CONTRIBUTING FACTORS AND IMPACTS OF OPEN BURNING IN THAILAND: PERSPECTIVES FROM FARMERS IN CHIANG RAI PROVINCE, THAILAND

Adelowo Adeleke[1], Tawatchai Apidechkul[1, 2, *], Phitsanuruk Kanthawee[1], Yanasinee Suma[1, 2], Pilasinee Wongnuch[1, 2]

[1] School of Health Science, Mae Fah Luang University, Chiang Rai, 57100, Thailand
[2] Center of Excellence for the Hill-tribe Health Research, Mae Fah Luang University, Chiang Rai, 57100, Thailand

ABSTRACT:

Background: Open burning is a major cause of air pollution resulting in several public health problems and death. It is a source of haze smoke in northern Thailand**.** There is a general perception that highland minorities are the major contributors to open burning in Northern Thailand**.** Therefore, this study aimed to investigate perspective on factors contributing to open burning behavior among farmers and impacts of open burning in Northern Thailand**.**

Methods: A qualitative study was carried out through in-depth interview and focus group discussions to find out the perspectives of farmers on factors contributing to open burning behavior and the impacts in northern Thailand. In-depth interview was conducted twice with 6 participants. Focus group was conducted four times with 42 participants including hill tribe and Thai farmers at hill tribe and Thai villages in Chiang Rai province.

Results: Factors like environmental health literacy, finance, culture and large scale farming, contribute to open burning behavior among farmers in northern Thailand. The rules against open burning of farm residues have not been fully effective. Open burning is still allowed; the only difference is time allowed to burn residues, especially in the highland areas.

Conclusion: Regardless of policies and efforts towards resolving the challenge of open burning, compared to previous years, open burning is on the increase, particularly in forested areas. Previous approaches towards tackling the issue have been viewed to be top-down. In light of this, a review of present policies, and making policies more all-inclusive, will provide new and perhaps more effective ways of managing the challenge of open burning.

Keywords: Open burning; Thai farmers; Highland minorities; Thailand

DOI: *Received: June 2016; Accepted: September 2016*

INTRODUCTION

Air pollution arising from various sources including open burning is recognized by public health as an important determinant of health [1]. Open burning is the single largest source of black carbon globally, at 42% dwarfing all other sources [2]. Globally, 3.7 million deaths were attributed to ambient air pollution in 2012. At 88.0%, low and middle income countries had the highest number of deaths. In a regional breakdown, it was found that the Western Pacific Region had the highest number of deaths (1,670,000) while the Southeast Asian Regions was second highest with 936,000 deaths [1]. The human respiratory system has a way of protecting against air pollution. However, prolonged or acute exposures to air pollutants can over load or breakdown these natural defenses [3]. Studies show that the contamination of air quality increases adverse health impacts [4]. Health problems such as

[*] *Correspondence to: Tawatchai Apidechkul*
E-mail: Tk2516ms@gmail.com

Cite this article as: Adeleke A, Apidechkul T, Kanthawee P, Suma Y, Wongnuch P. Contributing factors and impacts of open burning in Thailand: perspectives from farmers in Chiang Rai province, Thailand. J Health Res. 2017; 31(2): 159-67. DOI:

Chronic Obstructive Pulmonary Disease (COPD), asthma, lung cancer, and cardio and cerebra-vascular conditions were linked to air pollution [1, 5, 6]. Poor people, children and the elderly are the most susceptible group [1].

Smoke from field clearing fires in South East Asian countries has continue to cause hazardous haze pollution in South East Asia every year [7]. In June 2013, South East Asia was said to have faced a serious cloud of record-breaking haze pollution which impacted human health [7]. Open burning is one of the major sources of air pollution in Thailand [8]. According to Cuyahoga Falls Fire Department [9], open burning is defined as "any outdoor fire that does not burn within a container equipped with a chimney or stack". Open burning in agricultural settings and forest fires were identified as the sources of haze smoke, which are fueled by dry weather and high air pressure in northern Thailand [10].

Open burning is a common method of managing rice residue and control of weeds in Thailand. In Thailand, there was report of high level of particulate matter resulting from burning activities in 2010 [11]. In March 2016, Mae Sai District of Chiang Rai Province had a record 410 micrograms per cubic metre (u/cg) of harmful air particles. Smoke from open burning of fields is a leading cause of smog crisis in northern Thailand from January to April [12]. It impacts socio-economic development, tourism and public health and causes a disturbance to the daily life of the population in the region [13].

The research aims to investigate perspective on factors contributing to open burning behavior among farmers and impacts of open burning in northern Thailand by qualitative method. Previous studies identified farmers as the major participants in open burning activities in northern Thailand [11, 13]. The highland minorities are people that migrated from Southern China to northern Thailand many centuries ago. They have their own languages and they are mostly farmers [14]. There is a general perception that the highland minorities are the major contributors to open burning in northern Thailand [15].

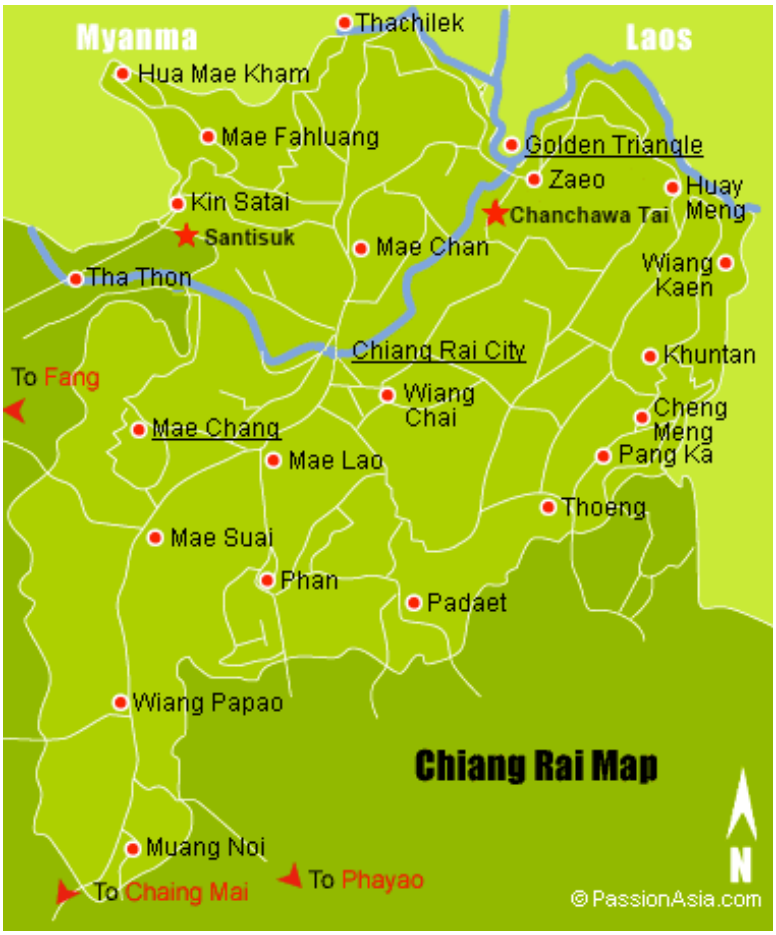

Figure 1 A map of Chiang Rai Province indicating the study area- Mae Chan. Source: The map was adapted from www.passionasia.com

METHODS

The qualitative method was used to elicit key information regarding the perspectives of contributing factors and impacts of burning in Northern Thailand by focus group discussion and in-depth interview with community leaders and public health officers.

The study took place at Thai and highland minorities villages in Mae Chan district which was identified as a hotspot area [13]. The study population consisted of local Thais as well as Ahka and Lahu [16] ethnic minorities who have been working as farmers for a period of at least three years. In addition, the ethnic minorities should permanently reside in Thailand, Figure 1.

Samples were recruited from farmers who have been in the villages for a long time and those who were willing to participate in the group discussion through the staff at the local health promoting hospital and the community leaders who are farmers themselves. Thai language proficiency was not an exclusion criterion as local language was also used in the process of data gathering. Totally, 48 participants were recruited for the study, including 3 community leaders, 3 public health officers and 42 local famers at both study areas. 12 farmers, 2 community leaders and 2 public health officers were recruited for the study at Chan Chawa Tai village. While 12 farmers, 1 community leader and 1 public health officer were initially recruited for the study at San Ti Suk village. But after reviewing the information obtained from the San Ti Suk study area, it was found that the information gathered was not saturated; as a result, two more focus groups were held in the area (at the San Ti Suk Health Promoting Hospital) with 18 participants in order to get more information.

After review of relevant literature, the guideline questions were developed and validated by three external experts before the main study. Focus group questions were divided into two sections. The first section contained questions pertaining to demographic information of participants. The other section consisted four parts with questions regarding farmers' perspectives on contributing factors and impacts of open burning, and questions on environmental health literacy with a little modification of the environmental health engagement profile [17].

Below is a summary of the other four parts:

Part 1: This part consisted of four questions regarding participants' level of pollution sensitivity and their knowledge of the association between pollution and illness, for example, what environmental problems exist in your community? What are the noticeable physical health problems?

Part 2: This part consisted of five questions regarding personal environmental action, for example, do you help yourself and others to reduce harm from air pollution in your community? How do you protect yourself during the smoke haze period?

Part 3: There were five questions in this part regarding participants' community environmental action, for example, what do you do with other members of your community to reduce environmental health problems in your community?

Part 4: There were six questions in the last part regarding other factors related to open burning, for example, what is the role of gender, religion, culture and finance when we talk about open burning?

Prior to the commencement of the focus groups, appointments were made with the staff at the Health Promoting hospitals at highland minorities and Thai villages where the focus groups took place. In-depth interviews were conducted first with public health officials and the community leaders to get some information which were used to develop questions for the focus group discussion. A total number of 3 public health officers and 3 community leaders were recruited from both study areas. Before information was gathered, participants indicated interest and also signed the consent form.

The first in-depth interview session which lasted for about one hour took place in January, 2016 at Chan Chawa Tai village in Mae Chan district, Chiang Rai Province with 2 public health officers and 2 community leaders. After that, 12 farmers, including 6 males and 6 females participated in focus group discussion which lasted for about one hour. The second in-depth interview session took place in February, 2016 at San Ti Suk village, Chiang Rai Province with 1 community leader and 1 public health officer. It lasted for one hour. Later on 12 farmers, 6 (3 males and 3 females) from Lahu tribe, and 6 (3 males and 3 females) from Ahka tribe were recruited for the focus group discussion which also lasted for one hour. The last two sessions took place on the same day in May, 2016 at San Ti Suk village with 18 participants (5 females, 5 males from Ahka tribe, and 8 females from Lahu tribe). Both sessions lasted for one hour.

Thai, Lahu and Ahka languages were used to elicit information. Audio recordings were transcribed into Thai by a Thai research assistant

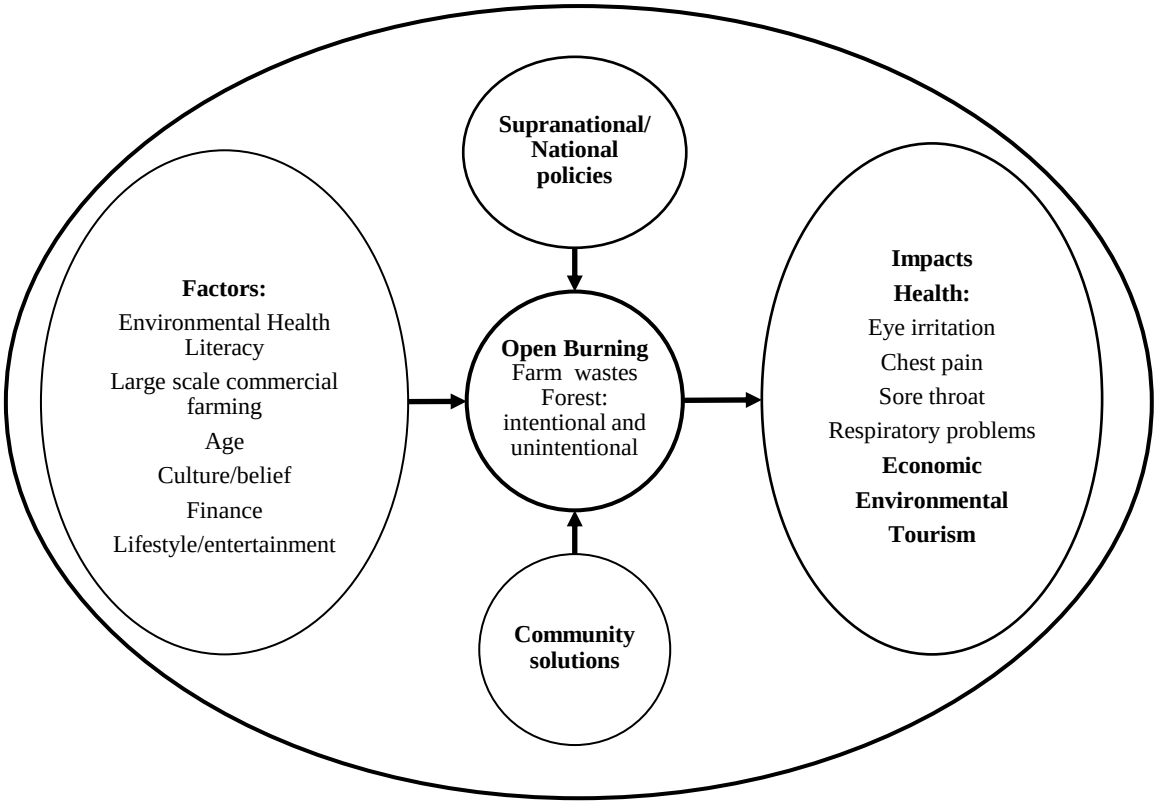

Figure 2 Highland minority famers' and Thai farmers' perspectives on contributing factors and impacts of open burning in Northern Thailand.

and further translated from Thai to English after which results were analyzed through content analysis.

Ethical considerations

This study was approved by The Mae Fah Luang University Research Ethics Committee on Human Research, Based on The Declaration of Helsinki (No.REH-58085). Before the commencement of focus group discussions, the participants indicated their interest and also signed the consent form. Participants were given a token for participating in the research.

RESULTS

From the results obtained, the following are the factors contributing to open burning behavior among farmers in Chiang Rai province (Figure 2).

Environmental health literacy

(a) Pollution sensitivity and pollution-causes illness

Most participants acknowledged the existence of environmental health problems in their community. According to a majority of them, there is air pollution in the community from March to April. One participant mentioned that air pollution comes from neighboring Laos and Myanmar. Whenever individuals burn wastes in those countries, smog flows across to Thailand and causes eye irritation. Two highland minority farmers reported change in environmental conditions in the month of April. According to one of them,

> *"Around April, I usually have eye irritation."*

The other participant said her eyes get sore and she feels uncomfortable while breathing. At this point, almost all the participants said they also experience similar symptoms (itchy eyes, breathing problems and sore throat). A participant reported that symptoms are related to smog, without it she feels healthy:

> *"When I drive a vehicle outdoor or when I go to the rice field, the symptoms will start to occur."*

Some highland minority participants reported that the issue of smoke is an important one. According to them, it is dangerous and problematic because it makes individuals sick, causes eye

irritation, suffocation and cough. Compared to the past (5-10 years ago), symptoms have worsened, thanks to increase in burning activities, particularly forest fires.

Opinions differed on those mostly affected by the problem. Some participants reported that villagers and unskilled workers are mostly affected; generally, people who work outdoors. Those who work in offices are less affected because they work indoor with air conditioners. Some other participants reported that sick people are mostly affected. The public health officer reported a higher number of patients at the community hospital during this period. Elders are mostly affected especially those with asthma and Chronic Obstructive Pulmonary Disease (COPD). Symptoms are more serious in sick people. Those with chronic diseases become easily tired and cannot breathe to reach their lung's full capacity. The community leader at the highland minorities' village reported that people with chronic diseases are the worst hit, while some participants mentioned that elders and children are mostly affected, as adults are stronger and better equipped to cope with it.

(b) Personal environmental action

In order to protect themselves from air pollution, participants reported wearing facial masks and staying indoors, and only going out when they really need to. A participant from the highland minorities reported the use of facial masks by children and the elderly, as a reactive measure whenever there is air pollution emanating from open burning of agricultural residues and forest fires, however, she does not know if this is practiced by everyone. According to the same participant,

> *"I am scared and a little bit worried." We live as best as we could because we do not know how to solve the problem of smoke,"* said another participant.

> *"Some people do not realize that smoke is dangerous to human health, so I do not feel worried,"* another participant added.

Asked if participants are aware that long term exposure to smoke is bad for human health? One participant said:

> *"I do not know, I think I will be fine"*

When there is smoke, another participant mentioned that they just take children away from smoke area. In the past few months, nothing was done to protect people's health:

> *"It has become a way of life. It happens every year. What will be, will be. There is nothing we can do about it,"* according to a participant.

According to public health officers, this is the most common measure taken by the villagers to protect themselves. Facial masks are readily available at the community hospital, as such easy to get. In the past, when family members fall sick, they gave them warm water and took them to the hospital. However, burning is inevitable because if they do not burn, it will be difficult to plant, according to a participant.

All the participants acknowledged that there are rules that prohibit open burning in the community and announcements are sometimes made to that effect. However, no participant reported how they collaborated with other members of their community in ensuring that such rules are adhered to; neither did they report how they contributed in decision making processes regarding this. One participant mentioned that burning is prohibited from February 6. Two others reported that offenders are charged and made to pay fines which could range from 2,000 to 5,000 baht. When the law newly came in place, villagers still burn residues. Presently, some obey the rules while some continue to burn irrespective of the fine and the environmental health consequences. Three participants went on to add that they try to warn others not to burn as a way of reducing air pollution in the community even though it was earlier mentioned that burning residues is 'unavoidable' because farmers need to hurriedly prepare farm lands for the new planting season.

(c) Community environmental action

When asked about reporting individuals that engage in open burning, participants from the highland minorities admitted that open burning is wrong but they do not report even though there are policies (Supranational/National) against open burning. No one wants to admit that they burn. At the village meetings held once in month, there was no talk of smoke, according to one participant. Announcements are made through wire broadcasting regarding when individuals are allowed to burn.

> *"When we burn, we make firebreaks to control the fire,"* according to one participant.

When such announcements are made, they tell members of the community that burning can cause smoke; however, they did not inform them about the health effects. Whenever announcements are made, collective efforts are made to reduce fire, but when there are no announcements, everything goes back to the same. The community leader asks villagers to help put out the fire even though it was reported that some villagers cause wildfire by open burning and animal hunting, and still get away with it.

Regarding the pros and cons of open burning (intentional and unintentional), most focus group participants mentioned that when they burn residues, it adds to soil nutrient, it is fast, gets rid of weed and some insects. However, one participant stated that burning near a forest could spread fire. Another participant said that

> *"It can destroy the surface of soil and kill earthworms. Nevertheless, we need to burn because our rice might be infected with disease"*

There are a great number of disadvantages if we weigh the pros and cons of open burning, but open burning is inevitable, according to one participant:

> *"If we do not burn residues, where will we keep rice straws?"*

The government tries to control open burning by launching policies and creating regulations. For example, the ban on all types of burning imposed for 60 days, or from 17 February -16 April by The Chiang Rai Provincial Government. This is considered a top-down approach. According to highland minority participants, this is done to control farmers rather than reduce the problem of open burning. One participant mentioned that he feels angry; another one said he is not comfortable with the rules. Community members in the San Ti Suk village also have their own rules against the spread of fire from open burning. Whenever fire extends to someone else's farm, the offender is fined. Some individuals abide by the rules against open burning because they fear the punishment that follows (not because they acknowledge the effect of open burning on environmental health). Community leaders in both areas warn villagers not to burn as there are penalties for those caught flouting such rules. Nevertheless, fire still occurs and one participant attributed this to people's actions- "sometimes unintentional action like smoking."

Large scale commercial farming

Thailand is an agro-based economy. There is need to farm more to support the economy, hence the increase in large scale commercial farming. While the highland minorities rarely talked about commercial and contract farming, among the Thai farmers, large scale commercial farming was reported as a factor. In the past, farming was done a low scale and usually once in a year. But presently, farmers have to use more land and farm more; sometimes twice in a year in order to meet the growing commercial demands for rice and corn. The end result is having more residues which are disposed of through open burning because it is fast and cheap.

Finance

While the average monthly income for Thai participants was 3,691 baht, the average monthly income for the highland minority participants was 3,237 baht. Some participants from the highland minorities mentioned finance as a factor. According to them, they needed to support their families financially, therefore they engage in hunting of wild animals and gathering of mushrooms for commercial reasons by burning forests during summer. The public health officer suggested that Thai farmers were asked to pile rice residues in the same spot but they complained of not having enough funds to hire laborers to bring every rice straw to the same spot; they have to think of costs and profits. The community leader at Chan Chawa Tai village mentioned that farmers have to rent land which is mostly owned by entrepreneurs. Farmers pay a yearly rent of about 500 baht to 1,000 baht per rai (1,600 square meters) when there are no harvests. In the year that farmers can harvest, the rent will rise. To stop planting rice is impossible because it is a means of catering to their needs. Although some portions are used for household consumption, rice is mostly cultivated for commercial purposes. Production cost is high and once rice is sold, what is earned is sometimes as little as 6,000 baht-8,000 baht per rai. It is a continuous cycle. If the amount earned can barely cater to their needs, then it will be difficult to set aside funds for alternative methods of waste management or hire laborers to gather such residues in one place as mentioned earlier, instead of burning which is considered cheaper and faster.

Gender, culture, belief and lifestyle/entertainment

Among the highland minorities, men are considered heads of the family. They are saddled with the responsibility of providing for their

households according to cultural demands. Also, there is need to farm more rice and corn as these are used for religious purposes. Consequently, there are more residues left after harvest and religious rites. Furthermore, compared to the Thai farmers, highland minorities reported that the hill tribe considers hunting as a form of entertainment. They set fire on the forest and as the animals run out; they hunt them and enjoy the sight of it.

DISCUSSION

This study demonstrates the interplay between the environmental health literacy of participants among other factors like culture, finance, large scale commercial farming, and environmental behavior, in this case open burning (Figure 1).

Overall, both sets of participants reported the existence of air pollution during the first three months of the year. In addition, they were able to identify symptoms like chest pain, eye irritation, sore throat and respiratory problems during this period. Both groups (Thai and highland minorities farmers) acknowledged the fact that the elderly and sick people are the worst hit. Environmental health literacy at its basic level refers to an understanding of the link between environmental exposure and health [18]. Based on this, environmental health literacy among the participants can be said to be mostly basic or rather low. O'Fallon and Symma [18] illustrated environmental health literacy as stages in increasing comprehension, application and creation of knowledge. Of all the reported cons of open burning, rarely did participants mention its effect on environmental health. Apparently, the environmental health problems associated with open burning were not considered a disadvantage. This could have been due to participants' low environmental health literacy level. Furthermore, the findings of this study add to the stance of previous studies on the association between knowledge and behavior [19-21]. For example, Hines et al., [20] noted that among other issues, knowledge of issues and knowledge of action strategies are significant correlates of responsible environmental behavior. Similarly, another study showed that people's intention to pursue environmentally responsible behavior increased after gaining knowledge about environmental health. From the foregoing therefore, it can be said that knowledge is an important factor when looking at open burning behavior. However, the difference between this study and previous studies is that environmental behavior is not only influenced by knowledge, but being able to apply such knowledge while pursuing environmental friendly behavior, which is what environmental health literacy in its entirety entails.

Finance, culture and large scale farming are some factors related to open burning. Among the highland minorities participants, culture, family support, lifestyle and fun seeking (entertainment lifestyle) are some of the main reasons why farmers engage in open burning, compared to their Thai counterparts. Among the Thai farmers, large scale commercial farming, time saving and finance were some of the factors mentioned. For the highland minorities, culture is a factor in open burning behavior. The males are believed to be heads of the family, therefore it is their duty to go out and look for food and also provide support for the family according to traditional demands. The males are the ones that go to the forests to get wild items while the females stay behind to take care of the home. During the dry season, when farming is less, they engage in hunting by setting forests afire in order to ensure food security for their families. Although this is related to culture, it can as well be looked at from an economic view point. During the dry season, there are fewer jobs to do and as such most of the farmers become jobless. Since they have no other occupation to engage in, they result to open burning so as to cater to their immediate needs. Perhaps, a fair chance in terms of job opportunity can allow some farmers to engage in other jobs thereby reducing open burning.

The Lahu tribe is more welcoming to change as most of the participants reported that they now plant lychee and tea, order than rice and corn. The case is different among the Ahka tribe. They still follow traditional methods of planting and they retain most of the crop types their forbearers used to plant. They are not concerned about improved or genetically modified seeds. They use corn, pigs and rice for religious purposes so they still maintain the old pattern of doing things. Therefore, finance, culture and religion are contributing factors in this case just as it was reported in another study; Ahmad and Ahmad, which found that knowledge of risk and environment were not major factors influencing open burning behavior, instead, finance and lack of knowledge of alternative methods of waste disposal were factors influencing open burning behavior among farmers in Pakistan [22]. Moreover, Gypmantasiri and Limnirankul [23] found an

association between culture and open burning behavior.

Existing policies prohibit open burning from January-April. However, farmers are allowed to burn residues from November to December because the soil is considered to be moist during this period, which is not always true, according to a participant. These policies can at best control open burning of farm residues to some extent, but it is difficult to control open burning of forests because the main actors are fearless young-adult males who mostly perpetrate the act at night, regardless of the rules. From the foregoing, it can be said that the rules against open burning of farm residues have not been quite effective. Open burning is still allowed; the only difference is time. The effects of air pollution have not been reduced instead, the timing has been shifted.

CONCLUSION

There is an association between factors like finance, culture, environmental health literacy and open burning behavior among farmers in northern Thailand even though some differences in terms of patterns, and time exist among some of the groups. Environmental health literacy among farmers is basic, which means farmers have some knowledge, can identify some environmental health issues like air pollution and its accompanying symptoms, but taking it further from there in terms of applying such knowledge in relation to their environmental behavior and action(which an advanced level of environmental health literacy) was not evident. Safety measures aimed at protecting themselves and reducing the impacts of smoke are rather reactive and not proactive. Compared to previous years, open burning is on the increase with serious impacts on human and environmental health. Despite the efforts of government and communities to resolve the problem, it persists and there seem to be no better options or ways of disposing agricultural residues as such the impacts continue to grow.

There is need to review policies, for example the 60 days ban in Chiang Rai Province which will be more effective if they are all-inclusive instead of applying a top-down approach in resolving the problem of open burning, as some highland minority farmers mentioned that they were uncomfortable with the ban because it does not take consider minority farmers' opinion. Also, highland minority farmers can be provided with job opportunities during the summer as some mentioned that they would like to try other jobs instead of burning forests and hunting animals to sell.

Some farmers consider the use of chemicals as an alternative to open burning. Of course both methods are harmful to human and environmental health. However, this raises the question of which method poses more threat to human and environmental health? Perhaps, farmers can be informed on the health impacts of both open burning and chemical methods of agricultural waste disposal. They can be provided with environmental health knowledge, and be taught and engaged on how to move further from being mere identifiers of symptoms during ambient air pollution to being able to apply useful environmental health knowledge regarding environmental behavior, for example, how to manage agricultural residues in an environmental health friendly manner.

Lastly, the results of this study will be useful for developing a quantitative tool for measuring environmental health literacy among farmers and can be useful to researchers who are interested in carrying out a study in the area of environmental health literacy which is a growing field.

ACKNOWLEDGEMENTS

The researchers would like to thank the participants, translators, and the staff at the health promoting hospitals for their help, cooperation, and time. We also would like to thank the Center of Excellence for the Hill-tribe Health Research, School of Health Science, Mae Fah Luang University, Chiang Rai, Thailand, for providing support in form of grant for doing this research and publication.

REFERENCES

1. World Health Organization [WHO]. Frequently asked questions: Ambient and household air pollution. [cited 2016 May 26]. Available from: http://www.who.int/phe/health_topics/outdoorair/databases/faqs_air_pollution.pdf
2. International Cryosphere Climate Initiative. Open burning. [cited 2016 May 26]. Available from: http://iccinet.org/open-burning
3. Spoolman S, Miller T. Environmental science. Belmont: Brooks/Cole; 2013.
4. Ostro B, Sanchez J, Aranda C, Eskeland, GS. Air pollution and mortality. In: Kumar P, Kumar S, Laxmi J, Eds. Socioeconomic and environmental implications of agricultural residue burning. [N.p.]: Springer; 2015
5. Agay-Shay K, Friger M, Linn S, Peled A, Amitai Y, Peretz C. Air pollution and congenital heart defects. Environ Res. 2013 Jul; 124: 28-34.

6. Dadvand P, Rankin J, Rushton S, Pless-Mulloli T. Ambient air pollution and congenital heart disease: a register-based study. Environ Res. 2011 Apr; 111(3): 435-41. doi: 10.1016/j.envres.2011.01.022
7. Stratieva, N. The 'Burning' problem of air pollution in South East Asia. [cited 2016 May 26]. Available from: http://www.worldwatch-europe.org/node/232.
8. Vichit-Vadakan N, Vajanapoom N. Health impact from air pollution in Thailand: current and future challenges. Environ Health Perspect. 2011 May; 119(5): A197-8. doi: 10.1289/ehp.1103728
9. Cuyahoga Falls Fire Department. Guidelines for open burning. [cited 2016 May 26]. Available from: http://cfo.cityofcf.com/web/sites/default/files/imce/fire/openburn.pdf.
10. Ministry of Public Health and Ministry of Natural Resources and Environment, Thailand. The Second National Environmental Health Strategic Action Plan, 20012-2016. [cited 2016 May 26]. Available from: http://infofile.pcd.go.th/mgt/EngPlan.pdf
11. Wiwatanadate P. Acute air pollution-related symptoms among residents in Chiang Mai, Thailand. J Environ Health. 2014 Jan-Feb; 76(6): 76-84.
12. Pramuansup P, Apidechkul T, Pasukphun N, Wongkarnka M. The Association between Particulate Matter 10 and Severity of Chronic Obstructive Pulmonary Disease, Northern Thailand. International Journal of Social Science and Humanity. 2013 Mar; 3(2): 163-6. doi: 10.7763/ijssh.2013.v3.219
13. Sirimongkonlertkun N. Smoke haze problem and open burning behaviour of local people in Chiang Rai province. Environment and Natural Resources J. 2014; 12 (2): 29-34.
14. Apidechkul T. A 20-year retrospective cohort study of TB infection among the Hill-tribe HIV/AIDS populations, Thailand. BMC Infect Dis. 2016; 16: 72. doi: 10.1186/s12879-016-1407-4
15. Delang CO. Deforestation in Northern Thailand: the result of Hmong farming practices or Thai development strategies? Society & Natural Resources. 2002; 15(6): 483-501. doi: 10.1080/08941920290069137
16 Princess Maha Chakri Sirindhorn Anthropology Center. Hill tribe. [cited 2016 May 28]. Available from: http://www.sac.or.th/main/index.php.
17. Dixon JK, Hendrickson KC, Ercolano E, Quackenbush R, Dixon JP. The environmental health engagement profile: what people think and do about environmental health. Public Health Nurs. 2009 Sep-Oct; 26(5): 460-73. doi: 10.1111/j.1525-1446.2009.00804.x
18. O'Fallon L, Symma F. The emergence of environmental health literacy—from its roots to its future potential. Environmental Health Perspect. [cited 2016 May 28]. Available from: http://dx.doi.org/10.1289/ehp.1409337.
19. Hines JM, Hungerford HR, Tomera AN. Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. The Journal of Environmental Education. 1987; 18(2): 1-8. doi: 10.1080/00958964.1987.9943482
20. Mobley C, Vagias WM, DeWard SL. Exploring additional determinants of environmentally responsible behavior: the influence of environmental literature and environmental attitudes. Environment and Behavior. 2010; 42(4): 420-47. doi: 10.1177/0013916508325002
21. Ratnapradipa D, Brown SL, Middleton WK, Wodika AB. Measuring environmental health perception among college students. Health Educator. 2011; 43(2): 13-20.
22. Ahmed T, Ahmad B. Why do farmers burn rice residue?: examining farmers' choices in Punjab. [cited 206 May 26]. Available from: http://www.sandeeonline.org/uploads/documents/publication/1006_PUB_Working_Paper_76_Tanvir.pdf.
23. Gypmantasiri P, Limnirankul B. Knowledge and best practices to encourage farmer behavior change in open burning. Chiang Mai, Thailand. Chiang Mai: Chiang Mai University; 2009. (in Thai)