Weathering Potential Explorer User Guide

The Weathering Potential Explorer includes several user-adjustable inputs and filters that shape how suitability is visualized. Use this map as a starting point to narrow down promising areas for ERW and not as a substitute for site-level planning, MRV modeling, or carbon flux estimation.

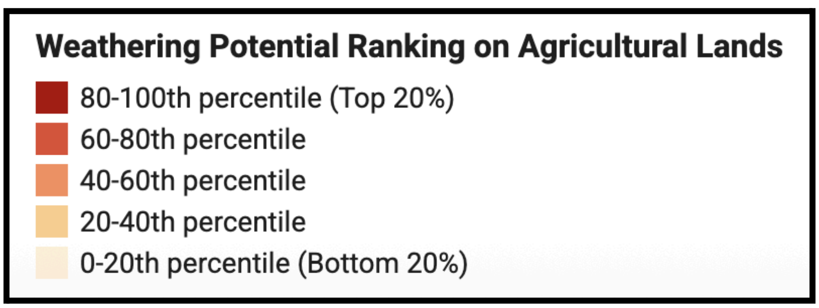
For the best experience, please use desktop fullscreen mode by clicking this button  on the top right corner.

Controls Tab

Percentile Ranking Legend (set as default)

or


The Explorer visualizes relative weathering potential using a color scale based on percentile rankings across global agricultural soils. Each pixel is ranked against other cropland pixels worldwide based on its environmental conditions for rock weathering, based on a simplified expression drawn from geochemical kinetics (see: **[Relative Weathering Potential Estimation]** for more detail on the formula used).



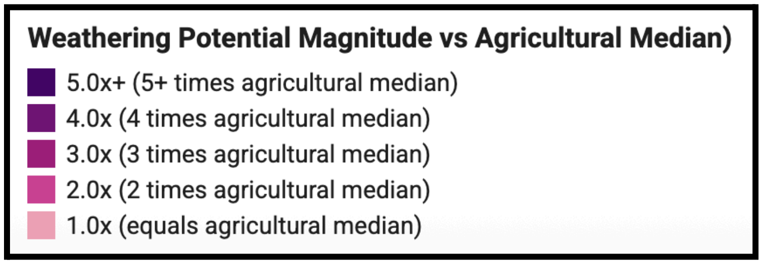
Here's how to interpret the color categories:

- 80-100th percentile (Top 20%) (Red): Among the highest weathering potential areas on cropland globally
- 60-80th percentile (Red Orange)
- 40-60th percentile (Orange)
- 20-40th percentile (Light Orange)
- 0-20th percentile (Bottom 20%) (Light Tan): Among the least favorable croplands for weathering based on current model inputs. This doesn't mean weathering is infeasible, just that conditions are less likely to be favorable for fast reactions, and local factors may matter more.

These rankings are based only on land currently classified as cropland according to the dataset selected (defaulted to GFSAD1000). Non-agricultural lands are not included in the percentile calculation. This scale is most useful for comparing regions or prioritizing areas for further investigation. Just because a site ranks lower does not mean it is a bad site, especially if other factors (like rock type, supply chains, or agronomic fit) make it work in practice. We explore more of these limitations in the full explainer article.

Weathering Multiplier

The Weathering Multiplier toggle offers an alternative way to interpret the model output. Instead of showing percentile rankings, this view tells you how much potentially faster weathering is expected in a given location compared to the global median across all croplands.



Here's how to interpret the color categories:

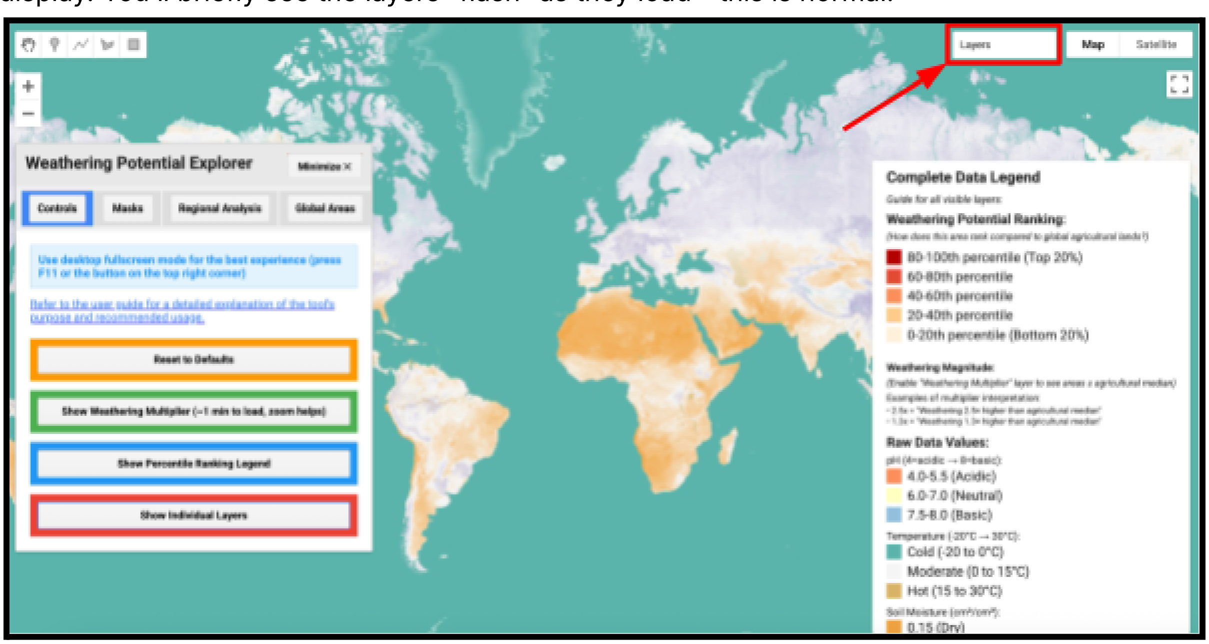
- A value of 1.0x indicates the global median weathering rate.
- Light pink areas are near the median (~1.0x).
- Pink areas are around 3x faster than the median.
- Darker purple areas are 5x or more faster than the median weathering rate.

This view is especially useful for understanding the magnitude of difference between locations. While the percentile map shows how a location ranks, it doesn't tell you how much faster weathering might be from one region to another. For instance, the 80th and 90th percentile might seem close, but if one is only 1.3x the median and the other is 10x, that's a major difference!

The Weathering Multiplier highlights these kinds of gaps, helping users see where weathering could happen substantially faster than average agricultural soils worldwide. This view also helps describe the shape of the distribution underlying the percentile rankings. It answers not just "how high is this ranked?" but also "how much *more* weathering is potentially likely to occur here?"

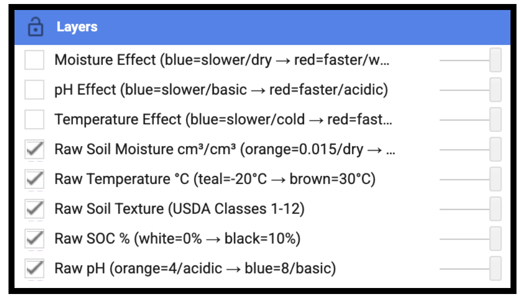
Show Individual Layers

Clicking "Show Individual Layers" will load all of the map's underlying environmental layers into the display. You'll briefly see the layers "flash" as they load - this is normal.



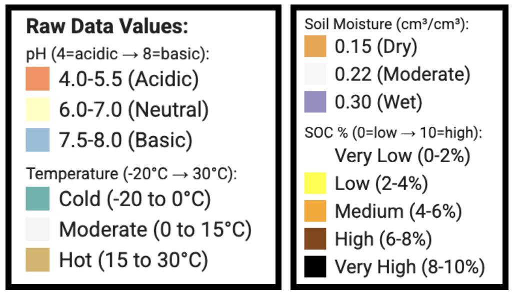
To view layers individually, click the “Layers” icon in the top-right corner of the map. This opens a control panel where:

- Each layer is listed separately
- Layers are stacked top-to-bottom, meaning the top-most selected layer is the one that’s visible
- You can use the opacity slider next to each layer to blend or compare them

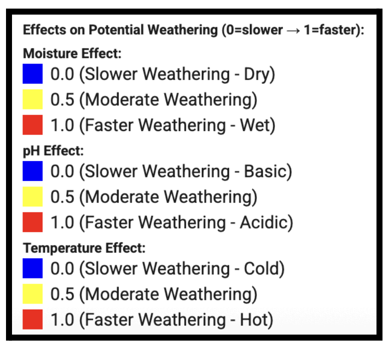


For each environmental variable (pH, temperature, moisture), you’ll see 2 types of layers:

1. **Raw Data Values:** showing the original environmental conditions



2. **Effect on Weathering Potential:** showing how each variable influences weathering rate in the model (scaled from 0 to 1, where blue is slower and red is faster)



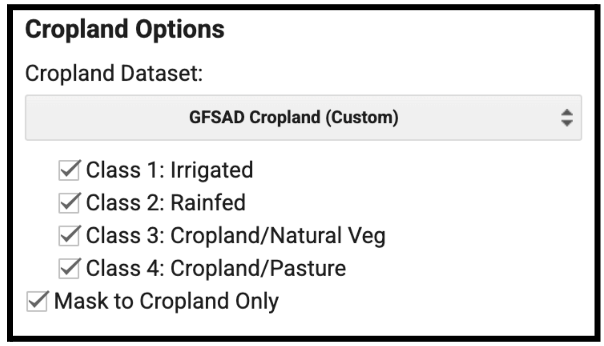
These individual layers are useful for understanding what’s driving the map output in different regions, and for exploring how each variable contributes to the model’s estimation of relative weathering potential.

Masks Tab

Cropland Masking

Users can optionally restrict the analysis to agricultural land by applying one of two cropland filters:

- **ESA WorldCover (10 m):** Offers higher spatial resolution and general land cover classification, ideal for detecting finer-scale agricultural patterns.
- **GFSAD1000 (1 km) (set as default):** Includes more detailed cropland type distinctions (e.g., irrigated vs. rainfed) but at coarser resolution, which may be better suited for large-scale regional planning.

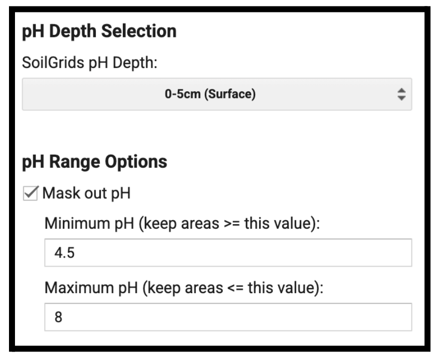


Both layers help highlight areas where ERW is operationally feasible (i.e. croplands that are already managed, routinely amended, and where ERW has been most commonly piloted), but may miss smallholder systems or mosaic landscapes in tropical regions.

pH Depth and Masking

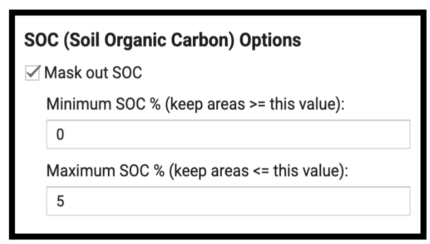
The Weathering Potential Explorer uses soil pH in H_2O from the SoilGrids dataset. You can customize two aspects of how pH is handled in the model:

1. **Select pH Depth:** Choose the soil depth from which pH values are drawn. Available depths range from 0–5 cm to 100–200 cm.
2. **Set pH Filter Range:** Optionally exclude soils with pH values outside a specified range. The default filter excludes soils with pH below 4.5 or above 8.0.



SOC masking

The Weathering Potential Explorer includes an optional filter for soil organic carbon (SOC), allowing you to exclude areas with very low or very high SOC content. SOC is measured as a percentage by mass from the OpenLandMap dataset at 0-5 cm depth. You can set both a minimum and maximum SOC threshold. The default setting keeps areas with SOC between 0% and 5%.



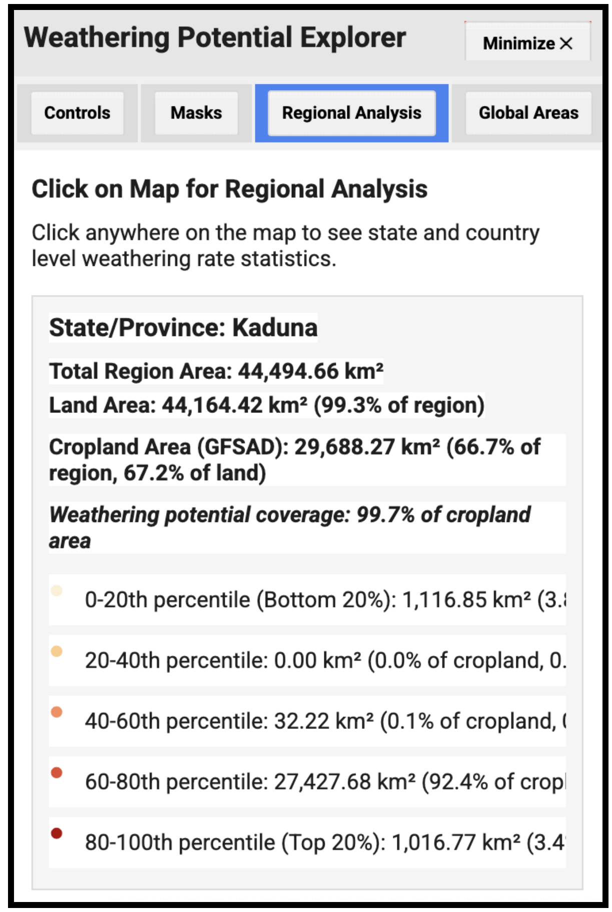
Soil texture masking

The Weathering Potential Explorer includes an optional filter for soil texture, using USDA classifications from the OpenLandMap dataset (0–5 cm depth). When you enable "Mask by Soil Texture", all 12 texture classes are selected by default, so no filtering is applied initially. All textures remain visible and included in the analysis.

When you deselect classes, unchecking texture types will:

- Hide those classes from the map
- Exclude them from the weathering potential analysis
- Limit results to areas with the remaining selected textures

Regional Analysis Tab



On-click regional statistics

Clicking on any region returns a pop-up summary that shows:

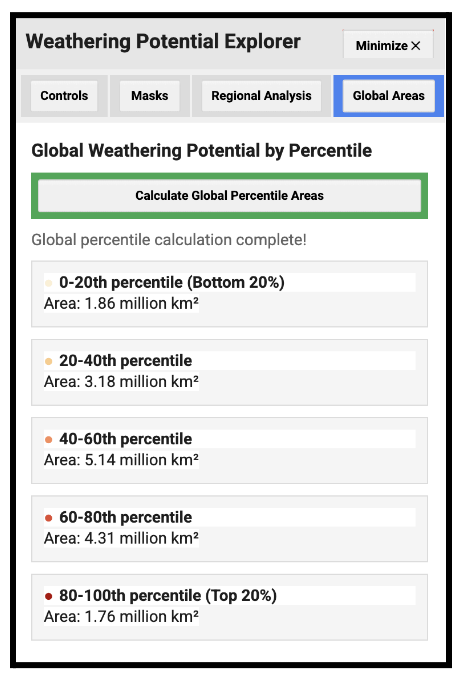
- Total land area and cropland area (if a cropland mask is applied)
- The distribution of pixels across relative weathering potential categories (from low to high)

These summaries reflect all active filters, including cropland, pH, SOC, and soil texture masks. That means the reported land areas represent only the portion of the region that meets your selected criteria. This helps you understand not just environmental favorability, but also how much land corresponds to your masks.

These summaries are based on administrative boundaries from the FAO GAUL Level 1 dataset (e.g., provinces, counties, or equivalent).

Below the regional summary, you'll also see a "Load country data for [Country Name]" button. Clicking this runs the same analysis for the entire country that contains the selected region, allowing you to quickly compare local and national suitability profiles.

Global Areas Tab



The Global Areas tab provides a summary of how land is distributed across relative weathering potential categories, aggregated globally.

Clicking the "Calculate Global Areas" button runs the same analysis used in the Regional tab, but across the entire globe. It returns total land area and cropland area (if masked), broken down by percentile categories, reflecting all active filters, including pH, SOC, and soil texture.

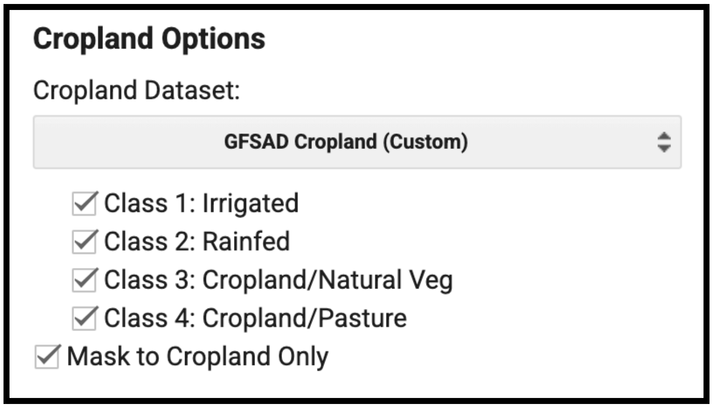
Use this view to get a quick sense of how much land exists globally under your filtering scenario.

EXAMPLE: NYANZA, KENYA

Let's walk through how you might use the Weathering Potential Explorer to assess relative weathering potential in a region of interest: in this example, Nyanza, Kenya.

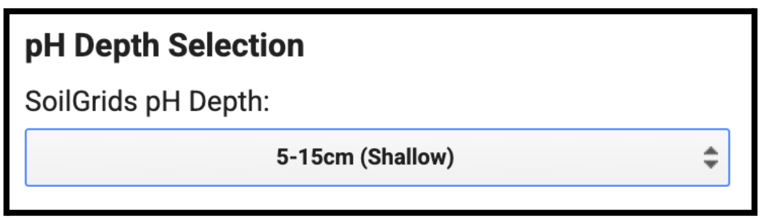
Step 1: Apply Cropland Masking

To focus on regions where ERW is likely to be operationally feasible, you apply the GFSAD cropland mask. This restricts your analysis to agricultural lands and filters out urban, forested, and non-arable areas. You keep all of the subclasses checked for this initial analysis.



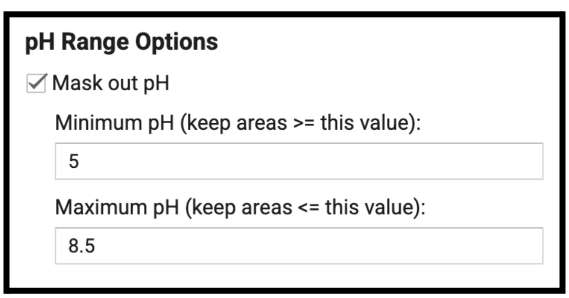
Step 2: Select a pH Depth

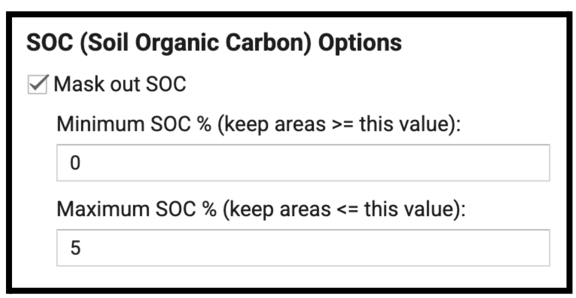
You select the 5–15 cm pH depth layer to be more representative of the root zone, where water movement, root activity, and mineral interactions are more stable and relevant for longer-term weathering.



Step 3: Enable SOC + pH Filtering

To avoid areas where bicarbonate generation may be reduced due to harsher soil conditions, you enable the filter that excludes land with soil organic carbon greater than 5% and pH less than 5 and greater than 8.5. Your reasoning is that while weathering can still occur in these environments, carbon may not be stored as effectively, or there may be a higher risk of releasing CO_2 from soil organic matter.



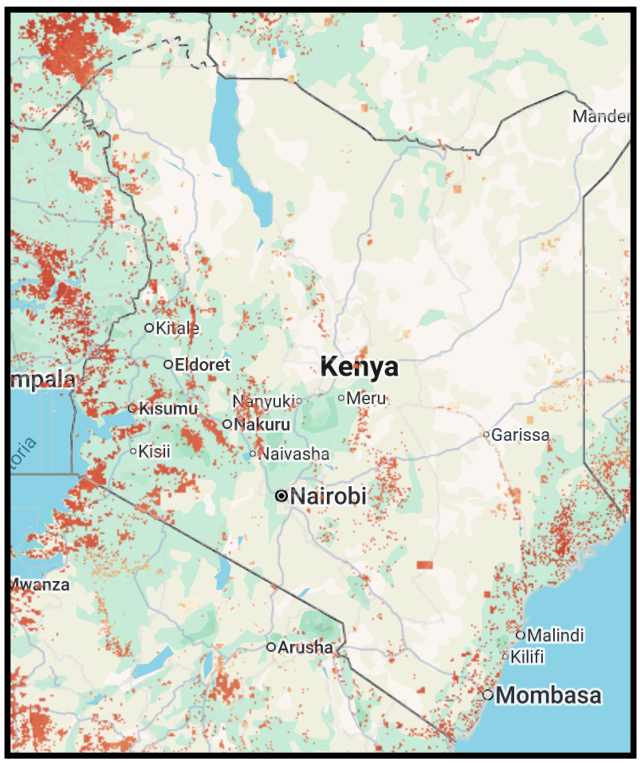


Step 4: Enable Soil Texture Filtering

To refine your analysis based on physical soil properties, you enable the soil texture filter and only uncheck the “clay” category to focus on areas with better drainage and more dynamic water movement, which are more favorable for sustained weathering reactions.

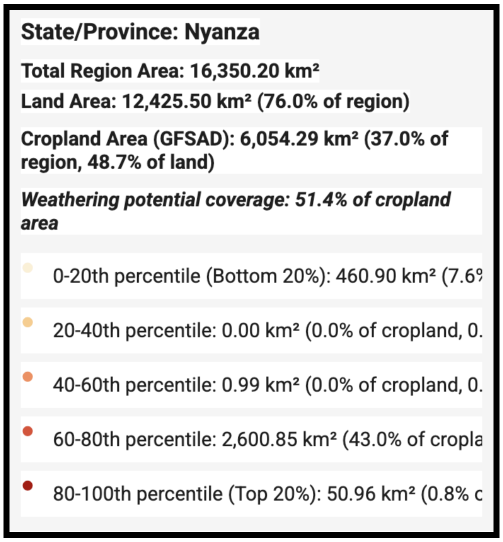
Step 5: Zoom In and Interpret the Map

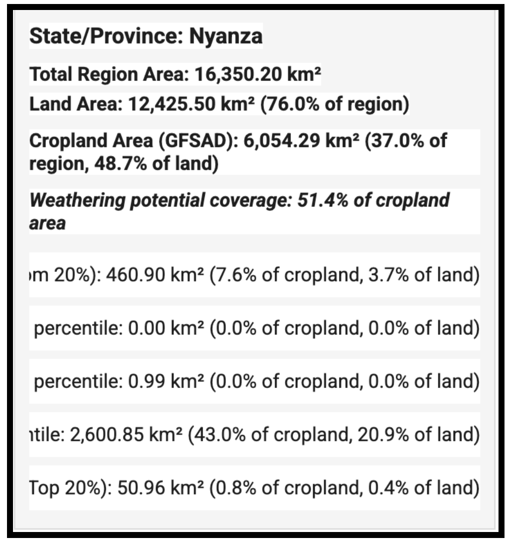
You zoom into Kenya and observe clusters of orange and red cells. These correspond to a relative weathering potential ranking in the 40-100th percentile.



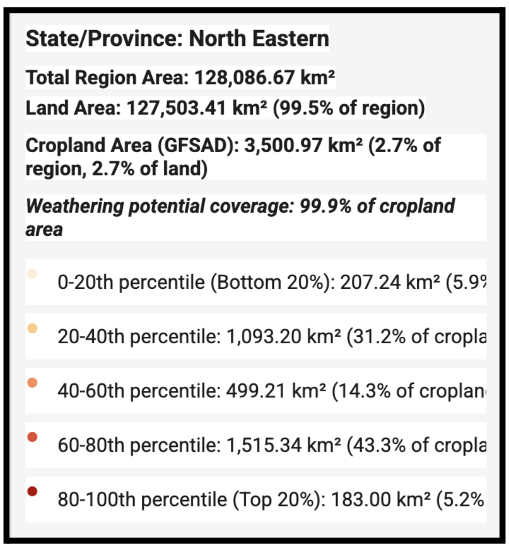
Step 6: Click for Regional Statistics

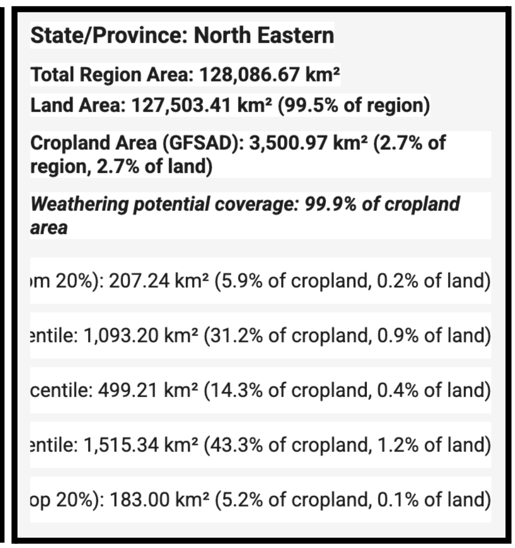
You click on the Nyanza region. A pop-up displays a breakdown of land area by weathering potential rankings, both for total land and for cropland (based on your selected filters).





You repeat the process for the North Eastern region, which shows a slightly different profile with more extensive land area, but less cropland coverage.





These breakdowns help you assess not just how favorable the region is environmentally, but also how much land actually meets your filtering criteria.

While the Weathering Potential Explorer is useful for highlighting promising areas, it is ultimately a first-pass screening tool. For local policymakers, researchers, or project developers, additional layers of information — such as feedstock availability, land tenure, infrastructure access, existing cropping systems, and soil amendment practices — will be essential for assessing where ERW can be viably and responsibly scaled.

Relative Weathering Potential Estimation

The Weathering Potential Explorer calculates a relative weathering potential based on a simplified expression drawn from geochemical kinetics. The underlying idea is that weathering speed is influenced by three key environmental factors:

- Soil moisture (s) – representing the availability of water to facilitate reactions
- Proton concentration ($[H^+]$) – derived from pH, which drives acid-promoted dissolution
- Temperature (T) – which accelerates reaction kinetics via the Arrhenius equation

The core relationship follows the form:

$$r \propto s \times [H^+] \times Ae^{-Ea/(RT)}$$

Where:

- *r* is the relative weathering potential
- *s* is a dimensionless soil moisture proxy
- $[H+] = 10^{-pH}$ is the proton concentration
- *T* is absolute temperature in Kelvin
- *A* is a pre-exponential constant (absorbed in normalization)
- E_a is activation energy (68.8 kJ/mol in our model)
- *R* is the universal gas constant

It's important to note that this model estimates a relative weathering index, not an absolute weathering flux (i.e., mass of rock dissolved or carbon removed over time and space). The values are normalized across all land pixels, allowing for comparison between regions, but not for carbon removal quantification without additional assumptions.

Also note that this model assumes static environmental inputs, including pH. However, in reality, the application of alkaline rock can rapidly increase soil pH, sometimes within the first few weeks or months after spreading. This creates a feedback: while weathering initially proceeds quickly in acidic soils, the reaction itself tends to raise pH, which in turn slows further dissolution. As a result, the modeled weathering potentials are best interpreted as upper bounds that are most accurate in the early stages of rock application or at low doses. Long-term weathering trajectories are likely to differ as soil chemistry evolves.[1] Similarly, soil moisture and temperature may be impacted by ERW deployments.

For further discussion on the factors that drive this model and key limitations, please refer to the full explainer article.

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[1] See Maher & Chamberlain (2014) for further discussion of dynamic soil chemical environments and Lasaga (1984) or White & Brantley (2003) for classical derivations of mineral dissolution rate laws.