# Assessment of Potential GNSS-IR Sites in Existing Tide Gauge Sites in the Philippines

Leila Micahella D. Cruz[1,2,3], Jasper B. Molleno[1,2], Luis Carlos S. Mabaquiao[1,2], Rosalie B. Reyes[1,2], John Dave C. Maclang[1,2], Dave Liam T. Ngo[1,2], John Michael Rey A. Zamora[2,4], Alexi Mae Y. Narca[1,2], Hanna Mae M. Garcia[1,2], Dennis Arsenio Bringas[5], Shelmark Penaranda[5], Beaverlex Algaba[5], Joshua Venerable[5]

[1]Department of Geodetic Engineering, University of the Philippines, Diliman, Quezon City, Philippines - {ldcruz6; jbmolleno; lsmabaquiao; rbreyes3; jcmaclang; dtngo1; jazamora2; aynarca; hhgarcia1}@up.edu.ph
[2]Training Center for Applied Geodesy and Photogrammetry, University of the Philippines, Diliman, Quezon City, Philippines
[3]Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines
[4]Electrical and Electronics Engineering Institute, University of the Philippines, Diliman, Quezon City, Philippines
[5]Physical Oceanography Division, Hydrography Branch, National Mapping and Resource Information Authority, Manila, Philippines - {dabbringas; sspenaranda; bnalgaba; ajpvenerable}@namria.gov.ph

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**Abstract**

GNSS Interferometric Reflectometry (GNSS-IR) converts GNSS signal-to-noise data into decimeter-scale sea level measurements; however, the Philippines currently lacks any operational GNSS-IR stations, leaving a gap in the national sea level observation network. This study evaluates the gap by assessing eight coastal GNSS stations of the National Mapping and Resource Information Authority (NAMRIA) together with 60 primary tide gauge stations to identify where GNSS-IR could be most effectively deployed. Fresnel zone footprints were mapped for each location, and RINEX files from the GNSS stations were processed using the Lomb-Scargle Periodograms (LSP) via the *gnssrefl* QuickLook module. Results indicate that reflection geometry, rather than receiver specification, governs feasibility: five GNSS stations namely, Davao, Guiuan, Legazpi, Manila & El Nido yields virtually no quality-controlled reflector height estimates, whereas Brooke's Point, Cagayan de Oro, and San Fernando produce 5-9 valid retrievals per day once the quality control is relaxed. In contrast, Fresnel zone analysis of the standalone tide gauge stations revealed several promising sites for GNSS-IR deployment, such as Baler, Jose Panganiban, and Pasacao. Other sites may become feasible with minor relocations and site-specific planning. The results delineate immediate opportunities and constraints for Philippine GNSS-IR expansion; follow-up work should prioritize on-site reconnaissance, refining equipment, and phased establishment of a dedicated GNSS-IR sea-level network.

## 1. Introduction

### 1.1 Background

Monitoring sea level is essential for understanding coastal dynamics, managing disaster risks, and supporting climate change strategies especially for archipelagic nations like the Philippines. Traditionally, tide gauges have been the primary instruments for measuring sea level (Baloran, 2006). However, these systems are susceptible to vertical land motion (VLM), such as subsidence or uplift, which can bias sea-level observations if not properly accounted for. To mitigate this, colocating tide gauges with Global Navigation Satellite System (GNSS) stations enables the separation of sea-level signals from land motion (Wöppelmann & Marcos, 2016).

Beyond correcting tide gauge measurements, GNSS technology has also been employed in a novel way: GNSS Interferometric Reflectometry (GNSS-IR). This technique utilizes the interference patterns between direct and reflected GNSS signals, particularly from nearby water surfaces to estimate sea level with decimeter-level precision (Larson, 2016). GNSS-IR offers several advantages: it can be low-cost, leverages existing GNSS infrastructure, and is especially valuable in remote or under-instrumented coastal areas where deploying conventional tide gauges is difficult.

However, not all GNSS stations are suitable for GNSS-IR applications. An ideal GNSS-IR station must meet specific geometric and environmental conditions to ensure reliable signal reflection and data retrieval. First, the surrounding environment must allow clear signal paths. This includes an unobstructed view of the sky, especially at low elevation angles (typically 5° to 25°), where reflected signals are most prominent (Nievinski & Larson, 2014). The station must also have an unobstructed downward view from the antenna to the reflecting surface to avoid signal blockage or scattering.

In the Philippines, where the satellite Fresnel footprint has a known azimuthal gap in the north, the reflective water body must be located south of the antenna for optimal signal coverage. Additionally, stations near busy ports or industrial zones may experience high levels of multipath interference from vessels, cranes, and nearby structures, reducing GNSS-IR signal clarity. Therefore, low-traffic or isolated coastal locations are preferred.

Ideally, the GNSS station should be placed centrally within its reflecting surface, such as on an islet, pier, or platform within a body of water, to maximize azimuthal symmetry and reflection coverage. Uninterrupted power supply and consistent data acquisition are also crucial to ensure reliable long-term GNSS-IR operation. The GNSS receiver should also be capable of recording signals from multiple constellations (e.g., GPS, GLONASS, Galileo) and frequencies (e.g., L1, L2), as broader signal diversity increases the robustness and temporal resolution of sea-level estimates (Roussel et al., 2015; Strandberg et al., 2019).

### 1.2 Gaps

Currently, there are no dedicated GNSS-IR stations operating in the Philippines. However, according to a 2022 report, the

National Mapping and Resource Information Authority (NAMRIA) maintains a nationwide network of continuous GNSS stations, which are primarily used for monitoring vertical land motion and ground subsidence. Some of these stations are located near bodies of water, presenting an opportunity to evaluate their additional potential for GNSS-IR applications (NAMRIA, 2022). This study investigates whether the GNSS signals they record can be processed to retrieve sea level variations using the GNSS-IR method.

A special case in this study is the GNSS station in Kalayaan Group of Islands: Pag-asa Island, located in the West Philippine Sea. This area is of strategic importance due to territorial and environmental considerations. Despite its remoteness, continuous and autonomous sea level monitoring in Kalayaan could provide critical data for both scientific understanding and national maritime interests.

To guide practical implementation of GNSS-IR across the country, the study also extends its scope beyond existing GNSS sites. Instead of evaluating arbitrary coastal locations, the study focuses on existing tide gauge stations, which are strategically selected for national monitoring. These locations are more likely to offer the necessary infrastructure, institutional support, and logical feasibility for GNSS-IR deployment. Colocating GNSS-IR with tide gauges also allows for mutual validation of sea-level data, supporting both operational and research needs.

### 1.3 Research Objectives

This study aims to act as a first-level nationwide screening to provide baseline assessment of the potential of existing GNSS infrastructure in the Philippines for GNSS-IR applications. We evaluate NAMRIA GNSS stations located near tide gauges and coastal areas, examine the feasibility of the GNSS station, and conduct a Fresnel zone-based assessment of all primary tide gauge stations in the country. The goal is to identify candidate sites for future GNSS-IR installation that can strengthen the national sea-level monitoring system.

## 2. Methodology

### 2.1 GNSS-IR for Existing GNSS Stations

GNSS data from stations situated near tide gauge locations were acquired from the Physical Oceanography Branch of NAMRIA. Specifically, sample datasets were obtained for eight sites: Brooke's Point, Cagayan De Oro, Davao, El Nido, Guiuan, Legaspi, Manila, and San Fernando *(see pink points in Figure 1)*. Additionally, the Pag-asa Island's GNSS station was also evaluated.

These NAMRIA stations are equipped with Topcon GNSS antenna and receivers, which generate data in the .tps format. To make the files compatible with GNSS-IR analysis, they were converted to RINEX 2.11 format using the online converter available at the Topcon Software Developer Network website (Topcon Software Developer Network, 2024). The converted RINEX files were then processed using the GNSS-IR software tool, *gnssrefl*.

### 2.2 Fresnel Zone Analysis of Primary Tide Gauge Stations

This study assessed 51 standalone tide gauge stations, excluding those already co-located with GNSS receivers (Figure 1), to identify potential sites for future GNSS-IR installations. Each station was evaluated through the analysis of its corresponding reflection zones, or Fresnel zones.

Reflection zones or Fresnel zones are critical regions where signal reflections occur and are used to determine the suitability of a site for GNSS-IR (Yalçin, 2023). These zones are ellipsoidal areas along the signal path between a GNSS satellite and the receiver, and their shape and orientation are influenced by satellite elevation angles and azimuths (Roesler & Larson, 2018; Roussel et al., 2014).

While GNSS-IR has shown potential for sea-level monitoring, there are limitations that must be considered before installation. The technique is highly sensitive to surrounding obstructions, reflections from unwanted surfaces, and local environmental conditions, which may affect data quality. Additionally, conventional geodetic-grade receivers can be costly, making widespread deployment challenging. A feasible solution is the use of low-cost GNSS receivers, such as the u-blox ZED-F9P, which has been successfully tested in GNSS-IR studies. For GNSS-IR applications, antennas with no multipath mask are preferred, as they allow the necessary signal reflections to be captured for analysis.

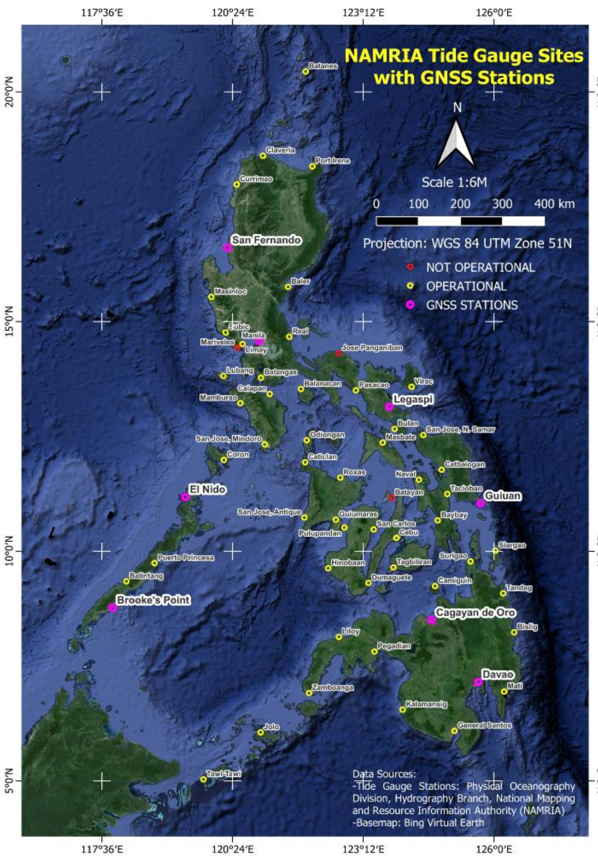

Figure 1. Philippine Tide Gauge Stations

To characterize these zones, the following set of equations based on the first Fresnel zone (n = 1) was applied as formulated by Larson and Nievinski (2012):

$$d = n\lambda/2 \tag{1}$$

$$R = h/tan(e) + (d/sin(e))/tan(e) \tag{2}$$

$$b = (2d\, h/sin(e) + (d/sin(e))^2)^{1/2} \tag{3}$$

$$a = b/sin(e) \tag{4}$$

$$x' = a\cos(\theta) + R \quad (5)$$

$$y' = b\sin(\theta) \quad (6)$$

$$x = \sin(\alpha)x' - \cos(\alpha)y' \quad (7)$$

$$y = \sin(\alpha)y' + \cos(\alpha)x' \quad (8)$$

where a = semi-major axis of the reflected path ellipse
$\alpha$ = satellite azimuth angle (in radians or degrees)
$b$ = semi-minor axis of the reflected path ellipse
$d$ = path difference based on the first Fresnel zone
$e$ = satellite elevation angle
$h$ = antenna height above the reflecting surface
$n$ = Fresnel zone number
$R$ = horizontal distance to the specular reflection point
$x'$, $y'$ = coordinates in the satellite frame
$x$, $y$ = rotated coordinates in the local reference frame
$\lambda$ = signal wavelength
$\theta$ = inner angle

To assist in the visualization and quick inspection of these reflection zones, the GNSS-IR Reflection Zone Mapping web tool was utilized. This tool provides a convenient and interactive way to examine potential reflection zones using site coordinates, antenna height, and signal geometry parameters.

Additionally, the *refl_zones* utility within the *gnssrefl* software package was employed to simulate the Fresnel zones for each site. Inputs included geographic coordinates, satellite azimuths, antenna and reflector heights, and GNSS frequency. Prior to deployment, visual inspection ensured that the Fresnel zones primarily overlapped with water surfaces. A minimum satellite elevation angle of 5° and a temporary maximum of 25° were initially set; the upper limit was later refined based on the final GNSS-IR analysis strategy.

**2.2.1 Tools Used:** Two software approaches were used to generate and visualize reflection zones: (1) The GNSS-IR Reflection Zone Mapping Web Tool, which provides interactive maps of reflection geometries based on station coordinates, antenna height, and signal parameters and (2) the refl_zones utility within the gnssrefl software package (Larson, 2021), which simulates Fresnel zones for multiple GNSS frequencies and azimuth/elevation masks.

Visual inspection was performed using Google Earth Pro, noting that no field reconnaissance was conducted at this stage.

**2.2.2 Assessment Metrics:** Each site was evaluated using a three-part scoring system that considered azimuthal coverage, environmental conditions, and potential interference (Table 1). For azimuthal coverage, a score of 2 was assigned to sites with a clear water sector of at least 120° within approximately 500 meters, 1 for a 60-120° clear or partially blocked sector, and 0 for less than 60° clear or mostly blocked by land. Environmental conditions were scored as 2 if the foreshore was open with no tall structures or trees within 50 meters, 1 if some vegetation, buildings, or modest relief were present within 20-50 meters, and 0 if dense buildings, trees, or steep coastal bluffs were within 20 meters. Potential interference was rated 2 for low traffic areas with few metallic structures, 1 for areas with small fishing piers, small ships, or minor metallic obstructions within 50-200 meters, and 0 for busy ports, ship lanes, or sites with cranes and pontoons within 50 meters.

The GNSS-IR Potential Score was then calculated as the sum of the three metrics and categorized as follows: 0-1 indicated relocation necessary, 2 reflected low potential, 3-4 represented medium potential, and 5-6 denoted high potential. This scoring enabled consistent site categorization and transparent prioritization for future GNSS-IR deployment.

## 3. Results and Discussion

### 3.1 Assessment of NAMRIA GNSS Stations

This study evaluated 8 NAMRIA GNSS stations located at Brooke's Point, Cagayan de Oro, Davao, El Nido, Guiuan, Legaspi, Manila, and San Fernando. These stations were selected based on their proximity to the coastal areas and a tide gauge station.

Figure 2. Brooke's Point (left); Cagayan de Oro (right)

Figure 3. Davao (left); El Nido (right)

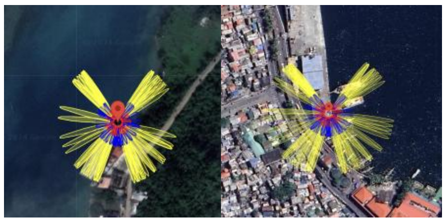

Figure 4. Guiuan (left); Legaspi (right)

Figure 5. Manila (left); San Fernando (right)

Figure 6. Kalayaan Station

The Fresnel zones are generated with the default parameters; 0-meter ellipsoidal height, mean sea level option for the reflector height, GPS L1 frequency, elevation angles of 5, 10, and 15 degrees, and full azimuth angles ranging from -90 to 360, year 2024, to probe for the maximum theoretical retrievals for each station.


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After Fresnel zone considerations, GNSS constellation retrievals underwent QuickLook analysis with quality control metrics to assess their performance. QuickLook is a sub-module in the gnssrefl software that provides a rapid diagnostic check of GNSS-IR data. It primarily generates visual plots (e.g., Signal-to-Noise Ratio (SNR), Lomb-Scargle Periodograms (LSP), reflector height time series) alongside summary statistics. This enables quick checks against baseline quality criteria, including retrieval count, SNR amplitude, and Fresnel coverage.

The LSP output shows retrievals per panel—gray for bad or rejected and colored for accepted—arranged by quadrant (0°–90° upper-right, 91°–180° lower-right, 181°–270° lower-left, 271°–360° upper-left) as in Figure 7.

To accommodate the multipath suppression capabilities inherent to geodetic antennas, the amplitude threshold was relaxed from 7v/v to 3v/v to capture usable suppressed signals. It must be emphasized, however, that accepting lower-amplitude signals without validation against in-situ tide gauges is not advisable for operational applications. This adjustment only indicates that there might be a potential usable signal but its accuracy is still unverified. Furthermore, the azimuthal and elevation constraints were imposed to better differentiate retrievals from water surfaces and those originating from land or infrastructures.

The retrieval statistics for the NAMRIA geodetic stations are recorded in Table 1 for a numerical comparison of station performance.

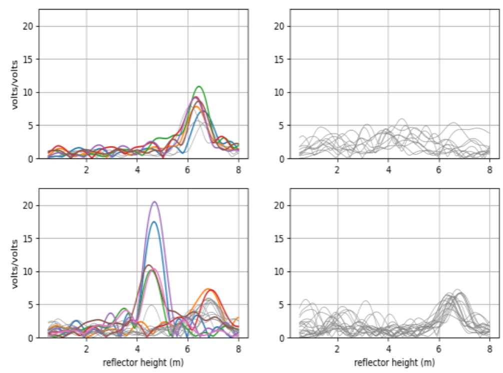


Figure 7. Brooke's Point Lomb-Scargle Periodograms with no constraints

Brooke's Point produced ~72 valid retrievals per day against ~55 rejected. This balance suggests that the site can provide consistent GNSS-IR observations, although noise remains significant. San Fernando station in La Union yielded the highest counts, with ~96 valid retrievals per day. Although a gap in coverage between 5:00–9:00 UTC+0 was observed, overall, the site performed the strongest among all stations.

In contrast, El Nido and Davao recorded low outputs, with ~12 and ~15 valid retrievals per day, respectively, while most signals were rejected. Guiuan produced ~50 valid retrievals per day, though with a high proportion of failed retrievals, limiting its reliability. Legazpi and Cagayan de Oro were the weakest, averaging only ~2 and ~4 valid retrievals per day. Manila performed moderately well at ~64 valid retrievals daily, but retrieval quality is likely affected by reflections from surrounding infrastructure. Kalayaan, being stationed too inland, yielded no valid sea level retrievals.

Figure 8. Manila geodetic receiver stationed near Manila Bay with a collocated radar tide gauge nearby

Stations such as San Fernando, Brooke's Point, Manila, and Guiuan produced retrieval counts that could support exploratory GNSS-IR applications. Comparing these with international benchmarks, the Philippine stations fall within the lower performance range but are not outside the norms reported in global archives. Established GNSS-IR sites in the Permanent Service for Mean Sea Level (PSMSL) database and published studies often record ~40 or more valid retrievals per day when all constellations are included (PSMSL, n.d.). By this measure, San Fernando (~96/day) and Brooke's Point (~72/day) were within the operational range, while Manila (~64/day) and Guiuan (~50/day) were close to the lower end. El Nido, Davao, Legazpi, and Cagayan de Oro, however, remain well below the minimum levels typically regarded as usable for sea-level analysis.

| Location | GPS | GLONASS | Galileo | Daily Average | | | Average |
|---|---|---|---|---|---|---|---|
| Station | good/ bad | good/ bad | good/ bad | good | bad | total | Amp. (v/v) |
| Brooke's Point | 19 / 42 | 53 / 13 | 0 / 0 | 72 | 55 | 127 | 16.41 |
| El Nido | 2 / 1 | 10 / 6 | 0 / 0 | 12 | 7 | 19 | 12.06 |
| Guiuan | 19 / 23 | 16 / 8 | 15 / 6 | 50 | 37 | 87 | 15.45 |
| Legazpi | 0 / 36 | 2 / 12 | 0 / 0 | 2 | 48 | 50 | 5.02 |
| Davao | 0 / 66 | 10 / 10 | 5 / 11 | 15 | 87 | 102 | 9.72 |
| Cagayan de Oro | 0 / 29 | 4 / 20 | 0 /0 | 4 | 49 | 53 | 13.93 |
| Manila | 10 / 39 | 26 / 6 | 28 / 17 | 64 | 62 | 126 | 16.06 |
| San Fernando | 19 / 33 | 30 / 2 | 47 / 3 | 96 | 38 | 134 | 11.71 |
| Kalayaan | n/a | n/a | n/a | n/a | n/a | n/a | n/a |

Table 1. Retrieval counts and mean amplitudes (v/v) from LSP analyses of Philippine Geodetic Stations. Amplitudes in column 8 correspond only to good retrievals.

These outcomes highlight the limitations of the original design of the NAMRIA receivers, which were configured for geodetic monitoring and vertical land motion studies. Features such as multipath suppression and elevated tracking masks reduce the number of low-elevation reflections available for GNSS-IR, limiting retrieval density. A full validation involving direct comparison with co-located tide gauge data and an RMSE analysis was beyond the scope of this initial assessment but is a critical next step for any sites chosen for operational deployment.

### 3.2 Fresnel Zone Analysis of Tide Gauge Stations

Although GNSS-IR started as a product from geodetic GNSS stations that already happen to overlook a body of water, there is growing evidence that deploying a dedicated, low-cost GNSS receiver directly at a tide-gauge site can accurately capture the sea level trend (Karegar et al., 2022; Cahyadi et al., 2023; Purnell et al., 2024). Multi-constellation deployments further lower the RMSE to the 2-5cm range and deliver reliable information suitable for flood and tsunami warning. (Purnell, et al., 2024; Srisutha & Park, 2024) This evidence shows that GNSS-IR is no longer a product of geodetic stations but a viable primary sensor, provided the reflection geometry is favorable.

This research explores the feasibility of GNSS-IR stations across the Philippines by analyzing their Fresnel zones. The Fresnel zone was used as the basis to evaluate whether each station allows for clear, water-based signal reflections essential for GNSS-IR. The analysis considered usable satellite azimuth and elevation angles, environmental obstructions, and the proximity of reflective surfaces such as seawater versus land or built-up areas. All the observations are tabulated in Table 2 of the Appendix.

Several stations, including Baler (Aurora), Jose Panganiban (Camarines Norte), and Pasacao (Camarines Sur) achieved a score of 5-6, placing them in the High Potential category. These stations feature ≥120° unobstructed water coverage, open foreshores with minimal structures, and low levels of interference, enabling consistent water-based reflections. Such sites are considered ready for GNSS-IR deployment without significant modification. In addition to a score of 6, Lubang is exceptional because the tide station is located on a man-made structure fully surrounded by water.

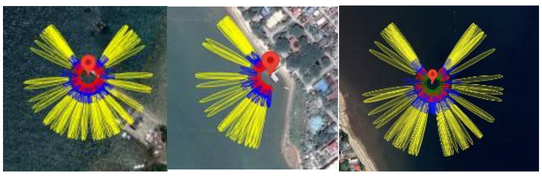

Figure 9. Baler, Jose Panganiban, and Lubang's Fresnel Zones (left to right)

Stations including Bulan (Sorsogon), Bantayan (Cebu), Balanacan (Marinduque), Baybay (Leyte), Dumaguete (Negros Oriental), and Zamboanga achieved scores of 3-4. While these sites exhibit usable reflection paths, their performance is reduced by exhibiting narrower azimuthal coverage (60-120°), nearby vegetation or built-up areas, or moderate interference from small ports and vessels. In the cases of these sites, optional relocation or careful antenna siting is recommended to improve water-reflection visibility.

Locations with major ports, such as Batangas and Cebu scored ≤ 2 points. These areas are subject to constant ship traffic, cargo loading cranes, and the presence of large metallic structures, which generate dynamic multipath interference. Unless relocation or mitigation measures are applied, these stations are considered less suitable for GNSS-IR monitoring.

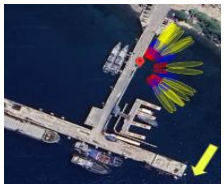

Figure 10. Zamboanga's Fresnel Zone and Ideal Location for GNSS-IR Station (yellow arrow)

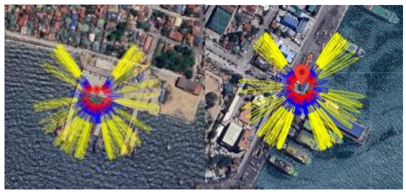

Figure 11. Batangas (left) and Cebu (right)'s Fresnel Zones

The results indicate that several tide gauge sites in the Philippines are already highly suitable for GNSS-IR, while others require relocation or additional field reconnaissance. Using the results of the analysis, High-potential stations should be prioritized to ensure reliable early deployment, while systematically addressing Medium and Low-potential sites can gradually expand the national GNSS-IR monitoring network.

By integrating Fresnel zone analysis with a transparent scoring framework, this study demonstrates a practical pathway for establishing GNSS-IR as a complementary tool for sea-level monitoring and coastal hazard management in the Philippines.

## 4. Conclusions

This study provides the first nationwide screening of GNSS-IR feasibility in the Philippines by assessing both existing NAMRIA GNSS stations and standalone tide gauge sites. Retrieval statistics quantified across multi-frequency multi-GNSS data from geodetic grade receivers showed that among these, only San Fernando, Brooke's Point, and Manila, produced retrieval densities approaching international benchmarks, while others were constrained by multipath suppression and sitting conditions.

Complementing this, Fresnel zone analysis and the scoring index framework on standalone tide gauge stations revealed multiple promising candidates for future GNSS-IR deployment. Fresnel zone analysis of national tide gauges was conducted considering azimuthal coverage, environmental conditions, and potential interference, scoring each site against these metrics providing an indicative measure for GNSS-IR potential. Areas such as Baler, Jose Panganiban, and Pasacao achieved high scores due to optimal conditions and should be prioritized for deployment. Likewise, Medium-scoring stations such as those in Batanes, Currimao, and Roxas may become feasible with minor relocation or further assessment while low-scoring sites face persistent challenges from heavily trafficked ports or obstructed environment.

Overall, this assessment highlights both the limitations and opportunities for expanding GNSS-IR use in the Philippines. While existing GNSS stations may require adjustments or complementary equipment to serve this purpose effectively, the combined use of retrieval statistics and scoring index provides a reproducible framework for prioritizing deployment, ensuring that GNSS-IR development is well-grounded and site specific.

The results serve as a practical basis for recommendation on phased deployment, ground validation and long-term network planning to strengthen national sea-level monitoring and disaster risk reduction.

Following the preliminary assessment of NAMRIA GNSS and Tide Gauge Stations, the researchers recognize strong potential in developing nationwide GNSS-IR applications. With high-potential sites already identified, available GNSS data in viable sites can be further processed for water level monitoring. Some locations, however, may require relocation or antenna modifications, which may compromise their primary geodetic function. To address this, pilot testing with low-cost, dedicated GNSS-IR systems at suitable sites is recommended.

The parameters used in this study represent only the minimum baseline requirements for GNSS-IR suitability. Future studies should refine site-specific system setups and configurations under varying local conditions, as well as account for environmental and physical changes (e.g., new construction, shoreline modifications) that may alter reflection environments over time.

In addition, the accuracy of GNSS-IR measurements should be systematically validated against traditional tide gauge records to establish reliability within the Philippine context. Once both pilot systems and methodological accuracy are confirmed, a phased rollout of dedicated GNSS-IR stations can be pursued. This would lay the foundation for a robust, complementary sea-level monitoring network that strengthens the country's capacity for disaster risk reduction and climate change adaptation.

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## Appendix

| Tide Station Name | Location | Usable Azimuth (°) | Elevation Angles (°) | Azimuthal Coverage | Environmental Conditions | Potential for Interference | **Score** | GNSS-IR Potential |
|---|---|---|---|---|---|---|---|---|
| BALINTANG | Quezon, Palawan | 0-45, 270-360 | 5 10 15 | 2 | 1 | 2 | **5** | High |
| BISLIG | Surigao | 180-360 | 10 15 20 | 2 | 1 | 2 | **5** | High |
| BANTAYAN | Cebu | 90-225 | 5 10 15 | 2 | 1 | 0 | **3** | Medium |
| BALANACAN | Marinduque | 250-360 | 5 10 15 | 1 | 2 | 1 | **4** | Medium |
| BULAN | Sorsogon | 0-60, 110-250, 270-360 | 5 10 | 1 | 1 | 1 | **3** | Medium |
| TAWI-TAWI | Tawi-tawi | 0-30, 315-360 | 5 10 15 | 1 | 0 | 1 | **2** | Low |
| BALER | Aurora | 180-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| BATANES | Batanes | 270-360 | 5 10 15 | 1 | 1 | 1 | **3** | Medium |
| BATANGAS | Batangas | NA | NA | 0 | 0 | 0 | **0** | Relocate |
| GUIMARAS | Guimaras | 140-360 | 5 10 | 2 | 1 | 2 | **5** | High |
| BAYBAY | Leyte | 220-360 | 5 10 15 | 2 | 1 | 2 | **5** | High |
| CEBU | Cebu | NA | NA | 0 | 0 | 0 | **0** | Relocate |
| CLAVERIA | Cagayan | 0-60 | 5 10 15 | 1 | 2 | 2 | **5** | High |
| CAMIGUIN | Camiguin | 300-360 | 5 10 15 | 1 | 1 | 2 | **4** | Medium |
| CALAPAN | Oriental Mindoro | 200-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| CURRIMAO | Ilocos Norte | 220-310 | 5 10 15 | 1 | 1 | 2 | **4** | Medium |
| CATICLAN | Aklan | 0-140, 250-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| CORON | Palawan | 0-130, 140-270 | 5 10 13 | 2 | 2 | 2 | **6** | High |
| CATBALOGAN | Samar | 160-230, 270-360 | 5 10 | 2 | 1 | 1 | **4** | Medium |
| DUMAGUETE | Negros Oriental | 140-230 | 5 10 15 | 1 | 1 | 2 | **4** | Medium |
| GEN. SANTOS | South Cotabato | 90-230 | 5 10 15 | 2 | 1 | 1 | **4** | Medium |
| HINOBAAN | Negros Occidental | NA | NA | 0 | 0 | 2 | **2** | Low |
| PORT IRENE | Santa Ana, Cagayan | 0-90 | 5 10 15 | 1 | 1 | 1 | **3** | Low |
| JOSE PANGANIBAN | Camarines Norte | 180-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| KALAMANSIG | Sultan Kudarat | 40-200, 220-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| LUBANG | Occidental Mindoro | 0-360 | 5 10 15 20 | 2 | 2 | 2 | **6** | High |
| LILOY | Zamboanga del Norte | 240-360 | 5 15 | 2 | 1 | 1 | **4** | Medium |
| MASBATE | Masbate | 120-330 | 5 15 | 2 | 1 | 1 | **4** | Medium |
| MAMBURAO | Occidental Mindoro | 0-160 | 5 15 | 2 | 1 | 2 | **5** | High |
| MASINLOC | Zambales | 200-360 | 5 15 | 2 | 2 | 2 | **6** | High |
| MATI | Davao Oriental | 90-265 | 5 10 | 2 | 1 | 1 | **4** | Medium |
| NAVAL | Biliran | 170-240 | 5 10 | 1 | 1 | 2 | **4** | Medium |
| ODIONGAN | Romblon | 180-215, 230-360 | 5 | 2 | 1 | 2 | **5** | High |
| PULUPANDAN | Negros Occidental | 150-250 | 5 10 15 | 1 | 1 | 2 | **4** | Medium |
| PAGADIAN | Zamboanga del Sur | 45-70, 110-230 | 5 | 1 | 1 | 0 | **2** | Low |
| PASACAO | Camarines Sur | 0-160 | 5 10 15 | 1 | 2 | 2 | **5** | High |
| PUERTO PRINCESA | Palawan | 235-360 | 5 10 15 | 1 | 1 | 0 | **2** | Low |
| REAL | Quezon | 0-145 | 5 10 15 | 2 | 1 | 2 | **5** | High |
| ROXAS | Capiz | 110-200 | 5 10 15 | 1 | 1 | 1 | **3** | Medium |
| SAN JOSE, ANTIQUE | Antique | 0-45 | 5 10 15 | 0 | 1 | 1 | **2** | Low |
| SUBIC | Zambales | 0-90, 270-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SAN CARLOS | Negros Occidental | 0-110 | 5 10 15 | 1 | 2 | 2 | **5** | High |
| SIARGAO | Surigao del Norte | 0-60, 80-250, 260-300 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| SAN JOSE, MINDORO | Occidental Mindoro | 0-80 | 5 10 15 | 1 | 0 | 1 | **2** | Low |
| SAN JOSE, N. SAMAR | Northern Samar | 245-300 | 5 10 15 | 0 | 0 | 2 | **2** | Low |
| SURIGAO | Surigal del Norte | 90-230 | 5 10 15 | 2 | 0 | 1 | **3** | Medium |
| TAGBILARAN | Bohol | NA | NA | 0 | 0 | 0 | **1** | Relocate |
| TACLOBAN | Leyte | 210-280 | 5 10 15 | 1 | 1 | 1 | **3** | Medium |
| TANDAG | Surigao del Sur | 220-360 | 5 10 15 | 2 | 2 | 2 | **6** | High |
| VIRAC | Catanduanes | NA | NA | 0 | 1 | 0 | **1** | Relocate |
| ZAMBOANGA | Zamboanga del Sur | 20-150 | 10 15 20 | 1 | 1 | 0 | **2** | Low |

Table 2. GNSS-IR Potential of Philippine Tide Gauge Stations