GeoPard Agriculture

All-in-One Precision Ag Platform and API

Oct 2023

https://geopard.tech

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Automated Platform for Precision Agriculture

Satellite data
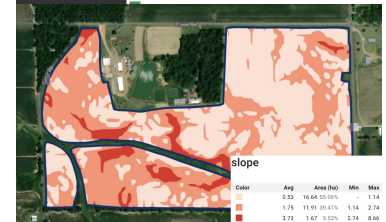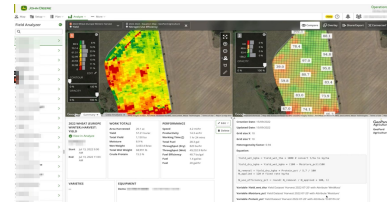- Multispectral: LANDSAT4-9, SENTINEL2, PLANET

Machinery data
- As-Applied datasets of fertilizing, sprayings
- As-Planted data
- Yield data: Grain moisture, Protein, Oil Content

High-density ground scanner data
- Electrical conductivity
- Soil moisture & Nutrients

Soil sampling data
- Laboratory analysis

Topography
- LIDAR
- ASTER, SRTM, Local country data
- Based on GPS data

Variable Rate Application maps for PrecisionAg
- fertilization
- desiccation
- seeding
- soil sampling
- crop protection

Equation Based Analytics
- Profit Maps
- Nutrient Use Efficiency
- Uptake Calculations
- Accuracy of As-Applied

Custom Analytics Pipelines

Scouting & Soil sampling recommendations

Benchmarking
- field heterogeneity
- field potential
- field current performance
- yield limiting factors

Integration with the John Deere Ops Center

Biodiversity & Regenerative Ag

API consumers
- Platforms and Services
- Mobile App
- Web Apps

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Agricultural Season with GeoPard

GeoPard helps to automate your agronomy workflows

- Season Planning
- Soil Sampling
- Fertilizing
- Seeding
- Crop protection/ Spraying
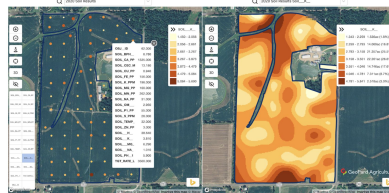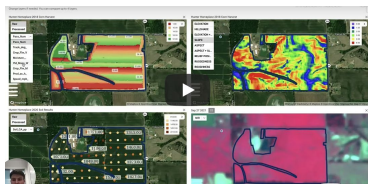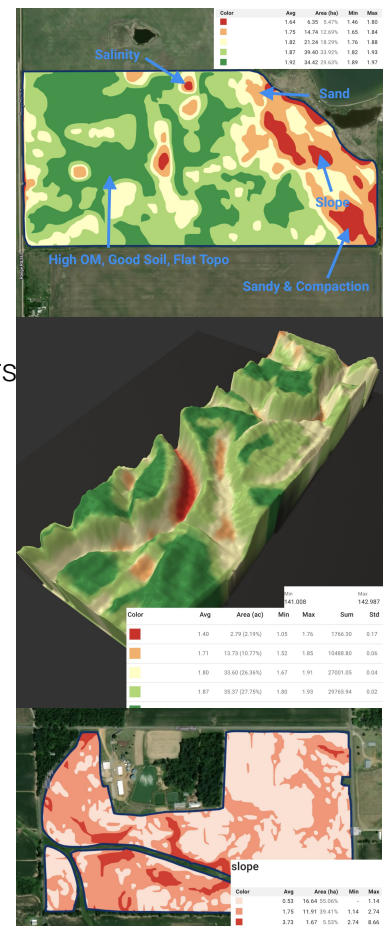- Desiccation
- Harvesting
- Post-harvest analysis

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How It Works

Automated powerhouse for sustainable and precision agriculture

- VR maps based on multiple data layers
- Flexible agronomic logic: apply any math/formula/equation to calculate recommendations
- Support of all common data types: satellite imagery, radar imagery, machinery data, scanners and sensors
- Automated solution for recommendations >> **Hyper-Automation of agronomy**
- Simple UX for fast manipulation with complex agricultural data
- Powerful API for integration into customer solutions and business processes
- Enabler for transition into Sustainability and Carbon efficient practices
- A.I. & Big Data
- Mobile apps with offline mode

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Demo & Documentation

https://docs.geopard.tech

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Team

Build solutions as one team for 10+ years in Precision Agriculture

2012	ZONER.AG precision agriculture platform	**2015**	BAYER · xarvio Digital Farming Solutions	**2019**	GeoPard
Co-founders of Zoner, acquired by Bayer in 2015		Technical Managers of Bayer Xarvio DF, acquired by BASF		Co-founders of GeoPard Agriculture	
Developed VRA maps engine widely used in the US, Canada, Europe		Mastered integration and developed foundation of Xarvio Field Manager, incl. GIS engine		**Automated decision support system and recommendations**	

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Variable Rate Use Cases

VR fungicide application

Data: Current vegetation & bare soil
Crop: Wheat

32% less crop protection applied
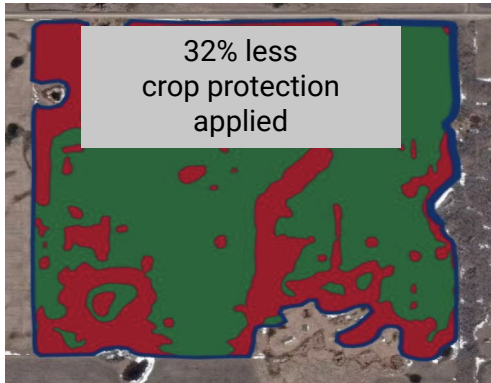
VR seeding

Data: Soil sampling (OM) & Topography & Last 15 years vegetation
Seeding rate: 60к-85к/ha
Crop: Corn

20% cost saving on ag inputs
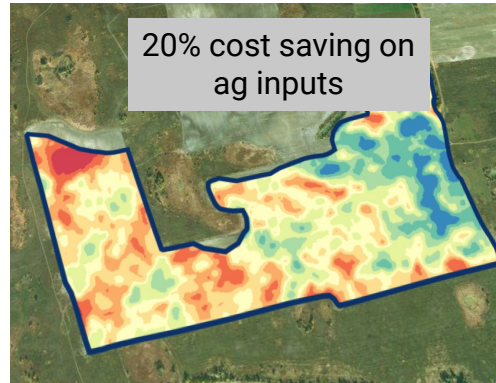
VR fertilizing

Data: ground scanners (SoilOptix, GeoProspectors, Electrical Conductivity), Topography, Historical vegetation
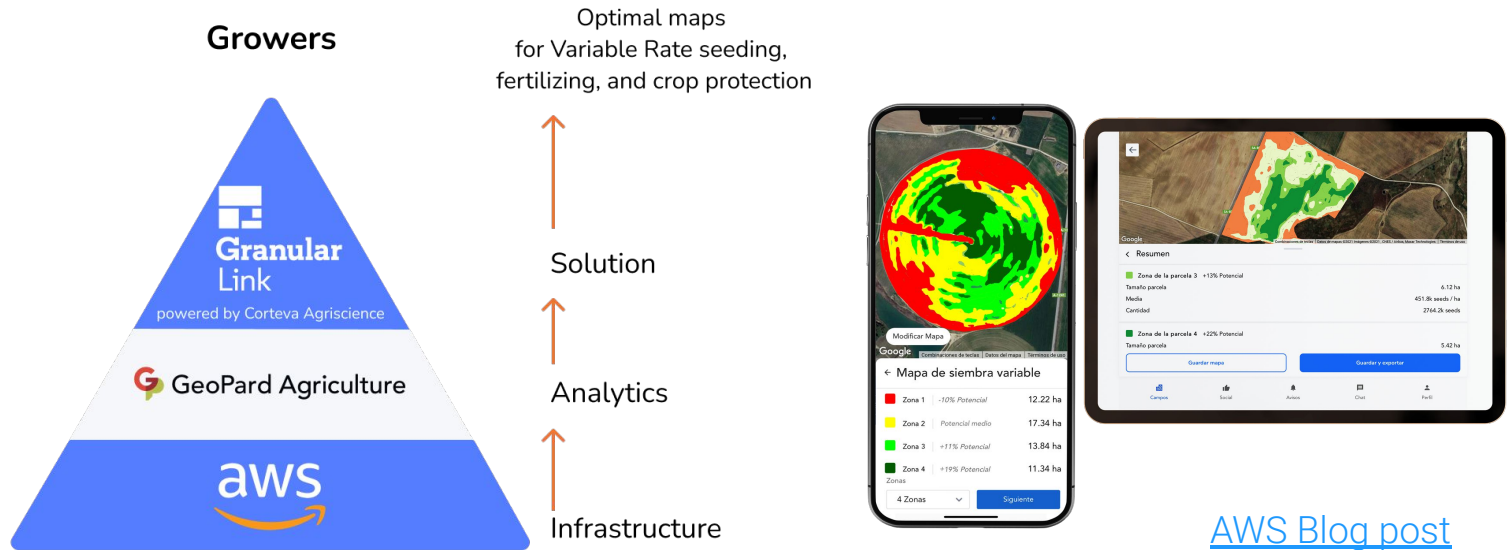Crop : Canola

30% less nitrogen applied

Color	Avg	Area (ac)		Min	Max
	23.36	29.76	18.57%	11.79	26.86
	30.25	27.92	17.43%	26.86	33.84
	37.69	37.66	23.50%	33.84	41.20
	45.17	49.74	31.05%	41.20	50.12
	54.63	12.94	8.08%	50.12	63.90
	71.99	1.64	1.02%	63.90	86.70
	96.02	0.56	0.35%	86.70	105.82

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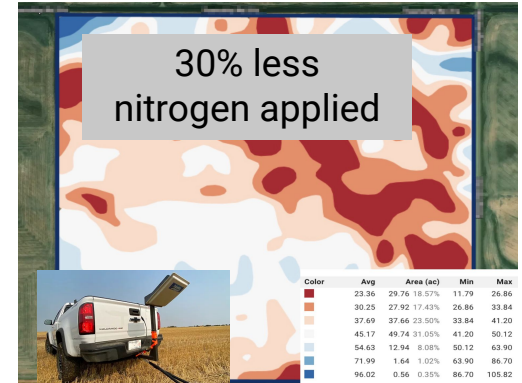
Corteva Use-case

WHO: Corteva Agriscience, Ag inputs manufacturer, USD 14.2B revenue, 21 000 employees.

SOLUTION: Automated Prescription maps via API

RESULTS: Launch Smart Farming commercial apps in EU countries in just 1 year

Growers

Optimal maps
for Variable Rate seeding,
fertilizing, and crop protection

Solution

Analytics

Infrastructure

AWS Blog post

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JohnDeere Ops Center Integration

Precision Farming Dealer: GeoPard Unveils Advanced Analytics Platform for Farmers & Dealers Using Deere Tech

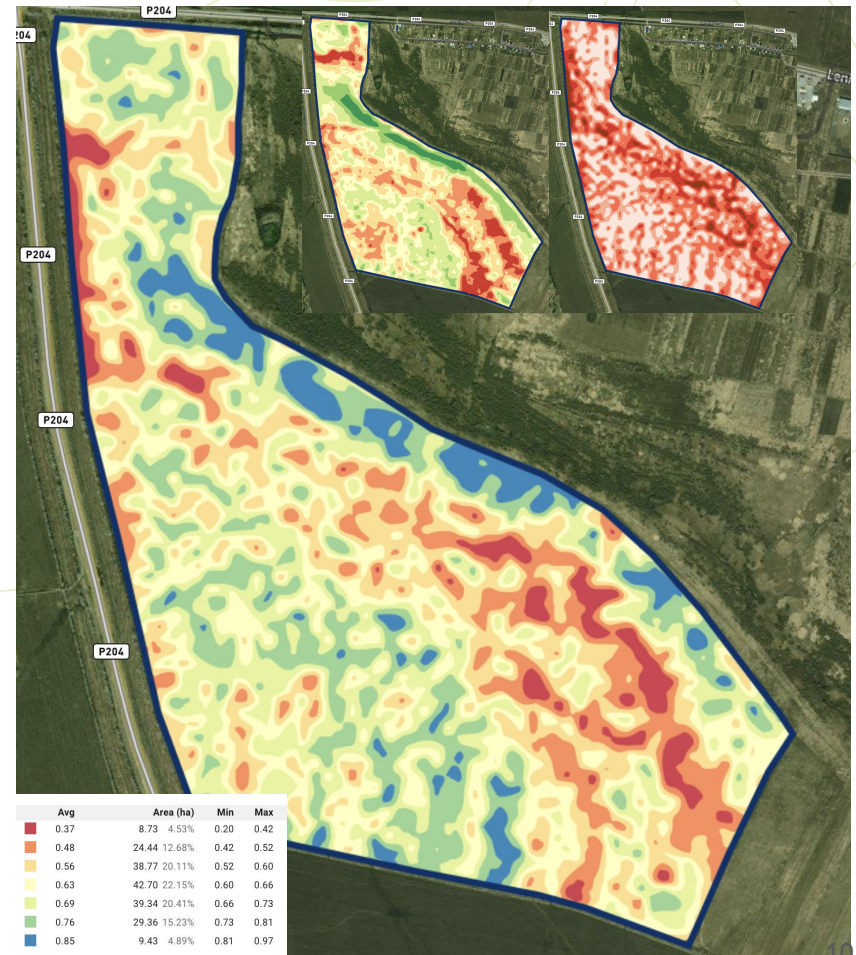Blog: Integration with MyJohnDeere Ops Center

Integration Overview and Tutorial

Multi-layer Maps

Delineation of management zones based on a combination of any data layers available in GeoPard with the flexibility to set a weight for each layer.

Example: 8 Years Historical Productivity (weight=1) and Slope (weight=-1)

Popular layers combinations:
- Satellite imagery (historical or in-season) and EC data
- Soil Sampling and Topography
- A mix of multiple vegetation indices

Avg	Area (ha)		Min	Max
0.37	8.73	4.53%	0.20	0.42
0.48	24.44	12.68%	0.42	0.52
0.56	38.77	20.11%	0.52	0.60
0.63	42.70	22.15%	0.60	0.66
0.69	39.34	20.41%	0.66	0.73
0.76	29.36	15.23%	0.73	0.81
0.85	9.43	4.89%	0.81	0.97

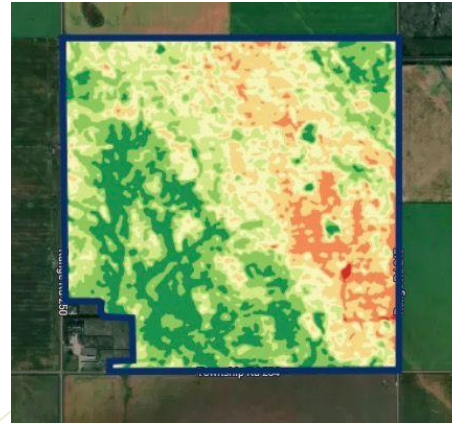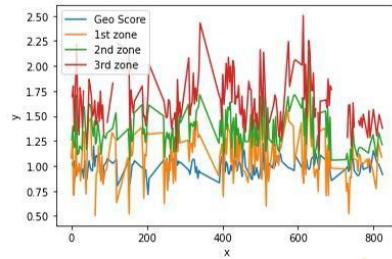GeoPard Agriculture
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Automated Field Potential Maps

Automated multi-year (up to 30 years and
the last 6 years stacked) field potential maps. Patented.

The heterogeneity index helps
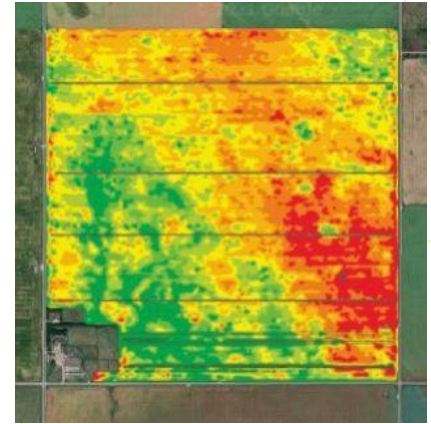benchmark fields and prioritise ag operations.
Blog: Multi-Year Zones
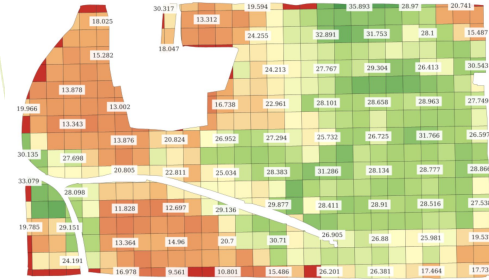Blog: Heterogeneity Factor

GeoPard Field Potential maps   **VS**   Yield data

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Equation based Analytics

- Integrate multiple data layers.
- Use GeoPard templates or customize your own.
- Calculate sub-field level ROI and economic efficiency.
- Integrated Variable Rate recommendations.
[Blog post with examples](#)

Tri-State: Indiana and Michigan Liming Rates for Organic Soils

📄 PDF Source

When the Target pH is 5.3 and the soil pH is < 5.3, then the LR = 37.6−(7.1 x soil pH).
When the Target pH is greater than 5.3 and the soil pH is < 5.3, then the LR = [37.6 x (7.1 x soil pH)] + [(target pH−5.3) x 5.0].
When the Target pH is greater than 5.3 and the soil pH is > 5.3, then the LR = [(target pH−soil pH) x 5.0]

Equation in Python

```
if targetpH == 5.3 and soilpH < 5.3:
    rerturn  37.6−(7.1 x soilpH)
elif targetpH > 5.3 and soilpH < 5.3:
    return  (37.6 * (7.1 * soilpH)) + ((targetpH−5.3) * 5.0)
elif targetpH > 5.3 and soilpH > 5.3:
    return  ((targetpH−soilpH) * 5.0)
else:
    return defaultLimeRate
```

Variables from datasets

targetpH

soilpH

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Nutrient Use Efficiency

Potassium Use Efficiency

Nitrogen Use Efficiency

… Your Formulas

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Nitrogen Use Efficiency
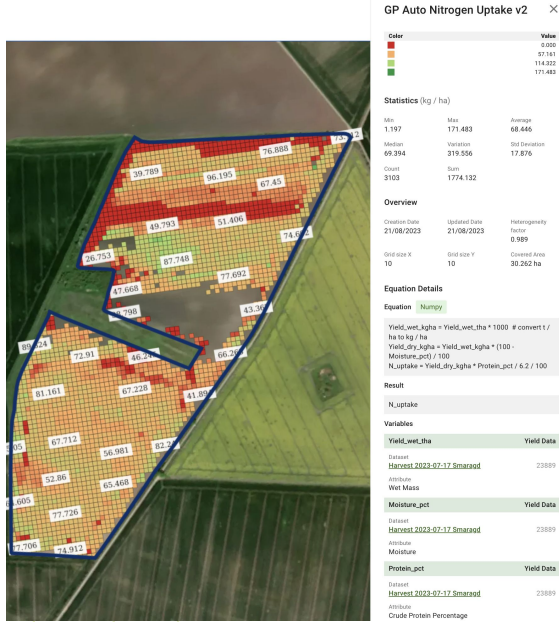
Nitrogen Uptake

Nitrogen Use Efficiency

Nitrogen Surplus

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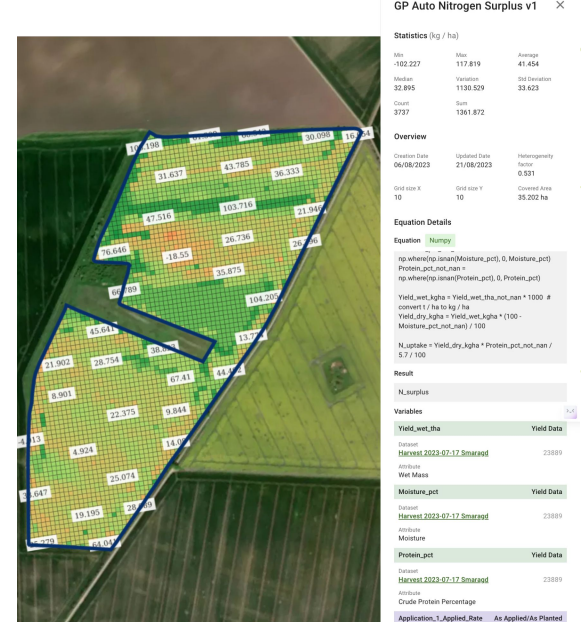
VR Recommendations

Lime Rx based on SoilOptix pH

Phosphorus Corn Recommendations
(South Dakota State University)

Potassium Removal based on Yield

Nitrogen: Target vs Applied

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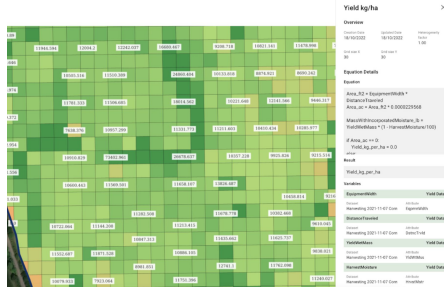
Yield Trends

Yield Calibration and Conversion based on DistanceTraveled(ft), EquipmentWidth(ft), HarvestMoisture(%), YieldWetMass(lb)

Yield Trend above/below Average

Dry Yield Calibration based on HarvestMoisture (%) and YieldWetMass (lb)

Yield Trend for 4 Datasets

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As-applied vs Rx
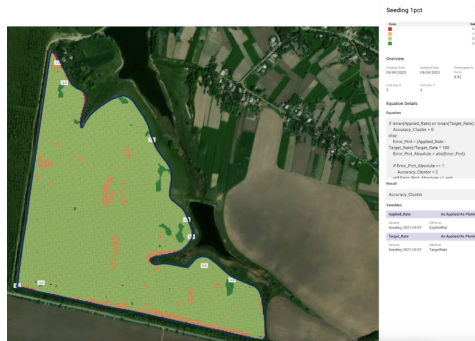
Cluster As-Planted Data to evaluate the Application Accuracy:
1) nodata 2) below acceptable range 3) in acceptable range
4) above the acceptable range

Vegetation Index (GCI) Difference between Two Satellite Images

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Yield Aggregation, Cleaning & Calibration
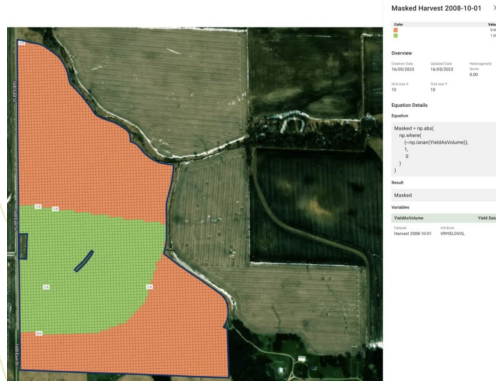
Clusters with and without Data for Yield Dataset
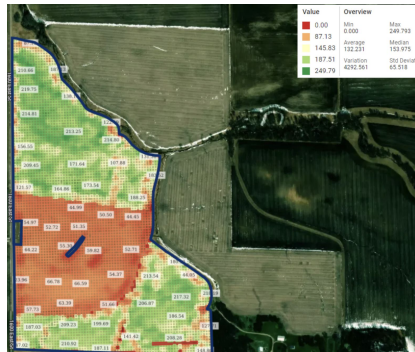
Combining 2 Yield Datasets
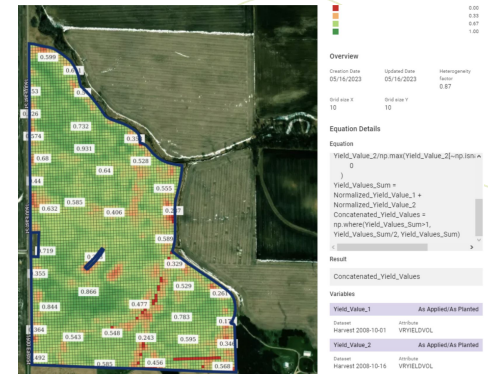
Combining and Calibrating 2 Yield

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Profit Maps
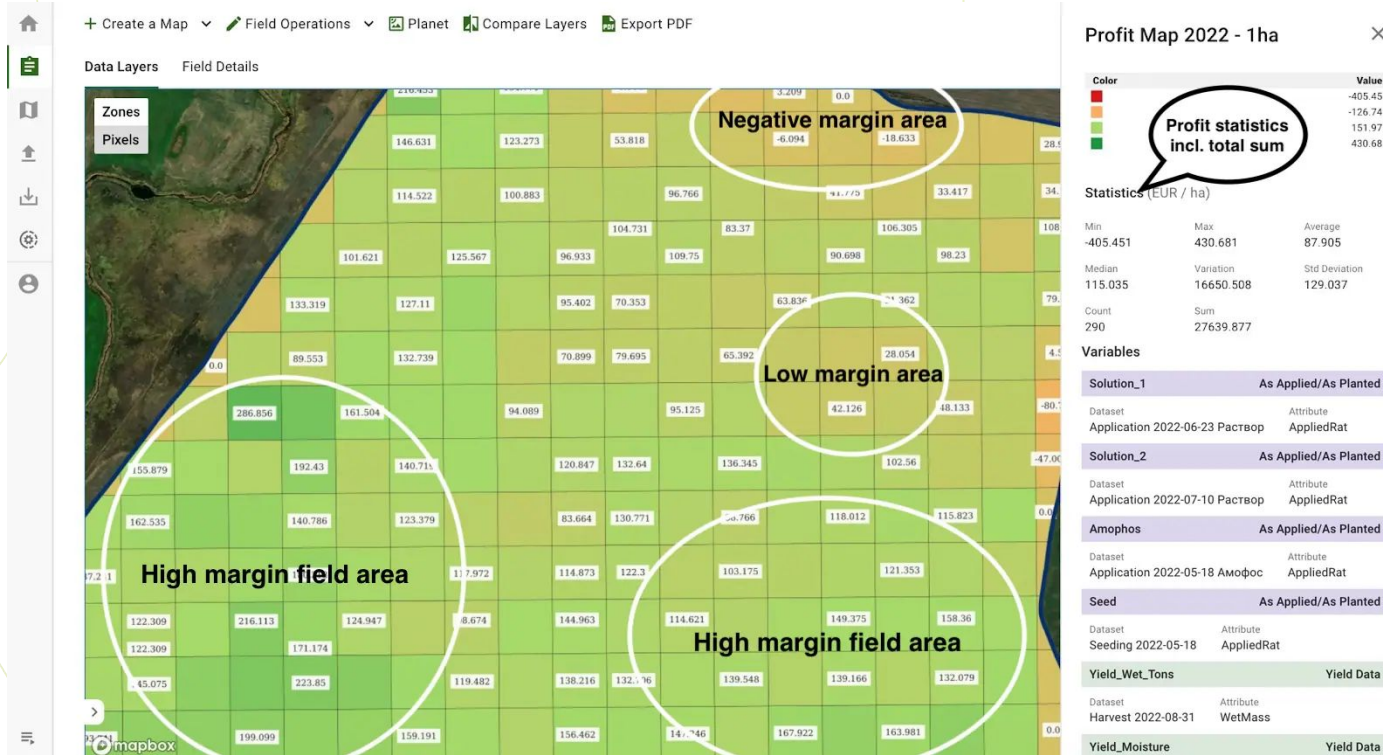
Use-Cases From Brazil

EVI
da vegetação
(10 anos)

+

CEa
do solo
(até 75 cm)

Subdivisão
da área em
12 unidades
de manejo

Área de cana
de 96 ha

1 2 3 4 5 6 7 8 9 10 11 12

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8 anos de imagem de satélite

Condutividade elétrica aparente do solo
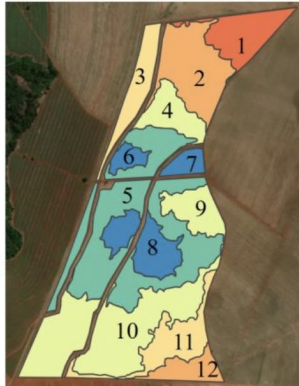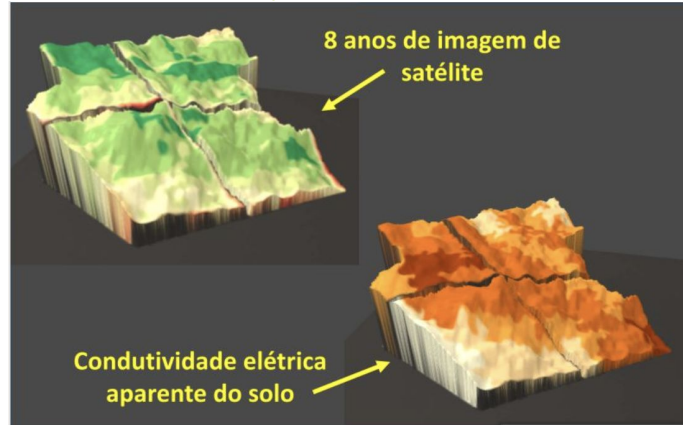
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Lucas Rios do Amaral

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Equations: Use Cases (6) - Yield Stats & Slope for VRA
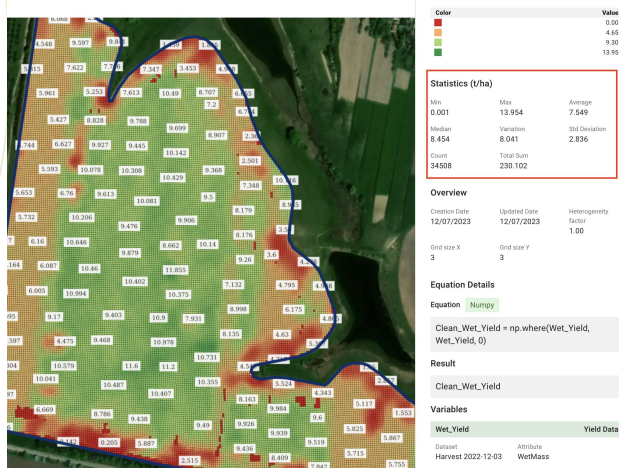
Yield Distribution (Statistics) including
Total Collected Yield
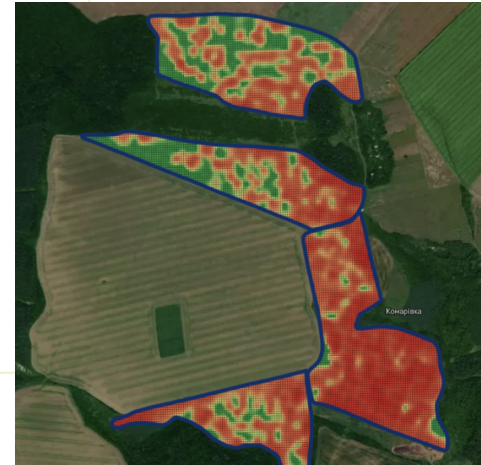
Convert Slope into Factor for VRA
Fertilizing, Seeding, Crop Protection

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3D Maps in Browser

Learn geospatial dependencies between data layers.

Combine **a base layer** (topographic, slope, relief positions, soil properties, or vegetation distribution) and **a cover zones map** (zones from yield, historical vegetation, organic matter, electrical conductivity, pH distribution).

3D model is visualized right in the browser without need of installing any additional software or plugins.

3D Maps - GeoPard Agriculture

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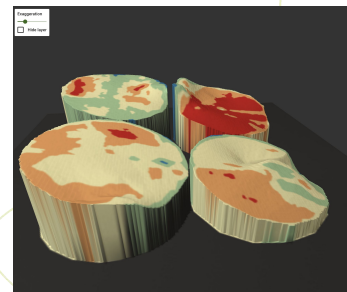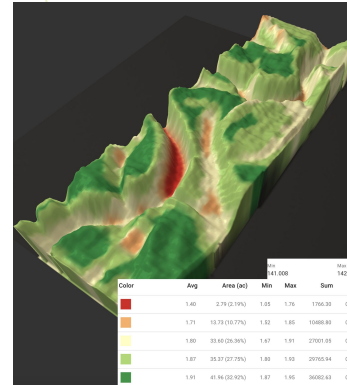
Topography Profile

Complete topographic profile including Elevation, Slope, Aspect, HillShade, Relief Position, Ruggedness, Roughness built on top of Remote Sensing or Machinery Datasets

Example: Slope and Relief Position maps.

relief position

Color	Avg	Area (ha)		Min	Max
	-0.04	14.39	47.64%	-0.19	-0.02
	0.00	14.70	48.67%	-0.02	0.02
	0.04	1.12	3.69%	0.02	0.14

slope

Color	Avg	Area (ha)		Min	Max
	0.53	16.64	55.06%	-	1.14
	1.75	11.91	39.41%	1.14	2.74
	3.73	1.67	5.53%	2.74	8.66

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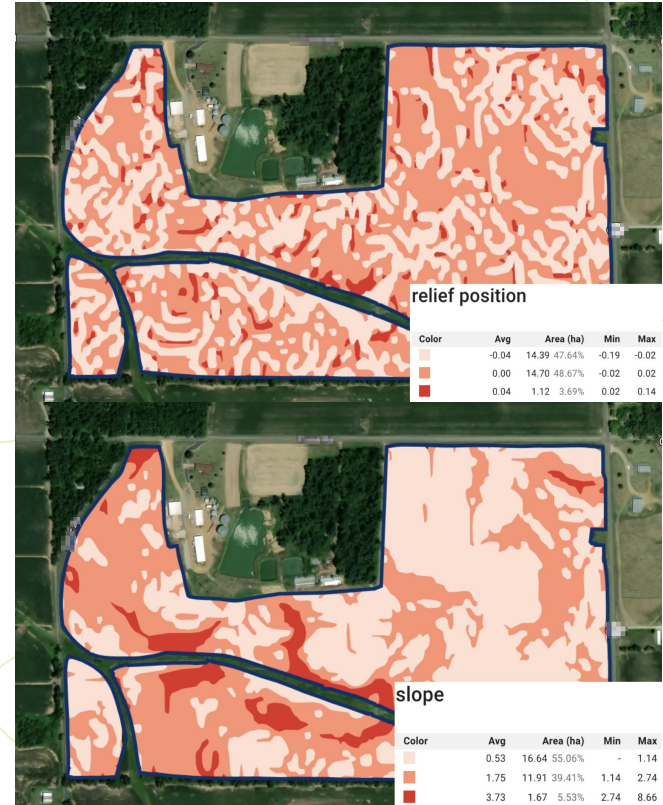
Use-Case: Automated Scouting

Automated detection of locations that need to be scouted.

Some examples:
- Estimate expected yield of the whole field by checking the development of crops in a certain place
- Unexpected low vegetation zones
- Scout yield limiting locations

Based on GeoPard unique maps such as field potential, stability, current productivity, multi-layers maps & cross analytics.
[Read more](#)

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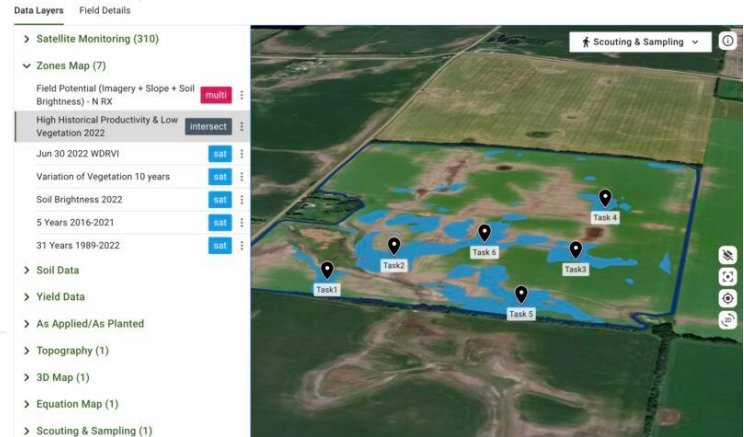
Soil sampling

Planning of soil sampling (zonal & grid), VRA maps based on soil data

Blog: Soil data analytics

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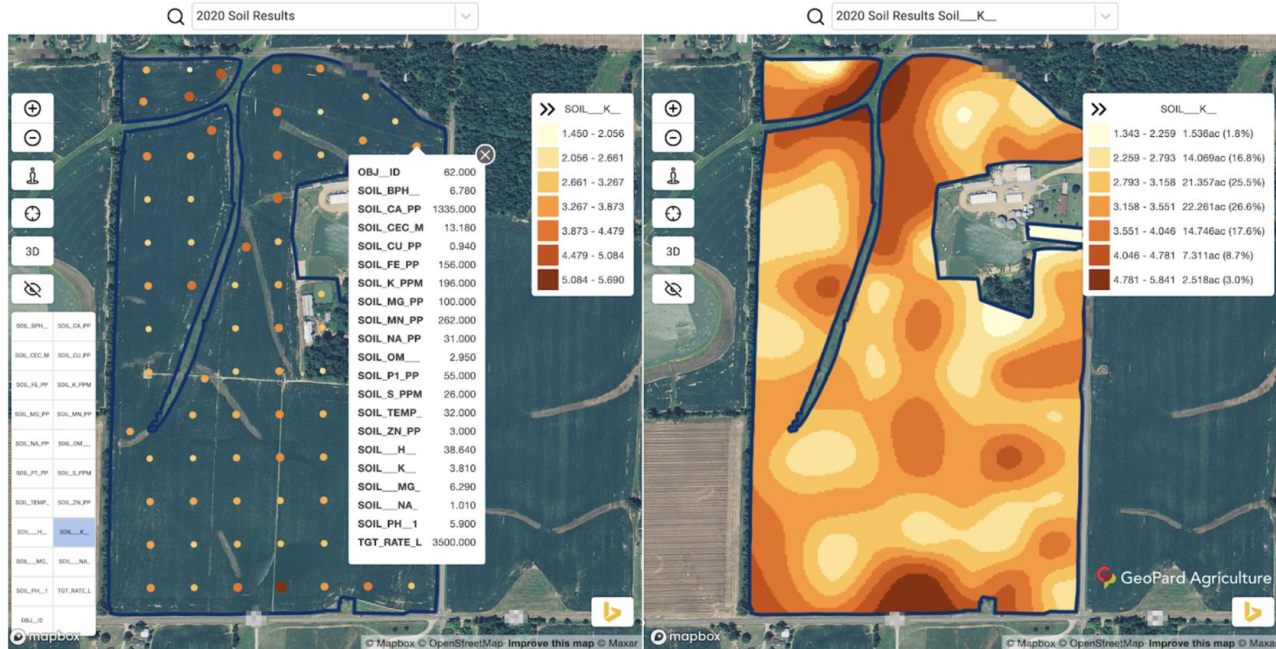
Use-Case: Detection of Yield Limiting Factors
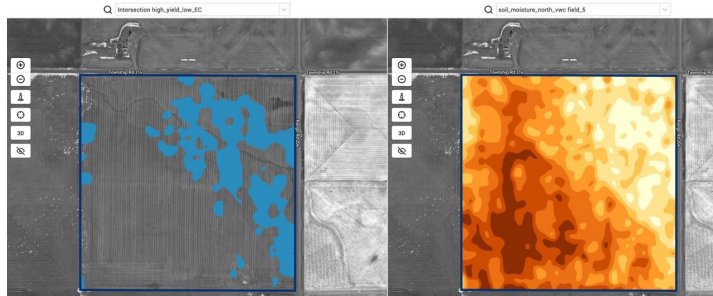
Yield / Soil Moisture correlation
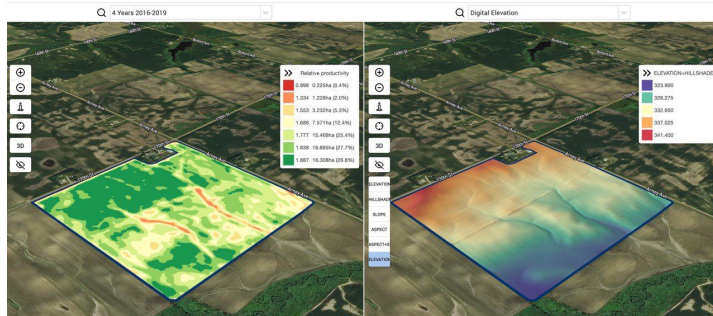
LIDAR topographic analytics

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VRA Maps, Cost Calculation and Export

Create Variable rate application (VRA) maps by adding rates to any management zone map.

Costs calculation for Rx maps - know your costs per zone and per product.

VRA maps are compatible with most agricultural machines and can be exported as a **shapefile**, **ISOXML** or to **JohnDeere Ops Center**

Zones Adjustments

Merge and split zones feature allows to make a few important things:

- Split polygons
- Merge polygons
- Draw strip trials
- Hand-free drawing tools
- Assign a polygon or a complete zone to another class Blog: Merge and Split zones

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Soil Brightness Index

Soil brightness works as a proxy for soil organic matter, sands, and salinity areas, and is becoming an increasingly important index for studying changes in soil conditions over time.

Relevant in measuring and monitoring soil degradation and soil erosion patterns.

Color	Avg	Area (ac)		Min	Max	Sum
	0.67	0.61	1.24%	0.64	0.69	185.82
	0.70	11.60	23.55%	0.67	0.72	3585.26
	0.71	15.45	31.35%	0.69	0.73	4933.49
	0.72	16.03	32.53%	0.71	0.74	5204.84
	0.74	5.58	11.33%	0.72	0.75	1836.29

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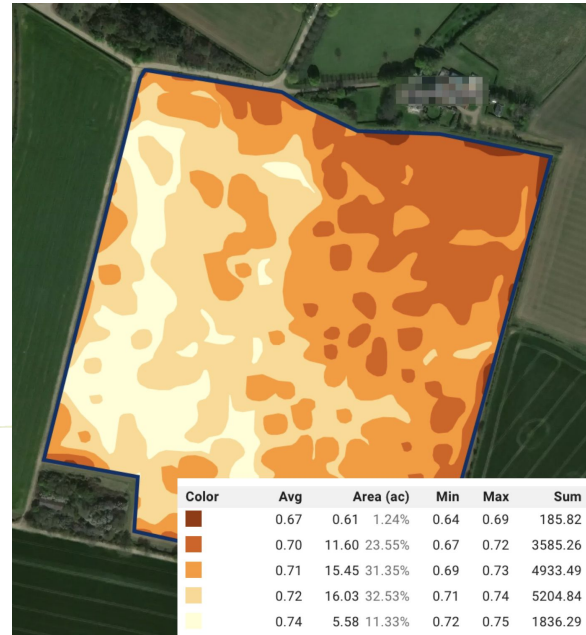
Stability Maps / Change Detection

Detect the most changeable and stable spots in the field during any period: the last 1-2 weeks or 1-2 months or even a couple of years (stability and variation of vegetation from season to season).

Coming: Combine with the latest image to see the positive or negative trends for every pixel.

Avg	Area (ha)		Min	Max
0.10	33.37	37.76%	0.07	0.11
0.12	37.30	42.21%	0.11	0.13
0.14	14.35	16.23%	0.13	0.17
0.19	2.87	3.24%	0.17	0.24
0.29	0.49	0.55%	0.24	0.36

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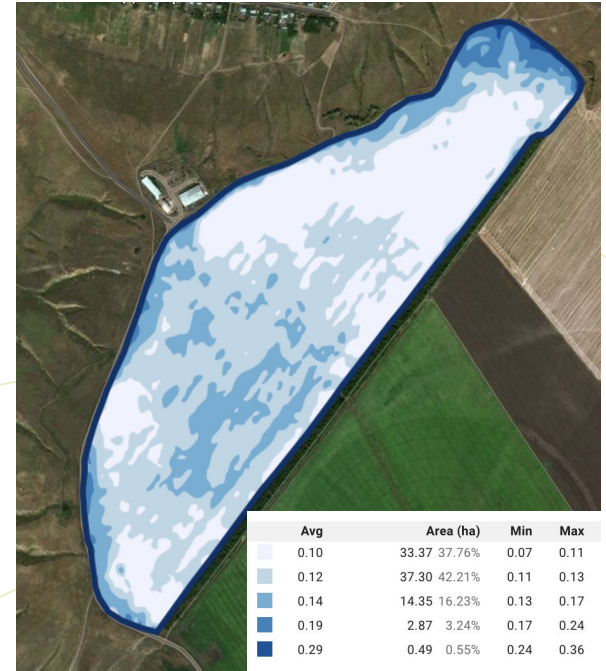
Intersection of Data Layers

Overlapping among management zones based on different layers to define dependencies between data layers, to identify the most interesting/valuable areas for extended analytics (scouting, soil, plant sampling), and to improve agronomic practices.

Example: Influence of high slope to low historical crop productivity.

rrelation between data layers

As-Applied and As-Planted Data Analytics

Monitoring of the VRA execution results including a comparison of planned and applied maps.
Useful for the calculation of ROI of Variable Rate technology.

Example: Comparison planned and executed VRA maps.
Blog post - Accuracy of Rx vs As-Applied
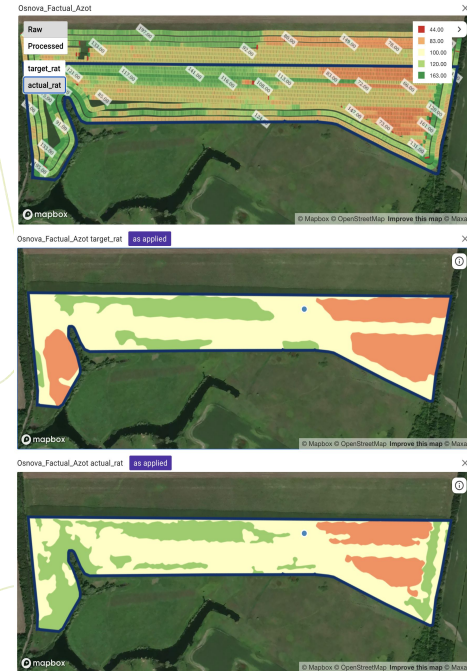
Yield Data Analytics

- Batch Import of harvesting data
- Automated Processing: Cleaning & Calibration
- Visualization & Analytics of all attributes
- Statistics per attribute on subfield level (moisture, protein, oil, per field, zone, pixel)

  Read an article in our blog

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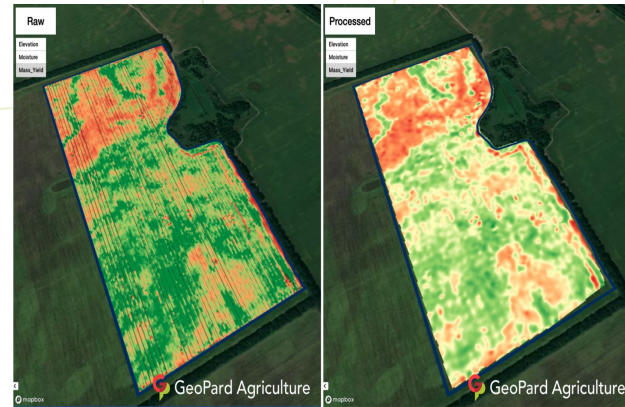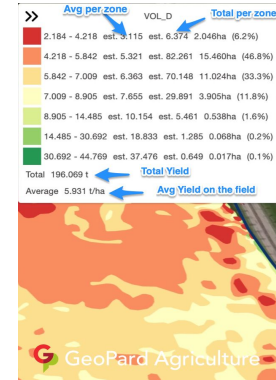
Yield Auto-Cleaning and Auto-Calibration

- AI & Rule-based models enable automated yield data cleaning & calibration
- Automatically calibrated data from several harvesters
- Smart Cleaning of abnormal values and j-hooks

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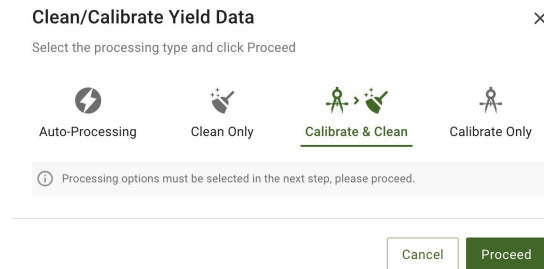
Trial Management & Analytics, Per Static block or Dynamic (e.g. yield per harvester)

Average Yield per harvester

Yield per zone, including Trial block

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Current and Historical Imagery

- Support field and region level with indices: RGB, NIR, EVI2, LAI, NDVI, GNDVI, IPVI, GCI, RCI, SAVI, OSAVI, NDWI, WDRVI, SBI, NDMI, MSI, CCCI, MCARI, TCARI, MCARI/OSAVI, TCARI/OSAVI
- Time-series analysis
- Accurate cloud and shadows detection
- Automated management zones for each new non-cloudy image during the season with configurable parameters (index, number of zones, min size of polygon)
- VRA maps - your own rules for rates calculation
- Export pixel-based imagery data to utilize in further analysis/models
- Data sources:
  - Sentinel 2 (2015 - …)
  - Landsat (1988 - …)
  - Planet (2015 - …)
  - Hyperspectral imagery (2022)

NDVI   Yearly ⌄

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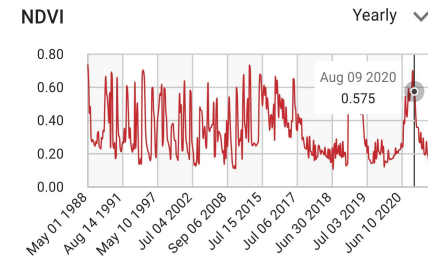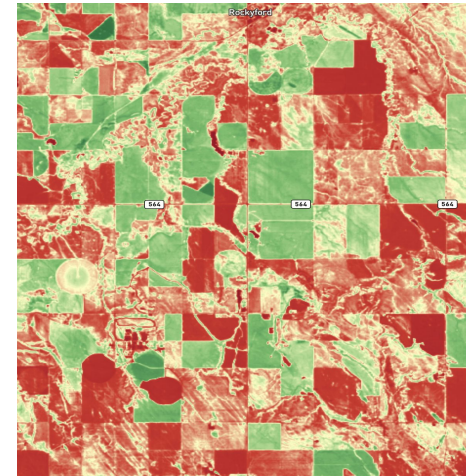
Relative Soil & Grain Moisture

- The index determines vegetation water content. It is useful for finding the spots with existing water stress in plants
- Lower NDMI values mark the spots where the plants are under stress from insufficient moisture
- On the other side, lower NDMI values following the vegetation peak highlight the spots that are becoming ready for harvesting first
  More in blog
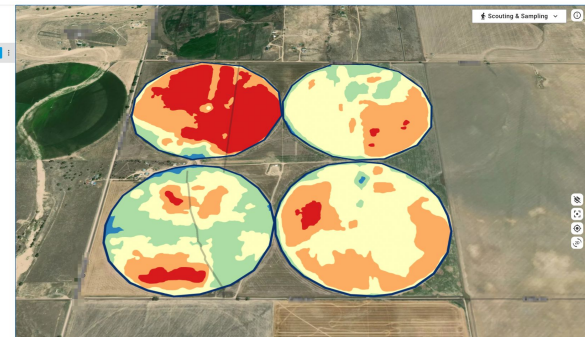
Best-In-Class Clouds And Shadows Detection

GeoPard provides [high accuracy of clouds and shadows](#) detection using proprietary algorithms.

The algorithm's accuracy is about 95%, while competitors have ~80% accuracy.

Enables **Automation of Analytics based on Imagery**

Advanced image filter allows looking at partially cloudy and cloudy images to verify decisions.

GeoPard Agriculture
Simplify complexity
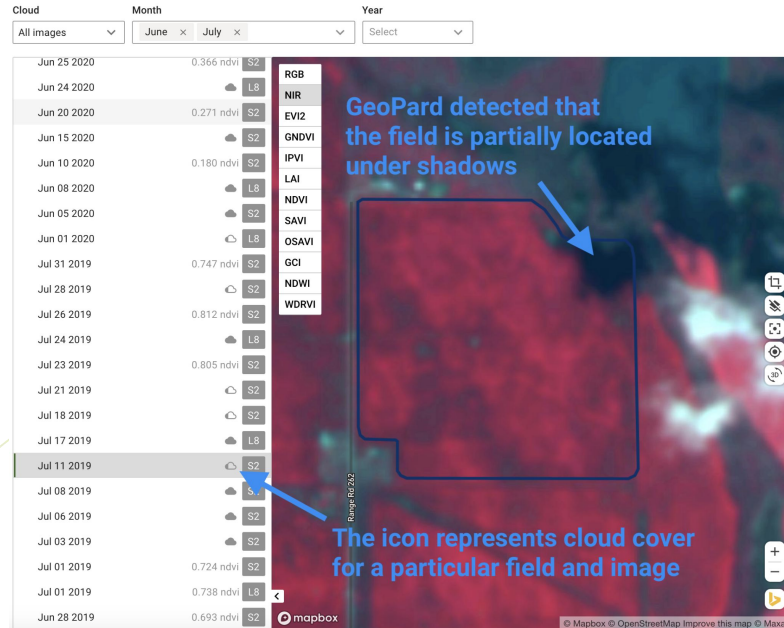
Planet Labs Imagery Analysis and Rx Creation

- Automated data processing includes:
- Clouds/shadow detection
- Data normalization and cleaning
- [Order imagery in 1 click](#)
- [Analytics products and VR maps based on Planet imagery](#)

Sentinel-2   VS   Planet Scope

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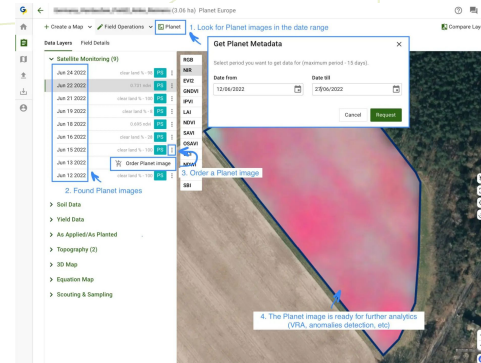
Mobile Application

Sync between mobile and web apps

- Online access to all the field datasets and VR zones
- Offline zones and soil maps and scouting capabilities including planning and executed actions with comments and photos

  Platforms: IOS, Android. Mobile and Tablets

  While Label applications

  [Mobile apps tutorial](#)

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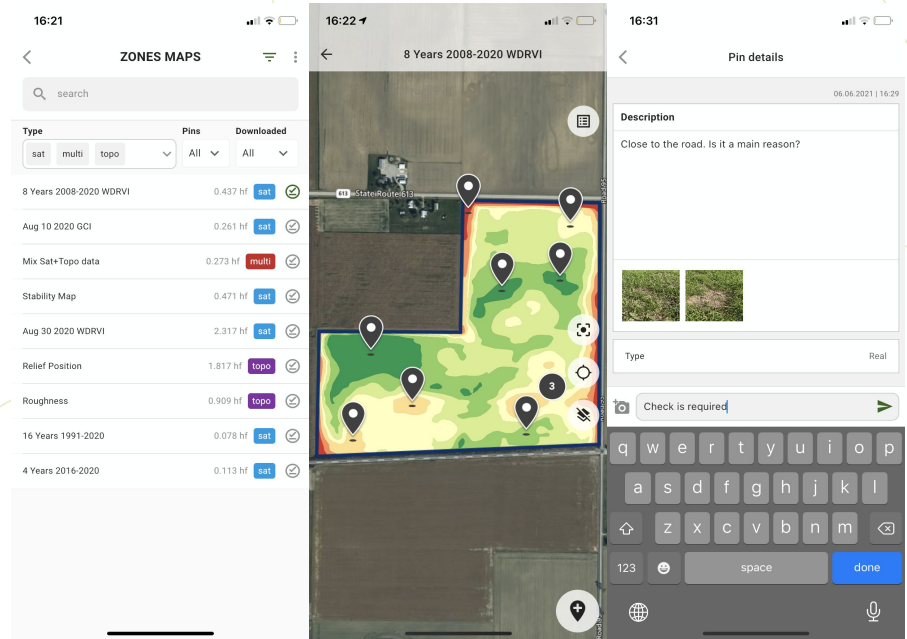
Powerful API and Automation

- All services are available for integration via API
- GraphQL
- OAuth 2.0 protocol
- Geodata: WMS, WFS
- The user interface for Administration
- User interface widgets for direct integration into other platforms
  Read more
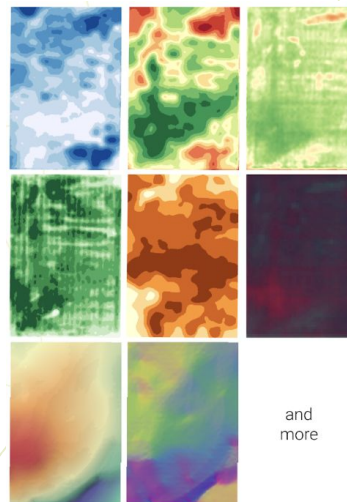
- boundary
- soil samples
- yield monitor data
- custom rules

API

- VRA maps
- custom management zones
- topographic maps
- soil maps
- yield maps
- vegetation indices with 3m resolution
- raw data
- change detection

and more

Farm Management Software

Ag Service Providers

Crop Production Companies

Digital Marketplaces

R&D Departments

Insurance Platforms

Ag Inputs and Machinery Producers and Distributors

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Data Compatibility

✅ Raven Slingshot and Viper Pro 4	Shapefiles
✅ Trimble	Shapefiles and Isoxml
✅ John Deere GS3 and GS4 data	GS3 details, GS4 details
✅ John Deere	MyJD Ops Center integrated, see details in our blog post
✅ AGCO	ISOXML and shapefiles
✅ CNH	ISOXML/shapefiles supported
✅ Topcon/TAP	Shapefile supported
✅ Mueller	ISOXML/Shapefiles supported, details here
✅ ISOXML	Claas, Topcon, Dickey John, CNH and others
✅ AgLeader Monitors	Shapefile support, details here
✅ Amazone / Amatron	Shapefile, ISOXML, Amatron 3 details, Amatron4 details
✅ GeoJson	Generic vector data format. Is supported by most GIS programs including Esri ArcGis, QGIS. Available for API users
✅ Shapefile	Generic vector data format. Is supported by most GIS programs including Esri ArcGis, QGIS
✅ API / Widgets for integration of GeoPard analytics into other systems.	

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Statistics for Zones

Calculate statistics on zone level to determine how accurate the measurements are.

Statistical metrics:
- minimum
- maximum
- average
- median
- sum
- standard deviation

Title	Number of Zones	Data Classification Type	Min Polygon Area in m2	
2016-2021 Potential	5	Natural breaks	1000	Run Analysis

Color	Avg	Area (ac)	Min	Max	Median	Sum	Std
	1.48	0.24 (0.42%)	1.30	1.61	1.49	165.92	0.06
	1.61	5.13 (8.97%)	1.39	1.82	1.62	3659.38	0.07
	1.72	10.85 (18.95%)	1.58	1.85	1.72	8358.38	0.05
	1.80	19.34 (33.78%)	1.72	1.88	1.81	15800.20	0.03
	1.86	21.70 (37.89%)	1.81	1.92	1.87	18243.71	0.02

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Statistics for Machinery Datasets

Calculate statistics for every attribute collected by machinery during agricultural operations
(Seeding, Fertilizing, Crop Protection, Harvesting)
to determine how accurate the operation was executed and total applied number of agricultural input.

Statistical metrics:
– minimum
– maximum
– average
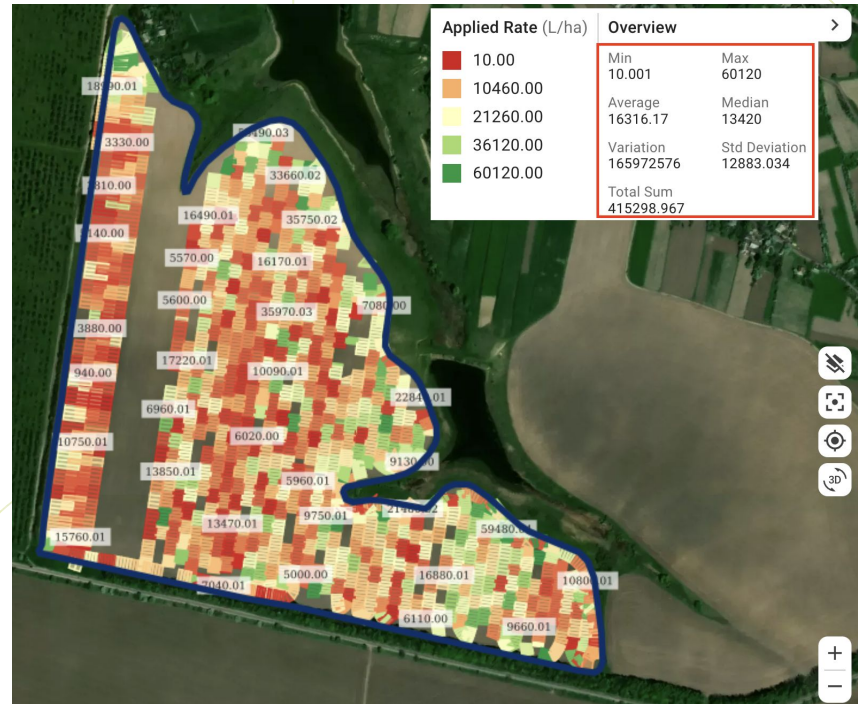– median
– total sum
– standard deviation

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PDF Reporting

Export as PDF any data layer including Imagery, Yield, Soil, As-Applied, Topography, Zones and Equations

A report can aggregate up to 60 data layers

It includes stats per attribute

2. Zone Maps

2.1. 1988-2023 Field Potential

Overview

Creation Date	Updated Date	Data Classification Type	Polygon min area	# of zones	Heterogeneity factor
23 Aug 2023	23 Aug 2023	Equal count	500	5	0.22

EVI2

Color	ID	Avg	Area (ac)	Min	Max	Median	Std Dev	Sum
🟥	1	0.36	6.26 19.73%	0.35	0.47	0.36	0.01	1007.15
🟧	2	1.14	6.45 20.30%	0.35	1.80	1.29	0.47	3328.39
🟨	3	1.76	7.23 22.76%	1.66	1.81	1.77	0.03	5656.17
🟩	4	1.80	6.56 20.66%	1.79	1.81	1.80	0.01	5284.25
🟢	5	1.81	5.26 16.56%	1.80	1.82	1.81	0.00	4298.02

Data Layers

Satellite Monitoring	
Index EVI2	Satellite images (28): 27 Jul 2023, 12 Jul 2022, 5 Sep 2021, 7 Jul 2020, 8 Jul 2019, 28 Jun 2018, 22 Jun 2016, 23 Aug 2015, 28 Jul 2014, 16 Jul 2013, 20 Jul 2011, 25 Aug 2010, 6 Aug 2009, 9 Jul 2007, 29 Jul 2006, 24 Jun 2005, 30 Jun 2004, 22 Aug 2003, 21 Jul 2000, 5 Aug 1997, 26 Jul 1996, 31 Jul 1995, 29 Jul 1994, 25 Jul 1993, 31 Jul 1992, 18 Jun 1991, 28 Jun 1989, 11 Jul 1988

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Automated Heterogeneity index

Decide which fields to target first with precisionAg

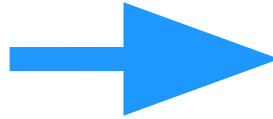# Sustainability and Carbon Module

Tillage

As-applied Fertilizer maps

Yield maps / GeoPard Field Potential maps

Cover Crops

Crop Rotation

... other factors

Per pixel calculated Sustainability Index

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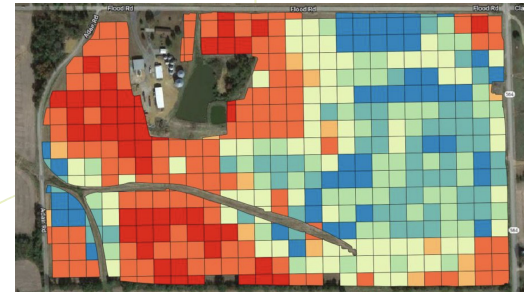
Recommendation on Carbon / Soil Samples

Basis to start Zonal soil sampling

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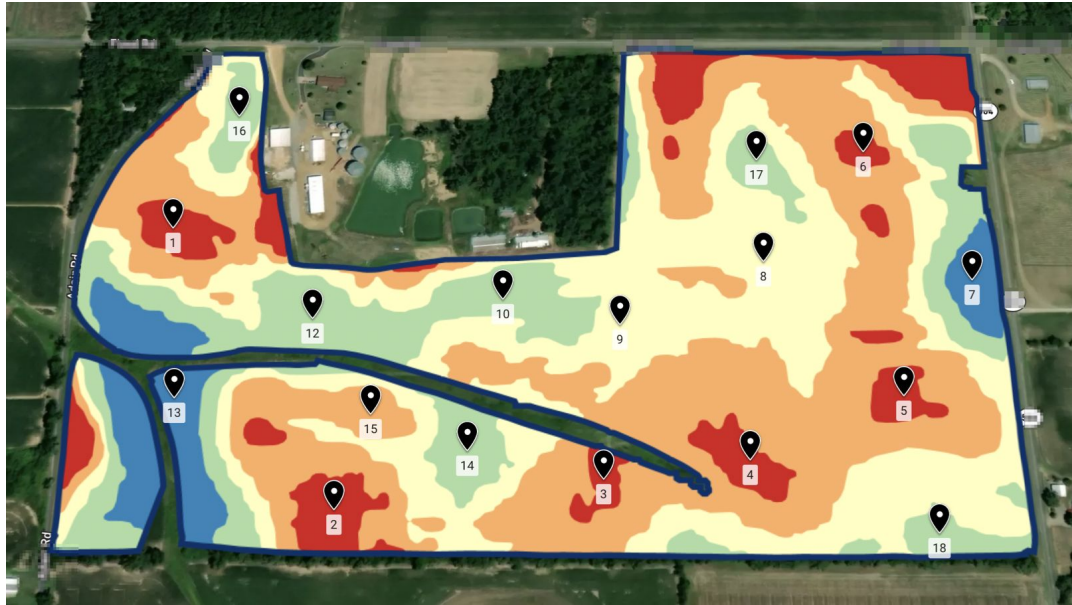
Web, Mobile, API, Widgets, White-Label

WEB: Online access to all features.

Example: Compare 4 data layers (satellite image, yield dataset, elevation, historical zones), create VRA map on a live map.

Mobile: Online access to all field datasets and zone. Offline zones and soil maps, and scouting capabilities including planning and executed actions with comments and photos.

API: All services are available for integration via API; GraphQL; OAuth 2.0 protocol; Geo data: WMS, WFS; User interface for Administration; User interface **widgets** for direct integration into other platforms

While-Label & On-Premise applications.

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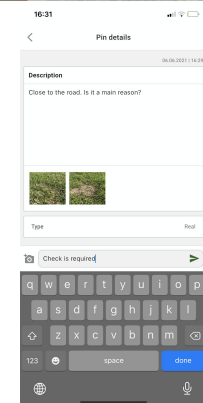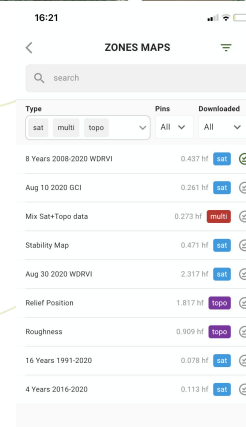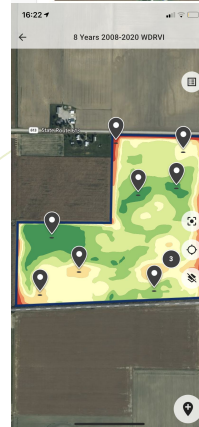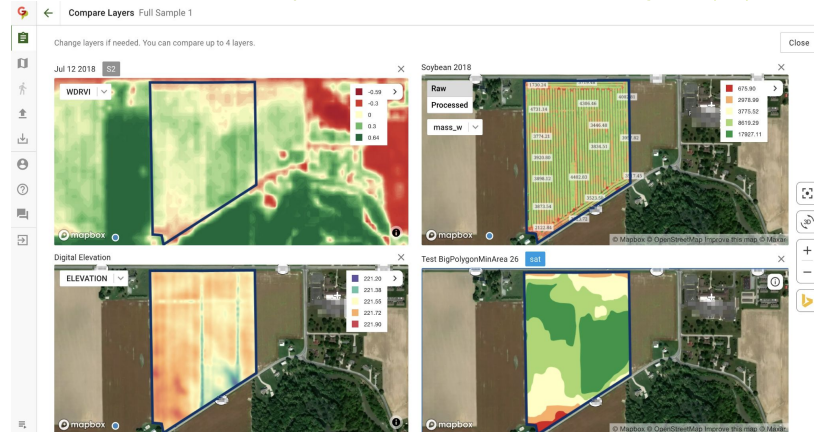
Partner Program

Partner Program
Join the GeoPard Community Partner Program and earn money by advising and bringing the solution to your network, promoting and telling how well GeoPard Agriculture works for you.

Clients
All clients who enter your referral code, follow your redirect link for registration or inform us of your recommendation will be identified as a referral sale. Clients receive a special bonus for registering with the referral.

Promo materials
We will provide you with marketing materials, videos, images, case studies, product demos and a dedicated affiliate manager to support you as our partner. Feel free to add information about GeoPard on your website and use your other channels for promotion.

Reward
The program includes payouts for bringing users into GeoPard Agriculture. You get high commissions: 25% of the annual income for the first 2 years of each referral sale. Read more about Program Terms and Conditions here.
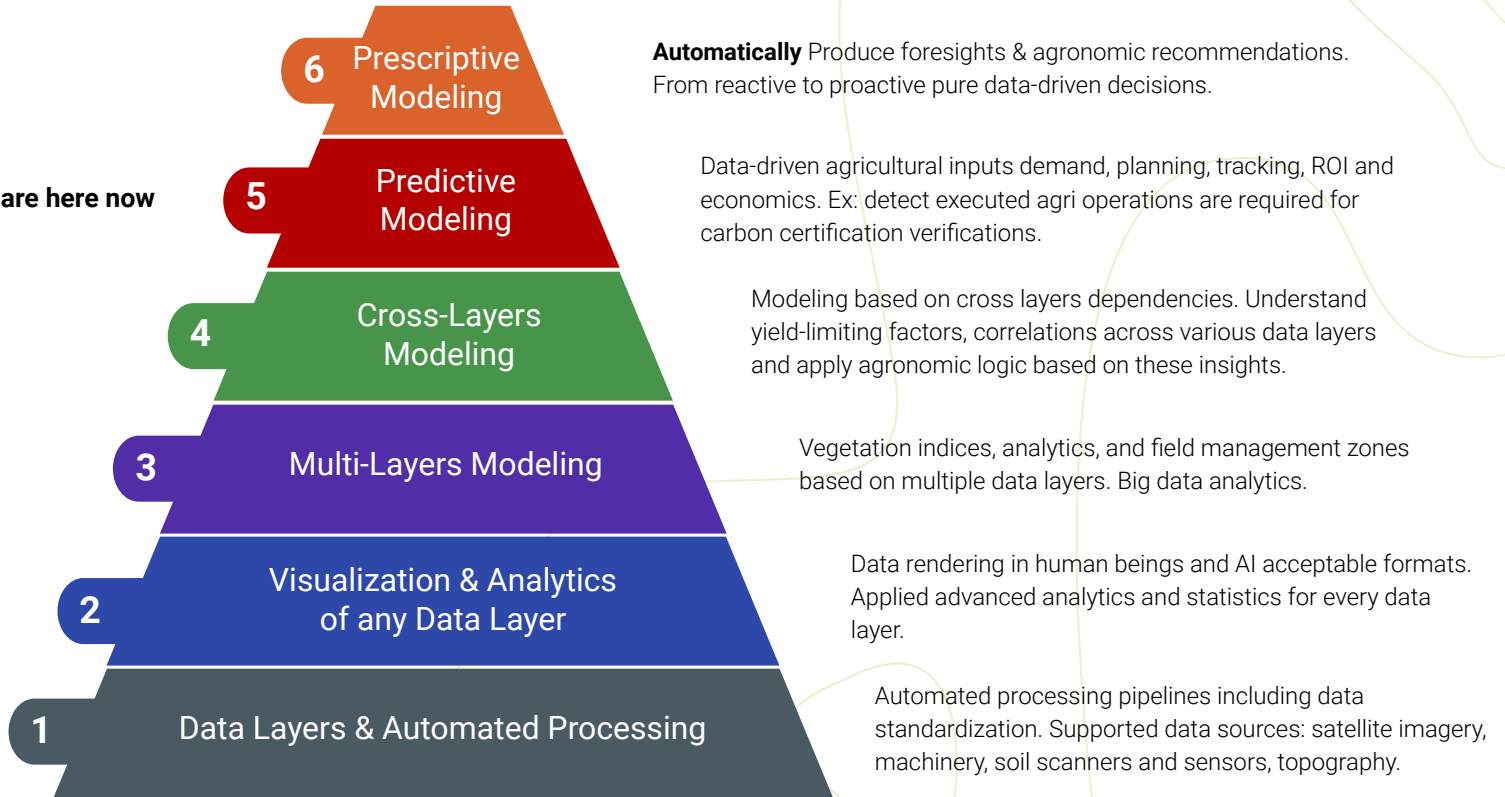
Read more

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Product Vision

We are here now

6 Prescriptive Modeling

5 Predictive Modeling

4 Cross-Layers Modeling

3 Multi-Layers Modeling

2 Visualization & Analytics of any Data Layer

1 Data Layers & Automated Processing

Automatically Produce foresights & agronomic recommendations. From reactive to proactive pure data-driven decisions.

Data-driven agricultural inputs demand, planning, tracking, ROI and economics. Ex: detect executed agri operations are required for carbon certification verifications.

Modeling based on cross layers dependencies. Understand yield-limiting factors, correlations across various data layers and apply agronomic logic based on these insights.

Vegetation indices, analytics, and field management zones based on multiple data layers. Big data analytics.

Data rendering in human beings and AI acceptable formats. Applied advanced analytics and statistics for every data layer.

Automated processing pipelines including data standardization. Supported data sources: satellite imagery, machinery, soil scanners and sensors, topography.

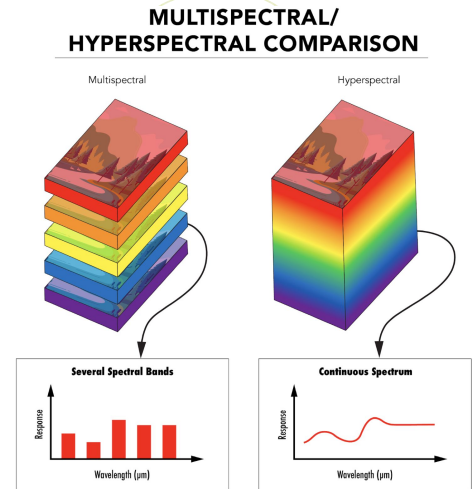GeoPard Agriculture
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R&D: Hyperspectral Imagery Analytics

GeoPard managed to successfully preprocess (clean, normalize), upload, calculate statistics, various indices and spectral signatures for HYPERSPECTRAL Imagery (±250 bands in comparison to ±10 bands from multispectral imagery).

Use-cases:
- Remote detection of sustainable & regenerative farming practices
- Distinguishing different plant species with similar spectral signatures
- Identifying plant biochemical composition
- Quantifying soil vegetation
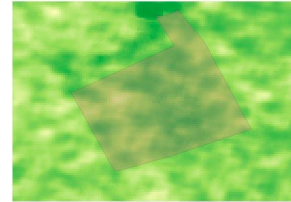- Calculating chemical attributes
- Accurate Carbon estimations

This is the part of the project partially funded by the EU and the Ministry of the Environment of North Rhine-Westphalia

MULTISPECTRAL/ HYPERSPECTRAL COMPARISON

Multispectral   Hyperspectral

Several Spectral Bands   Continuous Spectrum

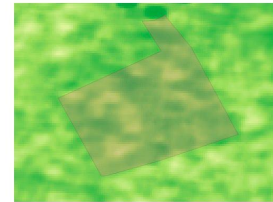Response   Response

Wavelength (μm)   Wavelength (μm)

R&D: Vegetation on Cloudy Days, Tillage & Cover Crops Detection

Products:
- Estimate vegetation in cloudy days
- Detect agricultural operations like tillage, sowing, harvest
- Detect cover crops
- Estimate soil moisture and physical soil conditions

June 21, 2020   July 03, 2020

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![GeoPard Agriculture logo] **GeoPard Agriculture**

Thank you!

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tel: +4917636322391

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