PERCEPTION ABOUT HEALTH RISK AND HEALTH PROTECTION FROM CROPS AND FOREST FIRE SMOKE AMONG HIGH SCHOOL STUDENT IN NAN PROVINCE THAILAND

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การรับรู้ความเสี่ยงต่อสุขภาพ และการป้องกันตนเองจากหมอกควันจากการเผาพืชและไฟป่าของนักเรียนชั้นมัธยมศึกษาในจังหวัดน่าน ประเทศไทย

นางสาวปวีณา คำแปง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
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Thesis Title	PERCEPTION ABOUT HEALTH RISK AND HEALTH PROTECTION FROM CROPS AND FOREST FIRE SMOKE AMONG HIGH SCHOOL STUDENT IN NAN PROVINCE THAILAND
By	Miss Paweena Kumpang
Field of Study	Public Health
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Accepted by the Faculty of College of Public Health Sciences, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

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ปวีณา คำแปง : การรับรู้ความเสี่ยงต่อสุขภาพ และการป้องกันตนเองจากหมอกควันจากการเผาพืชและไฟป่า ของนักเรียนชั้นมัธยมศึกษาในจังหวัดน่าน ประเทศไทย (PERCEPTION ABOUT HEALTH RISK AND HEALTH PROTECTION FROM CROPS AND FOREST FIRE SMOKE AMONG HIGH SCHOOL STUDENT IN NAN PROVINCE THAILAND) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ.ดร.อุษณีย์ พึ่งปาน, 79 หน้า

การวิจัยนี้จัดทำขึ้นที่จังหวัดน่าน ประเทศไทย มีวัตถุประสงค์เพื่อระบุสถานการณ์การได้รับข้อมูล การรับรู้ และการป้องกันตนเองเกี่ยวกับหมอกควันจากการเผาพืชและไฟป่าของนักเรียนในจังหวัดน่าน นักเรียนจำนวน 278 คน ถูกเลือกโดยการสุ่ม และเครื่องมือในการศึกษานี้คือ แบบสอบถามแบบตอบด้วยตนเอง ร้อยละ 60 ของกลุ่มตัวอย่างเป็นเพศหญิง มีอายุเฉลี่ย 16 (±1.65) ปี ร้อยละ 65 ศึกษาอยู่ระดับชั้นมัธยมศึกษาตอนปลาย แหล่งข้อมูลที่นักเรียนใช้สำหรับการรับข้อมูลเกี่ยวกับหมอกควันจากการเผาพืชและไฟป่ามากที่สุด คือ สื่อสาธารณะต่างๆ เช่น โทรทัศน์ วิทยุท้องถิ่น หนังสือพิมพ์ และป้ายโฆษณา นักเรียนส่วนใหญ่ได้รับข้อมูลในทุกประเด็นเป็นบางครั้ง โดยการห้ามเผาป่า พื้นที่เกษตรและชุมชน เป็นประเด็นที่นักเรียนได้ข้อมูลบ่อยที่สุด นักเรียนส่วนใหญ่มีการรับข้อมูลระดับปานกลาง (ค่าฉลี่ย 19.20±4.30) การรับรู้เกี่ยวกับอันตรายต่อสุขภาพจากหมอกควันวัดจากความคิดเห็นของนักเรียน นักเรียนส่วนใหญ่มีการรับรู้สูงและมีความเข้าใจที่ดีเกี่ยวกับสาเหตุของหมอกควัน และผลกระทบต่อสุขภาพจากหมอกควัน ทั้งนี้นักเรียนส่วนใหญ่มีการรับรู้ระดับปานกลาง (ค่าเฉลี่ย 27.00±4.21) นักเรียนส่วนใหญ่ใช้วิธีการต่างๆ เพื่อป้องกันตนเองจากหมอกควัน ทั้งการปรับที่อยู่อาศัย การปรับวิถีชีวิต และการมีส่วนร่วมกับชุมชน นักเรียนส่วนใหญ่มีการป้องกันตนเองระดับปานกลาง (mean = 6.54± 2.16) การศึกษานี้พบว่าปัจจัยที่มีความสัมพันธ์ต่อการปฏิบัติตนเพื่อป้องกันตนเองของนักเรียนประกอบด้วย ระดับชั้นที่กำลังศึกษา (p-value=0.036) การได้รับข้อมูล (p-value = 0.033) และโดยเฉพาะอย่างยิ่งการรับรู้ความเสี่ยง (p-value < 0.001) นอกจากนี้การได้รับข้อมูลยังมีความสัมพันธ์กับการรับรู้ (p-value = 0.011) การศึกษานี้แสดงให้เห็นว่าการรับข้อมูลมีความสัมพันธ์กับการรับรู้และการป้องกันตนเอง และการรับรู้มีความสำคัญมากที่สุดต่อการป้องกันตนเอง ดังนั้นจะต้องมีการเพิ่มการรับข้อมูลเพื่อให้เกิดการรับรู้ที่มากขึ้นซึ่งจะมีผลต่อการปรับเปลี่ยนพฤติกรรมป้องกันตนเองของนักเรียน

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต .....

ปีการศึกษา 2556 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก .....

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PAWEENA KUMPANG: PERCEPTION ABOUT HEALTH RISK AND HEALTH PROTECTION FROM CROPS AND FOREST FIRE SMOKE AMONG HIGH SCHOOL STUDENT IN NAN PROVINCE THAILAND.
ADVISOR: ASST. PROF. USANEYA PERNGPARN, Ph.D., 79pp.

The study was carried out among high school students in Nan Province, Thailand with the objective of determining the receiving information, perception, and health protection of crops and forest fire smoke. Two hundred and seventy eight students were randomly selected and provided with self-administrated questionnaire. About 60% of the students were female. The mean age was 16±1.65 years. Nearly 65% were studying in senior high school level. The public information sources such as television, local radio, newspaper, and advertisement were the most common sources which the respondents used to receive the crops and forest fire smoke information. Most students had received all information sometimes. Most students had moderate level of receiving information (mean = 19±4.30). The majority of students had high perceptions and good understanding on the cause of the smoke and environment and health effects of the smoke. Most students had moderate level of perception (mean = 27.00±4.21). Most students used all of the health protection measures to protect them from the crops and forest fire smoke including resident environmental adaptation; personal lifestyle modification; and community participation. Most students had moderate of health protection (mean = 6.54± 2.16). This study found that health protection was significantly associated with studying level (p-value=0.036), receiving information (p-value = 0.033), and perception (p-value < 0.001). Moreover the perception was significantly associated with receiving information (p-value = 0.011). Receiving information was the important factor of increasing the health risk perception and health protection from crops and forest fire smoke among the high school student. Health risk perception was the most important factor of health protection to avoiding and reducing the crops and forest fire smoke exposure. Therefore, increasing the receiving information need to be developed to make the perception which in turn will influence students to modify their behavior.

Field of Study: Public Health Student's Signature .....

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CHAPTER I
INTRODUCTION

1.1 Background and Rationale

Forest fire and using fire in land-use system annually affects several million Km^2 of forest and crops of the world. The smoke of crops and forest fire affects the composition and functioning of the global atmosphere (WHO/UNEP/WMO, 1999). Southeast Asia Region has fire and smoke problem in two periods of every year. First is in the dry season during March and April. People burn leaves, brush, and trash around their residential and cultivation areas. Farmers use fire to clear crop residue and old grass in pastures. In some locations, the forest is burned to create new agricultural land. The fire and smoke affects several countries such as Myanmar, Northern Thailand, Laos, Vietnam, and Southern China (NASA, 2010). Second period is during June and July when the haze crisis affected several countries in the region, including Brunei, Indonesia, Malaysia, Singapore and Southern Thailand. The problem flares up every dry season, in varying degrees. The haze period coincided with large-scale burning in many parts of Sumatra and Borneo (NASA, 2013).

Northern Thailand Provinces include Chiang Mai, Lumpang, Lumphun, Mae Hong Son, Chiang Rai, Phayao, Nan, Phrae and Tak. The number of crops and forest fire occurring across Northern Thailand has increased mainly during January to April since 2007 (Chomsin, 2010) that has been recognized as the haze crisis (Wiwatanadate & Liwsrisakun, 2011). The environment and human health have also been affected by the crops and forest fire smoke. Although, the fire and smoke problems have been solved by the several Ministries of Thailand and local governments since 2007, the fire and the smoke still has effects on the populations in these areas (Saiyasombut, 2013).

Crops and forest fire smoke is an aerosol. Smoke is composed of either solid or liquid particles in the colloidal system in the air as found in dispersed phase. (Statheropoulos & Goldammer, 2007). Crops and forest fire smoke, in case of big crop fire, can usually be spread many kilometers away from the flame-front. The distribution of the smoke depends on the meteorological factor; wind speed and direction, temperature, relative humidity (RH%). Usually, fine particles (particles less than 2.5 micrometers in diameter: PM2.5) can be transported for long distances (cross border transfer), whereas the coarse particles (particles less than 10 micrometers in

diameter: PM10) deposit on surfaces (e.g. Soil, streams) (WHO/UNEP/WMO, 1999). Crops and forest fire smoke can have impacts on the air, water and soil (Statheropoulos & Karma, 2007). Reduced visibility is the main impact of crops and forest fire smoke on critical infrastructures (Statheropoulos & Karma, 2007).

Toxicity of the crops and forest fire smoke mixture is the additive or the synergistic result of all the possible hazards. Components of the smoke vary according to the fuel types burned and the possible materials contained in the smoke (ContamSites, 2007). Crops and forest fire smoke can contain toxic compounds; such as carbon monoxide, nitrogen dioxide, sulfur dioxide, formaldehyde and acrolein (MSU, 2005). Especially, the toxic effect of fine particles is more aggressive than coarse particles. They cannot be stopped by the cells of the respiratory tracts and can penetrate the lungs. In this way, hazardous compounds absorbed by the fine particles can reach the air cell. Toxic effect of particles is related to the quantity of toxic substances that may be absorbed and the affinity for site of action (enzyme, membrane). The smoke can expose human body through the routes of oral (mouth, stomach, intestine, colon), pulmonary, cutaneous (skin), ocular (eyes) or parenteral. The health effects of the particle on human body are as follow_ skin corrosion/irritation, serious eye damage/ eye irritation, sensitization (allergy), germ cell mutagenicity, carcinogenicity, specific target organ systemic toxicity, respiratory irritation etc. (Seyenaeve, 2006).

The areas of crops and forest burning have detrimental impacts on economies, human health and safety, with consequences comparable in severity to other major natural hazard. However, crop and forest fires can be predicted, controlled and, prevented through the implementation of appropriate policies. The development of policies and guidelines to reduce the health impacts of smoke generated from burning crops must be linked with policies that address the smoke problem at its source (WHO/UNEP/WMO, 1999).

Several studies have established the crops and forest fire smoke impact to health of local residents (Amir et al., 2005; Ammann et al., 2001; Bowman & Fay, 2005). Several state and local governments have issued fact sheets and guidelines about health effect of crops and forest fire smoke and action plans to protect population health during the smoke events (Colorado, 2006; State of New Mexico, 2012; State of Oregon, 2010; USEPA, 2001). However, the hazards study has been on the perception of fire warnings, personal safety, vulnerability associated with forest fires, and fire mitigation and management practices-with limit the mention of health impact of

crops and forest fire smoke (Collins, 2005; Kneeshaw, Vaske, & Bright, 2004; McCaffrey, 2004).

Nan Province is one of nine Northern Provinces, where crops and forest fire smoke problems usually occur. Nan Province is included in the poverty province with the average income per person being the third lowest in Thailand (NESDB, 2010). Eighty-five percent of occupation is agriculture. The sparse population of over 477,000 consists of indigenous Lanna natives as well as other minority groups, mostly hill tribes such as Hmong, Wa, Kamu, Luo, Tin and Mrabri, making up 17 percent of the total population (PEI, 2010). One of the main underlying causes of poverty in Nan is having a limited amount of arable land. Up to 87 percent of its area (11,472 km^2) is heavily forested with mountainous terrain, leaving only 12 percent for agriculture and 1 percent for residential (PEI, 2010).

The situation of problem, the smoke episode of Nan Province has several causes of burning, such as; forest fire (natural cause); conversion of forest to new agricultural land, government support such as price guarantees and commercial crop policies, and investors support for villagers to do farm as Contract Farming are driving forces to rapid expansion of forest area for plantation (PEI, 2010), that relates to expansion corn farming in the forest, from 1,420 km^2 in 2007 to almost 1,600 km^2 in 2010 (NPANO, 2010); burning of agricultural residues, farmers always burn leaves, brush, and trash to prepare agriculture land. The burning is usually begun in March and new round of corn plantation is started in April (DNP, 2013) prescribed burning in forestry. Moreover, the smokes in Nan also contain air pollution from Southeast Asia Region.

There were 29 times of extinguish and the total burning areas were 0.5 km^2 in 2012. The number of extinguish times was increased and burning areas also increased in 2013 into 123 times of extinguish and 2 km^2 of burning areas in 2013 (DNP, 2013). The Municipality Office of Nan air quality monitoring station had reported the concentration of PM10 and other air pollution criteria. The 24 hour average of PM10 concentration during 13rd March – 14th April 2013 increased continuously to 99 – 270 microgram/cubic meter. Thailand defined exceeded 24-h average standard level of PM10 ~~is~~ as 120 micrograms/cubic meter and WHO defined exceeded 24-h average guideline level of PM10 as 50 microgram/cubic meter (PCD, 2013b). Crops and forest fire smoke had emerged as an important public health problem in Nan Province as it has become endemic throughout the country. According to Nan Hospital report, more than 8000 patients are admitted to hospital with asthma and other respiratory disease with the average of 300 persons per day in March 2013 (PRD3, 2013)

The Nan Provincial Government had annual action plan to stop burning and decrease the environment and health effects of the smoke such as plan fire to stop burning and put out the fire in forest and agricultural land; air quality monitoring; health surveillance; public notification; and public education (Nan, 2010). The public education and notification was important for public perception on risk (Bell & Oliveras, 2006; Blanchard & Ryan, 2003 ; Krewskiab et al., 1995; Macey, 2008). The public notification and education programs should be designed to educate the public about health effect of high concentrations of the particles; types of crops and forest fire, the effect on air quality; measurement to avoid and reduce the smoke exposure. Moreover, the information should include air quality monitoring; pollution-related illness; health impacts and mitigation measures; the action of local government to minimize the health impact of the fire events etc. (USEPA, 2001; WHO/UNEP/WMO, 1999).

The crops and forest fire smoke becomes an annual problem of Nan province. Perception, received information and health protection can be important factors to reduce the risks of the smoke exposure and prevent health impacts. This study focused on high school student because the students were the group of population whose chance to be affected by the smoke hazard is also high like other groups. They can receive the information from the common public information source and from special source in the school education system. It is important to start giving information to younger generation since raising smoke risk perception can influence in improving the health protection from crops and forest fire smoke (ENR, 2010). Moreover, the students with high perception and good health protection can disseminate the information and can be a good protection model for their families and communities.

The study of comparison between adults and adolescents perception about health threatening activities found that adult who had more experimental and occasional involvement had lower risk than the adolescents (Cohn et al., 1995). Participation of adolescent in risk behavior was linked to their risk perception (Gullone & Moore, 2000) and these behaviors may persist throughout life in the form of habits(Martha & Griffet, 2007)

This study aims to determine the current state of receiving information, perception, and health protection from crops and forest fire smoke of the high school students. Association between health protection of crops and forest fire

smoke exposure and socio-demographic characteristic, receiving information, and perception; association between receiving information and perception were assessed in this study. The result can indicate the action of local government in providing effective ways of raising perception and health protection of crops and forest fire among young people. Quantitative survey research method is applied in this study and the study population is students who are studying in Nuntaburivittaya School.

1.2 Research questions

What is the perception about health risk and health protection from crops and forest fire smoke among high school student in Nan Province?

1.3 Research objectives

The main objective was to determine the current situation of receiving information, perception, and health protection from crops and forest fire smoke of the high school students. The specific objectives were to assess the association between health protection and socio-demographic characteristics, receiving information, and perception; and to assess the association between received information and perception among high school student in Nan Province.

1.4 Operation Definition

Socio- demographic characteristics: refers to resident, sex, age, studying level, parental occupation, burning trash and brush etc. in 3 months, and family income per month.

Receiving information: refers to received information about cause of smoke, health effect of the smoke exposure, health protection measures, and notification on forbiddance burning, situation of fire, and air quality in Nan Province, measurement of avoidance and reduction the smoke-related the situation of air quality.

Perception about health risk: refers to awareness about cause of the smoke and environment and health effect of crops and forest fire smoke.

Health protection from crops and forest fire smoke: refers to health protection measures; residential environment adaptation; personal lifestyle modification; and community participation

1.5 Conceptual framework

Independent variables **Dependent variables**

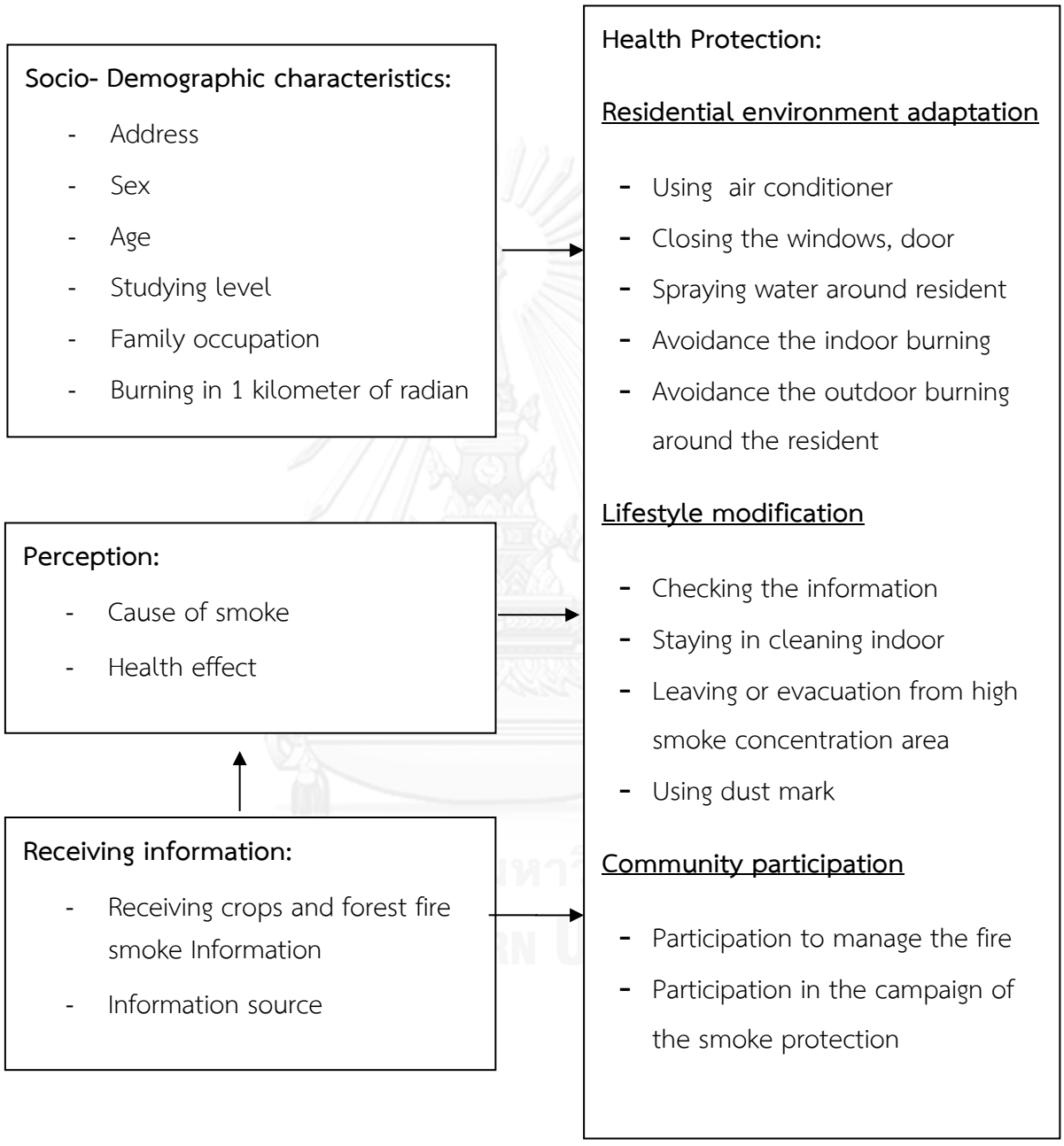


Figure 1: Conceptual framework of study (Blades & Hall, 2011; Macey, 2008)

CHAPTER II

LITERATURE REVIEW

2.1 Crops and forest fires formation

The air pollution originated by crops and forest fire smoke is an incident, which has influenced the global environment. In the recent decades, increasing application of fire as a tool for land-use change has resulted in more frequent widespread fire and smoke episodes with droughts that are attributed to inter-annual climate variability, or possible consequences of regional climate change. In metropolitan or industrial areas, the impacts of crops and forest fire may be coupled with the emission burden from fossil fuel burning and other thecnogenic source, resulting in increasing vulnerability of human (Statheropoulos & Goldammer, 2007)

2.1.1 Characteristics of crops and forest fire

A crop fire is the result of the interaction of three components- fuel, oxygen and heat of combustion. The fuel is in principle, the forest, or more generally, the crop fuels. However, other types of fuels and/or materials may contribute to the crops and forest fire, smoke formation and composition, due to the flame-front expansion (Statheropoulos & Karma, 2007).

Crop fuels have specific characteristics, such as fuel moisture and fuel temperature, which contribute to the combustion process. The moisture content of the fuel depends on the meteorological conditions, such as the air temperature and relative humidity, as well as the type of crops, such as size and shape. Crops fuel can be categorized as ground level (1-150 mm), bush level (1.5- 2.5 m.), low and medium-tree level (3-5 m.) and tall-tree level (>5m.), depending on their height (Smith, McCabe, Barrera, & Lindner, 2000). Generally, crop fuel with high moisture content, such as big branches or tree trunks produces water vapour that lowers the temperature of combustion and hence, favours smouldering. The specific characteristics of the fuel, such as the amount and size burned contribute mainly to the quantity of the smoke produced.

The O_2 to fuel ratio is affected by meteorological conditions (e.g.wind speed and direction) and also crop characteristics, such as crop density (packing ratio), shape and arrangement (structure). The O2 to fuel ratio mainly contributes to the type of components in the crops and forest fire smoke. O2 flow also affects the amounts of smoke produced, e.g. the amount of particulate emissions generated per

mass of fuel consumed during the smoking process is more than double of the flaming phases

The heat component of the triangle can contribute to the smoke components produced, i.e. it has been found that organic degradation of pine needles commences a 200-250 C°, while maximum evolution rate of organic volatiles occurs in temperature range of 350 – 450 C° (Statheropoulos, Liodakis, Tzamtzis, Pappa, & Kyriakou, 1997).

2.1.2 Crops and forest fire composition

Generally, Crops and forest fire smoke is an aerosol, which is defined as a colloidal system in which the dispersed phase is composed of either solid or liquid particles in a gas, usually air. Crops and forest fire smoke consists of water vapour, permanent gases, VOCs, SVOCs and Particles. Permanent gases include Carbon dioxide (CO_2), carbon monoxide (CO), Nitrogen oxides (NO_x), Sulfur oxides (SO_x) and Nitrogen trihydride or ammonia (NH_3). SO_x are usually produced in small quantities, because in general, crop fuel sulphur content is low.

Methane and various Volatile Organic Compounds (VOCs) have been found in Crop fire smoke. Identified Hydrocarbons were aliphatic, such as alkanes, alkenes and alkynes. Representative compounds include ethene, heptanes, decane, propene, 1-nonene and acetylene. Additionally, aromatic hydrocarbons, such as benzene and alkylbenzenes have also been identified; e.g. toluene, xylene, ethyl-Benzene. Moreover, VOCs mixtures included the oxygenated compounds: alcohols, aldehydes, ketones, furans, carboxylic acids, esters. Also, it has been referred that during fire-place pine wood combustion experiments and in a pine forest fire incident, chloro-methane was detected in the smoke produced. Chloro-methene has been identified as the most abundant halogenated hydrocarbon emitted during biomass burning consisting of dead and living crops. Semivolatile Organic Compounds (SVOCs) found in the crops and forest fire were polyaromatic hydrocarbons (PAHs), e.g. benzo (a) Pyrene (Statheropoulos & Goldammer, 2007).

Particles in the crops and forest fire smoke depending on their size, can be either coarse (>PM10) or fine (PM2.5, PM1, PM1<). The particulate matter can be primarily released to the atmosphere due to the combustion, or can be formed through physical or chemical transformations (molecular agglomeration of supersaturated vapours, nucleation). Primary particles can be elemental carbon or organic carbon particles. Inorganic or elemental carbon, also known as graphitic or

black carbon (soot), is a product of the incomplete combustion of carbon-based materials and fuels.

Organic carbon can also be produced via secondary gas-to-particle conversion processes. Condensation of hot vapour (VOCs, SVOCs) during combustion processes (tars) and also nucleation of atmospheric species results in formation of new particle, usually below 0.1 μm in diameter. Generally, low-volatility products either nucleate or condense on the surfaces of preexisting particles, yielding particles in the size range of 0.1-1.0 μm.

However, crops and forest fire smoke can exist as a more complicated mixture depending on the flame-front expansion. When the flame-front expands due to various reasons, e.g. meteorological condition, other fuels such as wastes can also be burned. In such case, crops and forest fire smoke can contain not only the components mentioned above, but also other hazardous pollutants, such as dioxins, due to the pyrolysis and combustion of wastes. However, another type of fuels and/or materials may contribute to the crops and forest fire smoke formation, affecting the smoke composition, i.e., when crop fire is expending to rural fields, rural/urban construction or landfills, then wood, plastics, fertilizers, or wastes can also be burned and materials, such as pulverized glass, cement dust, asbestos or plaster and also other chemical compounds can be contained in the smoke produced (Statheropoulos & Karma, 2007).

2.2 Types of crops and forest fire

This information is partially taken from the health guideline for vegetation fire events(WHO/UNEP/WMO, 1999). The following types of crop burning generate smoke, which may affect public health:

2.2.1 Forest fire

Forest fire is an uncontrolled fire in an area of combustible vegetation that occur in the countryside or wilderness area. The rainforests are usually too moist to allow the propagation of forest fire. However, extreme droughts in association with forest exploitation periodically create conditions of flammability, fuel availability and fire spread in the equatorial rain forests. Such events regularly occur in the forests of tropical South East Asia. They are related to cyclic climate fluctuations, triggered by the El Niño-Southern Oscillation (ENSO) phenomenon.

2.2.2 Conversion of forest and brush land to plantations:

There are two type of converting forest and brush land to agricultural; shifting agricultural, the fire used to clear areas for agriculture for a few years until yields decline, and then are abandoned and new areas are burned, old areas are allowed to return to forest vegetation; and permanent removal of forest to convert it to crop lands or grazing. Trees are felled, after extraction of marketable and useable trees; the vegetation is left to dry to better burning efficiency.

2.2.3 Burning of agricultural residues:

The substantial amount of agricultural residues, such as straw and stalks are cleared up by burning. The burning doesn't involve material of direct economic value. The agricultural residue burning is a major source of atmospheric pollution. By tradition fire is also a common measure to control brush and weed encroachment on grazing and croplands.

2.2.4 Prescribed burning in forestry:

Prescribed fires are the commonly used tool of forest management, particularly in North America and Australia. They burn to reduce the dry accumulation, combustible debris plant, which is the major cause of destructive forest fires. They are also used to eliminate shrubby vegetation, which competes with tree crops for nutrients.

2.3 Smoke dispersion

Crops and forest fire smoke is usually transported many kilometers away from the flame-front. Distribution of the smoke is depended on the meteorological data (wind speed and direction, temperature, relative humidity RH%). Usually, fine particles can be transported to long distances (cross border transfer), whereas the coarse particles deposit on surfaces (e.g. soil, streams) (WHO/UNEP/WMO, 1999). Table 1, some of the smoke pollutants and their transfer through the environment are presented. According, during the 1997 episode in Southeast Asia, the smoke-haze layer covered an area up to 10 million km^2 (Nakajima, Higurashi, Takeuchi, & Herman, 1999). Moreover, during 2002, the Canadian forest fires in a province of Quebec affected the PM levels of Baltimore U.S.A., located hundreds of kilometers from the source (Sapkota et al., 2005). Fires in Canada were also found to cause high concentrations of carbon monoxide and ozone over a period of two weeks in the Southeastern United Stated and across the Eastern seaboard during the summer of 1995(Wotawa & Trainer, 2000)

Table 1: Indicative crops and forest fire compounds and how they are transported from the source (WHO/UNEP/WMO, 1999)

Compound	Example	Note
Permanent gases	CO, CO_2	Transported over distances
	O_3	Only present downwind of fire-transported over distances
	NO_2	Reactive concentrations decrease with distance from fire
Hydrocarbons	Benzene	Some transport-also react to form organic aerosols
Particles	PM10	Coarse particles are not transported and contain mostly of soil and ash
	PM2.5	Fine particles transported over long distances

2.4 Environmental problems of crops and forest fire smoke

Crops and forest fire smoke can have impacts on the air, water and soil. The long-term effects of the crops and forest fire emission on atmospheric composition and global processes have been presented and discussed. Short-term effects of crops and forest fire include elevated trace gas, aerosol and CO_2 level, nitrogen deposition, acid precipitation, and local climate change, all of which may have direct negative or positive effects on plant functioning in undisturbed forest. Environmental impacts of crops and forest fire smoke include the increase of the ground level ozone, due to photochemical reaction of the smoke components in the presence of NO_2, e.g. CO and VOCs are considered ground-level ozone precursors (Hogue, 2005). Additionally, it has been reported that photosynthesis of three tree species was reduced by the smoke-haze of 1997 in Indonesia, due to elevated aerosol and atmospheric pollutant levels (Davies & Unam, 1999). The smoke can pollute surface water directly, by deposition, or can be part of the soil.

Impacts of crops and forest fire smoke on critical infrastructures

Reduced visibility is the main impact of crops and forest fire smoke on critical infrastructures. In 1994, the smoke from fires in Sumatra (Indonesia) initially reduced the average daily minimum horizontal visibility over Singapore to less than 2 Km.

Later, the visibility in Singapore dropped to 500 m. At the same time, the visibility in Malaysia dropped to 1 km in some parts of the country (WHO/UNEP/WMO, 1999). Other impacts on infrastructures include the irregularities in the operation of airports (reduced or cancelled flights), highways and hospitals, as well as, of army camps. For example the regional airports in Indonesia had to be closed during the haze period of 1997. In 1892-83, 1991, 1994, and 1997-98, the smoke episode in South East Asia resulted in the closing of airports and marine traffic. In addition, accidents on the highways or possible airplane crash and human losses can be the result of reduced visibility. Several smoke-related marine and aircraft accidents occurred during late 1997 (WHO/UNEP/WMO, 1999). According to a study (Muraleedharan, Radojevic, Waugh, & Caruana, 2000), the haze impact on areas, where a school and hospital were situated, during the 1998 smoke episode in Brunei Darussalam was significant.

2.5 Human health impact of crops and forest fire smoke

2.5.1 Toxicity of crops and forest fire smoke

Generally, toxicity is defined as the deleterious or adverse biological effects caused by a chemical, physical, or biological agent. Toxicity can be acute, defined as any poisonous effect produced within a short period of time, or chronic exposure.

Toxicity of the crops and forest fire smoke mixture is the additive or the synergistic result of all the possible hazardous smoke components, depending on the fuel types burned and the possible materials contained in the smoke. Additive toxicity is defined as the toxicity of a mixture of contaminants that is equal to the summation of the toxicities of the individual components. Synergistic toxicity is defined as the toxicity of a mixture of contaminants that may result to a total toxicity for greater than the summation of the toxicities of individual components (ContamSites, 2007).

Crops and forest fire smoke can contain toxic compounds such as:

Respiratory irritants: Irritants can cause inflammation of mucous membranes. Ammonia and nitrogen dioxide are indicative examples. Irritants can also cause changes in respiration and lung function, such as sulfur dioxide, formaldehyde and acrolein (MSU, 2005). According to specific studies, formaldehyde and acroleline were found suspected of causing respiratory problems for the exposed firefighters (Reinhardt & Ottmar, 2004)

Asphyxiates: They effect of the uptake and transformation of oxygen. Examples include carbon monoxide, which in high concentrations can result in immediate collapse and death. Methane and Carbon dioxide are also considered asphyxiates, A 17% inhaled oxygen content is safe limit for prolonged exposure. A 5% oxygen content is the minimum compatible with life. Concentrations of 1% produce stupor and memory loss (Stafanidou-Loutsidou, 2005)

Mutagens: A mutagen is an agent that changes the hereditary genetic material. Such a mutation is probably an early step in the development of cancer, e.g. formaldehyde, acroleine. Teratogens may cause non-heritable genetic mutations or malformations in the developing foetue, e.g. toluene (PTCL, 2007)

Toxic effect of particles: fine particles are more aggressive than coarse paeticles; they aren't stopped by the cells of the respiratory tracts and can penetrate the lungs. In this way, hazardous compounds absorbed by the fine particles can reach the air cell . Toxic effect of particles is related to the quantity of toxic substances that may be absorbed and the affinity for site of action (enzyme, membrane). In general, the biological absorption of particles by human body can take place by filtration though pores of membranes, simple diffusion, facilitated diffusion, active transport (against concentration gradient) or endocytose (pinocytose-phagocytose). Biological absorption can be oral (mouth, stomach, intestine, colon), pulmonary, cutaneous (skin), ocular (eyes) or parenteral. Some of the health effects due to particles can be acute toxic, skin corrosion/irritation, serious eye damage/ eye irritation, sensitization (allergy), germ cell mutagenicity, carcinogenicity, specific target organ systemic toxicity, respiratory irritation etc. (Seyenaeve, 2006).

2.5.2 Characteristics of exposure to crops and forest fire

Exposure to crops and forest fire smoke can be quantified as the concentration of the smoke components in the subject in contact, integrated over the time duration of that contract. In order to have a more representative assessment health impact of the smoke, it should be considered that exposure to the smoke is simultaneous exposure to multiple substances, such as gases, liquids, solids (mixed exposure). A potential synergism may exist among the various crops and forest fire smoke components. Exposure can be characterized as point, area/surface or network; such exposure characteristics should be taken into account in addressing exposure limits. Temporal/averaged, discrete/sporadic or continuous/cumulative exposure has to be taken into account in order to calculate an averaged, sporadic or cumulative exposure, respectively (Seyenaeve, 2006; Statheropoulos & Goldammer, 2007)

2.6 Receiving information

Some studies found that people receiving information related to their health threat, less serious and accurate than people non receiving information (Lerman et al., 2002). People who are informed that they have risks try to minimize the seriousness of the health threat and derogate the risk factor in order to maintain a favorable sense of their health (Renner et al., 2008).

Public perception for avoiding and reducing the environmental health risk pursue human knowledge into specific action to protect health impact. It should supported with clear messages and detailed information. Risk perception alone does not conduct directly to people adopting mitigation measures. (Paton, Smith, & Johnston, 2005)

Some studies found that people take action when they know which specific actions can be taken to reduce the risks; they are convinced that actions will be efficient; and they believe in their own ability to act(McClure, 2006). The facts are established for the success of public education including people need to be stimulate to look for the information (McClure, 2006) ; people look for consent and want confirm from many sources e.g. experts, community leaders, friends, television, web sites, and radio before they act (Lindell & Perry, 2000; Nathe, Gori, Greene, Lemersal, & Mileti, 1999); people will act with what they think others are doing; the group of people who start social epidemics include connector, information specialists (or experts), and persuadable people; the most remarkable lesson are learn form story that are unforeseen, simple, credible, particular and emotional; the continuous process of behavior change convert from contemplation to planning, then to action, and finally to maintenance (Sayers, 2006; UNISDR, 2004)

2.6.1 Source of the information

The government should improve the programs to reduce public's risk exposure. The government should identify the people most at risk; inform the risk population about the impending natural event or presently taking place; and advice for actions of the public to reduce their exposure to high concentrations of particulate matter. The government should also advise forethought if exposure cannot be avoided. The local communities may improve their own programs to act with public forest fire notification processes and state of smoke in their areas (State of Oregon, 2010)

Acts of giving information to public, especially for the young people help them become aware of the smoke risk. Taking and improving prevention skills are all important in ensuring existing and future generations maintain the relationship about using natural resources and environmental health. Formal education is not the only way youth gain knowledge on health risk of forest fire smoke exposure and protection to avoiding and reducing exposure to smoke in the society. Schools, families and communities have an important role to play in conveying this knowledge (ENR, 2010)

The following information source for public awareness and public education was adapted from the guideline: Public awareness and public education for disaster risk reduction of Red Cross (Red Cross, 2011)

Campaigns

The point of campaigns is to provide uniform, large-scale impact with standard messages. Campaigns comprehend a activities set such as publication, presentation brochures, audio and video materials and social media. However, the campaign must be carefully planned, require excellent organization and strong support of partners.

School interventions

The point of school interventions covers two areas include classroom learning and school activities. The school intervention requires support for long term planning and capacity building.

Audio and video equipment

The messages are highly controlled in audio and video production. Professionally produced videos are important for documentation, giver communications and public relations. The video production can be an important mean of indigenous knowledge, stimulating local creativity, distribute education, and sharing stories.

Web site

Web resource is the one of simple and inexpensive way to promote public perception for environmental health risk reduction. The messages of web page should easy to find and are no more than one click away from the home or landing page. The nation and local government have to continue to update the website or other media, including information on control action, real-time air quality data, health information, and links to the forecasts, fire assessments and current forest fire information.

2.6.2 Content of information for the public

Among the critical components of national governments' efforts to manage crops and forest fire episodes are the educating the population regarding the potential health impacts of air pollution produced in crops and forest fires. These education efforts must occur prior to the occurrence of an episode and also during episode periods to keep the population informed. The following component information should advisory to public (WHO/UNEP/WMO, 1999).

The education and notification programs should be designed to inform about the short term and long term damaging health-effects of high concentrations of particulate matter to the public. The disseminate information should consist of the natural event, such as forest fires, and the factors influencing the air quality. General education programs consist of information on smoke management, management tool requirements, health effects of smoke, the association between forest fire, open burning and smoke from forest fire, and health effect (State of Oregon, 2010)

Information on ambient air quality

Among the basic requirements for protecting public health during crops and forest fire emergencies is the provision of a reliable air quality monitoring and management system. Information on ambient air quality is of prime importance, as it is the basis of preventive and protective action that needs to be taken by the population to minimize damage to health. An air quality monitoring program should be a primary activity for protecting the public against air pollution episodes, such as crops and forest fires. In general, the air quality monitoring program could have the following objectives: to assess the nature and magnitude of air pollution problems; to monitor trends in the ambient air quality, so as to enable decisions to prevent air pollution episodes; to assess the effectiveness of pollution control measures implemented to improve ambient air quality

Once an air quality monitoring and management system is in place, authorities must decide on the air quality standards and goals to be set of the population. The standards and goals set by other countries or international agencies, that have carried out credible research on air quality and health impact, could be adopted.

Air Quality Index is easily understood as reporting air quality data to the general public. The public should be aware of the air pollution situation in the area

what level of air pollution can cause harm and unhealthy for them. The air quality index is a universal format that is widely used in many countries such as USA, Australia, Singapore, and Malaysia. Air Quality Index of Thailand is divided into 5 levels from 0 to 300. Each level is represented by different colors to symbolize and to compare the level of health impact. Air Quality Index 100 is quality standard, higher than 100 indicates that the concentration of air pollution exceeded the standard in a day and can start affecting the population's health. The following table1 shows Thailand Air Quality Index smoke concentration according to the Pollution Control Department.

Table 2: Thailand Air Quality Index (AQI) criteria (PCD, 2013a)

AQI	**Meaningful**	**Color**	**Guidelines for impact protection**
0-50	Good	Blue	No health effects
51-100	Moderate	Green	No health effects
101-200	Unhealthy	Yellow	- Patients with chronic respiratory tract should avoid exercising outdoors. - Healthy, especially children and the elderly. Avoid prolonged outdoor activities.
201-300	Very unhealthy	Orange	- Patients with chronic respiratory should avoid outdoor activities. - Healthy, especially children and the elderly should limit outdoor exercise.
More than 300	Hazardous	Red	- Patients with respiratory diseases should live in the building. - Healthy should avoid exercising outdoors.

This establishment of a well-managed air quality monitoring infrastructure and program would be the first step in building a health information system for the public. In the event that actual on site air monitoring data cannot be obtained,

estimation of smoke concentrations may have to be based on visibility observations, but their correlation with particle concentrations in the local context need to be validated. An example of such a relationship is shown in table 3

Table 3: Air quality assessment based on visibility condition (State of New Mexico, 2012)

Air Quality Index (AQI)	**PM2.5 or PM10 Levels (µg/m^3)**			**Visibility in Mile**
	1-3 hr avg	**8 hr avg**	**24 hr avg**	
Good (0 to 50)	0 – 38	0 - 22	0 - 12	11 miles or more
Moderate (51 to 100)	39 - 88	23 - 50	12.1 – 35.4	6 – 10 miles
Unhealthy for Sensitive Groups (101 to 150)	89 – 138	51 – 79	35.5 – 55.4	3 – 5 miles
Unhealthy (151 to 200)	139 - 351	80 – 200	55.5 – 150.4	1.5 – 2.75 miles
Very Unhealthy (201 to 300)	352 – 526	201 – 300	150.5 – 250.4	1 – 1.25 miles
Hazardous (> 300)	> 526	>300	>250.5	Less than 1 mile

It should be noted that in the event of an emergency due to crops and forest fires, the health alert advisory given in the previous 24-hour pollution levels (indicated by AQI levels) may not be adequate to help the population react quickly and modify their activities. Pollution indices should not be overemphasized. It is also important to report pollutant-specific information. This applies particularly to PM10 as the research community, and WHO air quality guidelines generally, do not supports the concept of a threshold (or no-adverse effect) level of particle exposure.

Information on action plan

A comprehensive communication should be developed to ensure that the population is fully prepared in the event of crops and forest fire pollution. This will

mitigate the impact of the smoke on the health and well-being of the general public. This is particularly important for the more vulnerable sections of the population, such as people with lung and heart illnesses, children, and the elderly. Based on the plan, government departments should draw up operating procedures to be adopted in the event of a crops and forest fire pollution emergency. These procedures should be widely publicized through the media, before the occurrence of any crops and forest fire pollution. This will ensure that the population knows the changes that would be made to public services and facilities, and familiarize them with the modifications in their activities that are necessary to reduce the health effects of pollution.

Information on health effects and cautionary statements

It is imperative that authorities monitor the population's health during a fire pollution emergency to detect any worsening of the impact at different pollution levels. Data on the smoke related illnesses from primary health care providers, hospitals, and mortality registries should be reported periodically. Monitoring the impact of pollution requires that baseline data are available for comparison. In the longer term, the information gathered would enable authorities to refine their national action plan.

Special emphasis should be placed on explaining the health effects of susceptible populations such as asthmatics, the elderly and children at different pollution levels. This will help ensure there are adequate preparations to deal with the expected increase in demand for medical services from the susceptible population during fire pollution episodes. Frequently asked questions, such as concern about the safety of food and potable water, should be addressed by authorities through the media. Based on available medical literature, there is no conclusive evidence to indicate that adverse health effects result from the consumption of exposed food or water.

2.7 Health protection: Mitigation measures

2.7.1 Residential environment adaptation

For non-air-conditioned homes or buildings, only limited protection from fine particle air pollution is gained by remaining indoors. The guidance of staying inside with doors and windows closed may offer little protection. Water spraying outside is the one way of preventing outdoor smoke to getting inside. Other

measures to reduce indoor pollutant include avoiding indoor activities which increase indoor pollution, and avoiding outdoor burning. One method of reducing particle exposure would be to decrease air exchange rates. This could be installing air conditioners for hot seasons to reduce the use of open windows.

To enhance the protection offered by staying indoors, individuals/building managers should take action to reduce the infiltration of outdoor air. Air conditioners, especially those with efficient filters, will substantially reduce indoor particle levels. Schools, childcare centers, retirement centers, nursing homes, hospitals, and hospices especially should be urged to provide air-conditioned rooms to susceptible individuals. To the possible extent, effective filters should be installed and maintained in existing air conditioning systems and individuals should seek environments protected by such systems.

2.7.2 Personal lifestyle modifications

In addition to remaining indoors, the authorities should advise members of the public on other mitigation measures involving personal lifestyle modifications, such as use of mask, evaluation of emergency shelters, checking air quality reports and paying attention to public health messages about taking safety measures, the reduction of physical activity and restriction of cigarette smoking.

The public should be advised on the use of masks, particularly when they are involved in outdoor activities during periods of air pollution. The public should also be informed about the selection of mask types of those available and their relative utility in keeping out particles from the smoke haze.

During intense haze, the public should avoid outdoor activity, rather than putting on a mask and staying outdoors for prolonged periods. However, for those who cannot avoid going outdoors, the use of respirators would provide some relief. In the case of those with cardiopulmonary illness who need to use masks on the recommendation of their doctors, they should choose the right respirators, i.e., those designed for particle removal.

In severe episodes, another protection strategy is the preparation of emergency shelters with effective air conditioning and particle filtration. Susceptible individuals who do not have access to other air-conditioned environments should be allowed free access to emergency shelters. These could be located inside large commercial buildings, educational facilities or shopping malls. However, the risk of infection from over-crowding within these premises is also needed to consider. The

emergency evacuation of whole populations to other geographical locations in response to smoke haze is not recommended as a mitigation measure.

2.7.3 Participation

People are especially motivated which themselves participate in solution, and especially when they believe it is they own idea. The point of participation learning is to engage people in discovery and solving the problem of the risk. The heart of all activities is the community's own experience of empowerment. The decision to close or curtail community activities will depend upon consideration of traffic, health, environmental, socioeconomic factors and other local conditions. Depending upon building designs, exposure in schools is likely to be similar to those in homes or community. However, visibility could be so low during severe episodes that the risk of traffic accidents could also be increased.

2.8 Perception on crops and forest fire smoke

The several studies showed the link between exposure to the crops and forest fire smoke and health effects. Moreover, few studies estimated the perception of residents about the health risks of forest fire smoke exposure and associated prevention to reduce these risks. Perception is the important factor of behavior change and the major role in public reaction to environmental exposures. Increasing public's perception and knowledge is a foundation for interference, promoting of protecting behaviours (Egondi et al., 2013)

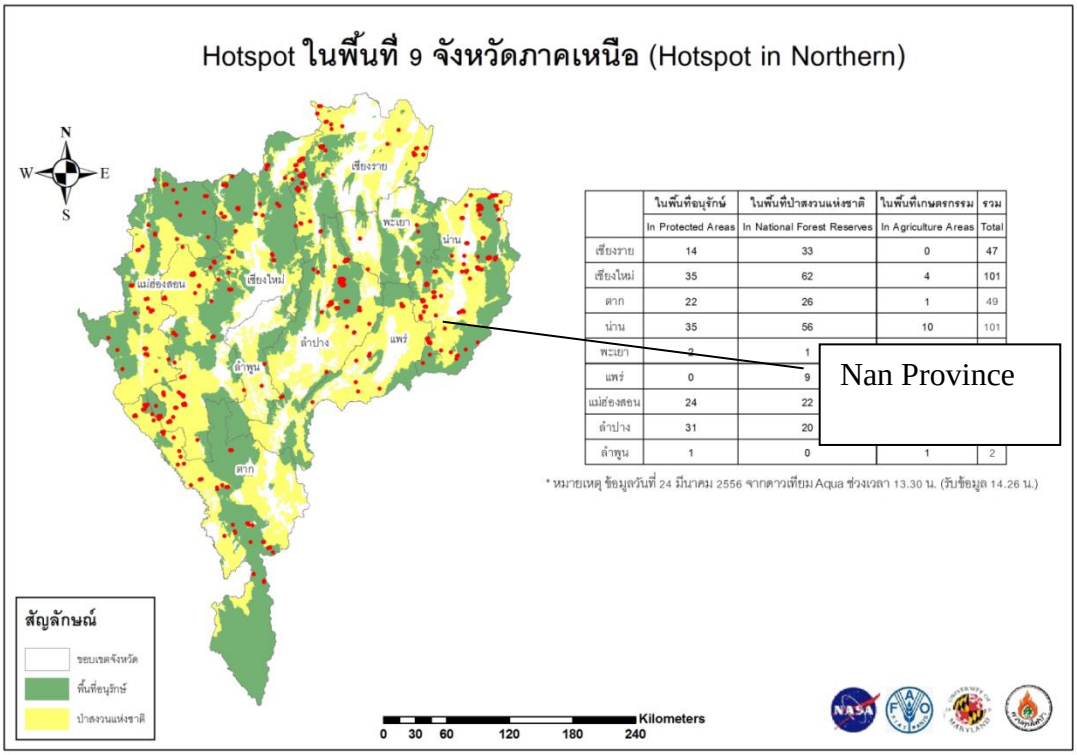
The complicated factors that affect public perceptions of the smoke may be different from communities and individuals. The individual factor of the perception of crops and forest fire may vary according to previous experience of forest fire (Blanchard & Ryan, 2007), local environmental secretary (Wertz-Kanounnikoff & Chomitz, 2008), income (Macey, 2008), and education level (Macey, 2008; Wertz-Kanounnikoff & Chomitz, 2008).

The health risk of crops and forest fire smoke exposure management programs and plans should consider some key points about public perceptions on crops and forest fire smoke such as public beliefs and attitudes about the advantages or harmfulness of forest fire and effects of smoke exposure, public concerns about controlling fire and reducing smoke exposure, and the understanding of individual effect (Blades & Hall, 2011). Moreover, community and individual level interventions for reducing exposure to crops and forest fire smoke are an important factor for

improving population participation. The efficiency of programs depends on peoples' perceptions of exposure and risk for individual agreement and operation. Study on health risk perception have observed the multi-factor with demographic, cultural and political characteristics which cause differences in perception (Egondi et al., 2013).

2.9 Situation of problem in Nan Province

The Natural Resource Office of Nan Province reported the fire situation. There were 29 times of extinguish and the burning areas were 0.5 km^2 in 2012. The number of extinguish times was increased and burning areas was also increased in 2013 that 123 times of extinguish and burning areas were 2 km^2 in 2013 (DNP, 2013). The hotspot is also indicative of burning in the areas, reported by the Forest Fire Control Division National Park, Wildlife and Plant Conservation Department.



	ในพื้นที่อนุรักษ์	ในพื้นที่ป่าสงวนแห่งชาติ	ในพื้นที่เกษตรกรรม	รวม
	In Protected Areas	In National Forest Reserves	In Agriculture Areas	Total
เชียงราย	14	33	0	47
เชียงใหม่	35	62	4	101
ตาก	22	26	1	49
น่าน	35	56	10	101
พะเยา	3	1		
แพร่	0	9		
แม่ฮ่องสอน	24	22		
ลำปาง	31	20		
ลำพูน	1	0	1	2

* หมายเหตุ ข้อมูลวันที่ 24 มีนาคม 2556 จากดาวเทียม Aqua ช่วงเวลา 13.30 น. (รับข้อมูล 14.26 น.)

Figure 2: Hotspots in Northern on 24 March 2013

Source:http://www.dnp.go.th/forestfire/hotspot/2557/Noaa_Modis_24_03_56.htm

The air quality monitoring station has been located at the Municipality Office of Nan since 2009. The report of Pollution Control Department has shown averaging 24 hours of PM10 concentration continuously increased to 99 – 270 microgram/cubic

meter during 13rd March – 14th April 2013. While Thailand defined exceeded the 24-h average standard level of PM10 is 120 micrograms/cubic meter and WHO defined exceeded the 24-h average guideline level of PM10 is 50 microgram/cubic meter. In February 2012, PM10 concentration was higher than that of the same day in 2013. The data of PM10 was low in the same day likely because of the air quality monitor station which had trouble functioning and lead to missing data. In Nan Province since 2009 to 2013, level of PM10 has peaked in March (PCD, 2013).

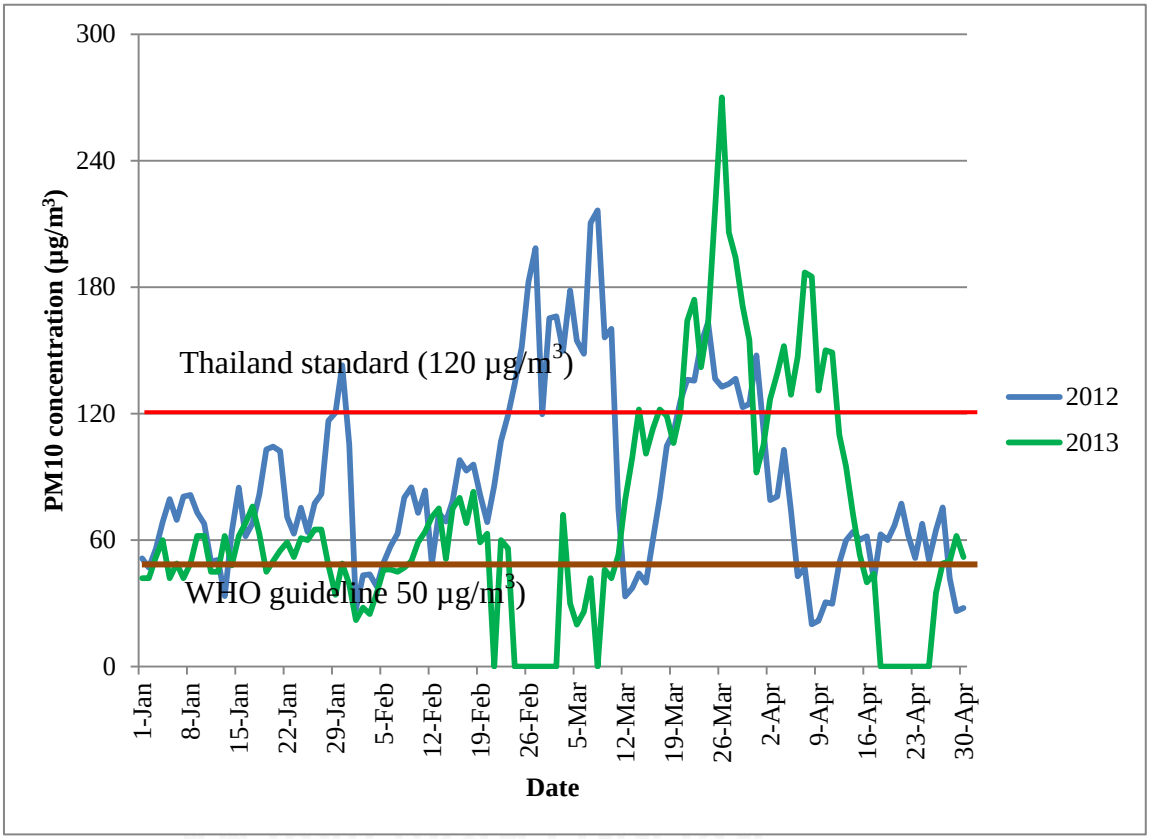


Figure 3: 24-h average concentration of PM10 in Nan Province

Source: http://aqnis.pcd.go.th/northhaze

The particulate matter is the principal pollutant of concern from forest fire smoke for the relatively short-term exposure. Disease Control Department (DCD) of Thailand has been monitoring the health effect in haze areas since 2011. The health surveillance system was monitored on respiratory system disease, cardiovascular system diseases, eyes and skin disorder (DCD, 2013). Fourteen hospitals of Nan Province have sent the monitored diseases data to DCD by weekly report. The worst situation of health effect in 2013 began in March; Nan Hospital reported that more

than 8,000 persons came to hospital with asthma and other respiratory disease, average 300 persons per day in March 2013 (PRDR3, 2013).

Table 4: The health effect related crops and forest fire smoke tracking by DCD, weekly rate (per 1,000 populations)

Week	Date	Cardiovascular disease (I00-I99)	Respiratory disease (J00-J99)	Eye irritation (H10-H19.8)	Skin irritation (L20-L29.9, L30-L30.9)
9	24 Feb. –2 Mar.	284.66	222.67	24.24	17.66
10	3-9 Mar.	241.06	265.00	23.94	27.65
11	10- 16 Mar.	394.15	329.66	36.01	26.84
12	17 – 23 Mar.	742.68	389.90	53.34	43.44
13	24 -30 Mar.	485.94	471.50	42.79	44.06
14	31 Mar. – 6 Apr.	476.37	389.90	35.22	24.76
15	17-13 Apr.	506.8	337.91	30.12	27.18
16	14-20 Apr.	392.39	292.08	29.59	30.75
17	21-27 Apr.	352.71	283.20	29.94	32.35

Source: http://dpc10.ddc.moph.go.th/epidpc10/list_report.php?item_id=1

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Design

This was a cross-sectional study concerning assessment of receiving information, perception, and health protection from crops and forest fire smoke among high school students in Nan Province, Northern Thailand.

3.2 Study population

The high school students in Nan Province were the target population because the students had a chance to get the information from community sources and extra source from school education system. The students can disseminate the information to their family and community. In addition, connection/ social participation is very strong among students in Nan Province (Hug Muang Nan Foundation) (prapai, 2011)

The students with high perception and good health protection may disseminate the information and they could be the good protection model for their families and communities. The downtown school was the target school because the school had students who are not only from the Nan municipality and the Mueang Nan District but also from several districts of Nan Province. There are 3 important high schools in urban of Nan Province; Srisawat Wittayakarn School (the boy school), Strisrinan School (the girl school) and Nuntaburivittaya School, which is a representative school of Nan Province in this study because this school is the coeducational school. This school was established according to His Majesty King Bhumibol Adulyadej's initiative and the students in this school are native from several tribes, such as Lanna native, most of them live in suburbs; and hill tribes such as Hmong, Wa, Kamu, Luo, and Tin. The students lived in several districts around Nan Province such as Mueang Nan, Phu Phiang, Wiang Sa, and Tha Wang Pha.

3.3 Sampling technique

Nuntaburivittaya School was purposively selected. Students were selected using simple random sampling method. In 2013, there were altogether 856 students in the level 1-6. There were 12 classrooms of 237 students in junior high school level (level 1-3); 21 classrooms of 619 students in senior high school level (level 4-6)

There were 30 – 45 students per a classroom. Three classrooms of junior high school level and 6 classrooms of senior high school level were randomly selected to collect the data. The total classrooms for this study were 9 classrooms including 1/3, 2/5, 3/1, 4/1, 4/6, 5/2, 5/4, 6/1, 6/7.

3.4 Sample size

Yamane (1967) formula was used to calculate the sample size with 95% confidence level (allowable error is 0.05).

$$n = \frac{N}{1 + Ne^2}$$

n = Sample size
N = Population size = 856
e = allowable error = 0.05

There were 856 students in this school. The sample size of this study was 272 students with 95% confidence level.

3.5 Study instrument

The self-administrated questionnaire was used to examine socio- demographic characteristics, access to information, perception of health risk, and health protection from crops and forest fire smoke.

Part A: Socio-demographic characteristic: Close-Ended Response Question including address, sex, age, studying level, parents' occupation, whether the family burned the crops and forest within 1 kilometer radius in the last 3 months, and family income per month.

Part B: Access to Information, in the last 3 months in 2014 (January – present) and the smoke episode in the previous year (January – April 2013).

B1 Receiving information: frequency of seeing or hearing about the issues and knowledge about causes of smoke, environment and the health effects of the smoke, and health protection measures, 7 items, and notification to stop crops and forest burning, air quality, and health protection, 3 questions. It was classified into 4 scales;

Frequently	=	3 score
Sometimes	=	2 score
Occasionally	=	1 score
Never	=	0 score

For descriptive analysis, receiving information was classified into 3 levels by mean ± SD into 3 groups: Low level of received information (<mean – SD.), Moderate received information (range of mean ± SD.), and High received information (>mean + SD.)

B2 Information source: frequency of seeing or hearing the above information from school education, and community information sources. There are total of 7 information sources. It was classified into 4 scales;

Frequently	=	3 score
Sometimes	=	2 score
Occasionally	=	1 score
Never	=	0 scores

Part C: Perception of the cause and environment and health effect of the smoke 11 items. It was classified into 3 scales which include both positive and negative;

For positive questions			For negative questions		
Agree	=	3 score	Agree	=	1 score
Not sure	=	2 score	Not sure	=	2 scores
Disagree	=	1 score	Disagree	=	3 score

For descriptive analysis, perception of student was categorized by mean ± SD into 3 groups: Low perception (<mean – SD.), Moderate perception (range of mean ± SD.), and High perception (>mean + SD.)

Part D: Health protection: health protections from crops and forest fire smoke include 11 measures in 3 parts; resident environmental adjustment in 5 measures; personal lifestyle modification in 4 measure; and community participation in 2 measures. It was classified into 2 scales;

Yes	=	1 score
No	=	0 score

For descriptive analysis, health protection of student was categorized by mean ± SD into 3 groups: Low health protection (<mean – SD.), Moderate health protection (range of mean ± SD.), and High health protection (>mean + SD.)

Validity test:

Index of Item Objective Congruence (IOC) was used to measure the content validity of the questionnaire. The content of the questionnaire was checked by consulting with 3 experts (Asst. Prof. Wattasit Siriwong, Ph.D, Nutta Taneepanichskul, Ph.D, and Benjawan Tawatsupa, Ph.D). Index of Item Objective Congruence (IOC) of the questionnaire was 0.6. The questionnaire was adjusted according to the experts' comments.

Reliability test:

After the validation, the revise questionnaire was tested for reliability by conducting a pilot study with 30 students in Sinjong School of Nan Province, where the students have similar characteristics with the sample population. The questionnaire was re-adjusted again. Cronbach's alpha was used to measure the reliability and the reliability of questionnaire was 0.8, as shown in Appendix B.

3.6 Data collection

Researcher contacted ~~to~~ the school director for permission to conduct the study. Then, informed the adviser of selected classrooms for the study (as shown in index 3.3) to collect data in the school report receiving day. After sampling the students during their school report receiving day, the students are relocated to the outdoor space and allowed them to in line according to their classrooms. The researcher gave the self-administrated questionnaires to the students who sit in front of the line and they passed them on to their friends in the line. Then, the researcher explained about purposes of the study, profit, confidentiality, freedom to withdraw, access to final report, and also informed them that the data will not be misused for other purposes. The students spent about 20 minutes to write answers in the questionnaire. After all students completed answering, they sent their questionnaire form back to the front of line. After finishing the session, the researcher distributed the books on knowledge regarding protection from crops and forest fire smoke to the students as a token of appreciation for contributing their time for the study.

3.7 Data analysis

The data was analyzed by using SPSS program, version 17 for windows. Descriptive statistics (frequency, percentage, mean and standard deviation) were used primarily to summarize and describe the Socio-demographic characteristic**,** Access to Information**,** Perception and Health protection. For analytical statistic, Chi-square was used to assess the association between health protection and socio-demographic characteristic, receiving information, and perception; and association between perception and receiving information

3.8 Ethical considerations

The study was approved by the Ethical Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University. The International Conference on Harmonization-Good Clinical Practice (ICH-GCP) was used. The certificate of ethical approval number was COA No. 058/2557. Any of the participants' personal information was kept confidential. Results of the study were reported as total picture. Any of personal information which could be able to identify them was not appear in the report.

CHAPTER IV

RESULT

This chapter provides the detailed description of the results from the analysis of the survey. The variables are described as number, percentage, mean, and standard deviation. It starts with the Socio-demographic characteristics data followed by the responses from each section of the questionnaire. The level of received information regarding crops and forest fire smoke, the level of perception on cause and smoke risk during the smoke episode, and the level of health protection of crops and forest fire smoke exposure were presented respectively.

Association between health protection from crops and forest fire smoke exposure and socio-demographic characteristics, received crops and forest fire smoke information, perception of cause and smoke risk during the smoke episode, and the associated between perception of cause and smoke risk during the smoke episode and received information regarding crops and forest fire smoke are also described in this chapter.

4. 1 Socio-demographic characteristics

This study was conducted in the Nantaburivittaya School of Nan Province. Two hundred and seventy eight (278) participants completed the survey questionnaire. Most students were living in the rural areas (94.2%): in this study the urban area was the Mueang Nan municipality, other areas of the Mueang Nan District and others were regarded as the rural area. More than half of the respondents (52.2%) were living in Mueang Nan District. The majority of the participants were female (64.4%). The median age of the respondents' was 16 years and the age range was from 12 to 20 years. The age group was classified into 2 levels; <15 and ≥15 years old: refering to the age level of Thai Population (Institute for Population and Social Research, 2010), Most students were ≥15 years old. Nearly 65% were studying in senior high school level. Most of them are living with father and mother (68.3%). Most of their parents' occupation was farmer. Nearly one-fourth of their families used to burn agricultural residues (24.1%). Majority of the families' incomes were less than 5,000 Bahts per month (49.3%), as shown in Table 5.

Table 5: Distribution of the respondents classified by socio-demographic characteristics

Characteristics	Number	Percentage
Address		
Community type		
Urban	16	5.8
Rural	262	94.2
Total	**278**	**100.0**
District		
Mueang Nan	145	52.2
Phu Phiang	56	20.1
Wiang Sa	22	7.9
Tha Wang Pha	16	5.8
Other District	33	11.9
Other Province	6	2.2
Total	**278**	**100.0**
Gender		
Male	99	35.6
Female	179	64.4
Total	**278**	**100.0**
Age group (years)		
>15	59	21.2
≥15	219	78.8
Total	**278**	**100.0**
Mean = 16.09 SD. = 1.65 Median = 16 Range 12-20		

Table 5: (continued) Distribution of the respondents classified by socio-demographic characteristics

Characteristics	Number (n=278)	Percentage
Studying level		
Junior high school	98	35.3
Senior high school	180	64.7
Total	**278**	**100.0**
Living with		
Father	8	2.9
Mother	36	12.9
Father & Mother	190	68.3
Relatives	37	13.3
Others (e.g. Priest)	7	2.5
Total	**278**	**100.0**
Father's occupation		
Farmer	111	50.0
Employee	24	10.7
Famer & Employee	25	11.3
Own business	13	5.9
Others	49	22.1
Missing (n)	(56)	-
Total	**222**	**100.0**

Table 5: (continued) Distribution of the respondents classified by socio-demographic characteristics

Characteristics	Number (n=278)	Percentage
Mother occupation		
Farmer	124	50.8
Employee	34	13.9
Famer & Employee	33	13.5
Own business	18	7.4
Others	35	14.3
Missing (n)	(34)	-
Total	**244**	**100.0**
Did the family burn the crops and forest in last 3 months		
No	163	58.6
Yes		
Burning of agricultural residues	63	22.7
Burning of waste	27	9.7
Burning of forest and brush land to plantations	9	3.2
Prescribed burning in forestry	11	4.0
Burn for more than one situation	5	1.8
Total	**278**	**100.0**

Table 5: (continued) Distribution of the respondents classified by socio-demographic characteristics

Characteristics	Number	Percentage
Family income per month (Baht)		
< 5,000	137	49.6
5,001 - 10,000	89	32.2
10,001 - 15,000	32	11.6
15,001 - 20,000	9	3.3
> 20,001	9	3.3
Missing (n)	(2)	-
Total	**276**	**100.0**

4.2 Receiving information

4.2.1 Receiving information in present year

The respondents answered the questions regarding how frequent they had seen or heard about the information regarding cause of smoke, health effect of the smoke exposure, and health protection 7 items, and notification on forbiddance of burning, situation of fire, and air quality of Nan Province, measurement of avoidance and reduction the smoke-related the air quality 3 items. The frequency of receiving information was classified into 4 scales. The score was given to each item as follow: frequently = 3 scores, sometimes = 2 scores, occasionally=1 score, and never = 0 score.

Table 6 showed that the students had received all of the information items sometimes (2 scores). The most frequently received information was item regarding the forbiddance of burning in forest, agricultural land, and community (36.7%) of the students as mean 2.18 which is followed by using mask to reduce the smoke exposure when living in air pollution (mean = 2.02) and the health effects of crops and forest fire smoke such as skin irritation, eye irritation, respiratory and cardiovascular illnesses (mean = 2.00). Nearly 15% of the students had never got any the suggestion to follow the information about crops and forest fire.

Table 6: Percentage of the respondents by the received information of individual item regarding crops and forest fire smoke.

Item	Percentage (%) (n=278)				$\bar{X}$ ± SD.
	Never	Occasionally	Sometimes	Frequently	
1. The smoke during January and April is increased from open burning such as forest fire, burning of agricultural land, and burning of residential waste.	5.0	18.7	64.7	11.5	1.83±.690
2. The smoke can cause some health effects such as skin irritation, eye irritation, respiratory and cardiovascular illnesses.	5.0	17.3	50.7	27.0	2.00 ±.804
3. The susceptible populations of smoke include people with respiratory and cardiovascular disease, children, and elderly.	5.4	21.9	46.8	25.9	1.93±.832
4. The suggestion to follow the information about crops and forest fire smoke such as air quality monitoring, population-related illnesses, health impacts, and mitigation measures.	15.5	28.1	44.6	11.9	1.53±.894
5. The reduction of the smoke by residential management such as closing window and door, spraying water around resident, avoid indoor and outdoor fires.	4.7	19.4	49.3	26.6	1.98±.806

Table 6: (continued) Percentage of the respondents by the received information of individual item regarding crops and forest fire smoke.

Item	Percentage (%) (n=278)				$\bar{X}$ ± SD.
	Never	Occasionally	Sometimes	Frequently	
6. The avoidance and reduction of smoke by lifestyle modification such as staying in clean indoor, limiting physical activity, and evacuating.	5.4	20.1	48.2	26.3	1.95±.825
7. The reduction of smoke when living in air pollution by using mask.	2.2	17.6	56.1	24.1	2.02±.711
8. Forbiddance of burning in forest, agricultural land, and community.	1.1	16.2	46.0	36.7	2.18±.735
9. Situation of fire monitoring, and air quality monitoring of Nan Province	3.2	19.4	60.5	16.9	1.92±.709
10. Measurement of avoidance and reduction of smoke-related air quality.	1.1	24.8	60.8	13.3	1.86±.638

For the distribution of received information level, respondents answered a total of 10 items with the total score of 30. The mean score of received information was 19.20 $\pm$ 4.29. The range of received information score was 5 and 30 respectively. The level of received information was classified by mean ± SD into 3 groups: Low level of received information (<mean – SD.), Moderate level of received information (range of mean ± SD.), and High level of received information (>mean + SD.). Most students had moderate received information (70.9%), followed by low received information (19.1%), and high received information (10.1%), as shown in Table 7.

Table 7: Distribution of receiving information level

Receiving information level	**Number (n = 278)**	**Percentage**
Low (5 – 15 scores)	53	19.1
Moderate (15 – 24 scores)	197	70.9
High (25 – 30 scores)	28	10.1
Mean = 19.20 SD. = 4.29 Range (5 – 30)		

4.2.2 Receiving information in previous year

The items of information that students had gotten in the previous year were similar to information items they got during this year. There was also similarity in classifying the frequency scales of receiving information. Table 8 showed the frequency of receiving information in the previous year. Most students had received all of the information items sometimes (2 scores). The item regarding forbiddance burning in forest, agricultural land, and residential waste was the most frequent item which students had received (38.8%) in the previous year with mean 2.18. This was followed by using mask to reduce the smoke exposure when living in air pollution (mean = 2.04), the cause of smoke during January and April is from open burning such as burning in forest, agricultural land, and residential waste (mean = 2.04). Nearly 15% of students had never gotten the suggestion to follow the information about crops and forest fire.

Table 8: Percentage of the respondents by the received information of individual item regarding crops and forest fire smoke.

Item	Percentage (%) (n=278)				$\bar{X}$ ± SD.
	Never	Occasionally	Sometimes	Frequently	
1. The smoke during January and April is increased from open burning such as forest fire, burning of agricultural land, and burning of community waste.	2.9	16.2	57.9	23.0	2.01±.71
2. The smoke can cause some health effect such as skin irritation, eye irritation, respiratory and cardiovascular illnesses.	3.6	17.6	54.0	24.8	2.00 ±.76
3. The susceptible populations of the smoke include people with respiratory and cardiovascular disease, children, and elderly.	5.0	17.6	54.0	23.4	1.96 ±.78
4. The suggestion to follow the information about crops and forest fire smoke such as air quality monitoring, population-related illnesses, health impacts, and mitigation measures.	14.4	28.4	45.0	12.2	1.55±.89
5. The reduction of the smoke by residential management such as closing window and door, spraying water around resident, avoiding indoor and outdoor fires.	4.0	18.3	52.5	25.2	1.99±.77

Table 8: (continued) Percentage of the respondents by the received information of individual item regarding crops and forest fire smoke.

Item	Percentage (%) (n=278)				$\bar{X} \pm$ SD.
	Never	Occasionally	Sometimes	Frequently	
6. The avoidance and reduction of the smoke by lifestyle modification such as staying in clean indoor, limiting physical activity, and evacuating.	6.1	20.1	49.6	24.1	1.92±.83
7. The Avoidance of the smoke when living in bad air quality by using mask.	2.5	18.7	51.4	27.3	2.04±.75
8. Forbiddance of burning in forest, agricultural land, and community.	0.7	15.5	45.0	38.8	2.22±.73
9. Situation of fire monitoring, and air quality monitoring of Nan Province	2.9	17.7	62.6	16.9	1.94±. 68
10. Measurement of avoidance and reduction of smoke-related air quality.	1.1	24.5	60.4	14.0	1.87±.64

For the distribution of receiving information level, the respondents answered a total of 10 items into total score of 30. The mean score of receiving information was 25.13 ± 4.37. The range score of receiving information was 10 to 30. The level of receiving information was classified by mean ± SD into 3 groups like the present year. Most students had high level of received information (64.4%), followed by moderate level of received information (29.9%), and low level of received information (5.8%), as showed in Table 9.

Table 9: Distribution of received information regarding crops and forest fire smoke in the previous year (2013)

Receiving information level	**Number (n = 278)**	**Percentage**
Low (10 – 17 scores)	16	5.8
Moderate (18 – 24 scores)	83	29.9
High (25 – 30 scores)	179	64.4
Mean = 25.13 SD. = 4.37	**Minimum = 10**	**Maximum = 30**

4.3 Source of information

The students responded the questions about the frequency and source of information they used to receive regarding the crops and forest fire smoke. There were 4 frequency scales of receiving the information from all of 7 sources. The score was given to each item as follow: frequently = 3 scores, sometimes = 2 scores, occasionally=1 score, and never = 0 score.

Table 10 showed that most students used all of the information sources sometimes (2 scores). Public information sources such as television, local radio, newspaper, advertisement were the students' most accessed information source (mean = 2.23). This was followed by village source such as broadcast, poster in village hall or temple (mean = 1.92), and school activities such as broadcast, poster and outdoor space activity (mean = 1.92). About 12% of students had never used the online source to get information.

Table 10: Percentage of sources which respondents received information regarding crops and forest fire smoke

Source of information	Percentage (%) (n=278)				$\bar{X} \pm$ SD.
	Never	Occasionally	Sometimes	Frequently	
1. Campaigns consist of local, district and province events	6.8	27.7	49.3	16.2	1.75±81
2. Classroom learning	2.2	27.7	51.4	18.7	1.87 ±.73
3. School activities such as broadcast, poster, outdoor space activity	4.0	22.7	51.1	22.3	1.92±.78
4. Village source such as broadcast, poster in village hall or temple	4.3	23.7	47.1	24.8	1.92±.81
5. Human source such as friend, family member, village health volunteer	7.2	27.0	46.0	19.8	1.78±.84
6. Public source such as television, local radio, newspaper, advertisement.	2.2	14.7	40.6	42.4	2.23±.78
7. Internet source such as website, social network	12.2	21.9	42.1	23.7	1.77±.95

Table 11 shows the information source which students used to receive the information in previous year. Most students used all of the information sources sometimes (2 scores). Public information sources such as television, local radio, newspaper, advertisement were also the most accessed information source that students used to get the information (mean = 2.25). These sources were followed by village source such as broadcast, poster in village hall or temple (mean = 2.01), and school activities such as broadcast, poster, outdoor space activity (mean = 1.92).

Table 11: Percentage of sources which respondents received crops and forest fire smoke information in the previous year (2013)

Source of information	Percentage (%) (n=278)				$\bar{X} \pm$ SD.
	Never	Occasionally	Sometimes	Frequently	
1. Campaigns consist of local, district, province events	4.0	30.6	48.9	16.5	1.78±.76
2. Classroom learning	3.2	27.7	53.2	15.8	1.82±.73
3. School activities such as broadcast, poster, outdoor space activity	2.9	24.1	50.7	22.3	1.92±.76
4. Village source such as broadcast, poster in village hall or temple	2.9	19.8	51.1	26.3	2.01±.76
5. Human source such as friend, family member, village health volunteer	6.8	24.8	49.3	19.1	1.81±.82
6. Public source such as television, local radio, newspaper, advertisement.	2.5	10.8	46.0	40.6	2.25±.75
7. Internet source such as website, social network	8.6	20.9	45.3	25.2	1.87±.89

4.4 Perception

The students also answered the questions regarding perception about causes, environmental impact, and health risk of the smoke (11 items). The responses were classified into 3 scales for both positive and negative items. The score was given to each item as follow: for positive questions; agree =3 scores, not sure =2 scores, disagree = 1 score, and for the negative questions; agree =1 score, not sure = 2 scores and disagree = 3 scores.

As the data shown in Table 12, the majority of student had high perception and good understanding on cause, environmental impact, and health risk of the smoke. Most students perceived the cause of smoke during January to April as burning in forest, agricultural land, and community areas (63.3%). They also have high perception and understanding on crops and forest fire smoke causing the dim weather (63.3%), and decreasing the visibility (62.9%). Crops and forest fire smoke can cause respiratory symptoms such as difficulty breathing, cough, and sore throat (65.8%); skin irritation (56.5%); and eye irritation (63.7%). The susceptible populations of the smoke impact include children (56.5%), elderly (51.8%), and people with heart or lung diseases (54.7%). Less than half students perceived that smoke from crops and forest fires do not affect their lives (47.5%), and they were not sure about which is more dangerous in comparison of smoke from crops and forest burning and air pollution from other sources (48.6%).

Table 12: Percentage of the respondents by the perception on individual item.

Item	Percentage (%) (n=278)			$\bar{X} \pm$ SD.
	Agree	Not sure	Disagree	
1. The causes of the smoke in Nan Province during January and April are the burning of forests, agriculture lands, and community areas.	63.3	25.9	10.8	2.53±.68
2. Crops and forest fire smoke can cause dim weather.	63.3	29.1	7.6	2.56±.63
3. Crops and forest fire smoke can decrease visibility.	62.9	29.5	7.6	2.55±.65
4. The crops and forest fire smoke can cause the respiratory symptoms such as difficulty breathing, coughing, and sore throat	65.8	27.7	6.5	2.59±.61
5. The crops and forest fire smoke can cause skin irritation.	56.5	37.1	6.5	2.50±.63

Table 12: (continued) Percentage of the respondents by the perception on individual item.

Item	Percentage (%) (n=278)			$\bar{X} \pm$ SD.
	Agree	Not sure	Disagree	
6. The crops and forest fire smoke can cause eye irritation.	63.7	31.7	4.7	2.59±.59
7. The children are the susceptible population to the crops and forest fire smoke.	56.5	38.5	5.0	2.51±.59
8. The elderly are the susceptible population to the crops and forest fire smoke.	51.8	43.2	5.0	2.47±.59
9. The people with heart or lung diseases are the susceptible population to the crops and forest fire smoke.	54.7	40.3	5.0	2.50±.59
10. Smoke from crops and forest fires doesn't affect your life.	23.4	29.1	47.5	2.24±.81
11. Forest fire smoke is less dangerous compared to air pollution from other sources	25.5	48.6	25.9	2.0±.72

Regarding the respondents' perception level, they answered a total of 11 items; total score of perception were 33. The mean of perception score for all respondents was 27 ±4.21. The range of the perception score was 11 and 33. The level of perception was classified by mean ± SD into 3 levels: low perception (<mean – SD. = 11 – 22 scores), moderate perception (range of mean ± SD. = 23 – 29 scores), and high perception (>mean + SD. = 30 – 33 scores). Most of the students had moderate perception (70.2%), followed by low perception (17.6%), and high perception (12.2%), as shown in Table13.

Table13: Number and percent distribution of perception level of respondents on crops and forest fire smoke risk

Perception level	Number (n = 278)	Percentage
Low (11 – 22 scores)	49	17.6
Moderate (23 – 29 scores)	195	70.2
High (30 – 33 scores)	34	12.2
Mean = 27 SD. = 4.21 Range = 11 - 33		

4.5 Health protection

4.5.1 Health protection in present year

The health protection measures topic comprised of 11 items in 3 parts; resident environmental adaptation 5 measures; personal lifestyle modification 4 measures; and community participation 2 issues. Table 14 showed that staying inside the clean resident was the measure the students mostly used to protect them from smoke exposure (73.0%) which is followed by closing the windows and door (70.5%), and avoiding outdoor burning (69.8%). The use of domestic air conditioner was the least used measure of the respondents in reducing smoke exposure (12.9%).

Table 14: Number and percentage of respondents by health protection against crops and forest fire smoke exposure.

Items	Don't do		Do	
	Number	Percentage	Number	Percentage
1. Using domestic air conditioner	242	87.1	36	12.9
2. Closing the windows, door	82	29.5	196	70.5
3. Spraying water around resident	152	54.7	126	45.3
4. Avoiding indoor burning	90	32.4	188	67.6

Table 14: (continued) Number and percentage of respondents by health protection against crops and forest fire smoke exposure.

Items	Don't do		Do	
	Number	Percentage	Number	Percentage
5. Avoiding the outdoor burning around the residential area	84	30.2	194	69.8
6. Checking the information such as air quality and mitigation measure-relating to air quality	118	42.4	160	57.6
7. Staying inside the clean resident	75	27.0	203	73.0
8. Leaving or evacuating from the high smoke concentration area	86	30.9	192	69.1
9. Using dust mask	93	33.5	185	66.5
10. Participating with community in management of fire such as extinguishing fire by you or reporting to local government when there is fire in the community or forest fire.	122	43.9	156	56.1
11. Participating with community or government in campaign regarding protection from smoke	100	36.0	178	64.0

For the health protection level, the respondents answered a total of 11 dichotomous questions (Yes or No). The score of 1 was given to every Yes answer and 0 to every No answer. The highest score was 11. The mean of health protection score was 6.54 $\pm$ 2.16. The range of health protection score was from 1 to 11. The level of health protection was classified by mean ± SD into 3 levels: low health protection (<mean – SD. = 1-4 scores), moderate health protection (range of mean ± SD. = 5– 9 scores), and high health protection (>mean + SD. = 10-11 scores). Most of the students had moderate health protection (72.6%), followed by high health protection (15.5%), and low health protection (11.9%), as shown in Table15.

Table 15: Number and percent distribution of health protection level on crops and forest fire smoke exposure

Health protection level	**Number (n = 278)**	**Percentage**
Low (1-4 scores)	43	15.5
Moderate (5– 9 scores)	202	72.6
High (10-11 scores)	33	11.9
Mean = 6.54 SD. = 2.16 Minimum = 1 Maximum = 11		

4.5.2 Health protection in the previous year

The health protection measures that students used to protect them from crops and forest fire smoke in the previous year were similar to health protection measures they are using in present year. There were also similarities in classifying the scales of practice. Table 16 showed that most of the students used all of mitigation measures to protect from smoke exposure except using domestic air conditioner. Staying inside the clean resident was the mostly used measure among the respondents in protecting themselves from smoke exposure (73.0%). Closing the windows and door (66.9%), and using dust mask (65.1%) stood as second and third mostly used measures respectively. Using domestic air conditioner was the least applied measure for respondents in reducing the smoke exposure (12.2%).

Table 16: Number and percent distribution of the respondents by level of health protection from crops and forest fire smoke exposure during the previous year.

Items	Don't do		Do	
	Number	Percentage	Number	Percentage
1. Using domestic air conditioner	244	87.8	34	12.2
2. Closing the windows and door	92	33.1	186	66.9
3. Spraying water around resident	140	50.4	138	49.6
4. Avoiding the indoor burning	100	36.0	178	64.0
5. Avoiding the outdoor burning around the resident	100	36.0	178	64.0
6. Checking the information such as air quality and mitigation measure-related to air quality	117	42.1	161	57.9
7. Staying inside the clean resident	85	30.6	193	69.4
8. Leaving or evacuating from the high smoke concentration area	100	36.0	178	64.0
9. Using dust mask	97	34.9	181	65.1

Table 16: (continued) Number and percent distribution of the respondents by level of health protection from crops and forest fire smoke exposure during the previous year.

Items	Don't do		Do	
	Number	Percentage	Number	Percentage
10. Participating with community in management of fire such as extinguishing fire by your or reporting to local government when there is fire in the community or forest fire.	106	38.1	172	61.9
11. Participating with community or government in campaign regarding protection from smoke	101	36.3	177	63.7

Concerning health protection level, the respondents had to answer the total of 11 questions. The score was given to each item as follow: yes = 1 score and no= 0 score. The highest total score was 11. Mean of health protection score was 6.39 $\pm$ 2.31. The range of health protection score was from 0 to 11. The level of health protection was divided into 3 groups: low health protection (<mean – SD. = 1-4 scores), moderate health protection (range of mean ± SD. = 5– 9 scores), and high health protection (>mean + SD. = 10-11 scores). Most of the students had low health protection level (54.7%) which was followed by moderate health protection level (28.1%), and high health protection level (17.3%), as shown in Table17.

Table 17: Number and percent distribution of respondents by level of health protection regarding crops and forest fire smoke exposure in the previous year (2013)

Protection level	**Number (n = 278)**	**Percentage**
Low (0 – 4 scores)	152	54.7
Moderate (5 – 9 scores)	78	28.1
High (10 - 11 scores)	48	17.3
Mean = 6.39 SD. = 2.31 Minimum = 0 Maximum = 11		

4.6 The association between health protection and socio-demographic characteristic, receiving information, perception, and the association between perception and receiving information

This part showed the association between health protection of crops and forest fire smoke exposure, and socio-demographic characteristics, receiving information, perception. In addition, it showed the association between perception and receiving information.

4.6.1 Association between health protection and socio-demographic characteristic

The researcher divided the level of health protection to 2 levels: Less than, or equal to mean (≤ 7) and Greater than mean (>7). Chi-square test was used to analyze the association between level of health protection and socio-demographic characteristic (gender, age group, studying level, etc.). This study found out that there was no statistically significant association between the socio-demographic characteristics investigated in this study and the level of health protection except for the variable of studying level showing significant association (p value = 0.034). The detailed description of these tests is shown in Table 18 to Table 22.

Table 18: Association between level of health protection and gender (n = 278)

Gender	Level of health protection		
	Less than, or equal to mean (≤ 7) No. (%)	**Greater than mean (>7) No. (%)**	**Total No. (%)**
Male	63 (63.6)	36 (36.4)	99 (100.0)
Female	129 (72.1)	50 (27.9)	179 (100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 2.121	df = (1)	(p-value = 0.145)	

As shown in Table 17, there was no association between the gender and level of health protection. Although there were more male respondents (36.4%) who had higher health protection than female (27.9%), no statistically significant association was found between level of health protection and gender (p-value = 0.145)

Table 19: Association between level of health protection and age group (n = 278)

Age group (year)	Level of health protection		
	Less than, or equal to mean (≤ 7) No. (%)	**Greater than mean (>7) No. (%)**	**Total No. (%)**
<15	37 (62.7)	22 (37.3)	59 (100.0)
≥ 15	155 (70.8)	64 (29.2)	219 (100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 1.415	df = (1)	p-value = 0.234	

As shown in Table 18, there were more younger students (37.3%) with higher level of health protection than older students (29.2%).However, no significant association could be found between age group and level of health protection (p-value = 0.234).

Table 20: Association between level of health protection and studying level (n = 278)

Studying level	Level of health protection		
	Less than, or equal to mean (≤ 7) No. (%)	Greater than mean (>7) No. (%)	Total No. (%)
Junior high school	60 (61.2)	38 (38.8)	98 (100.0)
Senior high school	132 (73.3)	48 (26.7)	180 (100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 4.355	df = (1)	p-value = 0.037	

As shown in Table 20, the studying level had significant association with the level of personal health protection with p-value statistically significant at 0.037. Regarding health protection, (38.8%) of Junior high school students had health protection level higher than the mean and only (14.4%) of senior high school students had high health protection level.

Table 21: Association between level of health protection and the family burning the crops and forest in the last 3 months (n = 278)

Did the family burn the crops and forest in last 3 months	Level of health protection		
	Less than, or equal to mean (≤ 7) No. (%)	Greater than mean (>7) No. (%)	Total No. (%)
No	116 (71.2)	47 (28.8)	163 (100.0)
Yes	76 (66.1)	39 (33.9)	115 (100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 0.841	df = (1)	p-value = 0.379	

As shown in Table 21, there was not significant association between experience of their families about the burning of crops and forest fires and health protection (p-value = 0.379). However, students with families didn't burn the crops and forest had the higher level of health protection less than the students with families did burn the crops and forest.

Table 22: Association between level of health protection and the family income per month (n = 276)

Family income per month (Baht)	Level of health protection		
	Less than, or equal to mean (≤ 7) No. (%)	Greater than mean (>7) No. (%)	Total No. (%)
< 5,000	94 (68.6)	43 (31.4)	137 (100.0)
5,001 - 10,000	61 (68.5)	28 (31.5)	89 (100.0)
10,001 – 15,000	27 (84.4)	5 (15.6)	32 (100.0)
> 15,000	9 (50.0)	9 (50.0)	18 (100.0)
Total	191 (69.2)	85 (30.8)	276 (100.0)
χ^2 = 6.611	df = (3)	p-value = 0.085	

As shown in Table 22; it was not statistically significant association between family income and health protection (p-value = 0.085). However, the students with higher family income had higher health protection except for the income level 10,001 – 15,000 Baht per month,

4.6.2 Association between health protection and receiving information

The researcher designed to classify the level of health protection into association study with 2 levels; Less than, or equal to mean (≤ 7 and Greater than mean (>7). This study also found out that the students who had low receiving information were nearby the high receiving information, therefore the researcher designed to cut off the level of receiving information to 2 levels; Less than, or equal to mean (≤ 19 and Greater than mean (>19). The association between level of health protection and receiving information was tested using chi-square test. The students with higher received information had higher health protection from crops and forest fire smoke. The level of health protection was significantly associated with level of receiving information (p-value = 0.033), as shown in Table 23.

Table 23: Association between level health protection and level of receiving information (n = 278)

Level of receiving information	**Level of health protection**		
	Less than, or equal to mean (≤ 7) No. (%)	**Greater than mean (>7) No. (%)**	**Total No. (%)**
Less than, or equal to mean (≤ 19)	84 (76.4)	26 (23.6)	110 (100.0)
Greater than mean (>19)	108 (64.3)	60 (35.7)	168 (100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 4.593 df = (1) p-value = 0.033			

4.6.3 Association between health protection and perception

The researcher designed to cut off the level of health protection into association study with 2 levels; Less than, or equal to mean (≤ 7 and Greater than mean (>7). This study also found out that the percentage of students with low perception was close to the students with high perception. Therefore the researcher designed to cut off the level of perception into 2 levels; Less than, or equal to mean (≤ 27) and Greater than mean (>27). The association between level of health protection and perception was tested by chi-square test. The students with higher perception had higher health protection about 2 times. The level of health protection was strongly associated with level of receiving information (p-value < 0.001), as showed in Table 24.

Table 24: Association between level of health protection and level of perception (n = 278)

Level of perception	**Level of health protection**		
	Less than, or equal to mean (≤ 7) No. (%)	**Greater than mean (>7) No. (%)**	**Total No. (%)**
Less than, or equal to mean (≤ 27)	106 (79.7)	27 (20.3)	133 (100.0)
Greater than mean (>27)	86 (59.3)	59 (40.7)	145 (100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 13.497 df = (1) p-value < 0.001			

4.6.4 Association between perception and receiving information

The level of perception was classified into 2 levels; Less than, or equal to mean (≤ 27) and Greater than mean (>27); and the level of receiving information was also classified into 2 levels; Less than, or equal to mean (≤ 19) and Greater than mean (>19). The association between level of perception and level of received information was tested by chi-square test. The students with higher received information had higher health protection. The level of perception was significantly associated with level of received information (p-value = 0.011), as showed in Table 25.

Table 25: Association between level of perception and level of received information (n = 278)

Level of receiving information	**Level of perception**		
	Less than, or equal to mean (≤ 27) No. (%)	**Greater than mean (>27) No. (%)**	**Total No. (%)**
Less than, or equal to mean (≤ 19)	63 (57.3)	47 (42.7)	110(100.0)
Greater than mean (>19)	70 (41.7)	98 (58.3)	168(100.0)
Total	192 (69.1)	86 (30.9)	278 (100.0)
χ^2 = 6.488 df = (1) p-value = 0.011			

CHAPTER V

CONCLUSION, DISCUSSION, AND RECOMMENDATION

This chapter will provide description and discussion of major findings and their significance to perception and health protection from crops and forest fire smoke. It also includes recommendations for further research.

This chapter will provide description and discussion of major findings and their significance to perception and health protection from crops and forest fire smoke. It also includes recommendations for further research.

5.1 Conclusion

5.1.1 The information receiving

The most frequently received information was item regarding the forbiddance of burning in forest, agricultural land, and community (mean=2.18), which is followed by using mask to reduce the smoke exposure when living in air pollution (mean = 2.02) and the health effects of crops and forest fire smoke such as skin irritation, eye irritation, respiratory and cardiovascular illnesses (mean = 2.00). About 15% of students reported that they had never received the suggestion to follow the crops and forest fire smoke information. Most students had moderate received information (70.9%), followed by low received information (19.1%), and high received information (10.1%).

The information source that student used to receive the information in this study was designed to cover the common source in the community and the school source. Campaigns/ events have the large-scale impact with standard messages that have led to social change (Red Cross, 2011) ; most students (49.3%) had received the information from campaigns /events sometimes. About half of students had sometimes received the information from school; classroom learning; and school activity. The community information channels such as community broadcast, poster at community hall or temple was the commonly used source for the students to receive the information. Public information source, such as television, local radio, newspaper, advertisement was the most common source that students used to receive the information.

5.1.2 Perception about health risk

Among ten items of perception on cause, environment and human health problems due to crops and forest fire smoke, the students had high perception on almost all of the items. Majority of students had high perception on the environmental effect of the smoke. The crops and forest fire smokes effect had caused the dim sky during the daytime (63.3%); and had decreased the distance visibility (62.9%). Most students had high perception about health effect of the smoke; crops and forest fire smokes were the cause of increasing of health effect; difficulty breathing, cough, and sore throat (65.8%); skin irritation (56.5%) and eyes burning (63.7%). The smoke had affected them. The occurrence of those health symptoms was higher during the smoke episode than during the period of cleaner ambient air.

More than half of the students had high perception regarding the susceptible populations which include children (56.5%); elderly (51.8%); and the people with heart or lung diseases (54.7%) getting affected by the smoke more than normal population. About half of the students had high perception about the disturbance of crops and forest fires smoke in their life. This item was the negative item and the highest score was given to the answer “disagree”. The last item regarding perception was the danger of crops and forest fire smoke compared with the smoke from other sources. About half of the students were not sure what type of smoke was more dangerous.

To describe the total picture of the students’ perception about health risk of crops and forest fire smoke**,** the perception was classified into different levels and it was found out that major portion of the respondents (70 %) had moderate level perception. About 18% had a low perception, and only a few (12%) had high perception.

The level of receiving information was significantly associated with level of perception (p-value = 0.011). About 60% of students with higher received information had better level of perception, while nearly 40% of students with lower received information had better level of perception. The study also found that the received information in the previous year was significantly associated with level of perception (p-value < 0.001). More than 85.0% of students with higher received information had better level of perception, while (11.1%) of students with lower received information had better level of perception.

5.1.3 Health protection from crops and forest fire smoke

Among of eleven measures of health protection from crops and forest fire smoke; most students mainly used avoiding or reducing the exposure of crops and forest fire smoke except using domestic air conditioner. About 13.0% of participants (12.9%) used domestic air conditioner to protect from crops and forest fire smoke exposure. The students used the other measures to adjust the environment of their resident to avoid and to reduce the smoke. Majority of them (70.5%) closed the windows and/or doors to protect themselves from outside air pollution. This measure was easiest and didn't need any resource to practice it. Less than half of the students didn't reduce the outdoor smoke concentration by spraying water around their resident. This measure not only needs enough water, but also needs spraying equipment. Most students avoided burning around their resident for prevent increasing of outdoor smoke, and avoided in door burning to increase the smoke in the resident.

Most students modified their lifestyle during the smoke episode. They checked the information such as air quality and mitigation measure related to the air quality (57.6%). Over 70.0% of respondents stayed inside clean resident as this measure was easiest to avoid the outdoor smoke. They avoided the high smoke concentration area such as limiting outdoor activity, evacuation to cleaner air area (69.1%). They used mask when they lived in high smoke concentration area (66.5%).

Most students participated in community activities to manage fire such as extinguishing fire by themselves and reporting to local government when they face the fire in the community or forest (56.1%). Most students participated with community or government in the campaign of the smoke protection (64%).

Regarding the total picture of health protection from crops and forest fire smoke, most students (72.6%) had moderate level health protection, followed by low health protection (15.5%); and high health protection (11.9%)

The socio-demographic characteristics showed no association with levels of health protection except the studying level where the junior high school students had higher health protection than the senior high school students. The burning in forest or agricultural areas or community areas within 1 kilometer radian from their resident was not significantly association with health protection with it was no (p-value = 0.379). Moreover, the family income was not significantly associate with health protection (p-value = 0.085); however the student with higher family income had higher health protection more than the student with lower family income. The

income was significantly associated with using domestic air conditioner ($p < 0.001$). The income was also significantly associated with avoiding to live in the high smoke concentration area as p-value = 0.004.

There were several items of information both knowledge and notification, which were directly associated with heath protection measures item by item. In addition, this study found that the level of health protection was significantly associated with level of received information as p-value = 0.033.

There was the strong significant association between the levels of perception and the level of health protection (p-value <0.001). The student with higher perception had higher health protection than the students with lower perception.

The comparison of health protection in the present year and the previous year; the means of health protection were 6.54±2.61 with range 1-11 and 6.39±2.31 with range 0-11, respectively. Majority of students (72.6%) had moderate health protection in the present year; and more than half of students (54.7%) had low health protection during the previous year. Increasing health protection and the received information in the previous year were significantly associate with p-value <0.001. Moreover, the information had contributed to high perception level with p-value <0.001.

5.2 Discussion

5.2.1 Information receiving

The questions about information in this study was adapted from the international guidelines for health organization to prevent public from crops and forest fire smoke (State of New Mexico, 2012; State of Oregon, 2010; USEPA, 2001; WHO/UNEP/WMO, 1999). We did not observe the current messages that local government had given to the public in Nan Provinces. This result showed that Nan Provincial government gave the important messages covering the knowledge and notification which public should know. However, the researcher should be survey to informative of Nan Province's office for comparing between communication and receiving to target group.

The result of information source of this study was consistent with the finding from the study of Krewski et al. and Macey which found out that television was the highest ranking information source for the public (Krewski et al., 2006; Macey,

2008). The public information sources are the easiest channel to receive the crops and forest fire smoke information. Audio and television have ability to disseminate information to virtually every household.

The information source concerning internet transfer such as web page (web sites) was the information source that most of the students never used to receive the information. It need cost to access the internet data. Although, web resource is the one of simple and inexpensive way to promote public perception for environmental health risk reduction (Red Cross, 2011) the family income of students may be impact to limited accessing the web resource. However, the social network was the common channel to connection in current year (Singkhajorn, 2010). Developing the easy messages and tools for adolescents may make more convenient to follow education and notification from both free cellular network source i.e. SMS, early warning and internet source i.e. Facebook, smart phone applications such as Line, What's app.

This study found that information receiving was the important factor that results for increasing the health risk perception and health protection from crop and forest fire smoke. Some studies found that people receiving information related to their health threat, less serious and accurate than people non receiving information (Lerman et al., 2002). People who are informed that they have risks try to minimize the seriousness of the health threat and derogate the risk factor in order to maintain a favorable sense of their health (Renner et al., 2008).

5.2.2 Health protection

This study was found out those 4 items of protection measures, showed significant association, junior high school students had practiced more than senior high school students i.e. avoiding the outdoor burning around the resident; using dust mask; especially in the item of community participation, participating with community in management of fire; and participating with community or government in campaign regarding protection from smoke. This could be due to the difference in amount of spare time junior high school students and senior high school students can have. Junior students can spend more time in the community and had a chance to cooperate with their community while senior high school might need more private time or took extra tutorial class to prepare the further study. The students with community participation activities had their own experience of empowerment to

protect themselves. The participation learning is to engage people in discovery and solving the problem of the risk (Red Cross, 2011).

This study found that family income was not significant associated with health protection. This finding was not consistent with the study of Macey that showed income had relationship with health protection of the smoke (Macey, 2008). However, the crosstab showed student with higher family income had more than health protection it may be caused by several reasons that the poor students either have to help their families to do the outdoor job or they have no cleaner air area to evacuate during the smoke crisis. However, there were several measures, which they could practice without needing to use money such as avoiding indoor and outdoor burning and following the smoke information.

This study found that the perception was the most important independent variable of health protection. The students with high perception who had an awareness of dangers of crops and forest fire, therefore they had to avoid and reduce the smoke exposure before it can destroy their health. This result was consisted with the results from the studies of environmental health risk perception on practice, which found risk perception is the important factor of public reaction to environmental exposures (Egondi et al., 2013; Hofmann et al., 2009)

5.3 Recommendations

1. The finding of this study showed that receiving information of student was important to increasing the health risk perception and health protection. Nan government and school can support the receiving information of student such as supporting to access the internet resource or free SMS of crops and forest fire smoke before and during smoke episode; participant learning of the school activity and classroom learning. The governor should create some types of audio and video production varies by length, distribution channels and professionalism of production such as short radio and television public service announcements (spots); short audio and video podcasts; and longer audio and video productions.

2. Future research relate to expand to how student can transfer the information to their family to reduce burning and reduce risk of exposure as well as health protection are also needed to develop and implement effectively for the fire.

3. Due to limitation of time and other resources, the study has been conducted only in Nuntaburivitaya School. Although this school is an important and

representative school in Nan Province, it might not be a representation of the schools in Northern Thailand as a whole. In future, more studies should be conducted in other provinces in the Northern part as well to find out the about pattern of information received, perception, health protection, and health effect from crops and forest fire smoke in several populations.

4. The tool of collecting data was self-administered questionnaires. Some students tried to copy the answers from their friends. This could affect the accuracy of the result. More qualitative approaches are needed such as using participatory or observation approach to see the real picture of receiving information or taking personal health protection, obtaining information from different sources such as other people who involve in the community or school, for example the provincial relation officer, the provincial health officer, the community leader and the school teacher.

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APPENDIX

Appendix A

A questionnaire

A General data

A1 Address: Community ..... Tambol .....

District ..... Province.....

A2 Sex: 1☐ Male 2☐ Female

A3 Age: .....years

A4 What is your grade?

1 ☐ Junior high school (M.1- 3) 2☐ Senior high school (M. 4-6)

A5 Who do you live with now?

1 ☐ Father 2☐ Mother 3 ☐ Father and mother

4 ☐ Relation 5 ☐ Other .....

A51 What the occupation of your family?

Occupation	Father	Mother	Other
1. Officials / government employees			
2. Employed (ie. salesman, contractors, etc.)			
3. Own business			
4. Farmers (more than one answer)			
1☐ Field crops such as rice, soybean			
2☐ Farm crops such as rice, corn, rubber			
3☐ Fruits such as lychee, longan			
4☐ Garden plant			
5☐ Others.....			
5. Finding forest resource			
6. Housekeeper			
7. Others.....			

A51 Did your family burn crops and forest around your house in 1 Kilometer of radian in the last 3 months?

0☐ No

1☐ Yes identify

- 1☐ Burning of agricultural residues
- 2☐ Burning of waste
- 3☐ Burning of forest and brushland to increased plantations
- 4☐ Prescribed burning in forestry

A6 How much your family's income per month?

1☐ < 5,000 Baht

2☐ 5,001 -10,000 Baht

3☐ 10,001 -15,000 Baht

4☐ 15,001 -20,000 Baht

5☐ > 20,000 Baht

B Receiving information

B1 Information items: Frequency of getting the following items of information about crops and forest smoke

Items	Present year (January – present)				Previous year (January – April 2013)			
	0	1	2	3	0	1	2	3
1. The smoke during January and April is increased from open burning such as forest fire, burning of agricultural land, and burning of residential waste.								
2. The smoke can cause some health effects such as skin irritation, eye irritation, respiratory and cardiovascular illnesses.								
3. The susceptible populations of the smoke include people with respiratory and cardiovascular disease, children, and elderly.								
4. The suggestion to follow the information about crops and forest fire smoke such as air quality monitoring, population-related illnesses, health impacts, and mitigation measures.								
5. The reduction of the smoke by residential management such as closing window and door, spraying water around resident, avoid burning indoor and outdoor.								

* 0 = Never 1 = Occasionally
2 = Sometimes 3 = Frequently

B1 (continue) Information items: Frequency of getting the following items of information about crops and forest smoke

Items	Present year (January – present)				Previous year (January – April 2013)			
	0	1	2	3	0	1	2	3
6. The avoidance and reduction of the smoke by lifestyle modification such as staying in clean indoor, limiting physical activity, and evacuating.								
7. The Avoidance of the smoke when living in bad air quality by using mask.								
8. Forbiddance of burning in forest, agricultural land, and community.								
9. Situation of fire monitoring, and air quality monitoring of Nan Province								
10. Measurement of avoidance and reduction the smoke-related air quality.								

* 0 = Never 1 = Occasionally
2 = Sometimes 3 = Frequently

B2 information source: Frequency of getting information regarding crops and forest fire smoke from the following information source

Information source	Present year (January – present)				Previous year (January – April 2013)			
	0	1	2	3	0	1	2	3
1. Campaigns consist of local, district, province events								
2. Classroom learning								
3. School activities such as broadcast, poster, outdoor space activity								
4. Village source such as broadcast, poster in village hall or temple								
5. Human source such as friend, family member, village health volunteer								
6. Public source such as television, local radio, newspaper, advertisement.								
7. Online source such as website								

* 0 = Never 1 = Occasionally
2 = Sometimes 3 = Frequently

C Perception of crops and forest fire smoke

Agreement about causes of the smoke, environment and health effect of crops and forest fire smoke

Items	Agree	Not sure	Disagree
1. The causes of the smoke in Nan Province during January and April are the burning of forests, agriculture lands, and community areas.			
2. Dim weather is caused by the crops and forest fire smoke.			
3. Decrease of visibility is caused by the crops and forest fire smoke.			
4. Increases of respiratory symptoms such as difficulty breathing, cough, and sore throat are caused by the crops and forest fire smoke.			
5. Worsening of skin irritation is caused by the crops and forest fire smoke.			
6. Worsening of eye irritation is caused by the crops and forest fire smoke.			
7. The children are the susceptible population to the crops and forest fire smoke.			
8. The elderly are the susceptible population to the crops and forest fire smoke.			
9. The people with heart or lung diseases are the susceptible population to the crops and forest fire smoke.			
10. Smoke from crops and forest fires doesn't affect your life.			
11. Forest fire smoke is less dangerous compared to air pollution from other sources			

D Measurement of protection the smoke exposure

Did you used following measures to protect yourselves from crops and forest fire smoke during the smoke episode

Measure	This year (January – present)		Previous year (January – April 2013)	
	No	Yes	No	Yes
1.Using domestic air conditioner				
2. Closing the windows, door				
3. Spraying water around resident				
4. Avoiding the indoor burning				
5. Avoiding the outdoor burning around the resident				
6. Checking the information such as air quality and mitigation measure related to air quality				
7. Staying in the clean indoor				
8. Leaving or evacuating from the high smoke concentration area				
9. Using dust mask				
10. Participating with community in management of fire such as extinguishing fire by yourselves or reporting to local government when there is fire in the community or forest fire.				
11. Participating with community or government in campaign regarding protection from smoke				

Appendix B

Reliability test for the questionnaire

Perception

Reliability analysis-scale (Alpha)

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
C01	24.63	18.240	.501	.552	.834
C02	24.47	17.499	.596	.860	.826
C03	24.40	17.559	.630	.866	.823
C04	24.27	17.651	.760	.877	.814
C05	24.27	17.857	.716	.813	.818
C06	24.20	17.752	.766	.862	.815
C07	24.37	18.033	.660	.825	.822
C08	24.43	17.426	.787	.880	.812
C09	24.43	17.771	.715	.942	.818
C10	24.43	20.668	.114	.381	.866
C11	25.10	22.231	-.119	.387	.886

Reliability Coefficients

N of Items = 11

N of Cases = 30

Cronbach's Alpha = .845

VITA

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