THE INTERNATIONAL HYDROGRAPHIC REVIEW

INTERNATIONAL HYDROGRAPHIC ORGANIZATION
MONACO

Publication P-1

No. 21

Contents

Page intentionally left blank

Editorial

At the time of writing this editorial, the top end of Australia is in the grip of two significant cyclones – Veronica and Trevor. I note this because in this edition, the first of the papers from the Philippines discusses the impact of cyclones and the research into understanding their influence on generating storm surges and increased water level heights. In an archipelagic island nation, with significant population density and increasing infrastructure projects along its coastline, storm surge has the potential to wreak havoc and destruction. In comparison, the two cyclones striking the sparse Australian coastline are impacting much smaller towns, but the precautions are still costly - whole town populations have been evacuated, mining ports shut down and bulk ore carriers have sailed from ports to safer offshore waters.

The origin of many of these cyclones is due to our ocean environment. Leaving the climate change debate alone, there is no argument about the impact that our oceans have on our climate. The more we study, the more we learn and can appreciate the importance of the ocean in our daily lives. The IHR was first published in March 1923 and the value of nearly 100 years of learned articles about all aspects of our profession provides a wealth of knowledge and an invaluable body of work. I encourage all in our profession to use this resource and ensure its ongoing value to our community by contributing articles and papers. We owe this to the next generation of hydrographers and all members of our profession who will benefit from our experiences and who have access to a consistent and rich resource of research material.

The second paper published as a Note in this edition comes from Land Information New Zealand (LINZ) and is a timely and practical discussion of the experiences of industry undertaking contract hydrographic surveys for national hydrographic offices (HO). With Australia planning to embark on a major contracted hydrographic survey program in 2020 (subject to final government approval), lessons learned from other HOs undertaking similar major contracting programs (e.g. New Zealand, the United States, the United Kingdom, etc.) will be invaluable. Even after 20 years of contracting, close cooperation between LINZ and its two contractors, is reaping benefits to all parties. Of course, in a contracting panel that comprises several companies, cooperation and optimal fiscal budget management can be more difficult to achieve, but that shouldn't stop all parties striving to improve. As more contract work becomes available, particularly for offshore nautical charting purposes, the industry will continue to rapidly evolve technology and processes. We are already seeing this with more use of autonomous vehicles and increased Research & Development into machine learning and artificial intelligence software solutions. It is definitely a most exciting time to be part of this profession.

I would like to thank the authors for their contributions, the willingness of my colleagues to review the papers and the staff of the IHO who compile the published version. I hope that you enjoy these papers and may be inspired to make your own contribution in the future. In my role as Editor, it is always a privilege to bring you a new IHR Edition.

Ian W. Halls
Editor

Page intentionally left blank

Article

THE ANALYSIS OF STORM SURGE IN MANILA BAY, THE PHILIPPINES

By Commander C. S. Luma-ang

Hydrography Branch, National Mapping and Resource Information Authority, (Philippines)

Abstract

In 2013, Typhoon Haiyan produced a storm surge over seven metres in San Pedro Bay in the Philippines that killed approximately 6,300 people. The event created significant public awareness on storm surges and exposed the lack of records and historical research in the Philippines. This study investigated the tidal height records during intense cyclone activities in 2016 and 2017 to provide accurate information about storm surge development in the largest and most populated coastal area in the country – Manila Bay. The results of this investigation indicated that there are consistencies in the characteristics of tropical cyclones that produce larger storm surges. The results also show that actual storm surge heights are generally smaller than predicted height values.

Résumé

En 2013, le typhon Haiyan a provoqué une onde de tempête de plus de sept mètres dans la Baie de San Pedro aux Philippines, faisant près de 6 300 victimes. Cet événement a provoqué une importante sensibilisation du public envers les ondes de tempête et a mis en évidence le manque d'archives et de recherches historiques aux Philippines. La présente étude a examiné les enregistrements des hauteurs des marées au cours d'activités cycloniques intenses en 2016 et 2017 afin de fournir des informations précises sur le développement d'ondes de tempête dans la zone côtière la plus étendue et la plus peuplée du pays, la Baie de Manille. Les résultats de cette étude indiquent des points communs dans les caractéristiques des cyclones tropicaux produisant de plus grandes ondes de tempête. Les résultats montrent également que la hauteur réelle des ondes de tempête est généralement inférieure à la hauteur prévue.

Resumen

En el 2013, el tifón Haiyan originó una marea tormentosa sobre una distancia de siete metros, en la bahía de San Pedro, en Filipinas, que causó la muerte de aproximadamente 6.300 personas. Este acontecimiento provocó una importante sensibilización pública sobre las mareas tormentosas y reveló la ausencia de archivos y de investigación histórica en Filipinas. Este estudio investigó los registros de las alturas de mareas durante las intensas actividades de los ciclones del 2016 y del 2017, para proporcionar información exacta sobre el desarrollo de las mareas tormentosas en la mayor y más poblada zona costera del país - la Bahía de Manila. Los resultados de esta investigación indicaron que hay coherencias en las características de los ciclones tropicales que producen las mareas tormentosas mayores. Los resultados también muestran que las alturas actuales de las mareas tormentosas son generalmente inferiores a los valores de las alturas predichas.

1. Background

The National Oceanic and Atmospheric Administration (NOAA) defines storm surge as the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by storm's winds pushing water onshore (***Figure 1***) (NOAA, 2019).

The amplitude of storm surge is attributed to several factors including the orientation of coastline with respect to the storm track, strength of the storm, local bathymetry and coastline shape.

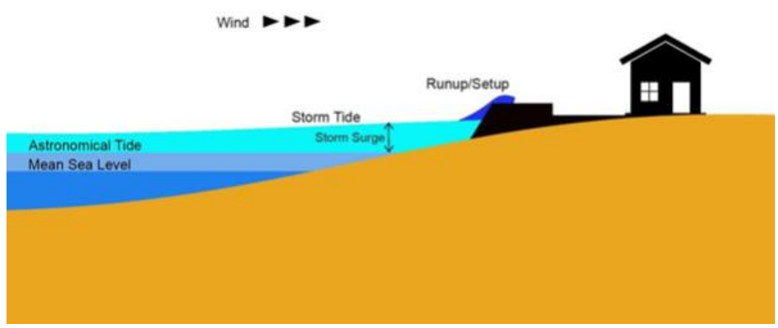

Figure 1. *Illustration of Sea Level, Astronomical Tide and Storm Tide*

The Philippines is located along the paths of tropical cyclones. Based on the ranking made by NOAA using their International Best Track Archive for Climate Stewardship (IBTrACS) database (NOAA, 2018), the Philippines ranks third in terms of the total number of tropical cyclone hits by country and it is second when it comes to the ranking of tropical cyclone hits by country since 1970. Despite the damage received by the Philippines from tropical cyclones yearly, the effects of storm surge have not been given much attention by the Filipino public until Typhoon Haiyan, known as Super Typhoon Yolanda in the Philippines, occurred in 2013. Super Typhoon Yolanda caused a storm surge of more than seven meters (Soria et.al., 2015) above the normal tide. The Philippines' National Disaster Risk Reduction and Management Council (NDRRMC), in its Final Report on the Effects of Super Typhoon Yolanda (NDRRMC, 2013), stated that a total of 6,300 individuals were reported dead and more than Php 80 Billion (US$1.5 Billion) damages was assessed. The enormity of the damage from Super Typhoon Yolanda made every Filipino aware of the term "storm surge" and many equated it to the term "tsunami".

The damage from the storm surge caused by Super Typhoon Yolanda, made a lasting impact not only to the residents of Leyte, but to every Filipino who witnessed through the media how high the storm surge was. Just like any phenomenon that is not fully understood, the term "storm surge" was subject to overuse and misconceptions. Without a definite measurement, storm surges in coastal areas such as Manila Bay can be overestimated and confused with wave run-up and set-up. Often, flooding in the coastal areas of Manila are now attributed to storm surge without any sufficient evidence. Whenever tropical cyclones develop, weather bulletins in the Philippines now include warnings of storm surge of several meters depending on the classification of the cyclone. The PAGASA Tropical Cyclone Warning System (PAGASA, n.d.) indicates that a storm surge of more than three meters is possible along coastal areas for Tropical Cyclone Warning Signal No. 5 or tropical cyclones that have maximum sustained winds of more than 220 kilometers per hour.

Despite the increased interest in storm surge and tides after Super Typhoon Yolanda, minimal effort has gone into analyzing the actual height of tides during the passage of tropical cyclones.

Most studies conducted on storm surge in the Philippines were modeling of the effects using the characteristics of previous storms and applying it to areas like Manila Bay. The study by Carl Drews and Weiqing Han (2009), concluded that if a Category 3 typhoon passes over Manila on a track similar to Typhoon Angela (Rosing in the Philippines) in 1995, Manila City will experience about one meter of storm surge in Manila Bay.

Metro Manila, or the National Capital Region, has been the focus of many studies on sea level rise and storm surge as it is the most populous region in the Philippines having thirteen million of the total 103.3 million population of the country. The City of Manila is the capital city of the Philippines and has 1.78 million population. Manila Bay is the biggest bay in Luzon Island and is also home to the biggest port in the country (***Figure 2***). Should a calamity impact the whole country, Manila is in danger of having the highest casualties and largest damage to properties because of its population and location of its infrastructures. A study by Lapidez et al. (2015) simulated storm surges for 30 cities and identified Metro Manila as one of the areas with a storm surge level as high as 3.90 meters.

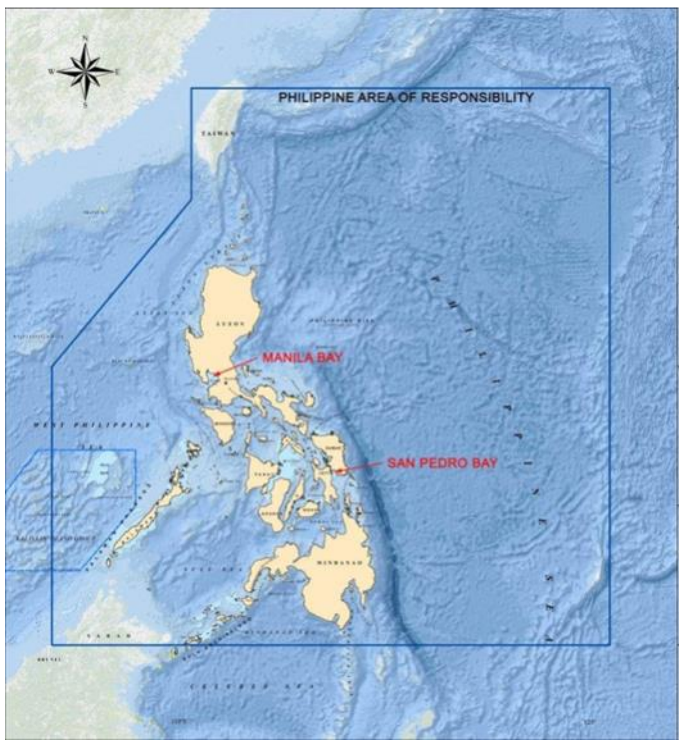

Figure 2. *Map of the Philippines showing the locations of Manila Bay and San Pedro Bay*

Despite the susceptibility of Manila Bay area to natural calamities, the population growth is increasing with people from other regions looking for jobs in the capital city. The land in Metro Manila is already crowded with structures and the government's current remedy is to develop further reclamation projects in Manila Bay. Manila City recently approved a multi-billion-peso reclamation project in Manila Bay covering 318 hectares of the water area. The adjacent City of Navotas also has a proposed 650-hectare reclamation project. Every Local Government precinct within Manila Bay has a proposed reclamation project. If all the proposals are approved, the entire length of the natural coastline of Manila Bay will be replaced with infrastructures and the shape of the bay will be changed significantly.

Given these changes, it is important that the historical storm surge and tide in Manila Bay be studied to understand the behavior of the water movements within the Bay during tropical cyclones. This information is essential for the effective design of reclamation areas including the ground elevation above the sea level, the height of sea walls and the size of breakwaters. Furthermore, actual observation is needed since simulation may not represent reality especially when modeling does not include all factors needed for accurate prediction.

The purpose of this study is to quantify the storm surge in Manila Bay produced by previous tropical cyclones. The period of 2016 to 2017 is used in this study because it was the only period where there were three operational tide stations inside the Bay (***Figure 3***) that could provide sufficient records to analyze the effects of cyclone activity in generating storm surges. The Manila South Harbor (MSH) Tide Station is a Primary Tide Station with tidal height recordings since 1901. The other two stations, Limay and Puerto Azul, are temporary tide stations and were established during the 2016-2017 hydrographic survey of Manila Bay and then removed at the end of 2017. MSH station is located at the northeastern area and the two temporary stations are located at the mouth of the bay, one on the north side and the other on the south side. The data from these two stations were included to determine whether there was drying in the opposite side of the bay when flooding happens on the other side as predicted in some studies.

Figure 3. *Location of the three Manila Bay tidal height stations*

National Hydrographic Offices such as the Philippines Hydrography Branch of the National Mapping and Resource Information Authority (NAMRIA) primarily measure tide heights to establish and update the vertical datum for navigational charts. However, hydrographic data are increasingly being used in other research fields besides charting purposes. Hydrographic data has proven useful in understanding the effects of natural disasters such as using bathymetric information to determine the possible magnitude of a tsunami in a certain area. Tidal height data are also important in the study of sea level rise. In storm surge analysis, tidal height measurements by hydrographic offices are not just a convenient source of data but are also the most reliable form of its measurement.

In September 2018, while the analysis of 2016-2017 storm tides was being conducted, Typhoon Mangkhut, known in the Philippines as Typhoon Ompong, hit the Philippines. It is the strongest typhoon to strike Luzon since Typhoon Megi in 2010, and the strongest typhoon to make landfall in the Philippines since Typhoon Haiyan in 2013. Mangkhut made landfall on the Island of Luzon on 15 September 2018 as a Category 5-equivalent super typhoon. It subsequently impacted Southern China including Hong Kong. Typhoon Mangkhut was the third-strongest tropical cyclone experienced worldwide in 2018. Due to the strength of Typhoon Mangkhut, the tide data during its passage was included in the study.

2. Area of the Study

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), which is the National Meteorological and Hydrological Services agency of the Republic of the Philippines, classifies tropical cyclones entering the Philippine Area of Responsibility (PAR) into five categories based on the maximum sustained winds in kilometers per hour - kph near the center (***Table 1***).

Table 1. *PAGASA Tropical Cyclone Categories*

Category	Type	Wind Strength (kph)
1	Tropical Depression (TD)	<61
2	Tropical Storm (TS)	62 - 88
3	Severe Tropical Storm (STS)	89 - 117
4	Typhoon (TY)	118 - 220
5	Super Typhoon (STY)	>220

In 2016, fourteen tropical cyclones entered the PAR ranging from Tropical Depressions to Typhoons. In 2017, twenty two tropical cyclones entered the PAR, including one Super Typhoon, leaving a total damage of US$15.7 Billion. This study analyzed the height of tides during the passage of 34 of the 36 tropical cyclones that passed through the PAR during these two years. The heights of tides during two tropical cyclones, Typhoon Nina and Typhoon Auring, were not recorded due to repairs being undertaken on the tide stations when the tropical cyclones passed. The paths of the 36 tropical cyclones that entered the PAR between January 2016 and December 2017 are shown in ***Figure 4***.

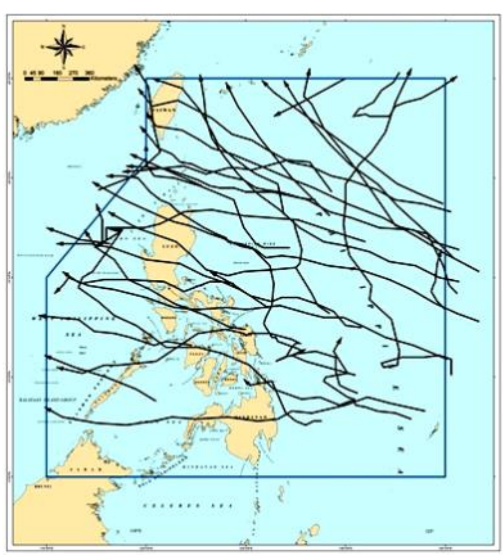

Figure 4. *Paths of Tropical Cyclones that passed through the Philippine Area of Responsibility (PAR) in* 2016 and 2017

3. Determining Storm Surge Height

The height of the storm surge was determined as the residual by subtracting the observed water level from the predicted water level. The Manila South Harbor Tide Station is located in an area where it is sheltered from waves and is able to measure still water. Wave run-up and set-up were already eliminated from the recorded data.

The graph in ***Figure 5*** shows the comparison between the observed and predicted water levels in the MSH Tide Station during non-storm days. The observed and predicted water level values closely match with each other when there is no weather disturbance.

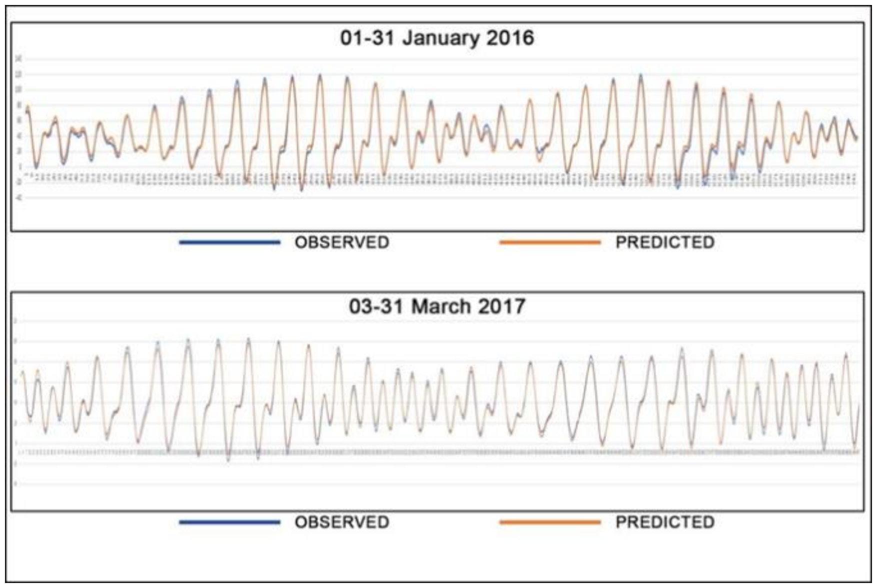

Figure 5. *Water level at MSH Station during non-storm days in January 2016 (above) and March 2017 (below)*

In comparison, ***Figure 6*** shows the observed and predicted water levels at MSH Tide Station during the tropical cyclone periods and it can be seen that the water level rose when four tropical cyclones made landfall in the island of Luzon.Typhoon Mangkhut, one of the most damaging cyclones, produced a maximum storm surge of 50 centimeters when it made landfall in Luzon Island and was directly north of Manila.

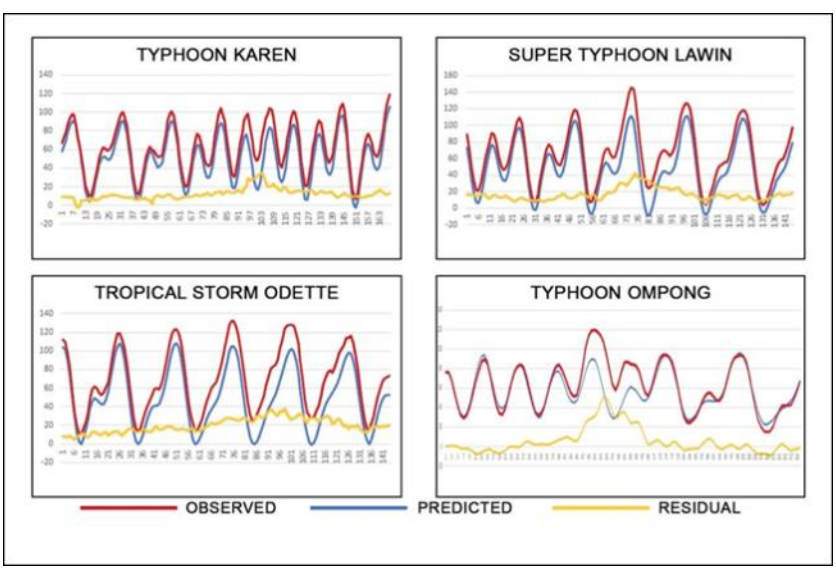

Figure 6. *Water level at MSH Station during Tropical Cyclones Karen, Lawin, Odette and Ompong landfall*

The analysis also showed that there are tropical cyclones that have no obvious impact on water level when passing through the PAR. ***Figure 7*** shows that water levels recorded at MSH Tide Station during TD Bising, TS Jolina, TS Kiko and TD Ambo, seem to have not changed or deviated much from their predicted levels. Tropical cyclones that did not make landfall in Luzon were generally too far away to create significant rise in the water level in Manila Bay.

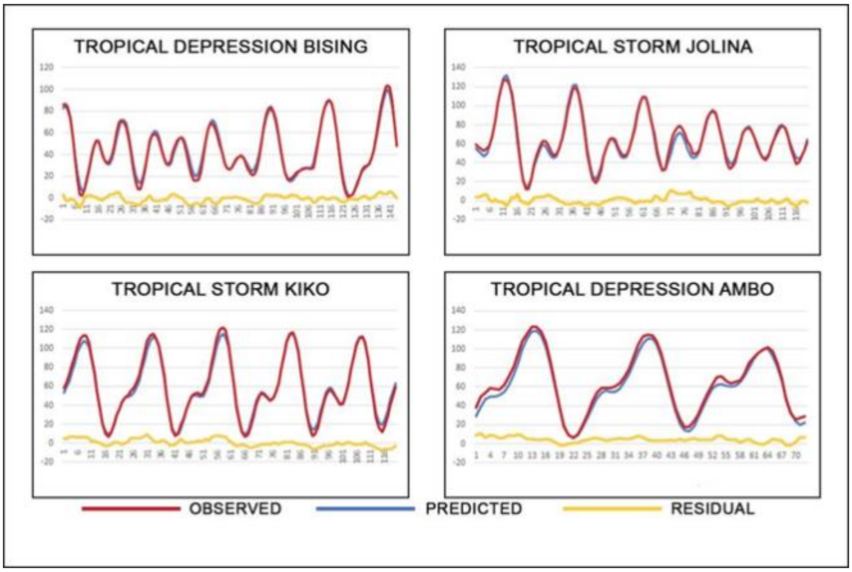

Figure 7. *Tropical Storms that did not produce significant storm surge*

Out of the 34 tropical cyclones with recorded tide height data in 2016-2017, there were only four (STY Lawin, TY Paolo, TS Karen, TY Odette) that caused a storm surge of 30 centimeters (***Table 2***). These four tropical cyclones had different wind speeds and paths and one tropical cyclone did not make landfall (***Figure 8***).

Table 2 : Tropical Cyclones and their highest residual values

CLASSIFICATION	MAXIMUM SUSTAINED WINDS NEAR THE CENTER	TROPICAL CYCLONE NAME (LOCAL)	HIGHEST RESIDUAL
SUPER TYPHOON	MORE THAN 220 KPH	LAWIN	42
TYPHOON	118-220 KPH	GORIO	22
		LANNIE	21
		PAOLO	30
		VINTA	22
		BUTCHOY	25
		DINDO	11
		FERDIE	15
		GENER	15
		HELEN	21
		IGME	16
		KAREN	35
SEVERE TROPICAL STORM	89-117 KPH	RAMIL	22
		CARINA	18
		ENTENG	11
TROPICAL STORM	62-88 KPH	DANTE	13
		EMONG	11
		HUANING	22
		ISANG	15
		JOLINA	11
		KIKO	9
		MARING	21
		ODETTE	38
		QUEDAN	22
		SALOME	20
		TINO	21
		URDUJA	18
		JULIAN	17
		MARCE	14
TROPICAL DEPRESSION	61 KPH OR LESS	BISING	-9
		CRISING	6
		FABIAN	-13
		NANDO	17
		AMBO	11

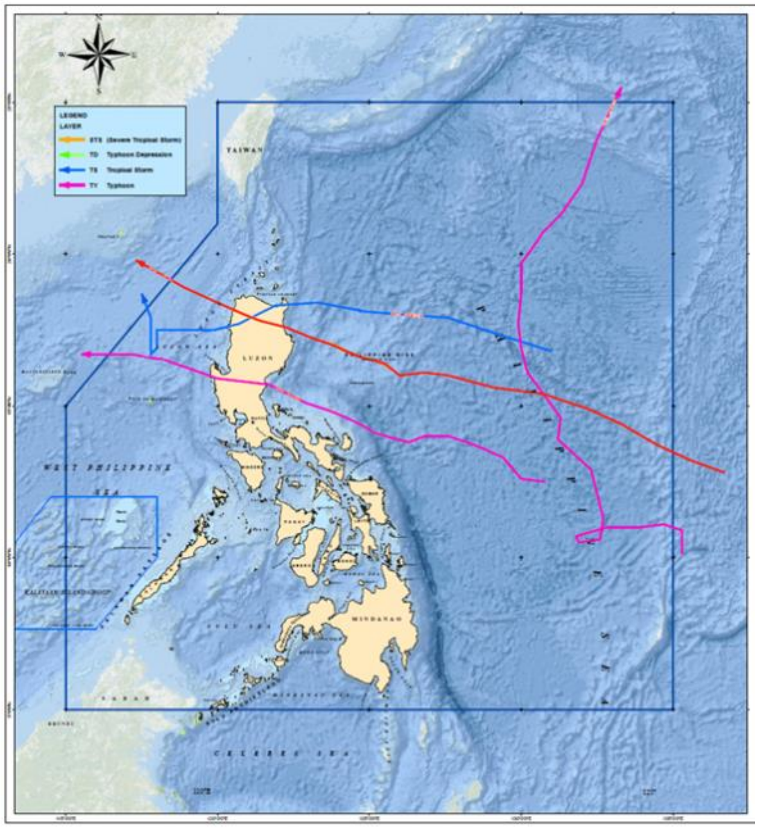

Figure 8. *Path of the four Tropical Cyclones that produced the highest storm surge from January 2016 to December 2017*

The cyclone that produced the highest storm surge was STY Lawin with a highest wind speed of 270 KPH. The other two were Typhoons (Paolo and Odette) and the last was a Tropical Storm (Karen). All made landfall in Luzon and north of Manila Bay except for TY Paolo which entered the PAR at the same time as TY Odette was exiting the PAR. TY Odette may still have influenced the wind in Manila Bay even though it was outside of the PAR.

In comparison, TY Ompong created 50 centimeters of storm surge in 2018, despite having a similar path to the three tropical cyclones that generated storm surges.

4. Study Outcomes

The data analysis suggests that the magnitude of a storm surge in Manila Bay can depend on the combination of a tropical cyclone's:

- sustained winds;
- distance from Manila Bay; and
- path.

The 2016-2017 data showed a consistency with respect to the path of the tropical cyclone and the height of surge produced. The highest rise in water level were created by tropical cyclones passing and making landfall north of Manila Bay. Tropical cyclones passing north of Manila produce onshore winds when it makes landfall in Luzon, thereby pushing the water towards the coastal area of Manila.

One interesting observation was that there is no obvious drying in the opposite side to the flooded part of Manila Bay. Carl Drews and Weiqing Han (2009) concluded that the northwest corner of Manila Bay will also experience rapid drying, followed quickly by storm surge heights up to 3 meters that could reach 5 km inland if a Category 3 typhoon passes over Manila on a track similar to Typhoon Angela in 1995. However, the actual tide height data does not show any obvious fall of water level below the predicted values at the Limay and Puerto Azul tide stations. ***Figure 9*** shows the recorded water levels in Manila South Harbor (MSH), Limay, Puerto Azul and the predicted tide in MSH in two different months in 2017. The upper image displays the month of May when there were no tropical cyclones. The predicted and recorded values in the three tide stations coincide with each other. In comparison, the data is quite different in October when cyclone activity occurred in the PAR. The water level in the MSH was higher compared to Limay and Puerto Azul.

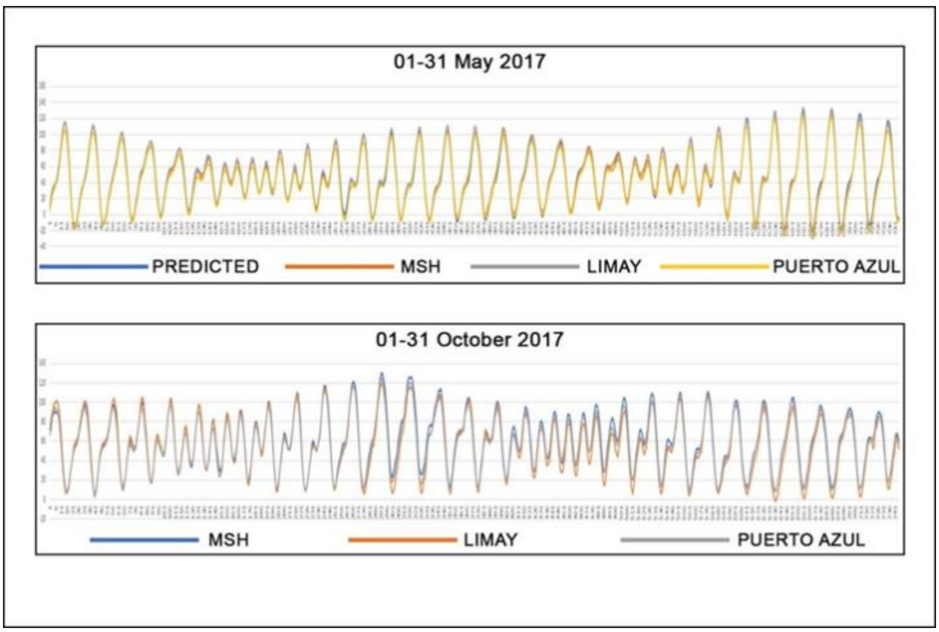

Figure 9. *Comparison of Tide Levels at Manila South Harbor, Limay and Puerto Azul Tide Stations*

The observed residuals from the tropical cyclones in the study period are generally smaller than the predicted heights from modeling studies. No tropical cyclone, including the strongest super typhoon, produced more than one meter of residual. STY Mangkhut produced only 50 centimeters of storm surge. Mangkhut had the ideal wind direction, strength and path to produce a large storm surge. However, it did not create the expected storm surge in Manila Bay when compared to the storm surge that Haiyan produced in San Pedro Bay.

The shape of Manila Bay may help to prevent the development of large storm surges. In comparison, San Pedro Bay is funnel shaped, is located at the east side of the archipelago and faces the Pacific Ocean. Tropical cyclones normally develop in the east side of the Philippines and travel westward towards mainland Asia. Manila Bay is semi-enclosed and located on the west side of the country. The location and configuration of Manila Bay likely reduces the movement of water that can create larger storm surges.

The study data indicated that floods that occur during tropical cyclones are not caused by storm surge. Seawalls along Manila Bay are generally higher than the recorded storm tide levels. Flooding has been caused by wave run-up and set-up. ***Figure 10*** shows the condition in Manila Bay when there is no weather disturbance.

Figure 10. *Sea condition in Manila Bay during calm weather and at high tide*

Figures 11 to 13 were taken during the morning of 15 September 2018 during TY Mangkhut. ***Figure 11*** and ***Figure 12*** are the same spot (breakwater) as ***Figure 10***. ***Figure 13*** is a sheltered portion behind that breakwater. ***Figures 11***, ***12*** and ***13*** were taken just a few seconds after each other and portray the different situations during TY Mangkhut. ***Figure 13*** shows the condition behind the breakwater – big waves do not form. Figure 11 shows the level of the water when there is no wave, whilst ***Figure 12*** shows the height of the waves striking the breakwater. The series of images shows that the maximum storm surge tide level was lower than the tops of the breakwater and seawalls. However, flooding was still experienced because water was thrown to the other side of the seawall by breaking waves. Floods did not occur because the water level was above the seawalls, rather it was due to the water from breaking waves exceeding the tops of the barriers. It is therefore important to differentiate storm surge which is sustained over a long period of time from waves which are generated within short periods.

Figure 11. *A breakwater in Manila Bay during the time TY Mangkhut passed trhough Manila (15 September 2018)*

Figure 12. *Waves hitting the same breakwater in Figure 11 during the time TY Mangkut passed trough Manila (15 September 2018). It was taken a few seconds after Figure 11 was taken*

Figure 13. *Behind the breakwater in Figure 11 (15 September 2018). Waves do not form behind the breakwater*

The study of the tidal height levels during the period of many cyclones in the two-year study period (2016-2017) did not show any obvious residuals between the observed and predicted tidal heights. However, this does not reduce the importance of understanding storm surge nor lead to neglect the potential damage in Manila Bay area.

The generated storm surge may increase when the configuration of Manila Bay is changed through land reclamation for example. Other factors that may increase the Bay's water height level during a storm include the discharge from the Pasig River, atmospheric pressure and the tide phase. When the storm produces a large volume of rain and increases the discharge from the Pasig River into the Manila Bay and this coincides with the highest tide of the cycle, the water level may go higher than previously recorded storm surge levels. Tropical cyclones also differ in characteristics. If a Super Typhoon moves very slowly from east to west passing through Manila, water may accumulate inside Manila Bay to produce higher than normal storm surge tide levels.

It must be noted that the study focused on the storm surge in Manila Bay. Due to the complexity of the shape of the Philippine archipelago, the rise of water level is not the same throughout the country. The storm surge may be higher in other areas even if there is no rise in water level in Manila Bay.

The amount of rain discharged by a typhoon can create more extensive damage than the wind as experienced during TY Ketsana (TS Ondoy in the Philippines). TS Ondoy's rainfall created flash floods that caused more damage than other Super Typhoons with higher wind intensity, but lower rainfall.

Further, reclamation projects will change the configuration of Manila Bay and this may either increase or reduce the magnitude of the storm surge. Continuous observation should be made to understand the effect of all factors that determine the impact of storm surge in Manila Bay.

The major differences between Manila Bay and San Pedro Bay are their location and orientation with respect to the usual track of tropical cyclones. San Pedro is facing the Pacific Ocean where tropical cyclones commonly originate. Thus, it is impacted by tropical cyclones before it makes landfall. Manila Bay is located on the West side of the archipelago and is impacted by tropical cyclones after passing through land. Generally, tropical cyclones weaken as they move inland because of the source of warm water is cut off. The mountain ranges in Luzon may also contribute to the weakening of the tropical cyclones.

San Pedro Bay has a funnelling shape and the bathymetry shallows as it reaches the narrow part. Its orientation with respect to the usual northwest path of tropical cyclones provides a long fetch of water or the horizontal distance over which wave-generating winds blow. On the contrary, Manila Bay has a constricted opening that limits the entry of water.

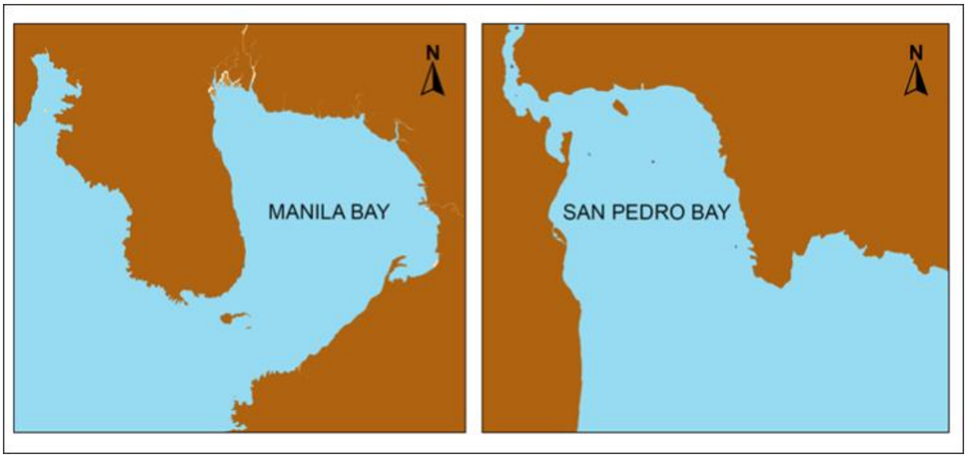

Figure 14. *Manila Bay and San Pedro Bay*

5. Conclusions

Understanding storm surge is important in an archipelagic country (such as the Philippines) frequented by tropical cyclones. It is even more critical in coastal, highly urbanized cities where damage and potential loss-of-life can be severe due to the population density and complex infrastructures. Many studies have identified Manila Bay as susceptible to storm surge and through modelling have predicted water level rise of several meters when a storm surge occurs.

This study used observed measurements from tide stations to determine how high the water level rose in Manila Bay during the passages of tropical cyclones. Tide stations in the Philippines were established primarily to monitor the sea level (mainly due to astronomical factors) for the support of hydrographic surveys. However, these records proved beneficial to other uses such mean sea level rise monitoring and storm surge analysis.

The results of the study highlighted that there is no single characteristic that is responsible for producing the largest storm surges in Manila Bay. Tropical cyclones rarely follow the same path nor have the same strength. Thus, the amplitude of storm surge varies from storm to storm. If a tropical cyclone changes its course sharply and deviates from the usual path such as Typhoon Chanchu in 2006 (not shown in this article), it may generate larger storm surge than what was measured in this study.

It is recommended that further studies be made to evaluate the contribution of other factors such as central pressure of tropical cyclones and characteristic of bathymetry for better understanding of storm surge generation and its impact in the country.

6. References

Drews, C. and Weiqing, H. (2009). **Modeling storm surge in Manila Bay using the ROMS** [poster]. Physical Oceanography Review Symposium, U.S. Office of Naval Research, viewed 17 August 2018. http://n2t.net/ark:/85065/d71n8058

Lapidez, J.P., Suarez, J. K., Tablazon, J., Dasallas, L., Gonzalo, L.A., Santiago, J. Cabacaba, K.M., Ramos, M.M.A., Lagmay, A.M.F., Malano, V. (2015). **Identification of Storm Surge Vulnerable Areas in the Philippines through Simulations of Typhoon Haiyan-Induced Storm Surge Using Tracks of Historical Typhoons**, viewed 10 September 2018 https://center.noah.up.edu.ph/

NDRRMC (2013). **Final Report re Effects of Typhoon Yolanda (Haiyan)**. National Disaster Risk Reduction and Management Council, Quezon City, p.65.

NOAA (2018). **Tropical Cyclones Records Page**, National Oceanic and Atmospheric Administration, Hurricane Research Division, viewed 10 August 2018, http://www.aoml.noaa.gov/hrd/tcfaq/E25.html

NOAA (2019). **What is storm surge?** National Oceanic and Atmospheric Administration, viewed 8 April 2019 https://oceanservice.noaa.gov/facts/stormsurge-stormtide.html

PAGASA. (n.d.) **Payong Pagasa: Tropical Cyclone Warning System**. Department of Science and Technology, Philippine Atmospheric, Geophysical and Astronomical Services Administration, viewed 24 August 2018
http://bagong.pagasa.dost.gov.ph/learnings/publication

Soria, J.L., Switzer, A., Villanoy, C., Fritz, H., Bilgera, P.H., Cabrera, O., Siringan, F., Yacat-Sta. Maria, Y., Ramos, R., and Fernandez, I.Q. (2015). Repeat storm surge disasters of Typhoon Haiyan and its 1897 predecessor in the Philippines, Bulletin of the American Meteorological Society, vol. 97, issue 1, pp. 31-48

8. Biography

Commander Carter S Luma-ang is currently the Chief of the Maritime Affairs Division of the NAMRIA Hydrography Branch (Philippines). He earned his Master Degree in National Security Administration from the National Defense College of the Philippines (2016) and his Bachelor of Science in Civil Engineering from the St. Louis University, Baguio City (1999). He completed the Category "B" Hydrographic Surveying Course at the Japan Hydrographic and Oceanographic Department of the Japan Coast Guard (2006) and attended the Rhodes Academy of Oceans Law and Policy (2012) and the Yeosu Academy of Oceans Law and Policy (2014).

Email: csl.namria@gmail.com

Page intentionally left blank

Notes

MULTIDISCIPLINARY SURVEYS: A CONTRACTORS TOP 10 TIPS

By D. Stubbing, K. Smith and S. Cox

Discovery Marine Ltd (DML), (New Zealand)

This article is based on a presentation given at the HYDRO18 Conference in Sydney and is reproduced with kind permission.

Abstract

Discovery Marine Ltd (DML) is a Small to Medium Enterprise (SME) in the hydrographic industry and has been providing contract services to Land Information New Zealand (LINZ), New Zealand's Hydrographic Authority (NZHA) for the last 10 years. The procurement model and service delivery approaches have altered during this tenure, realizing tangible benefits to both government and industry.

Background

The Australian Government is currently considering a similar shift towards a more comprehensive contracted industry hydrographic survey supply (IHO, 2018). This paper shares DML's experiences, observations and insights from the last 10 years as a provider of similar services to the New Zealand (NZ) government. The authors have summarized these in the form of 10 key tips for developing a sustainable, proficient and efficient hydrographic survey business to support the nautical charting market.

1. Define a clear brief

The key to any successful project starts with a clear and concise project brief. In the case of complex nautical charting surveys, the brief should establish clear requirements for the contractor to address, in particular whether the task relates to safety of navigation or science. It's important for the contractor to understand what must be achieved, what elements are critical and why, what specific deliverables are required, when they are required and in what form. Defining clear requirements also ensures that deliverables will be fit for purpose for all stakeholders.

Figure 1: *Multiple stakeholders, multiple deliverables; Community, fisheries, tourism, safety of navigation*

There may be instances where the best deliverable that typically demands a premium price is not warranted. As a contractor to government, DML has been conscious of ensuring work area allocation makes sense, without accumulating line miles for the sake of it. The trust that is established from this attitude is invaluable.

Once the survey requirements are clearly defined, it becomes easier to gain agreement from stakeholders on what datasets are required and what takes priority. Where multiple stakeholders have contributed to project funding, tensions can arise around operational protocols and priorities. In DML's opinion, capturing the priority dataset should define the lead contracting authority.

2. Don't pay lip service to stakeholder engagement

From experience, DML has seen that the best project briefs are developed collaboratively. This provides the opportunity to not only validate the questions but also explore possible operational and project challenges, opportunities for innovation and project efficiencies. Clients and suppliers should engage early with other stakeholders. Engagement must be genuine, inclusive, honest and respectful. You never know where the light-bulb moment will come from.

A huge benefit in early stakeholder engagement under LINZ's new supplier panel arrangement has been recognized. DML has participated in project reconnaissance which has directly impacted the project brief and specifications. There has been the opportunity to share our field experience to help unlock efficiencies and avoid project complication. Consulting industry early in the planning process also avoids suppliers feeling locked out and ensures the buyer is fully informed of any possible project roadblocks.

In software development, Linus's Law (Raymond, 1999) claims "given enough eyeballs, all bugs are shallow". With multiple stakeholders demanding a variety of deliverables this also becomes true of early engagement and development of the project brief.

3. Define the specifications clearly

It seems obvious that defining clear specifications is as important as a clear project brief, but there is not always a straightforward answer in multidisciplinary surveys. Hydrographic specifications for surveys and navigation products are well defined and understood internationally by industry.

By contrast, specifications around the capture of non-bathymetric datasets appears to vary between national agencies and is often dependent on the science questions being asked. These questions may not be the same for all locations within a project's geographic extent. In the case of acoustic data from MBES systems, there are well documented operational science guidelines. From what we have seen of these guidelines in practice in New Zealand, the science guidelines do not appear to define the quality of the product and are focused on operational inputs rather than final outputs.

Stakeholders agreeing on the science specifications is important, but of equal importance, is establishing which data set within the total project specifications is to take priority. This is key to field survey operations as there are likely to be several environmental factors and project constraints that may influence contractor decisions relating to data priorities e.g. bathymetry versus backscatter versus water column.

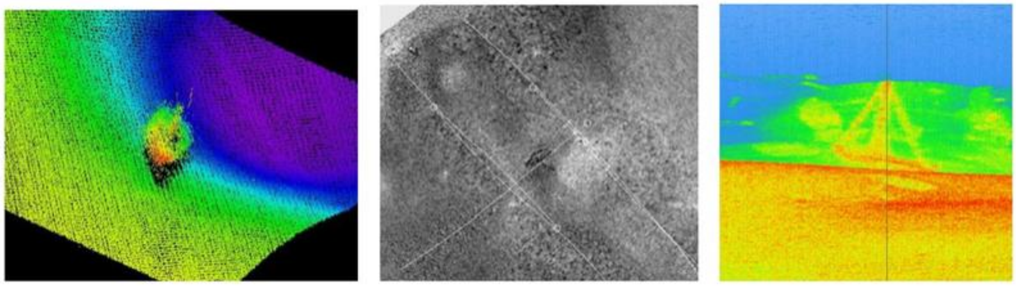

Figure 2: *Bathymetry, backscatter and water column data over a wreck*

4. If there is a need to trial new processes, validate early or fail fast

Industry moves quickly on technological advancements which are often not allowed for or covered in initial project briefs. Software upgrades can often happen halfway through a project. If the contractor identifies potential client benefits in trialling new equipment or solutions, then they must alert the client to this, have a defined process for validating them and/or fail fast strategy, allowing the project to proceed to an agreed Plan B.

Sometimes project timelines or constraints won't accommodate the flexibility for trialling new capability. However, for industry solutions to continually improve, there must be an openness to trials during 'real projects' when conditions permit. For a supplier to feel safe in doing this, the client must adopt an attitude that allows trials, specifically where failures are acceptable. Without this attitude fear will pervade and innovation will be stymied.

Contractors should not be afraid of proposing alternatives, so long as both parties are prepared to share the risk of failure.

5. Procurement model, panel or contestable?

Value-for-money underpins all government contracts. Recent trends towards panels of providers as opposed to contestable "winner takes all" contracts are attempting to create a win-win for both the client and suppliers.

When considering a panel, it's important from a contractor's perspective, not to over stack the panel. There's a real cost in being fit and ready to set to work at any moment. Expecting suppliers to be on standby without providing them with enough work is not sustainable for suppliers. Instead it's better to assess the available budget and work backwards to determine what level of contractor support is required for the short to medium term. It's unrealistic to expect industry to gear up in anticipation of work and then hold tight. In New Zealand, LINZ addressed this issue by understanding that annual budgets were probably only large enough to support two contractors. As such, their panel consists of two companies who are working collaboratively to ensure that they both derive enough income in any given year to support panel participation and deliver client requirements including sustainable capability and innovative solutions.

LINZ has also offered multi-year contracts to suppliers providing increased income certainty. This has helped suppliers justify their business cases for ongoing investment in evolving technologies and has also addressed very critical human factors within the industry. Hydrographic surveying is a challenging career that requires teams to be away from home for extended periods, often working long hours in remote locations.

People need security. Multi-year contracts provide increased income security for businesses which directly affects their people. It's untenable to expect staff to make the necessary lifestyle sacrifices that come with being a hydrographic surveyor and not compensate for this with adequate income security.

An alternative procurement model is one where budgets are fully contestable every year. In our experience this not only creates a lot of work for the procurement team and suppliers, it also creates excessive market fear of missing out. Fear creates a race to the bottom on price. This may seem beneficial to the buyer in the short term, but it's unsustainable for suppliers. Hydrographic surveying is a high-risk industry especially when projects are awarded on a fixed price basis. If margins are squeezed too far, players will leave the sandpit.

6. Get the contracting model right

For complex projects that involve several client stakeholders it's important to have clarity around who the client is and who the contractor is. LINZ shield contractors from multi-client environments by acting as the representative and legally bound buyer of all services. This prevents a situation where the supplier is drawn into conflict over competing priorities. It also ensures that there is a clear line of communication for contract negotiations and operations.

LINZ's approach has also ensured that contract documentation and specifications are simple and direct by acting as the lead client when multiple clients exist. The supplier should only be accountable to one contract document.

Where a project requires input from various contract suppliers, it's vital that there are clear lines of accountability on the supply side and that there is a clear project lead. The client will appreciate a singular point of contact.

It's important not to overburden projects with too much red tape, lawyering up costs everyone. To achieve the efficiencies that are available in an industry supply model, the buyer must be agile. This requires some customization ensuring contracts are fit for purpose and not a "one size fits all" approach. A contract that's designed for the procurement of an all of government consultancy service, will be overwhelming for a SME hydrographic survey supplier responding to a sub $5M project. Efficiencies will also arise if government establishes processes that enable uncomplicated delivery of quality line miles, not contract administration. SMEs by nature are not complex entities. Burdening them with the complexity that can exist within government processes, will rapidly erode any efficiencies being sought from industry.

Project risk must also be sized appropriately. Is it fair to burden a contractor with project risk for something that they have no control over such as weather? Or ask that insurances are held that would indemnify the buyer for a replacement vessel rather than a 10-day project. Insurances can be a minefield where industry ends up establishing cover, for cover that is ultimately already in place by government. Essentially double-dipping.

7. Develop a framework that encourages collaboration

Under a healthy panel of providers' environment, it is possible to remove fear from the table, a powerful notion for a small business. If the panel is sized appropriately for the market, trust between the client and panel members increases. There is space for discussion around innovation and development in frank, material ways.

There are also benefits to be gained from ensuring budgets are transparent. In our experience focus shifts to finding smarter more cost-effective ways to deliver outcomes, reserving budgets for future projects. Without this transparency, there is temptation to build in additional contingencies or margin in case there is a lean period ahead that the supplier must prepare for.

Being part of a panel has allowed DML to consider the treatment of weather downtime differently. We share weather downtime budgets with LINZ, refunding unused allowance for additional line miles as we approach the project completion. A win-win scenario for both organizations.

For the first time in 10 years, DML is collaborating with a competitor in a healthy manner which has resulted in better asset utilization and more productive outcomes. We are planning to share vessels to avoid duplicating mobilisation costs, working on the same project to achieve a faster project delivery and jointly develop process innovations to provide more efficient project outcomes.

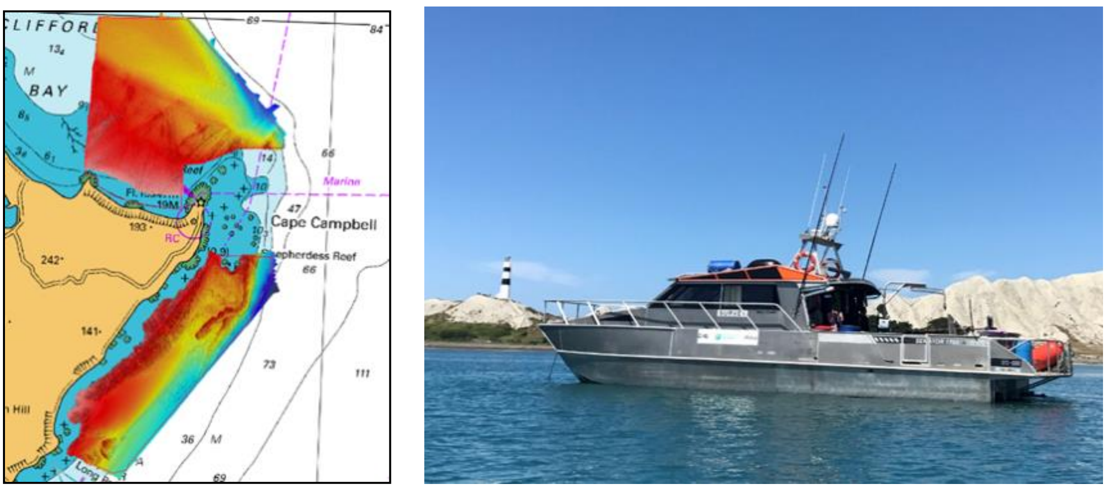

Figure 3: *LINZ HSS57 Kaikoura Survey, common survey area & shared resources*

8. Establish realistic timeframes for all aspects of the project

It's important to understand lead times for contract negotiations and contract signing and how this may affect operations. Don't allow this period to creep into seasonal weather windows for vessel operations. Outside stakeholders may not appreciate the urgency in getting projects underway to be completed within a seasonal weather window. This can impact on project risk or completion.

Funding and budgetary time frames need to be considered along with progress payments. There are inherently many upfront costs businesses must fund to initiate a project and this should be reflected in the payment schedule milestones. It's unrealistic to seek the efficiencies that an SME can offer, and yet expect them to bankroll large projects. Cash flow risk can be mitigated by prompt progress payments. Cash is king.

9. Have the right people, doing the right things

Hydrographic surveying is an applied science where the benefits of field experience cannot be underestimated. In our experience, not all IHO Cat A or AHSCP Level 1 hydrographic surveyors are born equal. It takes significant time in the field working on complex nautical charting surveys to be fully competent to deliver a quality project. This knowledge or training is currently acquired in-house working for companies that are doing this type of work. We have seen large gaps in knowledge irrespective of certifications. Some gaps are technical by nature and/or operational such as experience in managing people, vessels and technology in challenging environments. These gaps can arise in both the supplier's and client's teams.

Our advice is to ensure that people are adequately tested in a supportive environment before allowing them to lead major projects. This will prevent unnecessary errors or project stress. We undertake exchanges with LINZ where we work alongside each other to observe, understand and develop streamlined processes together. We recently worked to develop protocols for S-57 encoding (IHO, 2000) and are actively refining ancillary deliverables using a draft specification version.

Exchanges have enhanced our relationships and improved communication by having more direct communication pathways. For example, our Surveyors in Charge will talk directly to the client representative regarding operational matters and enabling them to achieve timely responses.

Having depth in your team is also vital. Staff burn-out will be a major issue if you over burden team members. No project can survive when relying on one key person. It's important that every role has a backup. As an SME, this may be a simple matter of training several people to have broad skill sets rather than a singular role.

10. Accept that compromise is unavoidable when dealing with multiple stakeholders

Competing demands by multiple stakeholders with different sized budgets requires compromise. While not all survey objectives may be known at the start of a project, if there is common agreement on a basic set of national data capture standards and deliverables, then the cry of "capture once, use many" can be delivered upon. In the case of New Zealand and Australia where the areas of responsibility for nautical charting and marine science are some of the largest in the world, the statement "some data, is better than no data" has significant bearing.

Conclusion

Since 1997, LINZ has been on a 20-year journey of outsourcing hydrographic services. Discovery Marine Ltd (DML) joined that journey in 1997/98 as LINZ's Quality Assurance representative for the first contestable nautical charting survey undertaken by LINZ – 97/98 3HS Kaikoura Survey. In 2007, the company started providing full nautical charting survey services to LINZ and has been a regular supplier ever since.

DML has experienced troubled times during a period of highly competitive contracting model. With the establishment of a panel of two providers in 2016/2017, LINZ has dramatically changed the way it does business with contractors.

The experiences by both contractor and client over the last 20 years have laid the foundation for a well performing panel. It seems only fitting that Kaikoura was the location for the first outsourced nautical charting survey journey beginning in 1997 and that this location was used again for another key milestone in 2017 – undertaking a comprehensive multidisciplinary survey.

References

IHO (2000). **Transfer Standard for Digital Hydrographic Data (S-57),** Edition 3.1, International Hydrographic Organization, Monaco.

IHO (2018). Australian Defence Project SEA 2400 PHASE 1 HydroScheme Industry Partnership Program (HIPP) Tender, **The International Hydrographic Review**, 19 pg. 61, International Hydrographic Organization, Monaco.

Raymond, E. S. (1999). **The Cathedral and the Bazaar,** O'Reilly Media. Sebastopol, USA.

Biographies

Declan Stubbing, B.Surv, MNZIS, CPHS1

Survey Manager

Declan leads Business Developement and R&D for DML. He has extensive technical experience in delivering complex surveys and enjoys finding innovative solutions for clients. His knowledge of system capabilities is extensive and ensures he stays abreast of technology innovations that present new possibilities for clients.

Declan qualified from Otago University with a Bachelor of Surveying (B.Surv) specialising in Hydrographic Surveying. He's completed the IHO FIG Cat A course and also holds CPHS Level 1 certification. Declan is a qualified mariner, holding an Inshore Launch Master (ILM) certificate and is a member of the New Zealand Institute of Surveyors (NZIS).

As one of DML's senior surveyors, Declan has led complex nautical charting surveys for the New Zealand Government, supported intensive dredging campaigns and is often lead surveyor for DML's local and off-shore projects.

E-mail: declan@dmlsurveys.co.nz

Kevin Smith

Business Manager

Kevin is the Business Manager for Discovery Marine Ltd (DML) based in Tauranga, New Zealand. He has a 36 years' experience in hydrography and IT stemming from roles in the RNZN and private industry. Over the years he has worked in New Zealand, Australia, the South Pacific, Seychelles, Canada, and the UK. Since leaving the RNZN in 1997 he has been involved with companies providing hydrographic services to Land Information New Zealand (LINZ) and wider industry.

As DML's Business Manager, he has participated in a number of LINZ Nautical Charting survey contracts, typically in a variety of roles including contract manager, project manager, IT support, MBES data processor and survey support.

Kevin is a member of the Australasian Hydrographic Society (AHS), Chairman of the AHS Awards Panel, Chairman of the AHS NZ Branch and a Member of the New Zealand Institute of Surveyors (NZIS).

E-mail: kevin@dmlsurveys.co.nz

Sally Cox

Director/Strategy

Sally Cox is a Director of Discovery Marine Ltd (DML) and also guides company governance and strategy. As a non-surveyor, she provides an alternative perspective to company development. Her business experience provides a comprehensive understanding of most business functions and can dive in to business requirements as needed.

Sally keeps the DML team focused on the company's strategic intent ensuring it will remain meaningful for clients and that the company continues to achieve its goals. She also helps in developing strategic alliances with collaborative partners.

Sally holds a BMS in marketing and management accounting and has had an extensive 'other career' helping build businesses, brands and bold ideas.

E-mail: sally@dmlsurveys.co.nz