

## THE ENVIRONS OF TARAPUR ATOMIC POWER STATION : THE ROLE OF GRASS IN THE LAND-USE PATTERN

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**ABSTRACT :** The focus of the present paper is to assess the suitability of expanding TAPS in relation to the grass belt around it. In this study the impact of a nuclear accident (in present or future reactors) within a perimeter of 50 km. is sought to be understood; since grass is the first link in the chain of radio-active ingestion, attention is focussed on grass as a crop in the region.

### INTRODUCTION

The Chernobyl accident in 1986 has heightened people's concern about situations which could be created by a runaway nuclear power reactor (Barnathan, 1986; Greenwald 1986, Lean 1986, Ramberg 1986). The concern in such a situation relates to the spread of radioactivity not only in the immediate neighbourhood but even across national frontiers (Serrill 1986). The radioactive substances released from a breached containment are fission gases, radioactive iodine and cesium. Of these radioactive iodine is the most lethal since it has a pronounced tendency to get accumulated in the thyroid gland. If deposited in the surrounding environment, it remains for prolonged periods of time leading to a series of reaction pathways which might enable these radio-isotopes to enter the human body. Thus radio-active iodine, deposited on grass is picked up by cattle that graze on such grasslands. The milk from these animals is contaminated and consumption of such milk will lead to radioactive iodine ingestion. Grass, therefore, is the first link in the grass-cow-milk pathway of iodine into the human body.

The measurements of Chernobyl fall-out in Sweden and U. K. brought into sharp focus the role of grass as an indicator, receiver and transmitter of radio-iodine (Fry et. al., 1986). Swedish calculations assumed that 66% of the iodine activity deposited on one square metre of grass is likely to appear in one litre of milk when one cow grazes on it (Devell et. al., 1986). Thus one of the first decisions taken by Sweden after the Chernobyl accident was to ban grazing of cows.

In India nuclear power generation dates back to 1969 when 2 units at Tarapur (TAPS I and II) were the first to go on stream. Subsequently two other plants in Rajasthan (RAPS I and II) and Madras (MAPS I and II) were commissioned. In order to utilize the infrastructural facilities created at nuclear power sites, such as TAPS, the Atomic Energy Commission (AEC) is envisaging the creation of a cluster of nuclear power units, i.e. each site having 4 units. The question now arises, whether, given the current level of human habitation and agricultural and industrial activities, will TAPS still qualify as a site for locating another 2 units. In an earlier paper the authors (Remedios and Sita, 1988) examined

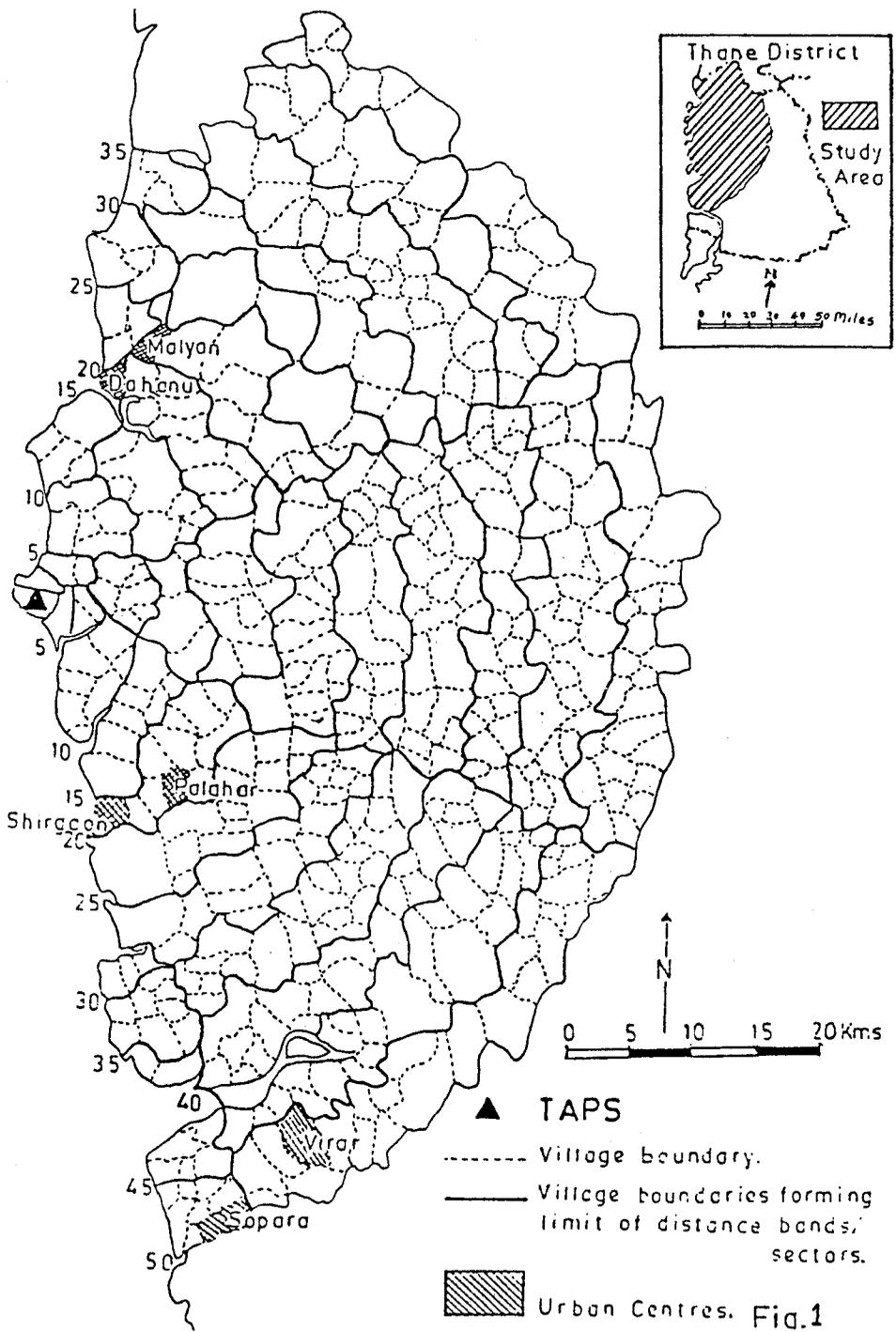


Fig. 1 : The Study-Area : Taps and its Environs

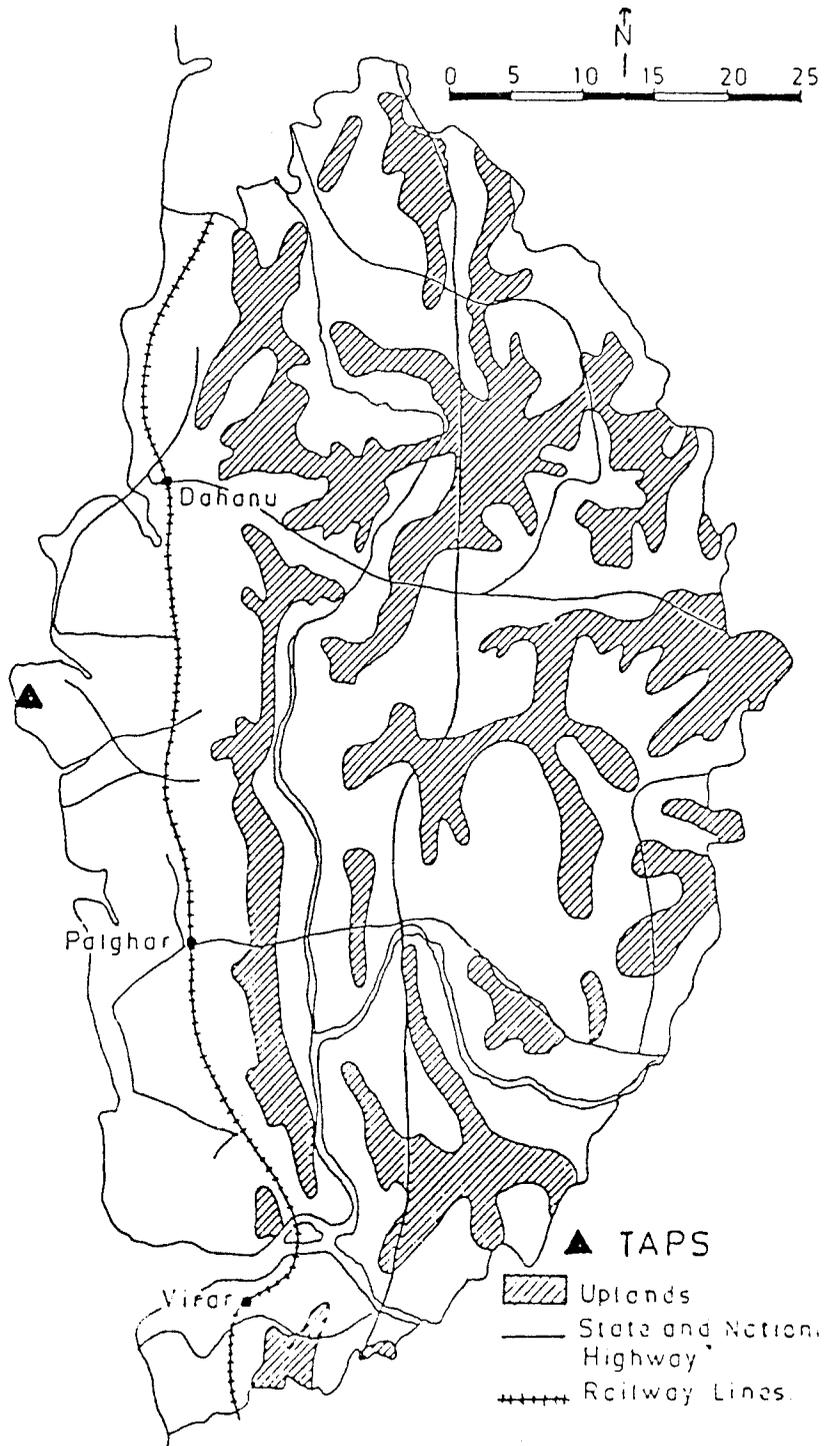


Fig. 2 : Taps and its Environs : Physical Feature and Routeways

the locational suitability of TAPS in relation to demographic characteristics of the area.

## METHODOLOGY

The study area encompasses the area within a radius of 50km. from TAPS. This area lies in the Thane district of Maharashtra and includes the entire taluka of Palghar and parts of the talukas of Dahanu, Talasari, Jawahar, Vasai and Vada (Fig. 1). Since TAPS is sited along the coast, the region forms a semi-circular unit having an area of approximately 2900 sq. km.

In order to analyse the land-use characteristics of the area in relation to TAPS, concentric circles at intervals of 5 km. were drawn centred on TAPS; thus 10 distance bands were delineated. The village boundaries were used for adjustment of the distance-bands so that each village fell in one distance band (Fig. 1). The topographical features such as uplands, coastal areas and rivers (Fig. 2) provided the physical background against which the land-use pattern could be interpreted. Physically the region had two almost distinct parts: a narrow coastal plain about 10 to 15km. wide, east of which is an inland hilly area dissected by streams. The major transport arteries viz. the Western Railway line and the Bombay-Ahmedabad National Highway run parallel to the coast and have a north-south alignment. The State highways are basically east-west and connect the railway stations to the interior villages.

To study the nature of land-use in the study area, the data given in the Census regarding the area under the major land-use categories i.e. forest, cultivated land, culturable waste and land not available for cultivation was analysed. This data was available for 1971 and 1981 and hence the proportion of the total area in each village under the broad land-use

categories was determined. This enabled the spatial pattern of land-use in relation to TAPS to be studied.

As indicated earlier grass plays a vital role in the pathway of radio-active substances into the human system. Hence it was considered relevant to assess the extent of grass cover around TAPS. For this purpose land-use data was obtained from tahsil records. Due to the constraint of time it was not possible to collect data for all the villages. Since a major part of the study area, particularly the area within 35 km from TAPS, lies in the 2 talukas of Palghar and Dahanu, the village-level data was collected for villages of the study area lying in these 2 talukas. Unfortunately it was not possible to obtain data for the same period in both talukas. As a result, Palghar data pertains to 1983-'84 while that for Dahanu refers to 1970-'80. Since grass is listed as a crop it was possible to determine the proportion of the net sown area devoted to grass in each village. Mapping of this variable afforded the spatial pattern of grass cultivation in relation to TAPS.

Primary data was collected mainly to throw light on the utilization of the grass grown in the immediate neighbourhood of TAPS. A household schedule was framed; the focus of the questions was to determine the extent of grass production, the use to which the grass is put, the amount of surplus available for sale and the destination of this grass. The second part of the schedule was directed at an investigation of the production and sale of milk in the area. This was rendered necessary since milk is also a link in the chain of radioactive ingestion into the human body. Lastly, a few questions were included to get an insight into the nature of awareness of the local people regarding the atomic power station.

The above mentioned primary data was collected for a random sample of households in the village of Kolavali which lies in Dahanu taluka about 8km. north-east of TAPS. This village was chosen because three-fourths of its total area was agricultural land and an overwhelming 92% of the cultivated land was under grass, Another reason for selecting this village was its location along a road just 8km. west of Vangaon station so that it could be directly reached from Bombay.

### OVERALL LANDUSE OF THE STUDY AREA

The area is mainly under forest or agriculture

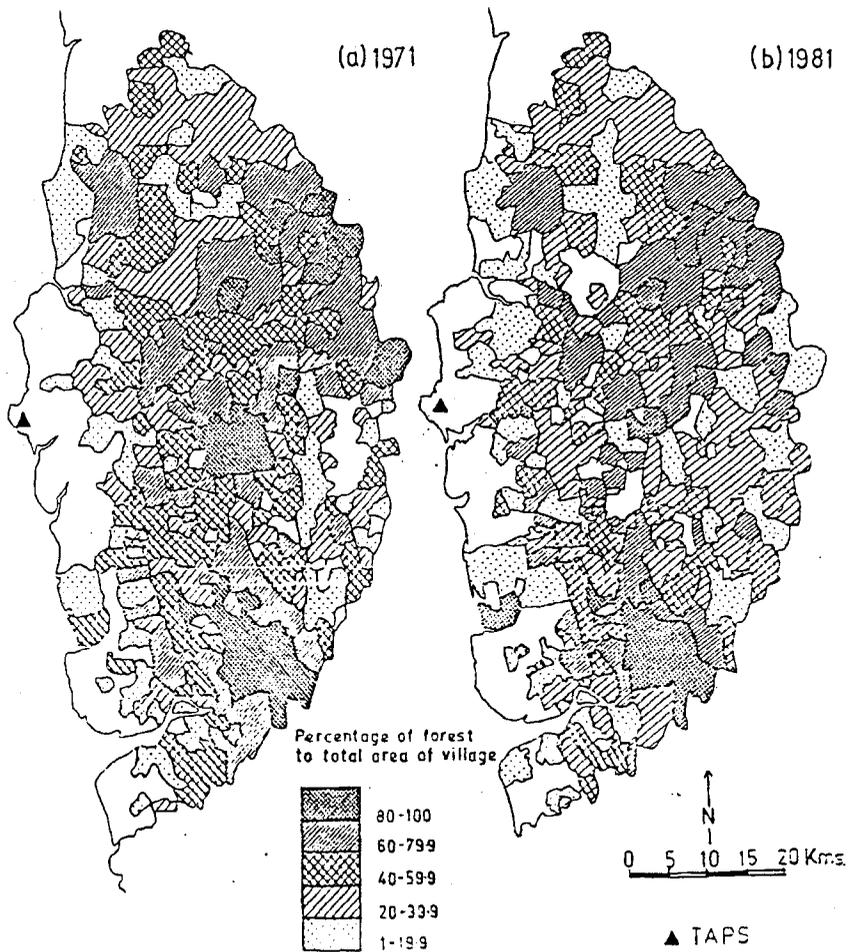
with each accounting for a little over 30% of the total area. Culturable waste and land not available for cultivation each cover 16% of the land. Urban area is very negligible. Between 1971 and 1981 agricultural land has decreased marginally while forested area has decreased by 6%. In contrast culturable waste and land not available for cultivation have each risen by 6%. Urban area has surprisingly declined by a small margin. (Table 1).

In 1981 forest cover is totally absent in the vicinity of TAPS and also along a major part of the coast to the north and south of TAPS

**Table 1**

**TAPS and its Environs : Proportion of Distance Band Under Broad Land-use Categories**

Distance Band	Year	Urban	Forest	Culti- vated Land	Cultu- rable for culti- vation	Land Not available	Total
< 5	1971	—	—	41.25	27.85	30.90	100.00
	81	—	—	39.73	37.16	23.11	100.00
5 to 10	71	—	0.26	44.49	36.17	19.08	100.00
	81	—	5.45	56.40	13.95	24.20	100.00
10 to 15	71	—	5.42	33.78	35.02	25.78	100.00
	81	—	12.21	50.32	19.10	18.37	100.00
15 to 20	71	9.57	22.49	33.91	15.08	18.95	100.00
	81	7.53	13.42	41.53	25.42	12.10	100.00
20 to 25	71	0.91	39.55	36.84	16.10	6.60	100.00
	81	0.52	25.99	29.87	30.78	12.84	100.00
25 to 30	71	—	47.42	36.75	7.55	8.28	100.00
	81	—	37.21	31.08	8.26	23.44	100.00
30 to 35	71	—	52.88	34.90	6.06	6.16	100.00
	81	—	39.96	32.33	13.96	13.75	100.00
35 to 40	71	—	43.93	37.23	8.95	9.89	100.00
	81	—	42.89	33.19	11.89	12.03	100.00
40 to 45	71	—	43.48	39.15	7.60	9.77	100.00
	81	—	40.89	25.74	15.24	18.13	100.00
45 to 50	71	1.95	49.47	32.41	10.34	5.83	100.00
	81	2.04	41.64	26.68	14.13	15.51	100.00
<b>Total</b>	<b>71</b>	<b>1.14</b>	<b>40.58</b>	<b>36.22</b>	<b>11.80</b>	<b>10.26</b>	<b>100.00</b>
	<b>81</b>	<b>0.90</b>	<b>34.03</b>	<b>32.00</b>	<b>16.97</b>	<b>16.10</b>	<b>100.00</b>



**Fig. 3 :** Taps and its Environs : Proportion of area under Forest

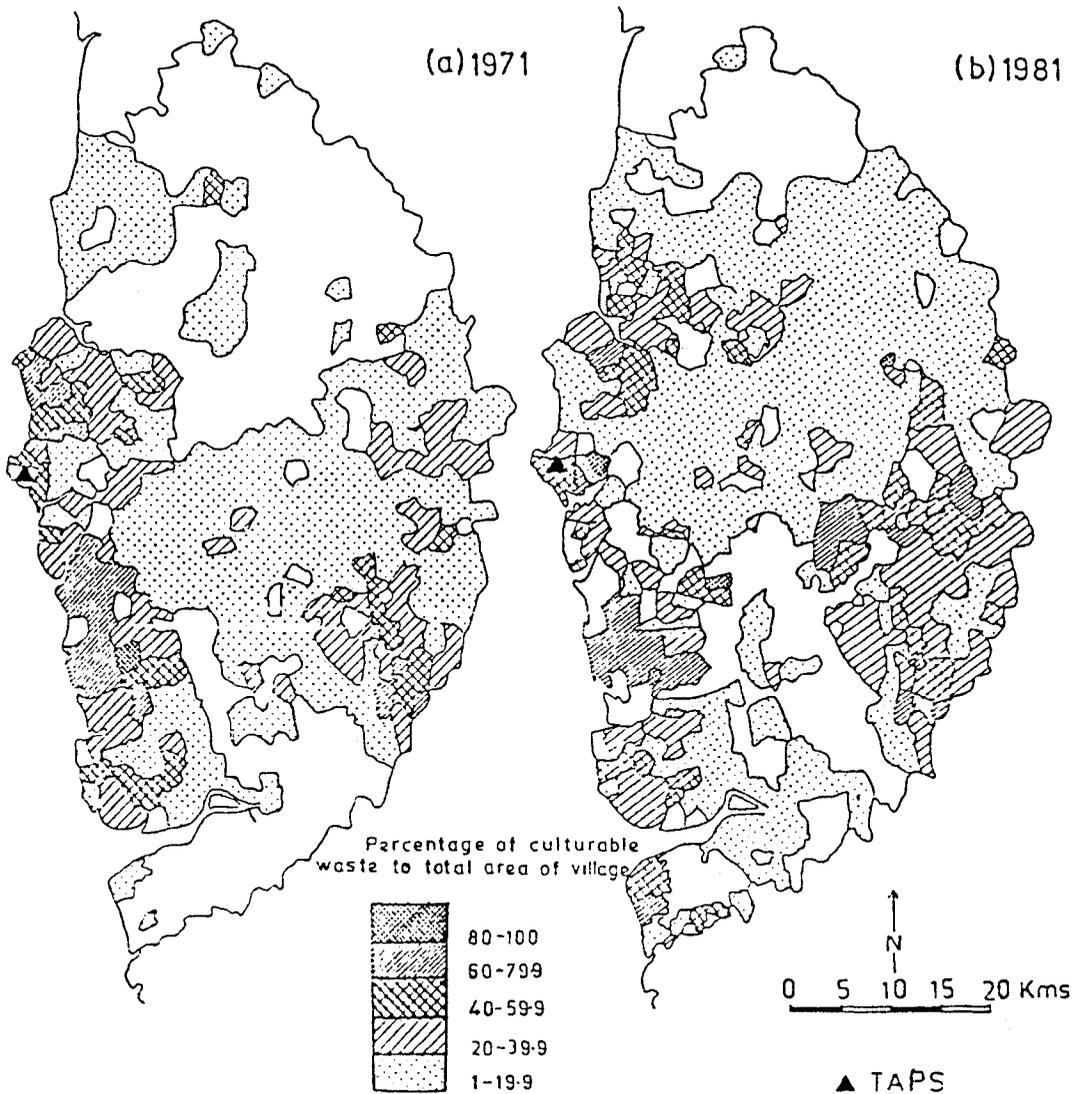
(Fig. 3). Areas with a high proportion of forested land, i.e. over 60%, lie towards the interior especially in the uplands. There has been a substantial decrease in forest cover between 1971 and 1981. Thus the patches having over 60% of forest land have shrunk remarkably. Though the immediate neighbourhood of TAPS lacks forest cover, along the coast, patches of forested land have

emerged in areas which were devoid of forest in 1971.

These patches, however, may be tidal flats with marsh vegetation and not forest in the true sense.

The spatial pattern of cultivated land in 1981 reveals a dichotomy between the coast and the interior (Fig. 4). The coastal area has on the

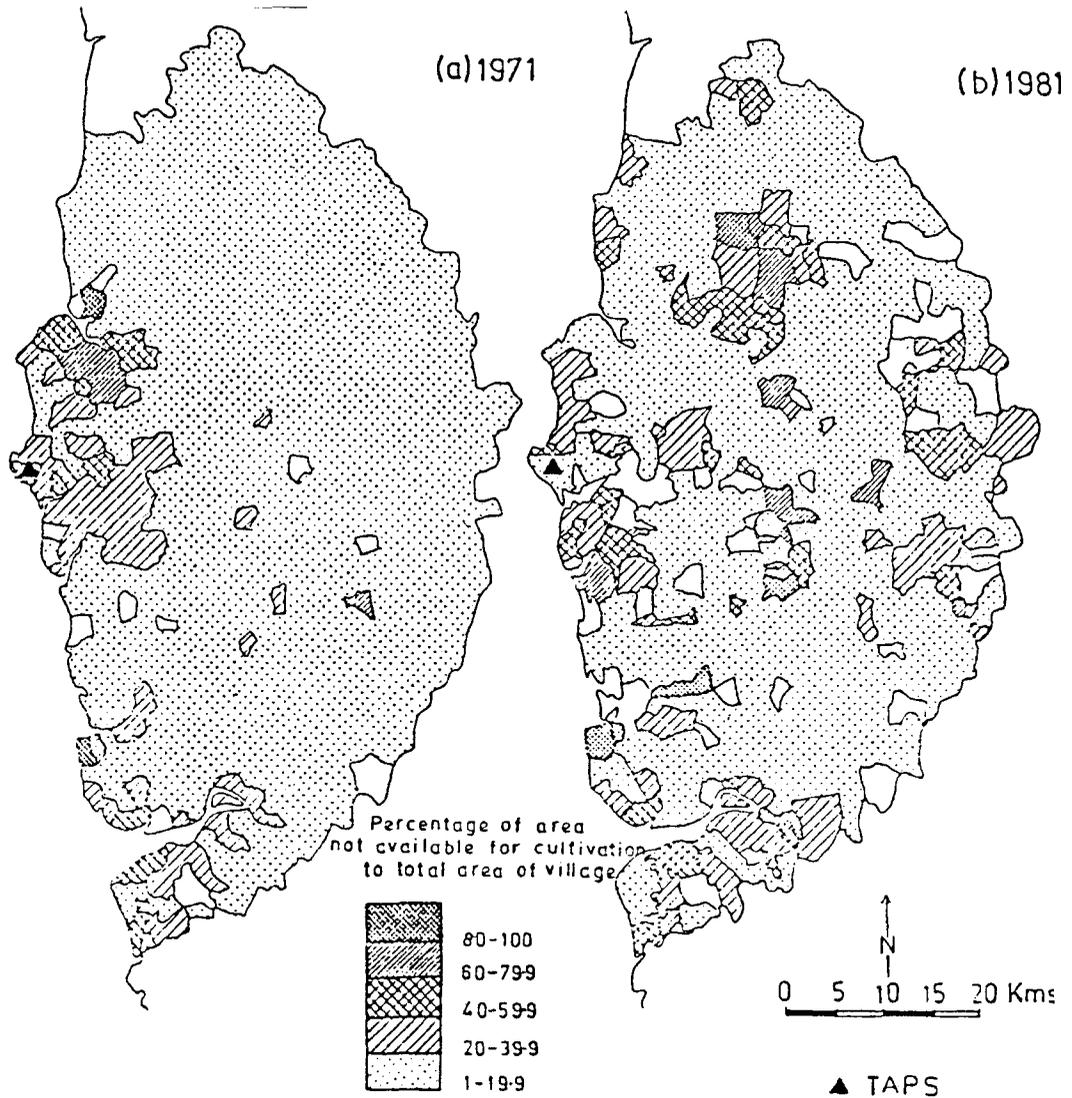




**Fig. 5 :** Taps and its Environs : Proportion of area under Culturable Waste

valley in the south. The areas with relatively higher proportion of cultivable waste are to be found along the coast and in the extreme interior. A comparison of the spatial patterns in 1971 and 1981 indicates an increase of this land-use especially in the area north-east of TAPS and in the southern part of the study area.

The proportion of land not available for cultivation in 1961 is generally below 20% with the exception of a few pockets (Fig. 6). In the interior, the small patches with over 60% under this type are the points where the State Highways cross the National Highway. A comparison of the the distribution in 1971 with that in 1981



**Fig. 6 :** Taps and its Environs : Proportion of area not available for Cultivation

reveals a noticeable increase in the proportion of land devoted to this use. Interestingly the increase is more obvious in the inland than in the coastal section, with the exception of the extreme south where there is a substantial rise in the proportion of this type of land-use. This is probably due to the impact of

Virar the terminus of the Western Railway suburban line which has resulted in a substantial urban sprawl in that section.

The proportion of land in each ring under the four broad land-use categories was also determined to study land-use in relation to TAPS (Table 1).

Forest cover is totally absent within 5km of TAPS, but accounts for an increasingly higher proportion of the area, with increasing distance from TAPS. Beyond 15km, however, the proportion of forested land had decreased sometimes by as much as 10% as in the rings between 15 to 35km of TAPS. Thus there is a sharp contrast between the inner and outer rings with the proportion of forested land in the outer rings about eight times greater than the corresponding proportion in the inner rings.

The picture with reference to cultivated land is the reverse accounting as it does for a higher proportion of land in the inner rings in comparison to the outer rings. Generally it accounts for 40% to 55% in the inner rings and only 25% to 35% in the outer rings. Between 1971 and 1981 the proportion of cultivated area within 5km of TAPS has decreased marginally. Beyond 5km upto a range of 20km there has been an increase in cultivated area by about 7% to 17%, but beyond 20km again the proportion of cultivated area to the total area of the ring has decreased sometimes only marginally by 2% but in other cases quite appreciably.

Culturable waste predominates within 5km of TAPS and in the rings between 15 to 25km. Beyond 25km less than 15% of the area is culturable waste. Between 1971 and 1981 there have been sharp increase by over 10%. On the other hand there has been a substantial decline in such land-use between 5km to 15 km. Beyond 25kms all the rings have registered an increase in culturable waste.

Land not available for cultivation accounts for a higher proportion in the inner rings than the outer rings. It varies from 12% to 24% of the total area of the rings. Between 1971 and 1981 there has been a decrease in the proportion

of such land around TAPS but a substantial increase in the outer rings. In fact beyond 20km the proportion of such land-use has doubled or even tripled.

### GRASS COVER IN THE STUDY AREA

With the aid of tahsil records it was possible to calculate and map the percentage of the net sown area under grass in each of the villages of Dahanu and Palghar (Fig. 7). With the exception of a few small areas grass generally accounts for over 20% of the net sown area. To the north and north-east of TAPS, it occupies as much as 60% and more of the cultivated land.

Using the same data it was possible to compute the percentage of the net sown area under grass within each distance band upto 35 km (Table 2). Though within 5 km of TAPS grass accounts for only about 32% of the net

**Table 2**

**TAPS and its Environs : Percent of Net Sown Area Under Grass in Distance Bands upto 35km.**

Distance Band	% of the Net Sown Area Under Grass
< 5 km.	31.98
5 to 10	84.35
10 to 15	56.19
15 to 20	55.66
20 to 25	45.99
25 to 30	46.85
30 to 35	39.21

*Source : Unpublished Tahsil Records*

sown area in the next distance band, it occupies an overwhelming proportion of the area (i.e.) 84%. On the whole, between 5 to 20 km it accounts for over half the cultivated area and decreases progressively at greater distances. Thus grass is a very important crop in the area in the immediate vicinity of Tarapur.

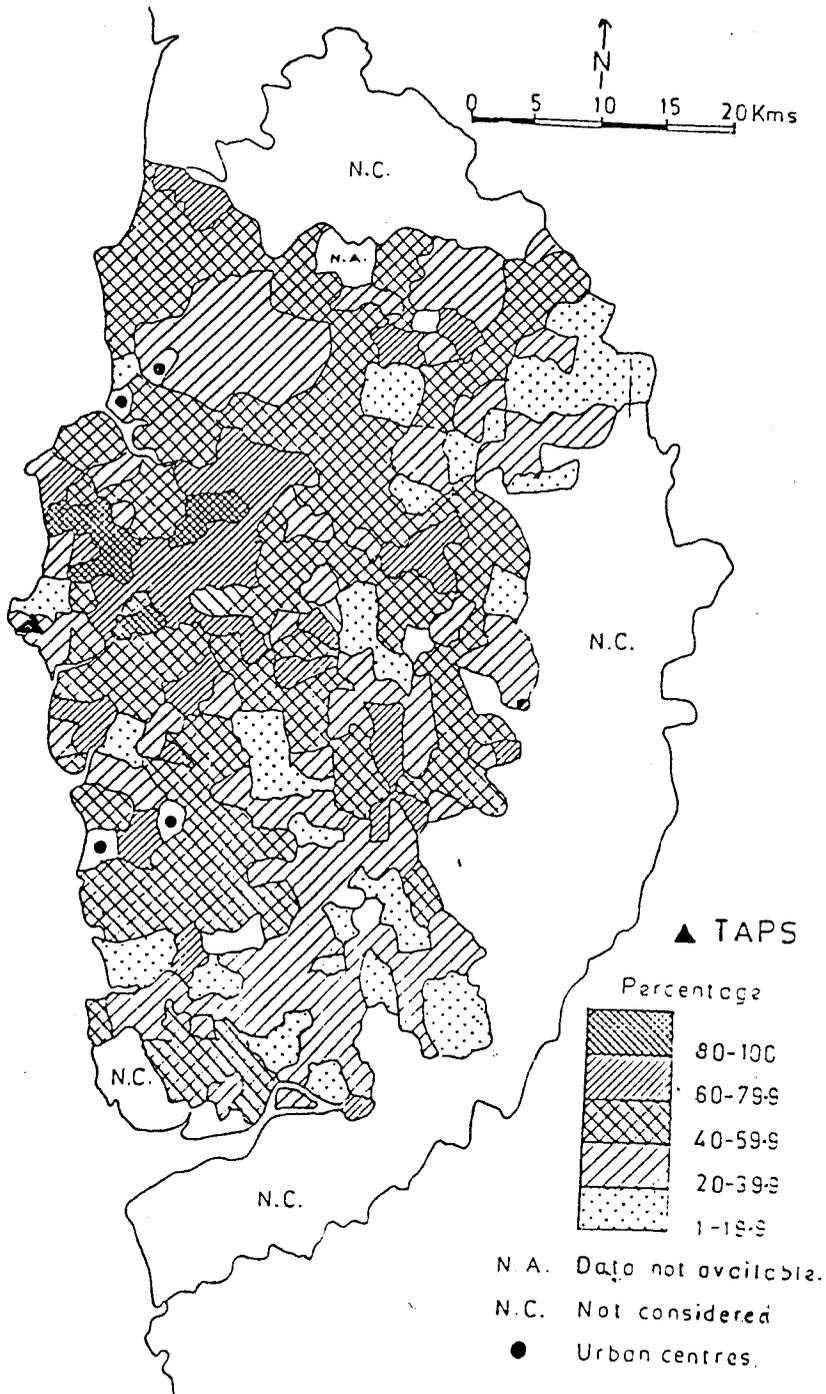


Fig. 7 : Taps and its Environs : Proportion of area under Gross to Net Sown Area

## PRODUCTION AND MARKETING OF GRASS

The Village of Kolavali which was selected for field work is located 8km north-east of TAPS. The village is primarily agricultural and of the total sample of farmers who were interviewed about 96% owned the land cultivated by them. While 77% were solely cultivators, 18% were also agricultural labourers and 4.5% were in professional service. The size of the land holding varied considerably and 45% of the farmers had holdings exceeding 3 acres (Table 3).

**Table 3**

### Size of Land Holdings

Size in Acres	% of Farmers
< 1	13.6
1 to 1.9	18.2
2 to 2.9	18.2
3 to 4.9	18.2
5 and more	18.2
N. A.	4.5
<b>Total</b>	<b>100.0</b>

The main crops cultivated were rice and grass. 82% of the total sample had some part of their land under grass. Only a few cultivated fruit and / or vegetables (14%). 50% of the farmers had devoted over 30% of their plots to grass (Table 4).

**Table 4**

### Amount of Land Under Grass

% of Land Holding under Grass	% of Farmers
< 10	11.1
10 to 19.9	16.7
20 to 29.9	22.2
30 to 49.9	27.8
50 and more	22.2
<b>Total</b>	<b>100.0</b>

Grass has been listed as a crop by the revenue authorities. However among the farmers, opinion as to whether grass is a crop or not was almost equally divided. Three major reasons were given by farmers who considered it as a crop. Firstly about 70% opine that grass by virtue of its commercial value should be designated a crop. Secondly 20% said that inputs are needed in growing grass and hence it should be considered to be a crop and thirdly another 20% felt that its value as fodder also accords it the status of a crop. The negative response was supported by three chief reasons: 42% felt grass grows naturally with the rains with no effort required by man; another 25% expressed the view that since it is not edible by man it is not a crop while 17% felt it is not profitable enough to be considered a crop.

On further interrogation, it was found that there were only three major inputs in respect of grass cultivation. Of all the operations, only harvesting was a standard practice among all the farmers, as grazing of animals is not practised. The animals are stall-fed on rice straw which does not have a commercial value. Harvesting, however, is an annual feature carried out in October after the retreat of the monsoon. The grass is not sold immediately but dried and converted into hay and thus 89% of the farmers reported marketing of hay while none marketed grass. Another common operation is fencing with 44% of the farmers using it to keep out stray animals. The only other input is labour; 22% of the farmers employ workers at harvest time. Apart from these, other inputs such as fertilizers, irrigation and improved seeds are generally not used.

The annual harvest of grass per farmer ranges from less than 500 kg. to over 5000 kg. (Table 5). Output is not a product of effort and input but is related to the amount of land under grass.

**Table 5****Grass Production**

Grass Production Kg/Year	% of Total Farmers
< 500	27.8
500 to 1000	5.6
1000 to 2000	33.3
2000 to 5000	11.1
> 5000	22.2
<b>Total</b>	<b>100.0</b>

It is noteworthy that 40% of the farmers reported a change in production within the past 10 years. Of these 71% reported an increase mainly due to turning over more land to grass and in a few cases due to the use of better varieties.

Questions were asked to determine the livestock economy with a view to establish how much of the grass or hay is consumed by the animals and how much is surplus for sale. 68% of the farmers had livestock; of them 81% had milch cattle. Only 19% had cattle exclusively for agricultural operations. It is noteworthy, that all the owners had less than 3 milch cattle each.

Since grass has a marked value the farmers prefer to feed their animals on rice straw. Thus 50% of the farmers reported that little or no grass is fed to cattle (Table 6).

**Table 6****Grass / Hay Consumption**

% of Output Given to Livestock	% of Total Farmers
< 10	50.1
10 to 19.9	6.2
20 to 29.9	12.5
30 to 49.9	15.5
50 to 89.9	6.2
90 to 100	12.5
<b>Total</b>	<b>100.0</b>

As a result of this 89% of the farmers have surplus for sale while the remaining were self-sufficient i.e. growing only enough for their own cattle. No deficit was reported by any farmer.

Though the farmers having a surplus were in the majority the amount varies and is generally low (Table 7). This may be attributed to the fact that the farmers have small holdings, devote little effort to growing of grass and harvest it only once in a year.

**Table 7****Surplus Grass**

Amount of Surplus (Kg / Year)	% of Total Farmers Having Surplus
< 500	31.2
500 to 999	12.5
1000 to 1999	25.0
2000 to 4999	18.8
5000 and more	12.5
<b>Total</b>	<b>100.0</b>

70% of the farmers sell their surplus to the Mahamandals which are the Government centres for collecting hay from individual farmers. These are set up at several points in the open air to collect, press, pack and resell the hay. Since the Mahamandals collect hay and not grass they appear about 2 to 3 months after harvest time after sufficient time has elapsed for the grass to be dried into hay. The Mahamandals were opened to prevent exploitation of the farmers and they offer an incentive in the form of higher rates as compared to the private agents. From these depots grass is transported to various parts of rural Maharashtra, Gujarat and even to Bombay. Those who do not patronize the Mahamandals have to deal with village agents.

## MILK PRODUCTION

As mentioned previously a large number of farmers had milch cattle i.e. 59% of the farmers and 81% of those who had livestock. However, all had only 1 to 3 animals and so milk production is understandably low (Table 8).

**Table 8**

**Milk Production**

Milk Production (litres / day)	% of Farmers with Milch Cattle
< 2	38.5
2 to 4.9	38.5
5 to 9.9	15.4
10 and more	7.8
<b>Total</b>	<b>100.0</b>

Thus over three-fourths of the farmers with milch cattle get less than 5 litres daily. 58% admitted to seasonal fluctuations while 33% reported a change in the last 10 years. Among the latter 75% complained of a decrease due to reasons such as a fall in number of milch cattle, decline in number of cattle in milk and increase in prices of fodder. Only a minority experienced an increase in production and this was due to a natural increase in the number of milch cattle.

With such a low daily output 67% consume their total output. The 33% who had a surplus were those who had an output exceeding 5 litres per day or those who did not consume any milk at all. Thus 50% had 2 and 5 litres while the other 50% had 5 to 10 litres surplus for sale. Among those selling surplus 75% found a market in the neighbouring villages while the remaining sold it to the local co-operative.

## FARMER'S PERCEPTION

The last part of the questionnaire makes an

attempt to determine the farmers' perceptions of Bombay, TAPS and the Tarapur-Boisar industrial belt. 72% of the respondents felt that Bombay has had no direct impact on them. Only about 18% expressed the view that Bombay is important as a market for the vegetables grown in the village and that it has an effect on the local prices. They also attributed to Bombay environmental effects such as expansion of salt pans and salinity ingress in wells. Thus they appear to feel that the influence of Bombay is more negative than positive.

The question regarding the influence of TAPS also evoked only negative comments. 68% of the respondents attributed to TAPS adverse effects on climate and environment. 73% complained of climatic changes such as rise in temperature and decline in rainfall, 33% felt it was responsible for plant disease and a change in fish taste, while 13% felt that it was responsible for an increase in salt pans. Other responses ranged from health hazards to fear of pollution in the event of an accident. However, about 60% of the respondents felt that TAPS has had no effect on cattle grazing activities.

The Tarapur-Boisar industrial belt evoked a mixed reaction. Of the 77% who were aware of its effect on their lives, 65% pointed out the positive aspect in terms of employment while 41% outlined the negative effects. About 29% indicated environmental pollution and odours; other criticisms include health hazards, water pollution and climatic changes.

## CONCLUSIONS

This study was undertaken with two main objectives in mind. The first one was to assess the suitability of expanding TAPS in relation to the grass belt around it. The second aimed at understanding the impact of an accident at

TAPS. With these objectives in mind an analysis of landuse within 50km radius of TAPS was carried out. Special emphasis was given to production and marketing of grass since it is the vital link in the chain of radioactive ingestion into the human body.

The study indicates that within 5km of TAPS there is a total absence of forest cover, a decline in the proportion of agricultural land and a 10% increase in culturable waste between 1971-'81. This suggests that the greenbelt may not be upto the desirable standards.

Though a forest cover is recommended around nuclear power plants it accounts for a relatively low share of the land within 20 km of TAPS. It is agricultural land which dominates the landscape accounting for over 40% of the area withing 20km of TAPS, excluding the 'sterilized' zone.

Grass is considered as an important crop, has a high commercial value and dominates the cultivated land. Moreover, the difference between the net sown area and gross cropped area is negligible indicating that grass fields are not devoted to any other crop during the year. In addition, grass does not require any long-term inputs and this accords it an even greater advantage in an area susceptible to land speculation.

Cattle grazing is not popular since the grass is harvested annually, dried into hay and sold to the local Government depots known as Mahamandals. Since these depots offer higher rates they are patronised by almost all the

farmers. The grass from these collection centres is transported to Gujarat and other parts of Maharashtra including Bombay. Thus contamination effects, in the event of an accident, may spread through the grass route to areas away from Tarapur.

Dairying is a low key occupation since the farmers can ill-afford milch cattle. Milk production is hence low and is consumed locally. Therefore milk from this area has a limited role in the pathway of radio-active ingestion.

Perceptions among the farmers had little variation. Bombay seemed to have a negative impact except that it provided a market for the vegetables grown by the farmers. If in time to come more farmers switch over to vegetables, it could also be source of radio-active intake. Adverse effects especially on the climate and environment were attributed to TAPS by the local farmers. The Tarapur-Boisar industrial belt was also perceived as a source of environmental pollution though its employment potential was considered to be a favourable feature.

Considering the local economy any leakage from TAPS will have a wide outreach beyond State boundaries. In Western countries, radiation contamination calls for a total prohibition of grazing. In the case of a leakage from TAPS the spread can only be arrested by a ban on the marketing of hay. In the light of these findings it is evident that TAPS is no longer suitable for potential expansion of nuclear power generation in that area.

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