

# Has pasture already peaked in 2000?

Steffen Fritz, Myroslava Lesiv, Linda See, Steve Stehman, Leandro Parente, Ivelina Georgieva, Lindsey Sloat, Ana Paula Matos e Silva, Nathalia Monteiro Teles, Vinicius Mesquita, Laerte Guimares Ferreira, Luis Baumann, Ichsani Wheeler



# Has grassland truly peaked in 2000?

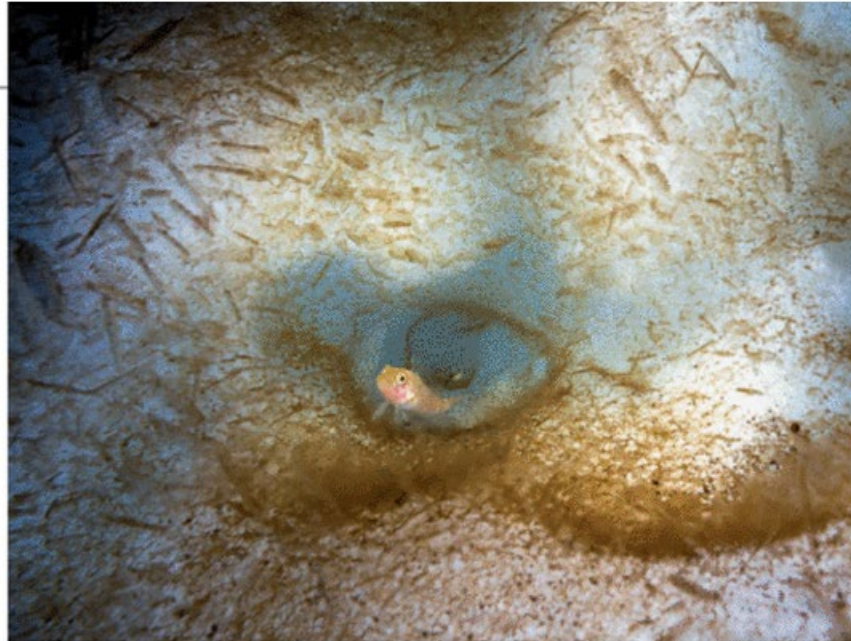
INSIGHTS

## LETTERS

Edited by Jennifer Sills

### ***Call for conservation: Abandoned pasture***

THE STATISTICS DIVISION of the Food and Agriculture Organization (FAO) has recently released its national land distribution data for the year 2013 (1), which is currently the only annual cross-country time series on agricultural land use. According to these data, over the past 15 years, total global pasture area has declined by 62 million hectares (-2%), the first significant decrease on record. In the 65 countries where pasture has shrunk, only 15 have shown an increase in total agricultural land, and across all 65, total agricultural area declined by 109 million hectares. This implies that pasture land



Evidence indicates that the Antarctic *Pagothenia borchgrevinki* can adapt to a range of temperatures.

conservationists need to move quickly, as | their usual  $-1.8^{\circ}\text{C}$ . Similarly, the Arctic cod

# Has grassland truly peaked in 2000?



BBC

Home News Sport Business Technology Health Culture Arts Travel Earth Audio Video Live

## The rewilding milestone Earth has already passed

10 September 2025

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Joseph Poore, Hannah Ritchie and Charles Godfray



However, according to the UN's Food and Agriculture Organization (FAO), global agricultural land use peaked in the early 2000s and has been

**ACHIEVING PEAK PASTURE**  
SHRINKING PASTURE'S FOOTPRINT BY SPREADING THE LIVESTOCK REVOLUTION

DAN BLAUSTEIN-REJTO, LINUS BLOMQVIST, JAMES MCNAMARA, AND KENTON DE KIRBY

THE BREAKTHROUGH INSTITUTE

The infographic is split into two vertical panels. The left panel shows a brown cow in the foreground with a mountain range in the background. An orange line graph is overlaid on the sky, showing a peak around 2000. The right panel shows a map of the world with a dashed black line graph overlaid, also showing a peak around 2000. The text 'ACHIEVING PEAK PASTURE' is at the top, and 'SHRINKING PASTURE'S FOOTPRINT BY SPREADING THE LIVESTOCK REVOLUTION' is in a black box below it. At the bottom left, the authors' names are listed, and at the bottom right is the logo for 'THE BREAKTHROUGH INSTITUTE'.



HOME > SCIENCE > VOL. 391, NO. 6781 > NATURAL GRASSLANDS USED FOR GRAZING LIVESTOCK CAN MITIGATE CLIMATE CHANGE

EXPERT VOICES



# Natural grasslands used for grazing livestock can mitigate climate change

VALÉRIO D. PILLAR AND BRUNA R. WINCK [Authors Info & Affiliations](#)

SCIENCE • 8 Jan 2026 • Vol 391, Issue 6781 • DOI: 10.1126/science.aaa8344

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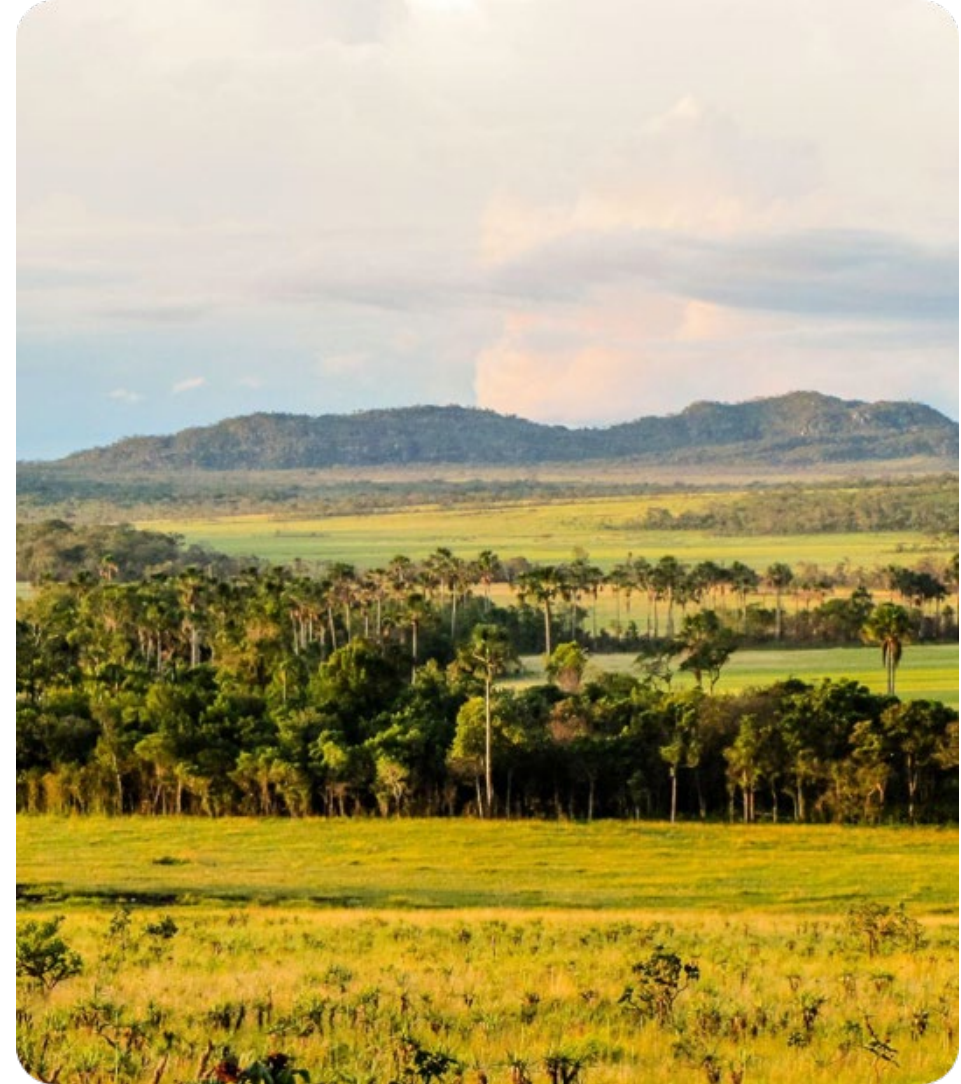
Natural grasslands cover about **40%** of the Earth's land surface. Grassland plants have largely **coevolved** with wild grazing animals, making these ecosystems generally **well-adapted to grazing** livestock. Evidence shows that when grazing is properly managed — such as avoiding soil tillage, excessive grazing intensity, and high nitrogen fertilizer inputs — grasslands can function as **net carbon sinks**, even after accounting for **methane emissions** from livestock. If parts of this vast grassland area are managed

## CURRENT ISSUE



# Importance of grassland mapping

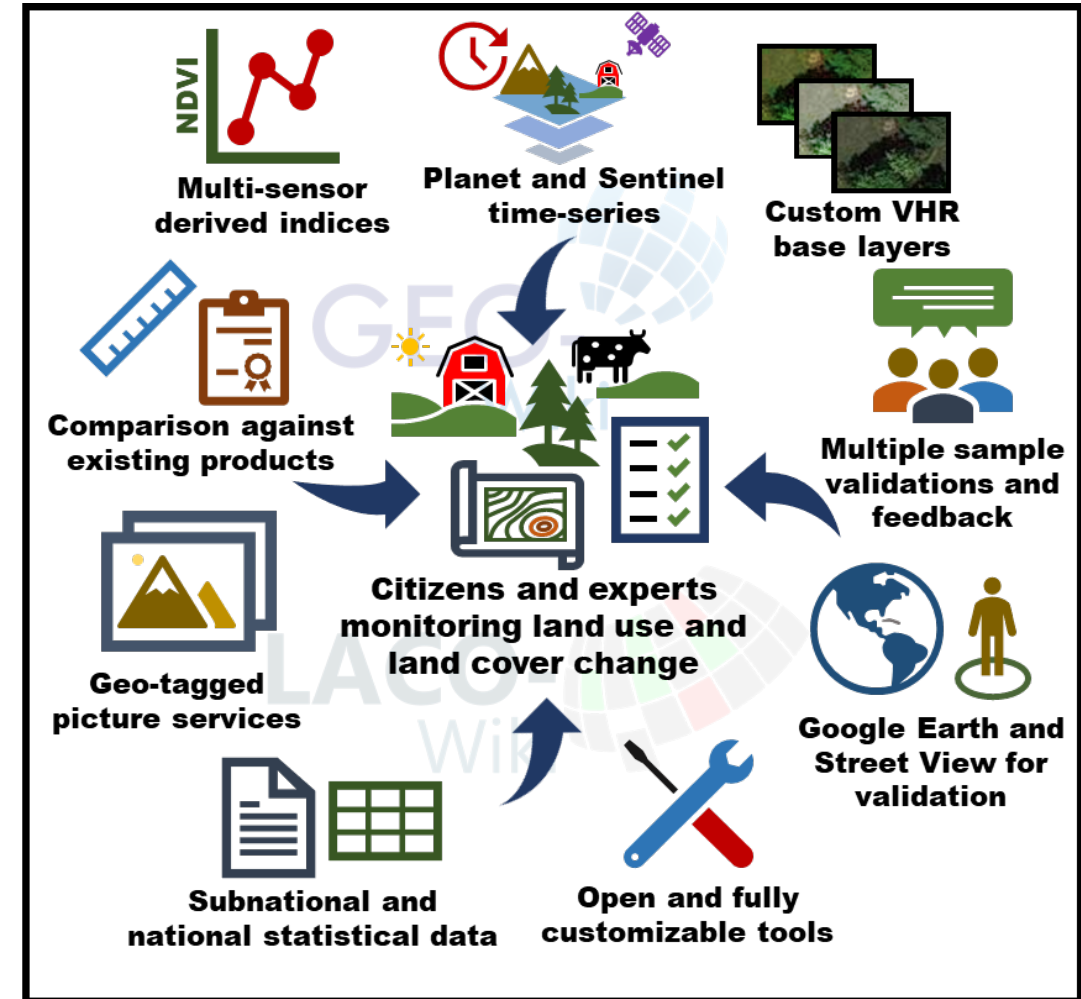
- Pastures and rangelands are the most extensive land use on Earth
- Significant lack of accurate and spatially explicit data
- Global Pasture Watch project produced the first ever grasslands time series maps 2000-2023
- Independent validation is critical



# IIASA's experience in Validation and Reference data collection

- Provided Geo-wiki validation tool for C-CLOPS – Global Copernicus Land Product 2015 – 2019
- Collected 160 K unique locations for Training data of Copernicus Land
- Validated Forest Management Layer: Lesiv et. al, 2019 Nature Sc. Data
- Validated World Cereal Product 50 K Validations
- Validated Corine European Land Cover Change Maps from 1990 (In Prep)
- Run several geo-wiki campaigns with altogether more than 1 Mio reference points

# Geo-Wiki toolbox



# Statistical validation

- Probability sampling
- Design-based interface
- Reality of study area mapped
- High quality validation data set
- Documentation:
  - Annotation protocol
  - Uncertainties related to the validation data set




Remote Sensing of Environment

Volume 231, 15 September 2019, 111199



## Key issues in rigorous accuracy assessment of land cover products

[Stephen V. Stehman](#)<sup>a</sup>  , [Giles M. Foody](#)<sup>b</sup> 

[Show more](#) 






Remote Sensing of Environment

Volume 148, 25 May 2014, Pages 42-57



Review

## Good practices for estimating area and assessing accuracy of land change

[Pontus Olofsson](#)<sup>a</sup>   , [Giles M. Foody](#)<sup>b</sup>, [Martin Herold](#)<sup>c</sup>, [Stephen V. Stehman](#)<sup>d</sup>, [Curtis E. Woodcock](#)<sup>a</sup>, [Michael A. Wulder](#)<sup>e</sup>

Tyukavina, A., Bontemps, S., Foody, G., Stehman, S. V., See, L., Olofsson, P., ... Xiao, X. (2024). Land Cover and Change Map Accuracy Assessment and Area Estimation Good Practices Protocol. Version 0.1. In A. Tyukavina, S. Bontemps, G. Foody, S. V.

# Geo-Wiki design-based interface

## GLOBAL PASTURE WATCH VALIDATION DATA COLLECTION

Global Pasture Watch Validation

Homepage Myroslava Lesiv Logout

Biome: Tropical and subtropical grasslands, savannas and shrublands  
Eco-region: Cerrado  
Country: Brazil

Don't show any overlays  
Global Pasture Watch  
Geocoding  
Global Pasture Validation

Select tool:  
Transparency:  
Start validation  
Stop validation

point id: 2147064  
your submitted validations: 833  
point lat,lon: -14.3225113728, -50.7064602603  
Esri image date: Mon Sep 09 2024

Sample Set Progress:

Jump to point - point id:  
Jump to point  
View in Google Earth  
View in GEE

Grid aligned with the map

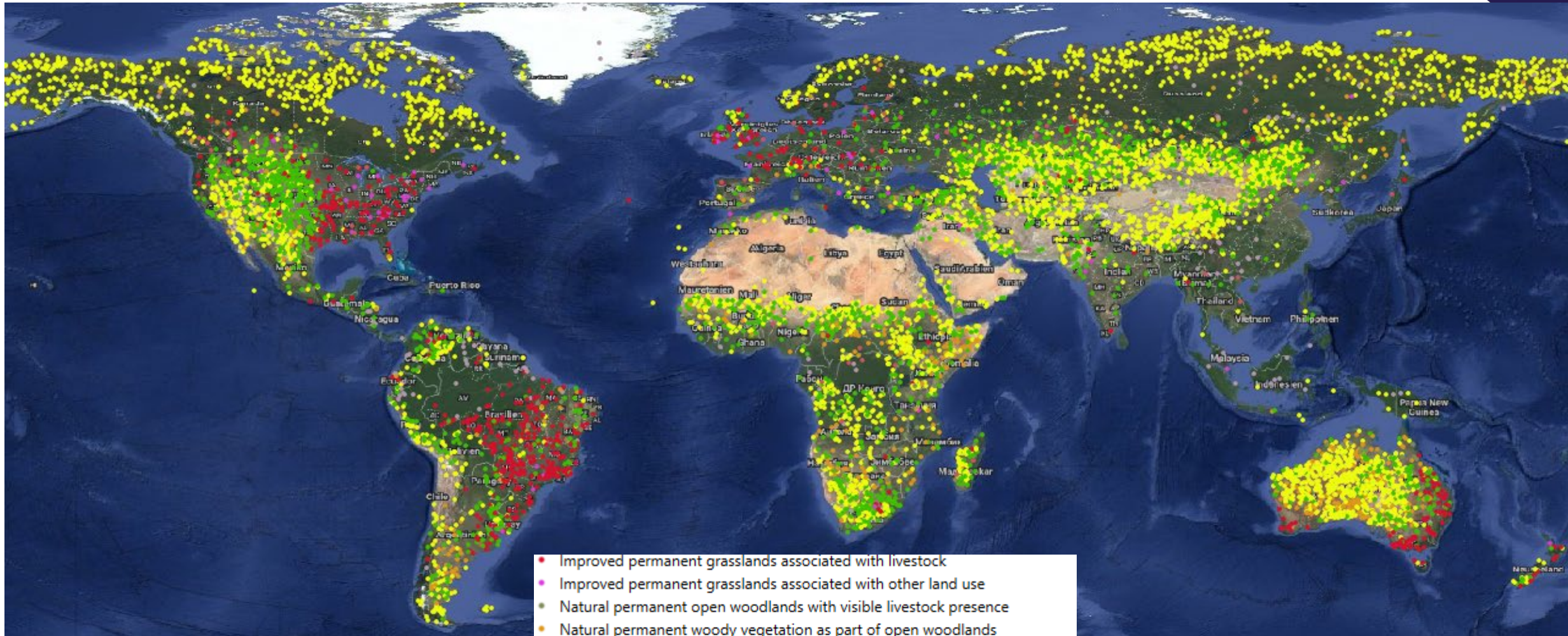
Natural/semi-natural permanent grasslands with no visible signs of livestock  
Natural permanent woody vegetation as part of open woodlands  
Semi-natural permanent grasslands with visible livestock presence  
Temporary grasslands associated with other land use  
Improved permanent grasslands associated with livestock  
Improved permanent grasslands associated with other land use  
Other land cover  
Not sure  
Natural permanent open woodlands with visible livestock presence

[clear pixel]

Any changes in grassland extent over 2000-2023 period?  
Yes  
No

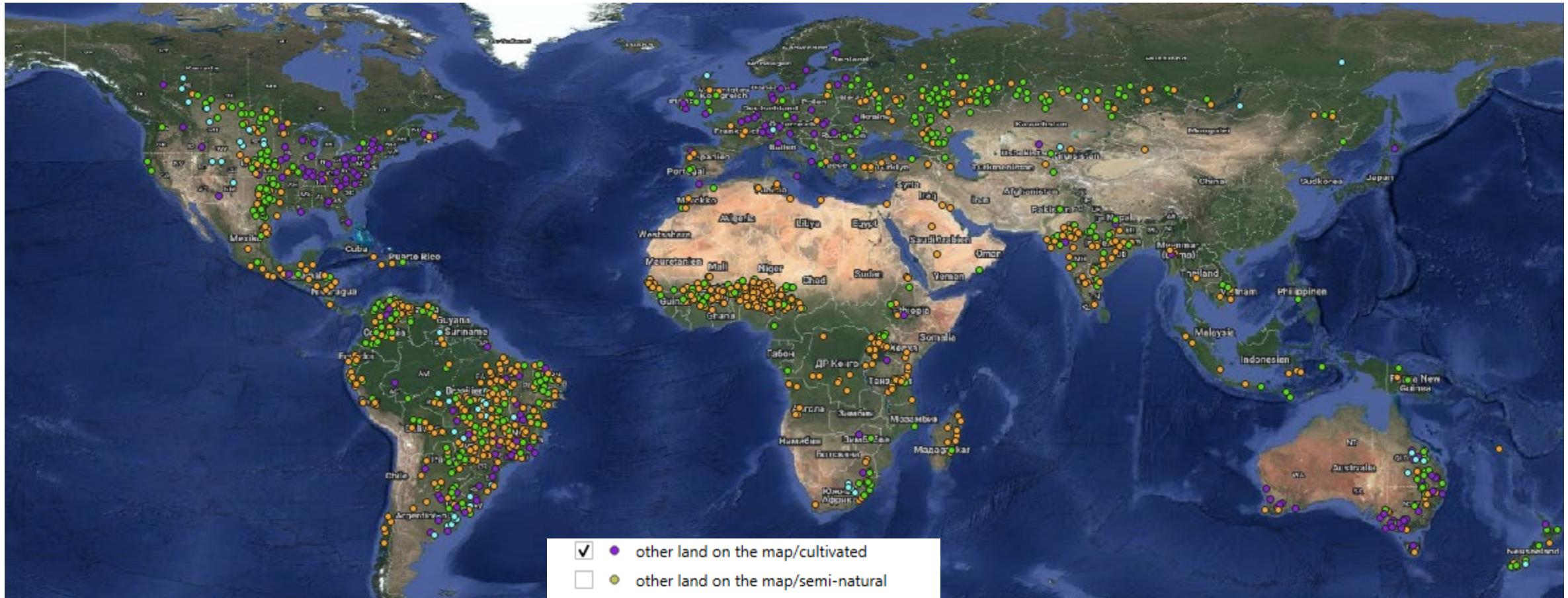
Comment:  
Submit Skip

# All Geo-Wiki classes



- Improved permanent grasslands associated with livestock
- Improved permanent grasslands associated with other land use
- Natural permanent open woodlands with visible livestock presence
- Natural permanent woody vegetation as part of open woodlands
- Natural/semi-natural permanent grasslands with no visible signs of livestock
- Not sure
- Other land cover
- Semi-natural permanent grasslands with visible livestock presence
- Temporary grasslands associated with other land use

# Cultivated disagreement with the map v11



# West Africa

Global Pasture Watch Feedback

Homepage

fritz



- 1 other land on the map/cultivated
- 10 cultivated on the map/other land
- 21 semi-natural on the map/cultivated
- 12 cultivated on the map/semi-natural



Don't show any overlays

Global Pasture Watch

- GPW 2020
- GPW 2020 vs C-GLOPS 2019
- GPW 2020 vs GLAD 2019
- GPW vs GLAD & CGLOPS comparison

Show legend Yes No

GPW Grassland Maps v2

Related Products

GPW change products

Training Samples

Comparison with the validation data set

- GPW 2020 V1
- GPW 2020 V2
- Validation data set( original classes)
- Cultivated disagreement V1 1
- Cultivated disagreement V2

Show legend Yes No

# South Africa

Global Pasture Watch Feedback

Don't show any overlays  
 Global Pasture Watch

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- GPW 2020 vs GLAD 2019
- GPW vs GLAD & CGLOPS comparison


Show legend **Yes** No

GPW Grassland Maps v2  
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**Comparison with the validation data set**

- GPW 2020 V1
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1 other land on the map/cultivated  
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 12 cultivated on the map/semi-natural



# Kasachstan

Global Pasture Watch Feedback

[Homepage](#)
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Don't show any overlays

Global Pasture Watch

- GPW 2020
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Show legend **Yes** No

GPW Grassland Maps v2

Related Products

GPW change products


Training Samples

Comparison with the validation data set

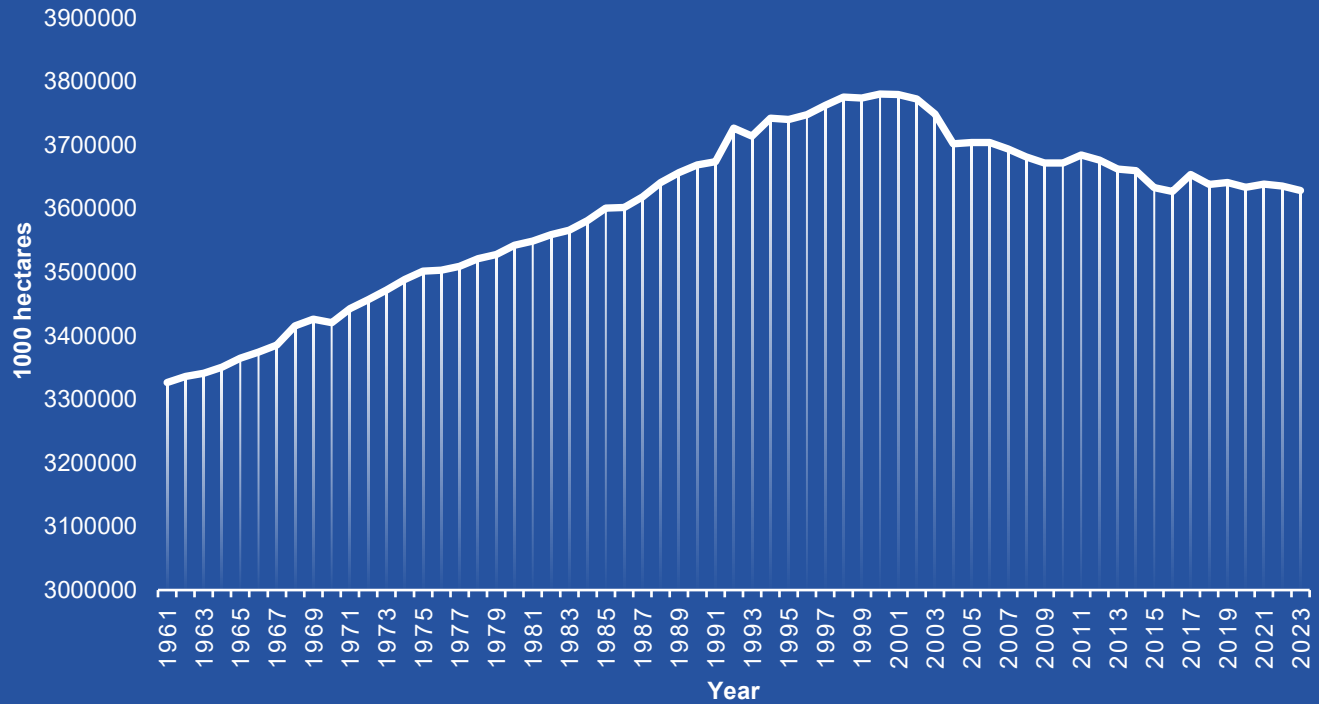
- GPW 2020 V1
- GPW 2020 V2
- Validation data set( original classes)
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- Cultivated disagreement V2

Show legend **Yes** No

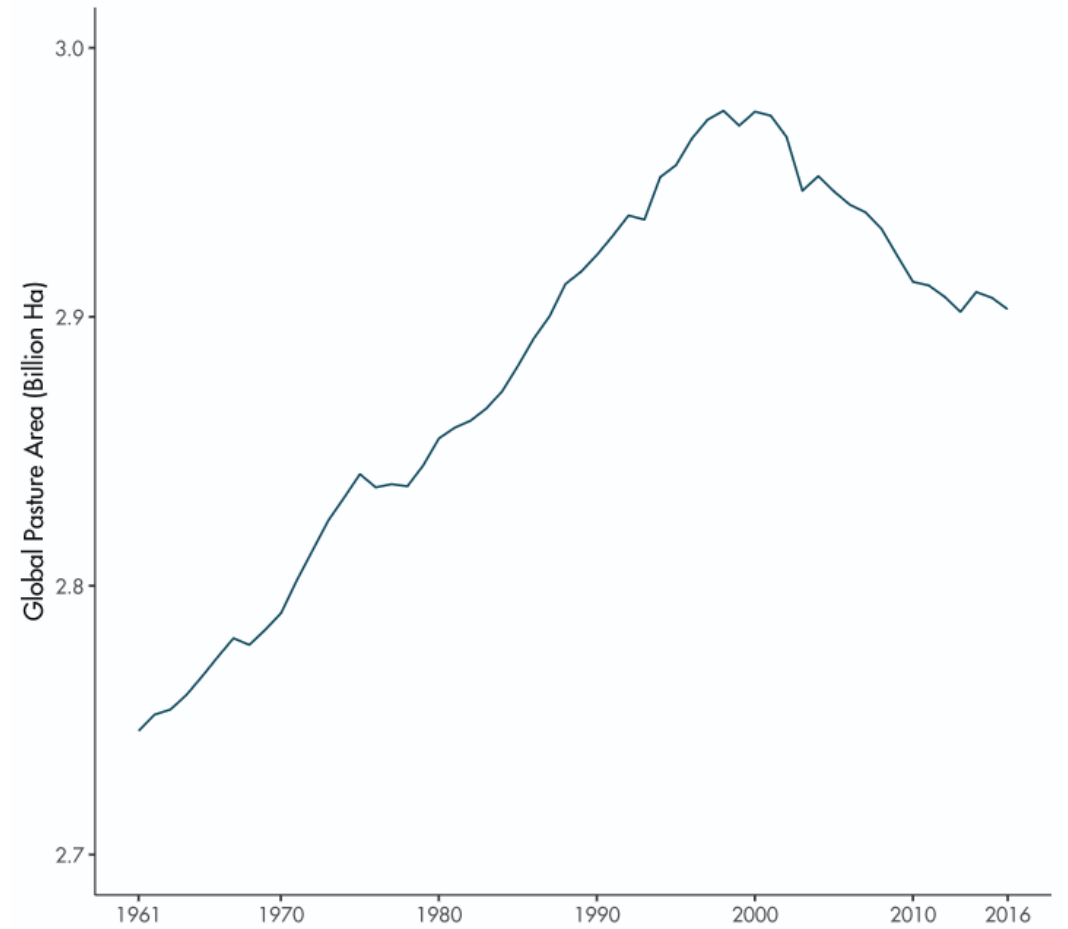
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- 12 cultivated on the map/semi-natural



# GLOBAL PASTURE & MEADOWS



Source FAO 2026



Source: FAO (2019).

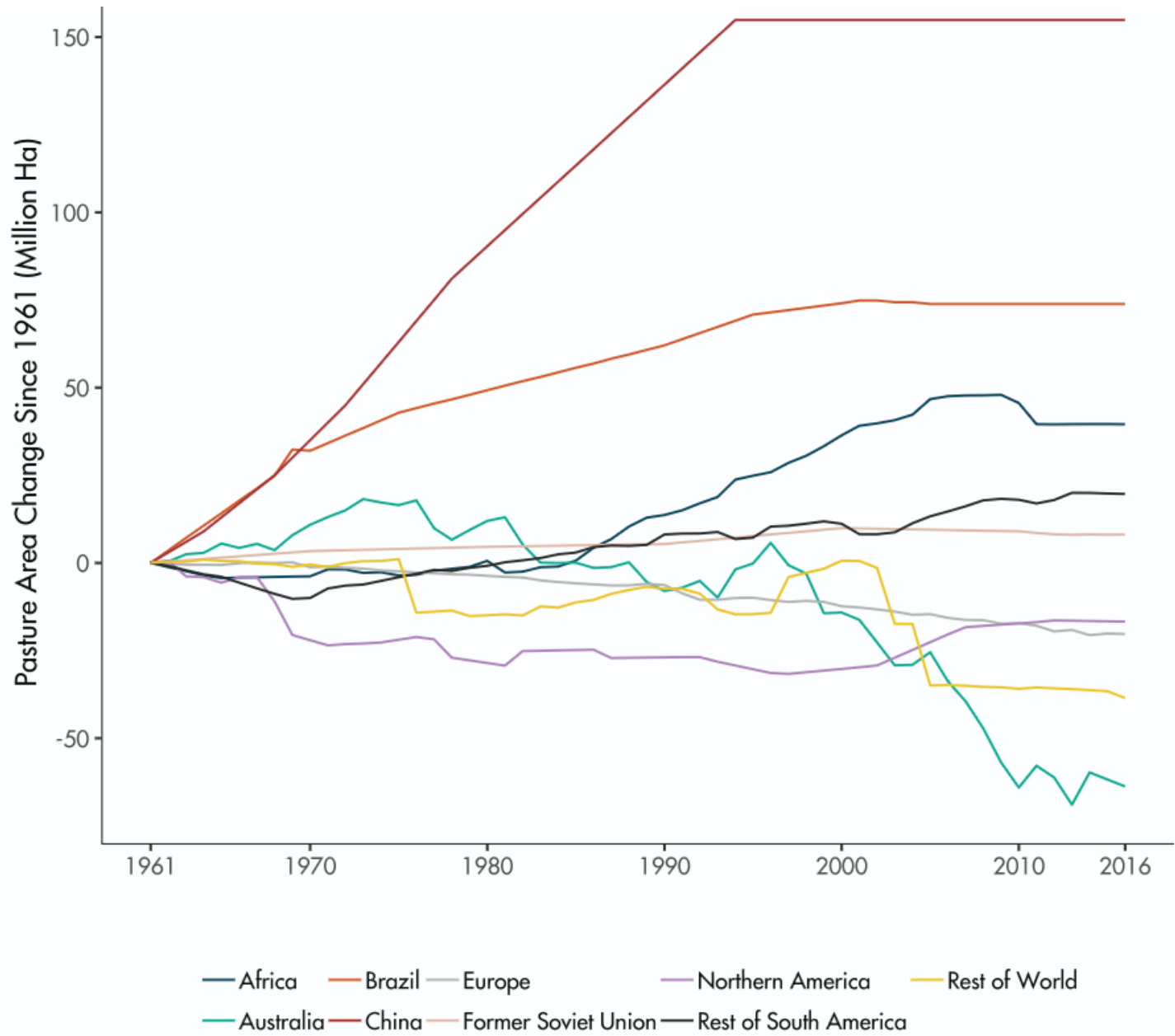
Source: Breakthrough Institute, Report on Peak Pasture

# Issues

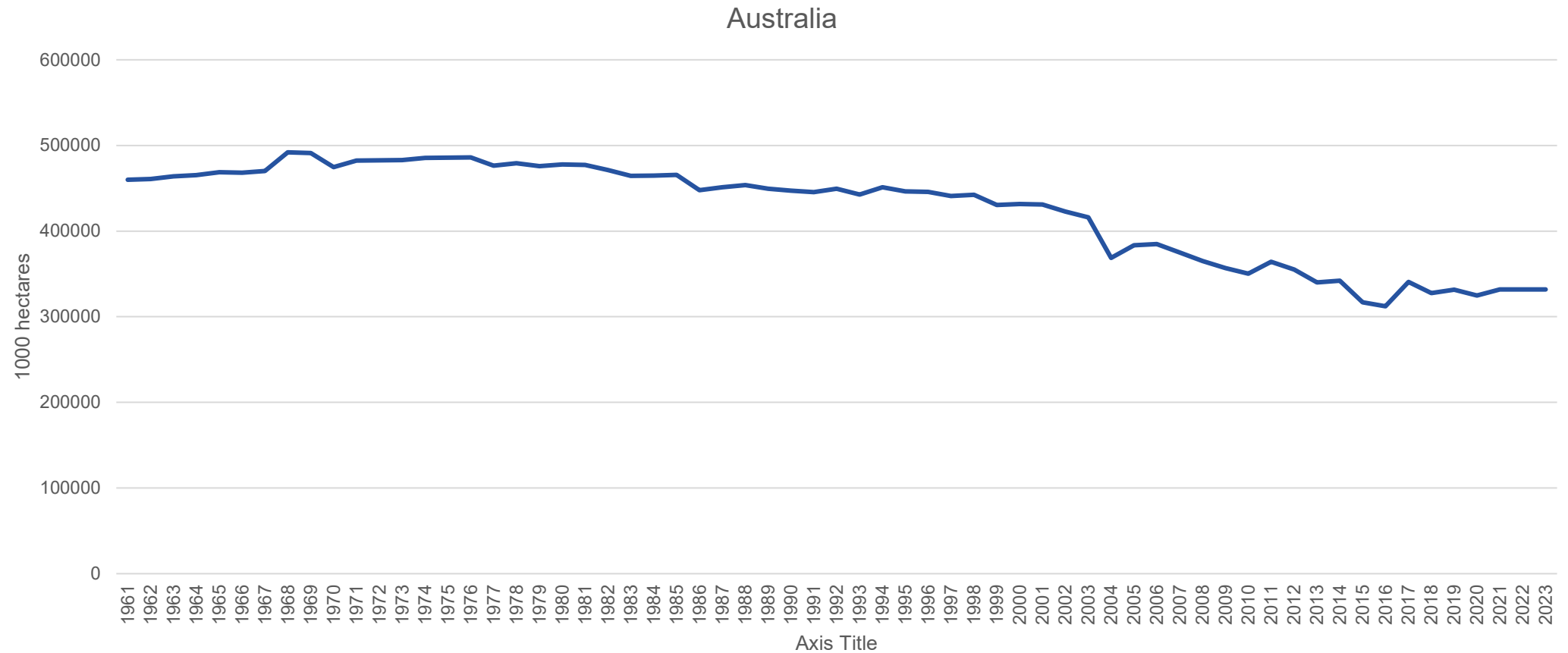
- Some countries start reporting Pastures and Meadows later in 1991/92 (e.g. Assabaijan, Belarus) in 2011 (Sudan), others stop reporting
- Countries change the definition or the way they measure Pasture: Argentina, Australia, Brazil, Chile, Iran, Mexico, Mongolia (Reclassification, changes in definition.
- Australia might have experienced the strongest effect of a change in definition, residual versus direct measurement

# Changes in definitions

<b>Country</b>	<b>Category</b>
<b>Argentina</b>	Reclassification
<b>Australia</b>	Reclassification + Definition changes
<b>Iran</b>	Definition changes
<b>Mexico</b>	Census / methodology updates
<b>Mongolia</b>	Reclassification



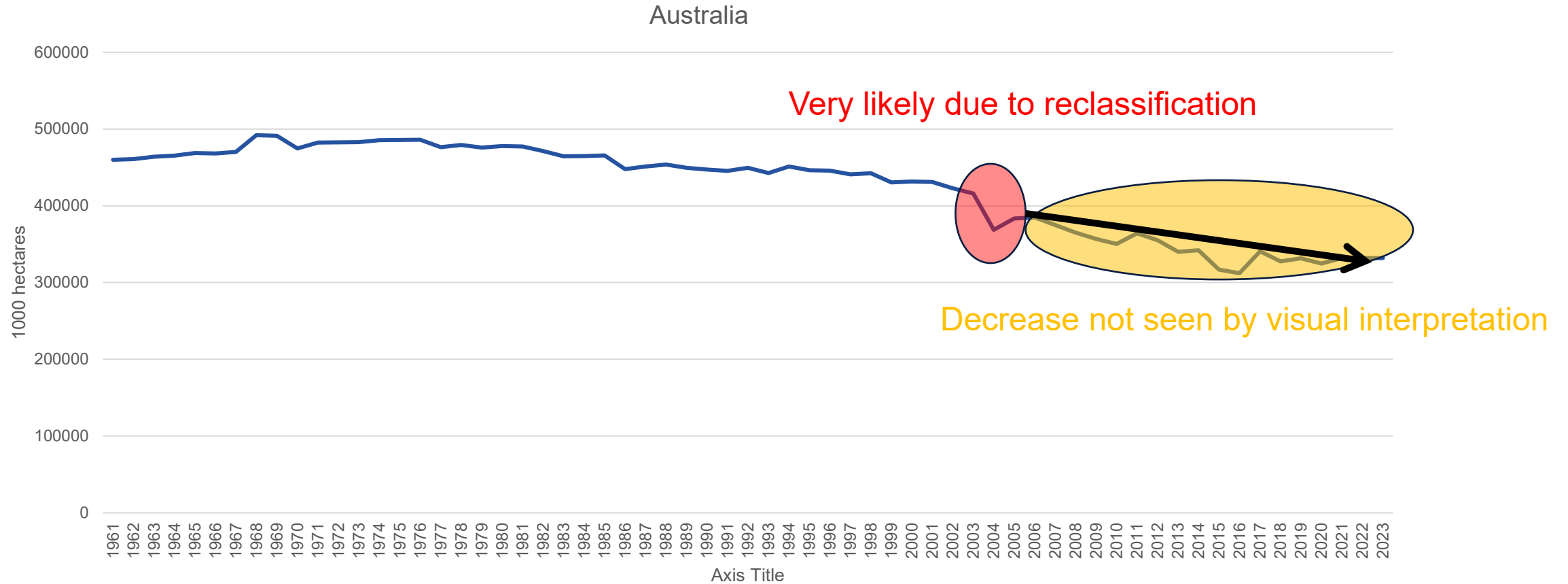
# Australia – changes 2003 – 2004 47 Million Hectares



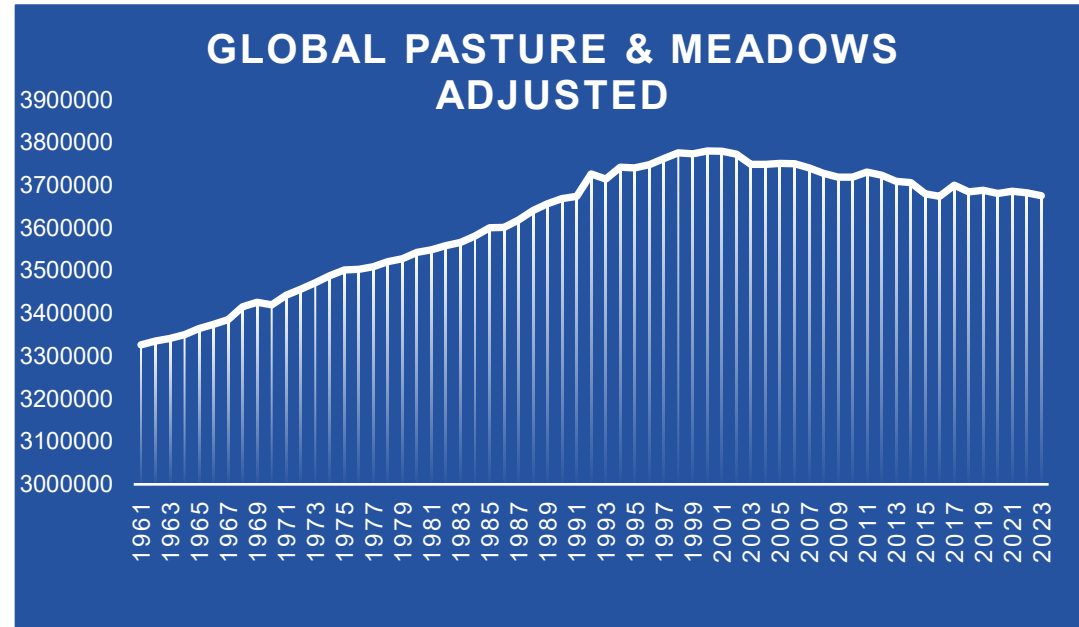
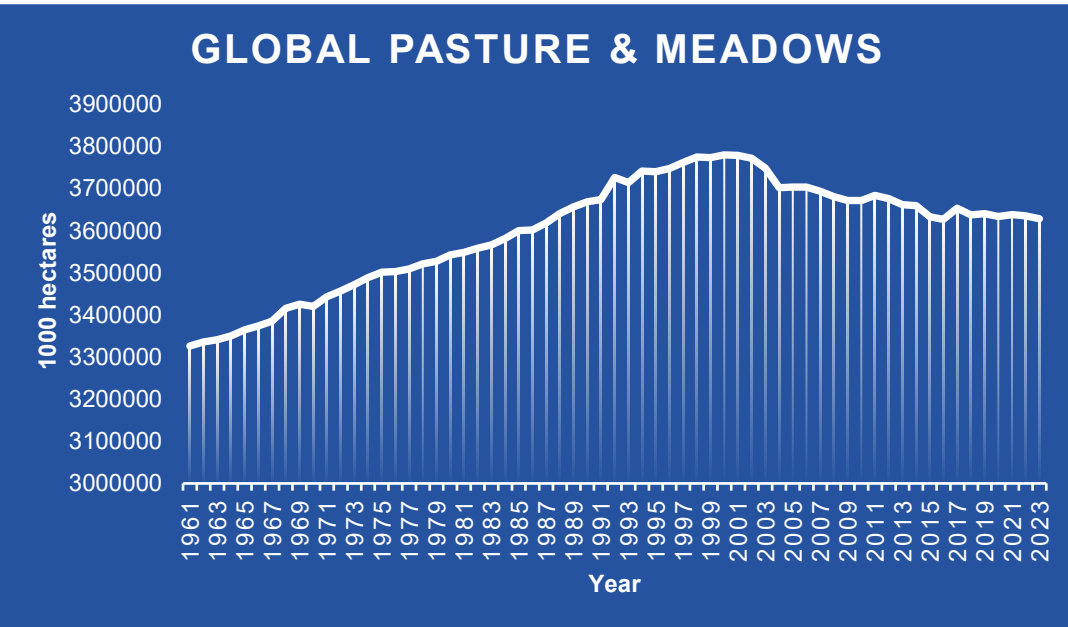
# Visual interpretation of samples

Summary stats in million hectares				
Period	Stable modified pasture, million ha	Stable native pasture	Loss	Gain
2000-2010	31,9	312,9	0,2	0,4
2010-2020	31,9	312,9	0,4	0,0
2020-2025	31,3	312,7	0,0	0,2

# Australia – changes 2003 – 2004 47 Million Hectares



# Definition adjusted global chart



Adjustments made due to definition/reallocation changes for Australia, Argentina, Iran, Mexico

Country	Category
Argentina	Reclassification
Australia	Reclassification + Definition changes
Iran	Definition changes
Mexico	Census / methodology updates
Mongolia	Reclassification



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Applied Systems Analysis

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## Description

Global annual grassland class and extent for 2000—2022 produced by [Parente et al. \(2024\)](#) within the scope of the [Global Pasture Watch initiative](#). The mapped grassland extent includes any land cover type, which contains at least **30% of dry or wet low vegetation**, dominated by grasses and forbs (less than 3 meters) and a:

- maximum of 50% tree canopy cover (greater than 5 meters),
- maximum of 70% of other woody vegetation (scrubs and open shrubland), and
- maximum of 50% active cropland cover in mosaic landscapes of cropland & other vegetation.

The grassland extent is classified into two classes:

- **Cultivated grassland:** Areas where grasses and other forage plants have been intentionally planted and managed, as well as areas of native grassland-type vegetation where they clearly exhibit active and 'heavy' management for specific human-directed uses, such as directed grazing of livestock.
- **Natural/semi-natural grassland:** Relatively undisturbed native grasslands/short-height vegetation, such as steppes and tundra, as well as areas that have experienced varying degrees of human activity in the past, which may contain a mix of native and introduced species due to historical land use and natural processes. In general, they exhibit natural-looking patterns of varied vegetation and clearly ordered hydrological relationships throughout the landscape.

The dataset is organized in 69 global mosaics (23 years for each time series) in COG (Cloud Optimized GeoTIFF) format, WGS84 Coordinate Systems (EPSG:4326) and pixel size equal to 0.00025 degrees, including: