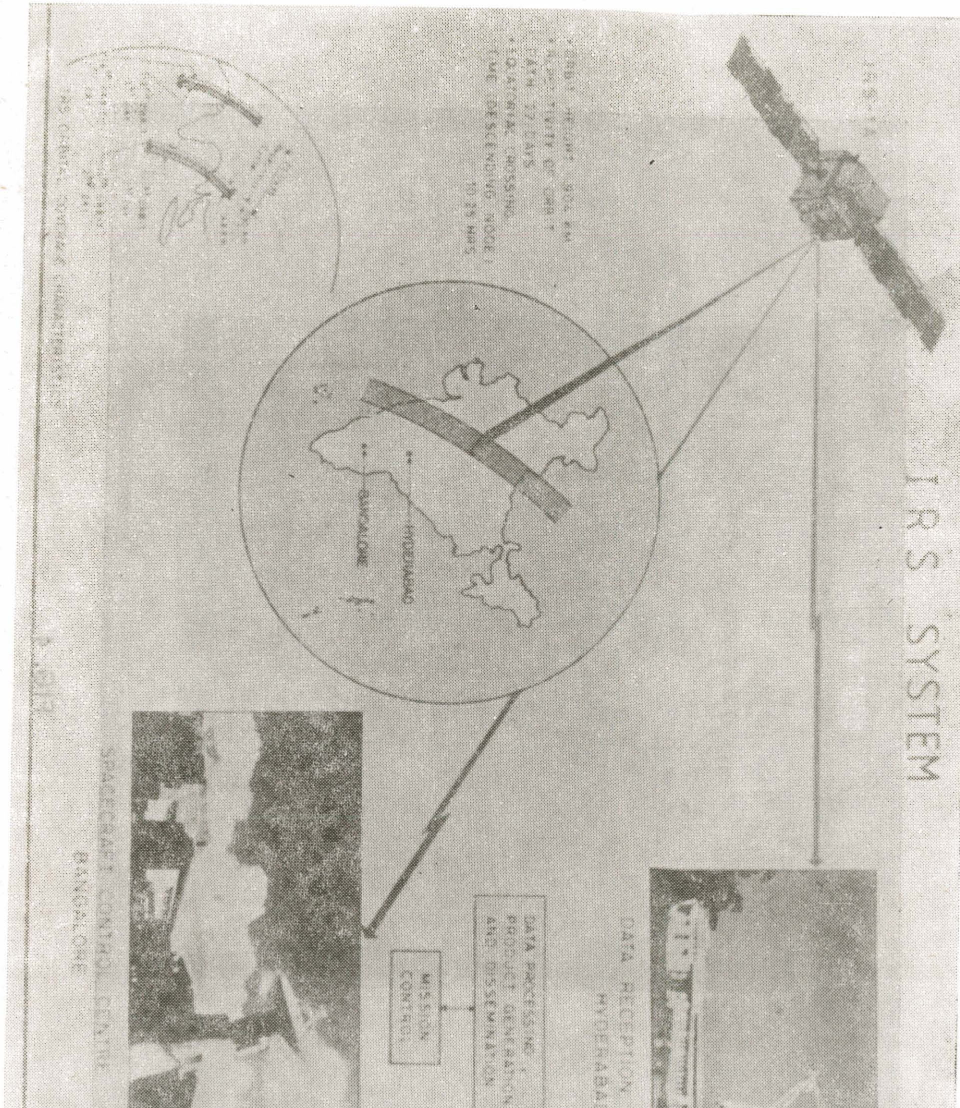

IRS SYSTEM
HYDERABAD
BANGALORE
DATA RECEPTION SYSTEM
HYDERABAD
DATA PROCESSING
PRODUCT GENERATION
AND DISSEMINATION
MISSION
CONTROL
SPACECRAFT CONTROL CENTRE
BANGALORE

FIG. 3

FIG. 4

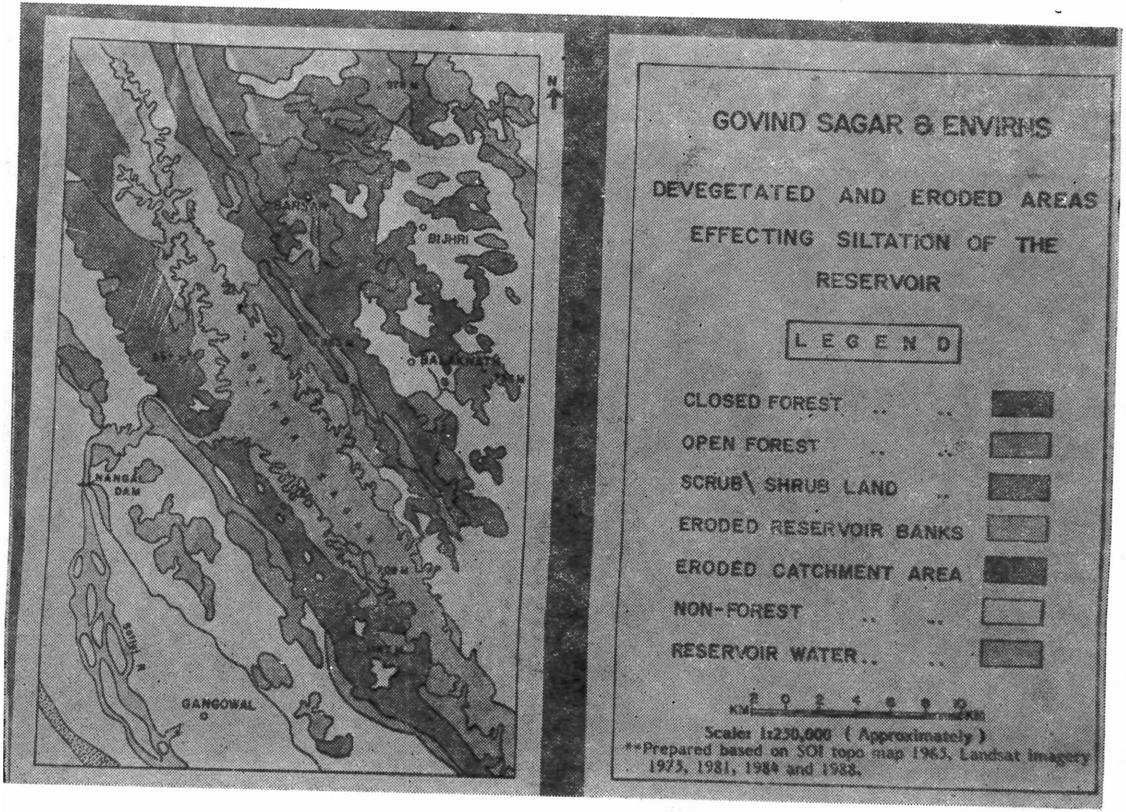

GOVIND SAGAR & ENVIRNS
DEVEGETATED AND ERODED AREAS EFFECTING SILTATION OF THE RESERVOIR
LEGEND
CLOSED FOREST
OPEN FOREST
SCRUB\ SHRUB LAND
ERODED RESERVOIR BANKS
ERODED CATCHMENT AREA
NON-FOREST
RESERVOIR WATER
KM 2 0 2 4 6 8 10 KM
Scale: 1:250,000 (Approximately)
**Prepared based on SOI topo map 1965, Landsat imagery 1975, 1981, 1984 and 1988.
BIJHRI
BARSAR
NANGAL DAM
GANGOWAL
N

FIG. 5

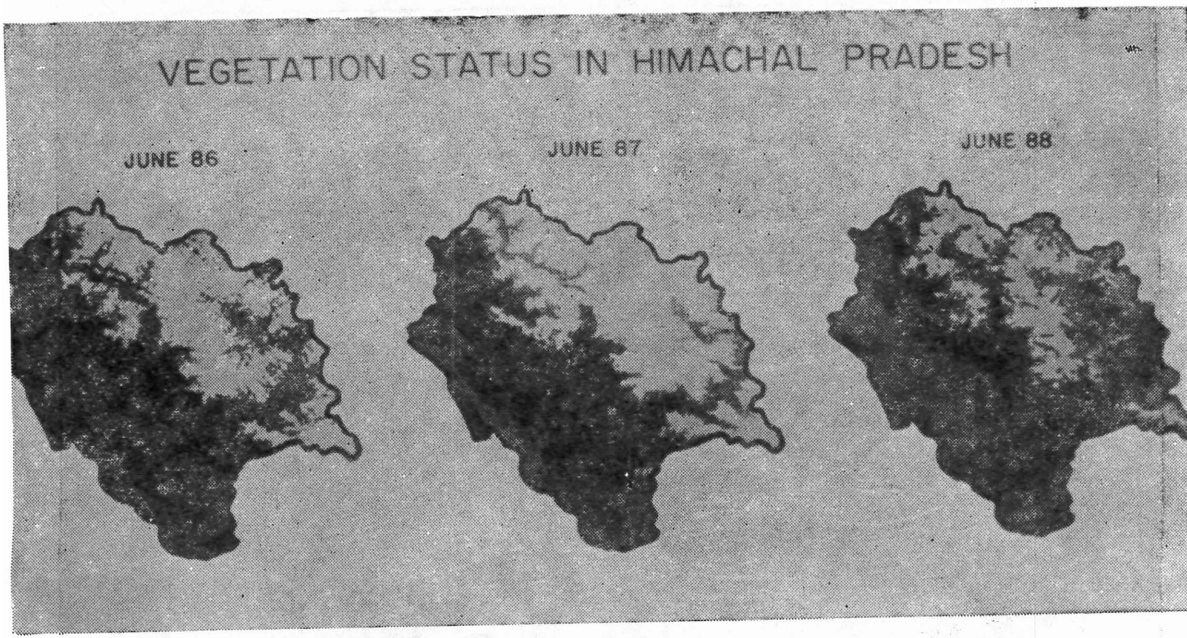

VEGETATION STATUS IN HIMACHAL PRADESH
JUNE 86
JUNE 87
JUNE 88

FIG. 6

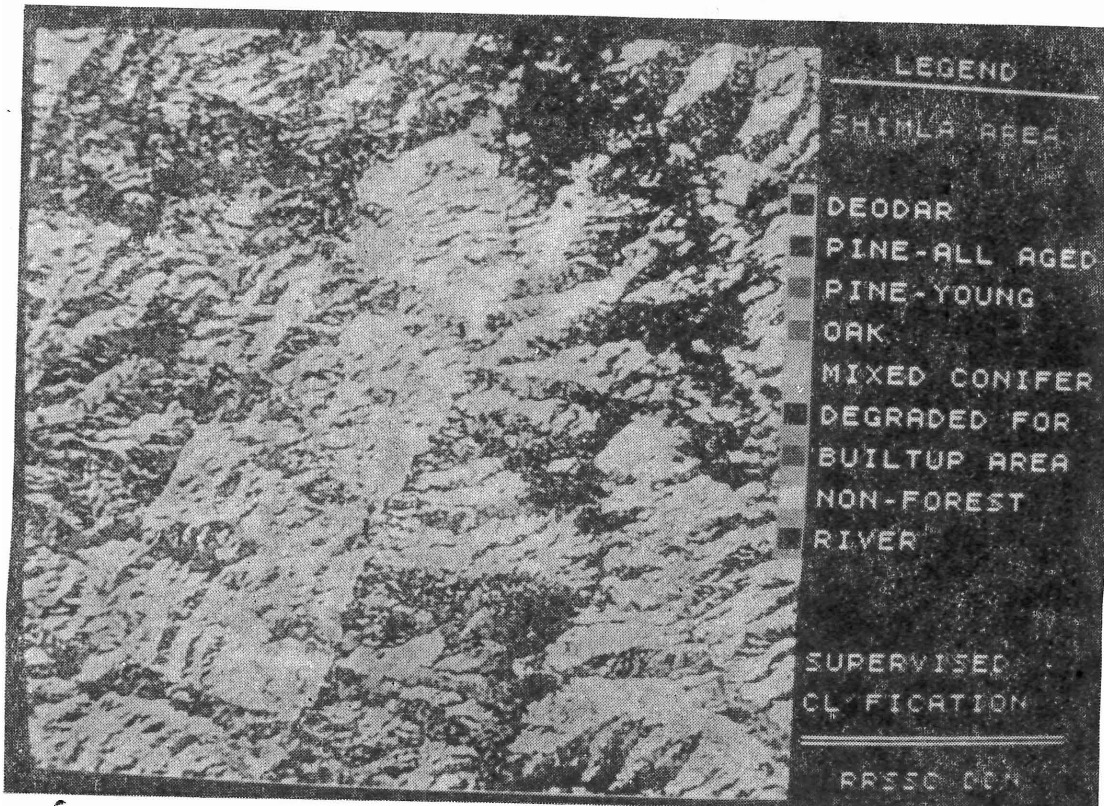
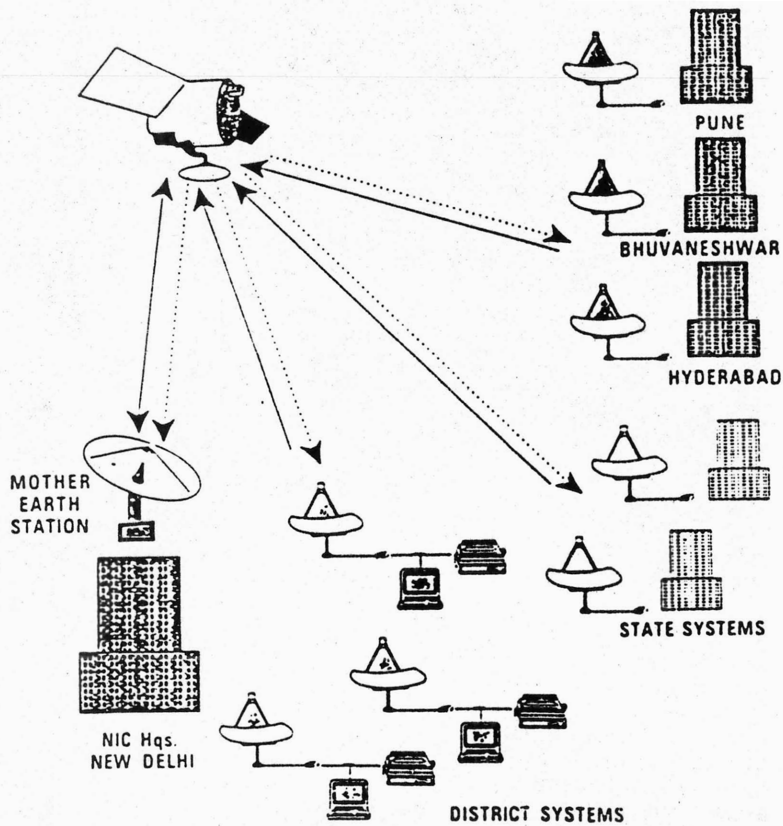
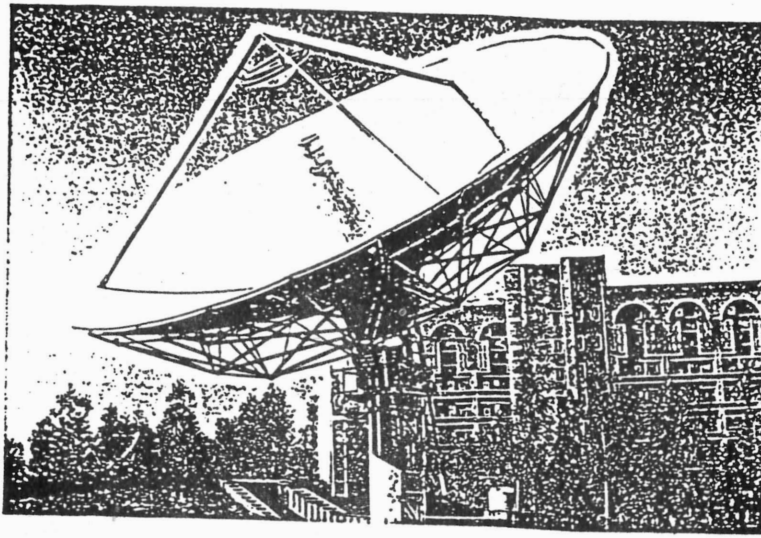

LEGEND
SHIMLA AREA
DEODAR
PINE-ALL AGED
PINE-YOUNG
OAK
MIXED CONIFER
DEGRADED FOR
BUILTUP AREA
NON-FOREST
RIVER
SUPERVISED

FIG 7

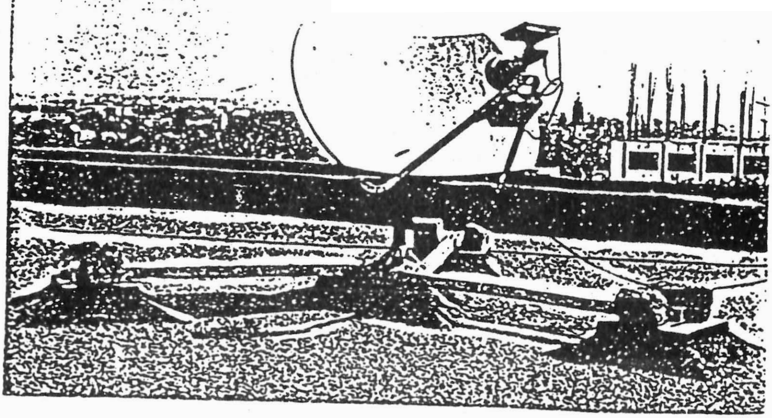


NICNET
A Nationwide Satellite Based
Computer-Communication Network

FIG - 8

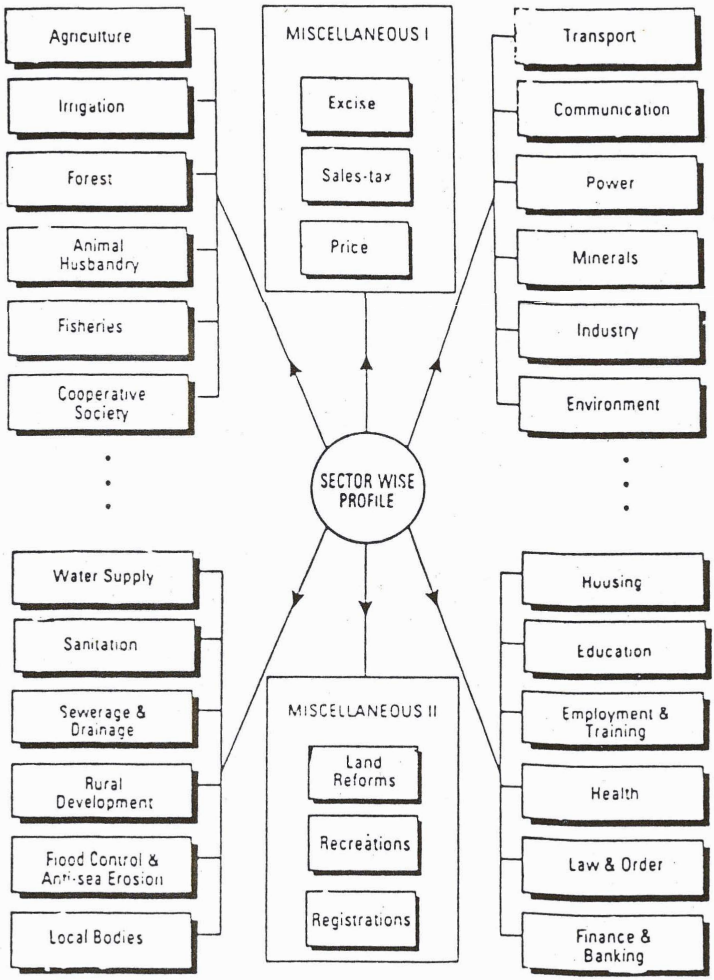


Mother Earth Station



Micro Earth Station

FIG - 9



DISTRICT PLANNING INFORMATION SYSTEM

FIG - 10