RIVER VALLEY PROJECTS AND SUSTAINABLE DEVELOPMENT: A COMPARATIVE STUDY OF TEHRI DAM & NARMADA VALLEY PROJECTS

Dissertation submitted to Jawaharlal Nehru University
in partial fulfilment of the requirements
for the award of the Degree of

MASTER OF PHILOSOPHY

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1998

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July21st, 1998

CERTIFICATE

Certified that the Dissertation entitled **"River Valley Projects and Sustainable development: A Comparative Study of Tehri Dam & Narmada Valley Projects"** submitted by **Sanjay Kumar** in partial fulfilment of the requirements for the award of the Degree of **Master of Philosophy** has not been previously submitted for any other degree of this or of any other University. This is his bonafide work and may be placed before the examiners for evaluation.

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ACKNOWLEDGEMENTS

I want to utilize this opportunity to express my deep sense of gratitude to my Supervisor Dr. S.S. Deora, who has guided me and offered valuable suggestions and corrections , which contributed a great deal to my whole study, without which this dissertation would never have been completed.

I am also greatly thankful to Prof. R.C.Sharma & Dr. M.Mohanty as both of them have contributed a great deal to my whole work.

I have special thanks to Shaishav , Ranjeet, Paps, Uttam & Mukesh for their kind co-operation and help they have rendered during my whole work.

I am thankful to the library staff of J.N.U. & Typists of Sri Balaji Communications, Ber Sarai .

Last but not the least, I am very much grateful to all my family members .

New Delhi
Date : July 21, 1998.

Sanjay Kumar 21.7.98.
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PREFACE

To sustain the growing population of the world , particulary in the third world countries , the process of development : Primary , Secondary and Tertiary has become urgent need .In this context the importance of River Valley Project increases tremendously .This dissertation basically deals with the positive and negative implications and its sustainability in the context of development process.

The first chapter deals about the concept and evolution of sustainable development .Recently there has been frequent use of the word sustainable development .It basically means the process of development that lasts.Considering the future of coming generations,the present generation has the responsibility to adopt such development process , that is sensitive about future generation .

In the second chapter there is discussion about large dams vs small dams . There are basically two school of thoughts and some are in favour of large dams ,while some favour small dams .The experience of China suggests to go for small dams , but this issue needs to be tackled , taking the local conditions and needs into cosideration . In the geographically varied country like India , a balance between the two is expeceted to be adopted .

Chapter three deals about the positive and negative implications of Narmada Valley Project. The same analysis has also been done in the fourth chapter

that is about Tehri Dam . Although the geographical locations of the two is different .

Ultmately a comparative analysis and the critical evaluation of the two have been done . So far as the Narmada valley is concerned ,the people are opposing it keeping the problem of rehabilitation on the top , while Tehri Dam is being opposed on the ground of environmental degradation , particularly about the biodiversity loss . In this background it can be safely stated that there is need to adopt perfect harmony between development projects , its negative impacts and the issue of sustainability.

First Chapter

SUSTAINABLE DEVELOPMENT: THE CONCEPT AND ITS EVOLUTION.

Sustainable Development has become a catchword for discussion and action because it seems to capture a widespread feeling that the state of the earth is somewhat precarious[1]. On the one hand we see around us evidence of progressive deforestation, changes in atmosphere such as thinning of above layer, a loss of biological diversity and growing volume of wastes that we are unprepared to handle. Many of our fellow citizens have a deep sense that somehow we may have let the relationship between the society and nature in this world get out of balance, that may be creating a threat our very survival.

On the other hand, not in opposition but in parallel we see around as that our social and economic systems are not delivering progress towards a better life for the most of the world's population. We see poverty violence, homelessness, hunger - and we see that in too many ways for too many people, economic and social condition are getting worse not better. In fact we have a growing sense that economic pressures are threatening our social fabric, nationally and internationally.

Origins and Definitions of the term

This notion developed first from the industrialised and developed countries about conserving nature in the face of global economic and demographic pressures related especially to geographic exploration in the tropics and pushed by a sense of crisis about the implication if population growth along with the gensal rise in the

awareness of environmental issues in the late 1960s[2]. The normative concept of sustainable development as presented is Bruntland Report reflects this double pre-occupation incorporating almost two decades of worldwide debate started at the Founex seminar in 1971. In the same year that the limits to growth was published a United staions conference in stockholm restructed a new sense of crisis about environmental problems on international scale[3]. In this declaration the stockholm conference stated that man has the fundamental right to freedom, equality and adequate conditions of life in an environment of a quality that permits a life of dignity and well being.

These developments, with roots ranging from George Perkins Marsh to the international geophysical year in 1957-58 stimulated a new level of attention to global environmental challenge. On the policy side. in 1980 the international Union for the conservation of status and Natural Resource (IUCN) issued a world conservation strategy as environmental experts began to dig into broader challenges of development: and the UN Environment programme established on a result of the Stockholm conference, promoted the concept of ecodevelopment which couples ecosystem dynamics with 'small is beautiful[4] " philosophies.

The ecodevelopment effort led in 1983 to the U.N. General Assembly's establishment of a World Commission on Environment and Development. The commissions 1987 report usually called the Brundtland Report after the commissions chair emphasised the importance of sustainable development, related mainly to meeting basic needs and recognizing environmental limits. If deeply concerned about global environmental change, especially ozone longer depletion.

The move toward government action as well as research and policy analysis culminated in the 1992 U.N. Conference on Enviroment and Development in Rio De Janerio. Organized in park to make the twentieth anniversary of the stockholm conference UNCED declared a legally binding international climate change convention and Biodiversity convention and "Agenda-21" a comprehensive blue print for a Global partnership for sustainable Development.

The Power of the concept and Dimensions -

Meanwhile government and other constituency have been remarkably receptive to the concerns embedded in the concept of sustainable development within the part several years. For example President Clinton has established a Presidential Council on sustainable Development and the United Nations has created a new commission on sustainable development. Agenda 21 calls for every developing countries to procure a sustainable development plan, with the process funded by the industrial countries. Such influential non-government organisations as the world resource Institute. The Siera club and the Union of concerned scientists have refocussed their rhetoric their advocacy and their programme development on sustainable development. Even the private sectors paying attention through such groups as the international Business Council for sustainable development. Sustainability, a dynamic concept taking into consideration the expanding needs of a growing world population implying by this a steady growth. It refers simultaneously to five dimensions:

(a) **Social sustanability:-** it means the setting of a development process bringing about a steady growth with greater equity of income and asset distribution so as to ensure a substantial improvement in the entitlements of the broad masses of

population and a reduction of a gap in standards of living between the have and the havenots.

(b) **Economic sustainability:-** it can be made possible by a steady flow of public and private investment, efficient allocation and management of resources and a fair external environment.

(c) **Ecological sustanability :-** Stretching out of the carrying capacity of the spaceship earth by intensifying the uses of the resource potential of the diverse ecosystems with minimum damage to the life supporting systems, limiting the consumption of fossil fuels and other easily depletable or environmentally harmful products and reducing the volume of pollutants by means of energy and resource conservation policies, recycling, substitution by renewable or plentiful and harmless resourcess, search for low waste and resource efficient technologies, promotion of 'regenerative agriculture' and agroforestry adequate environmental protection and last but not the least, self restraint in material consumption on port of the rich countries and privileged social strata all over the world.

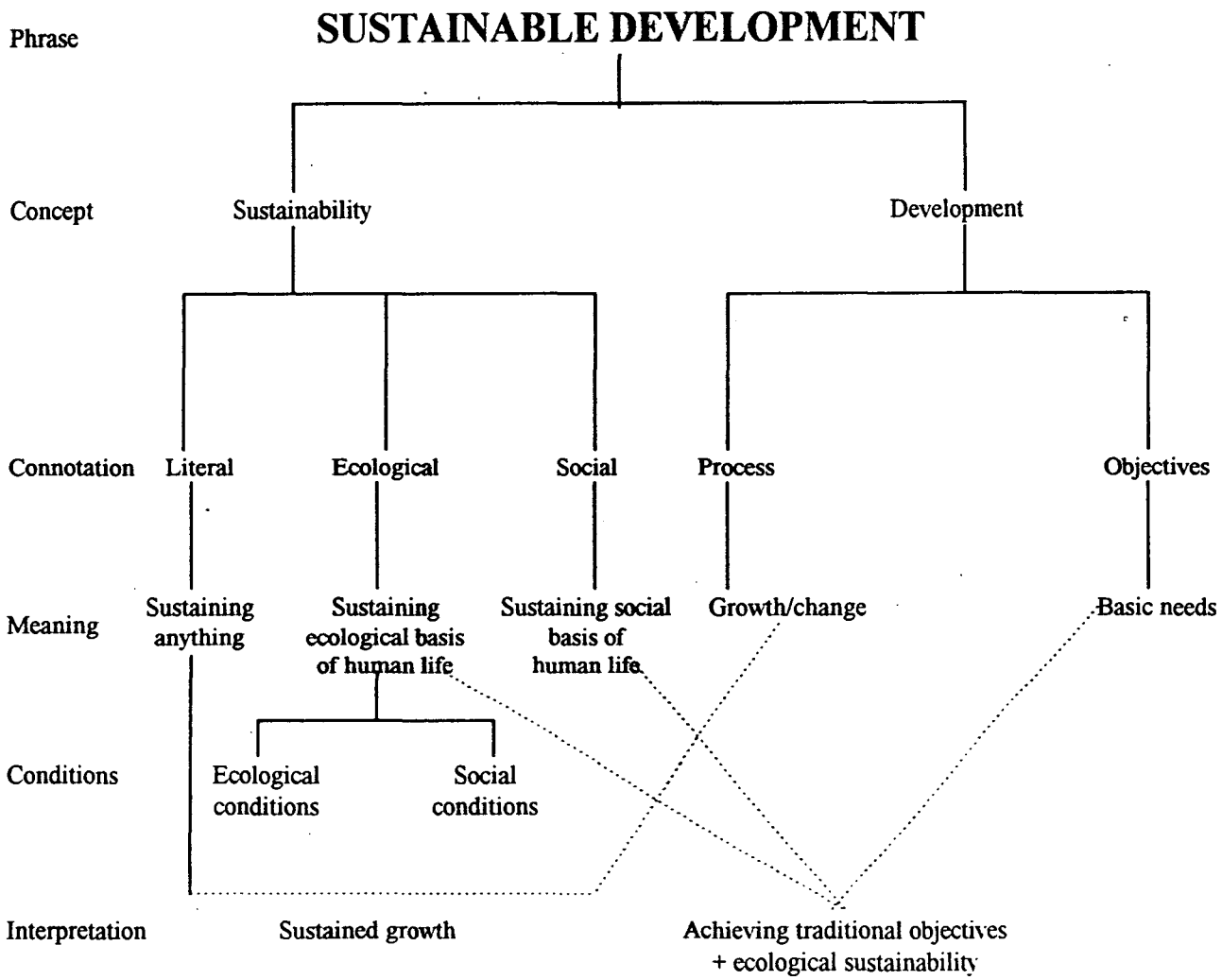
(d) **Geographical sustanability:-** Environmental disruption after results from an unbalanced spatial distribution of human settlement, and economic activities: excessive concentration of population in metropolitan areas and destruction of fragile but vitally important ecosystems through uncontrolled colonization processes are two instances. Hence the need to seek a more balanced rural-urban configuration and to establish a network of biosphere reserves to protect the biological diversity and assisting local population to live better.

(e) **Cultural sustainability:-** It is perhaps the most difficult to achieve as it implies that process of modernization should have endogeneous roots, seeking change with in cultural continuity; hence for multiciplicity of modernization paths to modernity, as argued by of Toyraine and the need to translate the normative concept of sustainable development into a plurality of local ecosystem specific, culture specific and even site-specific solution.

Thus the concept of sustainable development encompasses the new awareness of the limits of the spaceship earth and of the fragility of its global ecological balances, a need oriented approach to socio-economic development and the recognition of the fundamental role of cultural autonomy. It has a double function: the direction in which to move and a set of criteria to evaluate more specific actions.

The manner is which the phrase "sustainable development" used and interpreted varies so much that while O'Riovdan called sustainable development "contradiction in terms", Redcliff suggests that it may be just another development truisom. These interpretational problems, though ultimately conceptual, have some semantic roots. Most people use the sustainable development interchangeably with ecologically sustainable or environmentally sound development". This interpretation, characterised by sustainability being understood as ecological sustainability and conceptualization of sustainable development as a process of change that has sustainability added to its list of objectives.

In contrast sustainable development is sometimes interpreted as sustained growth or simply successful development. Below given figure stands for its interpretation.



The semantics of sustainable development

As one of the great intellectual and policy issues of the next generation, sustainable development consists remarkably well with our heritage and our strengths as discipline. It's defined by relationships between human and physical processes. it relates nature society issues to spatial pattern issues. It can draw from both location theory and social theory. It is linked directly to many of the same questions that underline society's recent rush of interest in geography - globalization, environmental problems and application of geographic Information system. It has the potential, in fact, to serve as an intellectual dynamic and normative forms for integreting our different prospectives on the world around us.

Consider as starting point four of the distinctive viewpoints that geography offers to discussions on sustainable development, drawn in part from the ongoing discussions of the National ACademy of Sciences: New relevance for the New century.

The main intellectual challenge associated with sustainable development is the diversity associated with it topical diversity in the subject matter, ecological diversity as an aspect of sustainable development, and spatial diversity in the new paths that may make sense store of these aspects of diversity, well understood. For instance, the reality of topical density presents a fundamental problem for traditional scientific disciplines that have thrived by focusing on particular aspects of reality. Ecologists focus on biodiversity to the exclusion of economics, economists focused on market forces to the exclusion of issues of justice, political theorists focused on issues of justice to the exclusion of issues of environmental costs.

What is needed from geography is leadership in building diversity into the sustainable development enterprise in ways that are intellectually sound and robust as well as pragmatic related to two different issues: the value of pragmatic related to two different issues: the value of diversity for sustainable systems and the tractability of diversity in coming to a clear understanding of sustainable development regarding the first, for example, what can be offered beyond extensions of the density stability hypothesis from ecology extensions of prigogive theory that random factors introduce opportunities for growth into otherwise decaying entropic systems or partnership in search for a new science of complexity. Clearly we start with the knowledge that similar combinations of social and environmental processes can lead to different nature society relationships in different places because different places represent different combination of historical experience and external influences. Regarding the second issue, it can be more active in working towards methods and other tools of integration-systematic, reproducible steps for putting pieces together in ways that are closer to real life than so much of traditional science.

Geographers have always been facinated with flows: flows within places in nature, in society and between nature and society, flows between places that take on patterns that in turn illuminate processes; flow through time that shape both of these. An eminent non-geographer, in fact recently suggested that geography's most fundamental contribution should be as the science of flows - seeking general truths that help in understanding a wide variety of kinds of flows. It is evident at least that sensal flow related questions are control to the sustainable development discussion and these could benefit from geography's perspectives.

In the case of nature society flows, how is sustainable development related to human responses to natural hazards and risks? How does it reflect resource use in a social and political context? How important is to improve the understanding of landuse? From these foundations, should it not be asked which physical resources are essential to development as it is known and which of these has no known technological substitutes, at least that canbe afforded? Should not it be asked which ecosystems are vital for sustainable human development and whether that are essential regardless of economic and social tradeoffs, and to what degree essentiality is a social construct ? Should it not be revisted what we know about how relatively stable human ecologies shift from one state to another and why and what the traditions mean in terms of both nature state society and socioeconomic sustainability? In the meantime other geographic perspectives also deserve greater visibility, that is, the complexity of reconciling rates of change its society with rates of change nature and the importance of value systems in determining sustainability meaning in various societies.

In the case of spatial flows it can be drawn upon perspectives that are so familiar to us what we undergo estimate their role in current debate. The fact is that the operational definition of sustainable development invariably focused on particular geographical areas. Agenda 21 focuses on the country; Project 2050 - a project organized in 1993 by world Resources Institute, The Brookings Institution and the Santa Institute-focuses on region. leaving the interpretation of that term to various participants from around the world. It may be upto geographers to assure that these areas are placed in spatial context. that their sustainability is seen in the context of

their relationship with their other places and their identity recognized as a social perception.

Geographers can be especially important in helping to illuminate how flows of resources, capital and political economic control shape the sustainability of uses of different places. Historically the sustainability of political economic systems in some places has usually been based on the non sustainable exploitation of others, which itself is a non-sustainable situation. Going beyond our notion's of pattern as both an indicator of and a parameter for process, geographers have often taken the lead in thinking about the interdependence of places. Note in particular our perspectives on dynamics of land markets where spatial economic social and environment flows meet and the growing significance of flows of capital and information in shaping a shrinking world.

It seems that about the interplay of flows related to exploitation versus flows related to positive innovation of access in exchange for control versus access with the retaliation of control, of tensions between scale economic and democratization; the inertia of pattern versus the rapidity of change. Geographers should also note with interest the preoccupation of the sustainable development literature with peripheral areas where sustainability depends vitally on what is happening in core areas as well on us and on our choices as well as on them and theirs. It is especially interesting to consider this interdependence in terms of the dimensions of sustainable development which serves to reduce economic inequalities.

Furthermore the sustainability, seen in the context of changes in the spatial flows such as the acceleration of flows when spaces compressed by processes of

technological change and globalization. Changes in spatial flows reshape the character of places and likes of people who live these and they reshape how places and space are defined as spatial structures produced under one set of conditions are displaced by others . How does sustainable development embrace this fluid kind of reality?

Related to temporal flows, geographers can help others in understanding the directionality and path dependence of human ecologies as they evolve in space and place. Our emphases on historical perspectives on places on changing spatial structures and on sustainable vrs non sustainable ecologies are exact what is needed in the debate over sustainable development.

In a forum where issues of centralization and decentralization are so prominent, geographers can make powerful contributions to question of scale of sustainable development paths are to be defined in terms of discrete geographical areas, is almost certain to be the case and if decisions are to be based on participating democracy in the areas concerned what scale of action does it imply? Before Yogoslavia disintegrated into tragedy an attempt was made to construct a political systems on this basis, turning most kind of governance over to local units usually transferred into English as communes. Over a period of a decade and a half, commune boundary systems were allowed to shift until they stabilized at a scale 494 of the 512 communes contained areas of less than 1200 km2 roughly equal to a square 21 miles to aside or a circle with a radius of 12 miles. Are great units of this small size what human ecological self determination; likely to mean?

Such a question relates to several streams of geographic research on relationship between people and sociopolitical participants. For example these is abundant evidence that the most important influences on many decisions are personal communication, which are related to a kind of "Choreography" of human interaction. Essentially because the time is limited and person to person contact takes time such interaction; fundamentally limited and moreover it takes time, the more and farther we move the less time; available for interaction. These constranits suggest that there are limits to the social and spatial scale at which accomodation can be reacted for some purposes - and idea that's reinforced by Friedmaan's theory of transactive social planning and action.

Second its possible that many of the environmental and economic systems that need to be sustained are more viable-at certain geographic scale, and that scale may differ from the scale that is most appropriate for human self determination. For instance, Thompson's classic book on Growth and Form offers repeated examples of situation where larger organisms are less agile and smaller ones are proportionately stronger and modern organization theory's saying much the same thing[5]. But what can be said ecology in nature? In 1979 Smithsomiah Institute initiated a project to define the minimum sized area at which a relatively diverse natural ecology is viable-an extremely relevant question. But because the answer was elusive and the project has largely shifted to other issues, emphasising the biological dynamics of forest fragmentation, the opportunity and the need for delimiting ecological scales remain. Here perhaps an opportunity to follow up clark's suggestion that not only the scale

domains characteristics of certain kind of systems, but domains differ between systems that may be super imposed in geographical space.

Third, how do these scales fit into existing spatial-administrative frameworks? Sustainable development will need boundary systems that correspond more or less to the scale at which it is carried out. "Our national boundary systems in many posts of the world are both too large and too small to handle such challenges as sustainable development: too large for mediation of complicated issues to be handled in a participative manner and too small for the necessary resources to be allocated in ways that will get the job done"[6].

This suggests a fourth question that is critically important in understanding global change: How actions and processes operating in one scale, say global, relate to actions and processes at another, say regional and local. From one direction it is easy to see how local conditions may be affected of global economic and environmental pocesses, but it is harder to see how global processes may be affected by local actions. Consider the experience of peace corps-with its powerful impacts in many localities but very little evidence of impacts at national level, much less globally. From the other direction it is clear that global processes are in fact the result of myriad of local decisions It's also clear that many of the complex relationships among environment economy and society at the global scale can only begin to be unravelled by careful locality specific research. This is the doubly true if localities are going to be given a chance to determine their own paths, since we donot yet have a sound understanding of how processes at different scales interact with one another. Geography has a chance to play a major role in addressing this need.

Finally the recognition should be for the growing power of the visual image in human communication in this age of information revolution. Across the world, the creation and diffusion of visual images; displacing the printed world as a triggering mechanism for issue identification, constituency building and agenda setting. And visual images including computer mapping and great photography are increasingly used to identify threats to sustainability and to to examine alternative path. No other form of communication's as powerful among such a wide variety of audiences, including scholars who are trying to associate creative thinking with empirical observations.

In this age of new "information super highways our skills in GIS-emphasizing their connections with subject matter knowledge-will be part of our contribution to the art and science of sustainable development especially as computer mapping's combined with photographic and other images in hypermedia information systems. We need to understand how to do this equitably, in expensively and well-at the same time that we remind ourselves and others that the communication of visual images is highly value laden and that the message can be swamped by the medium. Concomitantly our uses of images should be grounded in our tradition of fieldwork that links the abundance of secondary data and images to primary data of personal observation and experience.

On example of visualization's role in the sustaibale development dialogue comes from deforestation in the area drained by the Amezon. Few other issues of global environmental change have achieved as much immediecy through photographic image of for example, land clearing, and wood bushing. In the early 1980s earth

satellite imagery documented the extent of landuse change. Correlations between deforestation and transportation handbeen sharpened by maps of evolving road patterns and spatial diagrams are effective ways to show the different consequences of different causes of action.

Toward a Geographic System Theory of Sustainable Development :-

Given there prospects for interesting and useful professional contributions to the effort to make sustainable development a reality, one more step can be advanced—toward developing general theoretical concepts related to sustainable development? It would need to reflect instead the new epistemology of group research that has attracted considerable attention in discussions of global economic competitiveness. They would need to balance our research for generality with our characteristic appreciation for diversity. They would need to address understandings of system possibilities as well as predictions of system outcomes. And they would need to see theory as a heuristic devise rather than as a reflection of a mechanistic view of what's efficient or right. But scholars in geography and other disciplines need to fill the void of theory and intellectual substance that undermine sustainable development as a commitment for global and local action.

Without claiming to meet all of these conditions and in spirit of preliminary discourse, it is offered a few thoughts on the kinds of fairly general insights. The central challenge involves seeking sustainability in a world of constant change, which seems virtually a contradictions in terms. In the context, it seems that our theory building by offering a number of postulates as a basis for discussion and investigation:

(i) Given the reality of complex flows within and between places, sustainable development must be pursued in open systems. It is futile to endeavour to sustain by isolating the path to sustainability lies in assuring that diverse flows contribute to the pursuit of such goals as environmental management, economic progress and participative decision making not in arbitrary efforts to truncate flows.

(ii) Because innovations in the sense of new ideas or practices, mutations, rare events or other novel phenomena, are constructing being introduced at some places and spread to others through spatial systems - through human creativity if from no other source- a long term steady state or equilibrium is not a realistic target for any locality at any scale. Sustainable development is not a product but a process in which relatively near equilibrium states are joined through time by periods of transition from one state to another. It is more a matter of near equilibrium paths than of near equilibrium states.

(iii) In such a context, under pressur from human aspirations and technological change, both internally and externally, sustainability depends upon a balance between entropy - countering change stimuli and instability countering-mechanisms for assimilation all embedded in pervasive undertainty without the stimuli, systems decay rather than progress, and without the mechanisms for assimilation system can carried out of control the challenge is to modulate the stimuli by feed sales. Generally based in social institutions that guide the system onto path that improve system quality rather than destroying it.

(iv) There is more than one possible near equilibrium state for a locale at a particular time and more than one possible near-equilibrium path as that the locale moves from state to state. Sustainable development does not mean a single answer for each place. It is strongly conditioned by social context and values and by external relationships, it is strongly path dependent: and it exhibits considerable geographic differentiation. It may be associated with limits which are themselves subject to change - as when technological development results in substitute for scarce physical resources - but it embraces a considerable range of choice.

(v) Where sustainability is concerned the major decision points occur not during periods of near equilibrium but during times of stress, when urgency can be converted into radical actions near equilibrium conditions can shift far from equilibrium and relatively orderly adaptive transtitent tend to be replaced by discontinuous jumps involving considerable unpredictability. The work of prigo give and the complexity scientists point to conditions at a boundary between normal orderly behaviour and uncontrollable chaos, at which some combination of system complexity, survival instinct, learning and perhaps luck enables some systems not only to survive but to take revolutionary steps towards improvement and advancement. But it is also possible and in some circumstances likely that outcome will be destructive for some or all ports of the system.

(vi) Such stresses are more a function of rates of change parameters of a locality than of magnitudes of change. except when critical thresholds are involved. In

any locale, there is a rate of change beyond which existing systems cannot be maintained, and this rate of changes related to the period over which it is maintained. The longer a given rate is continued, the lower will be the rate that canbe assimilated without major decision points.

(vii) Rates of change that can be assimilated vary among systems according to their resilience or elasticity with respect to copying mechanisms such as linkage with broader networks. In many cases a locality's most important coping mechanisms, its overall level of socio-economic development since its capacity to find paths that keep stresses within manageable limits varies directly with its human, technological and financial resources.

(viii) In the long term, sustainable development's probably unrealizable in most localities until it is also approached in most others. Unless and until development is sustainable nearly everywhere, the global system remains a threat to local sustainability nearly everywhere because it tends to spread instability from place to place: for example, through population migration, the transport of environmental degradation, political conflict, or economic exploitation.

Putting Geography's Perspectives in Perspective:-

The Central question in sustainable development is whether during the next century or two or even in the next generation or two the world can simultaneously sustain four things 1) Economic development for all 2) Reasonable environmental stability 3) Decision making without coercion 4) Continued population growth. In order to able to have all four, we will have to be able to be highly innovative in

improving our understanding of complex systems, their resilience and their propensity to change; and in creating options that take the pressure off through technological and institutional change.

That is a great deal to ask, especially if the presumes grow quickly in the first or second quarters of the next century. A best guess is that our innovations and innovativeness may buy time to make the hard decisions without sacrificing economic opportunity, environmental quality or self determination - and it is very important to buy that time-but it will be found in the lifetimes of our children that we cannot have all four of these things. In order to achieve sustainable development, something will have to give - and that is an excruciating prospect. Clearly, population growth represents a challenge that world must address in the next century; it is obvious first target. Beyond this, though, it is unclear whether we can realize sustainability's three remaining dimensions (equitable economic development, a healthy environment and the right to make one's own choice) as long as we continue to live in a world where our choices are both self determined and very strongly self interested, where equity is someone else's worry and balance, something to be left to a fuzzy future.

During the 1992 International Geographical Congress, former U.S. Senator Gaylord Nelson argued that the key to unlocking real sustainability is a much stronger and more widely shared environmental ethic - to which we might add a stronger social ethic as well. It is possible that sustainable development will require an ethical revolution to go along with the other revolutions of our time: globalization, scarcity, information and democratization. If this is true, then geographic challenge goes for beyond our rates as a scholars and practitioners to our roles as teachers and as citizens,

who, through our research, our councel, our information dissemination, and our personal examples, advocate the principles of economic fairness and nature society balance.

This it seems is the final opportunity for integratin that lies in attention by geographers to the sustainable development issue. In addition to integrating knowledge in order to meet pressing social needs and helping to unify our various traditions as a discipline. Sustainable development focuses our attention on a great problem mutual concern that can help to integrate the various pieces of our individual professional lives — to integration in the interest of a problem that we are enough about to go that extra mile to do extraordinarily well, not only in our scholarship but in every aspect of the ways that we live as experts in something the world needs very badly.

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SECOND CHAPTER

DEBATE OF LARGE DAMS VS. SMALL DAMS

The morpho tectnonic framework :-

The geological history and structure of the Indian subcontinent are reflected in its physical features. The geology and physiography are so inter related that to understand one an appreciation of another is necessary. The subcontinent's divisible into three fundamental segments or units - the geology and physiography of each as distinctive they are:

(i) The Himalayas and their extension to the east and the west

(ii) The Indo-gangetic plains to their south and

(iii) The Peninsular India.

The stratigraphy, evolution and structure of these three divisions are entirely unlikely each other. The Himalayas and the mountain chains that extend beyond them are made up mainly of proterozoic and phaneorozoic sediments, largely marine and are tectonically highly disturbed. They owe their origin to diastropic movements which brought these mountains into existence in completely or comparatively recent geological times. They are characterised by highly folded and faulted rocks and physically attain enormous heights.

The great Himalaya Mountains stretch for 2500 km from the Mishni stills in the east to the Pamir in the west in a arc 150 to 400 km broad and convexing to the south. Most of the main ranges fall in India. Nepal and Bhutan, but the northern slopes are situated partly in Tibet, while the western extremity lies in Pakistan.

Afghanistan and the U.S.S.R. The Karakoram is the farthest range on the northwest: it strikes N.W - S.E. Its extreme northwestern and abuts against Hindu Kush, seperated by the Gilgit river at the Pamir, known popularity as the 'roof of the world' East of Karakoram stretch the Kunlun mountains to the north of Tibet. The Ladakh, Zaskar, Pir Panjal and the Dahula Dhar Ranges follow successively to the south of the Karakoram as parallel chains having the same trend. The Ladakh range branches into the Kailash range of western Tibet. The Nag Tibba an Mussoorie ranges in the Shimla Kumaon region and the Mahabharat Lekh Range of Nepal have the same strike continuation but are separated by the transverse flowing Kali river. The great Himalayas are paralleled on the south by the Siwalik range which forms an almost continuous chain of foothills. The high mountain ranges of great Himalayas in Nepal Bhutan Sikkim and North east India are not identified by separate names except for local appellations.

The Great Himalayas are classified into four parallel longitudinal zones which have distinguishing orographical and geological features as follows:-

(a) **Tibetan Himalaya:** It is about 40 km wide and lies just north of the Inner or Higher Himalaya at alttitudes of 3000 to 4300 m. It is made up of highly fossiliferous rocks ranging in age from the earliest Palaeozoic to Teritory. The existence of glacio marine sediments of Gondwana facies within these formation is of great significance since it indicates the possibility that some sections at least of the Himalayas were a part of Gondwana land. It is separated from the Eurasian plate by the Indo-Tsangpo Suture zone.

(b) **The Higher/Inner Himalaya:** It forms the northern most line of high ranges over 6,000 m in alttitude, covered with perpetual snows and boasting of the tallest peaks on the Earth's surface. This zone is hardly 50 km wide, and is formed mainly of granites and gneisses overlain by some sedimentary formations of the cambrian age. The gneisses are often thrust over towards the south by the main central thrust.

(c) **The lesser Himalaya :** It comprises the middle ranges and is closely related to the Inner Himalaya, though with inferior elevations of only 3600m to 4200 m It has an intricate system of ranges which are some 60-80 km wide. This zone is composed mainly of unfossiliferous Pre cambrian, Palaeozoic and Mesozoic formations.

(d) **The outer Himalayan zone :** It is separated from the lesser Himalaya at some places by flat bottomed valleys. It is represented by the autochthonous foothill of the Siwalik range which are made up of folded. partly fossili ferou sediments of tertiary age. Older rocks overlie the Tertiaries by a thrust called the Main Boundary Thrust The Siwalik range makes an almost continuou chain of more than 2400 km from the Indus gorge in the northwest to th Brahmaputra in northeast Assam bordering the Great plans. The height of thes hills seldom exceeds 1300 m and they are 10-50 km in width.

The Himalayas as great mountains came into, existence not more than 65-7 million years ago, though the rocks that make them up had undergone tectoni deformation in some earlier times as well. Though there are evidences of Pr cambrian deformation rocks. There are a period of movements towards the cambria

or beginning of the Ordovician. No disturbances of great intensity appear to have occurred thereafter uptil the upheavals that brought the Himalayas into existence during the Tertiary period. There was an earlier episode of gentle movements during the Carboniferous when marine sediments were raised, eroded and again depressed beneath the sea but they did not suffer any contortion. The diastrophic movements that raised the Himalayas into mountain chains of such gigantic proportions started in the late creataceous times and continued throughout the eocene, middle eocene, pliocene through to lower pleistocene and finally into upper pleistocene to subrecent times.

The disturbances which influenced the pliocene Siwalik and Karewa sediments of sub Himalaya extended to such widely separated regions as eastern Afghanistan and the Hundes areas of Tibet, north of the Gangotri Glacier in Garhwal, where similar diposits of the same age are found to have undergone much folding and tilting. There was comparative quiescene during the pleistocene through some movements were taking place all the time and are continuing during the present. The Himalayas are rising even now, and the rate of uplift had been calculated to be 7.5-10 cm per year. Since the last glacial episode over the past 20,000 years the Himalayas have risen 1,500-2000 mtr. height.

The Himalayan sediments were deposited in the Tethyan sea and were raised as a result of its closure due to the movement of Gondwana land continent northward. This Gondwana land continent was part of the Indian lithospheric plate which under thrust the stable Eurasian plate on the north. The drift took place in the late Mesozoic-earliest Cenozoic times. The Tethys Sea between the India and Asia started to close

during the Cretaceous. The boundary of these two plates is known as the Indus-Tsangpo Suture zone, along which subdirection was presumably taking place. This caused the doubling of the crustal thickness and uplift of the Tibetan plateau. Seismic and gravimetric studies have shown that the crust under the Tibetan plateau averages 60 km, while under the Himalayas it is maximum of 80 km and the average thickness of continental crust under the Indian plate is only 30-40 km.

The Assam Burma mountains also owe their origin to the underthrusting of Indian plate under the Burmese arc. The Kirthur-Suleman Ranges are on the western boundary of the Indian plate and presumably represent a transverse fault which extends to the owen fracture zone in the Arabian sea. The final Collision between India and Asia took place around 38 million years ago.

The main central thrust developed around mid-miocene, possibly due to reactivation of under thrusting ground this time. The main boundary thrust developed much later in the plio-pliesto cene time and is apparently unconnected with plate movements.

The Indo gangetic unit is a very young feature formed only during the Quarternary period. It has little to show by way of high relief and generally consists of undulating plains carved by highly developed river systems. It's surface is covered by sediments of Holocene or recent age on the west it includes the vast stretch of Thar desert.

The Indian Peninsula, entirely unlike the two preceding divisions, both geologically and physiographically. It is a stable mass of the pre cambrian rocks, some of which have been there since the formation of the earth. These rock masses -

have been there since throughout the geological history with hardly any structural changes. Among the few phaneorozoic events to affect the peninsula are the sedimendation during the Gondwana times and the Mesozoic era along with outpouring of the Deccan lavas. The topography of the peninsula, also rugged but not in the way of Himalayas. The peninsular mountains, except for the Aravali range, donot owe their origin to tectonism but to denudation of the pre existing plateaus leaving relict chains - they are mountains of circumdenudation.

An understanding of the morphology and structure of the peninsula is very important for proper understanding of an important part of Indian geology, mainly because it is composed of rocks which represent the original curst and some of the oldest sediments, now metamorphosed, ever laid down on the surface of the earth. It is mostly composed of low mountains and plateaus, drained by a network of streams watering its vast expanse. Most of the topography of Peninsula is rugged, except for the low lying coastal plains and the rann of Katchch.

The peninsula except for the coastal plains has been divided into following main physiographic regions:

1. The Central Highlands
2. The Deccan
3. The Eastern plateaus
4. The Eastern Hills
5. The Western Hills

(1) **The Central Highlands :-** These are wide tracts of hilly country bounded by the Aravali Range on the west, and the Satpura range on the south, seperating

the great plains from the peninsular plateaus. The Aravali range strectches from Delhi towards the south west for a distance of about 700 km. The east Rajasthan upland lying east of the Aravali, 250-500 m high consists mainly of ancient crystelline rocks. The Madhya Bharat Pathar is essentially a plateau with rock surface made up mainly of the ancient Vindhyas sediments, through which the chambal river has with a deep and wide valley. The Bundel Khand upland lies further to the east, presenting an old erosional surface cutout from granitic and genissic rocks. The Malwa plateau is a large physiographic feature made up mostly of lavas. It has rolling surfaces and flat topped hills dissected by several rivers of which the chambal, Betwa, and Parbati are important. East of the plateau, the Vidhyan scaplanals form a series of table lands, separated from each other by prominent sandstones scarps. At the foot of Vindhyan range lies the Narmada Valley which is a structural depression between the Vidhyan and Satpura ranges.

(2) **The Deccan: -** This a vast territory occupying the major part of the peninsula, extending from the stapura Maikala ranges in the north, through the Maharastra plateau, to the Telangana and Karnataka plateaus on the south. The Sahayadri forms their western limit. The Deccan traps occupy most of the Maharastra plateau, while archean crystallines mark the rest of the Deccan. Most of the great peninsular river courses run through the Deccan hills after arising from the Sahyadri Ranges.

(3) **The Eastern plateaus :-** The region has a much more varied topography than the Deccan. The main plateaus are the Baghelkhand and Chotanagpur. Also

included are the Mahanadi basin and the Dandakaranya and the much dissected Garhjat hills. The Baghalkhand plateau, bounded by the Son river on the north, and to its south occur anticlinal hills and synclinal valleys of sandstones and limestones which appear to be remnants of any ancient mountain of the type of the Aravali. The chotanagapur, plateau has three major levels, of which Ranchi plateau on granite-gneisses is the largest. To the west of the Chotanagpur plateau flows the Damodar River which drains the important Gandwana Coal basins. The Garhjat hills, south of the Chotanagpur, are made up of Khondalites and proterozoic sediments. The Simlipal massif is a remarkable feature of Precambrian rocks, attaining heights of over 1000 m. The Mahanadi basin is a low lying tract formed of the Chhatishgarh rocks, which extended to the Dandakaranya area.

(4) (5) **The Eastern and Western HIlls:-** The hill ranges are constituted of the Eastern Ghats and the Western Ghants which are essentially coastal ranges. Between the Mahanadi and Godawari rivers the eastern ghats are an almost unbroken chain of hills, but in their southern parts they occur as detached hills. The Western Ghats or Sahyadri Ranges are a major regular chain. Their northern part is made up of Deccan lavas and they rise as the sheer wall from the west coastal plains but from step like descents on their eastern flank. The southern part of the Sahyadri has a more dissected topography, an expression of the weathering of granitic gneiss masses. All the mighty rivers of the Deccan have their sources in the Sahyadri. There are the basic themes and concepts related to geology and physiography of India.

Large Dams Vs. Small Dams :-

The debate on large dams in India is organised along the following lines. These are some who totally oppose big dams on the ground of their not delivering the results that they are claimed to, and more, the social costs paid by certain sections are huge, while the benefits accrue to others. There are others who agree to the concept of big dams but want proper treatment meted to the environment - efficient planning and proper rehabilitation while another category is happy with the status quo and favour big dams as they exist without question. Here cost benefit methodology can be examined Along with cost benefit analysis of large dams in India environmental and social implications will also be considered. The techniques of resource accounting energy accounting and environmental impact assessment can be used at this point. Social issues will be examined from developing countries perspective where the state is suposed to play a crucial role in the alleviation of pove;rty and redistribution of assets.

Economic Evaluation:- Irrigation and hydroelectric generation have made giant strides since independence. India is now one of the biggest dam builders in the world: by 1979 it had construted some 1554 large dams at the cost of Rs. 10.560 crore nearly 14% of the total plan expenditure. Today we have 2240 large dams. The total installed hydro generating capacity as on 1982 was 13,856 MW as compared to about 1000 MW in 1950. The irrigation potential of major and medium surface irrigation projects increased from 9.7 million hectares in 1950 to 30.5 m. ha in 1985. The seventh plan provides for the creation of fresh irrigation potential of 4.3 m.ha at a cost of 120 billion. Foodgrains output has risen from 70 m tonnes to 170 m. tonnes.

The sixth plan documents of planning commission has admitted that the huge investment made in the irrigation has yielded disappointingly low results. The national average for irrigated land is 1.7 tonnes of grain per hectare while it should be 9.5 tonnes. A reason for this is emphasis on major and medium irrigation. The sixth plan document states that most of the states are unable to recover even the working expenses from the irrigation projects. The annual loss amounts to is 427 crore.

There is definite cost escalation in the project cost after the project blue print has been cleared. Cost escalation figures of about 254% is quite modest in comparison to those of public Accounts Committee. Thirty two major ongoing and initiated projects in the fifth and sixth plan studied by the PAc show the cost overruns of 500% or more. The committee also points out that the no project has been completed within the approved cost estimates since independence. There is also an indication of the rather long period taken for the construction of large dams. The gestation period is often over a decade. Conclusions cause drawn suggesting that the environmental calculations might go wrong by the time dam is finally completed. Similarly if irrigation is the immediate need to offset drought as is usually asserted then alternatives need to be identified with shorter gestation period. There is enormous delays in the completion of large dams, the average delay is about 160 per cent. The PAC points out that the no single project has been completed since independence within the stipulated target dates.

Environmental Implications:- Vast areas of land gets submerged under the reservoirs of dams. It is calculated that big river valley projects have swallowed 0.5 million ha. of forest land between 1951-1976 roughly one tenth of the area which has

benefitted from irrigation. For a proper land and water management adequate forest cover is a must. Instead of proper afforestation further deforestations taking place. It is in the hilly areas that forests are submerged for the construction of dams. As most of the dams take nearly a decade or more to complete the labourers working on dam sites put pressure on forest resources to meet their requirements for food, fuel and shelter putting enormous pressure on the catchment forests. Along with the flora there is inevitable loss of precious fauna. It is difficult to imagine the extent of this loss as there is no comprehensive study on them. These biological resources have evolved over millions of years and contain within them genetic resources that are directly linked to the survival of human beings. Many other crucial ecological functions like soil preservation, water replenishment and microclimatic stabilization have been ignored of late in the Narmada project, the government is talking about compensatory afforestation. Any such effort would offset just a fraction of total loss, however well meaning they might be. "It is quoted that over 6 million hectare have been severely affected by water logging. 4.5 million hect. by saline soils and about 2.5 million hect by alkali soils - composed to a total irrigated area of 40 in hectare" [1]

Irrigation without a proper drainage has disastrous effects. It is not enough to porvide water to the crops, excess water has to be drained. If not, this causes water logging and in some cases renders the land useless, as in the case of 1200 hect. in the Tawa command area. In 1981 the Auditor General of India pointed out that the Rs.3000 million Tawa project has reduced farm production instead of increasing it. The other problem is salinity. All soils contain salt. But the idea is to keep the right mixture required for the crops. A high salt contents also renders the land useless

seepage of water from unlined canal, can be result in staggering losses. A study from the Central water and power commission in 1967 revealed that nearly 71 percent of the water is lost in transit from reservoir to the field. It is only a question of time when the reservoir of the dam would be filled up with silts and other detritus and the dam will be rendered useless. The silts form a brick hard pan, mud flat when the reservoir gets filled up. The land is left un-suited for agriculture leaving a vast muddy wasteland.

Rehabilitation of the oustees is one of the least satisfactory aspects of reservoir projects. Most dams are constructed in remote hilly areas mostly inhabited by tribals and weaker sections of the society Big dams inevitably have huge reservoirs and therefore displace a large no. of people.

Displacement figure :-

Name of dam	Villages Displaced	Population displacement
Nagarjunasagar	18	13227
Krishnaraja Sagar	25	15000
Hirakud	249	18000
Almatti	228	20000
Bhakara	375	36000
Tehri	92	46000
Gandhisagar	228	51514
Sri Sailam	65	52049
Nizam sagar	40	67445
Tilaya	-	13455
Maithon	-	28030
Panchet hill	-	41461

Source - IIPA, 1988

Environmentalists are attacked for opposing nuclear thermal and also large hydroelectric projects. Hydroelectricity is conisdered to be the least pollutant.

Small Vs Large - The Question of Efficiency

The planning Commission figures show that it costs over Rs.2800 to provide irrigation to one hectare of land through major and medium irrigation schemes in comparison to 840 for an equal area by groundwater. Below given table points out that the outlay on minor schemes have been less but the potential realised is more.

Outlay on development of Irrigation potential

	Expenditure (Million Rs.)		Cummulative potential (in hect)	
	Major/medium	Minor	Major/Medium	Minor
Preplan benefits	—	—	9-7	12.9
First plan	3800 a	760	12.20	14.06
Second plan	3800 a	1420	14.30	14.79
Third "	5810	3280	16.00	17.01
Annual plan(1966-64)	4340	3260	18.10	19.00
Fourth plan	12370b	5130	20.70	23.50
Fifth plan	34120	8680	50.7	55.90
Annual plan (79-80)	10790	2600	26.6	30.00

Source — Draft 6th five year plan 1981.

"The cost of ground water development are hardly one fourth of surface water development in the seventh plan"[2]. Again a study by the Afro Asian Rural Reconstruction organization (1982) talking about irrigation planning concludes, "the investment cost of unit irrigated area for the major and minor irrigatrion projects was 118 percent more than for minor irrigation".

"Surface irrigation works may sure decisively over well irrigation possibly by a margin of 3:2"[1]. He rightly points out that It is in-appropriate to compare the irrigation projects on the basis of unit capital cost.

The success story of China in this field is an oft. quoted one advocating its implementation, in a big way in India. China has over 88000 small hydro powwer stations with the installed capacity of about 8500 MW. In contrast India has as installed capacity of 220 MW only till 1980 with no major plans for expansions.

Small hydal shemes require a only a drop of about ten metres only, they require less capital, there are lower distribution costs and transmission losses are negligible. Moreover, as production is small it meets local requirements and plays an important role in the overall development of the people of the rural areas. The Chinese experiment has demonstrated the important role such hydel units can play in overall development and direction towards the realisation of social justice.

In India there are innurmerable sites on the fast flowing hill streams and river slopes where small hydel schemes can be implemented by the construction of small dams. In some cases turbines can be fitted in the river bed to generate electricity. All that a small hill village would require is 0.1 MW of electricity. The great advantages that there can be operated by the local people; without much bureaucratic and technical help.

As per the central Electricity Authority, small hydel units cost between Rs. 8000-15000 per kilowatt of installed capacity in comparison to Rs.3000-7000 by large hydel power projects. However if we look at the small capital outlay, shorter gestation period, socio economic development, enrironmental costs loss of social and cultural

heritage and the menace of displacement, the difference can be more than substituted. The voluntary sector has installed a few micro hydel units successfully at Chamoli. Gopeshwar and Buddha Kedar where the lives and livelihood of the local people have changed for the better.

Building small chak dams with or without the provision of hydelpower generation is another viable option. A small dam can be constructed by putting a concrete block on the river stream or nullah and thereby storing water in a few acres of land, depending on the topography of the rite. The storage not only provides irrigation for Kharif and Rabi but also results in the recharging of groudwater thus enhancing irrigation by wells and tube wells in the adjoining areas. Apart from the agricultural development they play a crucial role in the regeneration of trees, bushes and fodder grasses.

Vanwashi Sewa Ashram in Mirzapur has constructed some 750 small dams, each costing about Rs.60,000 and irrigating about 40 acres of land. Similarly at Subhomarji village, 35 km north of Chandigarh, small dams have greatly improved agricultural productivity and the eco-system. The success of these experiments and also going by government records, irrigation by small projects is certainly advantageous. As far as electricity goes, we have a large installed capacity of hydropower. A lot more can be generated through mini and micro hydel projects. If China has a theorectical potential of 1,50,000 MW and a developable potential of 70.000 MW. India should not be far behind. However a proper assessment is lacking. It has been demonstrated that the alternatives are not only economical in long

run, have little or no negative effect on the ecosystem, and most importantly help in the genuine socio-economic development.

The neglect of these small projects is perhaps because that directly benefit the weaker sections and run countrary to status quo interests. The stakes in the case of small projects are not high for the contractors, engineers, politicians and bureaucrats. Thus what is needed is the perfect and complementary balance between large and small dams as per the requirement. Local needs should be taken into consideration.

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THIRD CHAPTER

THE NARMADA VALLEY PROJECT

As part of the developmental policy our country adopted since independence, to meet the requirements of the growing population for water, power and marketable commodities there has been the demand to utilise the waters of Narmada more and more, in particular after the commencement of Five Year Plans. Since Narmada flows through the States of Madhya Pradesh, Maharashtra and Gujarat this led to disputes between the involved States. In 1969 to solve this thorny problem, the Government of India constituted the Narmada Water Dispute Tribunal (NWDT). Almost after 10 years of legal wrangling the Tribunal came out with its final verdict. Massive schemes to tap the water potential of Narmada were given shape to by planners, technologists and engineers thereafter. The thrust of all these developmental measures was megal river valley schemes geared to meet power and water needs of the growing industries, urban centres and the needs of the rich cash crop farmers. Not only the technologists and planners but also the politicians were exclusively for such costly, unjust, short term resource mining.

According to current plans, the Narmada basin will have more than 3200 dams of which 30 will be major dams, 135 medium and the rest small. In fact the whole construction activity envisages a century long phase. Of this enormously destructive 'developmental blueprint' the most destructive dams will be the Sardar Sarovar Project (SSP) under construction at Vadgam in the Bharuch district of Gujarat and the

Narmada Sagar Project (NSP) envisaged at the Punasa in the Khandwa district of Madhya Pradesh.

But today Narmada is no longer an issue revolving around a dam or a number of dams. It has become the fountainhead of questions and thoughts related to the whole of human responsibility and human goals. Through Narmada, we are beginning to see the course we have opted for the future of the whole of humanity. The inter-relationships between economic development and the life supporting environment is better understood now. The issue of the sustainability of human survival dependent on natural resources particularly water, soil and easily accessible and less pollutive forms of energy, are being looked at critically. Social and political issues such as survival rights of trival societies, the immorality and impossibility of relocating people who are unable to compete with us in the current world, the need to and the means of truly democratising all decision making, the issue of involving people in the developmental processes are being brought up by the currently raging controversy regarding Narmada. Over and above all those tangible issues, there is the ethical, almost philosophical question of our right to destroy a river which could have flown eternally supporting a wide variety of cultural and natural landscapes for the short term despoilation of urban consumerism.

Historical Background

According to the integrated Narmada Valley Development Programme, the Narmada Sagar Project in Madhya pradesh and the downstream Sardar Sarovar Project in Gujarat must both be completed together. Adequate water has to be stored in the Narmada Sagar reservoir and let out to fill the Sardar Sarovar reservoir. The Narmada

Sagar when constructed will submerge 90,000 ha. Of land in Madhya Pradesh, while the Sardar Sarovar will submerge directly 39,000 ha. Of land spread over the States of Gujarat, Maharashtra and Madhya Pradesh.

Table 1.

Total Area (Official Estimate) to be submerged by the major Narmada Dams

Project	Total Submergence (Hectares)	Forest (Hectares)	Agricultural (Hectares)	No. of Villages
Sardar Sarovar	39,134	13,744	11,318	234
Narmada Sagar	91,348	40,322	44,367	254
Omkareshwar	9,393	2,471	-	27
Maheswar	4,856	-	-	58
Total	1,44,731	56,547	55,681	573

Source: Narmada Project Authority

This immense spread of land going to be drowned is immeasurably valuable forest which our denuded and desertified country can never afford to lose. Along with the forests earmarked for destruction are the richest fertile valley lands which had been under cultivation for millennia. The lands to be flooded are unquestionably the only sustenance for a large population of tribal and marginal farmers. Yet in our democratic, socialistic, independent country where development is supposed to be for the welfare of the ordinary citizens. the Narmada Water Dispute Tribunal has not bothered to estimate the socio-economic, cultural and ecological destruction due to the river valley development projects they have proposed. In spite of the fact that some of the dams in the Narmada basin were taken up for construction in the early 1960s, the various negative aspects of this project such as dislocation of large tribal populations. deforestation and even the total inability of the projects to deliver the envisaged

benefits came to light only towards the late 1980s. Developmental failures which should have enabled to rethink on our costly suicidal course have not even been topics of public debate. Even within the restricted ambit of directly affected people, such discussions have not evolved. Already the Narmada Sagar Project is stalled enmeshed in social, economic and ecological problems. But the Gujarat government in particular beginning from the Chief Ministership of the late Chimanbhai Patel took the stance that the Sardar Sarovar Project is the lifeline of Gujarat and bulldozing all objections went ahead with the project. In spite of critical feedbacks from institutions like the World Bank, irrespective of insurmountable financial crisis, each day adding to the terrible trail of human rights violations, the vested interests within the social and political leadership of Gujarat is obstinately going ahead with the construction of Sadar Sarovar Project .

Already 5 dams including Tawa, Sukta, Kolar, Bargi are nearing completion or are already completed as part of the Narmada Valley development. These dams are more than enough to show us the irreparable environmental and social disruptions and the massive economic loss inflicted upon the region. For example Bargi dam alone has uprooted and created more than a lakh refugees most of whom are tribal people whof have not been paid even a nominal monetary compensation until today. These hapless people who were part of the age old rich rural agrarian secure social systems have been transformed overnight into mere shadows of people counting their last days in the slums of Jabalpur and Vadodara. It is only since public spirited people like Dr. B.D. Sharma have brought out their horrendous plight that even within our country we are hearing about this section of our society earmarked for annihilation through our

development projects. We are shocked when confronted with this unpardonable injustice perpetrated on our own people. On the other side the disparity between the real achievements and the proposed returns from these huge investments in irrigation enhancement, drinking water supply and electricity generation schemes are even more unbelievable. For example Bargi was envisaged to irrigate 4.44 lakh ha. fields. But actually water reached hardly 12,100 ha. and even the lands that got the canal waters were totally destroyed through water logging. The soil was unsuitable for canal irrigation and the canal designs did not provide for draining the surplus waters. The Tawa project which was completed in the mid 1970's in Madhya Pradesh also created only waterlogged wasted lands.

The Tawa Project completed in 1981 was designed to irrigate 55,000 hectares. But by 1978 beginning itself problems of waterlogging became acute. It was advised that the entire canal be lined with concrete to prevent further destruction of fertile soils. Seepage loss from the canals had become 60% instead of the expected 30%. Lining of the canals and construction of artificial drains to connect with the natural drainage system to prevent waterlogging became so expensive that it was beyond the capacity of any farmer to repay. Command area development alone came to be as much as Rs. 5,700/- per hectare. Finally in some villages, roads were used as drains for the excess water from seepage and waterlogging. Also good agricultural land had to be diverted for construction of drains in order to prevent the rest of the land from getting destroyed. Thousands of acres of invaluable farmland became uncultivable wet deserts and the Tawa dam became a tragic case study of the horrendous consequences of large scale irrigation in fragile soils.

It is now feared that once the Sardar Sarovar Project is completed, it will prevent the drainage of the Narmada Sagar - Omkareshwar composite command groundwater reservoir in the direction of the natural slope of the Narmada Valley, that is towards Gujarat. Waterlogging will then affect more areas.

In areas where the fields are not waterlogged, the sudden availability of cheap and abundant fresh water through canals encourage the massive conversion of traditional farmlands which have wheat, jowar and other coarse grains along with citrus, bananas legumes etc. into very profitable water demanding cash crops like sugarcane. The sudden prosperity of the large landowners in turn initiates social and economic disequilibrium which has its negative impact both politically and ecologically. Once the canals are completed it need not be possible to actually regulate water use or encourage the really necessary and suitable crops like foods grains. The immediate profitability thereafter decides the direction of the evolution of the agrosystem to which the political leadership will always be subservient. Along with the disappearance of the cheap local coarse food grains there is the simultaneous, far costlier damage to the fields due to waterlogging, salination, chemical toxity etc. through excessive irrigation.

Since 1961 through the planned economic development implemented through Five Years Plans we have taken up the construction of 246 major River Valley Projects mostly for irrigation. Of this only 65 have been completed. Taking into consideration the negative environmental and social impacts of these mega projects and the fact that there is no possibility of recovering the thousands of crores of rupees invested in them, many experts and even the Parliamentary Public Accounts

Committees have repeatedly asked for a moratorium on mega dams. According to a report based on data of 1990, canal irrigation from big dams costs above Rs. 30,000. per hectare of command area. The soil and water conservation measures and other essential land preparation costs are over and above this estimate. We definitely cannot afford such an enormous squander of scarce national resource. Between 1975 and 1982, big dams alone have inflicted upon us the dead investment of atleast 20,530 million rupees[1].

To appreciate the magnitude of this fiasco, it is necessary to understand that the total potential that is claimed to have been created by the so-called major and medium sector of irrigation during the 40 year period from the beginning of the First Plan in 1951 to the end of the Seventh Plan in 1990 was no more than 20.2 million hectares. Even in this it has been reported that there has been an unexplained disappearance of 4.9 million hectares of precious irrigation potential. What has been reported as lost represents nearly 25 percent of the claimed total potential. The seriousness of the setback also becomes clear when we consider the replacement cost of the lost potential at today's prices. According to the Ministry of Water Resources the cost of producing 1.76 mh of irrigation potential by large projects during 1992-93 is Rs. 10.701 crores. Thus the cost of creating one hectare of potential during the first three years of the Eighth Plan comes to Rs. 60,000/-. On this basis the replacement cost of the lost potential would be considerably in excess of Rs. 30,000 crores if first, the figure of 1.76 mh is suitably corrected and secondly, if the escalation factor is alsdo taken into account [2].

The most irresponsible behaviour of the Ministry of Water Resources can be understood only if one sees how closely it has always identified itself with the major and medium irrigation sector and consistently painted it in the rosiest of hues. Yet the serious deficiencies and major scandals regarding large river valley projects have been brought to light again and again by responsible officials and researchers. Its failure to make quick use of the potential created by it and its neglect of the problems of waterlogging and salination in Command Area have become and well known. The premature siltation in reservoirs, causing disastrous floods during monsoon when the overflowing reservoirs have to be opened up to save the dam and absolute drought during summer because the silted up reservoirs cannot hold even a fractor of the expected storage also is a regular phenomenon all over the country. Its inability to increase water rates in order to meet an annual loss of around Rs.2500 crores on operation and maintenance charges alone also makes the whole venture economically unviable. In addition to all this the productivity of canal-fed areas is deplorably low and the damage the large scale canal irrigation does to vast areas of prime quality agricultural and land in our country is incalculable. According to a report an estimated 13 million hectares of land is forever destroyed by canal irrigation and the extent is growing[3]. The large scale conversion of agricultural land into monoculture tree crops or cash crops or housing colonies or industrial estates is also happening in spite of all the effort and funds pouring in for river valley projects for agricultural development. This sort of disastrous shift in land management also is taking place in the name of development. For example in Kerala the area under paddy cultivation is sharply declining even after the government has spent about Rs. 1500 crores on irrigation

projects. The total revenue earned after this heavy investment is only a paltry Rs. 2 crores per year. While it requires around Rs. 40,000 crores for the completion of spill over projects during the ninth and subsequent plans as far as the whole country is concerned, it requires Rs. 1000 crores more to complete the projects on hand in Kerala even according to present estimates. The case of the notorious Kallada Project in Kerala brings out the unviability of major dams clearly. This project in Kerala brings out the unviability of major dams clearly. This project in southern Kerala which was started 34 years ago and whose cost estimate has jumped from Rs. 13 crore to Rs. 458 crores is "still a good source of making quick money for engineers, contractors, politicians and a few layers" according to none other than the former A.G. of Kerala[4].

Objectives and Impacts of Sadar Sarovar Project

Sardar Sarovar Project is the costliest and the most massive multi-purpose project taken up in our country so far. According to the claims of the Sardar Sarovar Nigam Ltd., the apex body constituted to oversee the implementation of the project, 1.8 million hectares of land will be irrigated by this project along with the generation of 1450 MW of electrical energy. More than the raw figures, the promise of providing water to the 40 million people in the Kutch and Saurashtra part of Gujarat and the Barmer and Jallor districts of Rajasthan remains the most attractive objective of Sardar Sarvoar Project. But there are many in the world, not only environmental activists and human rights supporters but many highly competent economists, planners and technocrats who, along with the directly affected oustees from the Sadar Sarvoar Project, view this as the most horrendous social, economic and ecological designed disaster being implemented in the world today.

Impact Over Ecosystem

The Sadar Sarovar Project can be seen to be the most destructive project we have ever conceived when we take up the issue of the precious land that will be submerged, destroyed in many ways for ever. As mentioned earlier Sadar Sarover Project and Narmda Sagar Project will together submerge about 1,30,482 hectares of land of which 55,681 hectares is prime cultivable land and 54,076 hectares is forest land. In addition to this a very large area of forest and other land resources will be razed to the ground by the thousands of labourers staying in the area during the long years ahead for the construction of the dams. Over and above all this, there is the incalculable qualitative changes in the ecosystems due to the massive construction activities and long lasting environmental impacts of the dam and the reservoir. The degradation of surrounding forests and the destabilization of the remaining agro-ecosystem all around the reservoir are evident in all dams sites. The drastic change in the local climate of the area due to deforestation and the ecological adverse effects of the artificial reservoir of water on surrounding land and vegetation will ultimately harm the productivity of the land and trigger off a chain reaction of ecological destabilization of the whole area. The meandering reservoir will inundate all the low lying areas which will naturally contain the richest of forests and the most productive of agricultural land. The econological damage due to the fragmentation of the forests and the temperature and climate changes that the large body of water creates will naturally affect the overall rainfall, climate and productivity of the entire area. Moreover the loss of vegetation cover in the catchment of the reservoir will result in

massive siltation and curtain the inflow of water into the reservoir. This will together reduce the water retentitive capacity of the reservoir.

The additional land required for resettling the thousands of families and their livestock displaced by the project also has to be considered. In 1987 the Ministry of Environment and Forests had approved the diversion of 13,385,451 ha. of forest land for SSP. But actually the Department had tried to convince the Central and State Governments of the inadvisability of converting almost 55,000 ha. of forest into a reservoir.

The Department did not want any change in the legal status of the land in question, but had directed the concerned States to afforest double the area submerged in non-forest land as the project violated the 1980 Forest Conservation Act. It also had ordered the States to prepare catchment area treatment plans in detail and insisted that forest lands should not be used for rehabilitation of oustees and that tree felling would be permitted in the submergence areas only up to 4 meters below the full reservoir level. The Department also insisted that funds required for compensatory afforestation would be in addition to the normal State budgets for the Forest Departments and that such expenditure be at the cost of the project. There were also strict guidelines given for wildlife management, sand quarrying, surveying, & demarcating.

Impact Over Agriculture

The Sadar Sarover Project and the NSP together will destroy more than 1,27,000 hectares of fertile agricultural lands and rich natural forests through submersion. The more than 75.000 km long canals of envisaged so far, would alone

require more than 80,000 hectares of land. Over and above so much of productive land permanently destroyed there will be the enormous extent of land needed for the project colonies, powerhouses, powerlines, roads, quarries etc. This enormous land modification is being carried out currently with absolutely no environmental impact assessment, without paying any heed to directives from the Supreme Court, directions from the NWDT nor following the guidelines of the Ministries of Environment and Social Welfare.

The land which is being submerged is actually the most fertile lands which had been under cultivation for centuries under fairly stable and viable land use which never needed artificial irrigation. On the other hand extensive stretches of the Command Area where water is proposed to be taken through the costly canals are areas with black cotton soils, highly susceptible to waterlogging or very dry sandy soils susceptible to salination.

The SSP plans to irrigate 1.8 million ha. of land spread over 12 districts in Gujarat and an additional 75,000 ha in Rajasthan But the fact is that there is about 17 percent less water in the river than planned for. The amount of water actually available for use at the dam site at 75% dependability is only 22.69 million acre feet and not 27.22 MAF as assumed by the project authorities. The decreased water yield makes the entire claims of the project meaningless. The water from the Narmada according to the NWDTA is to be distributed in the ratio 65:32 to Madhya Pradesh and Gujarat while Rajasthan sharing the remaining 3%. Thus while under the original estimate of river yield at 27.22 MAF Gujarat would receive 9 MAF of water, under the revised actual yield of 22:69 MAF, its share would drop to 7.26 MAF. This reduced

quantum of water is specially significant for those at the tail end of the Sadar Sarover Project system that is Kutch and Saurashtra since they are the most likely to suffer if there is less water.

The availability of water in the SSP reservoir depends critically on the graduated release of water from upstream projects in Madhya Pradesh (Narmada Sagar, Maheshwar and Omkareshwar). None of these projects have any chance of ever being completed. Thus without water from these projects the irrigation and power benefit of SSP would drop by 17% and the irrigated area drop by 30%. These two pitfalls would mean a decrease in the area irrigable by the SSP to as much as 58-69% of the original estimate.

In addition to this, the irrigation efficiency of the Sadar Sarover Project is likely to be only 46% and not 60% as claimed[5] . This estimate is endorsed by the World Bank itself according to whom "most irrigation commands in India probably have an irrigation efficiency of 20 to 35%".

Over and above all this is the evaporative and seepage losses of water even in lined canals. However the project authorities have grossly underestimated these losses and have in paper raised the total area irrigable. This they have done by minimising the amount of water they would deliver per unit area. Thus the area to be irrigated will drop by an additional 23.3%. Hence it is to be assumed that the irrigation benefits of the SSP are likely to be only 44.53% of what is claimed[6]. All this will come to mean that the drought hit areas of Kutch, Saurashtra, North Gujarat and part of Southern Rajasthan will never benefit from SSP. In fact the project will be able to

irrigate only 1.6 percent of cultivable land in Kutch, 9.24% of cultivable land in Saurashtra and 20% of cultivable area of north Gujarat.

The worst threat from the SSP is the danger of agricultural land destruction by large scale canal irrigation. About half the proposed Command Area of the SSP is prone to waterlogging and salination. Preliminary studies have shown that less than half the Command Area can be called "suitable" for irrigation. 25.61 percent of the Command Area has severe limitations for sustained irrigation and 26.5 percent is not suitable for sustained irrigation at all. That means that 52% of the Command Area faces high to very high probability of waterlogging and salination. 41 percent of command area in Kutch and Saurashtra is not suitable for irrigation at all, whereas the remaining 59% has severe limitations for irrigation. Considering the skyrocketing cost of SSP construction, it is estimated that the cost of irrigating one hectare of the Command Area will be more than Rs. 1 lakh, making it the most unviable project.

The already well irrigated rich areas of Bharuch, Khera and Baroda districts will be the first to receive irrigation water naturally as in all such development projects. The economically strong and politically powerful areas will be given more water since the canal system will not be ready initially beyond the Mahi. Once the farmers get water in large quantities, they are forced to and also tend to shift from multi cropping food farming to water intensive cash crops shift from multi cropping food farming to water intensive cash crops like sugar cane as has happened over the entire Ukai dam command. By the time the whole system of canals are built, the economic and political clout that comes from growing cash crops makes it difficult for the government to curb their overuse of water. Seven large sugar factories have

already come up in the initial reaches of the SSP Command Area despite the fact that almost no sugarcane is grown there at present! In the Ukai Project in Gujarat, sugarcane now accounts for over 75% of the Command Area although the planners had originally decreed that only 30% of the command shall grow sugarcane. The official canal operation policy of the SSP is bombastic in its claims of just water distribution through water cooperatives, scientific protection of the irrigated area from waterlogging and salinity, but considering the gigantic dimensions of the project, vast areas to be irrigated and the existing corrupt and inefficient social, political and official systems, it would be impossible to fulfil a fraction of these regulations and conditions.

Sadar Sarovar Project and Drinking Water

Drinking water is planned to be supplied to 8215 villages and 135 urban centres in 12 districts of Gujarat, including all villages and cities in Kutch and Saurashtra. This claim has been one of the main moral and political justifications for the SSP beyond any consideration of cost-benefit analysis. Although bombastic claims about the supply of drinking water "permanently solving the water supply problems of villages in Kutch and Saurashtra" are abundant, none of this is supported by any comprehensive data, master plans or cost-benefit or feasibility analysis. The number of potential beneficiaries, villages and towns have increased tremendously without concomitant increase in the quantum of water earmarked for drinking water. At the time of NWDTA, no figures for drinking water beneficiaries were mentioned. But since then, the number has changed drastically from 28 million to 32.5 million to 40 million and again to 25 million. Similarly the number of villages that are supposed

to benefit has increased from zero in 1979 to 4719 in the early 1980 to 7234 in 1990 and finally to 8215 in 1991.

The project promises drinking water to 948 villages in Kutch and 4877 villages in Saurashtra. But surprisingly there are only 877 inhabited villages in Kutch and 4727 villages in Saurashtra! Apparently in their generosity the project authorities were inflating all the figures which could depict SSP as a most desirable developmental measure. It is now obvious that the project itself will never get completed nor will water flowing through the canals ever reach the villages at the tail end of the distributaries. At the same time work on the dam continues to take away all the money badly needed for rural developmental schemes in Saurashtra and Kutch including drinking water supply schemes which should have fructified immediately.

According to the two available reports on drinking water the total projected water requirements in 2021 for domestic, industrial and thermal power projects is estimated to be 1.37 MAF[7]. Sadar Sarovar Project is to provide 0.75 MAF which works out to a gross demand of 1.06 MAF after adding losses in the system.

The NWDTA had allocated 1.06 MAF for non-agricultural uses from Gujarat's share of 9 MAF water from the Narmada. Of this 1.06 MAF, 0.853 MAF has been set aside for drinking water purposes and the rest (0.207 MAF) for industrial use. According to one study drinking water requirements are 227 litres/capita/ day for cities with a population of more than 1 million, 140 LPCD for other urban areas and 70 LPCD for rural areas. In the same document the drought hit rural areas of Kutch and Saurashtra are assigned only 55 LPCD. It is mentioned that areas with high cattle density will be provided with 30L/cattle/day but then this need is ignored while

calculating the amount of water required! It is worth remembering how the sad picture of thirsty cattle was used in all the media as advertisement for the project's benefits.

The cost of supplying drinking water to an extensive area has not been included in any cost-benefit analysis of the Sadar Sarovar Poject to date. This additional cost will make the financial feasibility of the project very questionable. The estimated cost of supplying drinking water is 728 crores which is well over 1500 crores in current terms . The NCA report however asserts that the cost "would run to several thousand crores". It is considered 4719 villages in its cost estimates, the current number of villages is estimated to be 8215. The projected cost of supplying water to villages is 3-4 times that of supplying water to urban areas. Thus the cost of supplying drinking water may become incalculably high with the current increasing claims and targets.

It is displayed a strong urban bias in the supply of drinking water. In an area where the population is approximately 70% rural, 63% of project beneficiaries are urban dwellers. Cities are to receive 80% of the total quantity of drinking water. Four major cities, Ahmedabad, Vadodara, Rajkot and Jamnagar accounted for over 40% of the water to be supplied by SSP and Ahmedabad and Vadodara alone accounted for 25%. This it is clear that the large urban centres in Gujarat are to be the true beneficiaries of Sadar Sarovar Poject[8].

The geographical spread of the beneficiaries that is the area of Kutch and Saurashtra alone is 109, 630 sq.km. requires very large pumping capacities, thousands of kilometres of pipelines construction and maintenance, filtering and treatment plants and setting up of extensive bureaucratic and technical infrastructure, all of which is

prohibitively expensive. According to the Central Ministry of Water Resources and also the World Bank water will reach Kutch only in the year 2025 and Saurashtra in 2020. Another aspect is the need for large pumping facilities, all requiring electrical energy, due to the widely dispersed and diverse terrain. As such, the Sadar Sarovar Poject has run into serious financial crisis and hence it is highly probable that drinking water from Sadar Sarovar Poject may never reach these areas.

Generation of Electricity

The planned installed capacity of SSP is 1450 MW, of which 1200 MW will be generated by turbines installed in the riverbed powerhouse (RBPH) and 250 MW from the canal head powerhouse (CHPH). But actually power will never be produced at 1450 MW. The RBPH will produce electricity only when there is enough water in the river. As the canals for the SSP are completed, water abstraction for irrigation will decrease water diverted to the RBPH turbines. Thus the firm power generated by RBPH will drop from 415 MW to zero MW and the power from CHPH will increase from 24 MW to 50 MW. Thus the final firm power from the entire SSP is only 50 MW. Thus the final firm power from the entire SSP is only 50 MW, while at its highest, the firm power from SSP is 439 MW. However, the graduated release of water from the Narmada Sagar Project upstream is essential for even this power generation to occur.

It is now clear that the SSP will actually consume more energy in Gujarat than will ever be produced for Gujarat buy the dam. Power from the SSP is to be divided amongst Madhya Pradesh, Maharashtra and Gujarat in the ratio of 51:33:16. Gujarat's share of the highest firm power production is 70.4 MW (16% of 439 MW) which will

only be obtained in the few years the canals are not supposed to be in operation. Once the canals start functioning, the Sadar Sarovar Poject will require vast quantities of energy for lifting water in the canals, operating the extensive tubewells etc. Supplying drinking water to 8215 villages and 135 towns is going to require large expenditure of energy for pumping and maintaining flows in very long pipelines. None of these power costs have been included in any cost-benefit analysis of the Sadar Sarovar Poject.

The problem of Rehabilitation

The Sadar Sarovar Poject reservoir will directly destroy under submersion 37,000 ha. of land. Canals weirs, dykes, colonies for project staff, land to be protected immediately around the vicinity of the reservoir to prevent siltation, and for compensatory afforestation, forest land which will have to be developed into a Wildlife Sanctuary after evicting the local resident tribal societies will all together result in the displacement of more than 10 lakh people. A very significant proportion of the population which will be displaced are tribal societies. These tribal groups with very distinct cultural identities cannot easily adapt to any means of survival and in any place other than what they had been traditionally accustomed to. Our past experience and the current trends leave no doubt as to the fact that there is neither the political will nor the land or money even to merely physically resettle them. In today's cruel competitive world we all know that once such fragile human societies so deep rooted in their surroundings are uprooted they perish in no time. We can forcefully relocate communities but we can only rarely rehabilitate even individuals and never for sure human communities of such complex dimension.

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FOURTH CHAPTER

TEHRI DAM

Unlike the Narmada Valley Project which is located in the region of Central Indian Plateau, the Tehri Dam is located in different physiographic setup. The altitude is around 3000 mtr., it is being constructed in a very narrow valley.

A study of the Tehri Dam takes on additional importance, because it is the first time that a detailed environmental impact-assessment of a large dam has been undertaken officially, as a result of the collective organized protests of local citizens. The latter recognized the dangers to both the human and natural environment locally and in the overall area upstream and downsteam of the dam. The examination of the process of Tehri project clearance is revealing. At a meeting, which Shri HN Bahuguna was addressing, he was asked how he had cleared, when chief minister, a project which he was now opposing. He said that he had to examine the voluminous papers prepared by the project authorities, in the early hours of the morning, when was not at his best but that this time he had been with the files. He considered he had to trust his engineers. He acknowledged that he made a mistake and that he was now correcting it, it is ironic that Shri Bahuguna himself persuaded mistake and that he was now correcting it. It is ironic that Shri Bahuguna himself persuaded local people to drop their early opposition to the project, assuring them that it will bring local people to drop their early opposition to the project, assuring them that it would bring many benefits. Socio-political aspects linked with clear signs of damage due to the project and road building, with later availability of the Tehri Dam Project report, augmented

the fears of local citizens. They presented a petition to Parliament. A Parliamentary Committee of Enquiry was established but was unable to submit its report before the Janata Government, then in power, was replaced by the Congress. However, following continued representations, the late Prime Ministers, Mrs Indira Gandhi, ordered the establishment of a Working Group for the Environmental Appraisal of Tehri Dam in December 1979.

Seismicity of the Region

Noting the existence of four seismological observatories and that observations with mobile instruments indicated very minor seismic activity near Tehri, the Working Group considered that the "data so far collected is inadequate". It required monitoring "at more numerous locations" and "of the faults lying within a radius of 100 km of the Tehri Dam". For various technical reasons this has not been done but suitable instruments are now available. The report related its recognition that "it looks probable that the seismicity level may not be enhanced by the construction of the Tehri Dam in the absence of increase in seismicity in other large dams in the Himalaya. It also noted that in only 15 out of 425 large dams has seismicity increased due to reservoir filling it is revealed that the Tehri Dam's 260 metres height is relevant because six out of 20 reservoirs between 150m and 250 m i.e. 30 per cent. witnessed RIS[1]. The report required continued seismic monitoring" to build up a statistical data base and to take appropriate control measures as may be required anytime in the future - this has not been done.

Geomorphology

It is necessary to have a detailed geomorphological map of the catchment. It can be summarised as follows:

(a) Prepare geomorphic map on 1:50,000 scale to identify different types of land forms existing in the area.

(b) Conduct drainage basin analysis to know of the behaviour of channel network with fluvial processes.

(c) Present status of soil erosion in the catchment.

(d) Slope analysis for stability characteristics - rim of lake and the catchment.

(e) Genetic study of landslides.

(f) Identification of active and inactive landslides.

(g) Landslide zonation.

The Problem of Siltation

Due to physiographic condition and deforestation of forest in a catchment area the problems of siltation has become acute problem. The following steps have been taken and can be taken to check the siltation problem.

(a) Soil and water conservation, land use planning and flood control works should be done on a wathershed basis

(b) The flood control programme should be a combination of soil and water conservation in the upper reaches of rivers and streams:

(c) Afforestation and soil conservation must be ensured

(d) If any forest area is submerged or required for resettlement, equal forest area must be afforested

(e) The management of village common lands and the so-called wasteland should stress growing of fuel, fruit and fodder trees and grass. At present these areas do not give any economic return but are a source of sediment and floods.

(f) There should be provision for soil and water conservation measures in the project so that the large resources provided are utilized effectively:--financial resources being allocated.

(g) Roadside landslips and landslides and other slip-zones must be stabilized:--considerable stabilization done at the dam site but nothing in the other areas.

(h) Banning all commercial forestry in the catchment.

Figures from the Irrigation Commission Report are illustrative of the serious gap between estimated and actual rates. Conditions have already deteriorated further through deforestation, over-grazing and cultivation of steep slopes.

Annual rates of siltation in selected reservoirs (in acre ft)

Reservoir	Assumed Rate	Observed Rate
Bhakra	23,000	33,475
Naithon	684	5,980
Navurakshi	538	2,000
Nizamsagar	530	8,725
Panchet	1,982	9,553
Ramganga	1,089	4,366
Tungabhadra	9,796	41,058
Ukai	7,448	21,758

The project report also makes a comparison with figures quoted by Carl Brown of the US Department of Agriculture, based on the condition of the reservoir catchment of US rivers, drawing the conclusion on the 100 year expected life of the Tehri Dam. There is no meaningful basis for this comparison because there is a vast difference in the rate of soil erosion between US and Indian rivers. According to figures presented some years ago by Shri HN Bahuguna, then Minister of Irrigation, the rates of soil erosion in acre ft per 100 sq miles per annum are shown below:

India		USA	
Sutlej	150 acre ft	Columbia	1 acre ft
Beas	400 acre ft	Mississipi	6 acre ft
Ravi	400 acre ft	Tennessee	12 acre ft
Yamuna	400 acre ft	Colorado	36 acre ft
Kosi	500 acre ft	Rio Grande	61 acre ft

Development objectives

What emerges challenges the main purpose of planning in India, which holds that such projects should contribute to the general uplift of the common people. Though contributing to food surpluses and additing hydro-power, the negative impact on the economically-deprived sections by such large projects is well documented. Many villagers upstream have either been ousted or partially deprived to their lands and landless labour not even compensated. The economic condition of those who remain worsens, except for a minority. Downstream villages, once sure of abundant water from rivers find alternate flood and famine in water supply. In the Tehri area, hill

villages which once had springs, now fact acute water shortages. Reservoir water resources and energy generated go to urban centres, industry and richer farmers. Delhi already receives 200 cubic metres per second from the Ramganga dam and is scheduled to receive 300 cubic metres per second from Tehri. The resettlement areas are still as unsatisfactory as they were when visited in 1980 and the resettlement plan still unformulated. Except that we continue to apply precolonial feudal norms, there would be a crescendo of public protest at wheat the report records as, in effect, an infringement of "the constitutional and fundamental rights of the affected people."

Cost-benefit considerations

There are 1,554 large dams listed as under construction or completed. None has met the original completion schedule. All have exceeded the cost estimates very substantially and none has achieved the calculated benefits. The poor data-base and tendency to overlook inconvenient studies and to discouant contrary views has evidently contributed to many distortions. This may also cause severe problems in both the short and long term. Drought for successive years in Gujarat, Maharashtra and other states with more than doubling of the flood-prone area in a decade indicates the limitations and provides evidence of dependence on incalculable climatic variations and damage to the natural environment. For instance, of the large dams listed, 276 are in Gujarat and 631 in Maharashtra where the incidence of drought has steadily increased and forest cover has been severely depleted.

The structural design of the Tehri Dam is based on the expectation of the maximum credible earthquake once in the life of the dam. However the seismic co-efficients for the design vary from 0.15g through 0.25g to 0.56g[2]. All three used a

different base, but all lack in-depth seismic data, therefore 0.25 g may mean excessive cost through over design, while 0.56 g may mean economy at the expense of safety.

The Himalayan rivers are snow-fed. Although the first of the large dams, Bhakra, receives only 16 per cent of its flow from catchment rainfall, no in-depth glacierological study is available. Whatever flow data is collected is not for public distribution for security reasons, but there is ample evidence to show that it is able to contribute little to effective water management. Gujarat is again an example. In 1986 about 150 dams had to release flood waters while about 120 lacked enough. In 1987 most dams have almost no water and others barely enough for essential supplies. Though this fluctuation is a general feature for most dams, it is aggravated in Gujarat where total or near-total lack of continuous monsoon flow in rivers with dams, inhibits natural recharge of ground water acquifers. This has lowered the water table, led to drying up of wells and water salination, adding to drought hardship.

The environment and development

In the six years since the submission of the Tehri Dam Interim Report very little, if anything, has been done to respond effectively to the human and environmental aspects in development planning. The emphasis has remained on technological infallibility and the conviction that environmental considerations have to give way to the thrust for development. There is increasing realization that environmental conservation is an essential component for sustainable development. The changing policy approach has to strike a balance, as prosperity in the short term with a degraded environment becomes counter productive. An integrated examination of dams linking the environmental appraisal of the Tehri Dam and the implications of the Russian turn-

key project, which more than doubles the installed capacity of the whole project to the overall plans, hampers the immense energy potential of the Himalayan rivers.

Since Independence more than 200 projects involving large multi-purpose dams have been examined. Accurate statistics are not readily available but apparently 23 have been finalized, some completed and the rest under construction. With the exception of the Tehri Dam, there has been no examination of the impact of the Himalayan econology of the various hydro-electric power and other development projects, including staff accommodation construction, road building, etc. Such a monumental interference with the natural systems has caused many grave problems in the Himalayas and on the Gangetic plain. In all cases, including the Tehri Dam, the projects have been examined in isolation without any effort to consider the consequences or the accumulated environmental impact of so many major projects. Any meaningful assessment has to examine, in detail, the cumulative de-stabilizing potential of multiplicity of dams and the large number of other environmentally disruptive projects. Any meaningful assessment has to examine, in detail, the cumulative de-stablizing potential of multiplicity of dams and the large number of other environmentally disruptive projects, the over-exploitation of the forests in the catchment areas and the silt and flow contribution of the glacial areas. The known unstability of the Himalayan slopes in a highly active seismic zone has been seen only in relation to the design parameters of the dams. No meaningful weightage has been given to the known prevalence of landslides, the extensive deforestation and soil erosion and the heavy silt and bed load in all the Himalayan rivers.

Irrigation and hydro-electric power engineers are wedded to the building of dams as the most cost effective means of increasing food production and of generating hydro-electric power. Until recently, this was thought to be more economical and less damaging to the environment than other means of producing much-needed energy. Neither premise is accepted any longer. The evidence obtained from indepth studies of the numerous large dams built all over the world has shown that cost-benefit calculations have been tailored to meet planning parameters for clearance and that there is considerable damage to the natural and human environment. The evidence obtained from indepth studies of the numerous large dams built all over the world has shown that cost-benefit calculations have been tailored to meet planning parameters for clearance and that there is considerable damage to the natural and human environment. The latter has not been taken into consideration when calculating costs. The multiplicity of negative environment impact in general and on individual projects has forced a totally different evaluation. It is now recognized that dams are a high-cost, slow-gestation approach to energy generation. They constitute a major-interruption of the natural flow of river, resulting in substantial modification of the ecosystem and alternation of the hydrology upstream and downstream of the dam site. This has been highlighted by the prestigious Washington-based World Resources Institute study on major public financed irrigation systems. It points out that "large irrigation systems have extensive environmental impacts, displacing whole communities, flooding valuable forest and agricultural lands, and threatening critical ecosystems".

It can be made a similar indictment that "large-scale water projects have also provided the infrastructure for introducing new forms and scales of production Third World countries[3]. They have also been, however, a source of significant environmental change, unexpected harmful disease, the impoverishment of aquatic fauna and decrease of water quality. Furthermore, the resettlement of local people has seriously affected their cultural patterns and lifestyles. In the last 20 years, more than 500,000 people have been resettled, just for the dams financed by the World Bank. These social and environmental costs have very often outweighed the benefits of water projects and could explain the early interest in adopting an EIA (Environmental Impact Assessment) for evaluating this kind of project."

Even in purely techno-economic terms without considering human and environment factors, it is becoming clear that costs are seriously under-estimated and benefits grossly exaggerated in order to arrive at the cost-benefit ratio required for clearance. Mere feasibility and the assumed costs and benefits have now to be examined in relation to the environmental impact,l which affects the project itself, and results in the social, cultural and economic dislocation of the communities uprooted and those remaining in the area, following the substantive changes caused by the project on completion as well as during the construction period.

No detailed analysis has been done of the extensive overall augmentation of costs but the immense shortfall in benefits is well established. The Planning Commission has recorded that the production of irrigated lands is about 1.7 tons per hectare against the expectation of four to five tons per hectare. On a broader base the

Prime Minister stated the failure of such projects to provide benefits to the people in a statement at the State Irrigation Ministers' Conference:

"The situation today is that since 1951, 246 big surface irrigation projects have been initiated. Only 65 out of these have been completed; 181 are still under construction. We need some definite thrust from the projects that we started after 1970. Perhaps we can safely say about these projects that for 16 years we have poured money out. The people have got nothing back, no irrigation, no water, no increase in production, no help in their daily life. By pouring money out to a few contractors or a few thekedars and labourers to build canals and and may be Public Works Departments to construct the dam, we are not really doing our people a favour. The favour cmes when the project is completed, when the benefits of the project start flowing".

The tendency to assess cost-benefit ratios so that the resultant figure meets the planning requirements, is common to all countries. This general position was assumed by President Carter before he became president:

"In many Corps of Engineers, dam projects around the nation, the benefit-cost ratios have been grossly distorted. Data and premises on which project approvals are sought are erroneous and outdated"."On the Sprewell Buff Project, "c"nstruction costs were under-estimated, extremely low interest-rates were assumed, nearby lakes were ignored, population projections were exaggerated, environmental damage was concealed, power production estimages were based on overloaded generator rating...."

Independent observers in India and elsewhere have noted that the statis tical approach to cost-benefit analyses has invariably been presented to meet the required

parameters to ensure project clearance. In India one can safely assert that no major or medium hydro-project has met, even approximately, the original cost estimates. Also, every project, however beneficial, has failed to provide the targeted benefits. What is really conspicuous is the gap between the irrigation potential of 20.8 million hectares (mha) created at the cost of Rs.15,206 crores between 1951 and 1985 and the 15.6 mha actually utilized. The creation today of the 5.2 mha unutilized would cost an additional Rs 15,000 crores. In addition, at least seven mha of productive land has been salinized, some 22 mha of the catchments of major projects are critically eroded of which only two mha have been treated and irrigation projects have been causing losses around Rs 800 crores per year[4].

Humanitarian aspects related to Tehri Dam

The costs have almost totally ignored the human tragedy though some nominal attention has been given to rehabilitation. In practice there is no record of a single successful programme to resettle the oustees. Those uprooted due to the Bhakra Dam made little or no use of the official relocation offers. Except for those who resettled themselves in the catchment area, the uprooted have added to the urban and rural poor. Because each project has been viewed in isolation there is no overall estimate of the total oustees from the 1554 large dams in India. At a rough estimate the total is between six and a half to seven million souls, most of whom are from the economically deprived tribal and forest-dwelling sections, with no means of questioning the arbitrary acquisition of the areas that they have occupied from earliest times. It should be evident but is not "that the economic benefits of the water resource development should be conferred as much on the people uprooted and living in the

lake basin and catchment area as in the command area and in cities with their industries in the plains"[5].

The reality goes so very much deeper emotionally. People, wherever they are in the world, have a deep rooted attachment to the place of their origin, and Indians conspicuously so. How much stronger this is for rural people needs like emphasis ! This sense of loss is movingly expressed by an American, a Cherokee Indian, speaking about the inundation by the TVA Tellico Dam of a homeland from which his people had been moved a century earlier during the infamous "Trial of Tears". "We cannot separate our place on the earth from our lives on the earth nor from our vision and our meaning as a people. We are taught from lives on the earth nor from our vision and our meaning as a people. We are taught from childhood that the animals and even the trees and plants that we share a place with, are our brothers and sisters. So, when we speak of land, we are not speaking of property, territory, or even a piece of ground upon which our houses sit and our crops are sown. We are speaking of something truly sacred. Is there a people anywhere in the world that does not revere its homeland? Is there a human being who does not revere his homeland, even if he may not return ?"

Himalayan ecology

This view runs concurrently with the larger issue of the need for environmentally sound development for all development projects in the Himalayas, and indeed elsewhere. In 1975 a work was done to analyse the symbiotic relationship between the condition of the Himalayan ecology and the future well-being of the Indian people:

"The adverse consequences of indiscriminate deforestation and shifting cultivation are now manifesting themselves in numerous ways like flash-floods, landslides, soil erosion, silting of canals and reservoirs... The damage to the Himalayan ecosystem through extensive deforestation and landslides promoted by the methods adopted for the construction of roads, mining etc., has become a matter of global concern. If we do not arrest and reverse this process before the end of this century, the entire future of Indo-Gangetic agriculture may be in danger. Since the Indo-Gangetic belt has the maximum untapped agricultural production reservoir in the country, our ability to feed 1000 million in another 25 years is inextricably linked with the restoration of the Himalayan ecosystem"[6].

The Working Group emphasized that the sacred and mythological significance of the Bhagirathi and its identification with the continuity of Indian culture and civilization is a very significant element. It is related to deeply held emotional and religious values and traditional behaviour patterns, current over millennia. The inundation of Tehri town wipes out a pilgrim centre with two annual melas. The site itself allegedly lies in the Puranic Ganesh Prayag Kshetra. Some clain that the Ganesh temple at the confluence of Bhagirathi and Bhilanganga is described in Kedar Khand Puran.

Despite the planners' comparative indifference, the area does have special importance for the people quite apart from generational associations over several centuries. The Working Group, therefore, recorded its view that the arbitrary ousting and simultaneous dislocation of the life of the local people remaining in the area, the inundation of most of the richest agricultural land in the area and the cutting off of

villages on the opposite banks of the Bhagirathi and Bhilanganga rivers will cause great hardship. This, as the report specified, infringes on the constitutional and fundamental human rights of the affected people.

Flood control

The grave degradation and deforestation of the unstable slopes add substantially to soil erosion and increase the snow melt and monsoon run off with little water retention to maintain the flow during the rest of the year. The main source is from the 1875 sq kms of the 7511 sq kms under glaciers. Melt from them continues from February to October, generally speaking, to coincide with the height of the monsoon, complicating flow calculations and increasing flood potential. The combination renders meaningless and estimates of hundred year and thousand year floods. In addition, the recession of the glaciers, including the Gangotri glacier, has left large morainic stretches exposed which, with the impact of freeze-thaw action in an area 12 to 15 per cent of the catchment, adds considerably to the silt carried by the rivers and their tributaries. The Ganga basin thus combines significant monsoon precipitation with substantial glacial melt.

In the final recommendations of the Working Group's report, it emphasized the importance of mini and micro hydro-power schemes and those which did minimum damage to the environment. This coincides with the Planning Commission recommendation that such economically quick gestation projects should be given priority. Unfortunately, the hydro-power specialists have given very little attention to the immense potential in this field, partly because there is little prestige and limited financial allocation. A dramatic indication of the immense potential is provided by the

creation, in China between 1949 and 1983 of 8,500 megawatts (MW) of hydro-power from 76,000 micro and mini projects and since then has added 1000 MW every year by this means. Since most of this is allocated for rural electrification with consequent decentralization it results in a substantial reduction of transmission losses and the economic and environmental cost of transmission lines.

The details and the scope of Russian involvement are still shrouded in secrecy. Public announcements that the installed capacity will be 2000 MW, for which the appraisal was done, clearly involves construction of the Koteshwar Dam downstream as a storage for water. Implications have, obviously, not been examined and the project has been approved despite the absence of environmental clearance and without even environmental appraisal of the additional impact of the second unit.

The Russian experts have reportedly expressed confidence about dealing with all the environmental aspects. No information is available about events in Russia but there is considerable information and controversy about the immeunse social, economic and environmental damage, done to Egypt by the Aswan Dam constructed by Russian experts. There are fortunately or unfortunately some common features. Egypt has from earliest times been dependant on the Nile. India's past, present and future rest on the interrelation between the structurally unique Himalayas, the Ganga and the vast alluvial Gangetic plain. As in Egypt there are socio-cultural links but for Indians there is no break in the timeless religio-cultural traditions reaching back many millenia before recorded history, as important today as they were then.

The Aswan Dam represents an impressive high dam in the Himalayas. However, let us not face, as for the Aswan Dam, through lack of comprehensive and

accurate data, the environmental consequences of such a massive interference of the life-giving holy Ganga. President Mubarak's own words best illustrate the immeasurable negative consequences for Egypt of Aswan. At a recent meeting seeking help to solve "the major challenges that Egypt will face between now and the year 2000", he emphasized the need for serious scientific study of the problems. He concluded, "Among these the secondary effects of building the Aswan Dam require your special attention. To overcome them is, in effect one of the main challenges Egypt has to face". To many technically experienced observers there is almost no solution other than to revert to the old pre-Aswan dam as the following major consequences of Aswan make clear.

Egypt has learnt to its cost how the Aswan Dam, despite an important augmentation of irrigation and of hydro-power, has done incalculable damage to the natural environment, disrupting 7000 years of annual natural regeneration of the soil, changing the condition of the Nile delta and damaging the fish-rich lagoons at the mouth of the Nile through the blockage of the nutirent filled silt above the dam. The dramatic changes in the upstream environment have increased the silt load to such a degree that the estimated annual loss of 60 million cubic metres of storage per year on which the 500 years life of the dam is based, has increased to such a degree that a recent satellite-photo-based study now estimates that the life of the Aswan Dam is not likely to be more than 50 years. Health-wise, the increase of schistosomias in the four areas studied only three years after perennial irrigation, has risen from 10 to 44 per cent, 7 to 50 per cent, 11 to 64 per cent and 2 to 75 per cent.

There is considerable waterlogging and water channels are so clogged that even an input of US $ 600 million by the World Bank has according to a later World Bank survey, failed, and the salinity of the Mediterranean is reportedly increasing, at least partially, because ofd the Aswan Dam. Only some of these consequences were even marginally anticipated and to correct them Dr Tolba, Executive Director, UNEP, mentioned in a Delhi NCEP meeting that he, as the then Egyptian Minister in charge, had estimated the cost of correction a few years after construction would be over US $ 1000 million. The other aspects have increased the life-sustaining struggle of the vast rural majority.

The crucial issue rests on the advisability of building high dams in the Hamalaya. Harsh Gupta's study considers the earthquake risk too great. At a public presentation chaired by the Irrigation Secretary in 1986 he presented this view. In response to the Chairman's questions whether in the light of what he had said it was not right to build the existing dams. Harsh Gupta said, "I am afread So!" A 1980 study by the UP Irrigation Department provides obliquely a basis for his view: "It is a well known fact that the Himalaya have not attained their Isostatic Equilibrium. The movements related to the attainment of Isostatic Equilibrium are unnoticeable, being of the order of a few inches per thousand years and are simultaneously occurring in a very vast area in the entire Himalayas, in which Tehri Dam site occupies on insignificant area. Hence, these movements will not affect Tehri Dam or the reservoir. If, for arguments sake, it is presumed that these movements will adversely affect Tehri Dam and reservoir then they will affect all the existing and future dams located in the

Himalayas and therefore no dams should have been or should be constructed anywhere in the Himalayas."

A UP Irrigation Research Institute study on Sedimentation Problems of the Tehri Dam records conclusion which serve to emphasize the ureality of the siltation study and the calculation of the life of the Tehri Dam: "Sediment problem is a complicated one and the science dealing with the formation, transportation, deposition, measurement, analysis and treatment of sediment is still in a developing stage and needs consistent efforts for improvement.

Himalayan rivers carry comparatively large quantity of sediment due to unstable and steep slopes with rocks highly fractured, folded and faulted.

These sediment loads cause heavy damage to hydro-power stations by abrasion, to water conductor systems and the runner blades, and reduce useful life of the reservoir.

The concept of life of reservoir has not been generally properly understood. It is not correct to assume the life of reservoir as the designated period of 50 or 100 years for which the provision of silting is made in the reservoir capacity in the form of dead storage. Every year there is encroachment on live storage as well. A plot showing the available capacity versus time can be developed and from this plot it would be easy to ascertain the time when the project will fail to meet the minimum basic demand as originally fixed and this period is termed as the useful life of the project.

Experience as at Maneri Bhali Stage I is itself a typical case where failure to consider the impact on the turbines of the heavy silt-load caused considerable damage.

It also resulted in stoppage of work and considerable wasteful expenditure directly and through failure to generate power when out of action.

Whatever may be the reasons for clearing a project with such a dire disaster potential there can be no possible justification without extensive expansion of the data base on seismicity and siltation and corrective action for the many points listed in the Interim Report and repeated in more detail in the final report. Action is necessary on a number of other issues raised, such as measures to alleviate local hardship and reduce stress on the environment, a more comprehensive enlightened rehabilitation programme, creation of ahigh level catchment area authority and introduction of dam safety legislation. The large issue of the relationship between initial cost-benefit estimates and the project completion ones is crucial to ensure most effective utilization of scarce financial resources.

None of the projects under consideration or construction should proceed without detailed data-based Environmental Impact Assessments. This should be done professionally and subject to public scrutiny. This is essential because a resemblance that the EIA for the Narmada projects bears to a scientific study is purely accidental.

In the case of Tehri. in the light of 200 deaths, about 2000 injured and a damaged township at Koyna following a Reservoir Induced Earthquake, magnitude 6.3, an in-depth risk analysis is mandatory, based on extensive seismicity data nd information on the geomorphology of the catchment. The occurrence of earthquakes of magnitude seven with 100 metres of the Tehri Dam indicate tension build up leading to a magnitude of eight or more during the life of the dam.l None of the experts disagree about this. The structural design of the dam has been done on this

basis. The impact of one in the area of the dam or in the catchment or one of less intensity near the dam site or the reservoir will result in a catastrophic tragedy for Rishikesh, Hardwar and beyond: Neither the promoter nor those who build the dam will be around to bear responsibility.

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FIFTH CHAPTER

CRITICAL EVALUATION AND CONCLUSION

In a developing country like India, where an overwhelming majority of population are depending on agriculture, the execution of large dams is an important growth strategy. These multipurpose dams were known mainly for their contribution to economic development by providing irrigation, electricity and flood control, besides inducing significant benefits, have also caused huge displacement, injudicious use of finances, submergence of huge tracts of fertile and forest lands, destruction of wile life, widespread waterlogging, siltation, etc. In the process of dam building. India ranks among the important dam building nations in the world. So far, more than 1500 dams have been executed in different parts of the country, which are regarded as essential for meeting the country's critical requirements of agriculture, electricity for various purpose and flood control.

The Narmada project which has been a largest development since 1946, was subjected to long delay for various reasons has finally been cleared by the Union Government of India during 1987[1]. The Narmada project is considered as the biggest riverine complex ever attempted in the human history. The project envisages the construction of a series of 30 large, 135 medium and 3000 minor irrigation and power complexes, over a period of 50 years as a part of complex programme of irrigation and hydro-power development. The two largest dams constructed in the process are Narmada Sagar and Sardar Sarovar projects, which between them hold more water than any other dam in India. It has positive implications in terms of irrigation and

power benefits, employment generation & negative implications in terms of human displacement & ecological destruction.

The desirability of Tehri Dam Project has been increasingly questioned on safety and ecological grounds. With various claims and counter-claims being made on this subject today, it is instructive to look at what senior geologists officially involved in the project have to say about it. Here we look first at what the original project report has to say, and then at the opinion of reputed experts which has been officially obtained by the project authorities.

It is speculated that "Tehri dam site is characterised by rather difficult engineering and geological as well as seismological conditions. One should bear in mind that besides the fault zone occuring in 3-3.5 km from the dam site, the dam site is located in 20-25 km to the northeast direction from the main tectonic fracture of the Himalayan region in UP state. The area of the dam is subjected to seismic effects whose intensity by MM scale is up to VIII-IX balls"[2].

"Weak metamorphic formations occuring in the foundation and on the sides of the river gorge are characterised by their shale structure as well as by their bent from intensive weathering for disintegration into separate small blocks. Under such complicated tectonic geological characteristics of the site of Tehri Dam, located in the zone where seismic effect can reach VII-IX balls by MM scale. the problems of any type of dam construction of the height of 250 m, will be very serious and complicated".

The Marh tear, exposed about 4 km downstream of the Tehri dam-site. is parallel to the Deul tear. The Marh tear, by virtue of its upstream dip will lie at a

depth of around 7.5 km below the dam. If the release of stress in the event of future earthquake takes place along this tear, there may be a sudden fracturing and displacement along this fault.

"The Tehri dam will be located in a known seismic belt. No instrumental data is available to establish the current activity of the numerous faults and thrusts occuring in the area, some of which might have been active in the geologically recent times"[3].

A number of major landslides are present along the Bhagirathi river, the prominent ones being at Kangsali, Dobra and one upstream of Siyasu. The first two slides coincide with the suspected location of major tear faults which have caused widespread shearing of the bedrock. The removal of tee support to this sheared material by the river erosion has led to the formation of these slides. These slides are expected to be aggravated during conditions of rapid drawdown of the reservoir, wherever they lie at the higher level. In addition, along the trace of the Tehri tear fault from Kangsali to Raulakot, during conditions of rapid drawdown, a few more fresh slides are expected to develop. In the Bhilangana valley, the slides at Nandgam Khand and Gadolia are along the trace of the Tehri tear and Gadolia tear faults. These slides fall within the zone of the reservoir drawdown and are expected to get aggravated during reservoir operations. The area encompassed by the proposed TDP is of great geological complexity, as a number of thrusts and faults occur in the vicinity. The rock types exposed at the dam site area are the Chandpur phyllites, which dip steeply in a downstream direction. The project area lies in a seismically active zone of the Himalayas and a large number of earthquake shocks of varying intensity are felt in the area from time to time.

In the vicinity of the project, an area of one sq km was taken for detailed mapping to evaluate the status of activity in the Srinagar thrust. This study indicated that the Srinagar thrust has a dip of 30-45 degrees but that it steepens locally to 60 degrees. A few streams crossing the Srinagar thrust showed nick points, which indicate continuing geological activity along this thrust after the formation of the streams.

Experts in the National Geophysical Research Institute (NGRI) and university of Roorkee were asked officially for their opinion on the earthquake related risks of TDP. "NGRI and DEQ (Roorkee) reports incorporate the probabilities of earthquake occurrence in the immediate environment of Tehri Dam Project site"[4].

Further, both reports have pointed out a serious inadequacy of essential data on seismicity aspects which has to be urgently collected before anything very reliable can be said on the safety or otherwise of a structure like TD. However, the data gap pointed out by these experts remains substantially unfilled, but in blissful ignorance of the TDP authorities have ignorance of this TDP authorities have been making strange statements of confirmed safety of TDP since a long time.

The task of the geomorphological appraisal of the rim slopes was assigned to the Wadia Institute of Himalayan Geology. Excerpts from this report tell their own tale.

"Chandpur formation is the predominant rock formation in the whole area... By virtue of its composition and structure the rocks are generally weak and fragile. Top exposures are invariably highly cleaved and weathered. Tehri dam is situated within this rock formation."

"The slope instability is likely to be influenced following its contact with rain water. The working process associated with impoundment will cause.

(i) destabilisation and erosion of land,

(ii) further loss of agricultural land (hill sides), and

(iii) insecurity of settlements in the reservoir periphery".

Hence it is clear that experts have raised important doubts and fears about the safety and ecological aspects of Tehri Dam Project.

It reveals that though the Narmada Sagar and Sardar Sarovar projects create several benefits but the damages are outstripping the benefits. This does not imply in suggesting a ban on large dams. It simply draws attention in minimising the damages. The first step is proper planning and design of the project is required to outstrip the benefits with damages. Therefore necessary steps should be taken for fuller utilisation of power, which inturn increase the availability of electricity. The next important step is proper rehabilitation of displaced people. Provision of minimum facilities in the new resettlement colonies, selection of suitable site in accordance with the displaced people, imparting necessary training in the suitable trades of employment, arranging finance for various gainful vocations, providing alternative agricultural land within the command area are some of the important rehabilitation measures for planned rehabilitation. The next step should be the prior approval by the department of environment and be made as a pre-condition in clearing the projects. Further, there should be necessary provisions in the projects for massive afforestation programmes for preserving environment and also appropriate measures for checking-soil erosion, waterlogging in the project areas. Therefore, it is worth mentioning that without planned rehabilitation of displaced people measures for ecological balance, the very cause of executing large dams for nation's prosperity is lost.

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