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Dredging Research Technical Notes

Improvements to the Automated Real-Time Tidal Elevation System (ARTTES)

Purpose

This Technical Note describes an innovative approach for improving user access to the Automated Real-Time Tidal Elevation System (ARTTES) during inclement weather. The approach is based on statistical properties determined by the system in response to local weather conditions.

Background

The Automated Real-Time Tidal Elevation System broadcasts water level data to dredges and survey vessels for use in vertical control within a specified offshore operation area. Currently, the system may deny user access during disturbed weather. Although not a particularly significant problem for survey operations, increased user access is highly desirable for dredging operations.

Additional Information

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Introduction

The operation of ARTTES involves measuring and predicting water level at a predetermined site within the area of interest. The difference between the measured and predicted value (at the measurement site) is an indicator of the validity of the assumption that the astronomical tide component is dominant. Dominance means that the astronomical component of the tide is approximately one order of magnitude greater than the sum of the remaining components. No difference or small (a few centimeters) differences mean the assumption is robustly met within the entire specified area of operation and users can be confident of the broadcast system values. When differences between the predicted and observed values increase, as typically occurs during disturbed weather, the assumption of dominance of the astronomical tide component grows increasingly weak. At some difference between the observed and predicted tide, the assumption of tidal dominance is considered to be invalid for the desired degree of water level accuracy over the area of operation.

The present system uses an ad-hoc procedure whereby user access is denied when the difference between the measured and predicted water level exceeds approximately 0.2 m. The 0.2-m threshold is not a system accuracy specification, but a measure of validity of this particular system assumption. The ad-hoc procedure uses a purely deterministic prediction of the tide which uses a limited number of tidal constituents. Recently acquired data (within the past few hours to days) are not used in the prediction. However, these data are routinely stored in system memory and are readily retrievable.

Methodology

A statistical approach was adopted to develop an "adaptive algorithm," which permits short-term predictions of the nonastronomical component of water level changes. The predictions are based on present and recent-past water level measurements and permit rapid estimates of the next several values of a water level time series.

The technique used is a linear, unbiased estimator, sometimes termed "Kriging," for a stationary time series. For each estimate, the linear trend is removed, the covariance function for recent-past data is estimated, and the prediction computations are performed. When used in conjunction with the conventional tide prediction method, better water level predictions at the measurement site are made. The improved predictions allow extended user access to the system.

Implementation

Figure 1 presents an example of the implementation of the methodology as applied to a short data segment acquired using a current ARTTES system. The difference between the observed and conventionally predicted tide (the residual) is plotted as a function of time. Periods of denial of user access for the ad-hoc and adaptive algorithm procedures are shown. For a threshold residual of 0.2 m, access denial is reduced from one period of approximately 15 hours to two periods of 6 and 2 hours. Evaluation of the threshold-level/duration characteristics of the methodology are presently being performed. A detailed description of the methodology and user input requirements will be presented in a later technical report.

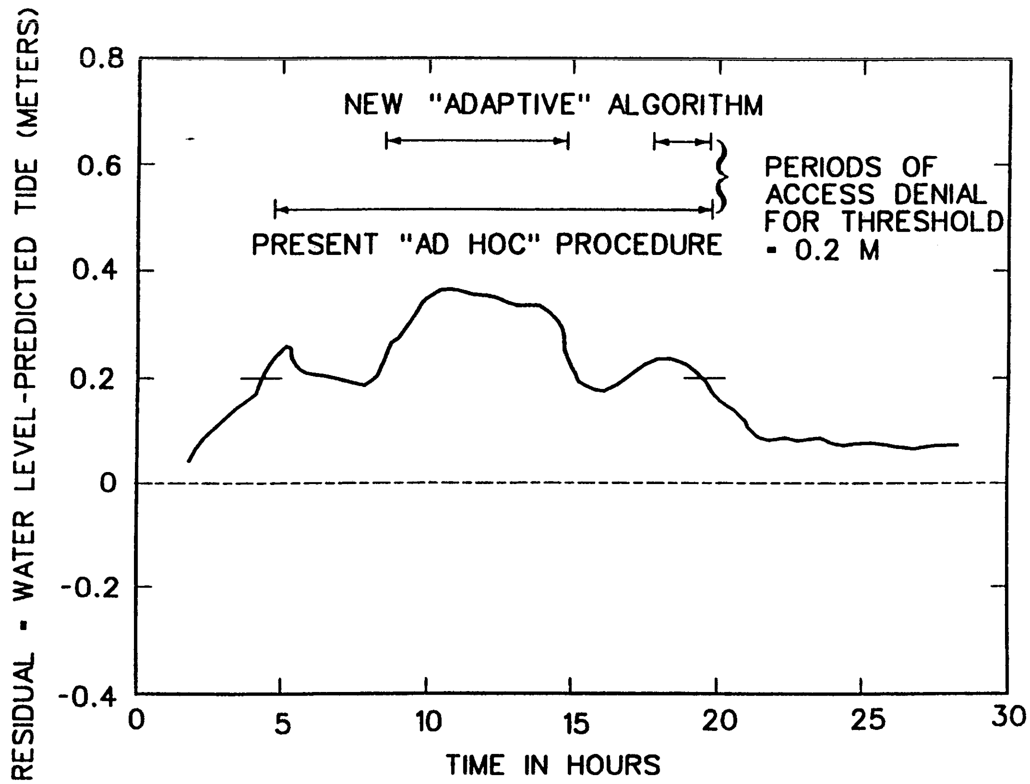

Figure 1. Comparison of ARTTES access periods for ad-hoc and adaptive procedures for 0.2-m threshold