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Uncertain skies: Forecasting typhoons in Hong Kong ca. 1874-1906

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Uncertain Skies: Forecasting Typhoons in Hong Kong c. 1874-1906

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Abstract

This paper explores the conceptualisation of «uncertainty» in late nineteenth-century meteorological thought. By investigating the story of meteorological forecasting in nineteenth and early twentieth century Hong Kong – a British colony since 1841 - it considers the changing ways in which forecasting was judged historically. In the early nineteenth century forecasting the weather was considered impossible. By the end of the century, it was confidently expected that the much improved understanding of weather patterns would lead to the ability to better predict them. During the intervening period «uncertainty» competed with «certainty» and «prediction» was mistaken for «predictability». The shift in perception was driven by various factors in Hong Kong including changing public perceptions of what science could achieve and, pressure on government to protect the public from extremes of weather. Such concerns helped shape the course of meteorology globally from a series of subjective abstract theories in combination with practical weather watching experience, into an objective pragmatic science based on observational analysis.

Whilst there has been some excellent scholarship on nineteenth-century British meteorology, the narrative has often concentrated on British shores. This article seeks to highlight instead the practices, places and experiences that contributed knowledge to the burgeoning field overseas whilst also connecting with others in this volume by considering the circumstances that contributed to changing perceptions of forecasting. In particular, it also explores how the qualification of weather phenomenon – in this case the typhoon - as «unpredictable» or «uncertain» opened the door to innovation and discovery.

Keywords

Forecasting, meteorology, history, typhoon, uncertainty, colonial Hong Kong.

Introduction: Forecasting, fantastical or foreseeable?

The question of whether it is possible to forecast the weather has been puzzled over by philosophers and scientists since antiquity. Even today our sophisticated super-computer generated forecasts countenance a margin of error: their *predictions* are based on percentage

possibilities, not absolute certainties. The scientific instruments available to early nineteenth century observers -the barometer and sympiesometer - were even less advanced and, only monitored short-term changes. Forecasting thus relied on a combination of instrumental analysis alongside observation of the skies, especially cloud types and wind direction, often in combination with traditions derived from folklore and the experiences of farmers and mariners. This knowledge was translated into popular almanacs (frequently derided by the nineteenth century intelligentsia) which combined observation, advice and illustrative description. Orlando Whistlecraft's well-known *Almanac and Meteorological Agricultural and General Handbook,* for instance, noted Saint's Days, major historic events and gave gardening advice alongside a commentary on the weather[1]. Whistlecraft was a self-professed meteorologist who believed that although «no one will again impute to us the absurdity of attempting to foretell the state of the weather in every place on the same day» (possibly a reference to the government's withdrawal of national weather forecasts that same year) it *was* possible through observation and study to «indicate its probable changes and also prevailing state over given periods»[2]. His words reflect the dominant sentiment of the day that general weather patterns could be anticipated through the careful surveillance of trends. Thus weather *reports* – published observations of what *had recently been* as opposed to what *will be* - were the norm and much less controversial[3]. Predicting the absolute certainty of rain or shine tomorrow was not in man's power to know.

The underlying belief that it was not possible to predict the unpredictable undermined serious scientific interest in forecasting. In Britain, Robert Fitzroy, first Director of the British Meteorological Office at its founding in 1855, had coined the term «forecast» to describe his advance weather *warnings* in 1861[4]. Even he had argued that his forecasts were not «prophecies or predictions» but «opinion as is the result of a scientific combination and calculation»[5]. Repeated accusations of inaccuracy led to their cessation only five years later[6]. The British Association for the Advancement of Science' (BAAS) pronouncement on the matter clearly reveals the official narrative. Storm warnings, they claimed, were never intended to be more «than that storms already known to exist at one place should be announced by telegraph at another place … there is nothing in them upon which to found such an elaborate system of foretelling probable weather»[7]. This polemic centred on the perceived difference between warning and prediction which, although Fitzroy argued they were two sides of the same coin, many did not agree[8]. Influential scientists, such as François Arago, mathematician, astronomer and Director of the Paris Observatory from 1830, is a typical example. A dedicated

forecasting sceptic, he elided the practice with ancient astrological prophesying[9]. The association of forecasting with astrology dogged the field for decades, not helped by the advent and popularity of Victorian astro-meteorology, proponents of which believed that the planets, sun, and moon influenced the weather[10]. The view that forecasting was unscientific also influenced important scientific bodies, including the British Royal Society, an organisation responsible for many imperial meteorological projects overseas[11].

It would be appropriate however to differentiate between storm *warning* and storm *forecasting*. Storm warnings were short-term. Their issuance was gauged by closely monitoring extant weather conditions, especially pressure observations. As more places and countries became linked by transoceanic cable from mid-century, the ability to produce more effective storm warnings across wide areas improved. Economic protectionism and public welfare also provided important stimuli toward improving storm warnings. Indeed, it was improvements in the accuracy of storm warnings over the century that led to an increasing sense amongst some that forecasting would be their natural progression. Yet, for many – especially those in scientific fields - forecasting remained within the realms of the fantastic.

Basic, yet important hurdles also provided barriers to developing forecasting over time and space. There was no shared global terminology to describe the weather for instance. Countries had their own separate, frequently competing classifying systems, reliant on subjective descriptors[12]. Even when classifying systems were generally adopted they were not uniformly enforced until much later, Luke Howard's classifying system for clouds (1803)[13] for example, or Francis Beaufort's Scale for wind force (1805). The importance of standardisation had been recognised officially at an international congress held in Brussels in 1853. The *Maritime Conference for devising a uniform system of Meteorological Observations at Sea* was attended by major European powers including Russia, Great Britain and the United States[14]. It addressed what were considered woeful inconsistencies in the meteorological instruments used on ships and their calibration; necessary observational corrections; and the standardisation of both the observations measured and the logs kept[15]. Yet it was decades before the conference resolutions were realised as several countries – including France and Britain – persisted in using their own methods[16]. This lack of consensus was to have repercussions for the study and prediction of storms in the Northwest Pacific basin. Effective forecasting also required a sound, reliable and fast method of communicating observations which was simply not available for much of the century, especially in Asia. Although the electric telegraph had revolutionised the possibilities

for communication over land and sea from the 1850s[17]. the reality was that the service – especially transoceanic cable – could be erratic. Too many factors – war, civil unrest, finances and, ironically, bad weather – continually interrupted the service[18].

This paper explores the conceptualisation of «uncertainty» in meteorological forecasting. It is based on a case-study of late nineteenth-century Hong Kong's meteorological services as a lens into the changing ways forecasting was conceived of historically, especially how the notion of «uncertainty» was reconceptualised as scientific «certainty». It argues however that this shift was felt more in the popular, than in the scientific sphere. In the early nineteenth century forecasting was riven with uncertainty and largely considered impossible. By the end of the century, meteorology was so normalised within the popular consciousness, that it was confidently expected by many that research into weather patterns would lead to the ability to predict them. Epistemological and disciplinary transformations had also pushed superstitious, astrological practices to the margins of formal scientific culture. Hong Kong's scientific establishment were less enthusiastic, perhaps because they saw the enormity of the problem first-hand.

The paper focuses on Hong Kong for reasons pertinent to the themes of this special issue but also to build on several recent and important arguments. First, the Hong Kong Observatory was an important node in an Asian and global meteorological network yet, its story (and its incredibly rich collection of surviving archival material) has received little attention. The Hong Kong story thus builds on a growing field of interest in the history of British meteorology, popularised most recently by Katherine Anderson, John McAleer, David Aubin, Charlotte Bigg, Vladimir Janković, and Jan Golinski amongst others[19], as well as the much smaller pool of work exploring the history of the Hong Kong Observatory and local meteorology[20]. Whilst there has been much scholarly attention paid to the meteorological history of the China Seas region more broadly, the Jesuit meteorologists of Manila in particular, the story of British meteorology has in many cases concentrated on British shores[21]. The researches, practices, and experiences that were undertaken by British representatives overseas were no less important in developing the nascent field. In seeking to highlight how British meteorology responded to conditions in overseas colonies, this article also draws from several critical post-colonial themes in the recent history of science that re-read the origins of imperial knowledge. The first is Joseph Hodge's argument that imperial science matured through learning new ways to deal with local specificities[22]. The second is the related claim which argues the necessity of looking

at how and where people acquired their knowledge. Kapil Raj has been a key influence here, suggesting we look toward the «less well-known» encounters, «practices and processes through which modern science was founded», especially in the «contact zones» where skills and knowledge were «circulated, negotiated, and reconfigured»[23]. No less significant has been Arun Bala's claim that knowledge from across the globe was critical to the development of Western science[24]. Effective meteorology and forecasting rested on trans-border communication and a global collaborative effort to address transnational problems in a joined-up way[25]. Nevertheless, it must be noted that cross-border collaboration was often fraught with tension and difficulty: it was not a smooth process politically, technologically or even culturally. The history of this science therefore offers an important insight into the wider socio-political circumstances of the day.

Second, Hong Kong is temporally and climatically distinct from Britain. The Northwest Pacific basin – in which Hong Kong is situated - is the most active typhoon region in the world[26]. The ability to produce accurate storm warnings or forecasts here was critical to the public safety and the economy of the region. A typhoon could severely disrupt trade – the foundation of Hong Kong's nineteenth century prosperity – by causing thousands of pounds of damages to the town and to the shipping industry, notwithstanding the loss of life. As a pre-eminent colony of the British Asian Empire, the British government had an economic and fiscal (as well as moral) duty to re-evaluate the «predictability» of typhoons. Imperial meteorology developed across a critical, anxious juncture in the reframing of empirical science where tensions between observation and speculation were at their height. The story of meteorological science is an excellent example of how the quest to learn and apply general laws through deductive analysis made it credible; authorising forecasting as science, not conjecture. As Steven Shapin argues this layer of credibility created a distinction between truth and falsehood, probable or improbable, in the pursuit of determining the legitimacy of «posited facts about the natural world»[27]. The story of how warnings and forecasts developed in Hong Kong directly appeals to this argument, as well as providing a window into how local specificities of climate forced open the door to innovation and discovery within a global discourse.

The original primary sources informing this article derive largely from the extant archives of the Public Records Office Hong Kong, supplemented by material made available online by Hong Kong University and Hong Kong Public Libraries. The Hong Kong Observatory records are an incredible and well-preserved resource, detailing years of correspondence and research

undertaken by successive directors and key staff. The material used here is only the tip of the iceberg. Other resources – such as colonial correspondence and photographs – survive in British archives including The National Archives and the British Library.

Watching the Weather in Nineteenth-Century Hong Kong

Fig. 1 Chart of the China Sea and East India Archipelago by James Imray and Son, 1855. Courtesy of the Singapore Maritime Museum and National Archives of Singapore[28].

The goal of weather watchers in before the late nineteenth century in Hong Kong was to give as much warning as possible of impending typhoons, not to issue daily predictions of sun or rain. The ravages of the dangerous typhoons had affected all aspects of life in Hong Kong from time immemorial. Thus it is no surprise that early literature and official records from the China Seas region reveal a keen understanding of the storms. Mainland China has one of the earliest official typhoon records (AD816)[29] and Chinese and Korean officials kept weather records – especially for precipitation - centuries before the British entered the region. When Hong Kong became a British Crown Colony in 1841, the methods then in use to foretell an impending storm were – on the most basic level – little different to those used by mariners and farmers then in Britain: folklore and experience. Hong Kong's local practices were famously described by Commander Hall that very same year:

> It is a curious and novel sight to watch the preparations which the Chinese make for the approaching storm; the mixture of superstitious observance and prudent precaution which they adopt … many of their houses, on these occasions, are decorated with lanterns stuck upon poles twenty or thirty feet high, huge grotesque looking figures, and various devices. The beating of gongs, the firing of crackers, and explosion of little bamboo petards, from one end of the town to the other, and in all the boats along the shore, create such a din and confusion, that a stranger cannot help feeling that there must be danger at hand of some kind or other besides that of a storm. It is also a curious sight to watch the hundreds of boats and junks getting under weigh at the same moment, all eager to get across to the opposite shore, under shelter of the mainland, as fast as possible, knowing full well that they would certainly be stranded if they remained on the Hong Kong side[30].

Hong Kong would gradually adopt a European system of storm warning which co-existed alongside extant local practices for many years. For the first four decades of colonisation, the British method in Hong Kong was largely derived from the system developed by Robert Fitzroy and his peers. The chief methods of foretelling the weather were the collection and analysis of multiple instrumental weather observations to ascertain seasonal patterns, and the study of real-time information as determined by the rise and fall of the barometer, state of the clouds, winds, and temperature. From 1839, the Meteorological Committee of the Royal Society in London, had instructed all Governors of all British colonies to keep journals «of the Weather; and of noticing Meteorological phenomena generally». Abstracts of these were required to be transmitted «home, half yearly, to the Colonial Office; where it is proposed they shall be preserved, in the library, to afford means for reference»[31].

By the 1860s, Robert Hart, Inspector General of the Chinese Maritime Customs Services (CMCS), had recognised the importance of increasing the number of meteorological registering stations along the Chinese coastline to improve the storm warning system. Facilities to register observations were normally provided at lighthouses and customs points. The Jesuit observatory established at Zikawei (Xujiahui), Shanghai in 1872 was also an important nodal point in the China Seas meteorological network, issuing storm warnings and conducting research. During the same period, little active research was underway in Hong Kong but weather observations were made at various points around the island and collated at the Harbour Master's Office, which was then responsible for issuing storm warnings. Observers used the barometer to detect an impending typhoon. These been widely distributed across the harbours, ports and ships of Britain and the colonies since the 1840s. That this was achieved at all was in no small part due to Robert Fitzroy's tireless campaigning and publications on weather prediction[32]. From 1873, the Hong Kong Harbour Master's Office updated the warning system with special signals to signify that a storm was at hand[33]. Despite these precautions, disaster was to strike the following year.

In the early morning of 23 September 1874, Hong Kong was hit by a major typhoon. The first indication of this impending disaster had come in the late afternoon of the 22nd. The Harbour Department's barometer had fallen to 29.74 and the wind had begun to blow «in fitful gusts». A steam-launch was sent out to warn nearby boats to take shelter in Kowloon Bay. Over the next few hours the winds had worsened, the storm peaking at around 2am with a shift in wind strength and direction, contributing to a tidal surge of four to five feet which overwhelmed the

sea-front promenades[34]. Between 1am and 4am winds wrecked homes and property. No part of Hong Kong was left unscathed. Rural villages were flattened. The season's rice crop was decimated. The Civil Hospital, Victoria and Stone Cutters' Island gaols and the central Police Barracks were badly damaged. The Gas Works were submerged, plunging the city into darkness. The island's communications were lost when the telegraph lines and submarine cables were severed. For the ships, sampans and junks then in harbour, it was a tragedy. In the aftermath, searchers found the beaches strewn with the wreckage of over 600 junks and 33 ships. Contemporary reports suggested that at least 872 people had died or were missing at sea and, on land, more than 800 people had lost their lives. At neighbouring Macau, the same typhoon has been immortalised in that country's history as one of its most severe nineteenth-century disasters, which left «the length of the beach in the whole of the inner and outer harbour … lined with corpses»[35].

Whilst typhoons are a regular seasonal occurrence of the China Seas, the exceptional magnitude of the 1874 event meant that it entered popular consciousness as an extraordinary and culturally defining memory. It also acted as a trigger point, raising many questions about the potential of science to help mitigate the scale of future disasters. With more resources devoted to the problem, might better warning of the impending catastrophe have been possible? Central to this question was whether the establishment of a permanent observational facility would facilitate a better warning system[36]. It was to be almost another decade before an observatory was established in Hong Kong but the notion that typhoons might be *predicted* was gaining momentum.

An Observatory for Hong Kong

The founding principle of the Hong Kong Observatory was to provide a time service for ships together with the making of «systematic and continuous meteorological observations»[37]. It was considered «beyond question» that there was «a great deal of local want for the daily issue … of trustworthy forecasts of the weather to [the ships], and to the local population of the harbour who swarm in thousands»[38]. The list of equipment purchased for the new observatory shows that they had at their disposal a barometer, a thermograph (for recording temperature and humidity), a sunshine recorder, an anemograph (wind speed and direction) and a rain gauge[39]. Within a few months of taking office in 1883, the first Director William Doberck published a lengthy report on the correct use of this equipment with recommendations as to the standardisation and timing of the observations[40]. He also updated the extant storm signal

system and ironed out a point of particular confusion by discontinuing the firing of a gun to signal incoming mail, to mark a distinction with the typhoon gun[41].

Forecasting at Hong Kong during the 1880s and 1890s mirrored that of contemporary meteorological services globally. The Director took charge of the time service, magnetic observations and issuance of storm warnings. He had three to four European staff who served as Meteorological Assistants and several telegraphists, clerks and computers, who were normally Chinese. Two of the longest enduring staff of this period were Doberck's own sister Anna (also known as Typhoon Annie), and Frederick Figg, the latter succeeding as Director in 1907 until 1912. The Meteorological Assistants collected observations from observatory instruments and external reports from regional stations and ships in harbour. Telegraphed observations would be received in coded form. These would be decoded and entered in a statistical register, data from which would then be plotted onto weather maps, creating synoptic charts. The resultant map of variables including precipitation, isotherms, isobars, wind speed and direction. These would be used to identify areas of high or low pressure and thereby the potential emergence of storms[42]. A warning could then be telegraphed to the meteorological stations most likely to be affected. If the storm was imminent, a coastal signal system of cones and drums would be raised to alert nearby shipping. In 1890, a night-time warning signal system using lanterns was also introduced[43].

Chasing Typhoons

The successful detection of a typhoon necessitated the collation of observations for as wide an area as possible. This necessitated good a good relationship and strong links between regional observatories, including those at Tokyo, Manila, Macau, and Shanghai[44]. In 1883, the network was extended via an arrangement made with the Great Northern and the Eastern Extension Telegraph Companies. This meant that by the time Hong Kong Observatory began operating, observations could be sent gratis between Hong Kong, Manila, Xiamen, Fuzhou, Zikawei (Shanghai), Vladivostock, Nagasaki and, the stations along the China Coast managed by the CMCS[45]. This information was incorporated into Hong Kong's *China Coast Meteorological Register* (CCMR) which began production in 1887[46]. Within three years, the CCMR was incorporating daily reports from sixteen stations regionally. They also published an annual review, *Observations and Researches made at the Hong Kong Observatory*[47]. Hong Kong's own weather reports were made available to the public through various newspapers, including the *China Mail* and issued separately to the Harbour Master's Office, Survey Department,

Medical Department, British Army and Navy, and the CMCS[48]. The burgeoning telegraph service enabled more and more records to be sent from other stations in China, Taiwan and Japan over the next two decades. By 1904, the Eastern Extension Telegraphic Company (EETC) was exchanging observations daily with Taihoku, Taichu (Taichung), Tainan, Koshun (Hengchun) in Taiwan and the Penghu Islands in the Taiwan Strait; Capiz and Tuburan in the Visayas, Philippines; Haiphong, Cap St Jacques (Vũng Tàu), Cap Padaran (Mui Dinh) in Indo-china, and Singapore and Labuan in the Straits Settlements[49]. Doberck was keen to demonstrate the importance of these data, announcing publically in 1893 «that all meteorological observations made on board ships between … were being tabulated, with the view of the issue of pilot charts for the China Seas and North Pacific'[50]. These charts determined the best oceanic tracks to enable safe passage for ships during normal conditions and, as communications and stations increased, also helped ascertain possible typhoon tracks. This was a simple, if time consuming, method of advance *storm warning*, albeit not *forecasting*.

From early on in his residence, Doberck had realised that the collation of observations alone was not enough to ensure ample forewarning of typhoons. Strong precedent in the field of storm studies had been set by the pioneering William Reid, Matthew Maury, Benito Viñes and William Redfield amongst others. Redfield, for example, made an important advance when he noted the circular pattern of destruction left by winds after a storm in New England in 1821[51]. However, the focus of these early observers and meteorologists had been the Atlantic, Indian Ocean and the Caribbean and it was well noted by contemporaries that the storms of the China Seas had many different features[52]. William Dampier was one of the first British mariners to describe Chinese «tuffoons» as rotary storms, an astute observation based purely on his personal experiences at sea in 1687[53]. Nevertheless, this conclusion had not escaped earlier Chinese scholars more used to the phenomenon: the earliest Chinese language characters for typhoon suggesting four wind directions[54]. In the nineteenth century, Heinrich William Dove and Henry Piddington published extensively on theories governing cyclonic storms, including those in the China Seas[55]. Dove cited the first-hand experiences of Dampier and the scholarly observations of his contemporary Bernhardus Varenius on the revolving winds surrounding cyclonic storms (though Dove's own inferences were markedly different)[56]. According to Varenius, Dove noted, the typhoon «bursts forth with violence and shifts round the horizon with a rapid rotating motion, and completes the circuit in the space of about twenty hours, producing the most vehement commotions in those seas by its raging fury and fierce whirlwinds»[57]. Piddington compiled an extensive list of historic storms in the region and

attempted to establish a set of laws explaining these phenomena. His publications had a profound influence on subsequent theories of storms and practical considerations surrounding forecasting at sea, including his recommendation to make use of the sympiesometer (developed by Alexander Adie in 1818) as an instrument for indicating an imminent tropical storm[58]. Nevertheless, the dissemination of competing storm theories created confusion, dominating much of the period's scientific discourse with many of the most prominent thinkers on the subject becoming adversaries including Elias Loomis, William Redfield and James Espy. The practical implications of the debate were aptly highlighted by an anonymous writer as he recalled the difficulties encountered by the *Omagh* whilst en route from Calcutta to Melbourne. «How important it was» he penned to the *Sydney Herald* in 1861

> to arrive at the true knowledge of these laws … not only the loss of several hundreds, perhaps thousands of pounds of property, but the loss of many lives may frequently be the result of our want of such knowledge… it is of some importance that Commanders of such vessels should have some definite idea of the theory... [59]

But ambiguity breed venture. Henry Blanford, government meteorologist in India, for example, argued strongly for expanding research in this field for this very reason. Indeed, his reasoning was cited as justification for building an observatory at Hong Kong[60].

Regional Competition

That research undertaken at a new observatory would fill a cavernous regional knowledge gap was of course a particularly British viewpoint. There had been a Jesuit observatory operating at the Ateneo College in Manila since 1865. With direction from Fr. Federico Faura, the Manila Observatory published daily weather observations as monthly bulletins and they had been responsible for issuing the first regional typhoon warning (with predicted passage) in 1879. By the time Hong Kong Observatory began operations formally – the Manila Observatory already had an established track record of typhoon forecasting and a good network of telegraphically linked national registering stations[61]. The Zikawei Observatory under the direction of Pére Auguste Dechevrens had also made extensive forays into typhoon forecasting since its opening in 1872. Often considered a rival to Hong Kong, Zikawei had produced storm warnings and weather forecasts using information provided by the CMCS registering stations from 1876[62] and, it was Dechevrens, along with Robert Hart, who had been instrumental in setting up a telegraphic storm warning network for the China coast[63]. In contrast, without an observatory,

forecasting in Hong Kong had lagged. As MacKeown notes «the first mention of a practical aspect of meteorological monitoring appeared, in the form of a notice of proposed storm warnings published in the 4 August 1877 issue of the [Government] Gazette». This entailed hoisting a black drum in the event of bad weather organised by the Harbour Master's Office[64]. In 1883 then, Doberck was faced with the unenviable task of catching up with his peers at Zikawei and Manila.

Doberck was determined to make his mark with his own research, despite receiving little support from the government. In 1887, he published a pamphlet entitled *The Law of Storms in the Eastern Seas*. Despite the title, Doberck's pamphlet was more practical than scientific, concentrating less on understanding the typhoon and more on advice for seafarers. The first section outlined indicators of an approaching typhoon, including cloud types, sea swell and barometric pressure alongside signs that would perhaps have been more familiar to the regular almanac reader. The unusual activity of vermin, snakes, spiders and beetles, or the «belief of the natives, that where there is a thunderstorm there will be no typhoon» are cited and credited. His depictions of gloriously coloured sunsets, phosphorescent waters, and lunar halos epitomise an old-fashioned method of perceiving and describing climate through poetic devices and prognostic signifiers, even including human health and its susceptibility to changes in atmospheric pressure. When a storm is imminent he argued, the «weather is then most unhealthy and depressing» and «Many people find it impossible to fall asleep»[65]. Such colourful narrative fits the pattern of his other published works, which MacKeown describes as «largely descriptive'[66]. The remainder of *The Law of Storms* focussed on what mariners ought to do when encountering a typhoon, an analysis of typhoon winds and paths, and classifying typhoon types. As to how a typhoon formed, or establishing the laws that governed them, Doberck was less forthcoming.

The pamphlet had a mixed reception, praised by some and critiqued by others. Contemporary German meteorologist Paul Bergholz, for example, contested Doberck's opinion on the angle and the direction of the wind in cyclonic storms, especially the question of whether wind attained a circular motion. Bergholz own investigations and those of Père Dechevrens at Zikawei Observatory had reached different conclusions[67]. Père Josè Alguè's storm theories (Alguè was Director at Manila Observatory from 1897) published as *Estudio teórico práctico* (Baguios or Philippine cyclones. A theoretical and practical study) in 1898, and translated as *The Cyclones of the Far East* in 1904, also contradicted Doberck[68]. The fact that the British

government refused to allocate Hong Kong Observatory funds or resources to help Doberck write and publish the original pamphlet or subsequent reprints may also be telling. Nevertheless this may also reflect on Doberck's uneasy relationship with the Colonial Secretary's Office at Hong Kong[69]. Indeed, this latter point may explain why several paragraphs of *Law of Storms* critiqued the government for not investing financially in meteorological research or staff. In Doberck's opinion, the skeleton staff meant that typhoon investigations had to be limited and a proper storm warning system could not be initiated[70]. Whilst he may have had a good point, Doberck's contentious behaviour did not help matters and, neither did it benefit him in working with other regional directors. The *Law of Storms* was released amidst a very public backlash concerning Doberck's antagonistic relationship with the directors of the Shanghai and Manila Observatories. Many people, both inside and outside of government, were worried about the impact that his ongoing feud might have on Hong Kong Observatory's ability to issue advance typhoon warnings[71]. The conflict, documented with relish in the *China Mail,* is revealing of the increasingly politicised nature of the regional storm warning system toward the end of the century.

Personalities, Politics and Disaster

The public had a right to be worried. The relationship between Doberck and his contemporaries at Shanghai and Manila was a critical factor in producing (or not) accurate forecasts of extreme weather. Incidents where early observations indicating typhoons at Manila or Shanghai were not acknowledged at Hong Kong were more frequent than should have been expected. In September 1886, for example, news of a typhoon travelling northwest to Hong Kong from Luzon was released in the *China Mail*. Hong Kong however had not issued a warning. Arguing that the main purpose of the Observatory was to issue storm warnings, the newspaper noted that Doberck «does not seem to fulfil his destiny» in regard to the «mutually-beneficial courtesies necessary to the prosecution of systematic meteorology and the prophesying of storms»[72]. Then in 1896, Doberck upset the Director at Zikawei Observatory by issuing an official statement in the press that the Shanghai observatory was deliberately ignoring Hong Kong's storm warnings[73].

Regional tensions came to a head in 1899 after Doberck made derogatory comments to the American Weather Bureau about the «unscientific» staff at the Manila Observatory. This incident led to the «suspension of all telegraphic typhoon warnings given at Manila, for any place outside of the Philippines» in March 1899[74]. In a series of letters written to the Colonial

Secretary between March and May, Doberck claimed that «one of the objects of the Jesuits is to undermine non-Roman Catholic institutions». The effect of the suspension he argued, was «injurious to the true interests of the public»[75]. The following month he added that «when the Jesuits get the warnings, which we have issued from the Hong Kong Observatory, they prevent these warnings from reaching the public or the newspapers in Shanghai or Manila except through their observatories…»[76]. The argument was resolved – on the surface at least – by the intervention of Lockhart and the Chief of the United States Weather Bureau Willis Moore. By June, Moore had persuaded Manila to lift the suspension whilst admitting – in the best politically polite manner - that Doberck had perhaps been ungenerous in his descriptions of Manila's meteorological officers[77]. The incident did nothing to change Doberck's attitude towards the Jesuit observatories.

In the early 1900s the difficult regional relationships would prove to have serious consequences. Unable to reach a compromise in adopting a coherent, uniform regional storm signal system (not fully resolved until 1917)[78], a ship floundered in an unexpected typhoon in August 1901. Hong Kong were blamed for not issuing a forecast until it was too late[79]. The same issue occurred again twice in 1904. In 1904, the Harbour Master at Swatow (Shantou, Guangdong province), China wrote to Doberck to ask «why no telegram of the last heavy typhoon was sent … I also beg to mention why on the 24th instant the ships *Hainan* and *Frithjof* left Swatow for Hong Kong and ran right into the bad weather…»[80]. The same year, the *China Mail* reported how mariners anchored at West Point on Hong Kong Island could not see the storm and typhoon signals which were by convention only raised at Kowloon and the Harbour Office[81]. It was only a matter of time before a major typhoon would tip the balance toward tragedy.

On the morning of 18 September 1906, a «fierce storm» with «blinding squalls of great fury» materialised at Hong Kong with only forty minutes warning. Labelled by contemporaries as the «most appallingly destructive visitation of the kind that the Colony has ever experienced»[82], up to 10,000 people lost their lives[83]. At least 64 large merchant and military vessels, 70 launches, 54 lighters and 652 junks were sunk or damaged[84]. An exceptional storm surge of up to 6.10 metres devastated coastal property «quite out of proportion to the severity of the typhoon»[85]. The «enormous extent of the losses, both to life and property, is attributable to the fact that … this typhoon gave no indication of its existence until close to the Colony»

eyewitnesses argued «and consequently no adequate warning of its approach was given by the Observatory»[86]. This was the view adopted by press and public who blamed Hong Kong Observatory and Doberck personally for the lack of warning. The outrage was such that a committee was appointed to conduct a formal inquiry.

According to evidence presented by the observatory, there was little to suggest the imminent arrival of a typhoon before 7am. Observations of wind and pressure the previous evening had been normal. The last observation of the 17th had been made at 10pm. These readings - an easterly force 1 wind (the lowest category of wind force on the Beaufort Scale corresponding to light air) and barometric pressure at 29.795 inHg, only slightly below normal - did not indicate an approaching storm. The final daily observations received from overseas observatories on the 17th, including Zikawei and Manila, likewise registered only force 1 winds, although the barometric pressure at Manila was a little low at 29.76 inHg[87]. On the morning of the 18th, the first reading had made at 7am, registering a drop to 29.698 inHg and force 3 winds[88]. At 8am the black Drum was hoisted, indicating a typhoon to the east within 300 miles[89]. By 9am the wind had reached force 10 and the typhoon was directly overhead. The suddenness of the storm was also corroborated by experienced witnesses. Captain Roach of the SS Haitan, for instance, testified that the storm had registered one of the steepest barometric gradients that he had ever known, adding, «the steeper the gradient the more sudden the storm»[90].

Others were less sympathetic. One of the chief eyewitnesses asked to give evidence was the French Consul and ex-naval officer Monsieur Liébert. In his opinion, negligent observatory staff had ignored the warning signs recognisable to anyone with experience of watching the skies. «I felt on Sunday September 16th and Monday 17th» he argued, that

> we were going to have a typhoon very soon and my rough observations were confirmed by several naval people who were in the harbour … the local signs were – since the 16th the atmosphere was heavy, the temperature exceptionally warm, the sky of a grey leaden colour with clouds thick in W… the sunset on Monday … was indicative of a typhoon. The sun set with sharp red colour, in parts purple, in others yellowish copper, behind a thick veil of grey heavy clouds. The appearance of the sky at sunset on Monday to anyone accustomed to these regions indicated a typhoon not far off[91].

Liébert also claimed that Zikawei had issued an early storm warning to French shipping in the area, though that warning had not apparently not reached Hong Kong.

There were also structural issues inherent in the management of, and resources available to, the observatory that may have contributed to the lack of forewarning. First the lack of a system (or ability) to receive cabled telegraphic communications overnight. Had communication stations been manned twenty-four hours, an earlier warning may have been possible. The log of the of the SS *Kwei Chow* for example had showed an «abnormally rapid fall» in barometric pressure between 2.20am and 3.50am on the morning of the 18th which *could* have been made known to a nearby station and cabled through to Hong Kong. Lack of resources was clearly an issue but so too was an attitude that comes across in the Observatory correspondence for the period: that the wider meteorological support network was not considered an *emergency* service. Time and again Doberck had had reason to complain to the press, for example, that after hours nobody at the press was available to receive messages or publish warnings. More importantly, overnight telegraphic staff were not trained to interpret coded meteorological messages[92].

Second, Doberck's evidence to the investigative Committee suggested that no observations were made between 10pm and 7am. However, Chinese staff made observations hourly overnight: these had been presented as evidence to the Committee. The issue here was that no *European* had manned the station and thus no *analysis* had taken place between 10pm and 7am. This critical factor delayed the warning. This raises the ugly question: did contemporary European racial beliefs contribute to the disaster of 1906? This was not a question that appeared to worry the investigative Committee who were more concerned as to where the Europeans were that night, than asking why the Chinese staff did not, or could not, report the barometric pressure changes.

Despite the evidence, the Committee found in favour of Hong Kong Observatory. Nevertheless, the scandal did little for Doberck's already tarnished reputation[93]. Already an unpopular figure in the local press and with the authorities in London, it is perhaps no coincidence that Doberck sought retirement in 1907 at fifty-five, the earliest his contract allowed[94]. Today the Hong Kong Observatory describes the 1906 event as a midget typhoon: a phenomena classified as a cyclone of less than 140 miles across[95]. This likely explains why observatory staff and regional weather watchers did not register its approach until it was too late. Experts who lived through the event like Lawrence Gibbs, a British engineer and keen

semi-amateur meteorologist based in Hong Kong[96], argued in 1908 that the typhoon had been less than 100 miles in diameter. This fact meant that the normal signs of a typhoon only registered in Hong Kong when the storm was nearly overhead and, it was too localised to have been verified by the other regional observatories[97]. Whilst recognising these complications Gibbs nevertheless went on to argue that this typhoon had not been abnormally severe. The fact which brought this typhoon «into such prominence» in his mind was still «the failure of the region's observatories to give any adequate warning, and the consequent heavy damage to ships and small craft»[98].

Shifts in Time and Perception

The 1906 controversy reveals a shift in the perception of forecasting over the latter part of the nineteenth century and provides a window into understanding these changing attitudes. In the mid-nineteenth century forecasting was new and untested. It was open to criticism, scepticism and doubt. It did not stand up to scrutiny. Many within the scientific world believed it impossible. By 1874, the destructive typhoon of 23 September was still considered an act of God. Whilst it had raised questions, a long-term forecast was not envisaged within contemporary or future provisions. Criticism of the Harbour Master's Office (then responsible for storm warning) or of any individuals did not enter the narrative. This suggests that forecasting was not expected to be part of the weather watchers' role. By 1906 however, Hong Kong Observatory was held to account for *not* forecasting the terrible typhoon of 18 September. This assumes a belief that forecasting was possible. The era of methodological science, the establishment of the observatory and the network of linked registering stations had produced a pervasive impression that anything, even the previously unthinkable, could be achieved through science. This idea had filtered into public consciousness as a sense that not only could the weather be predicted but, that government meteorological departments and observatories had a *responsibility* to so do. That this shift was perhaps more evident in the general attitude of the public rather than in scientific circles themselves however we shall see shortly.

The 1880s and 1890s were critical decades in this transformation. The period had seen a resurgence of the idea first vaunted in the 1830s and 1840s that, in order to have a proper system of forecasting, it was critical to have a linked, accurate, uniform system of global observations[99]. Doberck had underlined this in his *Law of Storms* arguing the importance of mariners' continued instrumental observations (instructions for which must of course be based

on his own *Instructions for making Meteorological Observations*, 1883) during a typhoon[100]. The First Conference of Directors of Meteorological Services held in Munich in 1891 confirmed formally how meteorological science had entered a new era of recognition, stressing the importance of standardising the observational record and its underpinning classifying systems in strengthening its position[101]. These were crucial factors in enabling forecasts to be made. Indeed, eminent Australian meteorologist Clement Wragge had maintained that «the primary objects [of the conference] are to bring about a thoroughly uniform method of meteorological observation all over the world» to affect «the future of the grand new science» especially «in its practical bearing on the welfare of the people»[102]. Hong Kong's efforts broadly tallied with developments globally, expanding and enriching the historical and contemporaneous observational record by integrating historic and contemporary observations made on land and at sea into weather maps, pilot charts, and storm warnings[103]. By the 1890s, forecasts were seen as separate from storm warnings and published in the local newspapers including the *Hong Kong Telegraph* and *China Mail*.

In 1893 an article in the *China Mail* captured how forecasting had come to be viewed, a far cry from the cynicism of earlier years

> Forecasting may be said to be the real object of all investigations into the science of meteorology, for when an explorer registers meteorological observations in a new country the ultimate object of his work is to throw light on the climate of that country, that is in other words to show by evidence what climate settlers in that country are to expect, and so to forecast its weather for them. Forecasts really grew out of storm warnings and these latter were brought within the bounds of possibility by the extension of the electric telegraph, some half a century ago[104].

The paragraph succinctly reveals how meteorology was constructed as the colonist's favoured science, as well as differentiating between the forecast and the storm warning. Nevertheless, the unknown author was keen to point out that despite having come on in leaps and bounds, forecasting was by no means infallible. Giving the example of Fitzroy who «tried to run before he could walk» by producing three-day forecasts, the author argued that even «we, after thirty years experience, find it very difficult to forecast with accuracy for … twenty-four hours». The author believed that the general public had forced the science to places where it was not yet ready to go:

> The actual re-establishment of forecasts [post Fitzroy], in this and in all other countries, has taken place in response to a general demand on the part of the public for weather announcements. In no single instance has a meteorological institute volunteered to supply forecasts. The duty has been thrust upon it by force of public opinion[105].

The discernible shift in the reading of forecasting as unknowable to knowable between 1874 and 1906 could therefore be considered as much a public perception as a scientific reality. Indeed, the scientific world did not always agree. In the words of Doberck himself in 1906: «Meteorology is not an exact science. Nothing can be predicted with certainty»[106].

These examples reveal a major gap in the popular and scientific understanding of forecasting. This gap grew out of a tension between the limits and expectations of contemporaneous knowledge in an era of scientific optimism. Analysing the course of a typhoon as it was plotted onto a synoptic map allowed for a probable percentage chance of a future route, based on past experience and extant meteorological factors. However, the public were in many respects cajoled into believing forecasts were more certain than they were. The necessity for simplistic language to effectively convey a message combined with confidence in scientific authority almost certainly lent an air of assurance to the warning or forecast. Storm warnings and forecasts were couched in the authoritative voice of the establishment. When they misguided or failed entirely, as in 1906, the scientific establishment left itself open to critique. In 1906 then, Hong Kong Observatory was working in a situation where expectation outweighed ability. The constraints of extant communications technologies combined with next-to-no knowledge or experience of «midget» storms meant the typhoon took everyone by surprise. At a time when the laws of storms were still being defined, first-hand experience was limited to seafarers, and communication fraught with problems, the general public had somewhat unrealistic expectations of the Observatory's capabilities.

Conclusions

Forecasting went through many different phases of conceptualisation in Hong Kong and in the world. In Hong Kong, and the wider area, the government and scientific communities could not stand idly by in the face of the extremes of weather that the region suffered. Public pressure also played a significant role, both in promoting a belief that forecasting was achievable but importantly, in drawing condemnation to failures in the science. Successful forecasting could

not happen in isolation however. A strong, co-operative network of regional observatories was critical to its success, as much as global innovations and developments in the field.

Although the 1880s to the 1910s could be considered a formative period in advancing the science, it was to be another two decades and more before forecasting really broke ground in the scientific world. Improvements were stimulated during the 1920s and 1930s by the necessity for better weather forecasts for the burgeoning aviation industry. Then, the pressures of war in 1939 made weather research critical to governmental interests[107]. The achievements of leading meteorologists during this period globally including Vilhelm Bjerknes, popularly considered the father of modern forecasting, took the field to new levels[108]. In the early twentieth century therefore we witness a marked shift in the scientific capacity as well as the perception of the possibilities of forecasting science. Even as early as 1906, there was little likelihood that forecasts might be abandoned, as they had been during Fitzroy's generation. By the 1920s, forecasting had acquired the confidence generated by governmental backing it so urgently needed. Liked or derided, the daily *forecast* had replaced the weather *report.* In popular and scientific consciousness, forecasting was considered a fundamental aspect of the meteorologist's job. Nevertheless, the tension between public expectation and scientific capability remained, arguably until today. This, argues Alexander Hall, is largely due the manner in which forecasts are presented and communicated to the public. The *deterministic* language of the forecasted event is set in stark contrast to the *probabilistic* likelihood of that event actually happening, in other words the percentage chance of a particular weather event is continually misconstrued as what *will* happen[109]. His statement sums up the fundamental quandary of forecasting the weather which has been, and still is to some extent, a task fraught with difficulty.

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[10] Anderson, *Predicting the Weather*, pp. 52-3.
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[49] HKRS842/3 1898-1903. Letter to the Colonial Secretary at Hong Kong from Manager-in-China, Eastern Extension Telegraph Company (hereafter EETC), 17 March 1898; HKRS842/4 General Correspondence 1903-1913, CCMR, 10 September 1903; HKRS842/4 General Correspondence 1903-13, Letter from Director of Meteorological Services Indo-China to Hong Kong Observatory (HKO), 2 May 1902 & Letter from EETC 20 August 1904.
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[64] Mackeown, *China Coast Meteorology*, p. 25.
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[74] HKRS842/3 General Correspondence, 1898-1902, f. 28r. Letter from José Algué, Manila Central Observatory to the Director of the Hong Kong Telegraph, 7 March 1899.
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[76] HKRS842/3 General Correspondence, 1898-1902. Letter from Doberck to the Colonial Secretary, 2 May 1899.
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1892. Another problem was the lack of night-time telegraphic operators at various of the Hong Kong stations, including the Observatory and Victoria Peak, as well as the post office: HKRS8421/2 General Correspondence 1895-7. Memorandum of the Harbour Master's Office, 28 October 1895.

[93] Ibid, *Report of Committee*, pp. 52, 55; MacKeown, *China Coast Meteorology*, pp. 191-2.

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[101] One of the results of the conference was the proposed adoption of an adapted version of Luke Howard's classifying system for clouds. Walker, *History of the Meteorological Office*, p. 110.

[102] *The Adelaide Observer*, 11 July 1891, p. 35.

[103] In 1893, for instance, Doberck requested historic observations from ship log books to enrich the regional record: HKRS8421/1 General Correspondence 1891-4. Government Notification no. 63 issued by the Hong Kong Observatory, f.106r.

[104] *The China Mail*, Weather Forecasts, 1 December 1893, p. 3. Accessed online 25.03.2017 at https://mmis.hkpl.gov.hk.

[105] Ibid.

[106] HKGRO, *Report of Committee*, p. 49.

[107] Ho, *Weathering the Storm*, pp. 206-10.

[108] For a good introduction see: J. R. Fleming, *Inventing Atmospheric Science: Bjerknes, Rossby, Wexler, and the Foundations of Modern Meteorology*, Cambridge: MA 2016.

[109] A. Hall, A Good Day to Hang out the Laundry, or a 10% Chance of Rain? Talking about risk and uncertainty in weather forecasts «WMO Bulletin» 66:1 (2017, pp. 58-61.

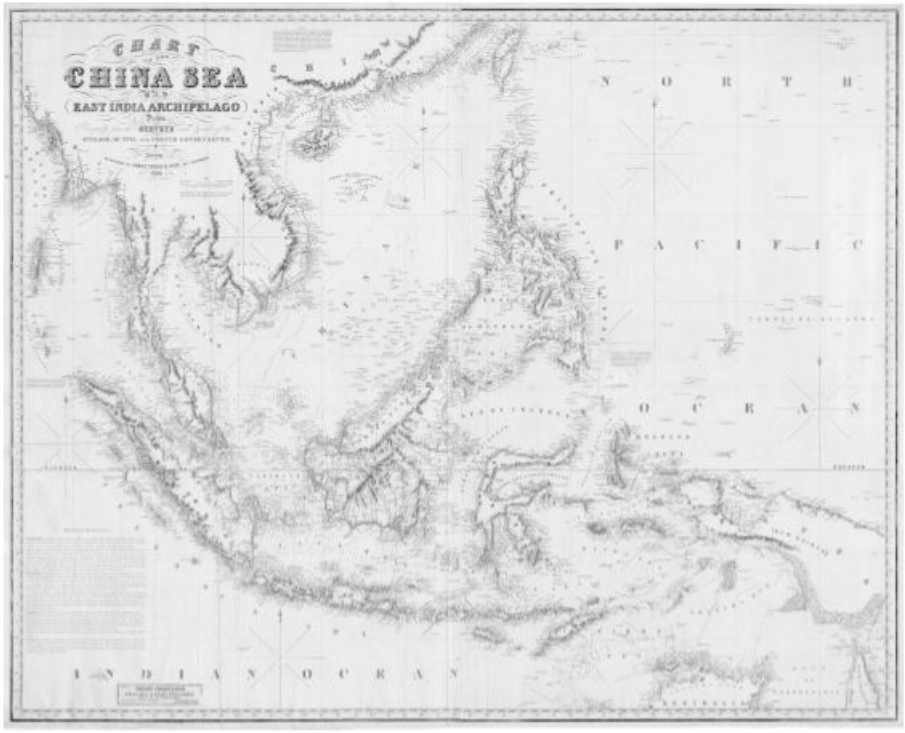

FIG. 1. Chart of the China Sea and East India Archipelago by James Imray and Son, 1855. Courtesy of the Singapore Maritime Museum and National Archives of Singapore.
National Archives of Singapore and Singapore Maritime Museum, CH 619, Media Image No: 2017HDN0003-0035_HC000075: chart of the China Sea and East India Archipelago, 1855.