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Thermal Power Plant-Its Impact on Agriculture: A Case Study

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Abstract:

The Kolaghat Thermal Power Plant (KTPP) was developed on the right bank of the Rupnarayan River in the district of Purba Medinipur (West Bengal, India) mainly to supply electricity to Calcutta and Haldia Industrial region. Being a coal based power plant, it releases high volume of particulate matter – ash. The dispersal and falling of ash on vegetative part have declined the quality of the crops grown in the surrounding area. Besides percentage of agricultural land and irrigated land have declined in some parts of the inner air shed area. These changes have led the development of more non-agricultural activities and land use pattern which ultimately have encouraged the State Government to declare developing a municipality area centering this power plant. The present paper is an attempt to investigate all the changes in agricultural sector in relation to the location of a thermal power plant.

Keywords: 1. Thermal power plant, 2. Fly ash, 3. Betel, 4. Cultivation, 5. Flower, 6. Kolaghat

1. Introduction

Development is a comprehensive term implying all round changes in economy and society. Electrical power is one of the key inputs for overall growth and development of any country, especially in commerce, industry and agricultural sectors. Coal is the chief source of electricity throughout the world including India. 3 pre-requisites required for the development of coal based power plant are good communication system, vast amount of land, and perennial water resources. Kolaghat Thermal Power Plant (22°25' E, 87°55'E) was developed at the right bank of the Rupnarayan River in Purba Medinipur District of West Bengal with all these 3 pre-requisites satisfied. It is situated along the boundary area of two Community Development Blocks of Purba Medinipur District - namely Saheed Matangini in south and Kolaghat in the north. Majority of these two blocks come under the airshed area of the plant. The local economy of the impact area is based on cultivation. Rice (*oriza sativa*) is the principal crop of this area. Significantly the impact area is one of the chief producing areas of two most important commercial crops of Purba Medinipur District as well as West Bengal. They are – flowers and betel leaves. (*piper betel*).

The thermal power plant has some impacts on local economy both as a developmental project and polluter of environment. The plant has started affecting the local agricultural sector from the 1980s through the process of agricultural land acquisition to recent years through functioning as it releases different waste materials- solid, liquid and gaseous. As Kolaghat Power Plant uses coal having high percentage of ash, it mainly releases particulate matter which directly or indirectly affect the crop pattern and productivity. In this paper attempt has been made to find out the changes in agricultural sector in relation to the location of the plant.

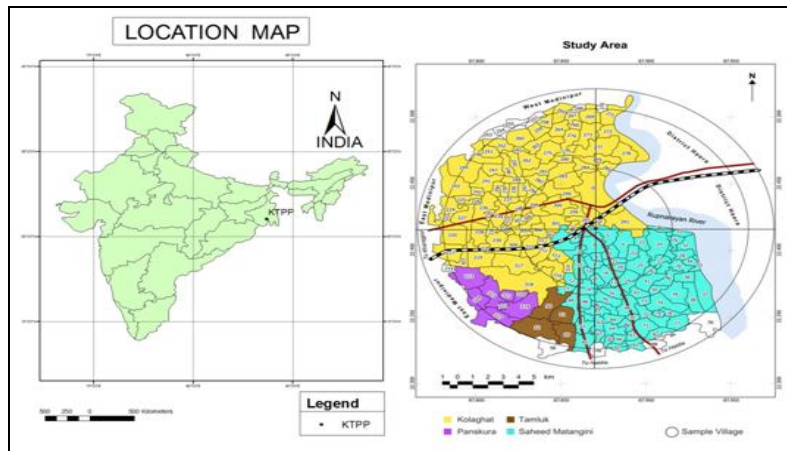
2. Objectives

Main objectives are to find out the changes in different aspects of agriculture in relation to the power plant.

3. Methodology

The present study is based both on primary data and secondary data.

- At first secondary information and data have been collected from different literature, website, and government offices. To find out the changes, the available data has been divided into two periods pre-commissioning (1970s to 80s) and post-commissioning period (1995 onwards).
- Primary data have been collected from field survey through questionnaire method. It must be mentioned that due to lack of availability of sufficient secondary data and scientific study done in this rural area, more emphasis has been given on the perception of the local respondents. The field study was carried out at a micro – level in the year 2012.



3.1. Selection of the Study Area

According to Claudia Elena Balanacea (2011) high capacity coal-fired power stations, like Rovinari (1760 MW) in Rumania, have a great impact on quality of soil as the distribution zone of heavy metals exceeds 10 Km far from the source. In accordance with this view, a study area having a radius of 10 km centering the Kolaghat Thermal Power Plant (KTPP) has been considered for the present study. As major portion of the two Community Development Blocks namely Kolaghat in the north and Saheed Matangini in the south fall in the airshed area, they have been chosen for this study. The study area has been divided into two zones- inner airshed zone lying within 5 Km distance from the plant and the outer airshed area lying within 5-10 Km distance from the plant. Again the whole study area has been divided into seven quadrants –North East Inner, South East Inner, South West Inner, North West Inner, South East Outer, South West Outer, and North West Outer.

3.2. Sample Design

Purposive Random Sampling Method is employed for the selection of sample population. Survey was done on the 100 farmers. 60 % are old aged (>60 years) and 40% were young with an age group 30-40 years.

3.3. Tools of Analysis

The primary and secondary data collected through various sources will be analyzed by applying appropriate statistical method such as the simple averages and percentages.

3.4. Limitations

There are some limitations of the study:

- The main drawback of primary data collected by random sample method is that it gives a generalized idea and overlooks some of the complicated situations.
- The study period covers a long time of about 40 years but the old data is not preserved properly by the governmental Departments, so for comparing the changes the researcher has to depend very much on primary information.

4. General Characteristics of the Study area

- It is a riverine plain falling in the mature part of the lower Rupnarayan basin. This is a monotonous plain formed out of the alluvial deposits borne down by two rivers mainly Rupnarayan in the east and Cossye (Kansai) in the west.
- Climate is characterized by hot summer & well distributed rainfall in monsoon; direction of wind is mainly from south west & south east for summer as well as most part of the year and it is north easterly in winter.
- Soil is mainly of clay & clay loam type.
- Economy is based mainly on agriculture; main crop is rice (*Oriza sativa*), besides that betel and different type of flowers and vegetables are cultivated. Kolaghat (former Panskura II) is famous for flower (mainly loose flowers) production and the other block is betel cultivation.
- Kolaghat Thermal Power Plant and Madras Cement Grinding Unit are two main industrial plants in the study area.

5. Main Characteristics of the Plant

- It is a coal based power plant; electricity is produced by burning pulverized coal in boiler.
- There are six 210 MW units with total installed capacity of 1260 MW.
- The plant was developed in two phases- Phase I (1984-90): 3 chimneys with a stack height of 120 meter and Phase II (1991-93): 3 chimneys with a stack height of 220.

Types of wastes released from KTPP: Any coal based power plant releases solid, liquid and gaseous waste materials of which gaseous and solid material are of great concern. Sulfur di oxides, oxides of nitrogen, carbon mono oxides, carbon di oxides and particulates are emitted from combustion of coal .The percentage of materials released by plant depends on many factors such as composition of coal, the type and size of plant, nature of parent coal, conditions of combustion, the efficiency and type of

emission control devices. (Adriano *et al.* 1980) As KTPP consume Bituminous coal of grade E and F having low sulfur and high ash (55-60%) content. (Mishra, 2004) the combustion of coal produces a large quantity of class F type (low CaO content) ash (Ram *et al.*, 2010). Ash is produced in two forms. About 20% of the ash in coarser form (diameter >100 μ m) remains at the bottom of the boiler, called bottom ash. Rest of the ash blow out as fine particulates (diameter 0.01–100 μ) with the burnt gases. Fly ash generation is 4 times of bottom ash generation. In audit year 2006-07 total ash generated was 1689357 metric ton of which 338124 was bottom ash & the rest was fly ash (Annual Report 2007, KTPP). Fly Ash of KTPP is mainly composed of silt and sand sized material with a moderate water holding capacity of 49-66%. Chemically it is alkaline in nature with a pH of 8.1-8.3 and mineralogically it is composed of mainly silica along with iron, aluminum, calcium and magnesium. (Maity. *et al* 1990). Besides fly ash, another material that is of great concern is sulfur di oxide. But the volume of this gas released by plant is low and remained far below the National Ambient Air Quality Standard determined by Central pollution Control India. (Annual Report published by West Bengal Pollution Control Board 1999 to 2003)

Kolghat Thermal Power plant generates different types of liquid wastes as following:

Plant	Effluent	Remark
Coal Handling Plant	Wash & storm water carrying coal dust	Plant Effluents
Oil decantation Station & oil pump house	Oil contaminated drain water	
De-mineralising plant	Acid / alkali effluents generated in regeneration of resins	
Boiler Plant	Blow down waste plant washing	Ash pond effluents
Ash pond:	Ash pond decanted water	

Source: Based on Annual Report, 2007 KTPP OFFICE

The plant authority uses the three local drainage and irrigation channels to release these effluents into nearby Rupnarayan River. They are Medinipur High Level Canal, Banpur and Dehati Canal. The first one is used to carry ash ponds effluents; the second one is used to release plant effluents and the last one for the removal of effluents from KTPP Township.

6. Changes in Different Aspects of Agriculture

- **Changes in agricultural land:** Though village wise land acquisition data is not available from Land and Land Reform Department of the State Government, but from the field survey it has been known that mainly agricultural land was acquired from the inner impact zone for the development of plant. According to the local Administrative Body whole or part of agricultural land was acquired from 12 villages; more than 80% of total agricultural land acquired was from two villages of inner eastern quadrants. So to find the changes in the inner impact zone, quadrant wise comparison have been done.

Quadrant name	% of agricultural land to total area(1971)	% of agricultural land to total area(2001)	Changes in % of agricultural land to total area
Inner Airshed Area			
North East	39.1	36.26	-2.84
South East	74.32	72.22	-2.10
South West	76.19	82.29	6.10
North West	75.44	85.71	10.27
Outer Airshed Area			
South East	57.65	84.05	26.40
South West	74.56	88.88	14.32
North West	79.98	87.92	7.94

Source: Prepared by the author on the basis of Census data 1971 and 2001

Percentage of Agricultural Land has increased in all the quadrants excepting the eastern inner quadrants. The main reason for the decrease is acquiring of fertile agricultural land from few villages having Jurisdiction List (J. L.) Number 292 (NE Inner Quadrant), J. L. No. 291(NE Inner Quadrant) J. L. No. 5 (SE Inner) and J. L. No. 3 etc along with expansion of urban area in the east.

- **Changes in Irrigated Land:** Irrigated area means the land irrigated by different means (well, canal, tube well, tank, etc) for the cultivation of crops. The % of irrigated area has increased in all quadrants excepting NE and NW inner quadrants. The main reason of such change may be due to siltation of two main canals - Medinipur High Level Irrigation Canal and Denan Canal through which the plant releases the waste water from township and ash ponds. It must be mentioned that the main source of irrigation in the study area is canal (53%) and these two quadrants exclusively dependent on canal irrigation as 60.17% (99.71 out of 165.71 hectare) of irrigated area of NE and 74.25 % (408.23 out of 540.62Hectare) of

irrigated area of NW inner have canal as main source of irrigation. The before mentioned canals fall in the river Rupnarayan and the choking of the mouth by ash siltation hinder the free flow of river water into the canal.

Quadrant name	Changes in % of irrigated land to total area (1971 and 2001)
Inner Airshed Area	
North East	-8.09
South East	62.84
South West	28.21
North West	-5.81
Outer Airshed Area	
South East	61.35
South West	31.22
North West	20.61

Source: Prepared by the author on the basis of Census data 1971 and 2001

7. Importance of Agriculture as Source of Livelihood

According to 2001 census 55.41 % of total worker of Purba Medinipur District depend on agricultural activity. But in the study area the % of agricultural worker varies from 13% in the North East Quadrant to 49.47% in the SE inner quadrant. The main reason for such low % in the NE inner is that land was acquired from all villages locating in this quadrant. The percentage of agriculture workers is also low in the NW inner quadrant because agricultural land was acquired from many villages for the development of township for the employees of plant. Moreover this part of study area is agriculturally backward due to decrease of percentage of irrigated area (-5.81) during the last thirty years and loss of soil fertility probably due to dispersal and mixing of ash from the nearby ash ponds.

Quadrant name	Number of agricultural workers			Percentage of agricultural workers to total workers		
	1971	2001	Change	1971	2001	Change
Inner quadrants						
North East	1914	1888	-26	32	13.098	-18.90
South East	3035	8470	5435	59.06	49.47	-9.58
South West	3834	7129	3295	67.38	42.84	-24.54
North West	2282	3793	1511	56.65	34.85	-21.80
Outer quadrants						
South East	7812	18371	10559	67.34	48.95	-18.39
South West	8101	15638	7537	67.5	42.55	-24.95
North West	8830	13942	5112	72.23	49.38	-22.85

Source: Compiled by the author on the basis of Census data

From the above table it is clear that the number of agricultural workers have increased in 2001 as compared to 1971 census year in all the quadrants excepting NE inner but the percentage of agricultural workers to total workers have decreased everywhere. In terms of total number the change is the lowest (1511) in the NW quadrants where many people are engaged in full time or part – time job in Kolaghat Thermal power plant. But in terms of percentage the change is lowest (-9.58) in the SE inner quadrant, followed by SE outer quadrant (-18.39) and NE inner quadrant (-18.90). It should be noted that the negative change in the percentage of agricultural workers is comparatively high (>- 20) in the western part as compared to east because of poor development of agriculture.

8. Changes in Area and Productivity of Major Crops

The dependency of local people on the agriculture has declined considerably but the base of the economy of the total study remains agriculture. The fertile alluvial soils, monsoon climate with copious rainfall, presence of high, medium and low land in association with expertise farmers have developed a strong agricultural base. The agriculture is intensive subsistence type with rice (*Oriza Sativa*) being the principal crop, other two important commercial crops betel leaves (*Piper betel L'*) and flowers.

- **Rice:** Here two types of rice –winter and summer are being cultivated. The former is sowed in the month of June-July and harvested in November - December. The other is sowed in December –January and harvested in April -May. Rice cultivation is dependent on water very much; winter rice on monsoon rainfall and summer rice fully on irrigation.

Block name	Area Coverage Under Winter Rice (Hectare)			Productivity (kg/ hectare)		
	Pre-operational Phase	Post Operational Phase	Change(%)	Pre-operational Phase	Post Operational Phase	Change(%)
Kolaghat	9657	8511	-11.9	2069	2182	5(+)
Saheed Matangini	5221	4952	-5	1776	1467	17(-)
Block name	Average Area Coverage Under Summer Rice (Hectare)			Productivity (kg/ hectare)		
	Pre-operational Phase	Post Operational Phase	Change(%)	Pre-operational Phase	Post Operational Phase	Change(%)
Kolaghat	4109	6891	+67	2437	3553	+46
Saheed Matangini	2907	4940	+79	2681	3530	+31

Source: Prepared by the author on the basis of data collected from Principal Agricultural Office, Tamluk, Purba Medinipur District, West Bengal, India

From the table it is clear that the area under the summer rice has increased in both the blocks, this is due to improvement of irrigation facility, use of high yielding variety seeds and chemical fertilizers. But its productivity has decreased in the Saheed Matangini block compared to the northern block- Kolaghat due to presence of clayey soil in association with occurrence of higher percentage of low land, and choking of a number of irrigation canals due to renovation of highway resulting water logging condition during heavy monsoon downpour (June – September) which persists up to the month of October and November during harvesting time. However this type of waterlogging situation helps in the early sowing of the summer rice but the productivity has not increased much. According to the farmers use of high dose chemical fertilizers, unscientific cultivation along with falling and dumping of fly ash result decline of soil fertility and so the low productivity.

- **Betel:** The betel plant ('*Piper betel L*') is an evergreen and perennial creeper, with glossy heart-shaped leaves which is consumed as a chewing stimulant. It is a great deal of both medicinal and economic value. Unlike the major crops which provide income only once or twice a year, betel vines provides a continuous and better source of income. The cultivation of betel vines require special care and attention and good amount of capital starting from preparation of greenhouse (*boroj* in local language) and bed to maintain soil moisture, temperature and humidity inside the greenhouse. Saheed Matangini C.D.Block used to hold the first position in terms of area and productivity of betel plant in the Medinipur District in the 1970s and 1980s (Principal Agricultural office, Purba Medinipur). Here 3 types of betel are cultivated – locally known as *Sanchi*, *Bangla* and *Mitha*. Of these, *Mitha* is the best quality because of its taste, having good demand not only in India but in the Middle East countries also. *Bangla* type, having some pungent taste still finds better than *Sanchi* type. Again *Mitha* betel grows slowly compared to *Bangla* type. Once rural economy of this block was flourished centering production, processing, handling, transportation and marketing of betel leaves to different parts of the country. But now it has lost its glorious past to other blocks. (Source: Principal Agricultural Office, Tamluk, Purba Medinipur).

9. Saheed Matangini Block

Year	Sanchi Type		Bangla Type		Mitha type	
	Area(Hectare)	P.Vity(motte/ hectare)	Area(H)	P.Vity(motte/ hectare)	Area(H)	P.Vity(motte/ hectare)
1985-86	60	310	40	420	250	510
1995-96	38	315	76	455	228	460
2005-06	40	350	80	450	230	450
2009-10	40	350	80	450	230	440

1 motte = 10000 betel leaves

Source: Prepared by the author on the basis of data collected from Principal Agricultural Office, Tamluk, and Block Agricultural Office, Chatra, Purba Medinipur District, West Bengal, India

From the table it is clear that area and productivity of *Bangla* and *Sanchi* type have increased compared to *Mitha* type. From the field survey the present author came to know that the new betel vines mainly *Bangla* type are being developed mostly in the outer airshed area. Betel fields provide sufficient number of leaves up to 10- 15 years, after that the productivity gradually declines unless and until the bed is reconstructed. The concerned block particularly the inner impact zone has long history of *Mitha* betel cultivation. According to them problem in *Mitha* type started in 1990s after the power plant commissioned; with increase in job opportunity to the plant and other various unorganized sectors, shopkeeping and other services centering the plant, age old fields,

problems of fly ash deposition on the field, increase in cost of production, lack of expert labor. The plant have indirectly discouraged the young farmers in cultivation.

10. Changes in Flower Growing Area and Productivity

Well drained light textured soil with a pH of 6-7, presence of highland and experienced farmers have helped much development of flower cultivation in the northern block. Flower cultivation is being practised in 80% of villages. In case of southern block, flower cultivation is practised in few mouzas along the bank of Rupnarayan River. The agricultural Department has divided the flowers into three seasons on the basis of flowering time: Summer, Bhadoi and winter.

Kolaghat- The Northetrn Block						
Years	Summer		Rainy		Winter	
	Area (H)	Productivity(Kg/H)	Area	Productivity	Area	Productivity
2000-01	650	120	1000	120	900	50
2003-04	400	120	500	120	400	50
2006-07	400	100	400	120	500	50
Saheed Matangini - The Southern Block						
Years	Summer		Rainy		Winter	
	Area	Productivity	Area	Productivity	Area	Productivity
2000-01	50	100	100	100	110	40
2003-04	80	120	120	120	100	40
2006-07	80	120	100	120	80	50

Area: H= Hectare Productivity: Kg / Hectare

Source: Prepared by the author on the basis of data collected from Principal Agricultural Office, Tamluk, Purba Medinipur District, West Bengal, India

From the above data it is found that the flower growing area of northern block has decreased under all type but the productivity has declined mainly for the summer flowers, other types has remaining the same. The reason may be qualitative degradation of flower in terms of size and colour due to falling of ash on different parts of flowering plant. As it is a north side block, the southerly wind blowing at a higher speed (15-20 knot) carry a large volume of ashes compared to other season. So dispersion covers a large area. Other factors may be deterioration of soil quality due to excessive use of chemical fertilizers, increase of average temperature, lack of scientific method of cultivation, nutrient deficiency and definitely unwillingness of farmers towards labor intensive and highly profit fluctuating flower cultivation is an important reason. According to the respondents based on a questionnaire survey, productivity has decreased due to decline of soil fertility as a result of intensive use of chemical fertilizer (50 %) followed by dispersal of fly ash (35%), lack of application of modern agricultural technologies (10 %) and lastly pest attack (5%) .

In case of southern block both the summer flower growing area and productivity have increased. But winter flower growing area has decreased though productivity has increased slightly. Here the rainy flower area fluctuates but productivity shows a declining trend probably due to water logging condition that persists for a long time. Majority of the respondents (45%) of southern block think that rainy flower production is hampered by water logging caused either by heavy monsoon rainfall or intrusion of tidal water from the Rupnarayan River. Since flower cultivation has flourished in the South Eastern quadrant along the bank of the river Rupnarayan, fly ash does not create much problem to this part as wind blows mainly from South west for most of the time in a year.

11. Changes in Types of Flowers Cultivated

Once the Kolaghat Block was famous for tuber-rose (*Polianthes tuberosa*) cultivation but now this has been declined considerably. 400 hectare land was used for tuber- rose cultivation in 2002-03 and only 200 hectare in 2009-10. During this time production has also declined from 11.60 to 6.05 crore spike (Source: Horticultural Department, Purba Medinipur).

Nowadays a new trend has been found that many farmers are converting the ash dumping wasteland into a flowery land through cultivation of ash resistant seasonal flowers like Chrysanthemum (*Dendranthema grandiflorum*), Dahlia (*Dahlia pinnata*), in winter and Hibiscus (*Hibiscus rosa-sinensis*) and Sunflower (*Helianthus annuus*) in summer, but not of white variety flowers due to ash deposition. This cultivation on the dumping ground gives the farmers a good return.

12. Conclusion

Rice is the chief food crop cultivated in the study area. Summer Rice productivity has increased in both the block due to use of high yielding variety of seeds. But percentage of this increase is comparatively high in the northern block than in southern block. On the other hand though the winter rice cultivation area has decreased in both the blocks the productivity has decreased in the southern block mainly due to water logging situation in monsoon. Both flowering plants and betel plants are very much sensitive

and cannot tolerate any extremity, nuisance etc. From the field survey and collected data as well, it can be said that the betel cultivation particularly *Mitha Type* has suffered the most because of size of the leaves and age of the plant. When rice and most of the flowering plants are seasonal in nature, betel vines remain in the field for many years and leaf which is the edible part suffer the most due to deposition of ashes and thick layering reduce the rate of photosynthetic activity (Sony and Senger, 1993) leading to decline of its productivity. It is also evident from the field study that problem of betel cultivation started in the 1990s after all 6 units of the power plant started functioning. Later on other factors such as rising of input cost, competitive market, use of chemical fertilizers, lack of expert farmers, reluctance of new generation to this labour intensive work, fluctuation of profit, opportunity of other type of job. Betel vines once developed supply sufficient leaves for 10-15 years. After that it has to be reconstructed to get a good return. It may be that the betel vines of the inner study area was 10 to 15 years old; the development of coal based power plant at this particular time accentuated the problem of low productivity.

Flower cultivation in the northern block has also suffered to some extent because the senior cultivators say that the quality of the flowers has deteriorated in terms of size, brightness and colour. Because of pollution the farmers cannot take the risk of cultivating more delicate stick flowers like tuberose (*Polianthes tuberosa*), gladiolus (*Gladiolus hortulanus*) and other seasonal flowers. However it can be said that the new generation do not bother too much about their old glory because cultivation has become a secondary job to them. Mainly women and senior members of the family carry on this tradition just to maintain the land.

Besides crop production some changes are also noticed in the study area, particularly in the inner area. Firstly dependency of local people on agricultural activity is comparatively low in the north and negative change is being noticed both in terms of number and percentage of agricultural workers. Percentage of agricultural land has decreased in the inner eastern part and percentage of irrigated area has decreased in the inner northern part. Because of number of changes in favour of urbanization, Government of West Bengal has decided to develop a municipality in this inner impact zone centering KTPP (Source : *the Ananda Bazar Patrika 10th September, 2013–A Bengali newspaper published from Kolkata*).

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