

Hawai'i property screening.

A transparent evacuation and directional fire-exposure prototype

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SCOPE

Two independent ordinal results: evacuation vulnerability and directional fire exposure. They are not averaged into a property danger probability.

BOUNDARY

This is a portfolio screening tool, not emergency instruction, a fire-spread forecast, an evacuation-time estimate, or a safety determination.

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Executive summary

This project began with manually drawn one-way-in/one-way-out access zones on Kaua'i. The statewide prototype preserves that route-access question while attaching it to searchable properties and explicitly separating it from fire exposure.

The system is intentionally conservative. Fuel and geographic continuity are evaluated before wind, heat, humidity, or slope can amplify a result. Open water cannot become surface fuel. A wide road interrupts a continuous surface pathway more strongly than a narrow road. Ember plausibility requires source fuel beyond a gap and is reported separately.

From manual zones to statewide screening

Manual polygons were a strong human-labeled baseline, but they did not explain the conditions of every home. The project assembled island-specific building baselines, public address points, and an OpenStreetMap road graph so the same question could be asked at a property scale.

AI did not become the statewide ground truth. It became a reproducible building-gap audit: useful for locating candidates outside the public source stack, but subordinate to newer authoritative county geometry where that geometry exists.

Building-source assembly and address matching

Kaua'i uses the project control footprints. O'ahu uses Honolulu official structures. Maui County uses its 2023 footprint service. Hawai'i Island uses the newer County of Hawai'i cohbuildings layer. Public address points support search and are associated with a nearby official/control footprint when a defensible candidate exists.

Raw county exports remain outside the public bundle. The browser requests bounded geometry or uses derived project indexes. Source vintage and redistribution boundaries are listed in the reproducibility appendix.

Evacuation vulnerability

The route engine snaps the selected property to the local OpenStreetMap graph, finds the first reachable major-road target, and returns a primary route plus topologically distinct alternatives when available. The interpretation is ordinal: very low, low, moderate, or high vulnerability, with confidence reported separately.

Major-road adjacency provides explicit route relief. A longer local connection, no alternative route, a larger snap distance, or mapped homes sharing the corridor can elevate concern. Shared homes indicate potential demand only; they do not estimate traffic or road capacity.

Directional fire exposure

LANDFIRE FBFM40 supplies fuel-model and nonburnable classes at 30 m. A local connected-cell grid is built around the property. Open water and conservatively buffered wide-road cells interrupt continuous surface pathways before environmental modifiers are considered.

NWS temperature and humidity estimate equilibrium fine dead-fuel moisture. Relative fuel behavior is then modified by wind movement and uphill alignment. A minimum-cost search asks whether mapped combustible cells connect an outer sector to

the 100 m near-home zone. The output is unitless and relative; it is not flame length, rate of spread, or arrival time.

Ember exposure is separate. It requires source fuel beyond an identified gap, plausible distance, sufficient wind, and alignment toward the property. Wind alone cannot invent an ember source.

1	Fuel + land class	Decode combustible and nonburnable geography.
2	Barrier gate	Interrupt surface continuity at water and wide-road cells.
3	Moisture + behavior	Apply weather and slope only to connected fuel.
4	Surface + ember	Report separate pathways, confidence, reasons, and limits.

Figure 1. Required order of operations. Environmental amplification follows, rather than replaces, geographic feasibility.

Current and historical evidence

NWS hourly forecasts supply timestamped weather context. WFIGS/IRWIN provides reported incidents, while NASA FIRMS provides satellite thermal detections. The interface distinguishes those evidence types rather than treating every thermal point as an incident.

Pacific Fire Exchange polygons show historical context from 1999 through 2022. They are not used to validate a future pathway. HCDP daily ignition conditions remain credential-gated and excluded until authenticated documentation and semantics are available.

Validation and release checks

Automated run: 13 passed in 2.06s. The report generator fails when this suite fails.

Scenario	Expected qualitative behavior
House on a beach with open ocean west and connected brush east.	westSurface: very-low; westEmber: very-low; dominantDirection: E
A lake interrupts the direct sector and there is no credible source fuel beyond it.	northSurface: very-low; northEmber: very-low
A divided freeway interrupts a fuel corridor north of the house.	surfaceLowerThan: narrow_grassy_road; possibleEmber: True
A narrow road crosses continuous grass fuels.	surfaceHigherThan: divided_freeway
Brush lies east of the house while wind movement opposes an approach from the east.	eastSurfacePlausible: True; surfaceLowerThan: brush_west_aligned_wind
Brush lies west and wind movement is from west toward the house.	westSurfaceElevated: True; surfaceHigherThan: brush_east_opposing_wind
Fuel lies downhill and the house is upslope under calm wind.	southApproachFavoredBySlope: True
No combustible fuel exists near the house under hot, dry, windy weather.	overallSurface: very-low; overallEmber: very-low

INTERPRETATION

A passing sanity case supports logical consistency, not predictive accuracy. Real-world calibration remains future work.

Representative property release gate

Island / source	Independent results	Performance
Kauai Kauai control buildings	Evacuation: moderate (high confidence) Fire exposure: high (moderate confidence) Retired browser heuristic: 29%	First: 8.983 s Cached: 0.0019 s
Oahu Honolulu official buildings	Evacuation: low (high confidence) Fire exposure: low (moderate confidence) Retired browser heuristic: 43%	First: 0.589 s Cached: 0.0016 s
Maui Maui official buildings	Evacuation: moderate (high confidence) Fire exposure: moderate (moderate confidence) Retired browser heuristic: 51%	First: 0.868 s Cached: 0.0038 s
Big Island Hawai'i County cohbuildings	Evacuation: low (high confidence) Fire exposure: moderate (moderate confidence) Retired browser heuristic: 34%	First: 0.333 s Cached: 0.0016 s

Table 2. Saved release sample across the four main islands. Results are qualitative screening outputs, not observed fire outcomes.

Known limitations and ethical boundaries

- No ignition probability, fire-arrival time, flame length, or structure-survival prediction.
- No live traffic, closure, roadway-capacity, gate, or official evacuation-order model.
- No structure-to-structure spread model and no calibrated spotting-distance prediction.
- NWS interpolation and atmospheric moisture are contextual estimates, not onsite observations.
- Road widths are inferred by class where measured geometry is unavailable.
- Private raw rasters and vectors are used locally and are not redistributed in the public bundle.

Reproducibility and source manifest

Engine version: 2026.08.1. Test command: python3 -m pytest -q. Manifest version: 1 (updated 2026-08-12).

Source	Role and status	Terms / official reference
HWMO internship project / local reference Kaua'i control building footprints	Kaua'i final-tool building baseline and model validation reference Status: internship reference dataset. Policy: Display bounded derived geometry in the personal project; do not present as a county-maintained statewide source.	No direct public URL recorded
City and County of Honolulu Structures / Facilities	O'ahu final-tool building baseline Status: service metadata varies by feature. Policy: Use for analysis and bounded display with attribution; recheck item terms before redistribution.	Official source Terms / documentation
County of Maui Building Footprints 2023	Maui County final-tool building baseline Status: 2023. Policy: Use for analysis and bounded display with attribution; recheck item terms before redistribution.	Official source Terms / documentation
County of Hawai'i cohbuildings_view	Hawai'i Island final-tool building baseline; supersedes AI candidates where county geometry exists Status: current ArcGIS service; discovered in 2026 project audit. Policy: Use for personal analysis and bounded display with attribution; do not redistribute the raw service export.	Official source Terms / documentation
Kaua'i, Honolulu, Maui, and Hawai'i county GIS programs County address-point services	Address search and nearest-building association Status: current service snapshots. Policy: Display only bounded search results and derived matches; raw statewide files remain private.	Official source Terms / documentation
OpenStreetMap contributors Hawai'i road-network extract	Evacuation routing, road classes, and inferred road barriers Status: local extract snapshot. Policy: Attribute OpenStreetMap and comply with ODbL for derived databases.	Official source Terms / documentation
LANDFIRE (USDA Forest Service and U.S. Department of the Interior) LF2024 Scott and Burgan 40 Fire Behavior Fuel Models, Hawai'i	Authoritative fuel-model and nonburnable geography for directional screening Status: LF2024, archive published 2025-12. Policy: Use for analysis and derived property summaries; raw raster remains outside the public bundle.	Official source Terms / documentation
LANDFIRE LF2024 Existing Vegetation Cover, Hawai'i	Vegetation visualization and contextual cover description only Status: LF2024. Policy: Use for analysis and derived display; do not substitute canopy cover for a fire behavior fuel model.	Official source Terms / documentation
U.S. Geological Survey 3D Elevation Program	Elevation, slope, and uphill direction Status: current national service / local statewide lookup. Policy: USGS data are public domain unless otherwise noted; attribute the source and disclose resampling.	Official source Terms / documentation
National Weather Service api.weather.gov hourly forecasts	Temperature, relative humidity, wind speed, and wind source direction Status: live; timestamped per result. Policy: Display timestamped derived context with NWS attribution and interpolation disclosure.	Official source Terms / documentation

Source	Role and status	Terms / official reference
Pacific Fire Exchange / University of Hawai'i NREM Hawai'i historical fire perimeters	Retrospective historical context; not pathway validation Status: 1999-2022. Policy: Personal display through bounded, year-filtered responses; do not redistribute the raw dataset without confirmed terms.	Official source
National Interagency Fire Center WFIGS / IRWIN wildfire incidents and perimeters	Reported current-fire evidence Status: live. Policy: Display timestamped incident evidence; do not describe it as exhaustive ignition detection.	Official source Terms / documentation
NASA FIRMS near-real-time thermal detections	Thermal-detection evidence separate from reported incidents Status: live. Policy: Keep MAP_KEY server-side; show bounded timestamped detections with NASA attribution.	Official source Terms / documentation
University of Hawai'i Hawai'i Climate Data Portal Daily wildfire probability / risk maps	Future official ignition-conditions context Status: Excluded / unavailable. Policy: Excluded from calculations until authenticated access and response semantics are confirmed.	Official source Terms / documentation
Esri and imagery contributors World Imagery basemap	Visual basemap only; never a training or authoritative analysis source Status: service-dependent. Policy: Display under Esri service terms; do not download, train on, trace for OSM, or redistribute imagery.	Official source Terms / documentation
Federal Emergency Management Agency USA Structures	Building-source comparison and AI gap audit Status: service snapshot used in source audit. Policy: Use as an attributed federal comparison source; raw local export remains outside the public bundle.	Official source Terms / documentation
Microsoft US Building Footprints, Hawai'i	Building-source comparison and AI gap audit Status: legacy v2 snapshot. Policy: Follow the repository license and attribution; do not treat as county authority.	Official source Terms / documentation
Overture Maps Foundation Buildings theme	Building-source comparison and AI gap audit Status: project audit snapshot. Policy: Use with Overture attribution and applicable data license; do not present as county authority.	Official source Terms / documentation