Re-Evaluating Multi-Purpose River Valley Projects

A Case Study of Hirakud, Ukai and IGNP

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The absence of post-construction reviews severely hamper assessments of multi-purpose river valley projects' (MRVPs) actual performance vis-a-vis *its claims. Long-term effects like ecological disequilibriums remain unaccounted for due to an absence of comprehensive pre-project environmental impact assessment. This article, studying three projects, namely, Hirakud, Ukai and Indira Gandhi Nahar Project (IGNP), clearly demonstrates the glaring and complete dichotomy between pre-construction projections and post-construction realities. Water-logging, salinity, sedimentation and health hazards have a high possibility of occurrence. Even flood control, irrigation and power generation are not effective as envisaged. These experiences, the article argues, need to be studied in-depth and made to constitute an important part of future planning for MRVPs.*

VOICES the world over have been raised against the construction of multi-purpose river valley projects (henceforth MRVPs). Notably the agitations against the Three Gorges dam in China, Arun III dam in Nepal, and in our country against the Narmada, Suvarnarekha, Koel Karo, Tehri, Indravati, Pooyamkutty and Sharavati projects have substantially undermined the almost blind belief that expensive MRVPs can be uncritically accepted as panaceas for the problems of underdevelopment. The objectives of flood control, irrigation, hydel power, besides an assortment of secondary benefits that are ostensibly to be met by these MRVPs, have begun to be judged *vis-a-vis* the costs of rehabilitation, deforestation, top soil erosion, reservoir induced seismicity and social consequences [Singh, Kothari and Amin 1991; Hildyard and Goldsmith 1984; Thukral 1992; McCully 1996].

'Big dam' proponents argue that the overall benefits far outweigh the costs. A World Bank Review (1991) stated that in the large Bank financed irrigation projects in India, 15 families benefited for each family displaced, while the ratio stood even higher for transport, water and urban development projects. Policy-makers therefore continue to condone the negative fallouts. Even to the extent of dismissing the violations of norms and procedures that occur with almost unfailing regularity during construction, as errors that need not challenge the sanctity of the project. The logic again being 'the greatest good for the greatest number'.

Inherent in such a schema is a clear dichotomy between those affected and those expected to benefit. For example, in the Sardar Sarovar Project (SSP) a major share of the submergence zone is located in Madhya Pradesh and partially in Maharashtra and Gujarat. In all the three states the brunt of the displacement will be borne by tribals whose lands will either become islands in the reservoir or will remain under water. These project affected persons (PAPs) are included in the costs of the MRVPs and counted against the supposed beneficiaries who will occupy the command area of the project. In effect victims of the submergence zone as costs are evaluated against those of the command for whom benefits are to accrue. Thus some are to lose in order that others gain.

However, the delineation into two zones with one bearing the costs and the other enjoying the benefits is fraught with several problems. For one, the beneficiary zone is not necessarily exclusive in terms of gain; rather, command areas as will be argued below are riddled with processes of marginalisation, ecological disequilibriums and a range of tensions derived from the MRVPs.

The Other Questions: Post-Construction Review

However, it is not merely the nature of the categorisation that is at issue. Rather, it is the complete lack of a comprehensive audit at the post-construction stage and monitoring of costs and benefits actually accruing ex post that is glaringly absent not only from the planner's agenda but also from the researcher's agenda. The lack of such an audit allows the planning authority to flaunt the ex ante data as an example of successful implementation of these projects. The question that needs to be asked and which we are going to pose is: aside from the social, ecological and direct economic costs that these projects bring in their wake, do these projects even fulfil the targets that they set for themselves? Does the planning authority even for academic purposes (leaving aside the larger political and social questions) undertake such a review to counter-check the basis of its own planning methodology?

Interestingly enough, not a single satisfactory comprehensive review (i e, including economic, ecological, and social impacts) of the performance of any MRVPs in India exists to date. Though there are reports on specific aspects of the beneficiary zone and some sort of documentation of trends in irrigation, health etc.[1] these are limited, sketchy and often give contradictory data. The government, despite being caught in the midst of a raging controversy over the efficacy of MRVPs and the profitability of these huge investments, is yet to review project performances even though some of the MRVPs have been in operation for several decades.

Some further questions can now be posed. Are the gains substantial enough to justify such large investments? Is it also the best way in which the money can be spent? And at a very mundane level, do the projected benefits even accrue as per plan or is the actual scenario far different from what was envisaged?

The inability to develop on past experiences, we feel, is a serious flaw in the overall calculus in which current MRVPs are being planned and executed. To partially fill this absence of what is certainly a vital input for future projects, a limited study was undertaken to evaluate three MRVPs – Hirakud (Orissa), Ukai-Kakrapar (Gujarat) and the Indira Gandhi Nahar Pariyojana (Rajasthan). The aim was to examine if a hiatus existed between what was delivered in contrast to what was promised. This review, however, is not a comprehensive survey, rather it is an attempt to serve as a forerunner to more substantial studies in the framework outlined.

It is our submission that there is need to redefine the concept of the 'beneficiary zone'.[2] A careful scrutiny of the command area (zone downstream of the dam) would yield its own layer of PAPs. Further, the MRVPs initiate certain long-term trends, both economic and social, which may severely erode the profitability of investments in these areas. Consequently, the beneficiary zone cannot be visualised as an undifferentiated bloc where the gains are unequivocally evident. The absence of such critical examination of the 'beneficiary zone' leaves open the space for proponents of the current paradigm of development to transform the touted benefits of existent MRVPs which are rarely questioned and therefore uncritically used to plan future projects.

In sum, MRVPs rather than only being challenged on the basis of costs need to be holistically evaluated on the benefits claimed within the larger rubric of the performances of completed MRVPs. This hopefully will undermine the false dichotomy of the beneficiary versus the project-affected (as in command area and submergence area), and emphasise the need for surveys at pre- and post-project stages in both the submergence as well as command zones.

Three Case Studies: Hirakud, Ukai and IGNP

Hirakud (completed in 1956-57) is one of the 17 dams designed exclusively for flood control out of a total of 1,554 dams [CSE 1982]. It is also one of the earliest and probably the most significant in the immediate post-Independence era. The subsidiary benefits being power generation, irrigation, navigation and tourism. The Ukai-Kakrapar (U-K) was constructed in two phases (phase I – Kakrapar weir completed in 1959 and phase II – Ukai dam completed in 1972) to provide irrigation, hydro-electricity and control floods on the river Tapi. The Indira Gandhi Nahar Project (IGNP) was to transfer water from the Sutlej and Beas to the desert lands of Rajasthan with the aim of providing irrigation and drinking water. Stage I of the main canal was completed in 1975 and stage II is yet to be fully operational.

A crucial input for time-scale comparative analysis is a database drawn over a period of time. Unfortunately documentation on these projects is fairly poor – which includes not only pre-construction but also post-construction data. In the absence of pre-project surveys, comparisons became difficult. Since we had concentrated on the command zone (the so-called beneficiary zone) we could at best only touch upon some of the questions.

Table 1: Cost Escalation of Hirakud Dam Project

Item	1947	January 1952	November 1952
Cost (Rs crore)	47.81	89	100.2
No of canals	6	3	2
CCA (ha)	350084	216800	157050
Power (mw)	350	268	200
Submergence			
(total)	54,000	NA	65,224.4
(cultivable area ha)	28,000	40,000	44,815.2

For example, the bureau of economics and statistics in Orissa conducted two socio-economic surveys of the Hirakud Ayacut in 1968 and 1986; but in the absence of such surveys for the pre-dam phase counterfactual analysis becomes almost impossible.[3]

Similarly, in the IGNP command, the lack of comprehensive pre-canal studies has tended to create the false impression that the desert was a singular expanse of sand, when, in fact, it supported a number of pastoral communities. One of the crucial social fallouts of the IGNP canal is that with settled agriculture in the canal zone these pastoral communities are being marginalised.[4]

Cost Escalation

Any Planning Commission project has to pass the project feasibility test of financial cost-benefit analysis of 1:1.5 [Singh et al 1991]. In the time period which separates the first conception of the project and its final approval (or even the completion of construction) there is a huge escalation of costs. The trick that is then employed to justify the project in the light of these cost escalations is to reassess benefits to meet the feasibility criteria.[5] For example, the Hirakud Dam was initially (in 1947) estimated to cost Rs 47.81 crore (Rs 478.1 million). It subsequently underwent two revisions in 1952 (Table 1).

It is evident from Table 1 that the original scheme was drastically altered. On the benefits side installed power generation capacity was pegged down by 150 MW (from 350 MW to 200 MW); the culturable command area (CCA) reduced to less than half and the number of canals decreased from six to just two. And on the costs side, the estimated costs almost doubled as did the amount of cultivable land to be submerged from 28,000 ha to 44,815.2 ha.[6] Though we were unable to find detailed financial estimates of the project plans, it would surely have been interesting to find out how the benefits had been upgraded despite not only the escalation of costs but also decrease in the expected accrual of benefits.

The construction cost of the IGNP canal was initially estimated at Rs 66.67 crore (Rs 666.7 million) in 1957. However, with the 1960 Indus water treaty and the enlargement of the scope of the project, several revisions were made. Up to March 1991 Rs 268.91 crore had been expended on stage I and Rs 516.03 crore on stage II. By the year 1990-91 the total expenditure on the IGNP had amounted to Rs 784.94 crore. Project authorities estimate that another Rs 700 crore would be required to complete the project by 2002 AD [Urmul 1991b]. However, in January 1991 the then Rajasthan chief minister, Bhairon Singh Shekhawat, disclosed that an additional Rs 1,400 crore would be required to complete the project by the Tenth Five-Year Plan period (2001-2005 AD). An independent estimate places the additional requirements at close to Rs

Table 2: Cropping Pattern in Pre- and Post-Hirakud Dam Project

Crop	Envisaged		Actual	
	Percentage Area	Area (ha)	Percentage Area	Area (ha)
Kharif				
Paddy	70	1,09,935.0	97	1,52,338.4
Sugarcane	10	15,705.0	**	**
Cotton	5	7,852.3	**	**
Others	15	23,557.7	3	4,711.6
Total	100	1,57,050.0	100	1,57,050.0
Rabi				
Paddy	33	20,973.6	70.6	1,10,997.2
Sugarcane	8	5,084.4	**	**
Cotton	7	4,448.8	**	**
Others	*	**	4.2	6,844.4
Total	48	30,506.8	74.8	1,17,841.6

Source: Panda (1986) Annexures B-1, B-2, B-3.

Table 3: Details of Cropping Patterns in the Ukai-Kakrapar Project

Crop	Proportion of CCA Envisaged Initially (Percentage)	Proportion of CCA Developed for 1989-90 (Percentage)	Annual Produce Envisaged Initially (000 tons)	Production Envisaged for 1989-90 (000 tons)	Actual Production for 1989-90 (000 tons)
Sugarcane	11.543	59.830	2995.2	5167.05	7366.26
Banana	1.180	3.579	118.2	171.00	268.17
Paddy	22.625	19.028	151.1	97.57	258.89
Sorghum	11.615	0.489	38.8	4.16	2.82
Wheat	12.187	1.906	61.0	11.25	9.90
Pulses	13.449	1.367	20.2	7.12	7.89
Cotton	13.314	2.626	35.5	7.20	9.56
Vegetables	8.051	1.812	188.2	63.00	104.64
Others	6.036	9.363	141.1	175.13	216.23
Total	100.000	100.000	3749.3	5703.48	8243.86

2,900 crore which includes central assistance of Rs 1,100 crore. But even then the IGNP is expected to be completed only by the year 2015 AD [Subramanian 1991].

We are not aware of any reassessment of these projects except a mention by the comptroller and auditor general (CAG) of cost overruns [Singh et al 1991]. Most importantly, we also do not find any concrete initiation of steps by the planning authorities to correct their estimates of new projects for the discrepancies in estimated costs and actuals on completion. The economic evaluation, for example, fails to account for the difference in the proposed and the post-construction cropping pattern. And as will be observed below, in none of the MRVPs under review here, the proposed cropping pattern matched the actual pattern adopted. The variance puts an important question mark over the manner in which cost-benefit ratios are arrived at.

Table 4: IGNP Water Requirement and Actual Release (Main Canal)

Year	Indented Requirement (cusecs)	Actual Discharge (cusecs)	Shortfall (percentage)
1981-82	2828456	2229778	21.17
1982-83	3071836	2341456	23.78
1983-84	2652424	2518646	05.04
1984-85	3395300	2428472	28.48
1985-86	2984555	2658790	10.92
1986-87	3892289	3848952	01.11
1987-88	3163700	2278128	27.99
1988-89	3274474	2891872	11.68
Total	25263034	21196094	16.68 (average)

Table 5 A: Area Affected by Water-Logging in the U-K Project Command

Caval System	Affected CCA (ha)
Surat branch	55,270
Kakrapar left bank canal	90,065
Kakrapar right bank canal	55,320
Ukai (both canals)	127,477

Changes in Cropping Pattern

In the pre-Hirakud (dam) period the major crops grown in Sambalpur were paddy, pulses, sesame, cotton and sugarcane. Rice was by far the most widely cultivated crop, occupying over 90 per cent of the total cultivated area. But there were an estimated 300 varieties of paddy cultivated in the district. Sugarcane ranked second in importance and the jaggery produced from it was famous for its superior quality and was a principle item of trade [Senapathi and Mohanti 1971]. When the Hirakud canals were being planned, the irrigation department had made certain projections of the expected cropping pattern in the command. However, as will be evident from Table 2 the actual cropping pattern is a far cry from the one envisaged.

As is evident from Table 2, 97 per cent of the CCA during kharif is planted with paddy. Though the concentration of paddy is not new to the area, what is, is the growth of HYV monocultures. Though the Command Area Development Authority (CADA) is keen to change the crop mix, a sort of 'land locking' has occurred; the regimen of water regulation in the canals leaves the farmers little choice but to adopt the watering pattern of the dominant crop. Moreover the marshy conditions of the low lands prevents cultivators from shifting to other crops.

In the U-K command there is a similar discrepancy between the cropping pattern envisaged and the actual crop mix prevailing.

Historically, prior to the U-K project, cotton was the dominant crop while food grains consisted of cereals, jowar, wheat and groundnut [Breman 1985]. With the coming of perennial irrigation there has been significant change in the crops and the distribution of land under different crops. As Table 3 highlights, over 60 per cent of the command has been taken over by sugarcane cultivation. Interestingly, less than 12 per cent of the area had been envisaged to be under sugarcane. It has ousted cotton from being the dominant cash crop; cotton now occupies a mere 3 per cent of the total cropped area. Many of the traditional foodgrains like jowar, wheat, paddy and pulses have almost been eliminated.

In IGNP, the contrast has to be understood differently. The command area in the pre-canal era was occupied essentially by pastoralists who had developed various mechanisms to cope with the harsh desert environment. A significant aspect of their strategy was to distribute risk; large herds of milch cattle were maintained on the rich Sewan grass (lasirius indicus). This was supplemented with a degree of subsistence agriculture with crops like moth (vigna aconitifolia), bajra (penisetum typhoides), til (sesamum indicus), guar (cyamopsis tetragonaloba) and chana (cicer arietinum). Besides these productive possibilities they had a variety of migration routes, including distress flight to overcome calamities.

The canal, which has introduced an intensive agricultural strategy, has now predominantly phased out this combination of animal husbandry and subsistence agriculture. The chief crops in the command at present are cotton, groundnut and wheat with some amount of vegetables and mustard. With land increasingly coming under the plough for cash crops, animal husbandry is fast declining. Several of the pasture lands (gochar zameen) which were communally held for fodder and fuel are now being parcelled out for commercial farming. The new production strategy tends to concentrate resources narrowly by focusing only on agriculture, and prevents the farmer from distributing his risks.

Though the argument that settled agriculture affords higher economic returns may seem strong, severe water-logging in the command coupled with high initial costs for preparing the land have provoked some serious rethinking on the ecological sustainability of such an agrarian strategy. Its social biases especially the marginalisation of pastoralists is also a matter of serious concern.

Table 5B: Increase in Water-Logged Area after Commencement of Canals

	CCA (ha)	Area with Water Table between		Area Affected	
		0-1.5 m	1.5-3 m	Total	Percentage of CCA
KAKRAPAR	199691				
Pre-irrigation (1957)			1075	1075	0.54
By 1989		11460	66000	77460	38.79
UKAI right bank					
Pre-irrigation (1973)			206	206	
By 1989		2150	21650	23800	
UKAI left bank					
Pre-irrigation (1973)		40	40	80	
By 1989		2040	13800	15840	
UKAI (both canals)	118554				
Pre-irrigation (1973)		40	246	286	0.24
By 1989		4190	35450	39640	33.44

Source: Government of Gujarat (undated).

Coping with Competing Demands

MRVPs are so named because the water stored in the reservoir is used for multiple purposes – control floods, generate hydro-electricity, feed the canals for irrigation, etc. However, competing demands on the reservoir space can create systemic problems. In the case of Hirakud and Ukai, there is evidence to suggest that conflicts over the use of reservoir space has detrimentally affected the capacity for generating power and undermined the ability for flood control.

While for flood control the reservoir has to be kept relatively empty, irrigation and power generation necessitate the filing up of the reservoir during the monsoon months. For example, the original plan for Hirakud had suggested the filling up of the reservoir to about 590 feet during July and August. But after the dam became operational, water is retained at about 607 feet, reducing the flood absorptive capacity of the dam by 1.5 million acre feet (maft) in July and August. By September 1, the reservoir is further filled to 612 feet to ensure full power generation. Thus presently the Hirakud can only absorb 3 maft on or before September 1, and even less if it occurs later in the month. These changes in reservoir filling schedules have apparently been necessitated due to higher inflows end-August onwards.

In 1980 there was a devastating flood downstream of the Hirakud dam. Among the many causes that have been forwarded to explain the occurrence, it has been suggested that large inflows in September met a full reservoir. This necessitated the sudden release of water from the reservoir, which resulted in floods downstream of Hirakud [Satpathy 1987].

Another significant set of observations highlights Hirakud's probable impact on floods in terms of their intensity and frequency. According to Mohanty (1983), the frequency of high floods in the Mahanadi basin have risen to once in 3.3 years from once in 3.48 years. While that of low floods have fallen to once in 3.35 years from once in 3.1 years. Moreover, between 1834 and 1926 there were six major floods with an average interval of 15.5 years. Between 1926 to 1955 there were four major floods with an average interval of 7.25 years and between 1955 to 1982 (the post-Hirakud phase) there were seven major floods with an average interval of 3.86 years. This represents a substantial increase in the frequency of major floods.

In the IGNP, competing demands are of a different nature. Of the 7.59 maft allotted to the IGNP, 6.72 maft is meant for irrigation purposes whilst 0.87 maft is reserved for drinking and industrial use. Therefore, at 75 per cent dependability of mean flow in the river (the normal dependability percentage in all irrigation projects) the quantum of water that would be available would only be 5.04 maft, which may be inadequate if the entire command of 13.58 lakh ha is opened up. Furthermore, Rajasthan has been witnessing problems in the quantum of water being released to it by the Bhakra Beas management board, as can be inferred from Table 4 [Urmul 1991a, quoting chief engineer, CADA, Bikaner].

Thus, on an average Rajasthan receives roughly 17 per cent less than the actual water supply allocated to it. In the rabi season of 1993-94, only 15,000 hectares were cultivated, down from 26,000 hectares in 1992-93. The reason being a 40 per cent drop in water availability. Whereas stage I has been allotted 3.37 maft (to irrigate 5.25 lakh hectares), in 1993 it drew 4.51 maft, i e, 26 per cent more than its share. Stage II which has been allotted 3.35 maft (10.12 lakh hectares to be irrigated) is receiving barely 1.89 maft [Agarwal 1994]. Despite the inadequate water supplies, the IGNP authorities are continuing with the completion of stage II and have, in fact, revised the estimated area to be irrigated at a little over 11 lakh hectares.

Ecological Problems

The sustainability of any developmental project vitally hinges on its ability to maintain the essential ecological factors on which its viability is dependent. Many of the MRVPs have become unsustainable because they have degraded the very resource base they intended to enhance.

From the point of view of enhancing agricultural production, water-logging in the command and salinisation of soils are two of the most significant out-growths of perennial irrigation. For flood control, irrigation potential and power generation, i e, all factors dependent on the reservoir space, soil erosion in the catchment is the most serious issue. Sedimentation in the reservoir due to increased soil erosion in the catchment is a result of multiple factors, many of them linked directly or indirectly to the MRVPs.

The compounding of such large amounts of water and the existence of permanent water-logging in the command has brought with it malaria in its most dreadful forms. The increased use of chemical fertilisers and pesticides; without proper safety precautions, has also led to health problems.

Water-logging: Government estimates of waterlogging in the command vary widely, from document to document and sometimes in the same document. Reproduced as Tables 5A and 5B are two tables from the same publication [Government of Gujarat nd].

Though showing widely varying figures, both these tables reveal an alarming state of affairs. If the second table is to be believed, water-logging has jumped in Kakrapar command from a mere 0.5 per cent of the CCA, prior to irrigation, to nearly 39 per cent after the commencement of canals, and in Ukai from less than 0.3 per cent to over one-third of the command. One of the reasons for this is that sugarcane, which is an annual crop, requires perennial irrigation and therefore the land remains wet for the considerable part of the year.

In IGNP, government estimates of water-logged areas are placed at 2 per cent in stage I [Urmul 1991b], while another report [WAPCOS 1989] puts it at 33.7 per cent. Moreover, the 'potentially sensitive' area (with ground-water level at less than 6 metres from the surface) occupies 1,99,980 hectares, roughly 38 per cent of the command area of stage I. The rising water table, whose rate of annual rise in the IGNP is almost 1.01 metres could very seriously aggravate the situation. In stage II, of the 2.8 lakh hectares surveyed by the CADA, about 33.8 per cent was found to have a hard pan layer up to a depth of 5 metres. An additional 27 per cent was found to have a hard pan up to 10 metres in depth. With the average rate of increase in the water table in stage II being 1.25 metres per year, large parts of the command area could witness a severe crisis from water-logging [Urmul 1991b].

For Hirakud, government agencies till recently did not accept that the problem of water-logging exists in the command. The current estimates put the extent of CCA affected at 7 per cent [Hirakud CADA nd]. However, the staff in the office of the executive engineer, soil and water management, Sambalpur, have been raising the issue of water-logging since 1974. The soil survey department, Sambalpur had surveyed 51,921 hectares and found 2,927 hectares (5.7 per cent) water-logged in Sambalpur district of the Hirakud command in 1974 itself.

Associated with the problem of prolonged water-logging in the command is the obvious fall-out – soil salinity, which is of permanent nature. It leads to declining yields and finally complete abandonment of cultivation in the saline areas. Though data on soil salinity was not available, there is a notable and definite increase in it as was pointed out by many farmers whose lands have been affected by it.

Sedimentation of the Reservoir: As we had occasion to point out above, increased and unanticipatedly large sedimentation in MRVPs is seriously threatening their efficiency and life-span. We found evidence to confirm this in the case of Hirakud.

The 1953 revised report of the Hirakud dam, based on 1947-51 silt data, anticipated the rate of siltation to be 52.46 acre ft/100 sq miles per year. It was argued that the live storage of the reservoir would be affected due to silting of the reservoir only after 132 years. During two cycles of hydrographic surveys in 1979 and 1982, the rate of siltation was found to be 138 acre ft/100 sq miles per year and 143 acre ft/100 sq miles per year, respectively. Evidently, the rate of siltation has more than doubled [Satpathy 1987]. The more than two-fold increase in siltation has jeopardised the life and efficiency of the Hirakud dam.

The original capacity of the Hirakud dam at reservoir level (RL) 192.02m (630 ft) was 8,105 Mm^3. Within a period of 22 years since the impounding of the waters, the capacity has been reduced to 6900 Mm^3. The total amount of silt deposited is 1205 Mm^3. The loss of storage capacity at different levels works out as follows:

	Capacity (Mm^3)		Percentage Loss of Capacity Per Year
	Original	New	
Dead storage			
RL 179.83 m (590 ft)	2262	1590	1.36
Live storage			
RL 192.02 m - 179.83 m	5843	5310	0.41
Gross storage			
RL 192.02 m (630 ft)	8105	6900	0.675

Source: Central Board of Irrigation and Power (1981).

The high rate of siltation has been associated with a loss of vegetative cover in the catchment of the Hirakud [Satpathy 1987]. According to one estimate, 75 per cent of the catchment of Hirakud, i e, 62,500 sq km, was under dense forest cover prior to the construction of the dam. By late 1980s, the figure had come down to less than 40 per cent (25,000 sq km) [Anon 1987].

It has been pointed out, using run-off (soil erosion) data that between 1872-1926 and 1927-1950 there was no significant deforestation. Since the construction of the dam there is a direct link between increased run-off and loss of vegetative cover [Satpathy 1987].[7] Such an observation is reinforced by Mishra and Dash (1984), who, in a study of the Sambalpur town and the area falling within a radius of 20 kilometres, using toposheets and landsat imagery, have argued that the loss of forests in the area has been greater in the period 1960-70 and 1970-75 in comparison to 1950-60. Rainfall seems to have gone down as a consequence and so has the number of rainy days.

In varying degrees, the same problem is faced by many other MRVPs. On the one hand, the multi-purpose dams face an inherent conflict of uses, as discussed in an earlier section, and on the other an unforeseen decline in reservoir space limits the use for any of the stated purposes – flood control, irrigation or power generation.

Health problems: Increased incidence of malaria has long been identified with expansion of canal irrigation [Whitcombe 1983, 1996]. We will examine available data in the U-K command where malaria is one of the most common diseases. In the absence of proper medical facilities, it takes a heavy toll, especially among the poor who cannot afford to get to the city hospital. Unfortunately, the data available at the district malaria office, Surat, are for the district as a whole, and separate data for the command area seem not to be available. It may not be wrong to infer, however, that a substantial number of the cases recorded in the district would be from the command area.

The information available, presented in Table 6, shows that in the first few years of the 1970s there was a quantum jump in malaria cases, with the percentage of people testing positive averaging much above 20 per cent. This fell somewhat subsequently, but has shown a great surge since 1987. Perhaps most alarming is the incidence of the most dangerous type of malaria, (caused by *plasmodium falciparum*), which has increased substantially in the last few years.

Further, in the U-K command the sugar co-operatives undertake spraying of fertilisers and pesticides from the air by helicopters and planes. During the day anybody walking on the highway, or working in the fields, is likely to receive a good shower of these chemicals. Since some of these products are quite toxic, and since there is a virtual absence of any safety measures, spraying is a serious health hazard. A number of people complained of dermatological and other problems which they felt may be due to such exposure. But no concrete data was available.

Conclusion

The absence of post-construction reviews severely hamper assessments of MRVPs' actual performance *vis-a-vis* its claims. The benefit zone, in fact, is riddled with several failings some of which set in as long-term effects like ecological disequilibriums. These remain unaccounted for in the initial costing due to an absence of a comprehensive pre-project environmental impact assessment, and, therefore, help inflate claims on the benefit side. A study of the three projects clearly demonstrate that several trends like water-logging, salinity, sedimentation and health hazards specific to the MRVP have a high possibility of occurrence. Besides these, the 'achievements' of flood control, irrigation and power are not as effective as envisaged. The Hirakud dam's role in flood control, for example, is increasingly being questioned. Similarly, cropping patterns are influenced by the pulls of the market rather than suited to the specific irrigation design. U-K command is a classic example of a highly water intensive cropping pattern directed towards sugarcane cultivation with all the resultant evils of water-logging and soil exhaustion. In the IGNP command, on the one hand, there is a shortfall in actual water availability for the canal network, while on the other, a hard pan layer at shallow depths severely threatens over a third of the command with water-logging. Evidently, each command has its unique set of experiences but what is glaring is a complete dichotomy between pre-construction projections and post-construction realities.

Table 6: Total Blood Sample Collections – Positive and P Falciparum – in Surat District, 1961 to 1990

Year	Total Blood Sample Collection	Total Positive Samples	Percentage of Positive Cases	Total P Falciparum and Mixed Cases	Percentage of P Falciparum and Mixed Cases to Total Positive Cases
1961	45938	690	2	132	19
1962	88383	586	1	243	41
1963	106934	756	1	147	19
1964	115658	452	0	103	23
1965	170129	318	0	49	15
1966	263513	692	0	112	16
1967	237676	1178	0	114	10
1968	236729	1734	1	160	9
1969	307429	8486	3	1137	13
1970	227920	15588	7	1834	12
1971	256631	81896	32	6279	8
1972	283806	91365	32	6215	7
1973	278512	69567	25	4044	6
1974	297115	71666	24	11747	16
1975	305681	83538	27	10568	13
1976	249395	65090	26	6097	9
1977	227264	44821	20	3152	7
1978	249264	32566	13	1191	4
1979	297548	25611	9	753	3
1980	310075	28510	9	1041	4
1981	291253	34020	12	1288	4
1982	255390	24720	10	1106	4
1983	250782	22805	9	2700	12
1984	241414	32459	13	8905	27
1985	233231	28905	12	8892	31
1986	278290	36090	13	13705	38
1987	377979	70477	19	32454	46
1988	496456	101692	20	47941	47
1989	443688	99044	22	44653	45
1990	489020	98118	20	91293	93

Source: District Malaria Office, Surat.

These experiences, we feel, need to be studied in-depth and made to constitute an important part of future planning for MRVPs.

Notes

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1 A few examples like Roy (1983) can be cited but even these are not the kind of exhaustive study one needs for proper evaluation.
2 In the current literature, the command area of the dam is treated synonymous to the 'beneficiary' zone.
3 However, it must be noted to their credit, that of the three dams we studied, Hirakud was the only one where even these surveys existed.
4 In Ukai too there is a similar lack of pre-construction database.
5 Benefit upgradation is a sleight of hand at financial jugglery as has been highlighted by Ram (1993) in the case of SSP where the level of documentation has been substantial due to constant monitoring by the activist groups.
6 The figures of actual area submerged vary in the different government documents we have referred. This is a problem which has been mentioned elsewhere too in this report. For the sake of uniformity and not erring on the side of excess costs, we have chosen the above figure. One source mentions the area submerged as 73,839.2 ha.
7 Figures about the amount of forests submerged by the Hirakud dam reservoir were not available.

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