WaveBack v1.3.1 · User Guide

Tsunami flow speed, depth and run-up from tsunami deposits · Khan, A. (2026) · distributed by TWM Global

> WaveBack is uniquely designed for ease of use: it needs no coding, runs offline in a browser, takes grain-size tables straight from GrainLab and writes the methods paragraph.

1. Editions

WaveBack (free), WaveBack_v1.3.1.html: the full Jaffe & Gelfenbaum inversion, Moore and Soulsby models, Froude checks, paleotsunami settings (compaction, mud cut-off) and all exports. **WaveBack Pro**, WaveBack_Pro_v1.3.1.html, adds tsunami-or-storm screening with boulder transport, Monte Carlo uncertainty and a ground profile with water surface. Panels marked PRO in the free edition describe what Pro adds.

2. Getting started

Save the .html file anywhere and open it in Chrome, Edge or Firefox. Nothing is installed and no data leaves your computer. The app opens on a demo: the published benchmark of Jaffe and Gelfenbaum (2007). Explore it, then click **New project**, or **Open project** to continue saved work.

3. The seven steps

Step	What you do
Project	Name the site and transect; choose modern or paleotsunami deposit, a compaction correction and a mud cut-off if needed; set grain density, water density and viscosity, grain shape (Corey factor, Powers roundness) and the resuspension coefficient. Leave defaults unless you have measurements.
Deposits	Add one row per sampling point: distance from shoreline, deposit thickness, flow depth (blank if unknown) and the grain-size distribution. Paste class size (mm or φ) with weight %, or sieve size with % passing from GrainLab. *Pro:* paste a ground profile and set the water level; blank depths then come from the profile.
Origin (Pro)	Mark the 29 deposit and site criteria as tsunami-like, storm-like, both or unknown, and enter any known wave and flow values (period, wavelength, wave height, number of waves, flow depth, duration, run-up, coast length); several are suggested from your data and count once you confirm them. Optionally enter a moved boulder for its minimum flow speed.
Flow speed	Choose the eddy viscosity profile (Gelfenbaum–Smith recommended), the Froude number for points with unknown depth and the depth uncertainty (±%). Click Run. *Pro:* set the uncertainty ranges and run the Monte Carlo analysis for medians and 95% ranges.
Run-up & checks	Moore et al. (2007) advection speed from the landward reach of coarse grains; Soulsby et al. (2007) water run-up from the inland limit of sand. Review the "Before you interpret" prompts.
Results	Transect figure, speed and concentration profiles, Froude numbers and a ready-to-edit results paragraph.

Export	CSV tables, SVG/PNG figures with the citation embedded, methods paragraph with references, project file, or everything in one .zip.

4. Reading the checks

Not converged: the model could not match thickness and grading; check the inputs or try another profile. **Not suspended**: some coarse classes could not be lifted at the solved shear velocity; they may have moved as bedload, so the speed is a minimum. **Froude outside 0.7–2.0**: revisit the flow depth. **Near the inundation limit**: flow there was waning and the steady-flow assumption is weakest.

5. Paleotsunami deposits and mud

Old deposits lose thickness to compaction and erosion, so their speeds are minimum estimates. A compaction correction of c% divides the field thickness by (1 − c/100); erosion cannot be restored. Silt and clay flocculate and do not settle as single grains: a 63 µm cut-off removes them and rescales the sand classes to 100%.

6. Monte Carlo uncertainty (Pro)

Each run draws thickness, flow depth, a grain-size shift (φ), the resuspension coefficient (log-uniform within a factor) and the bed concentration from the ranges you set, and repeats the inversion. Medians and 2.5–97.5 percentiles of converged runs are reported; the same seed repeats the same runs. Use wider depth ranges (30–50%) where depth was solved from the Froude number.

7. Ground profile (Pro)

Flow depth = water surface − ground. The water surface is either level at the shoreline value or slopes linearly from the shoreline level to the ground at the inundation limit; the ground elevation there is the run-up height. Measured depths always take priority.

8. Tsunami or storm (Pro)

No single feature separates tsunami from storm deposits, so the Origin step weighs many. **Deposit and site evidence**: 29 criteria in seven groups (trench, transect, sub-regional, microfossils and minerals, coastal lakes and lagoons, boulders, offshore deposits) from Morton et al. (2007), Pilarczyk et al. (2014), Costa et al. (2017), Sharrocks et al. (2025), Etienne et al. (2011) and Sakuna-Schwartz et al. (2015). **Wave and flow evidence**: 10 characteristics with order-of-magnitude ranges from Morton et al. (2007, Table 2) and NOAA, e.g. wave period 100–2000 s for tsunamis against 10–25 s for storms, fewer than 10 waves against more than 1000, flow depth up to 20 m against less than 5 m. Values inside the overlap count as "both".

WaveBack counts the tsunami-like and storm-like answers you confirmed (suggestions from your data count only after you choose "use my data"; scenario water levels never suggest answers): at least four, with at least twice as many on one side, give a leaning; otherwise it is inconclusive. This

rule is WaveBack's own convention. Criteria are not weighted, so read the table as well as the count. The inverted flow speed is shown but not counted, because the inversion assumes a tsunami deposit. Boulder speeds (Nandasena et al. 2011, submerged weight by default; full weight above water as an option after Bressan et al. 2018) are reported but not counted, because storm waves and tsunamis can produce the same speeds (Cox et al. 2020). Tidal deposits are outside WaveBack's scope.

9. Models and key equations

Jaffe & Gelfenbaum (2007): steady suspension $C_i(z) = C_{ri}\exp(-w_{si}\int dz/K)$, reference concentration from γ_0 and excess shear; shear velocity and source grading are found so the settled load matches the deposit. **Moore et al. (2007)**: $H/w_s = x_L/U$. **Soulsby et al. (2007)**: $R_S = R_w/(1+\alpha\gamma)$, $\alpha = w_S T/H$. Settling velocity after Dietrich (1982); threshold after Soulsby & Whitehouse (1997).

10. Validation

Benchmark (Jaffe & Gelfenbaum 2007)	Published	WaveBack
Gelfenbaum–Smith profile	9.1 m/s	8.96 m/s
Parabolic profile	8.8 m/s	8.62 m/s
Linear profile	7.8 m/s	7.67 m/s
Sensitivity tests (depth, thickness, γ_0)	+22, +23, +3, −44, +120%	+21.5, +22.1, +3.1, −45.1, +122.7%

The engine also matches an independent Python implementation to within 4×10^{-15}, including Monte Carlo samples. Full details in WaveBack_v1.3.1_validation.md.

11. How to cite

Khan, A. (2026). WaveBack: tsunami flow speed, depth and run-up from tsunami deposits, version 1.3.1 [Computer software]. Please also cite the models you used (listed in the exported methods paragraph).

Results support, and do not replace, the judgment of a qualified specialist.

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