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Thermal Power Emission and Its Impact on Betel Vine (*Piper betel*): A Participatory Action Research in West Bengal

Sk Wasaful Quader[1*], Arindam Ghosh[1], S. K. Acharya[1], Monirul Haque[1], Kabita Mondal[1] and Amitava Biswas[1]

[1]Department of Agricultural Extension, Bidhan Chandra Krishiviswavidyalaya, Mohanpur, Nadia, West Bengal, Pin - 741252, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author WQ wrote the first draft of the manuscript, collected data and done statistical analysis. Authors AG, MH and KM helped in collection of data and preparation of manuscript. Authors AB and SKA helped in interpretation and supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

Thermal power stations are now considered as the foremost global concern as these are responsible to produce detrimental effects on the environment. Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impact so proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. In this study, the perception of certain(60)farmers in 5 villages of Kolaghat block of Purba Medinipur, West Bengal, India are recorded and analyzed on the basis of their knowledge and views about thermal power, environment and about their individual enterprises. There are 10 independent variables-ages (x_1), education (x_2), family Member (x_3), income (x_4), homestead land (x_5), total Land (x_6), land under Boroj (x_7), input cost (x_8), and livestock number (x_9), distance of villages from Kolaghat thermal power plant (x_{10}) and 1 dependable variables- 1) perceived impacts of Kolaghat thermal power plant on betel vine(y_2). From this empirical study, it has been found to be

**Corresponding author: E-mail: skwasaful.7@gmail.com;*

concluded that the common perception among the betel growers is that the Kolaghat thermal power plant produces huge amount of flu ash which reduces their level of income on betel vine. Thick layer of fly ash reduces the quality of leaves and bronzing occurred which affect production. It affects betel vine borojes. It is found from the result that villages which are nearly placed at Kolaghat thermal power plant side are mostly affected.

Keywords: Environment; Coal based Thermal Power Plants; Kolaghat Thermal Power Station; Environmental Impact Assessment (EIA); social ecology; perception analysis; human health; betel vine; livestock health.

1. INTRODUCTION

Thermal power stations are now considered as the foremost global concern as these are responsible to produce detrimental effect on the environment. Leather processing for commercial purposes involves going through a set of complex and laborious operations, resulting in over 70% waste relative to the initial feedstock; a quarter of this waste is produced in Europe [1]. Humans were in the past more physically and psychologically connected to nature than people living in industrialized nations today. Environmental pollution is now extensively discussed phenomenon and it is often stated that pollution becomes severe since the onset of the industrial revolution; mainly due to the combustion of fossil fuels used for the generation of energy and transportation. Coal power refers to electric power produced from direct combustion of coal or combustion following gasification. Coal supplies the majority of the world's electricity due to its low relative cost and the global distribution of coal reserves. Fossil fuels such as coal are concentrated forms of energy and produce cheap thermal energy. Coal has been identified as main fuel for power generation till 2012 even with the development of feasible hydro – potential and non – conventional sources of energy in India. Coal will continue to remain the major fuel for meeting future electricity demand. Thermal generation contributes 63.4% of the total installed capacity. The total generation installed capacity of India is 115544.8 MW and the thermal power contributes 80187.5MW.

Thermal power plants are the major sources of environmental pollution. Some negative externalities arise from the use of coal as a primary electricity source. Negative health effects on the nearby human population, plant life and wildlife have been hard to quantify precisely and thoroughly. A typical thermal power plant generates ash–dump, emits SO_X, NOx, SPM etc. through its chimney which are responsible for acid rain. Effluents from it carry the load of oil and grease, free available chlorine, TSS, Cu, Fe, Zn, Cr, PO4 -3, NH4-N, Phenol, CN- etc. These wastes often produce more or less adverse effects on surrounding ecosystem, e.g., it can be mentioned that the PM can inhibit the normal respiration and photosynthetic mechanism of plant leaf which ultimately reduce plant productivity. During winter season, the cold north wind, (north – east monsoon wind) blows in this area. Huge fly ash flies with this wind in the area, as far as 10 kms south from the plant.

Betel vine an important cash crop is such a resource. Betel is a perennial tropical plant. Betel leaves help in digestion and its extract has some medicinal application. So the leaves are very commonly chewed by the people in India. It is an important cash crop of Purba Medinipur District of West Bengal, having good demand not only in India but abroad also. Purba Medinipur district ranks first in producing betel leaves in West Bengal. Tamluk subdivision of this district is famous for betel cultivation not only for quantity but also for quality. Among seven blocks of this subdivision Saheed Matangini holds 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. With production, processing, handling, transportation and marketing of betel leaves in different parts of the country, the rural economy of this block was flourished. But now it has lost its glory to other distant blocks such as Nandakumar and Mahisadal (Source: Principal Agricultural Office, Tamluk, Purba Medinipur). According to the local farmers the declining trend was started in the 1990s after the development of coal based power plant (Kolaghat Thermal Power Plant) in this locality and later on aggravated by some other factors [2]. Income from cash crops consists of betel vine, Rose, Jasmine, Tube rose have also been vulnerable to pollution created by fly ash [3]. So in this paper an attempt has been made to find the present status of betel cultivation in this block and to find

out the probable causes for declining trend of betel cultivation. Due to its high energy generation potential, coal is widely used in power generation in different countries. Although, the presence of carbon, hydrogen and sulfur in coal facilitates the energy generation in coal combustion, some pollutants including COx, SOx, NOx, particulate matter(PM)and heavy metals are accumulated in air and water and lead to severe environmental and health impacts as a result of leaching, volatilization, melting, decomposition, oxidation, hydration and other chemical reactions. In addition, fly ash, in both wet and dry forms, is mobilized and induces severe impacts including bone deformities and kidney dysfunction, particularly with exposure of radio nuclides [4]. The emission of these gases has been correlated with many health problems directly and indirectly, including skin, cardio vascular, brain, blood and lung diseases, and different cancers. The CO2emissionfromcoal combustion, during power generation, also leads to the interaction of CO2 with particulate matter (PM 2.5), which thereby changes the air quality and leads to increased asthma attacks and other respiratory and cardio vascular diseases with underlying poor life status. In haling particulate matters may cause some dangerous diseases, including chronic obstructive pulmonary disease (COPD) and lung cancer [5].

Cattle grazing nearby coal-fired power stations are exposed to fly ash. Fly ash consists of finely divided particles with size ranging from 5 to 120 µm. It is composed of oxides of iron, silicon, aluminum, magnesium, calcium, sodium, and potassium. Along with oxide, fly ash also contains toxic elements such as antimony, arsenic, beryllium, cadmium, fluorine, lead, mercury, selenium, thallium, and vanadium. These pollutants are dispersed and transported throughout the region and reach the population through numerous exposure pathways like inhalation, ingestion, and dermal absorption [6]. The majority of the bovine lungs derived from mining and industrial areas was dirty pink in color and mottled with black pigment [7]. Airborne pollution of pasture with heavy metals cause disorders in cattle characterized by poor condition, chronic diarrhea, reduced growth and weight, bilateral per orbital alopecia, multifocal alopecia, excessive lacrimation, and declined fertility [8]. A high concentration of mercury in the soil is observed to be translocated top land subsequently to the grazing cattle. In cattle, absorb mercury is distributed throughout the body and is stored mainly in the liver and kidneys [9]. Human beings are largely dependent upon the animal products such as milk. Therefore, there might be a possibility of high risk involved in consuming the animal products from the cattle exposed to pollutants [10]. In this investigation, domestic animals reared proximity to Kolaghat thermal power plant were studied to analyze the pollution related problem and there indirect effect on the human population.

A social ecology, as a holistic vision, seeks to relate all phenomena to the larger direction of evolution and emergence in the universe as a whole. In its deepest and most authentic sense, a specifically social ecology is the awakening earth community reflecting on itself, uncovering its history, exploring its present predicament, and contemplating its future [11]. The negative impact of KTPS on betel vine ecology is quite profound either on its yield and quality or on economic condition of their growers. Vine ecology is a complex whole, with several actors functioning simultaneously.

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Environmental Impact Assessment systematically examines both beneficial and adverse consequences of the project and ensures that these effects are taken into account during project design. It helps to identify possible environmental effects of the proposed project, proposes measures to mitigate adverse effects and predicts whether there will be significant adverse environmental effects, even after the mitigation is implemented. By considering the environmental effects of the project and their mitigation early in the project planning cycle, environmental assessment has many benefits, such as protection of environment, optimum utilization of resources and saving of time and cost of the project. Properly conducted Environmental Impact Assessment also lessens conflicts by promoting community participation, informing decision makers, and helping lay the base for environmentally sound projects. Benefits of integrating Environmental Impact Assessment have been observed in all stages of a project, from exploration and planning, through construction, operations, decommissioning, and beyond site closure. Kolaghat Thermal Power Station has massive impacts on surrounding areas and in overall environment as well. It

affects Human health, Plant health, Animal health and productivity significantly.fast developing economy like India, measurement of green house gases from the thermal power plants are very much essential in order to find out their values so that necessary policies of reduction of such gases can be formulated [12]. Though electricity has become a necessary service but conventional sources of electricity are jeopardizing natural habitats, flora and fauna, soil and air. Perception, like specific variable of the behavior, is the process by which someone receives, selects, organizes and interprets stimuli from the environment, giving them a meaning. In psychology, perception is a more complex psychological behavior that relates to a particular frame of reference developed in our personal and social boundaries. Meanwhile, there is an urgent need to reconcile development activities with that of environmental concerns for good. Perception Analysis by farmers is one of those several ideas and initiatives taken by researchers and planners to attain above mentioned goal. In this study, the perception of certain (60) farmers are recorded and analyzed on the basis of their knowledge and views about thermal power, environment and about their individual enterprises.

The specific objectives of this study were to elicit the general status of pollution level and perceived impacts on betel vine, cattle and human health. To estimate the impacts level in terms of a set of socio-economic and ecological variables .To estimate the system interactions and estimated outcome based on the selected variables. Based on empirical studies, suggest the remedial and mitigation measures for maintaining sustainability.

2. RESEARCH METHODOLOGY

2.1 Sampling Design

Both Purposive and Simple Random Sampling techniques are followed to collect necessary information from respondents and from different sources as well. In case of selection of State, District, Block and Villages Purposive sampling techniques is followed; where as in selection of 60 respondents, Simple Random Sampling is followed. An exhaustive list of respondents is prepared with help of block officials. From that list, 60 respondents are selected randomly.

2.2 Pilot Study

A Pilot study is conducted in the selected villages before starting actual data collection. In the commencement of this study, an informal discussion was carried out with some farmers, local leaders and extension agents. A brief idea regarding their socialization process, ideas, knowledge, adoption and rejection behavior, discontinuance etc were obtained for construction of reformative working tool.

2.2.1 Variables and their management

It is important for a researcher to point out the behavior of respondents and for this a deep understanding and knowledge of variables are prerequisite. Socio-personal, Agro-Economic, Socio- Psychological and communication variables are such types of variables, which have great impacts on the behavior of the people. Therefore, the selected variables have been operationalised and measured in following manner.

2.2.2 Age (x_1)

In all societies, age is one of the most important determinants of social status and social role of the individual. In the present study, the number of years rounded in the nearest whole number the responded lived since birth at the time of interview, was taken as a measure of age of the farmer.

2.2.3 Education(x_2)

Education may be operationalised as the amount of formal schooling attained/literacy acquired by the responded at the time of interview. Education is instrumental in building personality structure and helps in charging one's behavior in social life.

2.2.4 Family member(x_3)

It represents as the number of members in the individual farmer's family.

2.2.5 Income (x_4)

It shows the total family income an individual farmer in a year (including all sources).

2.2.6 Homestead land(x_5)

It shows the researcher the size of the land occupied by the household of individual farmer.

2.2.7 Total land(x_6)

It represents the size of lands that are under cultivation. It is either owned or leased land.

2.2.8 Land under boroj (x_7)

It is the total area of land which is brought under betel cultivation.

2.2.9 Input cost(x_8)

It is the amount of expenses that is required for crop production as input materials. It includes cost of planting material, manures and fertilizers, plant protection equipment, marketing and transport cost and labour wages etc.

2.2.10 Livestock number(x_9)

It is the total number of livestock, an individual farmer poses. It includes Cattles, Poultry birds, Swine etc.

2.2.11 Distance of villages from thermal plant(x_{10})

It represents the distance of each selected village from kolaghat thermal power plant. This variable is taken under consideration to understand if distance affects the impacts of kolaghat thermal power plant.

2.2.12 Perceived impacts of KTPS on betel vine (y_2)

It has also been witnessed that a functioning thermal power has a long lasting negative effect on surrounding crops. In this case special emphasis has been given on betel vine cultivation in nearby area of kolaghat thermal power plant. The impacts are measured on 10 scales through matrix ranking.

2.2.13 Pre-testing of interview schedule

Pretesting of interview schedule is done to detect the discrepancies that have emerged and to modify or remove these in interview schedule. Pre testing is also done to understand if the set questionnaire is competent enough to make the respondents answer the questions properly and objectively. After pre testing is done, the respondents who are being interviewed are excluded in final sample selection.

2.2.14 Method of final or field data collection

The respondents are personally interviewed. To get satisfactory answer local dialect, Bengali is used. The recent situation of COVID-19 pandemic within India hampers the conducted study as well as the plan of work. In spite of that the researcher tried his best to make this study successful.

3. RESULTS AND DISCUSSION

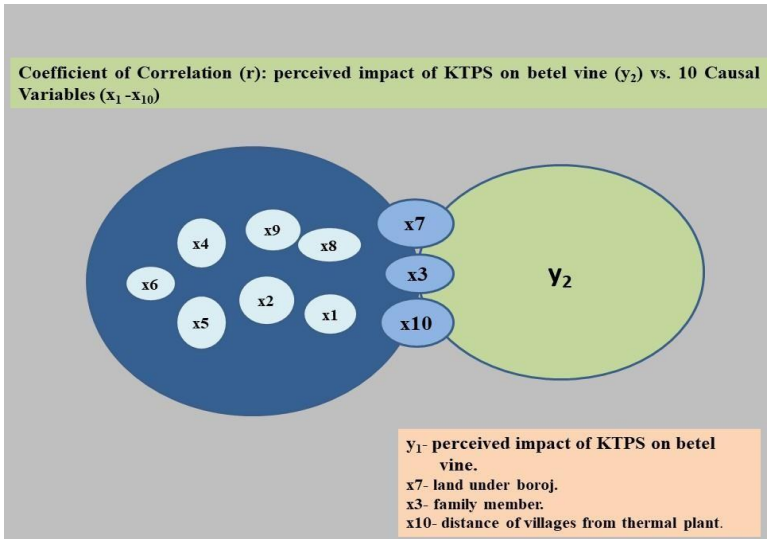
3.1 Coefficient of Correlation(r): Perceived Impacts of Kolaghat Thermal Power Plant on Betel Vine (y_2) vs.10 Independent Variable

It has been found that the variable land under boroj (x_7) has been recorded significant and positive correlation, while two other variables; family member (x_3) and distance of villages from thermal plant (x_{10}), have been recorded significant but negative correlation with the dependent variable, perceived impacts of Kolaghat thermal power plant on betel vine (y_2). The coefficient of correlation between land under boroj (x_7) and perceived impacts of Kolaghat thermal power plant on betel vine (y_2) signifies that when the area under boroj is higher, the impacts will be higher. This is because when the land is relatively large, it receives more fly ash generated from Kolaghat thermal power plant.

The coefficient of correlation between family member (x_3) and perceived impacts of Kolaghat thermal power plant on betel vine (y_2) shows that where the size of family is relatively small, the impacts of Kolaghat thermal power plant are high. Since the family size is small, the used to enjoy higher income per capita from betel vine. Any kind of negative impacts on betel cultivation has affected their economic status and motivation. So, it is to conclude that, the smaller is the family, the larger has been the impacts.

3.2 Multiple Regression Analysis: Perceived Impacts of Kolaghat Thermal Power Plant on Betel Vine (y_2) Vs. 10 Causal Variables(x_1-x_{10})

The full model regression analysis depicts that, with the combination of 10 causal variables (x_1-x_{10}), 87.60 per cent of variant embedded in the consequent variable perceived impacts of Kolaghat thermal power plant on betel vine ($_{y2}$). This is a substantive proportion of variant which has been explained with 10 causal variables (x_1-x_{10}).

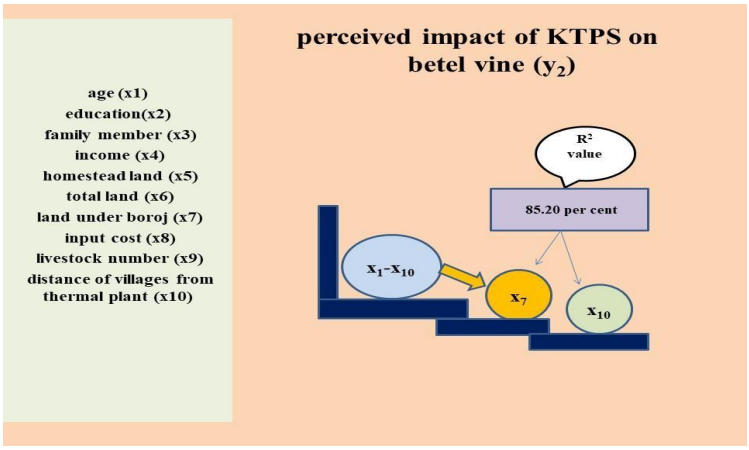


Model 1. Coefficient of Correlation(r): perceived impacts of KTPS on betel vine (y_2) vs.10 independent variable

Table 1. Multiple Regression Analysis: Perceived impacts of Kolaghat thermal power plant on betel vine (y_2) Vs. 10 Causal Variables(x_1-x_{10})

Sl. No	Variables	Reg. Coef. B	S.E. B	Beta	t Value
1	age (x_1)	.008	.006	.075	1.309
2	education (x_2)	-.004	.024	-.011	-.183
3	family member (x_3)	-.047	.055	-.063	-.865
4	income (x_4)	.000	.000	.020	.337
5	homestead land (x_5)	-.969	.820	-.068	-1.182
6	total land (x_6)	.143	.072	.201	1.995
7	land under boroj (x_7)	.354	.078	.322	4.529
8	input cost (x_8)	.000	.000	-.143	-1.417
9	livestock number (x_9)	.008	.034	.012	.218
10.	distance of villages from thermal plant (x_{10})	-.234	.027	-.650	-8.620

R square: 87.60 per cent. The standard error of the estimate: 0.48873



Model 2. Stepwise Regression Analysis: perceived impacts of Kolghat thermal power plant on betel vine (y2) Vs. 10 Causal Variables(x1-x10)

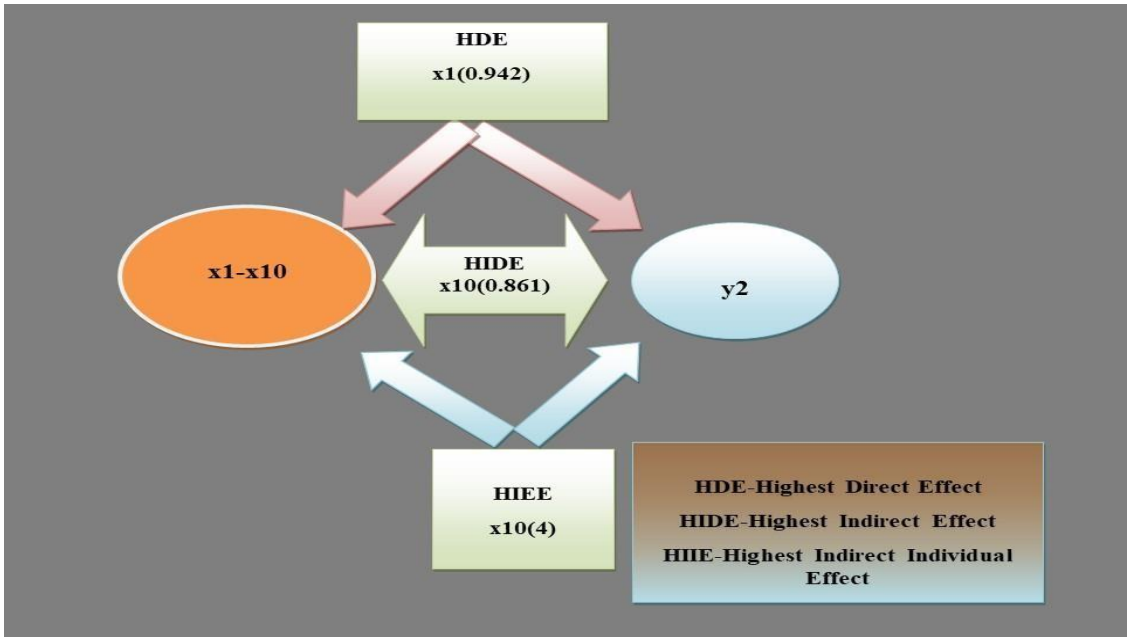
3.3 Stepwise Regression Analysis: Perceived Impacts of Kolaghat Thermal Power Plant on Betel Vine (y2) Vs. 10 Causal Variables(x1-x10)

It has been found that, 2 causal variables viz. land under boroj (x_7) and distance of villages from thermal plant (x10) have been retained at the last step and has contributed 85.20 per cent of the total variable explained .Which imply, these 2 variables are functionally most significant.

Farmers whose borojs are away, are relatively safer than, those borojs which are near to Kolaghat thermal power plant. Also the negative impacts of Kolaghat thermal power plant are relatively less to them. Those farmers who have higher area of land under betel cultivation are much likely to be affected by fly ash accumulation on their borojs as well on betel leaves. Means wider the area, wider will be the sink. The 2 causal variables here, land under boroj(x_7) and distance of villages from thermal plant(x_{10}) have together contributed 85.20 per cent of variate. So it can be concluded that these 2 variables have contributed more than 97 per cent of total variate 87.60 per cent. So these 2 variables got significant importance strategically.

3.4 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect; Perceived Impacts of Kolaghat Thermal Power Plant on Betel Vine (y_2) Vs. 10 Exogenous Variables(x_1-x_{10})

It has been found that age(x_1) recorded here has the highest substantive effect and distance of villages from thermal plant(x_{10}) has the highest indirect effect. This implies that higher the age of a person (respondent), better would be the perception. They have been observing the impacts of Kolaghat thermal power plant over a longer period and at the same time; distance of villages (borojs) from Kolaghat thermal power plant has shown an inverse relationship with its impacts, means more the distance, less will be the impacts. Particulate matters, aerosols, fly ashes are carried away by wind, the speed and direction of wind is responsible for carrying these things to nearby fields to make more unsuitable for betel cultivation. The residual effect being 0.123 means it is to conclude that only 12.30 per cent of variant in perceived impacts of Kolaghat thermal power plant on betel vine (y_2) can't be explained with the combination of 10 exogenous variables(x_1-x_{10}).



Model 3. Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect; Perceived impacts of Kolaghat thermal power plant on betel vine (y_2) Vs. 10 Exogenous Variables(x_1-x_{10})

4. CONCLUSION

The whole planet is facing ecological disaster. According to some Environmental scientists, the covid-19 pandemic can be correlated with these ecological disaster and environmental degradation. The worst recipients of pollutants in any form on human health, agriculture and livestock health, brings serious long span persistent effect upon them. Since the establishment of Kolaghat thermal power plant (1984), it has been generating electricity which is appreciated at the national level and at the same time, it went on polluting the environment and local ecosystems. From this empirical study, it has been found to be concluded that the common perception among the betel growers is that the Kolaghat thermal power plant produces huge amount of flu ash which reduces their level of income on betel vine. Thick layer of fly ash reduces the quality of leaves and bronzing occurred which affect production. It affects betel vine borojes. It is found from the result that villages which are nearly placed at Kolaghat thermal power plant side are mostly affected. The surrounding water sources are contaminated, the agricultural products are affected and productivity has also been negatively impacted. This study reveals that some selected socio-ecological and economic factor have caused the ecological fallout.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lazaroiu G, Mihaescu L, Negreanu G, Pana C, Pisa I, Cernat A, Ciupageanu DA. Experimental investigations of innovative biomass energy harnessing solutions. Multidisciplinary digital publishing institute. 2018;11(12):3469. Available:https://doi.org/10.3390/en11123469
2. Mandal S. Effect of Coal Based Power Plant on Betel Cultivation. International Journal of Multidisciplinary Research and Development. 2014;1(3):33–36.
3. Biswas A, Acharya SK, Burman S, Chakraborty A. Rapid Environmental Impact Assessment (REIA): the Perception and Impact of Thermal Power on the Social Ecology of Kolaghat, West Bengal. Journal of Energy Research and Environmental Technology (JERET). 2018;5(2):38–41.
4. Munawer ME. Human health and environmental impacts of coal combustion and post-combustion wastes. Journal of Sustainable Mining. 2018;17(2):87–96.
5. Cornell, Kayhla. Climate change and infectious disease patterns in the United States: Public health preparation and ecological restoration as a matter of justice; 2016.
6. Sepulveda A, Schluep M, Renaud FG, Streicher M, Kuehr R, Hagelüken C, Gerecke A. CA review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during

recycling: Examples from China and India. Environmental Impact Assessment Review. 2010;30:28–41.
7. Dogra RKS, Shanker R, Saxena AK, Khanna S, Srivastava SN, Shukla LJ, Zaidi SH. Air pollution: Significance of pulmonary dust deposits in bovine species. Environmental Pollution Series A, Ecological and Biological. 1984;36:109–120.
8. Swarup D, Dwivedi SK. Environmental pollution and effects of lead and fluoride on animal health (1st edition).New Delhi: ICAR; 2002.
9. Sharma MC, Kumar M, Sharma RD. Textbook of Clinical Veterinary Medicine. Edition 1, ICAR, New Delhi; 2009.
10. Mahajan VE, Yadav RR, Dakshinkar NP, Dhoot VM, Bhojane GR, Naik MK, Shrivastava P, Naoghare PK, Krishnamurthi K. Influence of mercury from fly ash on cattle reared nearby thermal power plant. Environmental Monitoring and Assessment. 2012;184(12):7365–7372.
11. Clark John. A social ecology, Capitalism Nature Socialism.1997;8(3):3-33.
12. Chakraborty N, Mukherjee I, Santra AK, Chowdhury S, Chakraborty S, Bhattacharya S, Mitra AP, Sharma C. Measurement of CO2, CO, SO2, and NO emissions from coal-based thermal power plants in India. Atmospheric Environment. 2008;42:1073-1082.

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