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Haze problems in Samoeng district Chiang-mai, Thailand

Teeputai Saengas[1], Thanarin Harnkiattiwong[2*]

[1] Southeast Asia nature and environment association, Chiang-Mai, Thailand
[2] Rattanakosin College of Innovation Management, Rajamangala University of Technology Rattanakosin, Bangkok, Thailand

*Corresponding author E-mail: thanarin.h@gmail.com

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Abstract
The weather around the world is changing. Its quality is deteriorating due to contamination from toxic substances, which may be in various forms such as gases and dust, which is called air pollution. This is a problem that the worldwide is concerned because it affects human health and causes serious diseases. The upper northern region of Thailand has been facing this problem for a long time, more than 2 decades. Therefore, this research aims to investigates the cause and find ways to solve the problem using qualitative research, physical and environmental survey techniques of the community, observation, in-depth interviews 34 key informants, data collection period from January to December 2024. The research results found that: the cause of the haze in Samoeng District is open burning and forest fires, which are caused by hunting and foraging forest products, which are the way of life of the people in this area. The factors that promote the severity of the haze problem are winds blowing across the border from other areas, climate change, and the basin. The short-term or urgent solution is, watering the roadsides to create a wet firebreak to prevent forest fires. The development of drones to better quality for extinguishing fires. The long-term solution is to strictly enforce the law against those who create sources of haze. The development of technology and modern tools can identify the source and amount of pollution. The last approach is to join in solving the haze problem at the regional and global level to benefit from technology transfer from countries with the potential to solve the problem.

Keywords: *Haze: Forest Fire: Open Burning: The Upper Northern of Thailand*

Introduction

The haze problem in the upper northern of Thailand has been occurring for a long time since 2007. The problem has become more severe because it has begun to affect the tourism and service businesses in the area. However, the problem has continued until 2019 when the government began to realize the importance of the problem by setting the level of solving the haze problem as a national agenda. While the current solutions have 2 approaches: refrain from burning by requesting for cooperation from local people through various methods such as public relations, providing knowledge about the impact of haze, and enforcing laws prohibiting burning during. critical haze periods. The second approach is using technology to solve the problem, such as using drones to survey fire spots and using satellites to survey hotspots by the Geo-Informatics and Space Technology Development Agency (Public Organization). In terms of requesting for cooperation from the public, it has been successful because almost every area that is the responsibility of the National Park and Forest Departments has been able to create a network of cooperation with the public to stop burning very well. Study in Samoeng District, Chiang Mai province Because Samoeng District is an area that still has a complete natural environment, there are more forests and mountains than plains and in 2024, this area with

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the most forest fires in Chiang Mai province (Thairath Online, 2024). Which has a wide impact because Samoeng District is adjacent to 3 important districts of Chiang Mai Province: Mueang Chiang Mai District, which is the city area and the center of the province; Hang Dong District, which is the location of Chiang Mai International Airport when haze occurs, it affects the operation of the airport; and Mae Rim District, which is considered an important tourist attraction of Chiang Mai Province and is a landmark of the province. This research aims to analyze the problem and find solutions to the haze problem in Samoeng District, Chiang Mai Province.

Materials and Methods

Study area

Samoeng District, Chiang Mai province located at UTM 47Q 471820 mE 2084037 mN, it is a forest area with abundant wildlife living in the area. Therefore, the work of many agencies overlaps, such as the Royal Forest Department, the National Park Department, which has declared it a national reserved forest area, part of Khun Khan National Park, including a wildlife sanctuary. Climate and average weather throughout the year average temperature throughout the year, generally ranges from 12°C to 34°C, with the lowest temperature being lower than 9°C and the highest temperature being higher than 37°C. The administrative area is divided into 5 sub-districts. (Department of National Parks, Wildlife and Plant Conservation, 2024) Most of the area is mountainous in the reserved forest area. People live in the plains between the mountains. Forest areas are divided into different types of forests as follows: 1. Pine Forest This type of plant is in the pine family (Pinaceae) with two important species: the two-leaf pine, and the three-leaf pine. 2. Dry Evergreen Forest This type of forest is found in valleys at an altitude of approximately 500 meters above sea level with an annual rainfall of between 1,000 millimeters. 3. Mixed Deciduous Forest: this type of forest exists at an altitude of 300 - 500 meters or more above mean sea level. The important plant species of this type of forest are in the teak family (Verbenaceae), such as teak, *Dalbergia oliveri* Gamble ex Prain, *Dalbergia glomeriflora* Kurz, *Bombax ceiba* Burm, ground plant. The understory plants consist of various types of grass and various types of bamboo. 4. Deciduous forest, or dry dipterocarp forest or grove forest. The terrain is quite steep and high, with laterite soil, low fertility, and is widely distributed. Important tree species include *Shorea obtusa* Wall. Ex Blume *and S. burmese* Sal. At the same time, the population in the area consists of local Thais and ethnic groups such as the Karen, Hmong, and Lisu tribes. Most of them work mainly in agriculture, farming, rice farming, and livestock. (Fca16, 2024)

Performance in the past 20 years

In 1995, Thailand announced the air quality standards and continuously improved them (Announcement of the National Environment Board No. 10 (1995) issued in accordance with the National Environmental Quality Promotion and Conservation Act (1992), regarding the determination of air quality standards in the general atmosphere. In 2004, the standard for particulate matter no larger than 10 microns was increased, along with the announcement of the National Master Plan for Open Burning Control, which was prepared after the Cabinet's approval on January 22, 2003 by the Pollution Control Department, Ministry of Natural Resources and Environment. The objectives are to reduce the forest fire area to no more than 120,000 acre per year, manage agricultural waste to replace burning by at least 240,000 acres, by 2007, and use agricultural waste as biomass energy to replace commercial energy consumption by 21 percent in 2006 and 25 percent in 2011, respectively. The final goal is to reduce open burning of waste by no less than 50 percent in all provinces and to utilize waste by no less than 30 percent of the total amount in 2006 (Pollution Control Department, 2004). Meanwhile, the overall air quality of Thailand in 2007 (January - November) has mostly improved, except in the beginning of the year when the northern region experienced haze pollution with particulate matter smaller than 10 microns since February onwards and has increased significantly since March 1, 2007. The highest 24-hour average was detected on March 13, 2007 in Chiang Mai province with a value of 396.4 micrograms/cubic meter (2.3 times higher than the standard) (Pollution Control Department, 2007). Later in 2010, the standard of particulate matter no larger than 2.5 microns (PM 2.5) along with the haze situation which is getting more and more serious, especially in the upper northern region of the country, the average measurement in Chiang Mai has been increasing continuously since 2016 - 2019 in March. In 2019, the highest PM 10 was 557 µg./m3 and the highest PM 2.5 was 470 µg./m3, which is considered the highest number in 4 years (Angkaew,

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2019). At present, the government's work is still in the same direction, which is to coordinate the work of government agencies at the central, regional, and provincial levels, including local administrative organizations in the area, to monitor and control burning. There is the establishment of a special command center to prevent and solve forest fire and haze problems at every level, the province, district, and sub-district levels by local administrative organizations. In addition, the Department of National Parks, Wildlife and Plant Conservation has supported the creation of a network to solve forest fire and haze problems, another approach that supports this is to encourage people, agencies, and organizations in all sectors to participate in thinking, planning, and implementing (Bureau of Forest Fire Prevention, Suppression and Control, 2024). The creation of a network between the government, private sector, and civil society can be implemented well, but it still does not achieve the goal of solving the haze problem. The area of Samoeng District is under the supervision of the Forest Protection Unit at Chiang-mai 11 (Samoeng) and the Khun Khan Samoeng Forest Fire Control Station (FCA. 16). There has been a severe forest fire situation in the Samoeng District in the past 5 years, the forest fires that occurred in 2021 and 2024. In 2021, a forest fire occurred in Ban Sala, Tambon Samoeng Tai on March 29, 2021. The fire suppression operation was difficult because the area is mountainnous, making it difficult to access the area, and the fire was severe because it was a dry bamboo forest, which is a good fuel for burning. When the fire was extinguished, an investigation the cause of the forest fire. It was found that it was caused by arson, possibly by people who gatherer or forager. The damage was 176 acres. (Office of Natural Resources and Environmental Policy and Planning, 2024). The fire incident in 2024 on March 29, 2024 was different from the forest fire in 2021 because there were many forest fires or hot spots, up to 84 of them spread throughout the area (Thairath Online, 2024) of the district, both in the national forest reserves, conservation forests, wildlife sanctuaries, and national park areas, which were also caused by arson.

Methodology

This research is qualitative research. The data unit is a primary document, including laws (Forest Act, 1941; Community Forest Act, 2019; National Reserve Forest Act 1964; National Park Act 2019), plans (National master plan for open burning control, 2004), measures (Measures to announce a ban on burning and solving the haze problem in 9 northern provinces, 2017), and other related regulations (if any). Secondary documents include research related to haze prevention using qualitative research techniques, surveys of physical characteristics and community environments, general and participatory observation. The data collection period was from January to December 2024. In-depth interviews were conducted with 34 key informants who firefighters officer, local residents, and academics specialize in environmental issues, as well as general interviews. Data quality was checked using methodological triangulation from different data collections: document data, interview data, and observation data on the same issue, which were then analyzed for comparison. The research tools included semi-structured interview forms, observation notes, and document notes. The methodology for monitoring the data is triangulation method, in terms of data collection methods: information from documents data, from interviews and observational on the same issue were analyzed to compare results, and the data source methods: interviews with key informants all parties on the same issue are then analyzed to compare results. Processing data by interpreting the data and creating conclusions to finding meaning in phenomena from the event or issue selected as a case study, data analysis steps are as follows: read the raw data carefully until understand and capture the main points, change main point to code, separate to group, connect ideas to find patterns. It is an overview of the phenomenon studied then summarize and explain the research results.

Results and Discussion

Causes of haze problems

The main causes of haze in Samoeng District are open burning and forest fires, while the cause of forest fires with the highest number of occurrences is hunting and gathering of forest products by local villagers, which is the cause of the most forest fires from 2019 to 2023. Forest fires occur from February to April and are most frequent in March. From table 1 show statistics and the highest causes of fires. In 2019, there were 192 times the most common causes of fire were gathering wild plants and hunting, 173 times, it is 81.18 percent of the total number of fires. In 2020, there were 124 times the most common causes of fire were arson, 80 times, it is 64.52 percent of the total number of fires. In 2021, there were 34

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Table 1. *Forest fires statistics*

Yearly Statistics	Number of Times Fires (fire periods per day)	The Most Common Cause	Percentage of all fire causes	Damaged Area (Total)
2019	192	gathering wild plants and hunting 173 times	81.18	2,867
2020	124	arson 80 times	64.52	2,025
2021	34	gathering wild plants and hunting 10 times	29.41	788
2022	71	gathering wild plants and hunting 19 times	26.77	991.25
2023	64	arson 35 times	54.69	122.25

times the most common causes of fire were gathering wild plants and hunting, 10 times, it is 29.41 percent of the total number of fires. In 2022, there were 71 times the most common causes of fire were gathering wild plants and hunting, 19 times, it is 26.77 percent of the total number of fires. In 2023, there were 64 times the most common causes of fire were arson, 35 times, it is 54.69 percent of the total number of fires. Forest fires it makes easier for hunters to enter areas and see burrows or holes where animals hide. In addition, burning is used to herd wild animals into encirclement and to herd them into watershed areas because wild animals are hot, they run to find water sources. Hunters therefore lie in wait in areas that are water sources, such as streams, swamps, and canals in the forest. Foraging for forest products is a belief and way of life of the villagers. If there is burning, it will make the plants in the forest grow again. They will burn the forest for about 1 week and then go back to collect the new shoots of vegetables. However, in theory, natural forest fires are beneficial in maintaining the balance of the forest because the accumulation of leaves and plant debris creates moisture and the seedlings cannot grow again. Therefore, in nature, forest fires should occur every year, but they should be surface fires, to maintain the natural balance of the ecosystem only. Blaze fires in forest areas, as they happen every year, not only damage forest areas and kill wildlife, but also destroy human health from haze or PM 2.5. In addition to forest fires on hills, savanna or grass along the roadside often catch fire. Statistics show that one of the causes of fires is tourists who may accidentally throw cigarette butts on the side of the road, to campfire, pretend to light them or arson, which is one of the causes of forest fires. The search for the cause of pretending to light forest fires is unclear it may be impetuous of the person who started the fire or a conflict between those responsible. The topography of the upper northern region of Thailand, which is high mountains and basin area, is a factor that promotes the severity of the haze problem and makes it difficult to solve. Basin topography, when there is open burning, combined with the dry seasons, winter and summer, the air is closed, meaning the air pollution is still in basin, the wind is calm, and there is no wind blowing PM 2.5 will accumulate in the basin area in large amounts. During the hot season in summer, the concentration of PM 2.5 will be higher than during the low temperature (Lin, *et al.,* 2018) and the hot and dry weather makes it easy for fires to catch and spread. Therefore, the haze will accumulate and wait until the rainy season to be washed away from the area. From Figure 1, the number of hotspots in the area of Samoeng district, all 5 sub-districts, Samoengtai, Borkaew, Maesab, Samoengnuea, and Yangmern in the past 3 years, green dot means the number of hotspots in 2022 is 141, yellow dot means the number of hotspots in 2023 is 638, red dot means the number of hotspots in 2024 is 847, which increases every year. Climate change is also a factor that exacerbates the haze problem. Samoeng District has a cold climate from October to February, but currently, the weather has changed, meaning that the temperature will only get cold from November to January and have a long summer season that affects the haze problem because during the high season in summer, the concentration of PM2.5 mass will be 2 or 3 times higher than during the low season. (Lin, *et al.*, 2018; Park, *et al.*, 2024). In addition to the wind, there are also causes of forest fires spreading from adjacent areas, including Hang Dong district, Mae Tang district and Mae Rim district. Fires spread from other areas, mostly by burning crops and agricultural

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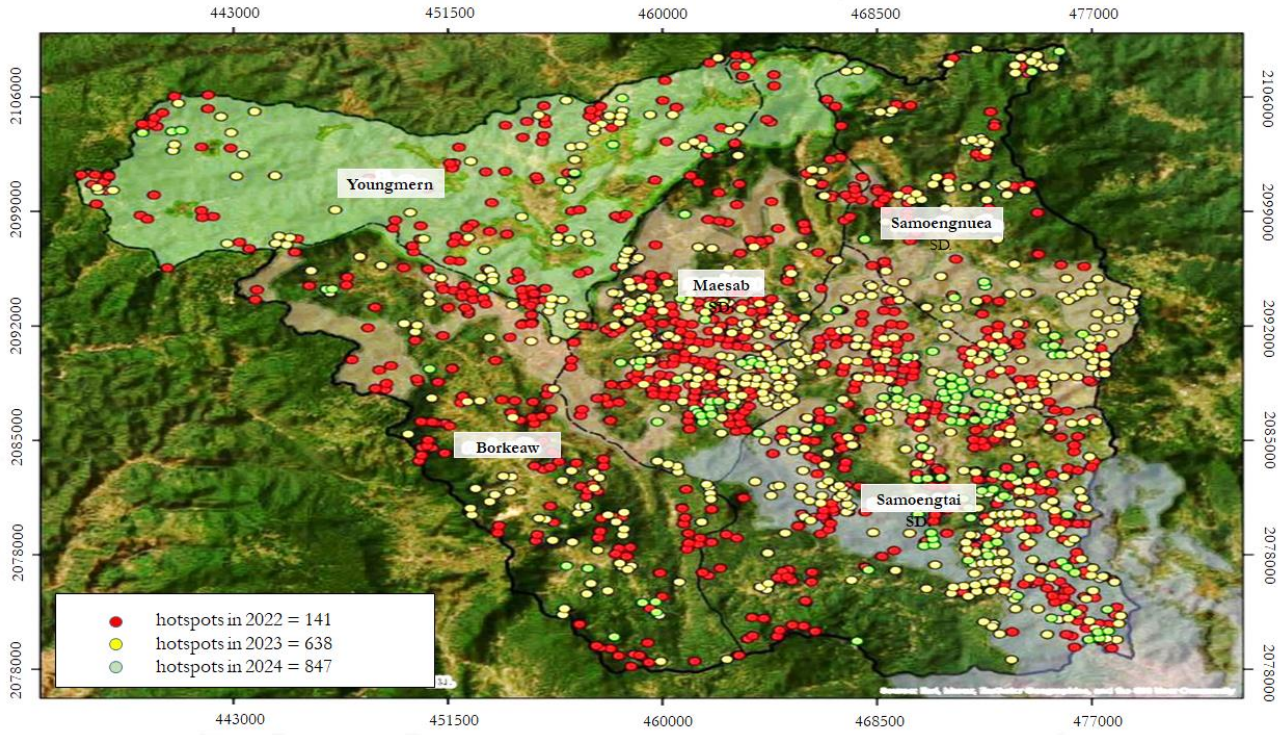

Figure 1. *Hotspots in Samoeng District, 2022-2024 (Khun Khan Forest Fire Control Station)*

waste, the area of Samoeng District is mountainous, making it difficult to extinguish a fire. Therefore, the haze has accumulated in the area more.

Problem solving to the haze

In the past, relevant agencies, especially government agencies, have introduced various methods and techniques to encourage people in the area to work together to reduce forest fires, which are the cause of the haze problem, such as fuel management techniques by reducing the amount of fuel, i.e. burning at specified times, rushing to burn, or compressing fuel into pellets, using fuel to make compost, creating firebreaks, and planting cover crops that keep the soil moist all year round, etc. The responsible agencies are mostly in the Ministry of Natural Resources and Environment. In addition, there are many other agencies in the area, such as agricultural agencies, land agencies, disaster prevention and mitigation agencies, public health agencies, environmental agencies, local administrative organizations, and Royal Projects.

Immediate solutions

Creating a wet firebreak on both sides of the road by watering to create moisture for the grass along the road. If water is used to moisten the leaves and the ground under the leaves and grass, it will be much more difficult for fires to start. There should be warning signs on both sides of the road in Thai, English, and other third languages, such as Chinese, Japanese, and Arabic, because during the dry season, when the weather is cold, many tourists like to visit Samoeng District. The helicopters it can transport water to extinguish fires is one of the solutions when forest fires, which cause haze. It is a more effective operation than using manpower to extinguish fires because access to the area is difficult and there are safety limitations. However, because it requires a high budget, using drones to extinguish forest fires, modified from drones used in agriculture for spraying, can hold 50 liters, with an estimated price of 10,800 USD. When comparing the prices of helicopters and drones, drones are more feasible for use in firefighting because they are cheaper and can be purchased in large quantities. They are also suitable for working in areas that are not very large, 1-10 acres, and often occur in small patches. The limitation of drones is that they cannot carry a large amount of water. Therefore, they should be used to carry chemicals that can extinguish fires (firefighting concentrate foam) instead of water for more efficient work.

Long-term solutions

Strict law enforcement, lessons from China and Singapore. China implemented a clean law in 2013, setting industrial emissions standards, upgrading out-

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dated manufacturing, promoting cleaner fuels, reducing greenhouse gas emissions, and improving air quality (Zhang *et al*., 2019; Zang *et al*., 2019; Sun *et al*., 2020). In Singapore, the government has set up 28 task forces on haze to implement the plan to reduce and manage the impact of haze in Singapore. This group of agencies, known as the HTF, led by the National Environment Agency (NEA), passed the Transboundary Haze Pollution Act 2014, which essentially sets emission and fuel quality standards for vehicles. Owners of vehicles that emit smoke can be fined up to S$2,000 for a first offence and S$5,000 for subsequent offences. Burning forests or farmland that affects Singapore's air quality is subject to fines of up to S$100,000 per day, and fines of up to S$2 million. There is also a jail sentence if convicted by a court. This measure also applies to those who purchase agricultural produce that has been burned (National Environment Agency, 2014) Thailand mainly uses measures of cooperation and campaigning. There is no strict enforcement of the law, although there are laws related to all sectors that cause haze, such as laws that require the agricultural sector to prohibit burning waste or burning to prepare the soil for future planting, laws related to forestry, forest burning, and the industrial sector, laws controlling factories that emit greenhouse gases, etc. When enforcement is not strict, this approach may take time to create awareness and wait for behavioral changes in the next generation. Developing technology and modern tools. The haze blown by the wind from other areas, at present, the agency is still unable to identify the source. It is only a prediction of the direction of the wind blowing into the area. It is not possible to clearly identify the coordinates, direction, and source of the wind. Also, in the airshed, the dust pollution basin, it is not possible to measure the exact amount of pollution in the basin. In addition, innovations in cultivation, especially monoculture plants without burning, should be developed, which can reduce cultivation costs more than burning. This will attract farmers to turn to the method of not burning more.Participate in solving the haze problem at the regional and global levels to gain opportunities to receive assistance, promote, transfer innovations and tech-nologies, including budget support to solve the problem.

Conclusions

In summary, the occurrence of the haze problem in Samoeng District, Chiang Mai Province is mainly caused by open burning and forest fires. Factors that make the problem more severe and difficult to solve are meteorological factors, climate change conditions, and topography, which is a basin (pan basin). When considering the approach and policies to solve the haze problem in the past, it was a top-down approach and policy to solve the problem, causing the district level agencies to have to follow the approach set by the government all along. The problems in each area have different causes, conditions, and formats. The local people should solve the problems, which will make the problem solved better than receiving orders or instructions from the top down. Solving the problems at the local level should be carried out in a concrete and rapid manner, with equipment, tools, and technology ready to reduce the damage that occurs urgently.

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