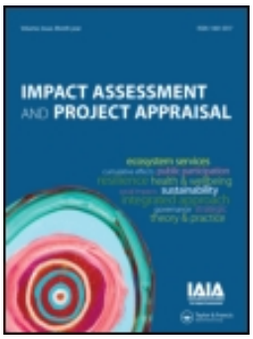

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PROFESSIONAL PRACTICE PAPER

Health impact assessment of a biomass power plant using local perceptions: cases studies from Thailand

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Operation of small-scale biomass power plants might cause some health impacts. This research aimed to assess physical, mental and social health impacts using public perceptions. Data were collected using a questionnaire interview and focus-group discussion. Two rice-husk power plants were selected for study cases. Three hundred and ninety local people were interviewed using a questionnaire and 45 community representatives participated in 6 focus-group discussions. From this survey, the top three health impacts based on public perception were frustration with having to clean their houses often because of dust from the power plant, the power plant increased local air pollution and air pollutants from the power plant irritated the respiratory system. Only half of the respondents believed that the power plant affected the community economically and increased their family income. In conclusion, operation of biomass power plants may cause health impacts to nearby residents. Further study to objectively quantify the impacts is recommended.

Keywords: health; health impact assessment; HIA; biomass; power plant

Biomass power plants are increasing throughout the world. It was estimated that the world's installed capacities of power plants will increase from 37.5 GWel at present to 55 GWel in 2020 (Ecoprog 2013). The situation is supported by the progression of biomass conversion technology with high efficiency at lower costs, marketing of alternatives, nonfood crops and global warming concerns (McKendry 2002). Biomass is a renewable energy that contributes no net carbon dioxide to the atmosphere (Gustavsson et al. 1995). Burning biomass for energy can also minimize air pollution from open burning of solid waste and agriculture residue (Gadde et al. 2009).

However, this bioenergy policy cannot continue without concern because the operation of biomass power plants involves various health hazards. Burning a large amount of biomass fuel will generate smoke that contains fine particulate matter, oxides of nitrogen and carbon monoxide, and other toxic compounds (Naeher et al. 2007). In an indoor setting, exposure to biomass smoke is associated with acute respiratory infections, chronic obstructive pulmonary disease (COPD), tuberculosis, lung cancer and premature death (Naeher et al. 2007; Torres-Duque et al. 2008). Ambient exposure also linked PM10 from biomass smoke to asthma (Boman et al. 2003) and COPD (Gan et al. 2013). Other activities might also cause health impacts. A report conducted by IOM (2008) on the health impact of the Rose Energy biomass power plant project identified five negative health impacts, including physical injury effects of power plants on workers; mental health and well-being effects caused by worry; concern and anxiety generated by the proposed power plants; transport and connectivity effects from the movement of the waste lorries and the increased risks of road traffic injuries; lifestyle and daily routine effects from nuisance effects from traffic, noise and dust; and land and spatial effects from the visually unattractive development site along with compacting the land around the proposed site.

Health impact assessment (HIA) is a structured method for assessing and improving the health consequences of projects and policies in the non-health sector (Lock 2000). It was defined as 'A combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population' (WHO Regional Office for Europe 1999). This tool is widely supported by the major international institutions because it enhances recognition of societal determinants of health, engages all stakeholders in structured discussions, encourages interdisciplinary work, aids the further development of human rights impact assessment, and increases awareness of the need for transparency and accountability in the policy-making process (Krieger et al. 2003). HIA also takes qualitative data of public opinion and concerns into account for a broader and more complete view of health impacts (Morgan 2003; Wright et al. 2005). Even though HIA should be conducted in prospective timing to influence current decision-making, a retrospective HIA is also useful for evaluation and learning purposes. This study was part of an overall HIA of biomass power plants supported by Ministry of Public Health Thailand. The objective of this study was to assess health impacts of biomass power plants using local perceptions on health issues.

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Methods

Study areas

Two small rice husk power plants were purposively selected as case studies based on the history of public complaints and the number of nearby residents needed for research study.

Plant I is a 6-MW power plant using a steam turbine system. The flue gas cleaning device is a wet scrubber. The company started with a rice mill business about 30 years ago, and 2 years ago, it expanded to a power-generation business. Plant I is in a small rural community about 50 km from the nearest province. At present, there is a population of 1354, 83.7% of whom finished grade 4 or did not attend school; most people are farmers and merchants. The community uses a water-constructed canal for agriculture. Tap water using an underground water source is the main water supply for household use.

Plant II is a 1-MW power plant using gasification and an internal combustion engine. It is located in a municipal area of a small town in lower northern Thailand. The company began with a rice mill business about 50 years ago, and about 5 years ago, a power-generation unit was added to the facility. Population growth put the plant in the center of the community surrounded with houses, a temple and other public facilities. Based on local statistics, there are 1264 people in the community, more than 50% of whom attended school for 4 years or less; a majority of them are hired as workers and merchants. The community is located on the side of a big river. Water for household utilization comes mainly from the municipal tap water system.

Study subjects

For the questionnaire survey, all households located within 2 km of the two power plants were the target population. Village health volunteers visited each household and interviewed the first eligible individual they met: adults aged >15 years. In each household, only one adult was interviewed. From 410 questionnaires distributed through 41 village health volunteers, 19 from plant I and 22 from plant II, 392 were returned with complete information, 181 from plant I and 211 from plant II, and were used for data analysis. To protect the study subjects, their names and addresses were not recorded. The subjects received no incentive to join the study.

Focus-group discussion aimed to elicit health impacts. Community representatives, village health volunteers and representatives of the local authorities, temple authorities, schools and local health services were invited to join the discussions. A total of 45 people participated in 6 focus-group sessions, 3 in each area. Each session was facilitated by the research team. Data were short-noted and tape-recorded.

Questionnaire

A questionnaire was designed using a broad definition of health that covers not only physical health but also mental, social and spiritual health (WHO 1946). In this study, physical health effects refer to the effects on the physical body caused by air pollutants, noise and road accidents; mental health effects are stress, concern, or fear related to or caused by power plant activities; and social health effects are the effects on community coherence and peacefulness and economic change in both negative and positive aspects. There were a total of 21 questions, 7 in each of the 3 aspects. All of the questions were written in a negative statement, except the two questions on economic impacts. In each question, the subject was asked whether they agreed with the statement that said biomass power plants caused the specific health impact.

Results

Characteristics of the respondents are presented in Table 1. Most of them were elderly (mean age = 52.8 year) with males and females in equal numbers. Almost two-thirds finished only grade 6 or primary school. The top three occupations were hired workers, merchants and farmers. Most of them were local people and had lived in the area for more than 20 years. There were 143 people (~35%) living within 0.5 km of the power plants.

Physical health

Table 2 shows the issues of physical, mental and social health impacts and the number of respondents who agreed

Table 1. Characteristics of respondents.

Characteristic	Number (n = 392)	Percentage
Sex		
Male	188	48.0
Female	204	52.0
Age (mean = 52.8, min–max = 15–87)		
≤ 30 years	38	9.7
31–40 years	42	10.7
41–50 years	93	23.7
51–60 years	92	23.5
≥ 61 years	127	32.4
Education		
Never attended school	50	12.8
Grade 1–6	251	64.0
Grade 7–12	62	15.8
Undergraduate or higher	29	7.4
Occupation		
Hired worker	173	44.1
Merchant	76	19.4
Farmer	62	15.8
Governmental service	13	3.3
Housewife	24	6.1
Other (unemployed, monk, not specific)	53	13.5
Length of residence		
≤ 20 years	89	22.7
21–40 years	167	42.6
≥ 41	136	34.6
Distance from power plant		
≤ 100 m	30	7.7
100–499 m	113	28.8
500 m–1.0 km	100	25.5
1.0–2.0 km	149	38.0

Table 2. Issues of health impacts and the number of people who agree.

Health impacts	Number who agree (person)	Percentage
Physical health		
The power plant causes air pollution	315	80.8
Dust from the power plant irritates the respiratory system	275	70.5
The power plant causes noise pollution	271	69.5
Dust from the power plant causes eye irritation	256	65.5
Dust from the power plant causes skin irritation	253	64.7
The power plant increases the risk of road accidents	224	57.1
Immigrant workers increase the risk of communicable diseases	205	52.3
Mental health		
Dust from power plant makes you feel frustrated with cleaning your house	321	81.9
The power plant makes you feel worried about fires and explosions	247	63.0
Noise from power plant bothers you	245	62.5
The power plant makes you feel worried that the local water resource will be polluted	243	62.0
The power plant makes you feel worried about chemical hazards	238	60.7
Having immigrant workers in the community makes you feel insecure and not safe	237	60.6
The smell from the power plant makes you feel irritable	215	54.8
Social health		
The power plant causes conflict between those who agree and disagree with the project	245	63.0
The power plant damages the road	245	62.8
The power plant affects water resource usage	198	50.9
Pollution from the power plant lowers the value of agricultural products	190	48.8
The immigrants who come to work in the power plant cause criminal and social problems	182	46.8
Positive impact		
The power plant promotes community economics	202	51.2
The power plant increases your household income	202	51.2

with each statement. For physical health, the issues which received the highest number of votes were ‘power plant causes air pollution in the community’ with 80.8% of the respondents agreeing: ‘dust from the power plant irritates the respiratory system’ (70.5%) and ‘the power plant causes noise pollution’ (69.5%). The other impacts were related to eye and skin irritation, increased risk of car accidents and increased risk of communicable diseases from the immigrant workers.

From the focus-group discussion, the participants highlighted that the power plants were a major source of local air pollution. Participants confirmed that they saw black smoke coming out of the smoke stack. They believed that the dust was dangerous to the respiratory airway and skin, especially for young children. The dust also irritated the eyes and made motorcycle riding difficult and unsafe.

> The power plant emits a lot of black smoke, especially during the night.
>
> The dust is black; it is from the burning of rice husks. If inhaled, it will irritate the nose and throat.
>
> Riding a motorcycle is dangerous. The dust will go into your eyes; it will severely irritate the eyes.
>
> Children, ages 2–3, often had skin rashes, especially those living close to the power plant.
>
> In the community, many people had allergies.

Mental health

For mental health, the problem that received the highest number of votes was ‘dust from the power plant makes people frustrated with having to clean their houses’ with 81.9% of the respondents agreeing (Table 2). The next issues were ‘the power plant made them feel worried about fires and explosions’ (63.0%) and ‘noise from the power plant disturbs them’ (62.5%). The other problems were related to concerns about contamination of local water resources and feeling insecure and unsafe by having immigrant workers in the community.

From group interviews, the participants reconfirmed that their mental health was poor. The pollution from the power plant made them feel stressed and often their normal life was interfered with. The groups reported that dust from the power plant dirtied their houses, clothes and other belongings. This dust also caused a bad smell.

> Our mental health is very poor, and we feel stressed. Many people complain about this, but we don’t know what to do. Some want to move away from the village.
>
> While eating, sometimes dust with a smell comes, and it causes a headache and nausea.
>
> There is a lot of dust; we have to clean the house often; and clothes cannot be dried outdoors.
>
> Our food, if not covered, cannot be eaten because of ash from the power plant.
>
> The temple is also affected; there is a lot of black dust in the temple as well.
>
> It smells like rotting rice husks, sometimes like rotting rice. The intensity of the smell depends on the direction of the wind.

Social health

For social health impacts, the highest recognition was that 'the power plant causes conflict between the supporting group and those who oppose the project' (63.0%) and 'the power plant causes damage to the road' (62.8%). Some also agree that the power plant introduces a criminal and social problem. For the economic aspect, about half believed that the power plant has brought a positive impact to their households and the community. However, many disagreed and supported the negative notions that it causes damage to the road and limits water resource usage. Thus, it decreases the agriculture product value (Table 2).

The focus-group discussion added more information about the problems. The participants highlighted the fact that only a small number of local people were hired. The power plant prefers immigrant workers because they are willing to accept all kinds of jobs with lower wages.

> The community economy is better, but only those who live close to the power plant can get a job.

> The power plant hires immigrant worker, most of whom are Burmese.

For negative impacts, they believed that pollution from the power plant interferes with vegetable and fruit growth. The participants also highlighted the problem of water contamination and water resource usage.

> Papaya trees have no fruit and the leaves are deformed. It is not easy to grow like before.

> Waste water is a big issue; runoff from the power plant contaminates the nearby land and water source. Recently, many fish and turtles of the temple died.

Discussion

Based on public perception, biomass power plants caused physical, mental and social health impacts on the local community. The majority of physical and mental impacts were associated with particles and noise. Aerosols might come from the biomass burning process and fuel transportation and waste handling (TEEIC 2012). The particles can cause respiratory disease and irritate airway systems and skin (Kayaba et al. 2004; Naeher et al. 2007; Torres-Duque et al. 2008). Power plants could generate noise by various activities and sources, including noise from preparation and transportation of fuel, noise from machine operation and trucks, noise from the boiler system and turbines and noise from the system cleaning process (TEEIC 2012). Literature review supported that environmental noise exposure affects mental health (Passchier-Vermeer & Passchier 2000; Stansfeld et al. 2000).

Increased risk of road accidents was another physical health impact perceived by local residents. Movement of big trucks to transport rice husks and rice ash is expected for this type of industry and this, without proper control, will increase road traffic, car accidents and road destruction. The public also recognized the problem of having immigrant workers in their community and the risk for communicable diseases. The study found that these groups of workers harbor some communicable diseases (Krairittichai et al. 2012). The participants also recognized social problems and felt unsafe when having immigrant workers in their community.

The social health impact was not reported much by the study groups, either by questionnaire survey or focus-group discussion. The problem that received the highest attention was conflict among those supporting and those opposing biomass projects. This kind of problem often occurs in a situation when the decision was made without public involvement. Currently, biomass power plants smaller than 10 MW are not under the Thailand environmental law, thus it is likely that the project can go on without community consultation (Juntarawijit & Juntarawijit 2012).

For economic issues, positive and negative impacts were recognized by the study group. Although often used to support the biomass power project, positive impacts received votes from only about half of the respondents while about the same number agreed with the negative impacts, i.e. damaging local roads, polluting water resources and decreasing agriculture product value.

This research may have some limitations. First, the methodology to assess the health impacts was subjective, and the data might be criticized for its accuracy. However, in this study, two different approaches, questionnaire survey and focus-group discussion, were used to collect data. Moreover, the results were congruent with toxicity data of pollutants from biomass power plants and supported by studies found in the published literature. Another problem was bias or prejudice of study subjects to the industry. To minimize the problem, we selected the case study without conflict at present. Also, the data were collected from a large number and different groups of people. This study cannot be generalized and must be used with caution. The impact of biomass power plants depends on various factors, such as fuel type, power-generation system, system operation and maintenance, and plant location. It may only represent the health impact of a small-sized power plant using rice husks as fuel operated without formal environmental and health impact law regulations. Further study to objectively quantify the impacts is recommended.

Conclusion

Subjects living within 2 km of the two biomass power plants perceived either physical, mental, or social health impacts. The problems which received the highest recognition were feeling frustrated with cleaning the house often because of dust from power plants, the power plant causes air pollution and dust from the power plants irritates the respiratory system. For social health, the major problem was conflict among those supporting and those opposing the projects. Economic impact was viewed differently and both positive and negative opinions received equal votes. This study presented a case study of retrospective HIA using public perception. The results can be used to initiate an in-depth quantitative study.

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