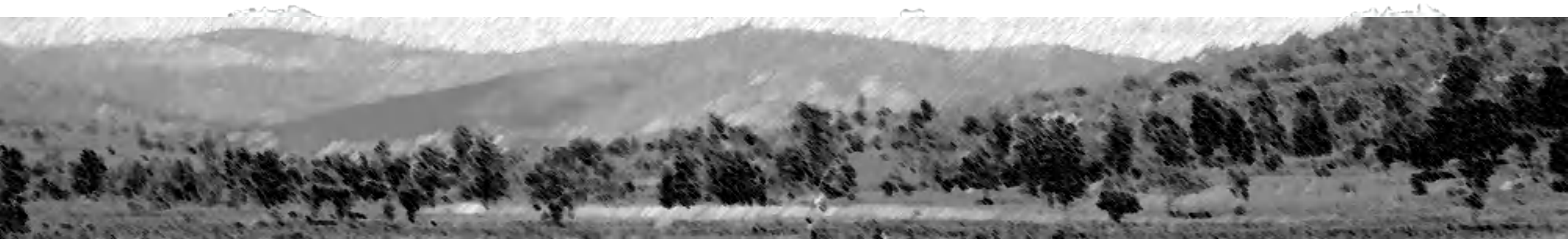
Advances in soil and land health monitoring and a new soil health coalition

Leigh Winowiecki & Tor-G Vågen
CIFOR-ICRAF Scientists
SOILdarity
17 January 2023

Key messages

- We can translate science into action to inform decisions
- We have the tools and methods to measure and track soil and land health, as well as the underlying processes of land degradation and impact of land management on soil health
- Through stewardship, we can improve soil health
- Encouraging farmer-led innovations – to tailor the healthy soil practices to meet needs is critical for scaling and for accelerating impact on the ground
- Public-private sector engagement is needed to bring equitable financial incentives to the famer to overcome economic barriers to scale soil health: for example the Coalition of Action 4 Soil Health (CA4SH)



Soil erosion is the most widespread form of degradation

> 25% of the Earth's surface is degraded, impacting 3.2 billion people (GLO2, 2022; IPBES, 2018)

TARGETED INVESTMENTS IN LANDSCAPE RESTORATION ARE URGENTLY NEEDED - AND THEY NEED TO BE PRIORITIZED, TRACKED AND FARMER CENTERED
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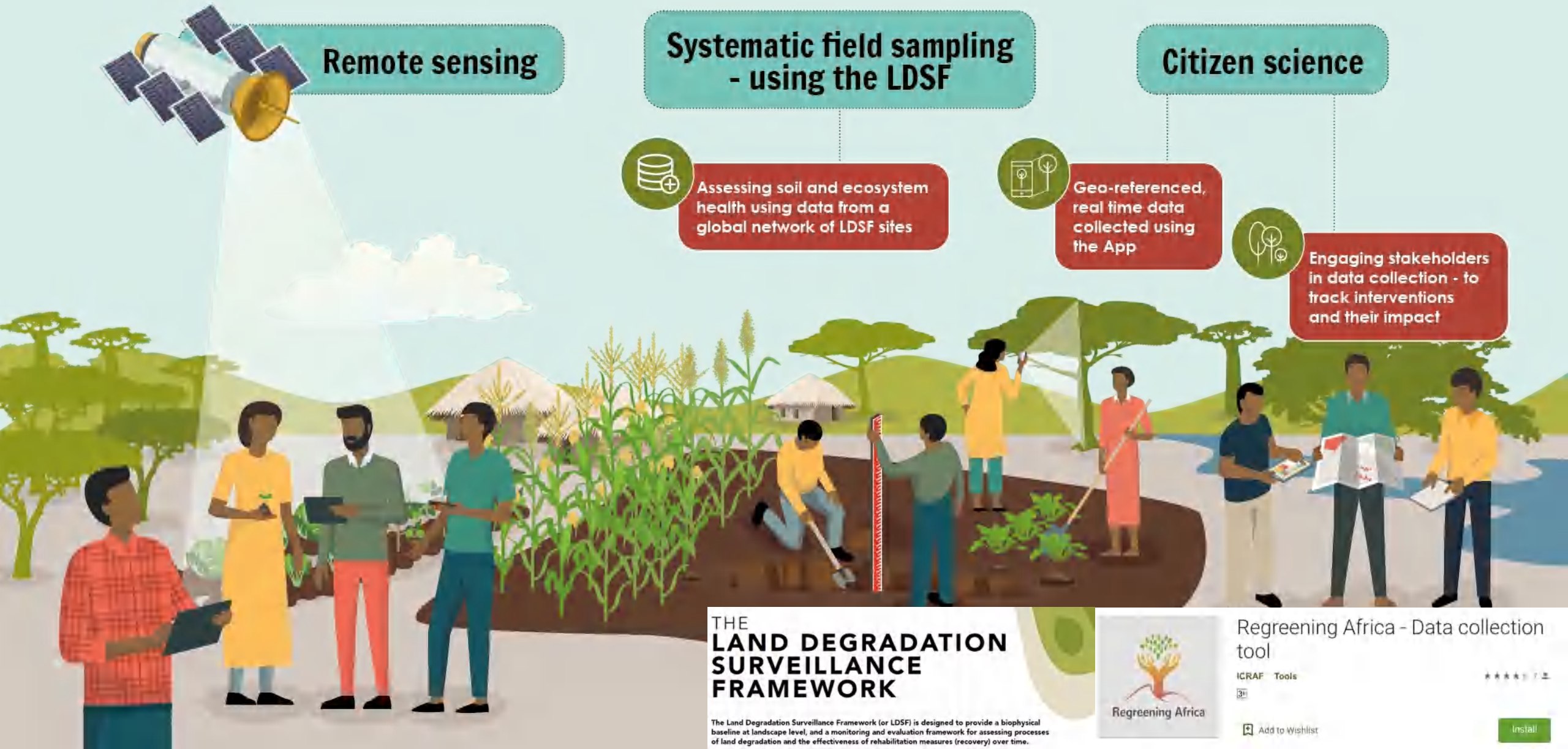
By combining multiple innovative monitoring techniques, we can understand drivers of land degradation and better target and track restoration progress in real time with multiple partners



THE
LAND DEGRADATION SURVEILLANCE FRAMEWORK

The Land Degradation Surveillance Framework (or LDSF) is designed to provide a biophysical baseline at landscape level, and a monitoring and evaluation framework for assessing processes of land degradation and the effectiveness of rehabilitation measures (recovery) over time.

Regreening Africa

Regreening Africa - Data collection tool

ICRAF Tools

3+

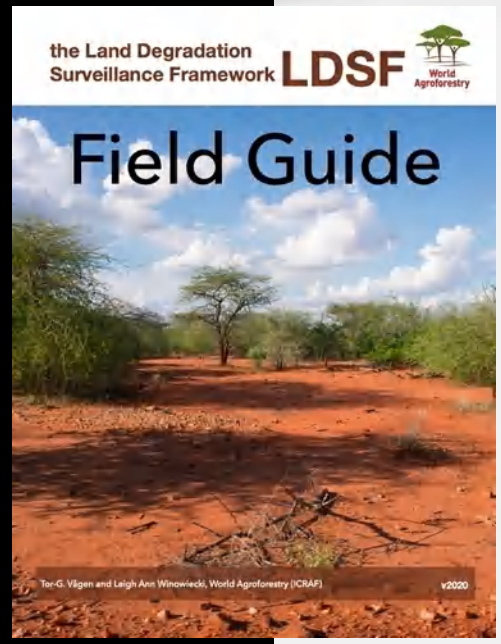
Add to Wishlist

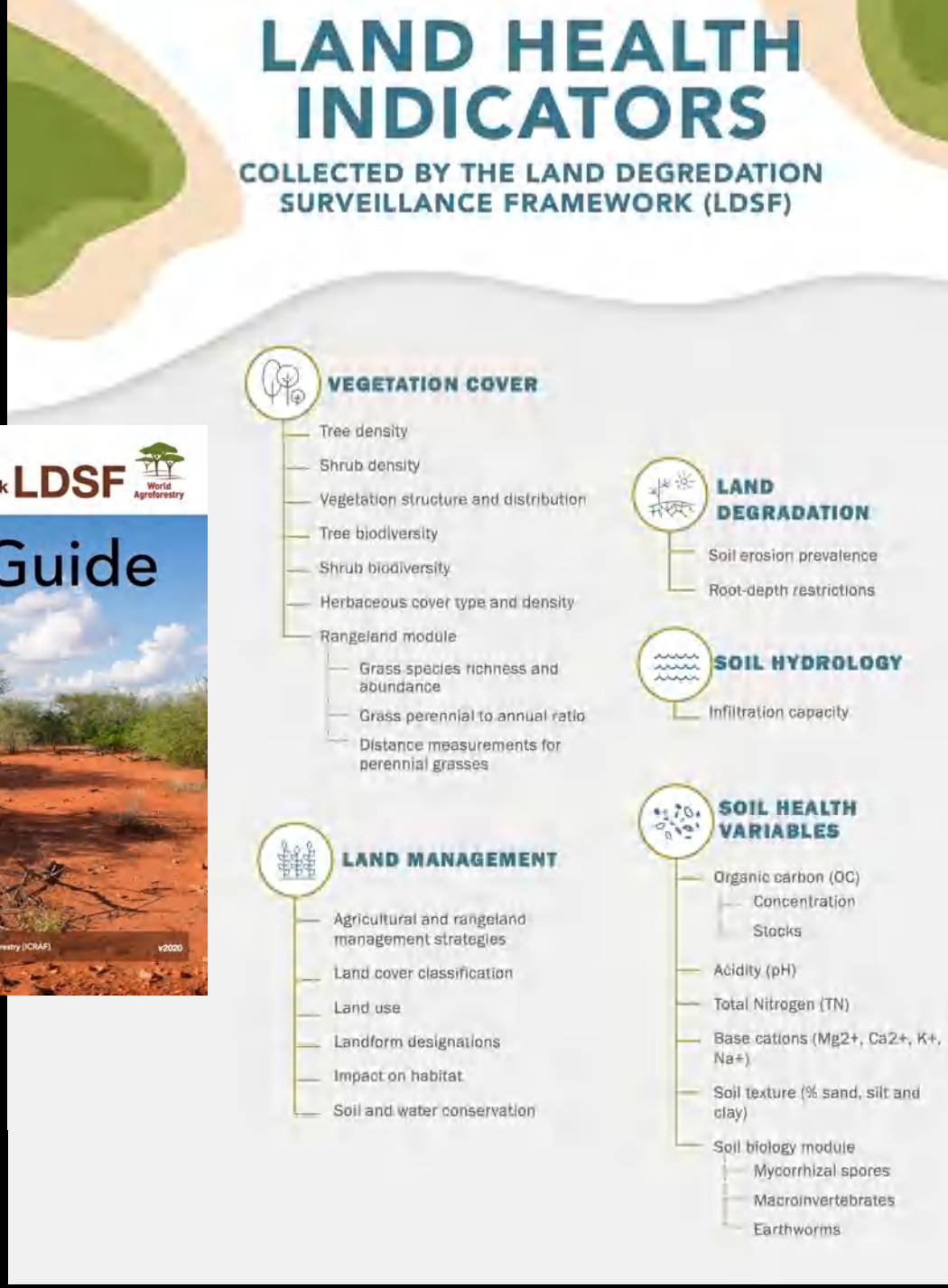
Install

The LDSF was developed in response to the need for…

Systematic and science-based assessment and monitoring of soil and ecosystem health at scale, using a robust and consistent indicator framework to:

- Assess of variability of and conduct a rapid assessment of multiple variables across landscapes
- Conduct robust statistical analysis on drivers of degradation and relationship between variables
- Produce high quality maps of key indicators
- Set a baseline that can be used to monitor changes over time

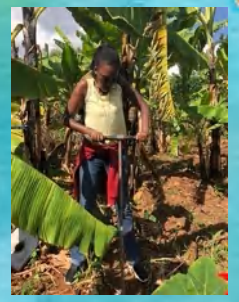




http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Robust and rapid monitoring systems to inform and de-risk investments
For example: The Land Degradation Surveillance Framework (LDSF)

http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/



Data-driven network of LDSF sites (each site is 100 km^2, with 160 sampling plots). One systematic framework across multiple projects, donors, initiatives.

Opportunity to expand to Europe!

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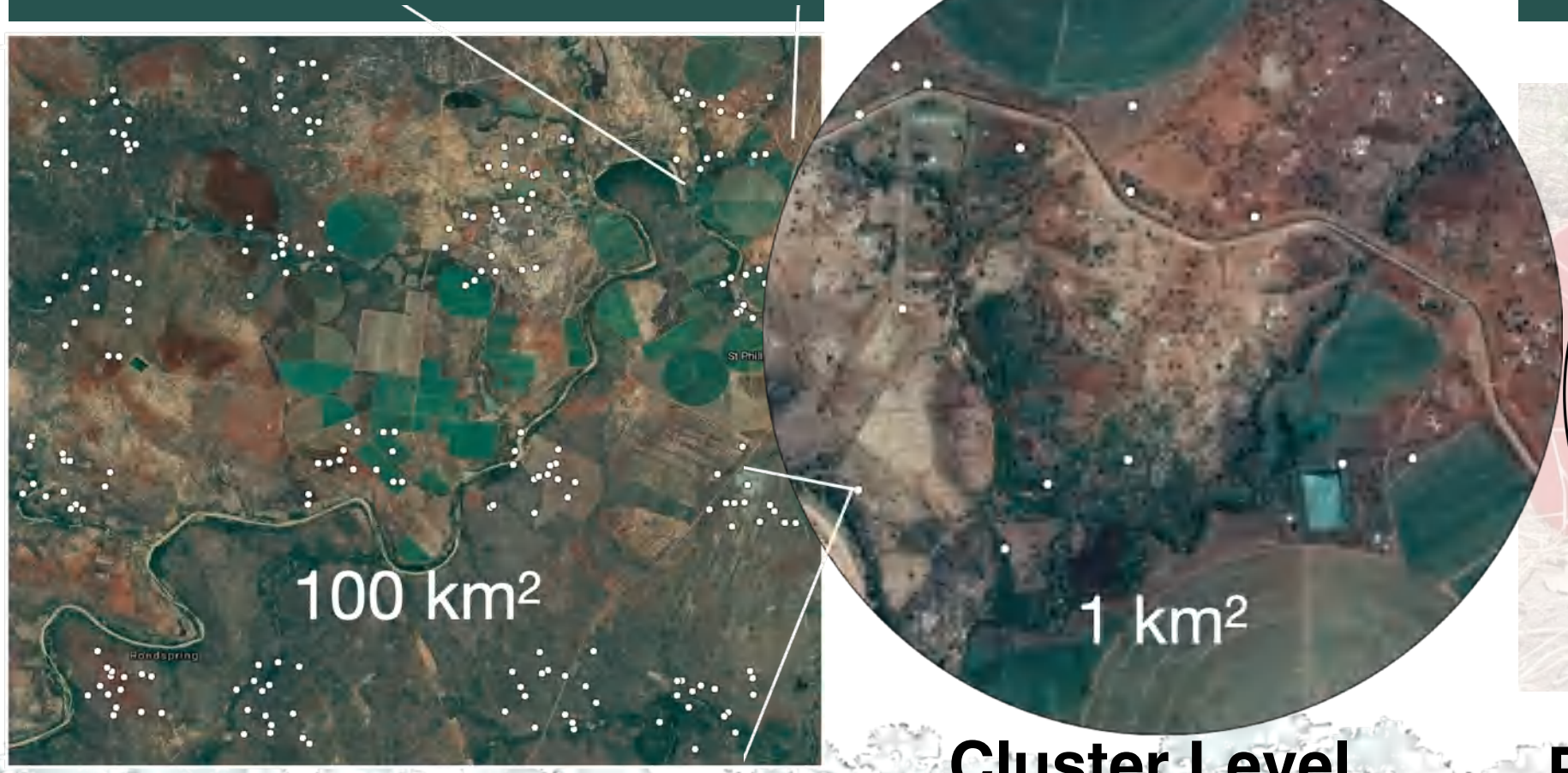
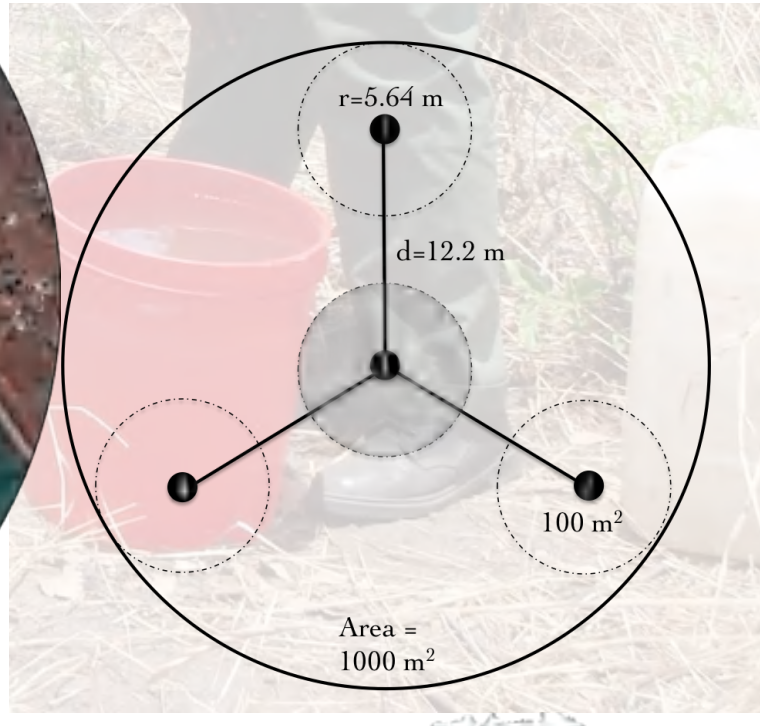
LDSF: Nested Sampling Scales

Unbiased sampling





Site Level (10km * 10km)

Cluster Level
16-1km² per site

Plot Level
10-1000m² per cluster

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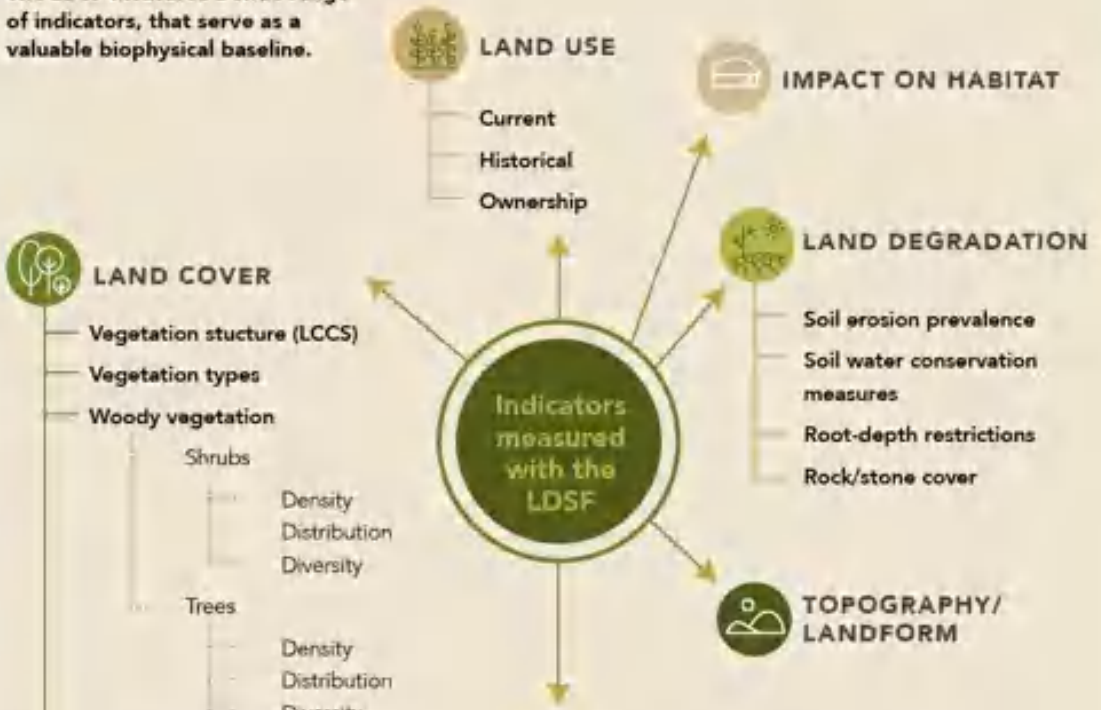
THE LDSF MEASURES MULTIPLE INDICATORS AT THE SAME GEO-REFERENCED LOCATION

LDSF INDICATORS

The LDSF measures a wide range of indicators, that serve as a valuable biophysical baseline.



Collecting Soil Samples in the LDSF

- Soil samples are collected in the field
- Soil samples are taken from each subplot (n=4) and composited at the plot level at two depths
  - 160 topsoil (0-20 cm) samples per site
  - 160 subsoil (20-50 cm) samples per site
- All soil samples are analyzed using mid-infrared spectroscopy – which enables landscape scale analysis
- Reference soil samples are analyzed using traditional wet chemistry (pH, organic carbon, total nitrogen, base cations, etc)
- Predictions are made using the spectra
- Soil cumulative mass samples (0-20,20-50,50-80,80-110 cm) for carbon stock calculations

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Shining a light on soils for land restoration

- MIR &NIR spectroscopy for accurate, robust, low-cost analysis of multiple properties, simultaneously
- **Can be used to analyze plants, compost, manure, fertilizers, liquids and yes soil!**
- Enables landscape scale sampling- which was previously limited by costs of analysis
- This has transformed research and **requires NEW skills of soil scientists**
- ICRAF has invested **>20 yrs to build a consistent spectral library (database) for a number of spectrometers**
- Investment in spectral data analytics

https://wle.cgiar.org/solutions-and-tools/science-driven-solutions/shining-a-light-on-soils-for-land-restoration/

Elvis Weulow of the ICRAF Soil and Plant Spectroscopy Lab demonstrating how to use th Spectrometer. Photo: World Agroforestry/Ann Wavinya

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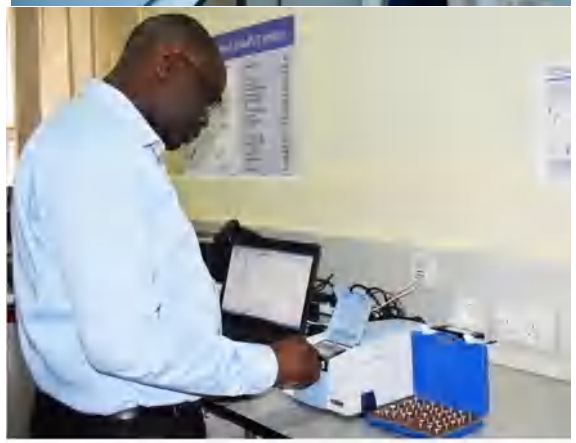
MIR Spectroscopy is Accurate, Robust and Cost-efficient



Elvis Weulow of the ICRAF Soil and Plant Spectroscopy Lab demonstrating how to use th Spectrometer. Photo: World Agroforestry/Ann Wavinya

Table 1. Summary of soil properties and model results for the for the mid-infrared spectroscopy predictions.

Soil property	Range measured (range predicted)	R^2	RMSEP†
Soil organic C (g kg^{-1})	1.75–30.31 (2.41–28.10)	0.98	1.3
pH	5.32–8.28 (5.52–8.07)	0.95	0.2
Sand (%)	6.4–78.3 (9.2–72.7)	0.94	5.0
Clay (%)	12.6–76.8 (15.6–74.2)	0.97	3.6

† RMSEP, root mean squared errors of prediction.

Vågen, T., L. A. Winowiecki, W. Twine, and K. Vaughan. 2018. Spatial Gradients of Ecosystem Health Indicators across a Human-Impacted Semiarid Savanna. J. Environ. Qual doi:10.2134/jeq2017.07.0300

https://dl.sciencesocieties.org/publications/jeq/articles/0/0/jeq2017.07.0300

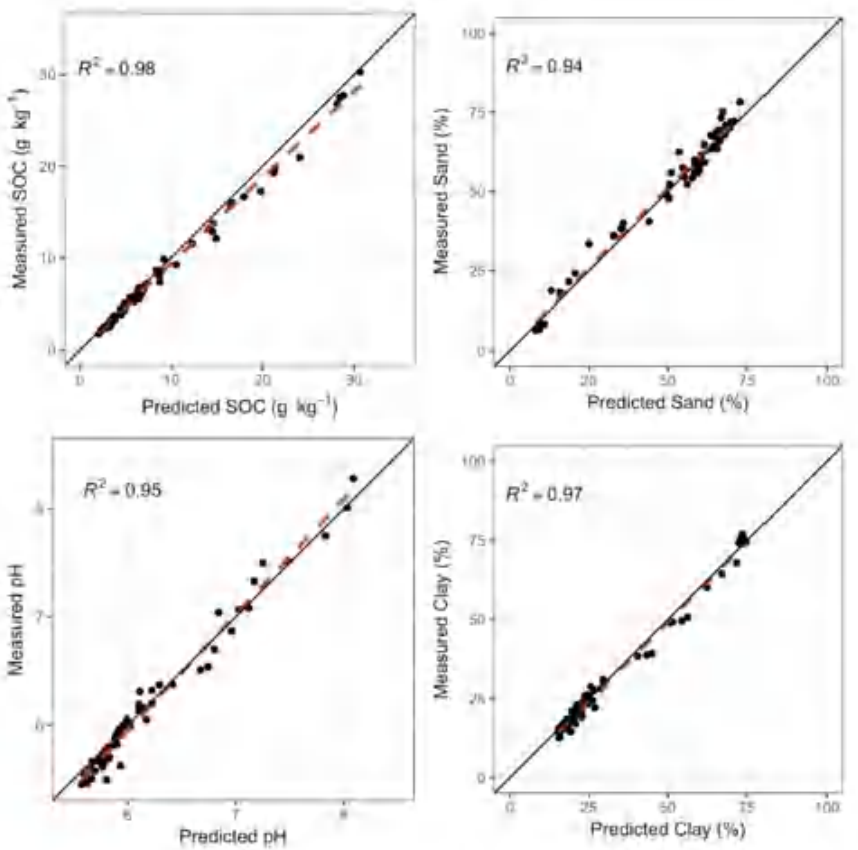


Fig. 3. Prediction results for soil organic carbon (SOC), pH, and texture according to mid-infrared spectral data from the two study sites combined. The red dashed lines represent the regression lines, and the 1:1 abline is the solid black line.

- Visit our webpage to learn more about what we are doing: https://www.cifor-icraf.org/research/theme/soil-and-land-health/

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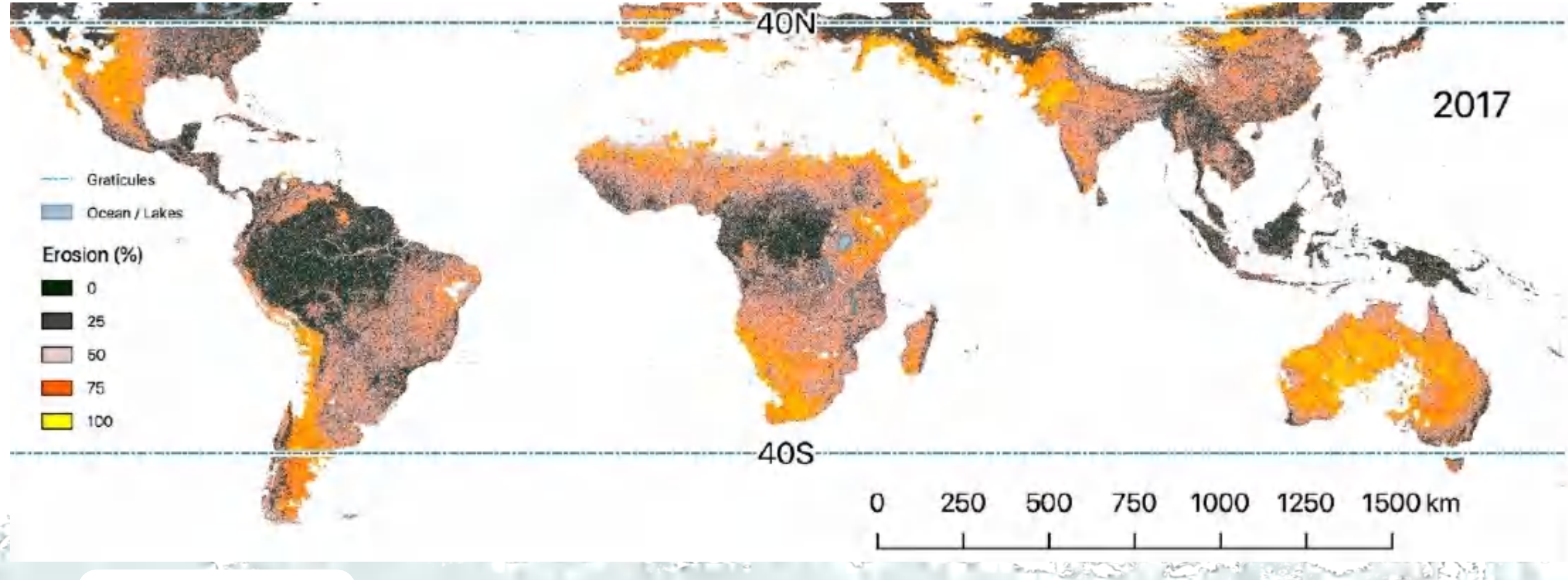
Applications of the LDSF

Photo: Kelvin Trautman

Soil erosion is a key indicator of land degradation

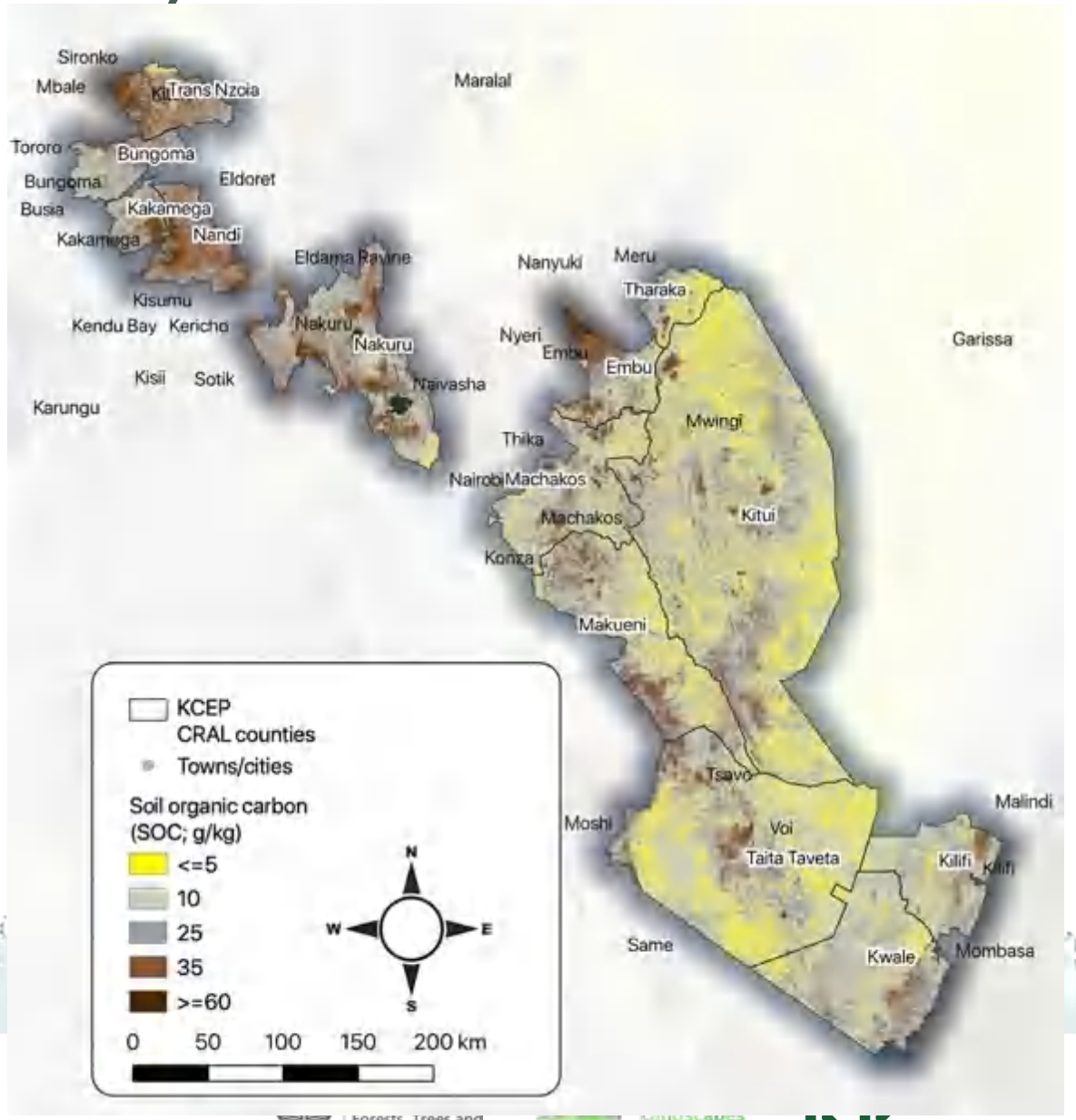


Global-level assessments for global crop and climate models

Vågen, T.-G.; Winowiecki, L.A. Predicting the Spatial Distribution and Severity of Soil Erosion in the Global Tropics using Satellite Remote Sensing. *Remote Sens.* **2019**, *11*, 1800. https://www.mdpi.com/2072-4292/11/15/1800

Map of Soil Organic Carbon (SOC) – for GoK

- Key indicator of soil health
- SOC influences the water holding and cation exchange capacity of the soil, soil fertility
- SOC is responsive to land management and vegetation shifts
- Map was developed using ICRAF's georeferenced database of ecosystem health indicators and the five LDSF sites, coupled with remote sensing imagery
- Landsat 8 at 30-meter resolution
- Accuracy > 80%
- Higher SOC in western counties compared to eastern, high variability



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Farm-level assessments at 30 meter resolution to track what is happening at the farm/household level – impact of restoration/ management options on soil erosion

Wote

Makueni

Town

Farm

Erosion (%)

0

25

50

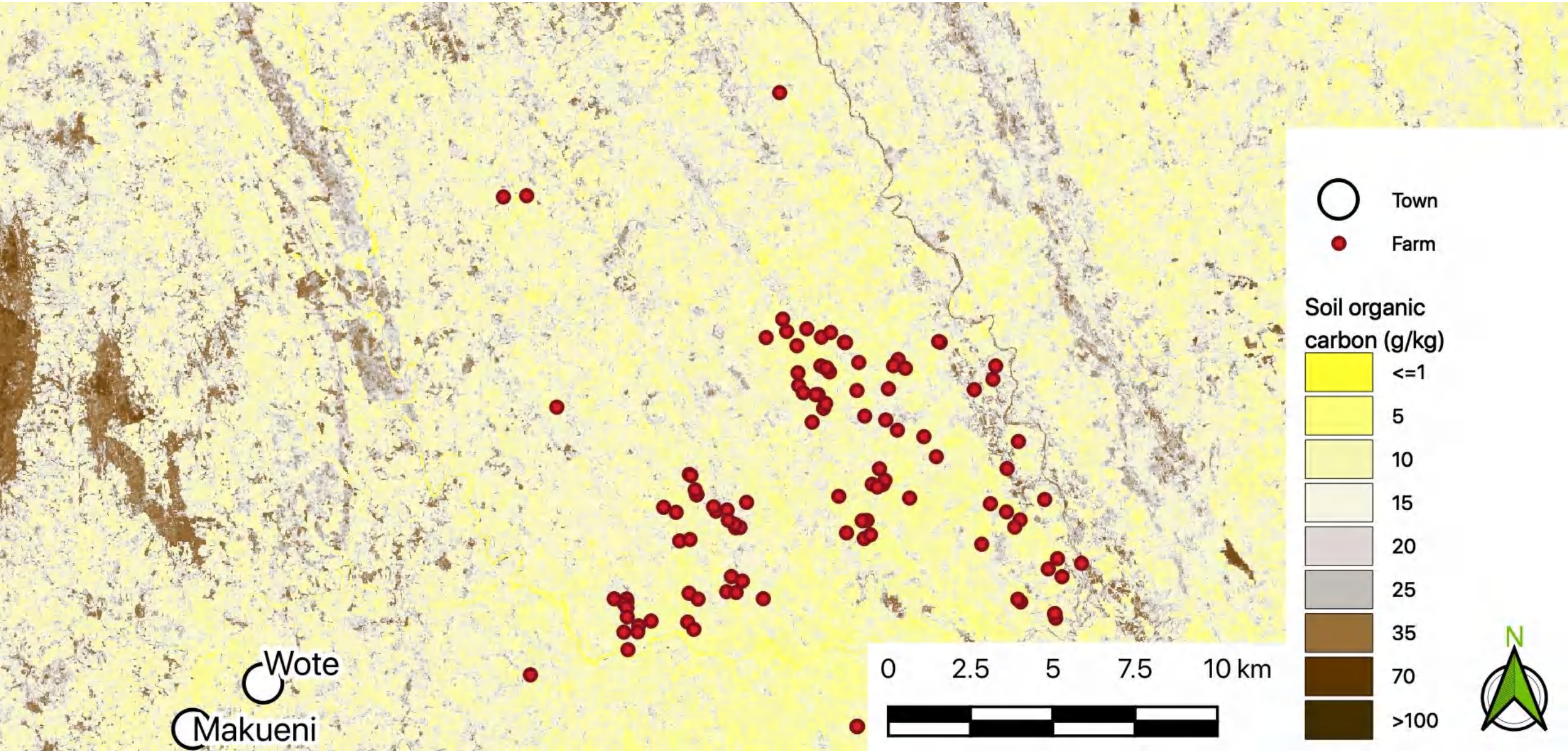
75

100

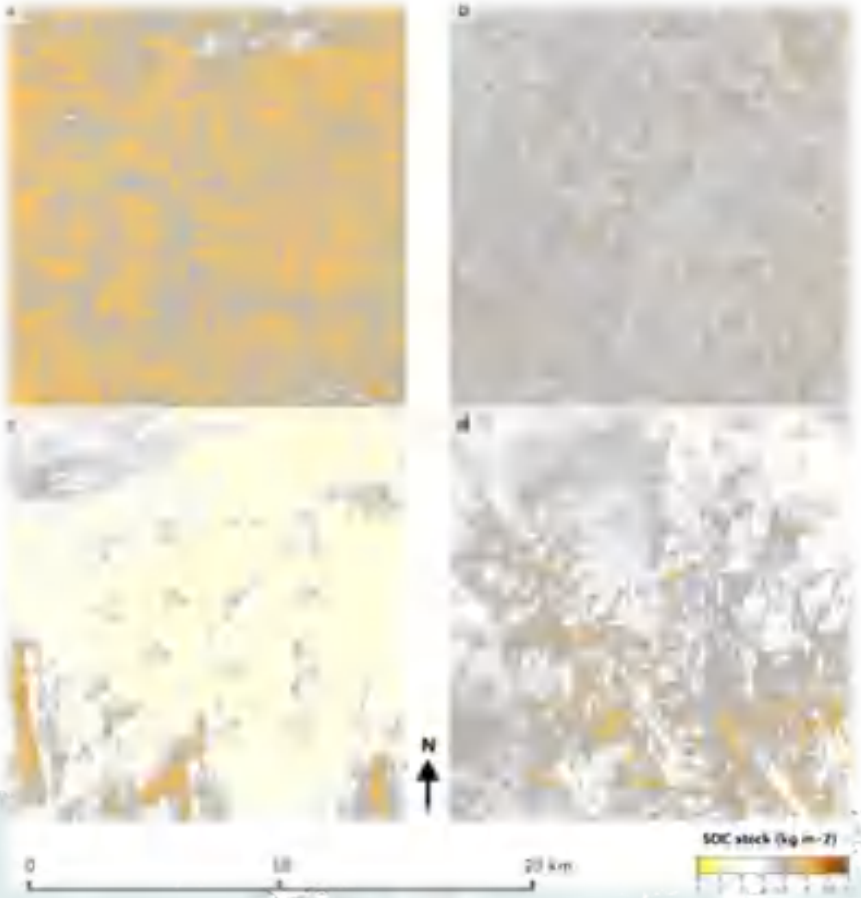
0 2.5 5 7.5 10 km

N

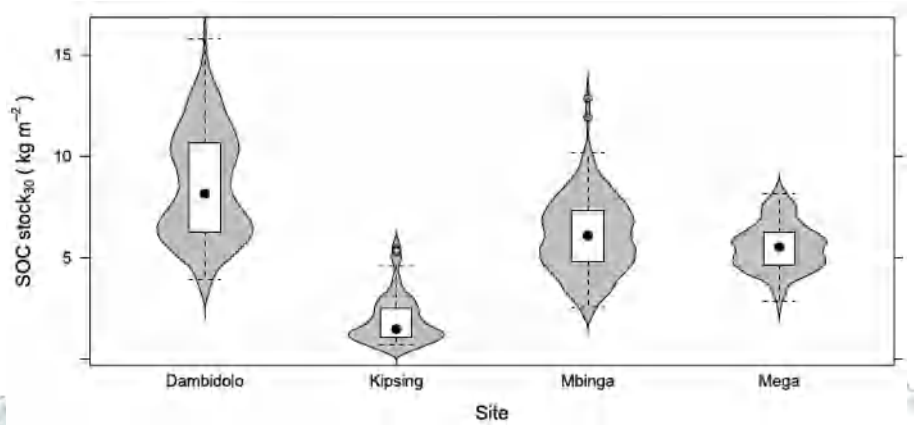
Important to assess multiple biophysical indicators at the same time to capture complexity: Example of soil organic carbon a key indicator of soil health



Example Output: Assessing Soil Carbon Storage as Potential Climate Change Mitigation Strategy



- Contrasting sites in Tanzania, Ethiopia and Kenya to demonstrate utility of method: SOC stocks to 30 cm
- To understand landscape patterns of SOC stocks
- SOC stocks are lower by 0.9 kg m^2 ($p < 0:01$) on average in eroded versus non-eroded areas.



Vågen and Winowiecki, 2013. Mapping of SOC stocks for spatially explicit assessments of climate change mitigation potential. Environmental Research Letters. 8

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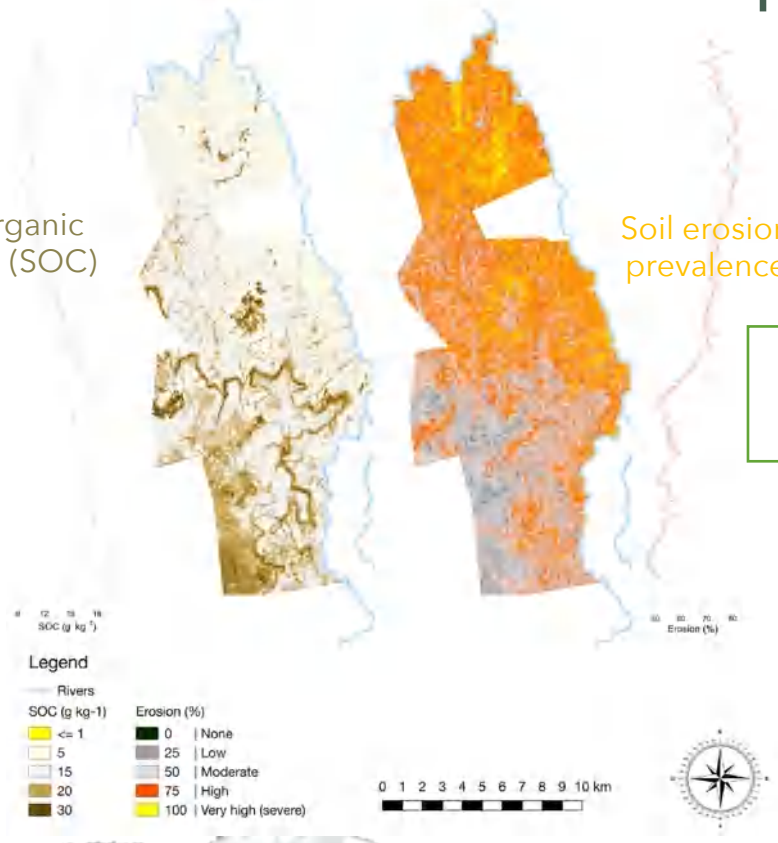
Another example- combining these data to inform restoration: Spatially explicit assessment of priority areas for restoration: SOC and Erosion in Laikipia County, Kenya

Soil organic carbon (SOC)

Soil erosion prevalence



Restoration priority areas

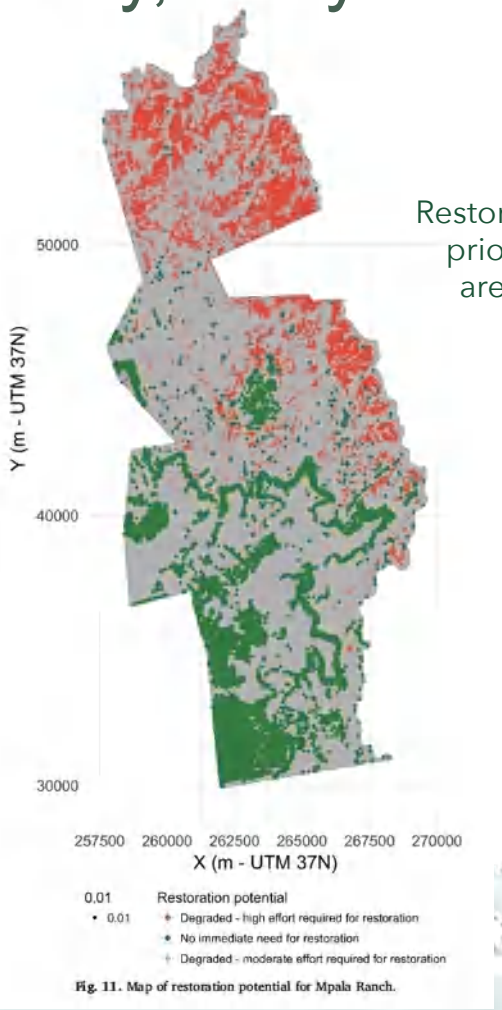


Fig. 11. Map of restoration potential for Mpala Ranch.

https://theconversation.com/lessons-from-kenya-on-how-to-restore-degraded-land-98178

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Winowiecki, LA., Vågen, T-G., Kinnaird, MF, TG. O'Brien. 2018. Application of systematic monitoring and mapping techniques: Assessing land restoration potential in semi-arid lands of Kenya. Geoderma. https://www.sciencedirect.com/science/article/pii/S001670611830510X

Regreening Africa App can be downloaded free from the Google Play Store: https://play.google.com/store/apps/details?id=org.icraf.regreeningafrica

More information here: https://regreeningafrica.org/in-the-news/the-regreening-africa-app/

THE REGREENING AFRICA APP

Regreening Africa | CIFOR | World Agroforestry

Features of the Regreening Africa App

TREE PLANTING MODULE

- Record details of farmers and regreened plot
- Chatacterise species composition and assess tree planting practices
- Track tree growth
- Field boundary recorded
- Number of trees planted
- Date(s) planted
- Location of trees planted
- Survival of trees

NURSERY MODULE

- Ensuring that farmers have access to quality planting materials and a wide range of species for tree planting
- Record nursery information and location
- Record nursery practices
- Record nursery production

FARMER MANAGED NATURAL REGENERATION (FMNR) MODULE

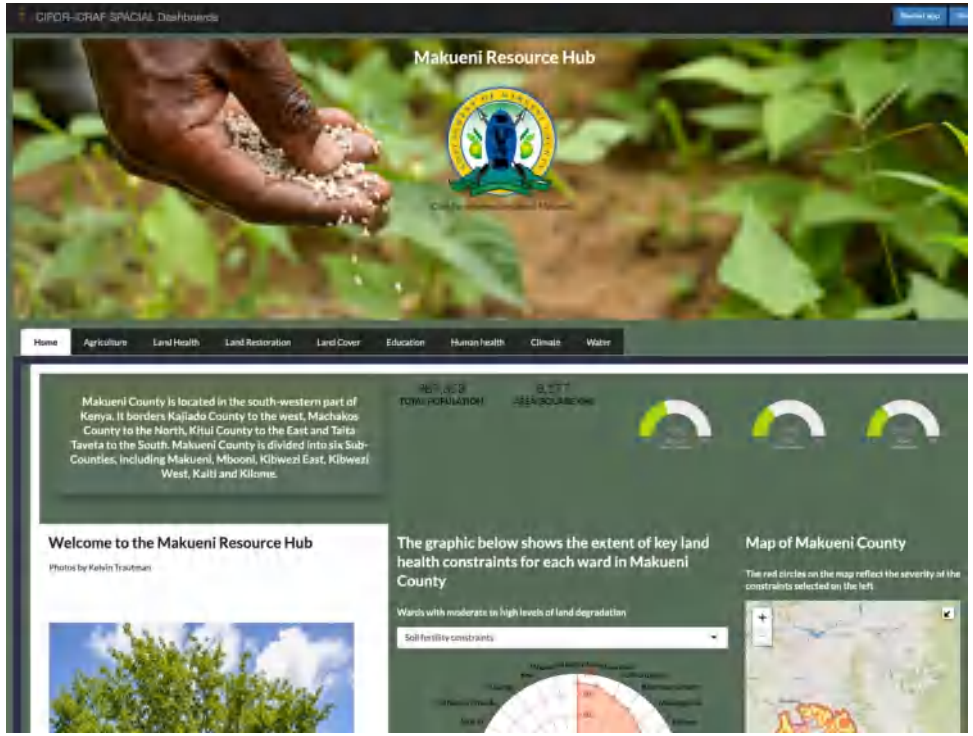
- Record details of farmers and regreened plots
- Characterise dominant species composition
- Assess FMNR practices

TRAINING MODULE

- Record training details
- Record gender participation in training sessions

Online Dashboards to explore and visualize these data: Kenya

- Makueni County Resource Hub: https://dashboards.icraf.org/app/makueni_resource_hub



- These LDSF and App data are combined into one online dashboard for Regreening Africa: https://dashboards.icraf.org/app/ra_dashboard

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Translating Science into action to accelerate impact on the ground: Stories of Transformation

Mongabay Series: Global Agroforestry

Farmers regreen Kenya's drylands with agroforestry and an app

by David Njagi on 26 August 2021

- *In Kenya, less than 20% of farmland is suitable for crops due to inadequate rains and degraded soils, and many farmers have seen their land produce less to the point of needing food aid.*
- *Dried-out soils create a hard pan that rains and roots can't penetrate, but in Kenya, more than 35,000 farmers have joined the Drylands Development Programme to regreen their lands with agroforestry, joining peers in Burkina Faso, Ethiopia, Mali and Niger.*
- *By planting annual crops among useful trees like mango, orange and neem, vegetables and animal forage crops receive enough cooling shade and moisture for them to take hold out of the scorching sun.*
- *As each farmer learns what combination of crops and trees works for them, the results are rapidly shared with researchers and fellow farmers through an app, speeding the rate at which all the program participants can benefit from the knowledge.*

https://news.mongabay.com/2021/08/farmers-regreen-kenyas-drylands-with-agroforestry-and-an-app/

https://www.cifor-icraf.org/restoration-for-resilience/dryland/

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UK PACT
GREEN RECOVERY CHALLENGE FUND

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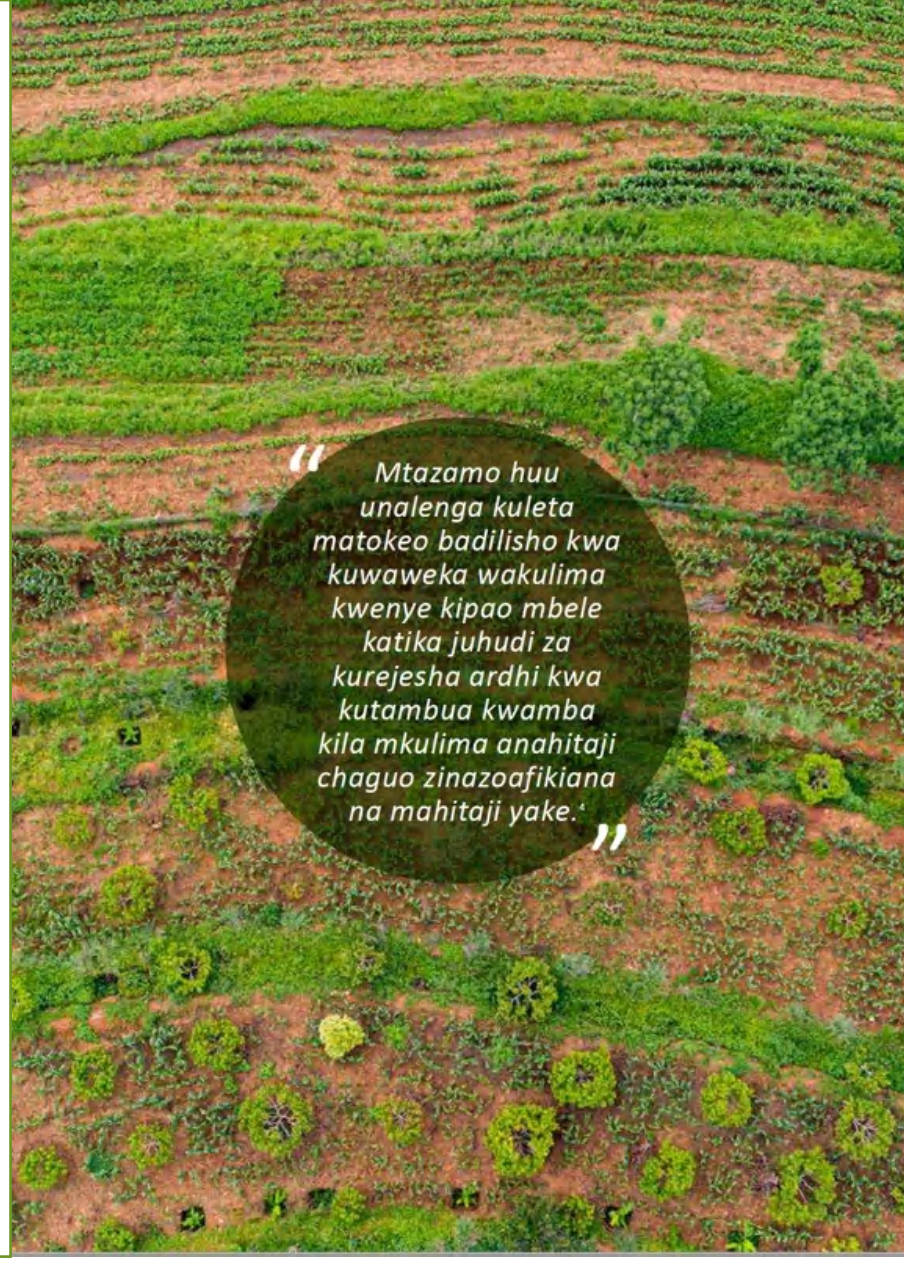
Kusaidia ubunifu wa mkulima katika urejesho

Mwongozo wa hatua tano kwa kutumia mtazamo wa chaguo za kimuktadha katika urejeshaji wa ardhi



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Kenyan farmers adopt new agroforestry strategies through research in development program

Soil-water conservation measures, farmyard manure composting, tree planting, farmer managed natural regeneration (FMNR)

https://forestsnews.cifor.org/65934/kenyan-farmers-adopt-new-agroforestry-strategies-through-research-and-development-program?fnl=en

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Gender Transformative Approaches to scale On-farm Innovations

Agroforestry 'basins' stir up big benefits for women in Kenya drylands

Gender dynamics blend with new farming methods in restoration project

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JULIE MOLLINS
@jmollins

Monday 4 May 2020

Shares 140

Photo credit: Kelvin Trautman

https://forestsnews.cifor.org/65320/agroforestry-basins-stir-up-big-benefits-for-women-in-kenya-drylands?fnl=en

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CA4SH Update

CA4SH
COALITION OF ACTION 4 SOIL HEALTH

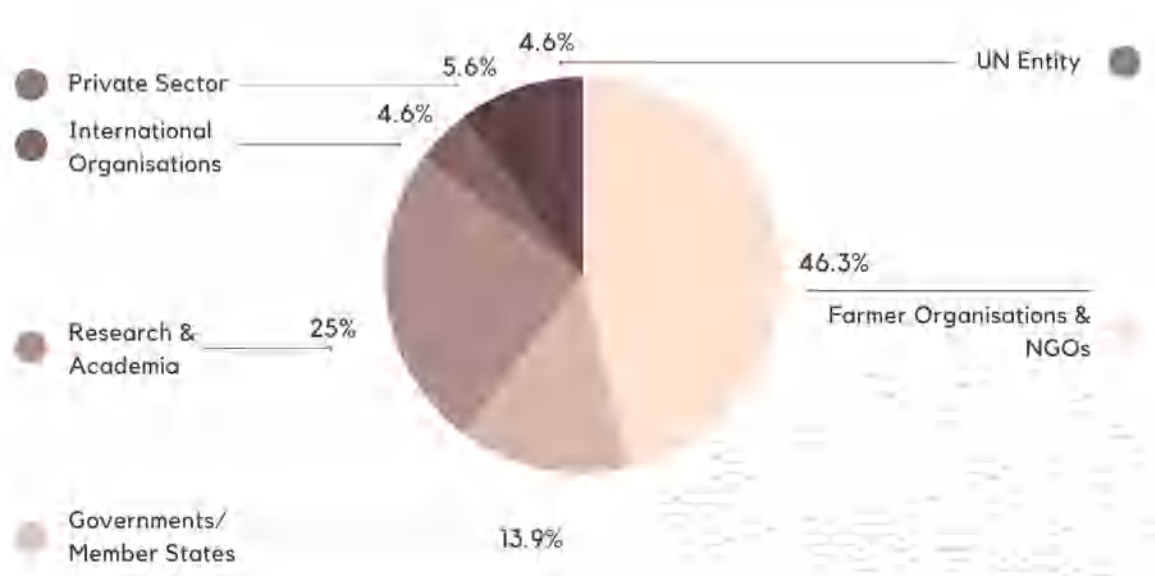
The main objective of the Coalition of Action 4 Soil Health (CA4SH) is to improve soil health globally by addressing critical implementation, monitoring, policy, and investment barriers that constrain farmers from adopting and scaling healthy soil practices

The goals of the Coalition include:

- **Integrate soil health considerations in policy** across the development, environment, and climate change domains, and along value chains.
- **Expand on research in development** into soil health practices, monitoring and evaluation, and financial tools and mechanisms.
- Significantly **increase** the number of hectares of **land under improved practices for soil health**.
- Significantly increase investments in soil health, by a margin of 5-10 fold above current financing commitments.

CA4SH
COALITION OF ACTION 4 SOIL HEALTH

> 110 partners to date



CA4SH UPDATES

Monthly Newsletter

Engagement Survey

Flagship Initiatives

Collaboration Calls

WELCOME TO THE CA4SH AUGUST NEWSLETTER!

The United Nations Framework Convention on Climate Change (UNFCCC) made the VERY exciting announcement that the **COP27 in November** will include the first-ever Food Systems Pavillion.

So what does this momentous news mean for CA4SH?

We have been invited to **co-lead the Pavillion** where Day 5 will focus on ***Boosting soil health for nature-positive production*** and **how soil can advance food security and acts as the world's biggest terrestrial carbon**

UNCCD FOOD DAY: Seeds of Change for a Nature-Positive Future

The first-ever UNCCD Food Day was held on May 12th at the Rio Pavillion, and CA4SH was there with bells on.

The session titled "Healthy Soil for a Healthy Planet" set a focus on how to transform our food systems from the soil up, as soil represents the very foundation of our food system. Through panel discussions, presentations and a Q&A session, CA4SH delivered a call to action for investment in global soil health.

Read the article

Sustainable soil movement grows at COP15 on land desertification and drought

Website: https://www.coalitionforsoilhealth.org/

Twitter @ca4sh_global

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COALITION OF ACTION 4 SOIL HEALTH

FOOD SYSTEMS PAVILION
COP27 EGYPT 2022

COP27
SHARM EL-SHEIKH
EGYPT 2022

HIGH-LEVEL PLENARY SESSION ON THE NEED FOR A SOIL HEALTH RESOLUTION

Friday 11 Nov 2022 | 13:00-14:00 | UTC+2

Food Systems Pavilion: Accelerating
#ActionOnFood for People and Planet

SOIL HEALTH RESOLUTION

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Therefore, the undersigned parties:

01 **RECOGNIZE** that soils are the basis of life and soil health[2] is the foundation of sustainable and regenerative food systems and food and nutrition security, and for improving livelihoods and supporting economic development;

02 **AFFIRM** that agricultural systems are part of the climate solution, through large-scale adoption of sustainable soil and land management practices that benefit nature and people;

https://www.coalitionforsoilhealth.org/soil-resolution

[2] Soil health is "the ability of the soil to sustain the productivity, diversity, and environmental services of terrestrial ecosystems" (ITPS, FAO 2020).

[2] https://stats.oecd.org/glossary/detail.asp?ID=81

03 **STRESS** the importance of aligning UN Conventions for climate change, biodiversity, combating degradation to synergize organization efforts and accelerate action on the ground;

Convention on Biological Diversity

United Nations Convention to Combat Desertification

United Nations Framework Convention on Climate Change

04 **CONSIDER** the critical role of increased soil health to achieve the objectives of the UN Decade of Ecosystem Restoration;

05 **REAFFIRM** the need for further international action and cooperation to revert current soil degradation processes.

CA4SH COALITION OF ACTION 4 SOIL HEALTH

NEXT STEPS FOR REALIZING THE SOIL HEALTH RESOLUTON

Raise awareness about the need for such a Soil Health Resolution Sign up to contribute to taking the it forward: https://www.coalitionforsoilhealth.org/soil-resolution

Read and share the draft Soil Health Resolution with member states to support an official process for COP28

Everyone has a role to play for protecting and conserving our soil ecosystems- let's work together to make this happen

Reach out to contribute to bringing the Soil Health Resolution forward together:

https://www.coalitionforsoilhealth.org/soil-resolution

Email: coordination@coalitionforsoilhealth.org

Email: L.A.Winowiecki@cifor-icraf.org

https://www.coalitionforsoilhealth.org/news/soil-health-resolution-high-level-plenary-at-unfccc-cop27-ca4sh-partners-gather-to-mobilise-soil-advocates-across-sectors

Thank you!

Contact:

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foreststreesagroforestry.org | globallandscapesforum.org | resilientlandscapes.org

The Center for International Forestry Research (CIFOR) and World Agroforestry (ICRAF) envision a more equitable world where forestry and landscapes enhance the environment and well-being for all. CIFOR-ICRAF are CGIAR Research Centers.

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European Union KCEP-CRAL KENYA CEREAL ENHANCEMENT PROGRAMME - CLIMATE RESILIANT AGRICULTURAL LIVELIHOOD(WINDOW)

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