# Global Ecosystem Restoration Index

**The Global ecosystem restoration index (GERI) is a composite index that integrates structural and functional aspects of the ecosystem restoration process. These elements are evaluated through a window that looks into a baseline for degraded ecosystems with the objective to assess restoration improvements or declines in a more integrated manner.**

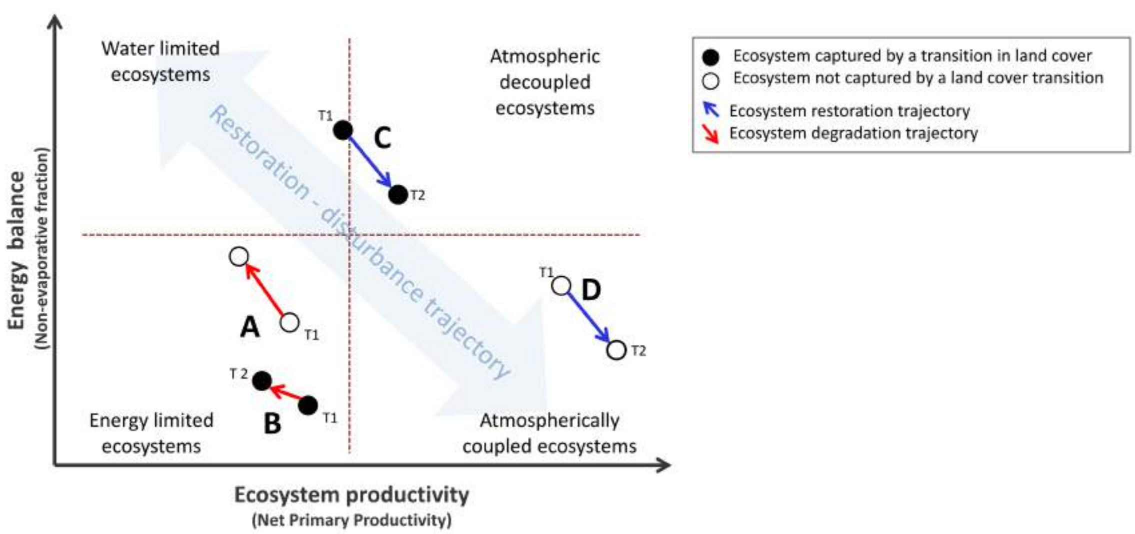
## Purpose of the index

There is still a lack of global indicators to assess Target 15 of the Convention on Biological Diversity. One of the main problems rests in the actual definition of restoration. Many ecosystem changes may lead to restoration of ecosystem functioning; however, not all these changes are caused by the same process. Land restoration is a composite term that describes different processes acting at different times, scales, and extents. We build upon recent advances on biodiversity science, remote sensing, and ecosystem mapping to design a composite index tailored to three key and complementary elements of ecosystem restoration: (1) change in ecosystem productivity (2) change in the ecosystem energy balance and (3) changes in land cover. Degraded areas defined in a baseline are the window into the world upon which we monitor these three aspects relative to the goals of Target 15.

**CBD Aichi Target 15**
Restoration of 15 per cent of degraded ecosystems

## Coverage

This composite index is produced for near the entire terrestrial surface of the planet at a spatial resolution of 1 km2. This allows for the GERI index to be aggregated to small regions, states, countries, continents and the planet. This index uses well vetted products derived from MODIS sensor, in orbit since 2001. These products are continuously being outputted and the expected data availability and planned mission continuity is an assurance of the temporal sustainability of the proposed index.




Modified after Nemani & Running (1997), in Ecological Applications
Hypothetical restoration trajectories in the two-dimensional space defined by net primary productivity and energy balance. Where A & B portray degradation trajectories; C & D portray restoration trajectories. Filled (empty) circles represent an ecosystem where a transition in land cover was detected (not detected).

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## Methods

The Global Ecosystem Restoration Index (GERI) addresses Target 15 goals by integrating three datasets derived from remote sensing and produced at global extent. These datasets were carefully selected because they address three different but related aspects of the land restoration process.
The first functional aspect is based on changes in land productivity, the second aspect is also functional and it is related to changes in the energy balance of the ecosystem, the third and final aspect is related to the structural changes and it is measured using identity transitions in land cover. These datasets are evaluated together though a window (i.e., mask) defined by a baseline of land degradation that aims to capture and discriminate very highly degraded ecosystems from degraded ecosystems.

**1) Change in land productivity**

This first component of the index addresses land degradation from a functional perspective. For this we use primary productivity indicators derived from vegetation indices. To correct for the effect of precipitation we calculate the Rain Use Efficiency (RUE), which is originally defined as the ratio between net primary productivity (NPP) and precipitation, and represents the capacity of vegetation to use water; the larger the capacity, the better the condition of the system.
For the precipitation time series we use the Climate Research Unit gridded precipitation dataset (CRU TS v. 3.23 ). Because restoration assessments require the definition of ecologically meaningful boundary conditions, we use the USGS Ecological Land Units dataset to rescale RUE in relation to climatic, geological and biotic conditions.

**2) Change in the energy balance**

The second component of the index evaluates land degradation from an energy balance perspective. Functional ecosystems should optimize the fraction of dissipated energy in the land surface in the form of latent heat flux (evapotrasnpiration). Therefore the partition of the available energy reaching the land surface into latent heat and sensitive heat provides key information on the restoration process.
We will use MODIS data on radiometric temperature, vegetation, and albedo to calculate the energy partition. Once the relationship between latent and sensible heat is calculated for every month of the full time series, we use a standard statistical technique to estimate pixel-based significant trends.
This pixel based metrics can then be aggregated and reported at any scale depending on the user requirements.

**3) Identity transitions in land cover**

To be able to correctly interpret trends derived from the previous two components we need to place them in the context of a land cover classification dataset that addresses the structural aspect of the restoration process. For this we use the Global Forest Change time series based on Landsat. We identify pixel based identity transitions from and to forest. This pixel based metric can then be aggregated and reported at any scale depending on the user requirements.
Although these three components are calculated independently they should be interpreted together because they provide insights into different but complementary aspects of the ecosystem restoration process.
All the data and metrics are available via the a dedicated web interface that will be developed by the German Centre for Integrative Biodiversity Research (iDiv) computational infrastructure

### Essential Biodiversity Variables:

**Ecosystem function class**
Net primary productivity

**Ecosystem structure class**
Ecosystem extent and fragmentation