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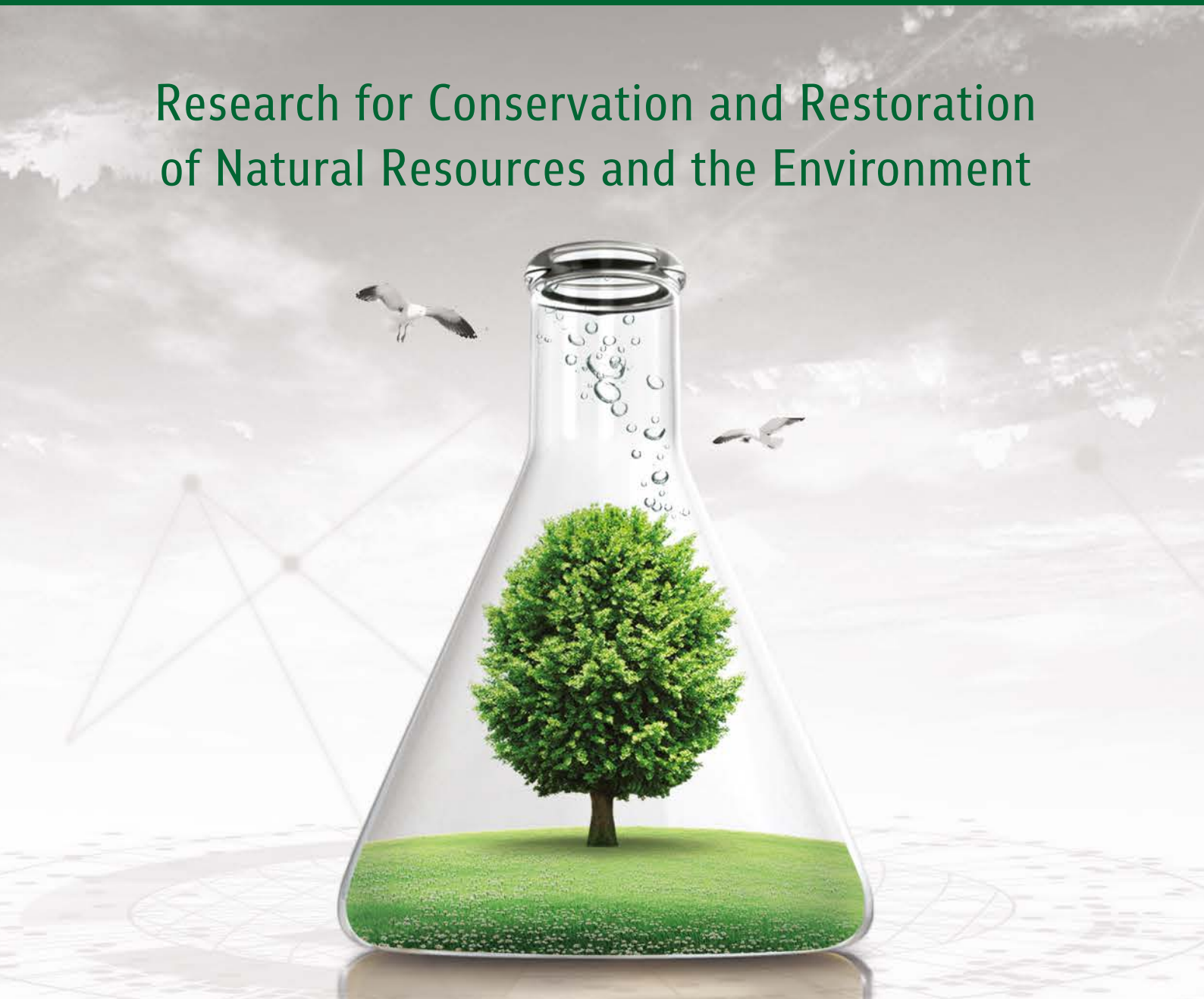
Research for Conservation and Restoration of Natural Resources and the Environment



- The Innovation of Mycorrhizal Mushrooms to Sustainable Reforestation with Native Tree Species
- Activities at San Kamphaeng Hot Springs that Affecting Water Quality in Tourist Attractions and Water Sources in Mae On Community
- Marine Debris
- Detecting an atmospheric condition amenable to causing air pollution using wireless signals

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Editor's note

Economic development has always brought with it environmental problems and climate change impacts. Unfettered, uncontrolled development has depleted the world's finite natural resources, while leading us today to countless environmental problems and a tipping point where runaway climate change threatens our planet's very existence.

Thailand is suffering increasingly from these environmental and climate change impacts, including natural resource degradation, environmental quality problems, water scarcity, soil loss, loss of forests and biodiversity, air and water pollution, hazardous waste problems, sea level rise and salinization. These problems are increasingly impoverishing land and aquatic ecosystems, and the livelihoods and quality of life of the people. The frequency and intensity of extreme weather events and natural disasters have also increased dramatically over the past decade.

Research into environment and natural resources is therefore crucially important for sustainable national development. Preserving our unique natural resources- our natural capital- will contribute to the country's long-term future development. Environmental research includes key domains such as research on spatial databases, natural resource management, biodiversity and spatial development. The research is urgently needed to assess development potential and determine measures and guidelines for environmental protection and restoration. We need research and guidelines into the exploitation of biodiversity and the establishment of a bioeconomy. This scientific and ecological understanding will be fundamental to the development of a thriving circular economy for the country, that will contribute to the economic, social and environmental equilibrium that we call sustainable development.

Editorial Board

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Contact Enquiries
Chula Unisearch, Chulalongkorn University
254 Chulalongkorn Research Building,
4th floor, Phayathai Road, Pathumwan,
Bangkok 10330
Tel: 0-2218-2880
Fax: 0-2218-2859
E-mail: unisearchjournal@gmail.com
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Interview

Assistant Professor Rossarin Pollawatn, Dr. rer. nat.,

Research for Conservation and Restoration of Natural Resources and the Environment

The Innovation of Mycorrhizal Mushrooms to Sustainable Reforestation with Native Tree Species

Pawara Pachit[1], Assist. Prof. Chanita Paliyavuth, Ph.D.[2],
Assist. Prof. Nipada Ruankaew Disyatat, Ph.D.[3]
and Assist. Prof. Jittra Piapukiew, Ph.D.[2*]
[1]Programme in Biological Sciences, Faculty of Science, Chulalongkorn University
[2]Department of Botany, Faculty of Science, Chulalongkorn University
[3]Department of Biology, Faculty of Science, Chulalongkorn University
*Corresponding author email: jittra.k@chula.ac.th

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Introduction

The extent and pace of deforestation in Thailand has been extensively documented in the literature, and is attributed primarily to the country's rapidly expanding population and the growing need for land for agricultural, housing and industrial purposes. Unfettered encroachment of forest lands without consideration for conservation has resulted in reduction of remaining forest area to a critical level, making it impossible to maintain the natural ecological balance. This has resulted in increasing frequency and intensity of natural disasters such as floods, droughts, storms and landslides. Aside from such incidents, deforestation also results in continuous environmental degradation through processes such as soil erosion by wind and water, loss of soil fertility, longer and more severe droughts, increasing unpredictability of rainfall, and deterioration in water quality. Moreover, these impacts are exacerbated by accelerating climate change.

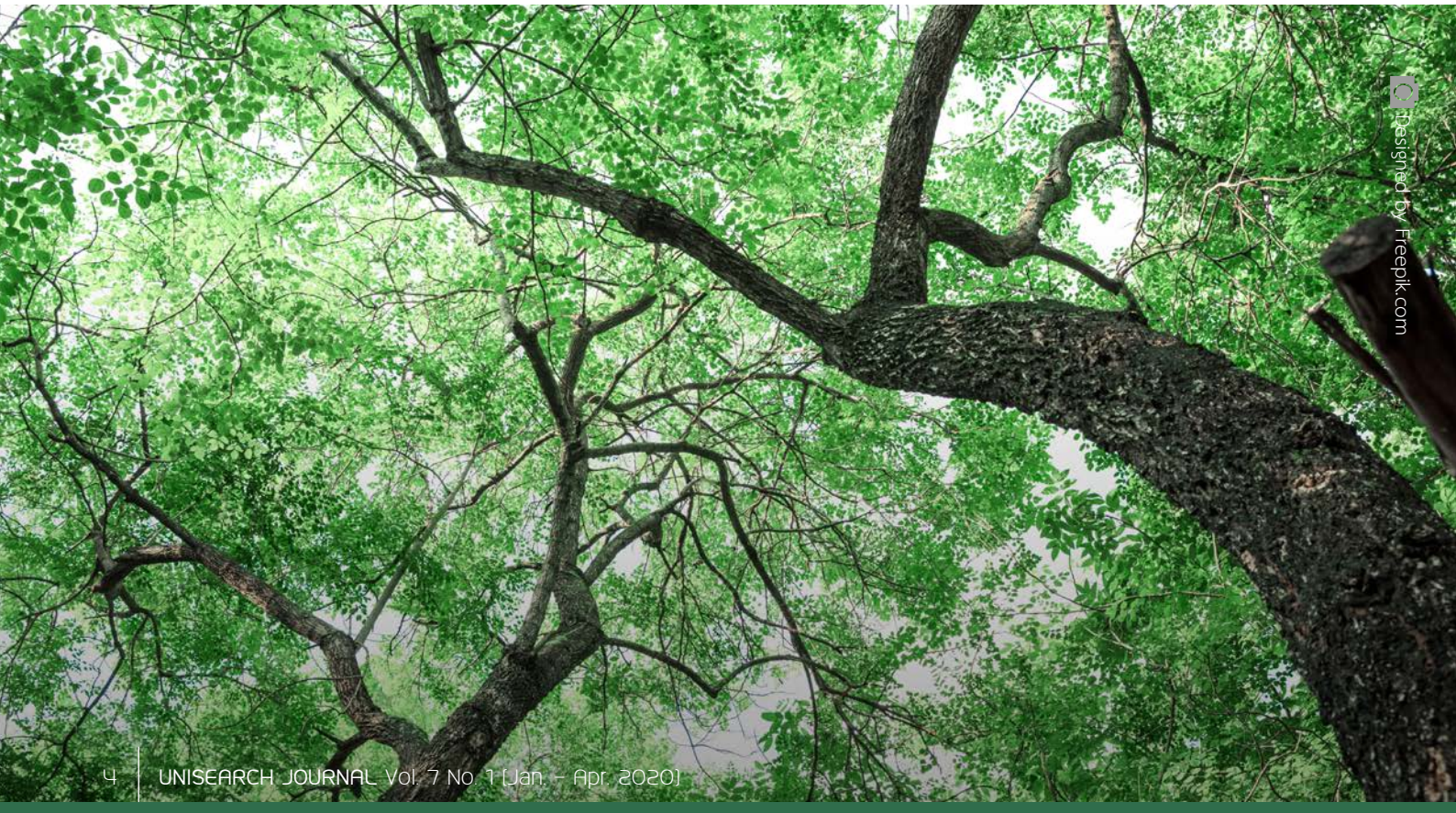
Conserving, restoring and expanding Thailand's forest areas is therefore critically important from an economic as well as an environmental standpoint. The government has set a goal to increase forest area to 40% of the country's total land area as part of the 12th National Economic and Social Development Plan under the 20-Year National Strategy (Royal Forest Department, 2017). Data from 2018 indicate that only 31.68% of the original forest area remains (Forest Land Management Bureau, Royal Forest Department, 2019). These alarming findings triggered a campaign to plant trees to increase the country's forested areas. Selection of locally adapted species is of course critically important to the success of such a campaign. Suitability for rehabilitation of disturbed land is particularly important in addition to adaptation to local soil, climate and ecological niche. Native species are therefore preferred.

Establishment of new forest stands can be enhanced by introducing natural helpers such as mycorrhizal fungi, which inhabit plant roots synergistically and can boost plant growth. Incorporating mycorrhizal spores into soil for tree seedlings can significantly improve survival rates of tree seedlings after transplanting, which, given the large scale of such operations, is economically important for reforestation initiatives.

Based on these previous findings, the research project *"**Innovation of mycorrhizal mushrooms to sustainable reforestation with native tree species**"* studied the use of mycorrhiza from the Barometer Earthstar mushroom (*Astraeus odoratus*) to stimulate growth after transplanting of dipterocarp tree seedlings. The Dipterocarpaceae family includes 695 known species of mainly tropical lowland rainforest tree, including many important indigenous trees in Thailand. The project also transfers research knowledge and technology to local communities to boost awareness regarding forest conservation and restoration as well as promoting sustainable use of forests.

Conclusion and recommendations

This project built on current knowledge about the relationship between mycorrhiza and native tree species (*Dipterocarpaceae*) to promote seedling growth and stand establishment after transplanting to open land for forest restoration. Use of mycorrhiza incorporated into planting holes contributed positively with increased seedling survival rates. Knowledge gained from this project has been shared with local communities in order to promote awareness of conservation needs, and sustainable ways whereby communities can conserve and restore native forest areas as well as encourage sustainable use of forests. The project clearly demonstrated the benefits of mycorrhiza for tree seedling establishment. However, further follow-up research should be conducted to further increase efficiency of reforestation using native species in order to expand and transfer knowledge to other communities in the future.



Activities at San Kamphaeng Hot Springs that Affecting Water Quality in Tourist Attractions and Water Sources in Mae On Community

Luechai Kroutnoi, Ph.D.
Chula Unisearch, Chulalongkorn University
Corresponding author email: luechai.kroutnoi@gmail.com

Introduction

San Kamphaeng Hot Springs in Mae On District, Chiang Mai Province is a project under the Royal Initiative. Originally a natural hot spring, local communities had long used the water to cook and treat skin ailments. In February 1974, the Tourism Authority of Thailand, together with the San Kamphaeng Village Agricultural Cooperative, officially opened the site as a tourism destination. The business operates under the supervision of the Mae On Hot Springs Administration Subcommittee under the Royal Initiative.

San Kamphaeng Hot Springs is a geyser formed by the periodic release of pressurized hot water accumulating in underground chambers. The chambers are tube-like holes reaching deep into the Earth's crust. The water accumulates until the enormous pressure forces the water up into the air. Geyser hot springs are typically associated with volcanic sites. Generally, geyser hot springs flash when the temperature reaches approximately 100°C and the process is repeated over time depending on the size of the geyser and underlying volcanic activity. The height of the geyser depends on temperature and pressure. San Kamphaeng Hot Springs has a temperature of 105°C, resulting in a water column of over 10 metres.

Today, San Kamphaeng Hot Springs and nearby attractions attract both domestic and foreign tourists, creating jobs and generating income for the Hot Springs Business and local communities in Mae On District.

The Tourism Authority of Thailand (TAT) recognizes the site's importance and has assigned a research team to study the feasibility of growing the business by optimizing and preserving the available resources. The study includes mapping, mineral water quality analysis, conceptualization and drafting of a master plan and guidelines for recreational activities in order to develop the business sustainably as a medical and health tourism destination. This will unlock the area's potential to create more jobs and benefit local communities through developments such as hotels and homestays, souvenir shops and food stalls, without adversely impacting on water and environmental quality both at the site itself as well as the surrounding water sources for the Mae On community.

Conclusions and recommendations

From analysis of surface water quality and use, the research team recommended guidelines for conservation of water quality for the San Kamphaeng Hot Springs. These focus on three critical locations in the vicinity of the spring:

Point 1 (Surface water around Huai Krai Canal): It is recommended to install an aerated lagoon for biological wastewater treatment. This will enable monitoring and improvement of water quality to meet minimum standards. The relevant government agencies should work together with private sector stakeholders to control wastewater discharge into Huai Khrai Canal.

Point 2 (Cesspool in front of Bodin Meeting Room 2): It is recommended to renovate or rebuild the cesspool in order to improve its efficiency. Installation of a plastic or concrete base as well as a cover will minimize contamination of the surrounding area.

Point 3 (Surrounding the windmill pond): It is recommended that all visitors be required to wash their feet thoroughly before soaking their feet in the hot spring gully. For convenience, foot-washing locations should also be provided along the route. Strict measures forbidding food and other littering into the water must be enforced, while a regular cleaning schedule along footbath paths must be established.

Marine Debris

Suchana Chavanich*,
Voranop Viyakarn, Kornrawee Iamsomboon,
Somrudee Jitprapai and Sucharee Burikul
Department of Marine Science, Faculty of Science, Chulalongkorn University
*Corresponding author email: suchana.c@chula.ac.th

Photo by www.thairath.co.th

Introduction

Marine debris is defined as waste produced by humans either on land or sea, and dumped in the sea, either deliberately or involuntarily. Today a large amount of waste is dumped into the sea due to ineffective waste management on land. At the same time, the fast-growing use of single-use plastics is exacerbating the plastic waste. Most plastics are not biodegradable, so that each piece of plastic waste may persist in the environment for several hundred years and is practically impossible to remove, resulting in adverse effects on ecosystems, marine life, environment and human health. To make matters worse, plastic waste breaks down into tiny fragments known as microplastics that today pollute every ecosystem throughout the world. Sea creatures involuntarily feed on these microscopic particles, causing lasting harm or death. Microplastics are also harmful to humans, particularly those who consume marine products. Therefore, it is crucial to have a plan, management process, policies and measures in place to reduce and dispose of various types of waste to reduce or eliminate sea dumping.

Conclusion and recommendations

Dumping our waste into the ocean is reckless and affects the environment both directly and indirectly. Plastic waste breaks down physically into microplastics, causing lasting harm to marine life and humans alike. Therefore, an effective and integrated waste management plan, management procedures, policies and enforcement measures are all crucial in order to reduce the amount of waste and ensure appropriate disposal of plastic waste and eliminate the practice of ocean disposal. It is also important to raise awareness regarding plastic waste disposal as well as social measures to encourage eco-friendly behaviour.

Article

Detecting an atmospheric condition amenable to causing air pollution using wireless signals

Sirin Nitinawarat, PhD.
Research Group on Applied Computer Engineering Technology for Medicine and Healthcare (ATM)
International School of Engineering, Faculty of Engineering, Chulalongkorn University
Corresponding author email: sirin.n@chula.ac.th

Introduction

Many megacities in the world, including Bangkok, face severe air pollution problems, which cause widespread health, economic and social impacts. The government and of course most people who are affected are aware of the problem, and large cities such as Bangkok are equipped with more than 50 pollution monitoring stations scattered around the city. Nevertheless, a number of technical challenges remain in implementing an effective monitoring and reporting system. These are listed below:

1) Due to their high price, there is a shortage of sensors measuring critically important parameters such as atmospheric PM2.5 levels;
2) Insufficient coverage by monitoring locations due to shortage of sensors; monitoring sites are scattered across a large area;
3) Lack of a disaster warning system that allows the public organisations to predict and prepare prevention or mitigation measures in a timely way.

Researchers have realised the potential of wireless communications to contribute to weather prediction systems. In particular, studies of the possibility of using the strength of wireless communication signals to monitor temperature inversion (TINV), a critical climate characteristic associated with severe air pollution, have yielded promising results (Bailey et al., 2011; Haikin et al., 2015; Incecik, 1996; Kallos et al., 1993; Kukkonen et al., 2005; Malek et al., 2006; Schäfer et al., 2012; Schrenk et al., 1949; Shmool et al., 2014). TINV is a reversal of the normal behaviour of temperature in the troposphere (the region of the atmosphere nearest Earth's surface), in which a layer of cool air at the surface is overlain by a layer of warmer air. This can occur anywhere in the troposphere up to an altitude of approximately 10 km. The inversion creates a barrier trapping pollutants in the atmosphere below the inversion, resulting in severe air pollution.

Recent research points to the potential of wireless signals in detecting and predicting the incidence of TINV more accurately. Simply reporting daily levels of PM2.5 is insufficient and does not address the root cause. Predicting and monitoring TINVs will contribute to our understanding of the sources and spread of pollutants throughout the atmosphere, and thus help in addressing the problem at source to minimize human impacts. Nevertheless, levels of atmospheric PM2.5 are certain to rise for the foreseeable future, with increasing frequencies of TINVs and lack of action to prevent emissions from industrial, vehicular and other point sources.

This article presents the findings of a research study on processing data from wireless signals to detect and report TINV. The research was carried out with partner wireless service providers as a starting point for future research.

Conclusion and recommendations

While the study findings point to the value of using wireless signals and their measurement to detect and monitor TINV, further research will be crucial in order to improve and develop the technology for commercial applications. The study generated the following recommendations:

1) Pilot the technology under diverse weather conditions to confirm the robustness of the relationship between wireless communication signal values and TINV weather conditions.
2) Foster cooperation with network providers to design a more extensive network station and automate the data collection/analysis system to enable a wider use of wireless communication signals to increase/enhance the accuracy of weather and air pollution predictions.

Photo by www.thairath.co.th

Research for Conservation and Restoration of Natural Resources and the Environment

Assist. Prof. Rossarin Pollawatn, Dr. rer. nat., an expert in diversity and ecological significance of Bryophytes and Pteridophytes, shares her research experience on biodiversity for conservation and restoration of plants, forests and terrestrial ecosystems that have been impacted by natural disasters triggered by climate change.

INDO-BURMA BIODIVERSITY HOTSPOT and Location of Bangladesh (Conservation International, 2007).

Thailand, the "Indo-Burma" biogeography, and the current biodiversity situation

"...Thailand is located in an "Indo-Burma" biogeography hotspot, one of the most biodiverse regions in the world..."

The Indo-Burma hotspot, covering a total 2,373,000 sq km, is ranked as one of the world's most biodiverse regions. The hotspot stretches from eastern Bangladesh and northeastern India, covering Myanmar, the south and west of Yunnan, China, and stretches to Laos, Thailand, Cambodia to Vietnam. Thailand is located at the very centre of the hotspot. The hotspot also includes Thailand's

southernmost provinces bordering Malaysia, and islands in the South China Sea such as Hainan as well as islands in the Andaman ocean within India's territory.

The Indo-Burma hotspot comprises a wide range of temperate and tropical ecosystems, both deciduous and evergreen, including coniferous, montane evergreen forests, tropical rain forest, dry evergreen forests, mangroves, grasslands and wetlands. The entire area is heavily influenced by monsoons affecting temperature and precipitation, while the climate ranges from cold in the north to tropical in the south. Additionally, the area is also affected by sea breezes throughout the year. Such unique environmental features have made the Indo-Burma hotspot a highly biodiverse area for both flora and fauna.

The species diversity and endemism chart for the Indo-Burma hotspot (Table 1) lists more than 13,500 plant species, of which half are endemic. There are 433 mammalian species, 522 reptile species, 286 amphibian species and 1,266 bird species, many of which are listed as endangered. A total of 750 species are classified as threatened as a result of encroachment for agricultural and industrial expansion, linked to local population growth. In 2011, the Indo-Burma region was left with only 5% of its original total forest area (Table 2). Therefore, it is highly important and beneficial to the region that each country invests in restoring native forests and ecosystems, which will also help restore a rich biodiverse ecosystem across the area.

Table 1 Species diversity and endemism of living things in the Indo-Burma region

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	13,500	7,000	51.9
Mammals	433	73	16.9
Birds	1,266	64	5.1
Reptiles	522	204	39.1
Amphibians	286	154	53.8
Freshwater Fishes	1,262	553	43.8

Source: The Critical Ecosystem Partnership Fund (2012)

Table 2 Diversity comparison of living things chart between each region

Region	INDO-BURMA		HIMALAYA		SUNDALANDS		WESTERN GHATS AND SRI LANKA	
Hotspot Original Extent (km²)	2,373,057 (100%)		741,706 (100%)		1,501,063 (100%)		189,611 (100%)	
Hotspot Vegetation Remaining (km²)	118,653 (5%)		185,427 (25%)		100,571 (6.7%)		43,611 (23%)	
Taxonomic Group	Species	Endemic Species	Species	Endemic Species	Species	Endemic Species	Species	Endemic Species
Plants	13,500	7,000	10,000	3,160	25,000	15,000	5,916	3,049
Mammals	433	73	300	12	380	172	140	18
Birds	1,266	64	977	15	769	142	458	35
Reptiles	522	204	176	48	452	243	267	174
Amphibians	286	154	105	42	244	196	178	130
Freshwater Fishes	1,262	553	269	33	950	350	191	139

Source: ENVIS Resource Partner on Biodiversity (n.d.)

Impacts of climate change on terrestrial ecosystems

In discussing the adverse impacts of climate change on ecosystems, many think first of the effects on ocean ecosystems such as coral bleaching or ocean acidification. However, terrestrial ecosystems are equally vulnerable to climate change impacts such as droughts, flooding, delays in flowering and missed pollination windows for pollinating insects, all of which of course reduce agricultural productivity. As for other groups of plants such as bryophytes, ferns, and flowering plants that are normally drought-tolerant, extended periods of water scarcity and high average temperatures may hamper reproduction process or recovery. Prolonged droughts are harmful in themselves, and also in increasing the risk of forest fires due to high temperatures and accumulation of dry leaves and biomass on the soil surface. Such fires can result in catastrophic impacts including loss and extinction of local species.

Limestone ecosystems: the importance of Thailand's terrestrial ecosystems

"...Limestone ecosystems cover only 4% of Thailand's total area, but represent important hotspots for plant genetics that are adaptive and resistant to dry environments..."

Limestone soils result from chemical weathering of limestone. Plants growing in the meagre soils found in rocky limestone outcrops must adapt to the environment through deep roots, resistance to drought and an ability to tolerate drastic changes in diurnal temperatures, including extremely cold night temperatures.

To achieve such adaptations and survive, plants growing on limestone mountains have developed special structures and mechanisms. For example, Dok Hin (*Selaginella pulvinata* (Hook. & Grev.) Maxim.) may roll their branches into ball to retain moisture. Some types of fern produce thick epicuticular wax to coat lower leaf surfaces, and roll up their leaves to reduce guttation, reviving with the return of more humid conditions. Plants such as Salat Dai Khao (*Euphorbia lacei* Craib), Ueang Mok (*Papilionanthe teres* (Roxb.) Schltr.) and Kood Ngern (*Cheilanthes krameri* Franch. & Sav.) and many other flowering plants have developed thick succulent stems and short leaves to retain water, while others such as Tien Nok Kaew (*Impatiens psittacina* Hook.f.) and Ta Hoen (*Hedychium spicatum* Sm.) shed their leaves and develop large fleshy storage roots. This group of plants only grow, flower, and fruit during the rainy season. Evergreen species such as *Ficus* spp. found in limestone soils have long extended root systems, able to seek water deep in the soil. Such areas are often mountainous and, remote and inaccessible, and new or location-specific species are frequently discovered. Their diversity and remoteness mean that mountainous limestone ecosystems are important biodiversity hotspots, of particular importance in seeking genetic adaptations to temperature fluctuations and drought.

Research to support Thailand's commitment to the Convention on Biological Diversity

"...if we possess all data of all living organisms in Thailand, we could use it to manage resources appropriately and come up with measures to prevent their extinction..."

Research into biodiversity in Thailand makes an invaluable contribution to the national and global inventory of species and their distribution. The commitment of all governmental Parties to the Convention on Biological Diversity requires gathering basic yet crucial biodiversity data, which contributes to planning and conservation efforts for threatened or endangered species. A range of initiatives are under way to contribute to this goal, including promotion of breeding programmes for Thailand's rare orchids that are threatened with extinction, such as the Fah Mui (*Vanda coerulea* Griff.), Ueang Pak Nok Kaeo (*Dendrobium cruentum* Rchb.f.) and Rong Tao Naree Doi Inthanon orchid (*Paphidiopedilum villosum* (Lindl.) Stein. The research will help ensure Thailand's orchid breeding industry continues to flourish. An additional initiative is also under way to conserve local forest herbs in the form of community forests, and adapted forest management to conserve native Thai plants in the wild, especially endangered species. Humans cannot replicate the natural environment; therefore, allocating more designated forest areas for conservation of all species will be crucial to long-term success.

Biodiversity for Thailand's biobased economy and circular economy

"...Tropical forests are the most ecologically diverse of all systems. Resources and data collected on biodiversity are today more complete, so Thailand should adapt and use this new knowledge to optimize natural resource management and conserve its rich natural heritage".

Studying biodiversity is crucially important in order to identify the natural riches all around us, that are vital sources to serve four basic needs: food, clothes, shelter, and medicine. It is therefore vital that we identify these resources that are available to us, understand their genetic basis, their applications and benefits. These data can then be used to select appropriate species to genetically improve and adapt. Many species can only be grown in Thailand due to their highly specialized genetic adaptation to the local environment. Their ability to thrive in harsh environments makes them suitable for future modification, especially wild local herbs and vegetables that are used to make medicine. Therefore, Thailand should redouble its efforts to adapt this new knowledge to benefit its natural resource management. Examples of successful projects that contribute to and make use of the biodiversity database are herbal medicines and products production at Chao Phraya Aphaiphubet Hospital, undertaken in collaboration with Dong Bang subdistrict in Prachin Buri, Thailand, and Kiriwong Village ecotourism in Nakhon Si Thammarat. Natural resources must be conserved and protected since they are being used and often exploited for monetary purposes, sometimes through biopiracy. Therefore, natural resource management should be implemented to ensure sustainable resource utilisation as part of a thriving circular economy for Thailand.


Tien Nok Kaew

Assistant Professor Rossarin Pollawatn, received a BSc in Biology from Prince of Songkla University, an MSc in Botany from Chulalongkorn University and Dr. rer. nat (Biology) from Nees Institute for Biodiversity of Plants, Bonn University, Germany. Assistant Professor Rossarin currently leads the Plants of Thailand Research Unit, Department of Botany, Faculty of Science, Chulalongkorn University.

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"Around us"

Assoc. Prof. Thavivongse Sriburi, Ph.D.

How Important Is Discipline?

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The COVID-19 pandemic has highlighted our society's problem with discipline: it has long been argued that "*Thai people lack discipline*", seeking only to satisfy their personal desires, regardless of potential consequences for others and for society as a whole. Such behavior is often justified (and not only in Thailand) by the gounds of human rights, freedom or privacy, even by the well-educated. Rather counterintuitively, it is often the educated, privileged or powerful who exploit their knowledge or power to disregard the law or social norms. Critics have often cast doubt about the role of discipline among such families - were they even taught it in the family?

"...There are two types of discipline. The first one is the discipline that everyone knows and follows, including the laws and regulations. The other one is a self-discipline that each individual has to establish and make oneself sincerely and constantly adhere to it. It is like a promise or ratification to oneself. This is the true discipline because the outcome is more real and certain than the regulatory discipline. Also, self-discipline is a supportive element to follow the regulatory discipline justly, completely, and successfully..."

(Speech by King Bhumibol delivered to cadets on the occasion of sword bestowing ceremony on 25 March 1981.)

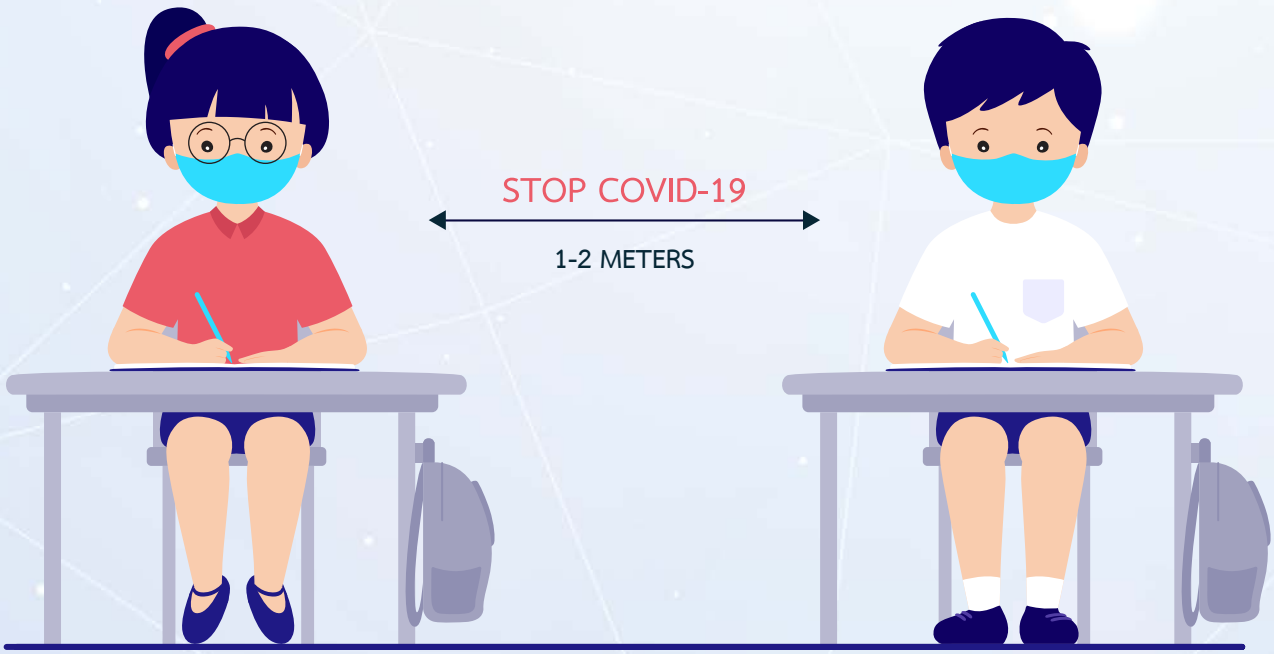
The term *"discipline"* is a tool to control behavior. According to the Thai Royal Institute Dictionary (B.E. 2542), discipline is defined as order, regulations and practice. Thai people are certainly taught this concept as synonymous with obedience, whether in school, at home or within occupational hierarchies. However, countless examples in domains ranging from politics, exploitation of natural resources, natural disasters, and current responses to COVID-19 show that while Thais may be outwardly obedient (e.g. towards authority figures) many are not disciplined. Such people believe rules are for others to follow, and will happily disregard social regulations or requests by the government that are clearly in the public interest (e.g. mask-wearing, social distancing). Such people, regardless of educational status, defend selfish behavior on spurious grounds of human rights or privacy. Countless conflicts have resulted from the impacts of such behavior in Thai society.

As a behavioral characteristic, discipline is described in terms of: 1) self-control; 2) following the lead; 3) following social norms; and 4) orderliness. Having discipline is a social duty for all people wherever they go, whatever they do, and regardless of status. It is of course true that everyone has rights; however, the exercise of these rights is limited by the principle that in expressing our individual rights, we do not restrict the rights of others.

Thus, our rights and freedoms must first conform to rules, laws, and regulations of the country. A disciplined society will advance economically and harmoniously and result in enhanced quality of life for all.

Phusara et al (n.d.: 17) define three types of discipline, each of which requires different ways of practice, as elaborated below:

1) *Personal discipline* refers to a certain set of internal rules for each individual. These translate into, and are usually described as, our 'personal values'.
2) *Duty discipline* refers to obedience to regulations or codes of practice defined by one's rank, status or position. For example, everyone in a family has a role as a father, mother, child, landlord or tenant. Each of these carry non-codified expectations



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relating to (for example) role models, leadership and subservience. There are also many other examples of duty discipline such as wearing of uniforms and paying respect to teachers at school.

3) *Social discipline* refers to adherence to shared norms in the public sphere, and differs from individual or duty discipline in its broader scope, covering public behaiour and limits to freedom of expression, etiquette, traditions and respect for religious principles, social traditions and conventions.

The above categorization implies that social discipline, as the overarching umbrelladefining group behaviour, is the most important, building on individual and duty discipline as its foundation. Although different cultures will have their own unique form of social discipline, all cultures depend on discipline as a fundamental tool for productive interaction among individuals as a society. All societies will benefit from discipline, particularly that which serves the public interest. Students perform better, traffic moves more smoothly and safely, corruption is eliminated and quality of life improves for everyone.

Everyone needs personal discipline and social discipline in order to function in society. For example, in Thai society, people "wai" to greet or show respect to seniors or as part of traditional ceremonies. Thai people are expected to demonstrate *"morality"* (i.e. good deeds) and *"ethics"* (i.e. good behavior). However, traditional customs are being eroded by Western influence, particularly among the younger generation- the 'wai' is being slowly replaced by the handshake. All too frequently, respect for the elderly is disappearing, rationalized by the assertion that 'everyone is equal'. Though we should not fall for the easy but false argument that others are to blame for the decline in moral standards in modern Thailand, if this continues, Thai culture will surely lose its discipline, morality and ethical foundation.

During the COVID-19 outbreak, the Government requested Thai people to strictly follow policies such as *"Stay Home, Stop the Disease for the Country"* and respect social distancing rules. However, the government has yet to issue any official document explaining the spread of the virus because of its unknown and fast-evolving nature. We know relatively little about its epidemiology and control and can only speculate over the prospects for development of an effective vaccine. Preventive measures are thus an essential frontline against widespread infection and outbreaks. Self-protection and quarantine seem to be the most effective measures, with social distancing recognized as key to prevent infections from taking hold within the community. In such a situation, personal and social discipline are quite simply a matter of life and death.

Today, social media plays an increasingly important role in daily life. Whilst traditional mass media are subject to laws, regulations and social discipline, social media are less subject to such constraints. News travels around the world in seconds via social media, and inaccurate information or misinformation on the pandemic may result in widespread panic, which is of course especially dangerous during a pandemic or period of political unrest. Inaccurate or false information can for example result in panic buying of foods and other commodities, leading to queues and conflict. In such situations, social distancing is often compromised. Panic buying results in shortages and overpricing- the consequences of a lack of social discipline.

Another example highlighting the lack of discipline in Thai society is seen in the resonse to government-announced curfews and closures. Though the reasons and personal consequences of violation are starkly obvious, the frequency of violations during the current pandemic reminds us how widespread is our lack of individual and social discipline. In many cases, authorities have had to resort to legal measures to ensure order and stop the spread of the disease for the benefit of society and the country.

As described above, basic discipline includes recommended and prohibited practices for people from all walks of life. Thai people usually assume that basic discipline applies to good practitioners in organizations or agencies such as punctuality, honesty, unity, and loyalty. Basic discipline is necessary for all, not only to government officials. People may have different roles to play and may need different types of discipline. However, individual discipline will always contribute to improved social discipline.

In conclusion, Thai people need to demonstrate higher levels of individual and social discipline, and shake off a tradition of 'not bothering' to follow the rules, and asserting the right and freedom to 'do what I want' irrespective of consequences for others or for society at large. We need to emphasize among all Thais the principle that freedom is not a carte blanche, but is limited by personal responsibility.

References

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Survey and Restoration of Rain Trees Planted by King Bhumibol at Chulalongkorn University

Assoc. Prof. Pavadee Ansusinha
Department of Landscape Architecture, Faculty of Architecture, Chulalongkorn University

As one of the five rain trees (*Samanea saman* Jacq.) planted in 1962 by the late King Bhumibol sadly fell on 8th June 2018, Chulalongkorn University considers it important to ensure the health of the four remaining trees. The objectives of this survey are to develop recommendations to restore the remaining trees planted by the late King and to collect data to improve the overall level of care of trees located on the campus. **Chula Unisearch** has been assigned to conduct ***"The Survey and Restoration of Rain Trees Planted by King Bhumibol at Chulalongkorn University"*** with the kind cooperation of the Royal Forest Department and several departments at Chulalongkorn University, including the Department of Botany and the Department of Biology, Faculty of Science; the Department of Civil Engineering, Faculty of Engineering; and the Department of Landscape Architecture, Faculty of Architecture. The scope of this survey covers an area of 1,800 sq m on the University campus.

The health of plants can be indicated by the function of leaves which produce their food through the process of photosynthesis. Leaves contain key pigments known as chlorophyll which captures light energy used for photosynthesis. If the photosystem does not function properly or is damaged, the leaves will reflect the light energy not used in the photosynthesis process in the form of chlorophyll fluorescence. Moreover, the ability of plants to absorb light at different wavelengths can also determine their anatomy and health.

Implementation of the survey was divided into 5 stages as follows:

1) Data collection and approaches: Background information on the history and importance of the rain trees planted by King Bhumibol, and the general characteristics of rain trees was collected. Data specific to the project were also gathered, including the renovation of the growing space of the rain trees, maintenance of the trees, and activities that took place around the growing space of the trees. Technical data were also collected, including

the approach for surveying and assessing the botanical, biological, and engineering aspects of the trees, how to restore the roots of large trees, and case studies related to reinforcing the strength and aesthetics of large trees.

2) Survey of the rain trees planted by King Bhumibol

- A *botanical and biological survey* was conducted to examine the anatomy of the four remaining rain trees planted by the late King, other nearby rain trees, and other rain trees over 80 years old rowing on-campus. The data were collected before and after landscape renovation. Predawn levels of chlorophyll fluorescence were measured using a chlorophyll fluorescence meter, while predawn leaf chlorophyll levels were measured using a chlorophyll meter (soil plant analysis development: SPAD) during the daytime and photo reflection value of leaves during the daytime.
- An *engineering survey* was conducted to explore the root system architecture and shape of the rain trees in order to determine optimal support points. The survey was carried out using the 3D point cloud technique and ground penetration radar (GPR), and electromagnetic locating (EM).
- A *landscape survey* was undertaken to investigate land use, beginning with analysis of physical features of the ground around the rain trees, the size, and components of the area and land use. An analysis of the physical area per rain tree was also conducted.

3) *The recommendation for the restoration and construction approach* included data collection and analysis, planning, and assessment of the restoration effort. This stage also covered design and construction of the renovation of the area and supports for the four remaining rain trees.

4) *The long-term maintenance plan* included recommendations for long-term plans, personnel, equipment and budget preparation.

5) *Monitoring and assessment of the renovation* included health monitoring and botanical assessment of the trees during and after restoring the root system and renovation of the adjacent landscape. After monitoring and assessment, a conclusion was drawn.

Based on the above implementation measures, it is anticipated that this survey will contribute to the body of knowledge on the health, structure and location of valuable trees located on the Chulalongkorn University campus. The survey findings may help the Office of Physical Resources Management to provide a high level of care for plants and trees on the university campus. Finally, the study can serve as a model for restoring rain trees in other urban areas and as an example of integrating knowledge from relevant organizations in a multi-disciplinary process.

Rama 4 Model: the Grand Opening

On 19 November 2019 Mr. Suchart Chokchaiwattanakorn, Deputy Minister for Transport, presided over the launch of an innovative initiative, the ***"Rama 4 Model"*** Project at the Conrad Hotel, Bangkok. Implemented by Chulalongkorn University in collaboration with the Ministry of Transport, Bangkok Metropolitan Administration, Metropolitan Police Bureau, National Research Council of Thailand, and Toyota Mobility Foundation, the project will work as a research cluster to address traffic problems in Bangkok and adjacent provinces. The Rama 4 area was selected for the first phase of the study, and **Chula Unisearch** was appointed as cluster coordinator for the project.

Also present at the launch event were Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, representing Chulalongkorn University and Assoc. Prof. Sorawit Narupiti, Ph.D., who presented an overview of the "Rama 4 Model" project. The launch event was followed by an academic seminar entitled ***"Working Roles and Goals."***

Public Hearing

The Office of the National Water Resources (ONWR) recently assigned **Chula Unisearch** to convene the Second Public Hearing on "***Drafting of Regulations, Methods and Conditions on Water Bill Calculator and the Drafting of Subsidiary Legislation regarding Water Resources (Section 4 Water Allocation and Usage)***". The hearing was held on 13 December 2019 at the Main Conference Room, Faculty of Engineering, Chulalongkorn University.

The hearing was led by Assist. Prof. Aksara Putthividhya, Ph.D., Water Resources Engineering Department, Faculty of Engineering, Chulalongkorn University, who presented an overview of the overall project and public hearing consultation process, together with the research team. The presentation covered water management and the different types of water usage, defined as Type 1, Type 2, and Type 3 according to Section 4 (Water Allocation and Usage) of the Water Resources Act B.E. 2561 (2018). The presentation also discussed methodologies for measurement and prediction of water usage to assess current readiness and future availability for multiple stakeholders, and the development and drafting of a water usage database. The presentation concluded with questions and answers from representatives from stakeholder groups.

Participants of the 5th "Bhumipalung Phandin" Chulalongkorn University Executives Program Recommend Guidelines for the Development of Kasorn Kasivit Water Buffalo School

Representatives from the 5th "Bhumipalung Phandin" Chulalongkorn University Executives Program, together with course instructors, recently visited the Chaipattana Foundation and were welcomed at the Foundation's headquarters by Sumet Tantivejakul, Ph.D., Secretary-General and M.L. Jiraphan Tavivongse, Deputy Secretary-General. The Foundation offered recommendations for development of the Kasorn Kasivit Water Buffalo School, Sa Kaeo province. The recommendations formed part of the Bhumipalung Nipon, the group's final project, entitled "Kasorn Kasivit: Development towards Sustainability."

The Kasorn Kasivit Water Buffalo Agricultural School in Sa Kaeo province is part of His Late Majesty's Royal Cow and Cattle Bank Project under the Chaipattana Foundation. It is aimed to preserve and develop traditional methods of rice farming using buffaloes instead of mechanical cultivation, and provides training to farmers to help them work with buffaloes, and to act as a knowledge-sharing hub for farmers to understand H.M. King Bhumibol's Self-sufficiency Philosophy. The school is located at Sala Lamduan sub-district, Mueang Sa Kaeo district, Sa Kaeo province which covers approximately 110 rai.

Welcoming 2020

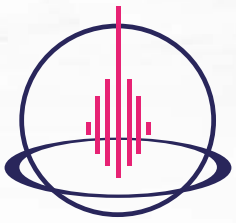
On Wednesday 25 December 2019, **Chula Unisearch** held a New Year's party to welcome the year of 2020 and foster unity and relationship among executives and staff members as well as to celebrate successes in the past year. On this occasion, the board of directors, faculty members, executives and employees enjoyed a meal together and further strengthened their bonds and sense of unity with some fun activities. The management team awarded gifts to employees to boost morale for the year ahead.

Alms Giving Ceremony for New Year 2020

On Wednesday 8 January 2020, **Chula Unisearch** directors and staff joined an annual alms-giving ceremony to mark the New Year at Phra Si Maha Pho Hall, Chamchuri 4 Building. The ceremony sought blessings for the prosperity of the management team and staff throughout 2020.

13th Book Donation

On Thursday 9 January 2020, Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch together with Unisearch staff, donated books to 69 Buddhist monks and novices studying at Phra Pariyatidhamma School. The donation was made as part of a project entitled "13th Books Donation: Teachers Make People, People Make Teachers", and was held in front of Chamchuri Square Building, Chulalongkorn University as part of a merit-making for the late King Bhumibol Adulyadej and Royal family members.



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