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SERVICING THE COLONIAL EXPLOITATION: THE FRENCH ESTABLISHMENT AND MANAGEMENT OF PHÙ LIỄN OBSERVATORY, 1899–1945

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Abstract: By the dawn of the 1890s, the French have basically pacified Tonkin (northern Vietnam) and began the process of colonial exploitation. But the strangeness of the Tonkinese weather, tides and currents, etc. were of great concern to the French. In addition, they must have been aware that a number of observatories had been established by various Western powers in East and Southeast Asian countries during the second half of the nineteenth century: in the Philippines (Manila, 1865), Java (Batavia, 1866), China (Shanghai, 1872) and Hong Kong (1882). In addition, the Japanese had set up an observatory in Tokyo in 1875.

In 1898, the French Colonial Government approved a plan to survey the Phù Liễn area, around 10 km north-west of Hải Phòng City (in the North of Vietnam), and in 1902 Phù Liễn Observatory was established as the first Central Meteorological Station in Indochina. In this paper we focus on three main topics: (1) The French colonization in Vietnam during the 1870s through 1890s; (2) The establishment of Phù Liễn Observatory between 1899 and 1902; and (3) the **o**rganization and activities of the Observatory from 1902 to 1945**.**

Keywords: French colonialism, Indochina, Hải Phòng, Phù Liễn Observatory, weather forecasting, meteorology, seismology, time service

1 THE FRENCH COLONIZATION OF VIETNAM DURING THE 1870s–1890s

In the nineteenth century, the French recognized the economic importance of colonialism, but their occupation of Vietnam in particular and Indochina in general was merely a part of their strategy to access the lucrative Chinese market. For a long time, the French wanted to control the area we now know as Vietnam (but they referred to as Cochin China) because of its geographical proximity to China and its domination of the East Sea (now known as the South China Sea).

In 1857, the Annam Research Committee of the French Government assessed Annam commercial benefits and concluded:

> It cannot be accepted that France has no colony or base in this China-closed area where trade will be strongly developed. Britain, the Netherlands, Spain, and Portugal have colonized several parts of this area. Russia begins to take their portion, and the US is trying to ensure its trade. We all agree that France will come and com-pete with the British in this region. (Devillers, 2006: 37–38).

In 1858, the French began their invasion of Vietnam. After setting up a Government in Southern Vietnam, they promptly sought a way to penetrate into China. In order to do this, they expanded their invasion into northern Vietnam. At that time, Hải Phòng was not an independent administrative unit. It was a land close to the sea that belonged to Hải Dương Province and was known as a gateway to the Tonkin Delta. It became an important link in the chain of France's penetration of southern Vietnam.

In 1873, the French colonists attacked the northern Vietnam for the first time. Led by Jean Dupuis and Francis Garnier they attacked Hanoi, occupied it, then continued to advance and quickly occupied Hưng Yên, Phủ Lý, Hải Dương, Ninh Bình and Nam Định. In light of successive French victories, in 1874, the Huế Court officially signed the Giáp Tuất Treaty (also known as the Philastre Treaty) with the French. It included a clause to open Ninh Hải (thereby allowing the French to use the Red River to exploit resources in Yunnan, China), and a clause to allow 100 French soldiers to permanently garrison troops in Hải Phòng (Figure 1). From this first military post, the French gradually expanded their economic, political and social influence, by exploiting the port of Hải Phòng, helping administer the city, and giving the French community priority in the Cấm River area.

In the 1880s, the Colonial Government in Hải Phòng focused on building and developing the port. On the other hand, they continued to improve their administrative management apparatus while French colonists aggressively expanded their activities in the area. After their second invasion of northern Vietnam, the French colonialists forced the Huế Court to sign

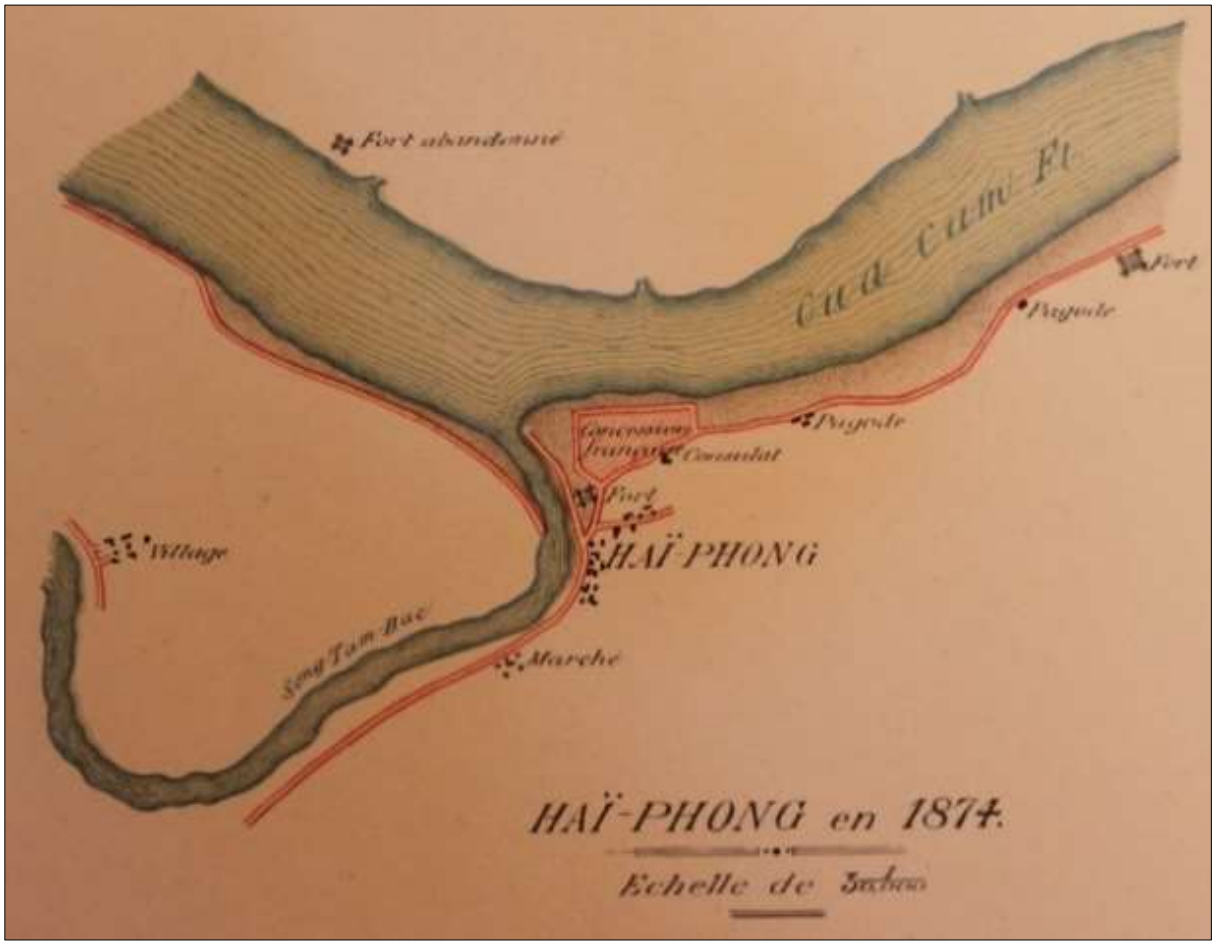

Figure 1: Map of Hải Phòng in 1874 (courtesy: Hải Phòng City General Library).

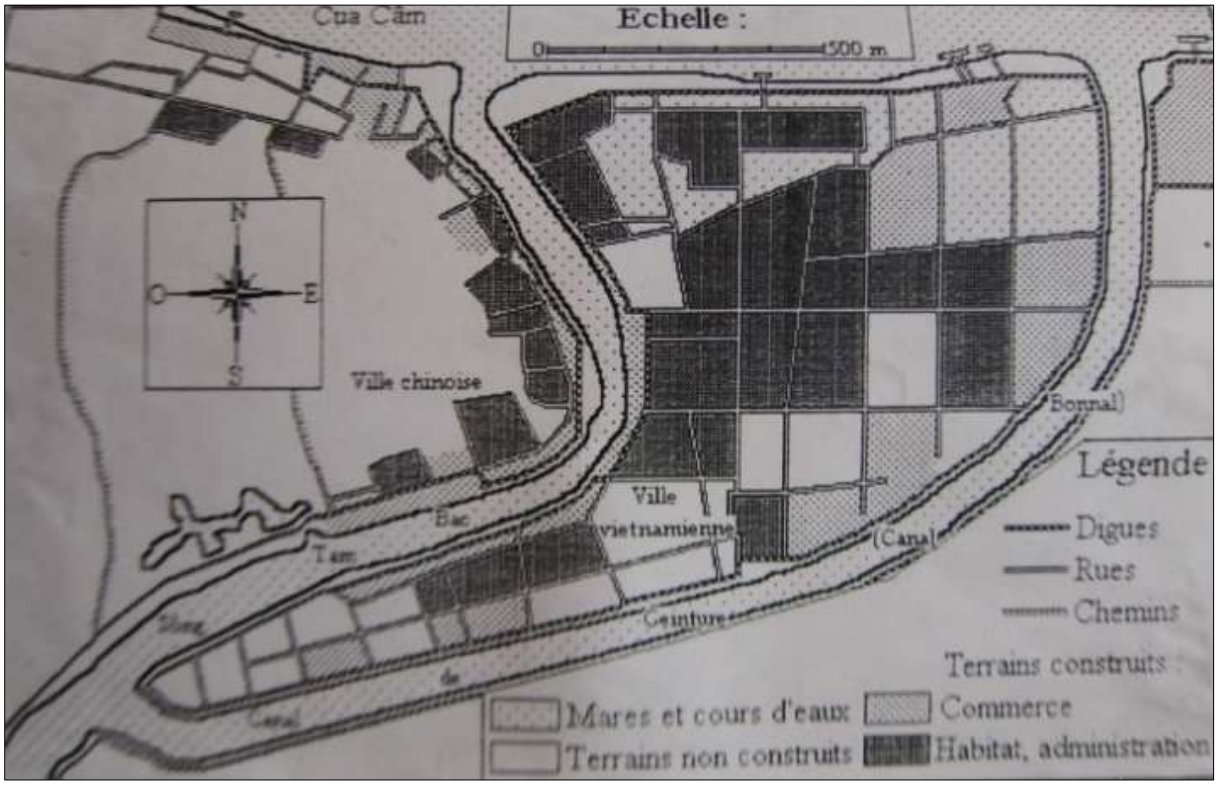

Figure 2: Map of Hải Phòng in 1888 (courtesy: Hải Phòng City General Library).

Figure 3: The 2019 photograph of the lighthouse on Hòn Dáu Island (photograph: Phuong Nguyen This Hoai).

the Harmand Capitulation Convention (in 1883) and the Patenôtre Capitulation Convention (1884), which created a long-term base for their domination of Vietnam.

On 19 July 1888, the Governor-General of Indochina and Central-Northern Vietnamese Resident, Superior Richaud, signed Decree No.87 to establish the City Council in Hà Nội and Hải Phòng. The Council was headed by a Mayor (who also was the Chairman of the Council) and comprised 30 Commissioners, 16 from Hanoi and 14 from Hải Phòng (Président …, 1888). Hải Phòng then officially became a Class-1 city (ville) on a par with Hà Nội and Sài Gòn. On 1 October 1888, King Đồng Khánh provided a concession that completely gave Hải Phòng to the French.

Then in the late 1880s, after carefully surveying the northeastern coastal area, the French built Hải Phòng harbor in 1885 and established Hải Phòng city in 1888 (Figure 2), in order to create an international port that connected Tonkin with other trading centers in Northeast and Southeast Asia.

In the process of managing and developing Hải Phòng Port, the French built a lighthouse on the highest peak of Hòn Dáu Island, at Hải Phòng. Construction of the lighthouse was begun in 1892, and it was completed in 1896 but only became operational in 1898. Designed by a French architect, it was a 2-storey building with a 5-storey 140-meter-high tower in the middle (see Figure 3). Its light could be seen from 40km away, and was a signal for boats and ships entering or leaving the port.

It was obvious to the French that, for the successful operation of Hải Phòng seaport, understanding the weather of this region was extremely important. By that time, the strangeness of the Tonkin weather, tides and currents had been randomly described in Western records and travelogues since the seventeenth century, attracting the attention of the French (e.g. see Borius, 1883; Delteil, 1885; Maget, 1881; Richaud, 1864; and Simon, 1886). In addition, from the time of their arrival in Vietnam in the mid-1800s, the French were aware that a number of observatories had been established by various Western powers in East and Southeast Asian countries, including the Philippines (by the Spanish, in 1865), Java (by

Figure 4: A view of Zikawei Observatory in Shanghai (after Schmitt, 1932: 176).

the Dutch, in 1866), China (by French Jesuits, 1872) and Hong Kong (by the British, in 1882). The Japanese had also established Tokyo Astronomical Observatory in 1875. So 'modern observatories', which focused primarily on time-keeping and meteorology rather than astronomical research, were a conspicuous feature of late nineteenth century Asian science.

2 THE ESTABLISHMENT OF PHÙ LIỄN OBSERVATORY (1899–1902)

In response to these developments, in 1898 the French Colonial Government began to consider the establishment of meteorological observatories in northern Vietnam.

The following year, the Indochina Supreme Council approved a plan to establish a Central Meteorological Service and Observatory for Indochina (Le Service Météorologique et l'Observatoire Central de l'Indochine). As a result, a survey of the Indochina region was carried out by Father Louis Froc, S.J. (1859–1932; Gauthier, 1932), the Director of Zikawei Observatory in Shanghai, China (see Figure 4).[1] He ended up selecting Phù Liễn, a hill 118 meters above mean sea level and about 10 kilometers to the north-west of Hai Phong. From this location, the new observatory could easily serve the entire Red River delta, and it also could easily be connected to the lighthouse on Hon Dau Island (Department of Agriculture and Commerce, 1899).

In 1900, Mr Capus, Director of the Department of Agriculture and Commerce, sent a map and plans of the Indochina Meteorological Department in Phù Liễn to Paul Doumer, the Governor General of Indochina and Elenthère Mascart, the Director of the Central Meteorological Bureau of France. Based on this map, Doumer signed Resolution No. 421 to construct the main building for the Indochina Meteorological Department at Phù Liễn. This building, as well as the overall plan of Phù Liễn Observatory, were designed by the French architect, M. Lichtenfelder,[2] who is said to have been strongly influenced by the design of the Zikawei Observatory (which had been constructed by the French several decades earlier). Claude-Jean-Baptiste Ferra, who would later be appointed as the first Director of the Observatory, supervised the construction. Endo and Matsumoto (2019: 35) state that Ferra "… studied mathematical sciences and had worked in observatories in Paris and Montsouris (Pyenson, 1993)."[3]

In 1902, the Central Station of Meteorology and Magnetism was officially established and was given the following major functions:

(1) Implement scientific activities relating to meteorology, magnetism and earthquakes;
(2) Collect and analyze information from meteorological stations throughout Indochina, and forecast upcoming typhoons and storms in the region in order to serve the maritime community; and
(3) Maintain and report a daily time service for Phù Liễn, accurate to half a second and based on transit telescope observations.

Figure 5: The imposing looking main building at Phù Liễn Observatory, built in 1899–1902 (courtesy: Phù Liễn Observatory).

Phù Liễn Observatory has 'modern architecture' compared to the contemporary period and was divided into two functionally-distinct areas: a working area and a living area.

The working area covered about 2 ha, and included two large buildings, one being the observatory, which was built on the highest part of the hill. The imposing-looking main building (Figure 5) was aligned E-W, and was built like a castle with 60 cm thick blue-stone blocks, and colourful tiled floors and ornately decorated windows, doors and other architectural features. It comprised three parts: a three-storey eastern wing, a smaller central two-storey wing and a six-storey tower. Given the design of the main building and the primary functions of the Observatory, we believe that the eastern wing originally included offices, a meeting room, staff facilities and the library, while the smaller central wing housed the meteorological records and working space. The final part of the main building was a six-storey tower (Figure 6), and there was a transit telescope on the top floor or on the roof, which was used to supply a local time service.

Originally there was direct ground-floor access between the three wings, which all featured the same distinctive floor tiles and contained many square-shaped rooms ranging between 10 and 25 square metres, all with out-

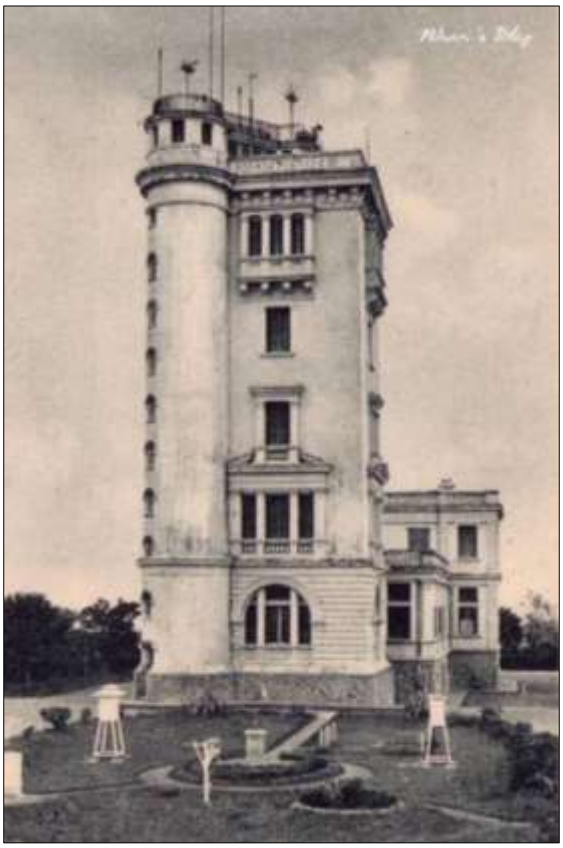

Figure 6: A view of the main Observatory building from the west, showing the tower and cylindrical spiral stairwell (courtesy: Phù Liễn Observatory).

Figure 7: The entrance and spiral staircase allowing external access to the tower wing (photographs: Nguyen Thi Hoai Phuong).

ward facing windows. Originally, the second floor in the three-storey wing contained three large interconnected rooms, while the top floor contained an assemblage of small rooms. The second storey also provided direct access to the top floor of the adjacent two-storey wing, which itself linked directly to the six-storey tower. In addition, the tower wing could be accessed externally via a spiral staircase (see Figure 7).

To the west of the six-storey tower there was a flat garden area about 20 meters long and 30 meters wide, which contained meteorological instruments (some of these are visible in Figure 6). A driveway ran past this precinct out to the entrance gate. Figures 8 and 9 show the recent appearance of the main building.

There was a smaller Observatory building about 20 meters North the main building, which contained two floors with eight large working rooms. This building is clearly visible on the left in Figure 10, and is currently in a derelict condition. Below this building, on the hillside, there was a large rain water tank that was divided into several sections, each from 6 to 8 meters deep.

The housing area was located lower down the hill, beside the road that ran from the Observatory to Kien An town. There originally were three villas and other Observatory buildings in this area, near Kiến An town. A Western style of construction was used for the houses, but two gates were built in an Eastern style. The one at the bottom of the hill was known as the Dragon Gate (due to its décoration with two dragons looking at the Moon), while the main gate at the top of the hill was decorated with four phoenixes and known as the Phoenix Gate. This combination of Eastern and Western cultural elements was a special feature of Phù Liễn Observatory architecture.

When Phù Liễn Observatory was completed in 1905, the main building was one of the most beautiful buildings in Hai Phong, and it joined other 'modern' observatories in Asia, including Manila Observatory in the Philippines and Zikawei Observatory in Shanghai (both built by the Jesuits—see Alvarez, 2023; Udais, 2003), Hong Kong Observatory (MacKeon, 2007) and Tokyo Astronomical Observatory in Japan (Nakamura, 2021).

Between 1945 and 1954, four floors of the tower in the main building and the housing area on the hillside were destroyed during the war with the French. As a result of the damage sustained the present form of the tower in the main building differs markedly from the or-

Figure 8: A 2019 photograph showing the front of the main Observatory building at the top of Phù Liễn hill. The Russian-made radar dome was installed in 1998 and removed in 2020 (photograph: Nguyen Thi Hoai Phuong).

Figure 9: A recent photograph showing the rear of the main Observatory building on the top of Phù Liễn hill. The Japanese-funded Phù Liễn Meteorological Radar Station (the concrete tower with the radar dome in the background) was constructed in 2017 (photograph: Nguyen Thi Hoai Phuong).

Figure 10: A view looking east showing the main building on the right and the two-storey secondary building on the left (courtesy: Phù Liễn Observatory).

Figure 11: A wall display listing Directors of the Observatory, 1902–2014 (photograph: Nguyen Thi Hoai Phuong).

iginal design, as a comparison of Figures 6 and 9 immediately reveals. Nonetheless, Phù Liễn Observatory remains one of the most outstanding examples of early twentieth century colonial architecture in Vietnam.

3 ORGANIZATION AND ACTIVITIES OF PHÙ LIỄN OBSERVATORY, 1902–1945

3.1 Introduction

According to a wall display at the Observatory (Figure 11), during the twentieth century, there were five French Directors of the Phù Liễn Observatory:

(1) Claude-Jean-Baptiste Ferra (1902–1909);
(2) Dr Georges Le Cadet (1910–1921);
(3) Monsieur Durand (1922–1926);[4]
(4) Étienne Bruzon (1927–1937); and
(5) A. Romer (1938–1940).

We have already met Mr Ferra and noted that prior to coming to Indochina he had worked at two professional observatories in France. Dr Le Cadet, who had a Doctor of Science degree, also had worked in meteorology in France (at Lyon Observatory) prior to joining the meteorological service in Indochina in 1906. His particular interest was in atmospheric electric-

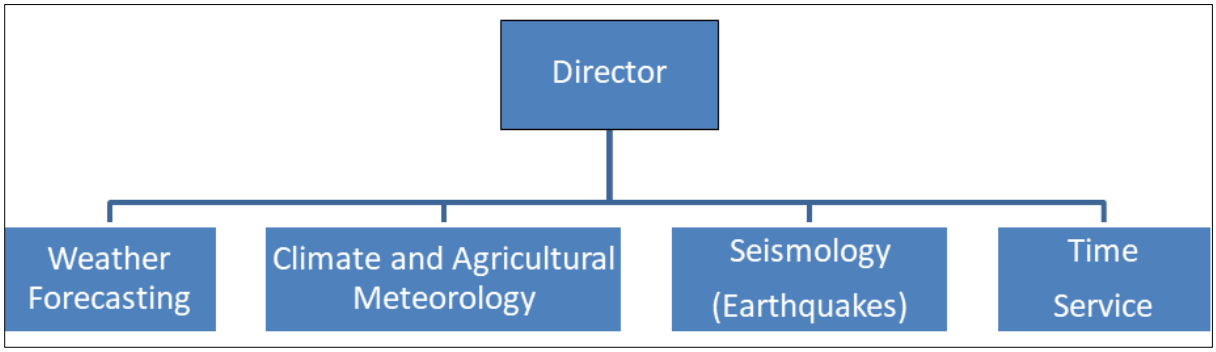

Figure 12: The organization of Phù Liễn Observatory (after Anonymous, n.d.).

ity (Endo and Matsumoto, 2019: 36). According to Pyenson (1993: 79), "Ferra believed that Le Cadet had the moral authority in the world of research [and] was [going] to bring Phu-lien to [the] world['s] attention." Sadly budgetary constraints and World War I kept the Observatory under-staffed and under-resourced so these high hopes were never achieved (Endo and Matsumoto, 2019). The fourth Director, Etienne Bruzon, was "… a retired Lieutenant in the French Navy, [who] joined the meteorological service in 1924 …" (Endo and Matsumoto, 2019: 38).

As Figure 12 indicates, when Phù Liễn Observatory opened there were four different Departments (Weather Forecasts, Climate and Agricultural Meteorology, Seismology and the Time Service). Each of these had a French Manager and a Vietnamese Secretary. In the 1930s, according to statistics, there were five French Managers and 54 Vietnamese administrative staff working at the Observatory (*Le Service Météorologique* …, 1930: 7).

In 1940, the Japanese invaded Indochina and replaced the French Colonial Government, and all the French nationals left the Observatory. Mr Nguyễn Xiển, an engineer who was also trained in mathematics and physics, became the first Vietnamese Director of the Observatory, and since that time all subsequent Directors have been Vietnamese.[5]

3.2 Weather Forecasting

Weather forecasting was the most important work of Phù Liễn Observatory. From the very day of its establishment, the Observatory collected and transmitted weather forecasts by telegram (and later by radio) to observers in Vietnam, Lao and Cambodia. It also connected with other international observers in South East Asia and the Pacific Ocean area to create weather maps, and especially to provide storm and monsoon warnings for ships at East Beach.

On 23 November 1904 the Governor General of Indo-China, Paul Doumer, stipulated the numbers and levels of facilities in the Indochina meteorological network: single meteorology alert columns in Da Nang, Hai Phong, Mui Dinh and Vung Tau; 12 meteorological stations and 29 climate stations. These meteorological and climate stations would send information to the central Phù Liễn Observatory, which would also receive information from other stations in the Indochina network (in Cambodia and Laos) and stations in the Asian network (China, Japan, the Philippines, the Carolines, and the Marianas), and also transmit information to them.

In 1917, Dr Georges le Cadet and M. Duran published a 50-page monograph about the rainfall in Indochina, which contained maps of rain fall for each mouth and for the whole year (Le Cadet and Duran, 1917). At that time, Le Cadet was Director of both the Department and the Observatory, while Duran was an engineer. Later, Étienne Bruzon and Paul Carton published a book with the translated English title *Indochina Climate and Typhoons in the China Sea* (Bruzon and Carton, 1930; cf. Robequain, 1930). By this time, Bruzon was Director of both the Indochina Meteorology Department and Phù Liễn Observatory, and Carton, an engineer, was Manager of Phù Liễn Observatory. These two books were regarded as valuable documents at that time.

In 1927–1928, the French Colonial Government began budgeting for the expansion of the Observatory's meteorological network (Report of the Phù Liễn Observatory in 1927-1928), in order to contribute to the agricultural and economic development of the country. Consequently, whereas in 1926 there were 17 observatories, 10 climate stations and 130 rainfall measuring stations, by 1930 these numbers had grown impressively to 26, 74 and 326 respectively (*Le Service Météorologique* .., 1930: 11). This is illustrated in Figure 13.

Up until 1930, the Climate Forecasting Department also created large climate maps twice daily, and Indochina climate maps were creat-

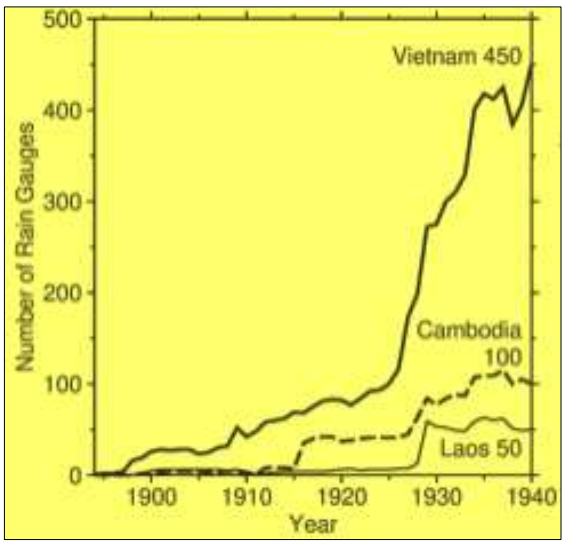

Figure 13: A plot showing the very rapid increase in the number of rain gauges in Vietnam during the 1920s and 1930s; the numbers listed near the right-hand margin for Vietnam, Cambodia and Lao list the actual number of rain gauges in these countries in 1940 (after Endo and Matsumoto, 2019: 39).

ed four times per day. Weather news for shipping navigation was notified daily. It was issued to ports and post offices near ports, and was 'broadcast' using semaphore signals to provide warnings for offshore boats. Especially, when a typhoon or storm threatened the land, this news was usually distributed throughout the day by telegraph and telephone.

In 1938, the Weather Forecasting Center was moved to Hanoi so that it could be used for aviation, and in 1963 the Phù Liễn Observatory reestablished weather forecasting for local use. Figure 14 shows a close-up of the radar dome currently sited on top of the modified Phù Liễn Observatory tower. Meanwhile, in 2017, the Japanese Government funded the construction at the Observatory of a radar station to enhance the ability to forecast natural disasters caused by climate change, and this facility is shown in Figure 9.

3.3 Climate and Agricultural Meteorology

The development of agricultural farming in Indochina created a demand for climate data. In 1926, Yves Henry (Inspector of the Agriculture and Forestry's Department) and Mr Durand (from Phù Liễn Observatory) were asked by the French Colonial Government to set up a spec-

Figure 14: A close-up of the French-made radar installed on the roof of the greatly modified Observatory tower in 1995. This radar dome is still there, and is just visible in Figure 15 (courtesy: Phù Liễn Observatory).

Figure 15: A Dutch pyrheliometer, used to measure sunlight, set up in the meteorological precinct at Phù Liễn Observatory (courtesy: Phù Liễn Observatory).

ial Center at the Observatory for climate and agricultural meteorology.

By this time, Phù Liễn Observatory was fully set up for meteorological monitoring, and was equipped with instruments that automatically measured and recorded wind, temperature, rainfall, humidity, sunshine (see Figure 15), air pressure and evaporation. In 1930, a weather station was established on Hòn Dáu Island, and equipped with a Lepaute automatic tide gauge (see Figure 16).

Meanwhile, the special Center at the Observatory for climate and agricultural meteorology gathered documents on tropical agriculture (especially agro-ecology) in different tropical countries around the world. These documents were stored and processed according to their content, thereby providing information for farmers about agricultural activities in Indochina (e.g. see Carton, 1930).

This Center cooperated with experts from the Department of Agriculture and Forestry in specific fields (e.g. coffee, tea, rubber, sugarcane), and also cooperated with the directors of farms. Thus, an agro-ecological network was established in Indochina.

Another highlight was that the Center also cooperated with the Department of Agricultural Meteorology at the College of Agriculture and Forestry, and students had to gain experience at the Observatory so that they could make measurements at agricultural experiment stations.

3.4 Seismology (Earthquakes)

In 1924, the Earthquake Measurement Station was established at Phù Liễn Observatory. The main instruments used to measure earthquakes were two Mainka horizontal automatic recorders with 450 kilogram pendulums that were made by a Paris precision mechanical-optics company.

Data about Indochinese earthquakes were

Figure 16: Part of a twentieth century tide gauge once used by the Observatory (courtesy: Phù Liễn Observatory).

sent to international earthquake centers in Strasbourg, Zikawei, Manila, Batavia and Tokyo. The underground tunnel that once housed the earthquake measuring instruments at Phù Liễn Observatory still exists to this day.

3.5 The Time Service

Before the advent of wireless time signals, accurate time was mostly communicated to shipping worldwide by means of time balls, disks, guns, lights, etc. Kinns, 2022). Accumulated evidence indicates that from 1888 a time ball was dropped daily in Hai Phong from a mast located at the top of Phù Liễn hill. Strangely, this service appears to have ceased in 1904 (Kinns, 2021: 448), about two years after the Observatory became operational.

Figure 17: The Prin transit telescope, currently on display at the Observatory (courtesy: Phù Liễn Observatory).

In Saigon, there was also a time ball on a signal mast by the harbor, and this was dropped twice-daily from 1908. Kinns (2021: 450) notes that this "… was still operating in 1937, but was deemed to be for local use only."

By this latter date, time signals were transmitted by radio worldwide, and at 10am Phù Liễn Observatory telegraphed ships and the general community at 600m and 34m. It also provided information for the Departments of Geography and Hydrographic Geography. To do this, the Observatory was equipped with a Prin transit telescope,[6] four Leroy standard clocks and two Auricosep clocks. Figure 17 shows the transit telescope, which is currently stored at the Observatory.

4 CONCLUDING REMARKS

During the nine-year war of resistance against the French, from 1945 to 1954, Phù Liễn Observatory was closed. After Hai Phong Independence Day (13 May 1955) the Vietnam Government decided to reactivate the Observatory's operations and on 1 August 1957 Phù Liễn Observatory began to operate again using a new name, the Phù Liễn Earth Physics Station. In 1963, weather forecasting was reintroduced. Then in 1970, an observatory was installed with an optical telescope, which at that time was the largest in Indochina. A new dome for the telescope was installed in 1978.

In addition, nine meteorological stations for agricultural meteorology were established by Phù Liễn Observatory. These were located at Phù Liễn, Hon Dau, Bach Long Vi, Cau Nguyet, Cat Bi, Vinh Bao, Cau Ngu, Cat Hai and Bang La. There also were seven suburban rainfall measuring stations. Phù Liễn Observatory and Bach Long Vi meteorological station both broadcast data to the international meteorological community.

After Vietnam became completely independent in 1976 the Government of the Socialist Republic of Vietnam merged the meteorological and hydrological work, and Phù Liễn Observatory was united with the Hai Phong River Hydrology network and renamed the Phù Liễn Hydrometeorological Station (see Nguyen and Le, 1986). It now serves the requirements of local hydro-meteorology and provides information to the National Hydrometeorological Station in Ha Noi.

During its existence, Phù Liễn Observatory was equipped with many modern scientific instruments—mainly from France—and it also received support from many overseas experts, especially those from Denmark, Germany, Japan, Poland and the Soviet Union.

Finally, we should note that in June 2018 the World Meteorological Organization formally recognized Phù Liễn Observatory for its contribution to international meteorology over a period of more than 100 years (see Figure 18).

5 NOTES

1. Zikawei Observatory was famous for its meteorological work (see Udias, 2003; Zhu, 2023).

2. M. Lichtenfelder's name does not come up in web searches of French (or any other) architects, so presumably he was not well known internationally. Thus, we have been unable to obtain any information about him–even his Christian name (so we don't even know if 'M.' refers to 'Monsieur', i.e. 'Mr,', or to his Christian name).
3. Endo and Matsumoto (2019: 35) also point out that Ferra "… joined the French Indochina Government in November 1888, and worked as a civil servant. Thus, he was simply an administrator without experience and knowledge of meteorology." That said, he may in fact have learnt some meteorology during his studies and/or while working at Montsouris and/or Paris Observatories.
4. In their study of the Observatory Endo and Matsumoto (2019) only list four French Directors, making no mention of Monsieur Durand. However, quite apart from the exhibit shown in Figure 11, *Le Service Meteorologique …*, 1930: 8) specifically refers to "… M. Durand, Directeur de l'Observatoire …"

5 Directors of Phù Liễn Observatory after the withdrawal of the French were: Nguyễn Xiển (1941–1945), Nguyễn Khắc Mão (1957–1959), Nguyễn Đình Phượng (1960–1982), Hoàng Anh Kim (1983–1988), Hoàng Ngọc Thu (1989–1992), Nguyễn Đăng Khoa (1993–1996), Nguyễn Đức Vượng (1997–2009) and Lưu Văn Hùng (2010–2014).

6. Georges Edouard Prin (1885–1959) was a Paris scientific instrument-maker, who—amongst other institutions—supplied Paris Observatory. His workshop was located on Boulevard Arago, close to Paris Observatory. He was associated with Secrétan for a number of years, and also collaborated with Gautier (Francoise Launay, pers. comm. to Wayne Orchiston, 13 March 2023; James Lequeaux, pers. comm. to Wayne Orchiston, 13 March 2023).

Figure 18: A commemorative plaque celebrating more than 100 years of meteorology at Phù Liễn Observatory (courtesy: Phù Liễn Observatory).

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