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ENVIRONMENTAL IMPACTS OF THE SARDAR SAROVAR PROJECT

Ashish Kothari and Rahul N.Ram
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The Sardar Sarovar Project (SSP), the largest and most expensive river valley project ever initiated in India, is often described by its proponents as Gujarat's lifeline. However, it's critics feel that it may be one of India's largest planned ecological disasters. In this book, environmental aspects of the SSP are discussed here in terms accessible to the lay reader: the need for an Environmental Impact Assessment of the project and the lack thereof, the way in which conditional environmental clearance was granted to the SSP and how that clearance has effectively lapsed; the possible environmental impacts of the SSP; and whether the SSP can be justified at all.

The environmental impacts are described such that basic ideas about environmental impacts of dams and irrigation projects are clearly spelt out, therefore setting up a framework within which projects other than SSP can also be examined.

Although this is an old study, its findings and analysis remain essentially valid.

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INTRODUCTION

The controversial Sardar Sarovar Project (SSP) on the Narmada River is planned to be the largest and most expensive multipurpose river project ever to be initiated in India. The project is supposed to irrigate 1.8 million ha. of land (see Map 1), supply drinking water to 40 million people, and create an installed capacity of 1450 MW of power, over the next thirty years (Raj 1992: 11). While proponents of the project label it as "the most studied river valley project in India", reality seems to lag far behind rhetoric. This booklet takes a look at the possible environmental impacts of the SSP in the context of the requirements and conditionalities laid down by the Government of India for such projects, examines the lack of a comprehensive EIA, the status of environmental studies related to the project, and the lapse of environmental clearance for the SSP.

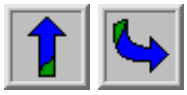
The highlights of the environmental case against the SSP can be summarized thus:

- **No comprehensive environmental impact assessment (EIA) of the SSP has ever been carried out.** It is shocking that such a large project can be allowed to proceed without such a basic condition being fulfilled.
- **The conditional environmental clearance granted to the SSP in 1987 has effectively lapsed.** The project authorities have not met most of the major conditionalities laid down by the Ministry of Environment and Forests - further work on the project is thus illegal.
- **The worst environmental impact of the SSP is likely to be in Gujarat, where over half the area to be irrigated is moderately to severely prone to waterlogging and salinisation.** The possible loss of about one million hectares of agricultural land due to waterlogging and salinisation is an environmental threat of epic magnitude, and is likely to seriously undermine the stated benefits. In addition, severe environmental impacts are anticipated downstream of the project, and even outside the so-called impact zone, e.g. in the forest areas where rehabilitation is planned.
- **Several key studies about environmental impacts of the SSP have not been carried out or remain incomplete.** In the absence of detailed studies (and, of course, access to those which have been carried out), the full nature and scope of the environmental impacts of the SSP and possible preventive and mitigative measures remain unknown.

The project authorities are thus currently pushing full steam ahead on a project, whose environmental impacts (such as can be assessed) are unclear or unknown, whose conditional environmental clearance has effectively lapsed, for which critical studies remain incomplete, and which has the possibility of destroying vast stretches of agricultural

land.

Our analysis of the environmental impact of the SSP is limited by the fact that several studies and documents which the authorities claim to have prepared are not publicly available. In addition, the magnitude of several impacts are unknown due to lack of studies. Finally, several environmental impacts are essentially unquantifiable, often because of the large number of uncertainties involved and the lack of a system to measure such impacts (e.g. microclimatic changes resulting from reservoir filling and large-scale irrigation). Such impacts are almost always neglected in cost-benefit analyses, but often carry large environmental and associated social costs. This analysis is therefore based on the limited documentation which is available on the SSP, on available experience of other projects, and on our own field observations.



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THE LACK OF AN ENVIRONMENTAL IMPACT ASSESSMENT

Summary: The diverse range of environmental impacts of major river projects requires a comprehensive Environmental Impact Assessment (EIA) before any project can be considered for clearance. This fact has been recognised in India at least since 1975, when the Central Water Commission issued its guidelines for studies on river valley projects. The SSP, like all other such projects in India, was not subjected to such an EIA prior to clearance : the study passed off as an EIA in the early 1980s was only a preliminary statement of impacts. Even now, over a decade after work on the project site started, and seven years after receiving conditional environmental clearance, a comprehensive EIA of the SSP is lacking.

Major river valley projects are known to have large-scale impacts on the physical and biological environment (Hildyard and Goldsmith 1984). Direct impacts are felt in four broad regions:

- upstream of the dam (submergence and catchment areas);
- downstream of the dam (riverine and estuarine ecosystems);
- command area (canal impact region);
- areas away from the above three regions where project-related activities are carried out (e.g. resettlement areas).

It is imperative that any proposed river valley project go through three steps regarding these environmental impacts:

1. A complete environmental impact analysis should be conducted before the project is considered for clearance, and the results of the analysis be used for judging the viability and desirability of the project.
2. If the project is considered viable and desirable on social, economic, environmental, and technical grounds, it is necessary to take preventive and ameliorative measures related to the negative environmental impacts. This requires complete workplans and their implementation.
3. Finally, once the project is built, it is important to constantly monitor the environmental impacts, and the measures taken to address them.

These three steps (prior impact analysis, implementation of environmental workplans, and post-construction monitoring) are now well-accepted parts of the planning process of river valley projects the world over. We examined the Sardar Sarovar Project (SSP) from the point of view of such a planning process.

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The major environmental impacts of the SSP should, in theory, have been studied in a comprehensive environmental impact statement before the Sardar Sarovar Project was given clearance. This was necessary to determine whether any unacceptable environmental losses were foreseen which would necessitate modification or rejection of the project. In addition, the magnitude of likely environmental impacts and the costs for their prevention and amelioration needed to be factored into a cost-benefit analysis to obtain a true picture of the financial viability of the project.

Virtually every single river valley project in India has so far ignored these basic principles, years after they have become adopted both internationally and domestically. Indeed, as early as 1975, the Central Water Commission (CWC), Government of India, had issued guidelines for conducting investigations regarding major irrigation and hydro-electric projects (CWC 1975). The chapter on environment in this document clearly states that:

"The planning, construction and operation of irrigation/ hydroelectric/ multi purpose projects have considerable impacts on navigation, fish culture, wild life, recreational aspects and overall ecology of the affected regions. Some of these aspects on the ecology of the region as well as the overall environment are irreversible in nature. It is, therefore, necessary that a careful evaluation is made of these impacts, whether good or bad ..."

The CWC guidelines then demarcated the "minimum surveys and investigations required" (emphasis added), including :

- effects on fishing downstream
- area of reserve forest ... as also the estimate of the wildlife population in the area proposed to be submerged, and indications for the possibilities of alternative proposals for relocation of the affected wildlife
- waterlogging potential, and steps to be taken to mitigate this problem
- silting/scouring of the river bed
- impact of flood problem (presumably relating to flash floods caused by sudden releases from the dam)
- salinity of flow in the river channel (including, presumably, saltwater ingress)

A few years later, the Department of Environment and Forests, Government of India, issued Guidelines for Environmental Assessment of River Valley Projects (DOE 1985). These guidelines specify the various studies which are necessary as part of an EIA, including on forests and wildlife in the submergence zone, waterlogging potential, upstream and downstream aquatic ecosystem and fisheries, water-related diseases, climatological changes, and seismicity.

The SSP authorities claim that their project has departed from previous practice by carrying out such an EIA before seeking clearance. This is far from the truth. A comprehensive EIA of even the major impacts of the SSP is not ready even now, more than

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two decades after the Narmada Water Disputes Tribunal was set up, over a decade after preliminary work started on the project, and seven years after the Government of India gave it conditional environmental clearance.

It is important to note that **the Narmada Water Disputes Tribunal (NWDT), set up to adjudicate on the sharing of waters between the riparian states, completely ignored the critical environmental issues of the project**. This is despite the fact that the Tribunal's core issues, like the benefits to be expected from SSP and the costs to be shared (NWDT 1979), are inextricably dependent on environmental variables (e.g. state of the catchment, waterlogging potential in the command, and economic loss of forests). Conversely, the tribunal's award regarding the height of dam, sharing of benefits, and others are the primary determinants of the scale and kind of environmental impacts to be caused.

The Tribunal chose to ignore environmental issues despite the existence of the 1975 CWC guidelines as well as several major publications on the environmental aspects of river valley projects in the tropical countries (Ackermann 1973; Farvar and Milton 1973). The "sacrosanct" nature of the Tribunal's Award, which the SSP authorities often quote, must be questioned on the basis of these inadequacies, especially since they directly impinge on the validity of its final conclusions.

In the absence of any directions regarding environment from the Tribunal, have the SSP authorities made their own environmental impact assessment ? A report prepared by the M.S. University, Vadodara, over a decade back (MSU 1983) has often been put forward by project authorities as the EIA for SSP. It is, however, little more than a preliminary statement of the possible impacts of SSP, and that too only for the Gujarat portion of the upstream and downstream areas; it almost completely ignores the command area. The objective of the study, as stated in the document, was to "suggest ways and means of achieving optimum utilisation of the Narmada waters without any appreciable damage to the river ecosystem". Having said this, the study goes on to consider the environmental impact of only the SSP, as if this was already established as the "optimum" way to utilize the Narmada waters. Indeed, if no "appreciable damage to the river ecosystem" was the objective of the study, a major dam could never fit the bill!

The study was based on only 6 months of data collection, that too only in Gujarat (though the impacts are also to be felt in Madhya Pradesh and Maharashtra), and did not include any seasonal or temporal variance. The reports admits, for instance, in the case of forest loss upstream: "As this bench mark study was conducted during the dry months only, not much of the undergrowth could be observed"; and further: "Viewed in the context of the large area going

under submergence, the samples (of flora) appeared to be inadequate" (MSU 1983). A number of critical impacts were mentioned but not studied in detail, includinj micro-climatic changes, loss of flora and fauna, increase of disease carrying vectors, ecological impact of forest loss, and others. And yet, the report gave the SSP the green signal, going so far as to imply that the benefits outweighed the costs. Indeed, even before starting the study, the researchers appear to have taken the project as necessary and

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desirable: in the introduction to the report they say that "dam construction and impoundment of water for irrigation and power generation thus become essential features towards amelioration of the State's (Gujamt's) economy." It is not at all surprising that the study came to the 'conclusion' that the project is environmentally viable.

In 1989, two years after the project was given conditional clearance by the Government of India, the same institution (M.S. University) put forward a proposal for more in-depth studies on various ecological aspects of the SSP, and was given the contract. The bias of the researchers, which influenced the unwarranted conclusion of their 1983 report, slips out in a revealing statement in this proposal: "Now that the project is a reality (i.e. the clearance has been obtained), a dream come true for the state of Gujarat, it is necessary that all the negative impacts pointed out by the group in their short-term report be taken up for more detailed investigations" (MSU 1989) (bracket explanation added).

Even today, there is no comprehensive EIA of the project. A large number of studies have been undertaken and some completed, but the project authorities have never bothered to try to put all the studies together. It is essential that they look at the entire range of impacts, or vital inputs will be lost. For example, waterlogging studies need to be examined by those looking at the spread of disease vectors in the command; downstream studies need to look at run-off studies, and so on. Such a holistic view has never been taken.

Given the lack of any comprehensive EIA, it is worth examining how the SSP obtained conditional environmental clearance, and how it has been allowed to continue with construction despite the effective (and officially acknowledged) lapse of clearance due to clear violations of the conditionalities.

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LAPSE OF CONDITIONAL CLEARANCE TO SSP

Summary: The clearance given to SSP In 1987, by the Ministry of Environment and Forests, was conditional. It was stipulated that within a specified time period, various assessments and workplans had to be prepared. The implication was that if these conditions were not fulfilled, clearance would be revoked, which in turn meant that further construction would not be permitted. However, despite the clear and acknowledged fact that for several years these conditions have remained unfulfilled, clearance has not been formally revoked, and construction has been allowed to continue. This makes a mockery of the entire process of environmental clearance.

In 1987, conditional environmental clearance was given to the SSP by the Union Ministry of Environment and Forests (MoEF). For several years before that, the Ministry had stalled clearance because it felt that data was inadequate to make a decision either way. During this period, intense political pressure was mounted by the Government of Gujarat on the Centre, demanding a quick clearance. Finally, in late 1986, the MoEF appeared to be giving in to this pressure. Nevertheless, it expressed its uneasiness with the state of project planning in the case of both SSP and its sister dam, Narmada Sagar Project (NSP), in a note sent to the Prime Minister in late 1986 (MoEF 1986).

In this note, the Ministry emphasized that though project formulation had been in progress for more than three decades, the absence and inadequacy of data on some important environmental aspects still persisted. The Ministry acknowledged that "the NSP is not ready for approval in an objective sense" and thus, given the critical technical and operational linkages between the two projects, felt that **"it is neither desirable nor recommended that the SSP should be given approval in isolation on technical and other grounds"**. Expressing further reservations, it was stated that "it is possible that the requisite information would at no time be fully available". However, in a familiar and completely unjustified argument, the Ministry acknowledged that **"a large amount of money has already been invested on SSP"** (at that time less than 5% of project costs had been spent!) but felt that "it may not be too late even now to modify some of the parameters of NSP and SSP to minimise environmental damage".

The Ministry's note held out the promise of capitulation with the accompanying fig-leaf of shifting blame for future mishaps. It recommended the setting up of a body with "adequate powers and teeth to ensure that the Environmental Management Plan does not remain only on paper but is implemented; and implemented pari passu with engineering and other works." The term "*pari passu*", literally meaning 'with equal speed' or 'simultaneously and equally', is

bureaucratese par excellence. It sounds reassuring, but means practically very

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little, since nobody bothered to specify exactly which part of the 'Environment Management Plan' was to be pari passu with which part of the 'engineering and other works'.

To complete the illusion of firmness, the Ministry went on to insist that the proposed body "should possess the authority to stop the engineering and other works by all means including withholding of sanctions, approvals, tenders, contracts and funds to ensure that the Environmental Management Plan gets implemented as per the approved plans and time schedules. The powers to withhold funds should be applicable to the funds made available from the State, the Centre and the foreign agencies."

Even the MoEFs highly critical assessments of the environmental implications of SSP were severely limited, leaving out vital aspects such as the impacts on the command area and the downstream ecosystems. In private, MoEF officials dealing with the subject have always maintained that SSP (and NSP) should not have been cleared. The complete failure of the "pari passu approach" has recently been highlighted in a paper on the SSP by a senior MoEF official who has been involved in assessing river valley projects since the inception of such assessments (Maudgal 1993). He has suggested that this approach should be abandoned since it allows project authorities to completely subsume environmental concerns to the exigencies of construction schedules, and results in a failure to adequately safeguard the environment.

The environmental implications of the SSP were so serious, that when the MoEF finally capitulated in 1987, it still gave only conditional clearance to the project (MoEF 1987a). It is well known that the conditionalities were put in only due to the insistence of a few courageous officials of MoEF, who refused to give up even when the pressure became well-nigh unbearable. It was a brave but ultimately fruitless gesture. What was supposed to mean `we will let you build the dam, but only if the following conditions are met' was effectively interpreted as `the dam is environmentally sound, because the MoEF has cleared it (and never mind the conditionalities)'. This was the case with both the clearance given on environmental grounds in 1987, as also the clearance given under the Forest Conservation Act later that year. Over subsequent years, project authorities have conveniently blanked out the conditional nature of their 'license', and the Ministry of Environment and Forests has remained powerless to revoke this 'license'.

What does "conditional clearance" mean ? As far as we am concerned, the very act of setting time-bound conditions implies that **if the conditions are not met within that time frame, clearance would automatically lapse, and thus all further work would be in violation of the law** . Conditional clearance is irrelevant if it doesn't

mean this.

And now we come to the conditions themselves. In the case of the environmental clearance, the most important conditions were about the acquisition of data (surveys and studies) within a stipulated time frame. This was done to allow an accurate assessment of the environmental problems to be made and necessary ameliorative and mitigatory measures to be taken. In addition, the complete Catchment Area Treatment Programme and the Rehabilitation Plans were required to ensure that these were completed before the reservoir

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filled. Critically, it was left to the Narmada Control Authority (NCA) to ensure that environmental safeguard measures were planned and implemented pari passu with progress of work on projects.

A second set of conditions were added when the MoEF gave clearance under the Forest Conservation Act of 1980 (MoEF 1987b), to divert forest land for the purposes of the project. These conditions stipulated that the State governments had to report all non-forest area available for rehabilitation (by 30.11.87) and that no project-related work in forest areas would be allowed to commence till this was done; that afforestation equal to double the forest area lost would have to be raised on degraded forest land, as well as an equivalent area on non-forest land (i.e.. a total of three times the forest area lost); a plan for catchment area treatment would have to be evolved by 30.11.87; that the legal status of the land would remain unchanged and that no forest land would be utilized for the rehabilitation of oustees.

To summarize, complete plans for compensatory afforestation, catchment treatment, and rehabilitation of oustees on non-forest land were supposed to be provided by late 1987 (according to the forest clearance), or by 1989 (according to the environmental clearance). In addition, complete details on command area development, survey of flora and fauna, carrying capacity of surrounding area, seismicity, and health aspects, had to be ready by 1989 (according to the environmental clearance).

The most blatant violation of the condition regarding use of forest land for rehabilitation occurred in 1991, when about 2700 ha. of forest land in Maharashtra were released for rehabilitation in what was termed a "one-time exception". Despite this assurance, an additional 1500 ha. of forest land were again released in Maharashtra for rehabilitation of oustees in early 1994, at the insistance of none other than the Prime Minister.

It is a well-known fact that none of the studies and plans required by late 1987 were submitted that year (See Morse and Berger 1992, for a detailed discussion). The 1989 deadline also passed by without any complete study or workplan being ready. This in itself is not surprising, since these deadlines were made to be broken. From a scientific viewpoint, the time frame set for the acquisition of data and completion of studies (2 years) was totally absurd. A more reasonable period would have been five to seven years. But this was not acceptable, since that would have implied postponing construction, with its attendant political and financial costs. The ingenuity of the pari passu clause (or its innocent foolhardiness?) together with the unrealistic time frame, allowed construction to proceed merrily along without any hurdles.

Thus a consensus of blindness was forged between the Central Government, concerned State governments, project authorities, and the World Bank. Everyone knew that the time-bound conditions were a charade, and that "clearance" was the all important word. Project authorities showed no urgency whatsoever in carrying out the studies, and with a nod and a wink, assigned absurd time frames for the studies they did commission.

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Since the end of 1989, it has been repeatedly pointed out that clearance should technically be deemed to have lapsed, since the conditions have never been fulfilled. This has been admitted as such in various meetings of the Environment Sub-group of the Narmada Control Authority. For instance, in the Agenda for the 9th Meeting of the Sub-group, the Ministry of Environment and Forests noted that:

" ... a number of studies and surveys are still being carried out based on which Environmental Action Plans would be formulated. In the absence of a definite time frame for each of the studies, surveys or action plans, the implementation of the requisite safeguards and action plans pari passu with the construction of engineering work would obviously not be possible. Under the circumstances, the approval granted must be deemed to have lapsed ... It is therefore, considered imperative that project authorities be directed to ... seek renewal of environmental and forestry clearance beyond December 1989."

As far as our knowledge goes, no such fresh clearance was sought and obtained; on the other hand, violation of conditions has continued. Despite this, construction on the Project has been allowed to carry on. The Narmada Control Authority unilaterally decided that fresh clearance was not needed (Maudgal 1993). Clearly, the Ministry of Environment and Forests on its own does not have the clout to order a halt to construction, even if it might make veiled threats to the effect.

Remember that the Planning Commission too gave conditional clearance to the SSP in 1988; one condition was that the environmental conditionalities should be fulfilled. Thus, this clearance too should have deemed to have lapsed. The strange anomaly is that, since the forest clearance stipulated that studies were to be completed by the end of 1987, the conditions had already been violated when the Planning Conunission accorded conditional clearance in 1988!

The MoEF and the Planning Commission must share the blame for reducing the sanction of conditional clearance to a travesty, for the authority of this sanction has been completely undermined by allowing project authorities to get away with blatant violations of mandated conditions.

It is by now clear that the SSP is under construction without a thorough assessment of environmental impacts, and furthermore, is being allowed to progress while its conditional clearance has effectively lapsed. These aspects could perhaps have been made light of if the environmental impacts of the project were, *prima facie*, minimal. However, let us look at the possible environmental impacts of this project, to understand why critics consider the SSP to be a potential disaster.

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ENVIRONMENTAL IMPACTS OF THE SSP

The environmental impacts of the SSP have been classified under the four regions mentioned above: upstream of the dam, downstream of the dam, the command area, and other affected areas. The major impacts are discussed below, not in order of their importance, but region-wise. After analysing available information, we feel that the most crucial impact of the SSP is likely to be waterlogging and salinisation of the command area, hence this issue is covered in considerable detail.

Upstream of dam

Loss of forests and terrestrial biological diversity

Summary: The forests of the SSP submergence zone, while considerably degraded, still contain a large diversity of flora and fauna that is capable of supporting over 70,000 people. Though compensatory afforestation and wildlife conservation measures are being undertaken or planned, there is no feasible way of completely recovering the loss of these forests, or of saving much of the biological diversity that they contain. This is heightened by the fact that compensatory afforestation in the case of SSP is being done in Kutch, an ecological zone completely different from the Narmada Valley. There will therefore be an inevitable loss.

The SSP reservoir will submerge about 39,134 ha. of land, of which 13,743 ha. are forest land. Ilese mixed deciduous forests are often referred to as "degraded", which they are. There has also undoubtedly been considerable loss of the area's biological diversity due to a variety of biotic and commercial factors. Indeed, one (but only one) of these factors was the felling of the forests in the Gujarat part of the submergence zone at the behest of the project authorities themselves: **in 1983-84, three years before the project was given envirorimental clearance, 2493 ha. was clearfelled, "looking into the urgency of the project and fearing the submergence of those low-lying areas in case they are not clear-felled quickly"!** (NPG 1986; exclamation mark added).

Despite considerable degradation, these forests continue to be an important life-support system for the people in the submergence zone, and still contain a diversity of plant and small faunal life. In the case of flora, for instance, local tribals identify over 150 species that are of economic, nutritional and cultural importance to them (Baviskar 1992). Apart from economically important species like teak (*Tectona grandis*), bamboo (*Dendrocalamus spp*.), arjan (*Hardwickia binata*), mahua (*Madhuca indica*), tendu (*Diospyros melanaxylon*), and salai (*Bosivellia serrata*), the forest is also rich in ecological terms. A study of the SSP catchment area in Gujarat (an area larger than, and

containing, the submergence zone) reported that six

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hundred plant species have been collected there (MSU 1992). Botanists of the M.S. University are also reported to have found in the submergence zone, "important flora, i.e. plants which although not endangered or rare in the sub-continent as a whole, occur infrequently in Gujarat." In their 1983 report, these botanists observed rare species like Radermachem, Spermadictyon, and Cochlospermum (MSU 1983).

Available studies seem to suggest that very few large animals remain in the submergence area, though "traces of large cats" in Maharashtra are significant (NCA 1993), and one of us has heard smaller cats calling at night in the Jhabua part of the submergence zone. Studies on the loss of forests under submergence, and the consequent loss of wildlife, are stated to have been completed for Gujarat, but those for Madhya Pradesh and Maharashtra are still (mid-1994) underway. However, studies have focused primarily on large animals and flowering plants, paying less attention to or ignoring the much greater diversity of smaller animals, non-flowering plants, and fungi, and completely (perhaps understandably) leaving out micro-organisms. The ongoing study in the Maharashtra part of the submergence zone, for instance, indicates that there is "still a wide diversity of invertebrates, reptiles, and birds" (NCA 1993). In the absence of more definite information, it is therefore not possible to discuss the full impacts of the dam on wildlife in the submergence area.

Compensatory afforestation has been put forward as a means of "compensating" for the loss of forests. In the SSP, compensatory afforestation is to occur over an equivalent acreage of non-forest land plus double the acreage of degraded forest land. This is a welcome change from previous projects when forest was diverted without any compensatory measure. However, no human agency can recreate a natural forest which has evolved over millenia. The diversity of organisms and the incredible complexity of relationships between them and their abiotic environment in natural forests are still not well understood by biologists, let alone artificially replicated. In other words, there is inevitably a loss of essential features and components of a forest in any clearance of natural forest and its replacement by a human-made plantation.

This inherent defect is greatly heightened in the case of SSP, where compensatory afforestation is being carried out in Kutch - an ecological region which is completely different from the submergence area. If the intention of compensatory afforestation is to replace the forest that is being lost, the SSP effort is a mockery. Senior forest officials appointed by the NCA to assess the plantation have said that "It is impossible to replace the tropical deciduous forests submerged due to Sardar Sarovar Project, in the arid district of Kutch..." and "... any plantation in Kutch will be only "mitigatory" and not "compensatory"" (Ojha 1989; Kushalapa 1992).

In the case of the terrestrial wildlife which will be affected by the submergence, it is not yet fully clear how the authorities plan to ameliorate or minimise the loss, since studies and workplans are not yet complete. One step which has already been taken is to add an area adjoining the reservoir to an existing sanctuary (Dumkhal, now renamed Shoolpaneshwar), thereby giving additional protection to its forests and wildlife. However, this has created its

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own set of problems, especially related to the villagers living inside the newly declared area. People of the 104 villages in the Shoolpaneshwar Sanctuary asserted in 1993 that they will not move out. Are the social costs of the project to be increased by forcing them to leave too?

Moreover, the justification for such 'compensatory' measures is that it is acceptable to sacrifice some forest and wildlife in one region, so long as forest and wildlife in another area are given protection. In a situation where India has already lost most of its forest and wildlife, it is worth asking whether such trade-offs are still acceptable.

Other possibilities being considered are to relocate certain wild animals, collect and put into botanical gardens certain "important" plants, and create conditions for the terrestrial wildlife to migrate to adjoining forests (NCA 1993). There are virtually no successfull cases of this having been done in India on any large scale: the expertise and experience simply does not exist. What is most critical, however, is that none of the measures, suggested will be of use for a majority of the smaller animal species and almost all plant species (which, in official parlance, are not even considered wildlife).

There will thus be the inevitable loss of the majority of wildlife if the project comes through, and this is likely to remain a major unquantified environmental cost. The loss has already begun with clearfelling, and with the submergence of land in the 1993 and 1994 monsoons. We still await workplans.

Aquatic habitat and biological diversity

Summary: The upstream aquatic ecosystem will be seriously disrupted by the dam, though the full impacts are not yet possible to predict. At least one threatened species, the Marsh crocodile, could be affected. Ameliorative measures being planned focus almost exclusively on commercially useful fish, ignoring all the other aquatic fauna and flora. As in the case of terrestrial wildlife, there is likely to be a loss of the area's wildlife which cannot be compensated in any way.

A dam changes a river ecosystem into a lake, with attendant changes in flora and fauna composition. The Narmada is known to be one of India's least polluted and disturbed major rivers, as also one of its oldest, and is therefore likely to have a large diversity of aquatic life. Unfortunately, till date no comprehensive list of this diversity is available.

The project authorities claim that "none of the aquatic fauna of the Narmada is listed as rare or threatened in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List." This is not true. The Freshwater or Marsh crocodile (Crocodylus

palustris), listed as globally threatened in the IUCN Red Data Book, and considered threatened within India as well, is found in the area. One of us has seen it in the submergence zone of SSP, and villagers along the river's banks report frequent sightings.

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The probable loss of breeding grounds due to submergence could be disastrous (though the reservoir could become a new home), an aspect which needs to be studied. Even the existing breeding grounds have not been identified to date. We cannot predict possible impacts on other aqautic fauna, and on the aquatic and riverine flora in the absence of comprehensive ecological surveys.

Importantly, fish provide a major protein component of the diet of all the tribal people living along the river in the summer months, in addition to being the source of livelihood for many other people. Once the reservoir is formed, fish populations will fluctuate considerably, increasing at first, but stabilizing later or even suffering a long-term decline (Goldsmith and Hildyard 1984). What will happen to the people dependent on fish for their livelihood and nutritional needs in the interim? Even the fish farming programmes proposed by the project authorities will take a long time to come to fruition, and may well be cornered by powerful outsiders to the area. The experience of Bargi Dam, the first dam to be completed on the Narmada River, is relevant here. People who were resettled from the submergence zone were denied the right to, fish in the reservoir, with the fishing contracts being auctioned to the highest bidder instead of being awarded to the fishing cooperative set up by the government. The Bargi oustees have made several strong protests regarding this issue in the last year or so.

Studies are supposed to have been completed for the entire submergence area, and the proposed reservoir. Compensatory measures for the loss of aquatic biodiversity are not yet completely planned out, but the major suggestions include "selective stocking of the reservoir with a combination of indigenous fish species; research into and instigation of pilot projects for the artificial propagation of important species; setting up of an Interstate Fisheries Development Board to control and monitor fisheries exploitation and to coordinate research and development; monitoring of potential pollution sources", and others (NCA 1993).

What is instructive is that the focus of the studies and proposed measures is exclusively fish. Among fish, too, the emphasis given in various official reports is on commercially important species. There appear to be no moves to avert or minimise the negative impacts on other aquatic species, which is a serious flaw considering that fish fauna make up only a small part of total aquatic biodiversity. Once again, there will be an inevitable loss due to submergence.

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Catchment Area

Summary: SSP's catchment is under heavy pressure, and there is a distinct possibility of premature siltation of the reservoir, as has happened in many other Indian projects. Catchment Area Treatment has been initiated, but appears to be far behind schedule in Maharashtra and Madhya Pradesh. The problem of lands identified for treatment is as yet unresolved. Non-completion of upstream projects like Narmada Sagar, Omkareshwar and Maheshwar, would increase the catchment area of SSP, with a concomitantly higher silt inflow.

All rivers carry silt in varying amounts and all reservoirs get silted up over time. The rate of siltation generally determines the lifetime of a reservoir. Data from several large reservoirs in India show that the actual rate of siltation is on the average 200-400% higher than the siltation rate assumed while planning the project (ICR 1972; PAC 1983). Siltation occurs in the area below the irrigation canal take-off level (dead storage) as well as above that (live storage). Siltation in the live storage reduces the amount of usable water in the reservoir, and this is frequently very high. One of the main causes for increased siltation rates is deforestation of catchment areas, and poor soil conservation practices. There is no reason why the SSP case should be any different: Satellite imagery of the last two decades shows significant loss of vegetative cover all over the catchment, a trend which is only likely to continue in the near future. There is a possibility of siltation rates in the SSP reservoir being higher than currently estimated, in which case the lifespan of the dam would be affected. Here too, further comment is not possible in the absence of comprehensive documentation on this aspect.

To combat siltation, the SSP plan envisages catchment area treatment (CAT), to be carried out simultaneously with dam construction. Consensus on the area to be treated was achieved only after much wrangling and argument between states and various ministries. Finally it was decided that only the critically erodable land directly draining into the SSP reservoir will be treated at project cost (NCA 1993). This is about 185,000 ha and represents only about 7.5 % of the total catchment area below the Narmada Sagar Dam, and about 27 % of the critically erodable land in the catchment. Since the "high and very high" erosion categories form a relatively small part of the catchment, the absolute magnitude of the silt contributed by them could be substantially less than that contributed by the other eroding areas. The project authorities and indeed the World Bank have expressed the "hope" that the rest of the area will be treated by the relevant state governments (mainly Madhya Pradesh), but so far, as far as we are aware, there is no plan, and no allocation of funds.

A related point is that CAT of the area upstream of the SSP reservoir catchment is to be done under other proposed projects such as

Omkareshwar, Maheshwar, and Narmada Sagar. However, these are all substantially delayed; Omkareshwar has received conditional environmental clearance only in 1994. This virtually ensures that treatment of the catchment upstream of the SSP reservoir will not done in time, and a substantial part of the silt load

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for a stretch of several hundred kilometres up the river will be transferred to the SSP reservoir. This could decrease the life-span of the dam.

Studies on the "very high" and "high" erosion-prone areas draining directly into the reservoir are said to have been done. However, at least in the case of Maharashtra, the studies done earlier have proved inadequate, and a revised assessment is still underway. A recent NCA (1993) document contradicts itself on this point: on page 48 it says that survey work, preparation of a detailed map, and micro-watershed development map, are all `complete for all states', while on page 90 it says that the task of "determining the net area of sub-watersheds and thus the total area of CAT required" still needs to be done.

CAT is already underway, though minutes of the NCA Environment sub-group meetings show that both Maharastra and Madhya Pradesh are far behind schedule. Targets and achievements listed show striking discrepancies between figures in various NCA documents. For instance, the targeted figures for 1994 are shown as 10,000 ha. in the June 1993 document while the July 1993 document asserts that 6400 ha. will be treated. In the case of Madhya Pradesh, the NCA document of June 1993 (NCA 1993) states that 17,000 ha. have been "treated to date", while the Environment Sub-group's July 1993 document (ESG 18th Meeting, 1993) gives the corresponding figure at 11,161 ha. nearly 6,000 ha. less than claimed to have been achieved just one month before!

Most worrying is that about 99,000 ha of the area slated for CAT is non-forest land. People are opposing government interference on their fields, and the traditional aggressive methods of the Forest Department are unlikely to prove effective. Additionally, NCA (1993) in fact admits, that "a substantial part of the CAT area is in fact designated forest which has been encroached and used for agriculture by local people. These people are reluctant to allow local forestry officers on to 'their' land until the matter of the legality of their tenure has been resolved." CAT thus has the potential for greatly exacerbating the social impacts of the project. The project authorities seem quite unfazed by this, stating that "work has now commenced in the areas free from dispute and is scheduled to be completed by March 1996." This is a queer twist of logic: if a "substantial part" of the area to be treated is encroached, how can treating only the undisputed part achieve the full CAT target? Either the treatment will get substantially delayed, or it will be over a substantially smaller area than necessary.

A neglected facet of the problem is that reservoir impoundment and displacement of people by SSP will itself lead to negative impacts on the catchment area. Pressures of timber, fuelwood and grazing needs currently being absorbed by the forests and grasslands of the submergence zone will be transferred to the remaining, adjoining

forest and common land. For instance, a lot of the timber needs of those on the norther side of the Narmada is met from forests across the river in Maharashtra. Once their access to the forests is cut off by the reservoir, or once the forests in the submergence zone are cut, these tribal people will be forced to exploit the remaining forests on their own side at a much greater rate. Yet another impact on the catchment area may result from the migration of displaced people into

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the forests, especially in the case of oustees from M.P. who may not want to resettle in Gujarat, and would rather choose land close to their original villages.

Waterlogging Around Reservoir

Summary: The SSP reservoir could cause waterlogging, especially in the plains area of Madhya Pradesh, which will be sandwiched between the reservoir and the Narmada Sugar canals. Studies on this seem to be absent.

The SSP reservoir could cause waterlogging in surrounding areas. This is a distinct possibility in the plains of Nimar (Madhya Pradesh), especially because the area has predominantly black soils, which are extremely prone to waterlogging due to their high water retention ability. Such an eventuality is heightened by the fact that a considerable amount of land in M.P. will be sandwiched between the reservoir and the canals of the Narmada Sagar Project (NSP). The Indian Institute of Science has already projected that the NSP command area is heavily prone to waterlogging (Sridharan and Vedula 1985).

This potential problem has so far merited only a brief paragraph in the SSP's indicative EIA (MSU 1983). Without going into any detail, the report comes to the mysterious conclusion that the problem may not be expected to arise. In the absence of more information, it is not possible to give further comments. There is, of course, no ameliorative action plan. A team member of the Independent Review, set up by the World Bank, told one of us that, according to the hydrologist appointed by them, the deposition of large particles of silt in the tail-end of the reservoir would cause increased flooding in the surrounding areas as the level of the river-bed would rise - this would not only increase the extent of submergence, but increase the tendency for waterlogging to occur. Such an eventuality should have been studied in advance.

Breeding of Vectors

Summary: The presence of the reservoir, as also of residual water pools and waterlogged lands in surrounding areas, could increase the incidence of diseases like malaria. Action plans to combat this still rely heavily on the use of pesticides, which are not only becoming less effective, but are becoming a serious health problem themselves.

Reservoirs in tropical latitudes have often resulted in an increase in water-borne and water-related diseases. Indeed, the term "engineer-made malaria" has been used in India as far back as 1938 (Russell 1938). The possibility of an increase in malaria around the SSP reservoir is very high. In earlier documents, this possibility was

dismissed by the project authorities by the untenable statement that there will be no rise in malaria because in the summer the reservoir level will fall, stranding the larvae, while in the monsoons the reservoir

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level will rise, drowning the larvae (MSU 1983; various ESG minutes and agenda notes). This argument was maintained by the authorities for at least 6 years, and it was only in 1991 that a proper study has been initiated to investigate the possible increase in incidence of malaria. In the case of both the reservoir and the command area, the possibility of increase in malaria has now been confirmed (Kalra 1992).

Official vector control in India is usually done with pesticides. The SSP authorities are no different. DDT, BHC, and malathion are the most common pesticides used to control malaria. These pesticides affect aquatic life in reservoirs. Fish and fish-eating birds concentrate these pesticides in their bodies and accumulate large quantities (see, for instance, Vijayan 1991), which could ultimately also affect people living along the reservoir. Pesticides would also be ingested by people who get drinking water from the SSP canals. It is possible that such health impacts will be minimised by the dilution effect of the water, but it would be prudent to do assessments of the possible concentrations of pesticides which could build up. No such assessment has been made. Though repeatedly alerted to thew aspects, "insecticidal spraying" still remains a major part of the vector control strategy (NCA 1993).

It is also worth noting that while health facilities to combat epidemics of diseases like malaria are common in the non-tribal plains area of Nimar (M.P.), such facilities in the tribal areas of all three states are woefully inadequate or absent. The brunt of any increased malaria is thus likely to be borne by the most marginalised residents of the affected area.

Other Aspects

Reservoirs have various other associated environmental impacts, including the spread of weeds on and around the water body, the possibility of inducing seismicity, and subsidence of areas adjacent to the reservoir (the rim). We are not making any comments on these, as basic information on them is not available to us.

Downstream of Dam

Riverine Ecosystem

Summary: The SSP will result in the destruction of hilsa and giant freshwater prawn fisheries downstream of the dam, in addition to having negative impacts on other aquatic life, including the mahseer. Additional problem include the impact of flash floods. These problem could be compounded by the increasing concentration of pollution, because the dam will reduce river flow and encourage the growth of urban/industrial centres and of intensive fanning.

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The construction of a dam drastically changes the volume and seasonality of flow of water in the river downstream. Secondly, dams block the flow and deposition of nutrient-rich silt to the downstream area. These changes lead to serious adverse impacts on the downstream river, reducing fish migration and breeding, increasing the concentration of pollution in relation to freshwater, changing the composition of flora and fauna, and affecting land fertility adjoining the river (White 1978). Such impacts have been documented in several dams the world over, e.g. the Aswan Dam in Egypt, and the Amu Daria Dam in the former USSR (Goldsmith and Hildyard 1984).

While most dam projects are supposed to specify how much water they will release downstream, the SSP has made no such provision. The Gujarat Government did ask the NWDT to set aside 0.716 MAF every year for downstream releases (in addition to the water assigned to Gujarat), but the Tribunal declined to do so, indicating that Gujarat had to release downstream water from its assigned share. Currently, project plans call for Gujarat's entire share of water to be diverted into the irrigation system (SSNNL 1989). However, a study on downstream impacts commissioned by the project authorities has indicated the need for regular downstream releases throughout the year (Wallingford 1993). As far as we are aware, the project authorities are yet to suggest any concrete measures for this.

In the case of SSP, all studies to date suggest that fisheries are likely to suffer in the stretch below the dam (MSU 1983; NCA 1993). In fact, the latest study has stated that "The eventual decline of hilsa (Hilsa ilisha) and giant freshwater prawn (Macrobrachiun rosenbergii) seems highly probable, certainly after Stage 2 (i.e. on full development of irrigation) (Wallingford 1993) (words in parentheses added). After full development of irrigation, virtually no water will be released downstream except during the monsoons. The loss of this fishery would represent an annual loss of Rs. 40 to 80 crores to the fishermen (Wallingford 1993), and probably an additional Rs. 40 to 80 crores to the fishing industry, since retail costs are at least double that paid to fishermen. The hilsa in fact has already suffered heavy declines due to large dams in several parts of India (Jhingran 1991). The Narmada'is also one of the important areas for India's best "sport" fish, the mahseer, which is also threatened with decline due to the dam. The possible impacts of the dam on all non-commercial aquatic fauna have been completely neglected in all the studies done to date. In fact, detailed studies on the ecology of even the hilsa and the giant freshwater prawn have not been done to date, though a general study on ecology of the lower Narmada has been commissioned.

Aquatic life is also likely to suffer due to the fact that there will be less water to dilute the pollution already being discharged into the river. In the Mahi river in Gujarat (about 40 km north of the Narmada), pollution is carried upstream twice a month (tidal effect),

since the Mahi dam has substantially reduced river flow (CD Patel 1993). The pollution load is also going to increase as irrigation from the SSP along the north bank and from Karjan dam along the south bank will cause greater use of pesticides and artificial fertilisers, though the Wallingford study (1993) says that at current levels of use, toxic effects are not a problem. In addition, the power and other outputs of the dam will encourage urban and industrial

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growth (NCA 1993). Consequent increases in domestic and industrial pollution, combined with strongly reduced flows in the river, will in all probability have a serious adverse effect on the riverine ecosystem and its flora-fauna, including fish. In addition, Wallingford (1993) states that the reduced silt load in the river and consequent increase in photosynthesis, linked to increased pollution concentrations, may result in eutrophication of the estuary.

Another dam-related phenomenon which causes severe damage is a flash flood, unleashed when the dam's flood gates are suddenly opened to save the dam during heavy rains. This happens frequently with Indian dams. The SSP will at best mitigate floods, reducing the volume of floodwater by about 20% (ORG 1983b). It must be kept in mind that even this is likely to be an overestimate, since it assumes that upstream dams are in place, particularly the NSP with its very large capacity to hold flood waters. As the yearly flooding is reduced, however, the great danger is that people will encroach onto the floodplain, as has happened all over India (CSE 1991). Wallingford (1993) lists this as a substantial risk, and states that such encroachment would result in the loss of flood control benefits, as has already happened in the Surat area with respect to the Ukai dam.

Apart from the impact on downstream communities who are heavily dependent on fish for their livelihood or as a major source of protein, the inevitable loss of land fertility due to the blockage of silt by the dam could affect agricultural yields, though Wallingford (1993) asserts that this would be offset by the irrigation provided by SSP and the Kadan dam. The reduced availability of drinking water to the human settlements downstream will have serious implications for the health and quality of life of the resident population. Wallingford (1993) concludes that the reliability and quality of river wells and freshwater intakes will deteriorate on full development of irrigation, adversely affecting direct use of river water for drinking, bathing, and other purposes.

Studies on the impact of the dam on downstream riverine ecosystem have yet to be completed. The Wallingford (1993) study is the most comprehensive and authoritative to date, yet they themselves list a substantial number of studies that need to be done for a complete assessment. Incomplete work includes a study "... to assess impacts on downstream aquatic ecosystem (and) to assess impacts on river bank ecology" (NCA 1993). Likewise, a study on "the likely future patterns of discharge from the SSP and the effects this will have on water quality, river and estuary morphology, aquatic biology and, in particular, fish ecology" is to be done.

It must be mentioned that the Rs. 3 crore Wallingford (1993) study is itself based on faulty assumptions about the quantity of flow in the river, which is the primary basis of their conclusions. Wallingford has assumed, or has been told to assume, a much higher natural flow in

the river than is now accepted (CWC 1992): this completely skews their conclusions about the timing and degree of negative impacts. In addition, the phases of project development mentioned in their study are now completely outdated, rendering much of their intermediate-term, predictions useless.

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However, the Wallingford study has confidently asserted that "... there are no downstream impacts whose magnitude and impacts are such as to cause doubts over the wisdom of proceeding with the Sardar Sarovar Projects provided that appropriate monitoring and mitigation measures are applied." (Wallingford 1993) (Note the inevitable escape clause!). The NCA, with even less accountability at stake, has chosen to do away with even the escape clause, asserting that "there would be no downstream impacts whose magnitude and effect would be sufficient to threaten the viability of the project." (NCA 1993). We are at a loss to understand how such a definitive conclusion has been reached when studies are as yet incomplete.

Estuary

Summary: For the same reasons as given above (water and silt flow reduction, pollution, flash floods), the Narmada estuary is likely to be adversely affected by the SSP. Saltwater ingress at the mouth of the river could be the most serious impact, with consequent declines in fisheries. Salinisation and increased pollution of underground water used for drinking and irrigation could take place around the estuary. Coastal geomorphology is likely to change, and bank erosion could occur.

River estuaries are complex, dynamic ecosystems, created over millenia by the interplay between seasonally fluctuating freshwater flows, sea tides, silt deposition, mangrove and other vegetative growth, and other factors. A major change in any one of these `ingredients' can affect the entire ecosystem, and in turn the other components of the ecosystem. Such changes can be caused by a dam, for the same reasons stated above (changes in water flow and silt deposition, increase in pollution concentration, and flash floods). The Narmada estuarine area is an important site for fisheries, and is also the location of the one of India's oldest ports, Bharuch.

Saline ingress affects the river till about 72 km upstream from the river mouth at present, while tidal effects are felt as far up as 100 km upstream (Wallingford 1993). Reduced flow in the Narmada due to the SSP would cause salinity to increase in large parts of the river. The river would literally flow backwards during the tides in the dry season, transferring salt and pollution from Bharuch upstream. Estuarine species are finely attuned to the daily and monthly variations in salt content of the water. Changes in the salt regime can affect the entire ecosystem, disrupting breeding and physiological functioning. In addition to low water flow affecting hilsa and the freshwater shrimp discussed above, the negative effect of salt ingress is likely to have a serious impact on other fauna and flora, but "little information is available on the marine ecology at the mouth of the estuary" (Wallingford 1993). However, the livelihood of the fisherfolk downstream of the dam is likely to be lost, and indeed both the Wallingford (1993) report and an earlier NCA (1992) document

talk of "rehabilitating" the 4700-plus fisherfolk families.

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Saltwater ingress also causes salinisation of drinking water as saltwater seeps into the underground aquifers. Bharuch currently lies on the eastern fringe of an extensive zone with saline groundwater. Large areas on both banks are likely to be affected by an extensive ingress of salt into groundwater after dam construction (CD Patel 1993). Those farmers using groundwater for irrigation are also likely to be seriously affected. A similar fate has already struck several villages on the banks of the Mahi river (north of the Narmada), where groundwater has not only turned saline, but the river water too is undrinkable for half the month due to high salinity and pollution (CD Patel 1993).

Reduced water flow can affect the shape of the land itself. In the Gulf of Khambat, there is a net transport of sediments towards the land due to the high tidal range (CD Patel 1993). In the Mahi river mouth, severe erosion of the northern bank has been attributed to the Mahi and Panam dams, as reduced flow has changed the pattern of deposition and the erosion of tidal forces. Similar bank erosion may occur in the Narmada, and the river mouth may be blocked due to reduced flow. The river may be forced to carve out new channels. This would also affect the functioning of Bharuch port.

The impacts of SSP on the estuarine ecosystem are still under study (NCA 1993) hence workplans are not yet finalised. It is simply stated that action plans will be worked out to counter the impacts. As such, we cannot comment on the adequacy or otherwise of the ameliorative measures. It is clear that water will have to be released from the dam throughout the year to prevent salt ingress, which could reduce the irrigated area of the SSP. Whether this will actually happen only time can tell.

Command Area

The command area of SSP is probably the most neglected in terms of environmental impact studies. The 1983 M.S. University report completely ignored it, and studies on various impacts were mostly started only after obtaining conditional environmental clearance. The latest relevant NCA document, of June 1993, states that "studies are ongoing to complete the work necessary to compile an environmental assessment of the development of the Command Area ... The results of these studies, most of which should, be available within one year, and which should all be available by the end of I994, will be used to devise an environmental management plan for the Command Area." (NCA 1993).

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Waterlogging and Salinisation

Summary: An analysis of available information suggests that about 55% of the SSP command area may be affected by waterlogging and salinisation due to surface irrigation, an environmental problem of staggering magnitude. Studies are not complete and hence no detailed action plan exists. Current proposals are based on a complex technological system which has not been tried out elsewhere on even a much smaller scale, and one which could easily be defeated by social and managerial difficulties.

Waterlogging and salinisation of the proposed command area represent potentially the largest environmental threat arising from the SSP. In arid and semi-arid areas drainage is usually geared to low rainfall conditions and is usually incapable of handling the much larger water amounts brought by surface irrigation. This, along with seepage from canals, overuse of water by farmers, and other factors depending on the geomorphology of soil and subsoil layers, lead to increasing water accumulation below the surface. Secondly, subsoil water and soils in and regions tend to be saline due to inadequate flushing by rainwater. Irrigation water, being saltier than rainwater, adds more salt to the system, leading to increased likelihood of salinisation.

Waterlogging and salinisation are global problems of staggering magnitude: according to the United Nations Environment Programme (UNEP), between 30 to 80% of the world's irrigated land is suffering from these and the related problem of alkalinisation (the large range of estimates is due to differences in definitions being used by various experts, and the lack of comprehensive information from many countries). In India, it is estimated that at least one-fourth of irrigated land is facing these problems (DOE 1985).

Pakistan has an arid zone similar to much of the command area of SSP. By the mid-1970s, waterlogging and salinisation were estimated to affect 11 million of the 15 million hectares of irrigated land in Pakistan, leading to "a pronounced reduction in the main crop yield" (Elgabaly 1980) : more recent estimates are not available with us. A similar region is the command area of the Indira Gandhi Nahar Pariyojana in Rajasthan where large parts of the irrigated and adjoining areas are already facing waterlogging and salinisation, just a few years after commencing irrigation.

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What are the possibilities of these problems being faced in the SSP command? A preliminary study called "Regionalisation of Narmada Command" (ORG 1982) divided the SSP command area into 13 agroclimatic zones (Map 2), and classified them into irrigability classes as shown in Map 3. These irrigability classes are based on several soil parameters including the composition of the soil and factors related to drainage. The Soil Survey Manual of the Indian Agricultural Research Institute recognizes six irrigability classes:

1. Few limitations for sustained use under irrigation
2. Moderate limitations
3. Severe limitations
4. Marginal for sustained use under irrigation
5. Temporarily classified as not suitable pending further investigations
6. Not suitable for sustained use

Areas classified as Class III are moderately prone to waterlogging, whereas Class IV-VI have severe waterlogging problem under sustained irrigation. It is possible to calculate the SSP command areas under different irrigability classifications from Map 3. The results are shown in Table 1 and 2.

Less than half the command area can be called "suitable" for irrigation. 25.6% of the command area has severe limitations for sustained irrigation (Class III), and 26.5 % of the command area is not suitable for sustained irrigation at all. In other words, 52% of the command area faces high to very high probability of waterlogging and salinisation if the SSP is completed. (It should be emphasized here that the preliminary land classification done by ORG (1982) is for the gross command area, and not the culturable command area.)

An additional factor is that the main soils in $Z_{7\text{-}9}$ are medium deep black soils, while $Z_{2\text{-}4}$, have substantial areas of black soils (ORG 1982). Black soils are known to be unsuitable for sustained canal irrigation, as their high clay content gives them a propensity to get waterlogged. The experience with the Ukai dam, just south of the proposed SSP system, is illustrative. The Ukai command has substantial areas of black cotton soils. Before canal irrigation (1957-58) only about 100 ha (less than 0.5% of the command) reported waterlogging, but by 1991, over 77,000 ha had waterlogging even in the pro-monsoon season (CD Patel 1993).

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Taking irrigability classifications and areas of black soils and saline aquifers into account, about 55% of the command area appears to be in danger of waterlogging and salinisation, an environmental disaster of epic proportions in the making.

Detailed studies indicate that the actual potential for waterlogging and salinisation is even worse than what was indicated by the preliminary study. A study of Zones 1-4 of the SSP command (Table 3) conducted by Core Consultants (1982) concluded that 54% of Z2, 64% of Z3 and 100% of Z_4, is liable to be affected by waterlogging and salinity. Comparison of Tables 2 and 3 shows that while the preliminary study indicates 20.9% of Zones 1-4 as prone to waterlogging and salinisation, the detailed report puts that figure at 45.5%, almost double the original. Even if we exclude the problematic Zone 4, the relative area prone to waterlogging and salinisation increases from 8 % to 36.5 % !

A study done on Zone 7 reports that 74 % of the area is severely problematic for irrigation (ORG 1981). The study concludes that since the area suitable for irrigation in zone 7 is such a small fraction of the total area of the zone, it is questionable whether this should be brought into the SSP command. The report suggests that a change in cropping patterns under the existing regime may be more fruitful.

Incredibly, detailed studies have so far been completed for only 5 out of 13 agroclimatic zones! A four volume pre-feasibility level drainage study for regions 5-13 of the SSP recently completed by a consultant group (CES 1992) has carefully refrained from delineating areas that would be prone to waterlogging under the SSP. However, they estimated that under normal operations, approximately 3.12 Million Acre Feet (MAF) of groundwater will have to be pumped out every year to prevent waterlogging. This is

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equal to the total utilizable groundwater resources of North Gujarat and Kutch combined (PP Patel 1993), and more than half of the water that is to be delivered for irrigation! This will also require construction of major drains and related works at a cost of about Rs 1600 crores, to say nothing of the energy cost of pumping groundwater (CES 1992).

These costs have not figured in the financial cost-benefit analysis of the project. There are very real fears that, given the resource crunch which has already hit the project, such measures will remain neglected, so that even in areas where the problem can be averted, it may crop up.

Before the CES study, the project authorities claimed to have a "foolproof system" to deal with any problems. They asserted that not a single hectare will get waterlogged or salinised. The plan was to have groundwater sensors placed along every 100 Km of the 18,000 Km command area. These would, be linked to a central computer, which would analyse the data and send out commands to the canal heads to stop the flow of water into areas showing signs of waterlogging. In addition, a mix of irrigation-only, drainage-only and irrigation-cum-drainage tubewells would be operated on the command of this central computer (SSNNL 1989). It would truly be a technological miracle if such a system could be installed and operated. Unfortunately, there is not even a pilot project using this system anywhere in the country. We have no idea how such a highly centralised and complex information and engineering system will work under field conditions. Given the track record of irrigation systems in India, it is unwarranted optimism to hope that such a system will work in a "foolproof" fashion.

Waterlogging and salinisation are amongst the few potential environmental impacts of SSP for which a reasonable quantity of specific data is available. Preliminary surveys have suggested the proneness of large parts of the command area to these problem. Detailed soil surveys, drainage studies, and groundwater assessments have only recently been commissioned, and are not expected before the end of 1993, if not later. The CES (1992) report states that "detailed information on topography, climate, hydrogeology, hydrologic data of major natural drains/rivers, soils and groundwater conditions are required to be collected in a systematic manner...". According to NCA (1993), an "integrated review of soil studies" was "due to start in March 1993" (strangely, this statement has been made in a June 1993 document!). In the case of groundwater and drainage studies, to be done by a foreign firm, the same document has this to say: "start date to be determined". Thus, it is still unknown how much of the command area is actually irrigable, what is the extent of remedial measures to be required, and what is the likelihood of being able to use ground-water to supplement surface waters for irrigation.

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Loss of Biological Diversity

Summary: The spread of irrigation into the SSP command is likely to have a serious deleterious effect on some species. Parts of the SSP command have natural habitats of extreme significance, including the Rann of Kutch with its unique flora and fauna. The large-scale disturbances due to canal construction, habitat changes caused by canal irrigation, and the agricultural expansion which will follow are likely to have severe negative consequences, specially on sensitive species such as the highly endangered Wild Ass.

Parts of the SSP command area have natural habitats of great national and global significance. For instance, Nal Sarovar Sanctuary near Ahmedabad is one of western India's largest wetlands, attracting over 120 migratory species of birds. The Dhrangadhra Sanctuary in the Little Rann of Kutch is a unique salt desert and wetland ecosystem not found anywhere else in the world, harbouring endemic and endangered species like the Wild ass (*Equus hemionus khur*). The Velavadar National Park near Bhavnagar (Saurashtra) has perhaps India's largest concentrations of the threatened Blackbuck (*Antelope cervicapra*).

Project authorities have claimed that "copious amounts of fresh water" resulting from the project will benefit wildlife in the sanctuaries in the command area (Raj 1989; Pathak 1989). Such blanket assertion display ecological illiteracy. All ecosystems develop in a particular regime of water availability and other climatic and geological conditions. Introduction of canal waters into and and semi-arid regions drastically changes the dry nature of the land, greatly increasing humidity and soil moisture, and transforming sparsely vegetated landscapes into relatively lush green ones.

To a lay person, this appears to be a change for the better. However, such a viem is based on a misunderstanding. Every type of natural habitat has its own composition of flora and fauna, and wildlife in and regions is uniquely adapted to living in dry, hot conditions. Put the same creatures into a tropical rainforest, and the humidity and dampness will kill them. It is an experience from all over the world that desert and and zone ("xeric") flora-fauna are driven out with the introduction of canal irrigation. In India this impact is beginning to be seen in the Indira Gandhi Nahar Pariyojana (IGNP) command area in Rajasthan, where the population of animals like the Desert fox (*Vulpes vulpes pusilla*), the Desert cat (*Felis libyca ornata*), the Caracal (*Felis caracal*), and the Indian gazelle or Chinkara (*Gazella bennetti*), and of plants like the nutritious sevan (*Lasirius sindicus*), are declining (Prakash and Ghosh 1980; Prakash 1992).

Simultaneously, the changing environment makes it possible for creatures to enter and survive which would have previously not been

found there. Consider birds which are found around human settlements: these are rarely seen in forests, but when the forest disappears, the sparrows and the crows proliferate. They displace and outcompete the original inhabitants. The newcomers are 'generalists', able to survive in a wide variety of habitats. Again, to a

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lay observer, it would seem that the diversity or abundance of local animals is increasing. However, what has happened is that introduced biodiversity from another area has begun to replace the unique, indigenous biodiversity of the area. The now colonisers are not in any way unique, as they are found in many other areas. Again, this process can be seen in the case of the IGNP (Prakash 1992).

In the SSP command, there is justifiable fear that species of plants and animals unique to the arid areas will be adversely affected by the processes mentioned above. Especially susceptible will be the Rann of Kutch. This unique ecosystem is a complex and delicate mix of arid lands, tidal wave inundation from the Gulf of Kutch, and freshwater flooding from inland. Such a part-desert, part-wetland ecosystem is not found elsewhere in the world. The delicate balance of this ecosystem is bound to be disturbed by the introduction of `copious amounts of freshwater' - it will push out the xeric flora-fauna which are uniquely adapted to the Rann, and replace them with generalist species. Particularly threatened could be mammals, like the Wild ass and birds like the Large desert lark (*Alaemon alaudipes*) and the Desert or Creamcoloured courser (*Cursorius cursor*).

The Wild ass is one of the world's rarest mammals, this subspecies being found only in the Rann. This and other animal species will also be threatened by other aspects of the project. The project authorities themselves recognise, that "there may be certain adverse impacts because of the canal network criss-crossing the area with impacts on unrestricted movements of wild ass for browsing etc., as also impacts on arid zone fauna." (TOR Wild Ass 1992). This has been confirmed by the findings of a study carried out by the Wildlife Institute, Dehradun, completed in June, 1994. They have recommended that work on two branch canals be immediately stopped due to almost certain negative impacts on the wild ass. Other possible impacts include the tremendous disturbance which canal construction will cause (including the movement and settlement of large numbers of labourers, and the movement of vehicles and equipment), and, perhaps most seriously, the conversion of browsing and grazing lands into irrigated agricultural fields. These impacts have also been felt in the IGNP area, with disastrous effects on and zone wildlife.

As regards the Nal Sarovar Sanctuary near Ahmedabad, it is important to note that this consists of a huge, shallow and seasonal lake. The rise and fall of water levels and the periodic drying and inundation of sections, are critical aspects of such a lake, and integral to the survival of its flora and fauna. Currently, the lake rarely exceeds 3 metres in depth, but the SSP authorities plan to construct an 8 metres high embankment and utilize the lake as a storage reservoir. Almost all of the large numbers of migratory birds currently found at the lake are shallow waders, not deep diving birds. An 8 metres deep lake will make the environment complete unsuitable for them, and drastically change the lake ecosystem.

Even worse, project authorities are considering a plan to have multiple uses of the lake, possibly by "compartmentalising" it into a part-conservation part-usage waterbody (TOR Nal Sarovar 1992). The disturbance this would cause would be considerable. Finally, as identified by the project authorities themselves, agricultural development in the command area

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around the lake could have a negative effect (TOR Nal Sarovar 1992), the greatest danger being the large-scale use of fertilisers and pesticides, which will eventually flow into the lake. Attention should be drawn here to the increasing number of studies showing severe poisoning effects of pesticides on wetland birds (e.g. in the Keoladeo Ghana or Bharatpur National Park in Rajasthan - see Vijayan 1991), and degradation of wetlands by fertiliser inflow (GOI 1990 ; WWF 1992).

Studies by expert groups are underway to predict the impacts ot tne canal network and irrigation on the Nal Sarovar Sanctuary, the Dhrangadhra Wild Ass Sanctuary, and the Velavadar National Park (NCA 1993). The studies initiated have completely impossible time-frames, given their rather ambitious scope. Only six months have been assigned to study the Nal Sarovar Lake. The list of topics to be covered is similar to that studied for the Bharatpur wetlands by the Bombay Natural History Society, which that highly competent organisation took ten years to complete! The incongruity between the TOR and the time frame is equally striking in the proposed study of the impact on the Dhrangadhra Wild Ass Sanctuary. Furthermore, some impacts are not part of the Terms of Reference of these expert groups, such as the impact of freshwater on the salt desert and seasonal wetland ecosystem of the Rann of Kutch, or the impact of the spread of agriculture around (or inside) the Rann.

We very much fear that the studies will tend to be superficial. Given the political climate in which the SSP is being built, it is extremely unlikely that the studies will recommend any drastic redesigning even if it is found that there is a likelihood of one or more wildlife species being seriously endangered by the project. They will be reduced to suggesting measures to minimise impacts instead of studying the desirability of interfering with the ecosystem at all. We feel that it is unlikely that mitigative measures will avoid or signficantly reduce the degradation of these unique ecosystems - such problems are largely inherent and unavoidable when converting naturally and zones into artificially humid tracts.

We would stress here that this problem is entirely created by the project authorities themselves, since they did not think of doing these studies in the first few years of project planning, and are now trying to rush through them to make it appear that the environmental aspects of SSP are well looked after.

Other Impacts

The SSP canal network could cause other possible impacts in the command area, including the spread of water-related diseases and disruption of natural drainage patterns.

A rise in the incidence of malaria is definitely anticipated by the

project authorities; we feel that the rise may be even more serious than they are expecting, because they have considerably under-estimated the possible extent of waterlogging. Canals and waterlogged areas can become major breeding centres for malaria vectors. As in the case of diseases

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around the proposed reservoir (discussed above), the planned ameliorative measures in the command area are also heavily dependent on chemical control. This could in itself become a major source of health problems. This issue has been raised several times in the meetings of the NCA Environment Sub-group, but has not been satisfactorily resolved.

The canal network will disrupt natural drainage patterns in the command area. The impacts of this are difficult to predict in the absence of information. However, according to newspaper reports in Gujarat, the Ajwa Tank in Baroda remained unfilled in 1993, despite good rains, because the drainage system into the tank had been blocked by the canal, while fields above the canal reported waterlogging in 1993 and 1994. A canal network as large as the SSP's (75,000 km. in length) has the potential to cause serious problems in this respect.

Other Impact Areas

Resettlement Sites

Over 4200 ha of forest land in Maharashtra have so far been released for the rehabilitation for SSP displaced persons in Maharashtra. This was despite the statement in the conditional clearance that "no forest land will be used for rehabilitation of oustees." This was also done without any survey of the flora-fauna of the area. It is now anticipated that more such land will be released in Madhya Pradesh, which has the largest number of displaced persons. In addition, rehabilitation will result in increased pressure on the existing natural resources, with particular effect on grazing lands, forests, and waterbodies. Since the majority of resettlement sites for the people to be displaced by the SSP are not yet known (only about 20% of those to be displaced have been assigned resettlement sites), it is not possible to analyse these effects here.

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SOME CONCLUDING COMMENTS

Environmental Studies Conducted for the SSP

Summary: While the SSP project authorities have commissioned and conducted more studies on environmental aspects than has ever been done for any dam project in India, almost all of these were started subsequent to having started work on the project, and most of them subsequent to having obtained clearance in 1987. Moreover, a number of the studies conducted have serious shortcomings. Finally, and most importantly, several aspects remain unstudied, or only cursorily assessed.

The number of environmental studies conducted on SSP is unprecedented in the history of Indian dam-building. Subsequent to the 1983 report by the M.S. University, a series of very brief reports on some environmental aspects of the SSP (misleadingly labeled "Workplan for Environmental Effects") were produced by the Narmada Planning Group in 1986. Detailed assessments of these aspects were started only after 1987, when the Government of India accorded conditional clearance. Since then, an impressive number of reports have been produced on the environmental aspects of the project, a number which certainly surpasses anything that has been done for any other project in India. (Detailed listings of available studies, and their findings, are available in official documents).

Considering the almost complete lack of any environmental studies in previous projects, such an effort is very laudable. What is important though is not the number of such studies in SSP compared to other projects, but the fact that these studies are still not adequate for collective consideration as a comprehensive EIA. Furthermore, these studies cannot be called impartial 'scientific' assessments, as discussed below.

How Independent are the Comissioned Studies?

Many of the environmental studies conducted for SSP fall far below the that should be required in term of quality, impartiality, and comprehensiveness. Their credibility is also sometimes doubtful. Several studies appear to have been conducted with the sole purpose of justifying the project.

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Most of the studies have been commissioned by the project authorities themselves, and several conducted by consultants or organisations whose biases are evident from their own statements (e.g. the example given above of the M.S. University). Several studies commissioned well after construction started, have only been asked to suggest ameliorative measures, rather than make critical studies reflecting on the environmental feasibility of the project. In addition, these studies are not made public till much after they are screened and edited by project authorities. In such a situation, and with finding fully under the control of then authorities, truly independent studies are difficult to expect (though not impossible).

In addition, no peer review of the process and methodology of these studies is carried out. A less than professional approach to studies is much easier to generate and encourage under an environment of secrecy where no public scrutiny is possible. While not wishing to cast any aspersions on any of the persons who have conducted the commissioned studies of SSP, we would frankly like to challenge the independent nature of some of these studies, due to the above-mentioned factors. This is, of course, not a problem restricted to SSP; other projects in other parts of the country might suffer from it in even greater intensity.

Project Costs Arising out of Environmental Aspects of SSP

Summary: Costs of ameliorative and mitigative measures for environmental impacts of the SSP could rise above Rs. 4300 crores. A vast majority of these costs have not been included in any cost-benefit appraisal of the project. Given the severe financial constraints of the SSP, it is highly probable that most ameliorative and mitigative measures will never be carried out. This is specially true for the drainage works, the lack of which could prove to be disastrous.

Costs of ameliorative and mitigative environmental measures for the SSP have been suggested by some (though by no means all) of the studies. They add to up to a very impressive total, most of which has simply not been considered when the cost-benefit analysis was undertaken. Catchment area treatment for only the critically erodable, directly draining, land is currently estimated to cost Rs 146.43 crores (ESG 18th Meeting Agenda Notes 1993), up from only Rs 2 crores estimated 30 years ago. Compensatory afforestation is currently estimated to cost Rs 72.57 crores (ESG 17th Meeting Agenda Notes). Cost of major drainage works only (excluding over 50 major bridges, countless minor bridges, and the substantial energy costs of pumping out groundwater), is estimated to cost Rs 1600 crores for Regions 5-13 (CES 1992), and at least another Rs 200 crores for Regions 1-4 (Core Consultants 1982). No cost estimates are available for fisheries development, health care, wood and vector control measures,

downstream impact control measures, sanctuary protection, and other measures.

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All these costs add up to over Rs 2000 crores. And this is only the base cost. Adding price and physical contingencies usually more than doubles the cost: the World Bank estimated the base cost of the SSP as Rs 6264 crores and the total cost at Rs 13,640 crores in 1995 (WB 1985). Using similar ratios, the cost of environmental mitigative and ameliorative measures could rise to over Rs 4300 crores! The cost of the SSP excluding environment and rehabilitation costs is already projected to be well over Rs 20,000 crores (Ram 1993). Add the "environment" costs, and the financial burden of the SSP becomes truly unbearable. In such a situation, and given the current financial crunch faced by the project, we wonder whether most of the environmental mitigative measures will ever be undertaken for the SSP. This is specially true for the drainage measures: if total drainage costs alone are over Rs. 3600 crores, it is more than likely that drainage will simply be ignored over most of the command, as has been done in so many projects all over India. This would have very serious consequences in terms of waterlogging and salinisation over large parts of the SSP command.

Putting it All Together: Is the SSP Justified?

The SSP, in a sense, is a victim of changing standards and perceptions. Almost all earlier mega-projects in India blithely ignored social and environmental costs. When the SSP was planned, it was perhaps 'natural' for the project authorities to concentrate exclusively on technical parameters and wish away environmental and social drawbacks with facile statements about "environmental enhancement" and "chance for tribals to enter the mainstream of development". However, the proven ill-effects of mega-projects have now become too compelling to ignore, and the attention paid to them by both the national and global community has forced even insensitive international lending agencies like the World Bank to do some serious rethinking, and to impose environmental and social conditions on funding.

Consequently, the SSP can boast about the largest number of environmental studies ever conducted for a mega-dam project in India. This does not mean that these studies comprise that essential requirement: a comprehensive EIA. Nor must it be thought that project authorities conducted these studies willingly; they had to be forced into them by public pressure and donor insistence. In other words, the Government still has not internalized the fact that comprehensive environmental studies are not irritating asides, but are essential to carry out sustainable development projects.

The conditional environmental clearance granted to the SSP has been in repeated violation for the last five years, and the SSP is progressing as an illegal project. A whole range of environmental impacts remains unstudied to date, and the project has the very real capacity to render

thousands of hectares infertile due to waterlogging and salinisation, turn the lower reaches of Narmada into a saline stream, and permanently damage fragile and unique ecosystems in Kutch and Saurashtra. The convenient and ineffective *pari passu* clause has

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virtually ensured that environmental issues will be relegated to the background, the imperatives of construction bulldozing their way past any logic and rationality.

A critical analysis of the benefits claimed for the SSP (Ram 1993) has revealed that the SSP has no comprehensive plan for drinking water supply, that it is likely to irrigate less than half the 1.9 million hectares claimed, and that firm power output from the SSP will be only a fraction of the installed capacity. Taken together with the analysis of environmental impacts of the SSP carried out in this study, the viability and desirability of the project itself must be questioned.

Even at this stage, we can only conclude that the SSP must be halted until a comprehensive EIA is available, and until this EIA is tied in to other basic studies (including social impact, financial viability, and alternatives). Only such a process can determine whether this project is worth pouring more money into, whether some essential design changes can help make it viable, or whether some genuinely effective and less damaging alternatives can be found to solve the water crisis of Kutch, Saurashtra and North Gujarat.

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