

Calculating Wave Reflection From FUNWAVE-TVD Output Using Python

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1 Objective

waveref.py is a Python module containing functions, including functions that produce wave reflection statistics from two gauges (Goda 76) and help determine ideal gauge placement (Wenneker and Hofland 14).

2 Implementation

2.1 Prerequisites

The module is dependent on NumPy, and tested in Python 3.10.5.

2.2 wn()

wn() is a recursive function that returns a wave number approximation using Newton-Rhapson method. Observe the wave dispersion relation:

$$\omega^2 = gk \tanh kh \quad (1)$$

Where ω is the angular wave frequency, g is the gravitational acceleration constant, k is the wave number, and h water depth. Construct $F : (\omega, k, h) \rightarrow \mathbb{R}$ such that:

$$F(\omega, k, h) = gk \tanh kh - \omega^2 \quad (2)$$

Suppose ω and h are constant. Suppose initial guess k_i . Then,

$$k_{i+1} = k_i - \frac{F(k_i)}{F'(k_i)} \quad (3)$$

Given (2):

$$k_{i+1} = k_i - \frac{gk_i \tanh k_i h - \omega^2}{g \tanh k_i h - gk_i h \sec^2 k_i h} \quad (4)$$

Define $\text{wn}()$ by the following pseudocode:

$\text{wn}(k_i, \omega, h, \epsilon) = \{$

(1) $k_{i+1} \leftarrow k_i - \frac{F(k_i)}{F'(k_i)}$

(2) If $|k_{i+1} - k_i| \leq \epsilon$ then return k_i .

(4) Else, $\text{wn}(k_{i+1}, \omega, h, \epsilon$
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2.3 reflection()

$\text{reflection}()$ returns wave reflection statistics. Let:

- x_i and x_r respectively be the coordinates for the incident wave gauge and reflection wave gauge.
- Δl be the distance between x_i and x_r
- h be the water depth at x_r .