Social and Environmental Issues of Public and Private Power Plants in West Bengal : An Empirical Study

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Abstract

Thermal electricity is the major sources of energy having more than 58% contribution to total energy production in India and this also has highest potentiality of pollution. Now that per capita consumption demand for electricity has been increasing substantially, in order to match demand and supply, private players have entered into this segment along with public sector companies. This paper attempts to study some of the socio-economic and environmental issues of two thermal power plants one each from the public and private in West Bengal viz. Bandel Thermal Power Station run by the government of West Bengal under WBPDCL and Budge Budge Generating Station is in the private sector under CESC. Data have been collected through personal interviews by using stratified random sampling technique used on three types of respondents. This study highlights some social and environmental consequences created by the power plants. It also exposes the impairments caused to the society and environment viz. air, water, noise pollution, etc. The paper discusses different remedial activities undertaken by the projects managers as the responsible corporate citizen.

Keywords: *Coal Ash, Pollution, Social and Environmental Impact, Project Affected Families. Families in Buffer Zone, Social Representatives.*

Introduction

Energy is the key resource of industrialization as well as for modern living. Per capita energy consumption increases with economic growth both for domestic consumption and business activities; hence building capability of electricity generation is imperative for any modern economy. Fossil fuels particularly coal-fed power plants is the indispensable source of energy generation worldwide. But Coal-fired thermal power plants, have inverse relation with environmental system. Yet countries including top ones such as United States and China adapted this source of energy due to cost effectiveness as compared to other sources of energy.

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This research paper investigates potential environmental, social and economic impacts of thermal power plants (TPPs). Critical environmental effects such as radiological impacts of different emissions of gases, effluent and leaching of wastes from disposal locations, dust in air are hazardous to the surroundings areas of Thermal plants. It also has an adverse effect on the ecological environment such as polluting river and causing infertility of land and unhealthy living conditions for humanity, massive displacement of inhabitants, destruction of wild animal including aquatic animals, etc. especially near the plant sites. Emission from plants has been causing global warning thus disturbing lives in the planet. For example, traditional fossil-fuel used in the Thermal Power Stations emits about 37.8% of all Green House Gases (GHGs) in the atmosphere, mostly in the form of carbon dioxide (CO_2). In 2013, power plants have emitted 42% of the total CO_2 emissions in the world. During the period of 1971 to 2013, CO2 emission in India has been rising i.e. discharging about 1868.6 million tons (mt) of CO2 in 2013. As per International Energy Agency (IEA), India has been ranked third for emission of energy related CO_2 in 2013. According to CEA-Fly Ash Report-2014 during 2012-13 at least 138 TPPs in India have generated almost 163.56 mt. poisonous toxic pollutant of coal ash. The report showed that ash utilization has been improved to 61.37% in 2012-13 only merely 10% below the level of 1996-97. Nations have been successful in adapting some measures to regulate emissions generated by Thermal Power Plants through various measures though complete eradication has not been possible.

The installed power generation capacity of India increased from a mere 1,362 MW in 1947 to 223343.60 MW in 2013 and coal-fed generation is accounted for 58.3% of it (Source: CEA annual report 2012-13). Significantly 85.94% of the thermal power plants are coal-fed consuming at least 457.8 million tons (mt) of coal annually. The electricity generation has been raised from 5.1 BU in 1950 to 912.06 BU in 2012-13 yet having a shortfall of about 17.94 BU during this period. By installing 10338 MW, West Bengal has made a considerable contribution in Indian Power Sector (IPS) during 2012-13 and at least 89.07% were from TPS.

Literature Review

Studies on similar issues relating to thermal power plants in India are extremely scanty. Pandey (1983) observed that pollutant concentration in the surrounding area of thermal power plant have adversely impacted plants and soil causing steady dreadful conditions of biotic and abiotic elements in the ecosystem there. This research paper, while restricted its investigation only in the area of plants and soil, observed possible damage to soil fertility, elimination of deciduous plant species, trees, shrubs, herbs and grasses from environs around thermal power plants. Ishikawa (1988) observed that rapid increase in use of coal for TPPs causing huge quantities of coal-ash. The study recommended introduction of inorganic fibre production technology which could melt coal-ash in a fusing furnace and process into fibres. Dutta (1997) examined the environmental and health effects of emission of coal-ash from thermal power plants. It leads to distraction of fertility, penetration of the fine particles deeply inside ones lungs effecting human health, etc. The paper recommended measures to utilize fly-ash. Ichikawa and Sada (2002) on the basis of a study in methods of detection and evaluation of environmental impact of TPPs, found that concentration of air pollutants and suspended particulate matters in the atmosphere had been major source of pollution. Lee and Lee (2007) studied the efficiency of actual energy generation and emission rate among different IGCC power plants and found that performances of different IGCC power plants were more efficient having superior environmental as compared with conventional coal-fired power plants. The paper focus on the social effects of the power plants. Mukhopadhyay (2008) analysing effect of thermal emission on air pollution, concluded that this had been due to the inefficient use of fossil fuel energy. In his research study, Direskeneli (2010) found that Thermal power plants in India occupied a dominating part in the field of conventional and non-conventional sources of energy and this was the main sources of environmental pollution. The research recommended improvement in the methods of the energy generation to be made mandatory**.** Comparing two sources of energy viz. Thermal and Solar, Muanjit et al. (2010) observed that unfavourable impacts of GHG effect and global warming of fossil fuel power plants were prime grounds to set up renewable eco-friendly solar cell

energy generating plants in Thailand. He observed some environmental effects in solar module in the manufacturing phase; this source was found to be friendlier to the environment than fossil fuel power plants. Lewins and Schwalbe (2011) in analysing work potential of the fuel, emphasized on measurement of the efficiency of the thermal power plant but here the social effect of the fossil-fuelled plants has not been discussed. Lokeshappa and Dikshit (2011) investigated the negative impact of industrial wastes including fly-ash in plant surrounding environs. Das and Paul (2015a, 2015b & 2015c) have made an attempt to investigate the socio-economic and environmental issues in surrounding vicinity of different thermal power stations in West Bengal.

Research Objectives and Methodology

Primary emphasis of the present study is on the comparison of social and environmental degradation caused by public and private power plants in two areas of West Bengal. The paper will also analyse different remedial measures undertaken by the project authorities for betterment of the afflicted people. Thus, the present study will cover following :

a) Assess the social and environmental effects of surrounding area due to private and public thermal power plants.

b) Examine social disturbances, if any, caused due to project operations.

c) Assess the remedial measures for afflicted people initiated by project authorities.

The present study is empirical and exploratory in nature on the basis of both primary and secondary data. Primary data have been collected through survey using structured questionnaires on the residents of surrounding area of Bandel Thermal Power Station (BTPS) under West Bengal power Development Corporation Limited (WBPDCL) and Budge Budge Generating Station (BBGS) under Calcutta Electricity Supply Company (CESC). The study has been conducted during the period of 2014 to 2015.

In a two-stage sampling techniques used in the study, in the first stage, two sample plants have been selected on the basis of convenience sampling technique. In the second stage, adjacent regions termed as project affected families (PAFs) in each of the selected power stations have been chosen by using the stratified random sampling technique taking power plants as the centre of each selected region. Households in different selected regions with 1km, 2km; etc. radius surrounding the plant were interviewed with the help of quota sampling technique within a stratum. Basing upon the pilot survey on this issue, the PAFs up to 5km radius surrounding of the selected plants were interviewed using structured questionnaire for primary data collection. Secondly, some families in buffer zone (BZFs) beyond 5 km radius have also been interviewed for the purpose of comparison zones between vicinity and buffer. Lastly, opinions of some selected Social Representatives (SRs) viz. local government and non-government bodies, institutions and social activists in project affected areas have been collected through a special type of structured questionnaire. Power plants office including its employees, Block Office, Gram Panchayat (GP) or Municipality Offices, District Offices and other power sector related organizations have also been understaken. Secondary data from different websites, various books, journals and dailies have been taken into account.

Collected data have been analysed by SPSS software. Simple computations, tabulations and cross-tabulations have been made to facilitate the application of appropriate statistical techniques. Different statistical methods have been used to arrive at some decisive inferences. Some qualitative data analysis techniques, viz. scaling and measurement techniques for qualitative data, different scaling techniques like Likert's Summated Scale, Semantic Differential Scale, etc. are also adopted.

Data Analysis and Findings

A comparative study with detailed analysis between public and private power sectors on the basis of collected data have been carried out. Analysis covers demographic profile, socio-economic status, impact of TPPs, awareness of PAFs, investigation on social disturbances, remedial measures undertaken,

disclosure of CSR activities and measuring association of different environmental parameters with distance from power stations. Respective results and interpretation all these are presented under different subsections sections.

About the Selected Power Plants

a) Bandel Thermal Power Station (BTPS)

BTPS is situated in Hooghly district of West Bengal 1 Km away from the Assam Road and connected with a metal road 3 km off the Grand Trunk Road (NH–2). In 1962 four units of 82.5 MW each it had been inaugurated as the first major but smallest thermal power generation station under WBSEB. In 2001, this TPS has been handed over to WBPDCL, the largest West Bengal state owned power generation undertaking contributing major share to the state power sector since its inception during 6th plan period (1980-85).

b) Budge Budge Generating Station (BBGS)

BBGS is a major power generating station in West Bengal under CESC, the largest ever privately owned power generation in the state commissioned in 1997 on the east bank of Hooghly River near about 6 km from Budge Budge and nearly 25 km from Kolkata. It consists of 3 units of 250 MW capacities each. It has been honoured with number of awards for meritorious activities on environment management along with pollution control and for the excellence performance in ash utilization. It has been recognized as the 'zero effluent discharge' status.

Study Areas

a) BTPS: Of the 10 G.P.s and 22 wards under Chinsurah-Mogra Block and Bansberia Municipality respectively affected by BTPs plants, the required information has been collected from each of four G.P.s and Wards respectively situated within a distance of 5 km from power station. Again second the survey has also been conducted to collect data from the areas beyond 5 km i.e. Buffer Zone (BZ) of the plant. For the third data set, opinions of some Social Representatives (SRs) surrounding the project have and also taken into account. Table 1 has summarised the location-wise collected data of Project Affected Families (PAFs), Project Affected Persons (PAPs), Families in Buffer Zone (BZFs), Persons in Buffer Zone (BZPs) and SRs in BTPS surrounding locale.

b) BBGS: Survey has been carried out within a distance of 5 KM in most of the 15 wards under Pujali municipality. Again, the information has also been collected from the wards beyond 5 km i.e. BZ of the station for second stage of analysis. For the third set of data views of some SRs surrounding the project have also been considered. Details of the studied PAFs and PAPs, BZFs and BZPs as well as SRs in BBGS surrounding areas have been summarized in the Table 1.

General Profile

The responses of 404 and 309 PAFs within 5 km of BTPS and BBGS respectively constitutes 48.6%, 17.6%, 12.1%, 18.3% and 3.5% for BTPS and 16.2%, 22.5%, 30.4%, 18.3% and 12.6% for BBGS in the radious of 1km, 2km, 3km, 4km and 5km respectively. For 95 and 52 BZFs in respective plants, responses are 38.9%, 31.6%, 19.5%, 6.8% and 2.2% for BTPS and 17.3%, 9.6%, 36.5%, 26.9% and 9.6% for BBGS in 6km, 7km, 8km, 9km and 10km respectively. Again some selected 50 and 37 SRs in roughly 5km of respective plants surrounding regions have also voiced their opinions. Distribution of the selected sample families are 6.4%, 31.9%, 34.9% and 26.8% for BTPS and 42.4%, 15.9%, 8.4% and 33.3% for BBGS from east, west, north and south respectively. The most of the families surveyed are nuclear type (56.2% and 67.6% respectively). Again 48.3% and 83.8% of the sample in respective PAFs are in general caste. Correspondingly 99.4% and 64.1% belongs to Hindu and rest 35.9% of BBGS are Muslim. It reveals that PAFs of respective plants surrounding areas consist of 1553 and 1509 PAPs comprising 54.3% male and 51.4% female for BTPS and 51.4% male and rests are female for BBGS. For BZFs, total of 343 and 267 BZPs respectively for two region, consists of 48.4% male and 51.6% female for BTPS while these are 52.4% and 47.6% for BBGS. Majority (43.7% for BTPS and 40.3% for BBGS) of the PAPs of the selected PAFs in corresponding surveyed areas are in the age

group of 20 to 40 years. It shows that only 20.2% and 6.2% respectively of the sample PAPs have an education up to higher secondary level whereas it is 22.2% and 15.7% for corresponding BZPs. The study reveals that only 41.9% and 10.7% PAFs of respective plants areas earn more than Rs.10000 per month while it is 55.9% and 28.8% for BZFs. So most of the PAFs are in very small income group, it is comparatively pitiable for BBGS regions.

Table 1 : Summary of Surveyed PAFs, PAPs, BZFs, BZPs and SRs

		Upto 5 Km		Beyond 5 KM		
TPPs	**Name of the Blocks**	**PAFs**	**PAPs**	**BZFs**	**BZPs**	**SRs**
	Chinsurah-Mogra	357	1363	72	262	37
BTPS	Bansberia Municipality	47	190	23	81	13
	Total	404	1553	95	343	50
	Pujali Municipality	309	1509	52	267	37
BBGS	Total	309	1509	52	267	37
	Grand Total	713	3062	147	610	87

Source : Authors' Survey

Socio-economic Status

With respect to transport and communication services the survey reveals that in BTPS and BBGS areas 83.7% and 91.9% PAFs and 98.0% and 94.6% SRs respectively have expressed average or better than average facilities available in their surrounding areas. Most of PAFs (about 57.2% and 100% respectively) have considered that they have the metal roads facilities. Most of the PAFs as well as SRs in both project surrounding belts are satisfied with the existing education facilities except 29.2% PAFs in BTPS and 13.5% SRs in BBGS areas have the opposite views.

Each type of respondents of both selected plant areas has sufficient primary as well as high school facilities (Table 2). However majority of them, mostly in BBGS areas, are too much frustrated as there are no higher education facilities in their region.

Majority of the PAFs in BTPS (81.5%) and BBGS (76.4%) areas along with SRs 84% and 56.7% respectively have expressed their contentment with existing medical facilities.

Table - 2 : Type of Educational Facilities in Three Zones

Type of Educational	PAFs(%)		SRs(%)		BZFs (%)	
Facilities	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Primary School	99.8	91.6	100	100	100	100
High School	72.0	89.3	70.0	94.6	91.6	76.9
College	25.5	0	6.0	5.4	2.1	0
Libray	50.7	8.7	6.0	5.4	2.1	0
Nil	0	0	0	0	0	0

Source : Authors' Survey

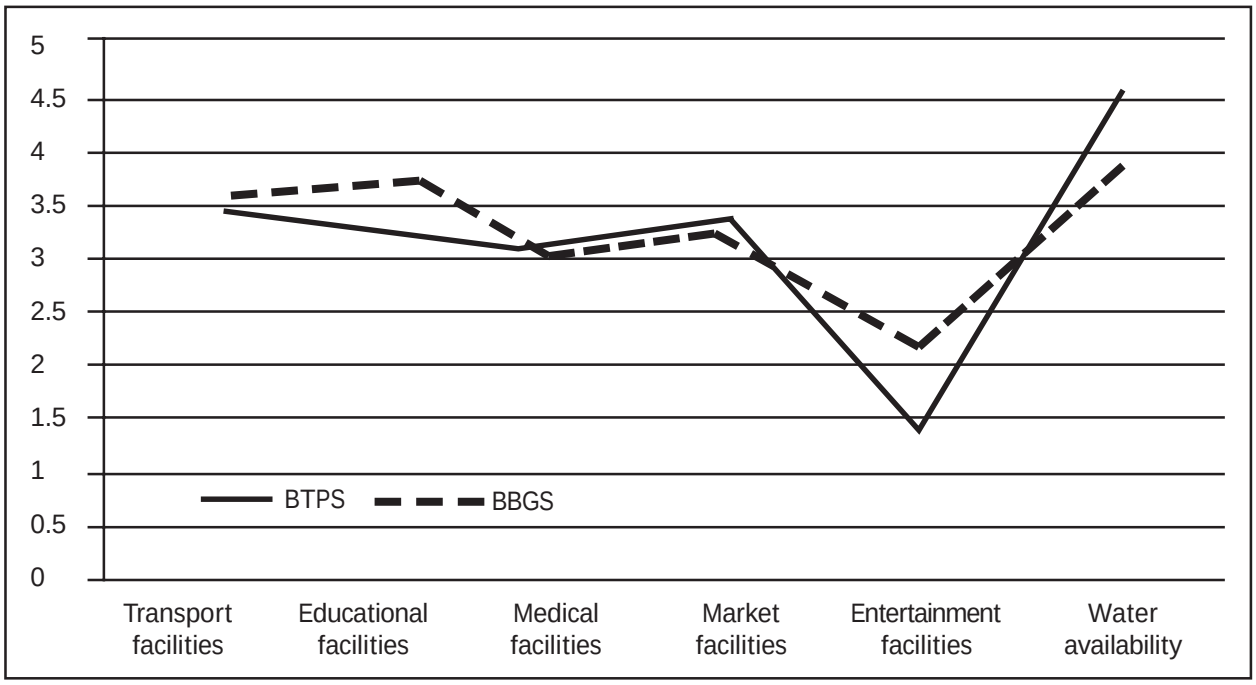
Table - 3 : Type of Medical Facilities

Type of	PAFs(%)		SRs(%)		BZFs (%)	
Facilities	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Health Centre	97.3	91.9	94.3	89.3	100	80.8
Nursing Home	23.0	8.7	22.2	12.6	38.9	36.5
Doctor's Chamber	96.5	58.3	91.4	62.4	100	94.2
Not Present	0	0	0	4.8	0	1.9

Source : Authors' Survey

Table 3 shows that most of the respondents of each category in plants areas have sufficient health centre (over 90%). A very few selected BZFs in BBGS (1.9%) areas has expressed their dissatisfaction on the aspect. The study illustrates that entertainment facilities like different cultural activities including games & sports in both plants surrounding areas are below normal. It is comparatively better in BBGS localation. Majority of the respondents of all sections in each of the surveyed areas are happy about their available water as well as market facilities.

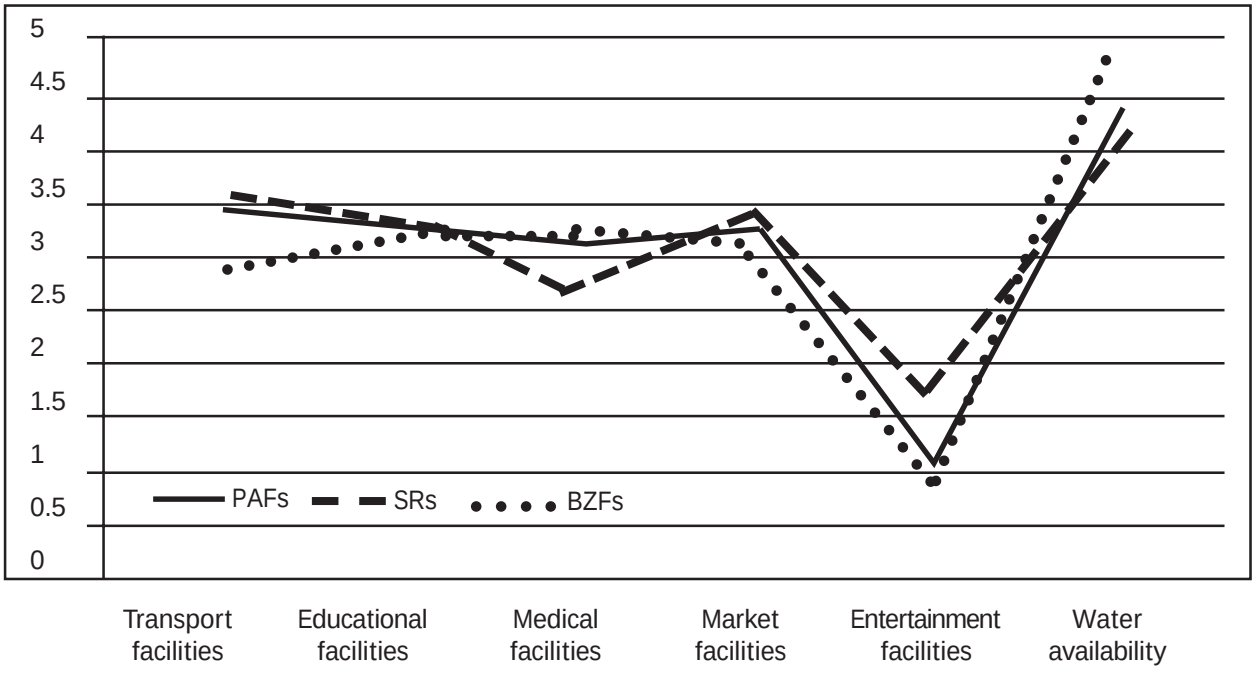
Figure 1 : Power Station Wise Social Impact



Source : Generated from the survey

Social impact covering some of the different social issues of both power plants neighbouring have been portrayed in Figure 1

Figure 2 : Assessment of Social Impact from PAFs, SRs and BZFs



Source : Generated from the Survey

The Figure 2 exhibits the assessments made by all categories of respondents on social impact surrounding the project areas.

Social Disturbance

Opinions of three sets of people on social disturbance experienced by affected inhabitants in the surrounding areas of the project have been noted in detail in Table 4.

Table - 4 : Immoral Activities Related to Thermal Power Plant

Immoral Activities	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Not Applicable	91.1	51.8	4.00	59.5	100	88.5
Applicable	8.9	48.2	96.0	40.5	0	11.5
Total	100	100	100	100	100	100
Highly increasing	0	0	2.1	0	0	0
Increasing	0	100	60.4	100	0	0
Indifferent	2.8	0	31.3	0	0	16.7
Decreasing	0	0	6.3	0	0	83.3
Highly decreasing	97.2	0	0	0	0	0
Total (Applicable)	100	100	100	100	0	100
Mean	1.06	4	3.58	4.00	0	2.17
S.D.	0.33	0	0.65	0	0	0.41
Skewness	6.00	0	-0.82	0	0	2.45
Kourtosis	36.00	0	0.32	0	0	6.00

Source : Calculated from Survey data

Table 4 illustrates in details that institution of TPS causes the social disturbance. It shows that at least 8.9% and 48.2% PAFs as well as 96.0% and 40.5% SRs in BTPS and BBGS project surrounding areas respectively have similar experience. Most important point is that almost every respondent in BBGS areas have declared that immoral activities have been increasing gradually in their zone.

Again most of the PAFs (71.1%) and SRs (26.7%) in BBGS regions believe that such activities have been increasing because of various contractors and unknown persons are entertained by TPS. However, in BTPS surrounding region none has reported similarly.

Environmental Impact

Establishment of TPPs silently pollutes its nearby atmosphere and promptly changes the lifestyle of surrounding people. Hence, its environmental impact is most important. Considering the responses of the PAPs and others in each selected project affected areas (PAAs) some of the important environmental effect have been studied in the subsequent sections.

Table - 5 : Coal - ash Damped

Sourrounding Their House	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Yes	87.1	67.0	94.0	62.2	0	13.5
No	12.9	33.0	6.0	37.8	100	86.5
Total	100	100	100	100	100	100

Source: Calculated from Survey Data

Most of respondents of the selected PAFs and SRs in both TPPs areas have strongly expressed their displeasure as coal-ash has been damped all over the place in their locality while families at a distance from plants do not feel so negatively(Table 5).

Table - 6 : Geological Change Due to Coal-Ash in the Locality

Geological Change Due To Coal Ash In The Locality	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Uniquely	22.8	53.4	2.0	62.2	0	9.6
Completely	45.0	13.6	88.0	0	0	0
Partially	24.3	17.5	4.0	10.8	7.4	15.4

Geological Change Due To Coal Ash In The Locality	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Very Little	7.9	12.6	6.0	21.6	8.4	3.8
Not at all	0	2.9	0	5.4	84.2	71.2
Total	100	100	100	100	100	100
Mean	3.83	4.02	3.86	3.92	1.23	1.73
S.D.	0.87	1.22	0.53	1.46	0.57	1.30
Skewness	-0.38	-0.85	-2.64	-0.76	2.38	1.64
Kourtosis	-0.50	-0.60	7.71	-1.19	4.40	1.46

Source: Calculated from Survey Data

Similar views as in earlier cases have been echoed on geological changes due to coal ash damped in their belts. Table 6 discloses that at least 67.8% and 67.0% selected PAFs and also 90.0% and 62.2% selected SRs in BTPS and BBGS surrounding areas respectively are extremely worried about it. But most of the BZFs (92.6% and 75.0% respectively) have opposite views on this issue.

Table - 7 : Presence of Dust in House

Presence of Dust in House	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Very High	8.2	47.2	44.0	94.6	0	1.9
High	38.6	16.5	16.0	5.4	0	28.8
Average	29.7	35.9	20.0	0	8.4	15.4
Low	23.5	0	8.0	0	89.5	32.7
Very Low	0	0.3	12.0	0	2.1	21.2
Total	100	100	100	100	100	100
Mean	3.31	4.1	3.72	4.95	2.06	2.58
S.D.	0.92	0.92	1.41	0.23	0.32	1.18
Skewness	-0.04	-0.31	-0.74	-4.11	1.38	0.15
Kourtosis	-0.99	-1.43	-0.74	15.8	6.34	-1.28

Source : Calculated on the basis of survey responses

Table - 8 : Noise Pollution

Presence of Dust in House	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Very High	3.7	50.8	0	48.6	0	0
High	39.4	11.7	64.0	24.3	0	0
Average	26.7	0	28.0	21.6	8.4	0
Low	30.2	23.6	4.0	5.4	91.6	51.9
Very Low	0	13.9	4.0	0	0	48.1
Total	100	100	100	100	100	100
Mean	3.17	3.92	3.52	4.16	2.08	1.52
S.D.	0.90	1.60	0.76	0.96	0.28	0.50
Skewness	-0.03	-0.53	-1.80	-0.74	3.04	-0.08
Kourtosis	-1.25	-1.48	-3.23	-0.65	7.41	-2.08

Source : Calculated on the basis of survey responses

With respect to views on noise pollution caused by TPS, from the descriptive statistics of the Table 8, it is annoying for more than average (3 point) PAFs as well as SRs. Negative Skewness for both types of respondents have also similar significance. On the contrary, reverse views have been found out for BZFs from it.

Table - 9 : Air Pollution Caused by T P P

Air Pollution Caused by TPP	PAFs (%)		SRs (%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Very High	15.3	93.5	0	86.5	0	0
High	39.6	5.2	64.0	8.1	0	23.1
Average	29.0	1.0	26.0	0	8.4	17.3
Low	16.1	0.3	4.0	5.4	91.6	38.5
Very Low	0	0	6.0	0	0	21.2
Total	100	100	100	100	100	100

Air Pollution Caused by TPP	PAFs(%)		SRs(%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Mean	3.54	4.92	3.48	4.76	2.08	2.42
S.D.	0.94	0.34	0.84	0.72	0.28	1.07
Skewness	-0.15	-4.98	-1.77	-3.32	3.04	0.26
Kourtosis	-0.86	29.00	2.68	10.80	7.41	-1.17

Source: Calculated from Survey Data

Majority (54.9%) in BTPS and almost every (98.7%) PAFs in BBGS along with SRs of 64.0% and 94.6% respectively are too much concerned on high or very high level air pollution owing to various emissions out of TPPs. The Table 9 also shows that surrounding areas for both plants the mean value lies above 3 point and distribution is negatively skewed. All these indicate that TPS causes the air pollution. In contrast most of the BZFs have expressed reverse views.

Table - 10 : Impact of Air Pollution on Trees and Agricultural Land

Impact of Air Pollution on Trees and Agricultural Land	PAFs(%)		SRs(%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Very High	18.1	72.8	4.0	86.5	0	7.7
High	20.3	8.1	72.0	0	0	11.5
Tolerable	32.2	18.8	16.0	8.1	5.3	13.5
Low	13.6	0	4.0	0	22.1	34.6
Very Low	15.8	0.3	4.0	5.4	72.6	32.7
Total	100	100	100	100	100	100
Mean	3.11	4.53	3.68	4.62	1.33	2.27
S.D.	1.30	0.82	0.79	1.04	0.57	1.25
Skewness	-0.15	-1.40	-1.90	-2.79	1.58	0.83
Kourtosis	-0.96	0.61	4.20	7.11	1.56	-0.31

Source : Calculated on the Basis of Survey Responses

As regards the observation on impact of air pollution on agricultural land and trees in PAAs, (Table 10) the majority of both PAFs (80.9%) and SRs (86.5%) in BBGS area have expressed the high or very high terrifying impact of thermal plants while in BTPS observed pollution report in lands in neighbouring regions to some extent was low (38.4%) for PAFs and 76.0% for SRs as compared to those of BBGS. However, responses of both BZFs of TPPs areas on environmental effects have not been negative. The descriptive statistics also give similar indications.

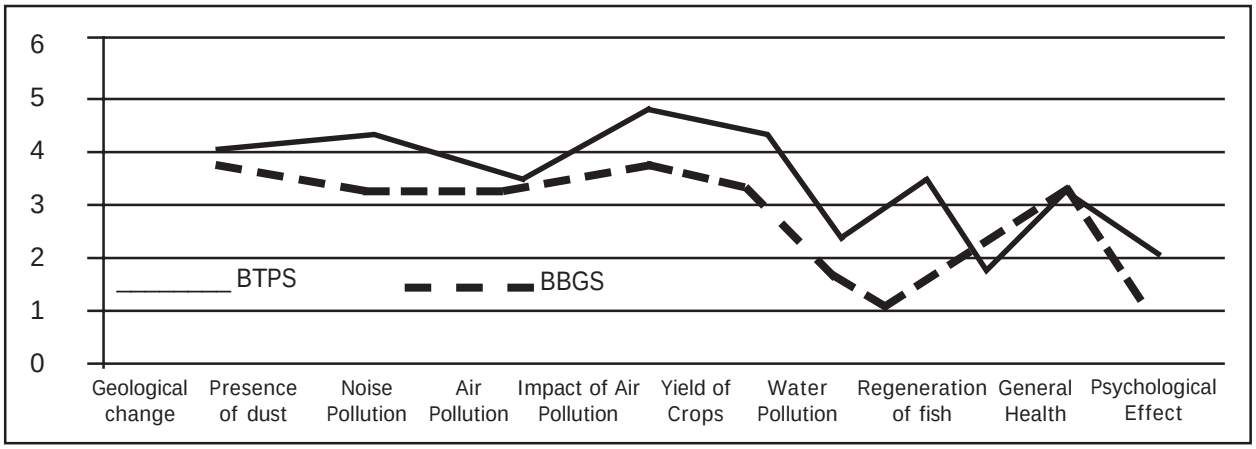
Table - 11 : Yield of Different Crops

Yield of Different Crops	PAFs(%)		SRs(%)		BZFs (%)	
	BTPS	BBGS	BTPS	BBGS	BTPS	BBGS
Families with no Cultivated Land	86.6	89.3	2.0	70.3	82.1	71.2
Families with Cultivated Land (Currently)	13.4	10.7	98.0	27.7	17.9	28.8
Total	100	100	100	100	100	100
Highly Increasing	0	0	0	0	23.5	26.7
Increasing	0	15.2	24.5	0	17.6	60.0
Static Day by Day	24.1	12.1	18.4	0	58.8	13.3
Decreasing	22.2	45.5	51.0	54.5	0	0
Highly Decreasing	53.7	27.3	6.1	45.5	0	0
Total (Families with Cultivated Land)	100	100	100	100	100	100
Mean	1.7	2.15	2.61	1.55	3.65	4.13
S.D.	0.84	1.00	0.93	0.52	0.86	0.64
Skewness	0.62	0.67	0.38	-0.21	0.81	-0.10
Kourtosis	-1.30	-0.47	-1.05	-2.44	-1.15	-0.13

Source : Calculated on the basis of survey responses

Table 11 shows that almost 75.9% and 72.8% PAFs with cultivated land at present and 57.1% and 100% SRs of the same in BTPS and BBGS surrounding areas respectively have expressed that yield of crops has been significantly declining. In each case, the mean score is under point 3 level which is also signify the same. But in both cases BZFs respondents have reverse views.

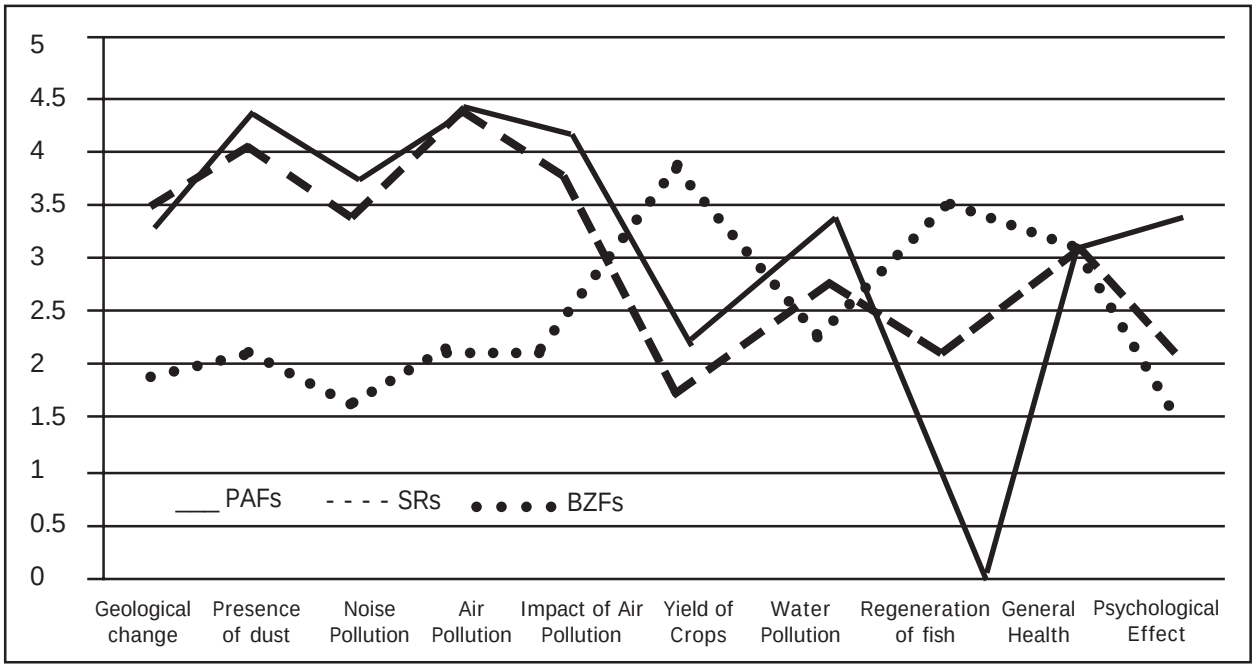
Figure 3 : Power Station-Wise Enviornment Impact



Source: on the basis of survey responses

Project-wise Environmental impact of both TPPs taking into account their diverse environmental affairs such as geological change, noise, air pollution, etc. has been portrayed in Figure 3. Relatively BTPS demonstrates conditions as compared to other plants .

Figure 4 : Respondent-wise Assessment of Overall Enviornment Impact



Source: on the basis of survey responses

Assessment of different sorts of respondents on overall environmental impact of various issues have been diagrammatically exhibited in Figure 4. It presents that BZFs have largely differed from that of others who have mostly similar experiences.

Remedial Measures in PAAs

Several stern measures have been taken to neutralize environmental effects of TPS with positive effect in PAAs. Lastly the study has also been conducted to gather some views of the neighbouring residents regarding various remedial measures which have been undertaken by the project authorities or government for improving lives of the affected people and locality.

a) Curative Measures

Curative measures Initially various provided by the project authorities have been studied as described in the subsequent table.

Table 12 : Rehabilitation of PAFs

Rehabilitation	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Not Applicable	98.8	73.5	80.0	70.3
Applicable	1.2	26.5	20.0	29.7
Total	**100**	**100**	**100**	**100**
Uniquely	0	0	0	0
Totally	0	0	0	0
Partially	0	8.5	0	0
A little	0	12.2	0	0
Not at all	100	79.3	100	100
Total (Applicable)	**100**	**100**	**100**	**100**
Mean	1.00	1.29	1.00	1.00
S.D.	0	0.62	0	0
Skewness	0	1.97	0	0
Kourtosis	0	2.56	0	0

Source: Calculation on the basis of survey responses

Table 12 presents that at least 1.2% and 26.5% selected PAFs in BTPS and BBGS areas respectively have to give up their land and/or houses for construction of plants. Opinions of 20.0% and 29.7% SRs surveyed are also the same. The study also reveals only in BBGS rehabilitation took place and only a negligible sample of land loser families have been displaced partially (8.5%) or in a small way (12.2%).

Table 13: Employment of PAFs in the Project

Employment in the Project	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Not Applicable	98.8	73.5	80.0	70.3
Applicable	1.2	26.5	20.0	29.7
Total	**100**	**100**	**100**	**100**
Yes	100	11.0	0	0
No	0	89.0	100	100
Total (Applicable)	**100**	**100**	**100**	**100**

Source: Calculation on the basis of survey responses

It is observed from the Table 13 that most of the studied land-loser PAFs (89.0%) in BBGS areas have not yet been employed in the project whereas it is reverse for BTPS. But according to SRs no one got alternative employment from either TPS areas.

b) Preventive Measures

Views of selected PAFs and SRs on different remedial measures initiated by the TPS authorities as well as Government in both PAFs have been observed in this study. Proper execution of these measures may bring in improvement in the economic condition of the project affected communities.

Table 14: Infrastructural Development

InfrastructuralDevelopment	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Roads	71.5	100	100	100
Bridges	1.0	0.3	8.0	5.4
Culverts	2.2	0	56.0	5.4

Infrastructural Development	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
School	32.7	75.7	100	83.8
Buildings	1.2	0	24.0	0
Libraries	6.2	0	2.0	0
Drainage	12.1	77.3	90.0	59.5
Drinking water	37.9	91.6	92.0	94.6
Rural electrification	94.3	100	4.0	100
Earth filling	0	0	6.0	0
Irrigation	0	0	0	0
Direct power supply to PAA	0	0.3	0	0
None	0	0	0	0

Source : Calculation on the basis of survey responses

The survey (Table 14) reveals that most of the PAFs as well as SRs in each project area have expressed their satisfaction with regard to expansion on most of the infrastructural facilities. With respect to facilities such as drinking water, etc. comparatively respondents of BBGs want more of these facilities as compares to BTPS.

Table 15: General Welfare Scheme

General Welfare	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Tree plantation	95.5	27.8	96.0	40.5
Health camps	8.2	81.6	6.0	89.2
Sanitations	0.2	18.4	24.0	16.2
Family welfare camp	0.2	15.5	2.0	29.7
Adult education centre	0.2	56.0	0	67.6

General Welfare	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Dispensary	0.5	13.9	80.0	29.7
Street light	96.5	99.7	96.0	94.6
None	1.0	0	0	0

Source : Calculation on the basis of survey responses

Table 15 shows the comparative picture on the attitude of sample PAFs and SRs in each survey area on various general welfare activities like tree plantation; organize health camps, sanitation, street light programme, etc. undertaken by project authorities.

Table 16: Employment Generation Scheme

Employment Generation Scheme	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Employment in project	1.0	0	76.0	0
Employment under contractor	0.2	8.7	0	0
Allotment of shops	0	0	2.0	0
Self employment program	97.5	42.7	34.0	43.2
None	1.5	57.3	0	0

Source : Calculation on the basis of survey responses

Table 16 shows that about 76.0% SRs and 1.0% of sample PAFs in BTPS areas have expressed their positive views about employment in projects whereas none of respondents in BBGS area has similar views either among SRs or PAFs .

Table 17: Pollution Control Measures Taken by TPPs

Pollution Control Measures Taken	PAFs (%)		SRs (%)	
	BTPS	BBGS	BTPS	BBGS
Very quickly	0	0	10.0	0
Quickly	0.2	0.3	22.0	5.4
Slowly	1.5	8.4	42.0	5.4
Very slowly	3.2	0	20.0	0
Not at all	95.0	91.3	6.0	89.2
Total	100	100	100	100
Mean	1.07	1.18	3.10	1.27
S.D.	0.33	0.58	1.04	0.80
Skewness	5.43	3.00	0.02	2.84
Kourtosis	32.20	7.30	-0.27	6.85

Source: calculation on the basis of survey responses

Most of the respondents (both PAFs and SRs) of each TPS area have expressed their dissatisfaction on the reluctant and indifferent attitudes concerning the environment pollution of the project authorities who are rarely interested to launch any pollution control measures in the power station (Table 17).

Association of Different Variables with Locational Distance from Power Station

Table 18 furnishes the Pearson correlation coefficient of some of the different observed social as well as atmospheric issues with distance from particular TPP and its impact of the same.

Table 18: Association of Social & Environmental variables with Distance from TPPs

Variables	r	Study Area of TPS		Significant
		BTPS	BTPS	
Significant geological change	r_{dv}	-.105*	-.692**	With the increase in distance, environmental damage has been declining for all TPP.
	P	.034	.000	
Awareness of pollution caused by TPS	r_{dv}	-.112*	-.078*	Awareness of pollution caused bt TPS among PAP has gradually been lessening with increasing geographical distance
	P	.024	.170	
Presence of dust in house	r_{dv}	-.733**	-.449**	As distance is increasing, presence of dust on residence has been decreasing,
	P	.000	.000	
Noise Pollution	r_{dv}	-.718**	-.165**	Noise pollution has been in declining trend with geographical distance from TPS
	P	.000	.004	
Air Pollution	r_{dv}	-.736**	-.006	Air pollution has also the similar effect.
	P	.000	.918	
Impact of air pollution on trees & agricultural land in locality	r_{dv}	-.546**	-.247**	Impact of air pollution on trees & agricultural land in locality has been reducing as distance has been increasing.
	P	.000	.000	
Yield of different crops	r_{dv}	-.035	-.176**	Yield of different crops is positively correlated with distance from respective TPP.
	P	.482	.002	
Quality of different crops	r_{dv}	-.062	-.322**	Better quality of water is improved as distance from TPS increases.
	P	.212	.000	
Quality of available water	r_{dv}	-.062	-.322**	Immoral activities have negatively been related with distance from TPS.
	P	.212	.000	
Immoral activities	r_{dv}	-.279**	-.360**	General health of family members is improved with distance from TPS.
	P	.000	.000	

Source : Calculation on the basis of survey responses

Variables	r	Study Area of TPS		Significant
		BTPS	BTPS	
General Health of family members	r_{dv}	-.067	-.014	Opinion on effect of pollution during last 5 years is negatively correlated with the distance.
	P	.179	.808	
Level of pollution over last 5 years	r_{dv}	-.077	-.342**	Opinion on effect of pollution during last 5 years is negatively correlated with the distance.
	P	.122	.000	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Here 'r_{dv}' denotes Pearson Correlation coefficient between distance from TPS (d) and observed variable (v) and 'p' denotes the significant (2-tailed) level.

Variation of Environmental Condition with Distance and Direction from Plants

There are several environmental issues surrounding TPS plants which have already been analyzed. To study the impact of its adjoining area, ANOVA is used to check the variation of environmental conditions with distance from a plant and its direction. The different variables considered in this section are taken together and by using Likert's summated scale the overall environmental condition is assessed in adjoining area of a plant. A plant is considered as the centre of the location of the study. Individual households in different circular directions from the centre of the plant. (i.e., 1km, 2km, 3km, etc. radius from the plant) is treated as the Distance Factor and direction of Factors. (i.e., east, south, west etc.) is treated as the Direction Factor. To study the variation of overall environmental conditions with respect to distance and direction of a plant, the ANOVA technique is used and the following results are obtained.

Table 19: Variation of Environmental Condition with Distance Direction

TPS		With Distance			With Direction		
		F-Value	P-Value	Conclusion	F-Value	P-value	Conclusion
Environment Condition	BTPS	17.4701	.000	highly varing with distance	39.5152	.000	highly varing with direction
	BBGS	28.5025	.000	highly varing with distance	48.6223	.000	highly varing with direction

Table 19 displays that the overall environmental condition surrounding the project is highly varying in accordance with the distance from BTPS (F-value = 17.4701, p-value = .000), and BBGS (F-value = 28.5025, p-value = .000). Again it also presents that the overall environmental condition has high level of variation towards different directions of BTPS (F-value = 39.5152, p-value = .000) and BBGS (F-value = 48.6223, p-value = .000).

Concluding Remarks

This comprehensive study enumerates the social, economic and environmental issues due to of public and private thermal power plants. Findings of this research are based on the opinions of sample respondents selected among affected people (PFA) around the surrounding area of projects along with BZFs and SRs. Research finds that PAFs have been permanently residing at their existing place and a large number of them have lost their land for construction of plants but have not yet been compensated properly. At present, they have only a small quantity of agricultural land. Majority of them have an education up to secondary level and belong to low income group. With respect of socio-economic status, it reveals that most of the respondents in each project surrounding areas are satisfied with the available transport and communication facilities. As per available educational facilities, the respondents in BBGS surrounding area are comparatively more satisfied than that of BTPS locale. But most of them in both the regions are dissatisfied with the non-availability of higher education facilities. Majority of the PAFs in the surrounding both the projects, have expressed their contentment with existing medical facilities. Medical facilities are comparatively better in BTPS. The availability of entertainment and cultural facilities in BBGS area is comparatively better even if it is below expectation. Thus, as regards social facilities, it may be concluded that sample respondents are of opinion that BBGS surroundings are in better than those of BTPS.

The study reveals that almost every respondent in BBGS areas has expressed their experiences of social disturbances including varieties of immoral activities on increase gradually in their neighbourhood due to the fact that various contractors and unknown persons have been frequenting. TPS areas. However, in BTPS area, no one has made such remarks. PAFs in each case are terribly concerned about the geological change caused by the coal-ash damped in their place. Majority of the PAFs as well as SRs in BBGS area have expressed their anguish about the presence of high level coal-ash in air around house in addition to the noise pollution. Such displeasure is comparatively low in BTPS project surrounding locality. Almost everyone in BBGS area is seriously concerned about the high level air pollution owing to emission from TPS as compared to BTPS. On the contrary, most BZFs have remained silent on this issue. The study also reveals that in connection with overall environmental impact, relatively BTPS is in healthier condition than other one. Significant decline in yield of crops has been opined by respondents in both the TPS. Majority of PAFs believe that pollution caused by TPS is the prime cause of crop yield fall. However, BZFs have expressed opposite views.

Majority of affected respondents including SRs are satisfied with different infrastructural development as well as welfare activities undertaken by project authorities in surrounding areas. As regards School, Drinking water, etc., BBGS is in better position. To maintained social and ecological balance, different corrective measures should be put into service by the particular power authorities to reduce the social and environmental unpleasant occurrences. It is recommended that the project authorities should come forward as socially responsible citizens adapting sufficient CSR activities which may, somewhat, mitigate damages caused by TPS. The project authorities along with the government should have a proper rehabilitation arrangements for the dispossessed families. Afforestation programmes in plant surrounding region along with installation of pollution control devices should be highly appreciated. They should intimate constructive performances in these areas to counter social and economic damages to environment. The project authorities should comply with the provision of CSR rules of Companies Act, 2013 under which the corporate compulsorily should allocate 2% of net profit for different social welfare activities.

References

Das, J.K. and Bose, S. (2009). Environmental and Social Reporting by Power Sector Enterprises in India, *Indian Accounting Review*, Vol. 13 (2).

Das, J. K. and Paul, Mahadeb (2015a). Social and Environmental Impact of Thermal Power Plants: An Indian Case Study, *International Journal of Information, Business and Management*, Vol. 7 (3).

Das, J. K. and Paul, Mahadeb (2015b). Social Cost-Benefit Analysis of Thermal Power Plants: A Study of Budge Budge Generating Station, *Journal of Business and Economic Issues*, 5 (2).

Das, J. K. and Paul, Mahadeb (2015c). Some Social and Environmental Issues of Thermal Power Plants: Empirical Evidence from West Bengal, *Anveswa*, 8 (3).

Direskeneli, H. (2010). On Thermal Power Plants at our Backyard, *The Journal of Turkish Weekly*, 27 April.
Dutta, M. (1997). Fly-ash – An Environment and Health Perspective*, A Toxics Link*, New Delhi.

Hegde, P., Bloom, R. and Fuglister, J. (1997). Social Financial Reporting in India: A Case. *The International Journal of Accounting*, Vol. XXXII (2).

Ichikawa, Y. and Sada, K. (2002). An Atmospheric Dispersion Model for the Environmental Impact Assessment of Thermal Power Plants in Japan - A Method For Evaluation, Journal of the Air and Waste Management Association, March, Vol. 52 (3).

Ishikawa, Y. (2005). A Study on a technology to produce Inorganic Fibers by melting Coal-ash, *World of Coal Ash (WOCA)* http://www.flyash.info

Lee, C. and Lee, S.J. (2007). Evaluation on the Performance and the NOx Emission of IGCC Power Plant Integrated with Air Separations Unit, *International Energy Journal,* Vol. 8.

Lewins, J. D. and Schwalbe, K. (2011). Towards an Internationally Agreed Efficiency Measure for Fossil-fuelled Power station, At Conference XI, Chemnitz, July.

Lokeshappa, B. and Dikshit, A. K. (2011). Disposal and Management of Fly-ash, International Conference on Life Science and Technology.

Muanjit, C., Natanee, V. and Tanongkiat, K. (2010). Environmental Impact Analysis of Solar Cell Power Plant Compared with Fossil Fuel Power Plants in Thailand, *Asian Journal on Energy and Environment*.

Mukhopadhyay, K. (2008). Air pollution and Income Distribution in India, *Asia-Pacific Development Journal,* Vol. 15 (1).

Pandey, S.N. (1983). Impact of Thermal Power Plant Emissions on Vegetation and Soil, *Water, Air and Soil Pollution*, Vol. 19 (1), January.