A Study of the Characteristics of the Wave Field near Taipei Harbour

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ABSTRACT

A long-term program to monitor the coastal environments of the Taipei Harbour was launched by the Port Authority of Keelung Harbor (PAKH) a few years ago. A current meter (type S4ADW) from the InterOcean Company USA, is mounted on an observing pile to record the wave field condition just outside the breakwater. To monitor the nearby coastal area, a navigation radar atop of the administrative building of the Harbour is used. It is interesting to compare the results from these two distinctly different measuring methods.

Estimates of the significant wave heights from radar image sequences compared favorably with on site measurements. Comparisons of both measured and estimated maximum wave heights, on the other hand, have shown that results based upon radar images are lower than those actually measured. It is shown here in this paper that estimates based on the empirical relationship of $H_{\text{max}} = 1.44 \times \max(H_S)$ lead to slightly underestimate the actual maximum wave height. A new relationship between these two wave heights is proposed for further use for the coastal area of Taipei Harbour.

KEY WORDS: Remote sensing; radar imaginary; significant wave height; maximum wave height.

INTRODUCTION

Of all the factors influencing coastal environment, winds and waves are probably the most dominant ones. Since these factors are due to Mother Nature, little can be done to change them. On the other hand, man-made constructions can change the local conditions drastically, and thus induce severe changes of the environment. Since, however, coastal and/or ocean constructions are vital for a country’s development, the best that can be done is try to minimize the possible damage(s).

The Taipei Harbour is located in the northern Taiwan. It is a new harbour that is still under construction. The Port Authority of Keelung Harbor (PAKH) is responsible for all the planning and constructing works involved. To gather the fundamental information of the coastal processes around the Harbour area during and after construction, a long-term monitoring program is launched by PAKH a few years ago. Data collected through the program will be used for the assessments of possible environmental impacts, as well as for further future planning, of the Harbour.

It is well-known that on-site direct measurements yield the most reliable results. It is also generally accepted that to cover a larger area, remote sensing techniques must be used. Among all possible remote-sensing instruments, the use of marine radar is a rather attractive alternative. This is due to its relatively low acquisition and maintenance costs, as has been pointed out by many researchers. The PAKH has therefore decided to employ both instrumentations.

Radar sensing of wave climate is not a new technique. Most researchers have, however, used radars with finer resolutions such as SAR (see for example, Schulz-Stellenfleth, 2003; Schuler et al., 2004; Hoja, 2004). Recently, a monograph on this topic has been published by Kanevsky (2009).

X-band marine radar has been used as an acquisition tool of wave climate for at least more than three decades. The German research institute, GKSS, has started the research in the late 80’s. Their research efforts were commercialized carrying the name WaMos (Wave and Surface Current Monitoring System). Furthermore, there are researchers from all over the world interested in this topic. A vast amount of literature, published in various languages, can be found (See, for example, Nickerson & Clarke, 1988; Senet, 1996; Seemann, 1997; Gommenginger, 1997; Takase & Hirayama, 2000; Robinson et al., 2000; Nomiyama & Hirayama, 2003; Dankert & Rosenthal, 2004; Yim et al., 2006; Lentine, 2006; Li et al., 2006, just to name a few.)

The methodology of acquiring wave field parameters from sea clutter was discussed by numerous authors, and will not be detailed here. Essentially, an empirical relation between the (significant wave) heights and sea clutters was used. Other parameters of the wave field can be acquired through frequency spectrum, which, on its side, is transformed from the (2D-) wavenumber spectrum using a linear dispersion relation. In passing it is noted that the maximum wave height is supposed to be related to the significant wave height through:

$$H_{\text{max}} = 1.44 \times \max(H_S)$$

However, it is well-known that no theory can predict the maximum