GeoPard Agriculture

Data Analytics SaaS and API for PrecisionAg

July 2023

https://geopard.tech

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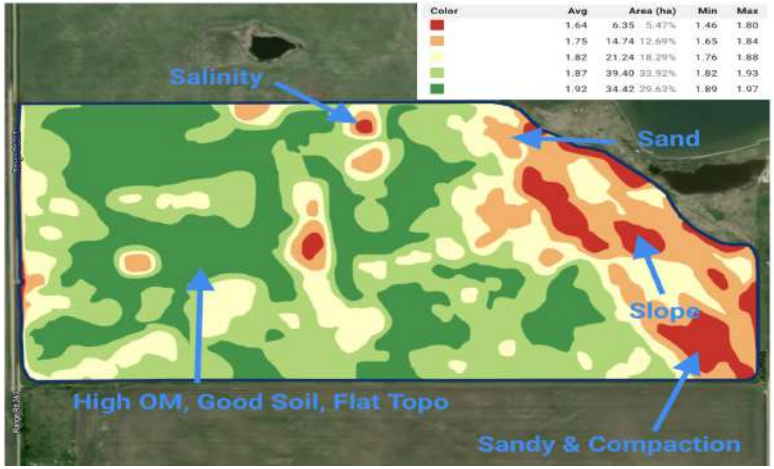
Precision & Sustainable Agriculture Benefits

- ✓ Yield increasing - 10%
- ✓ Saving fertilizer - 20%
- ✓ Reduction of residual Nitrogen in soils up to 50 %
- ✓ Decrease usage of harmful chemicals
- ✓ Reduce GHG emissions and sequester carbon with carbon farming



GeoPard Agriculture
Simplify complexity

Agricultural Season with GeoPard

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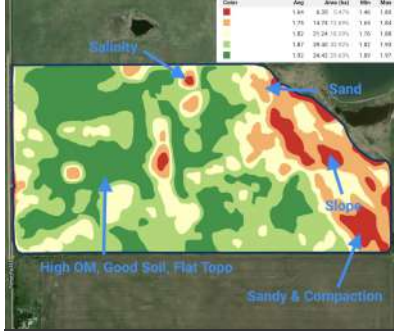
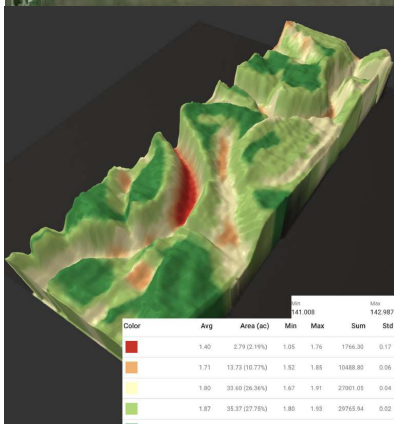
Automated Platform for Sustainable and Precision Agriculture

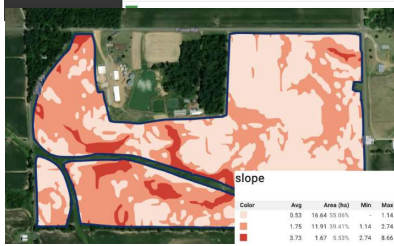
How It Works

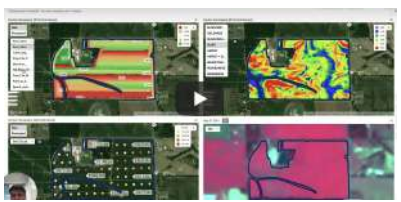
Automated powerhouse for sustainable and precision agriculture

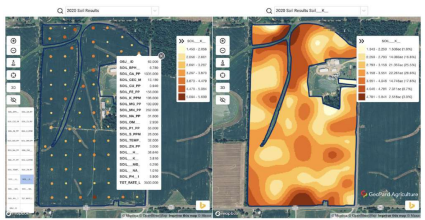
- Flexible agronomic logic: apply any math/formula/equation to calculate recommendations
- Support of all common data types: satellite imagery, radar imagery, machinery data, scanners and sensors
- Automated solution for recommendations >> **Hyper-Automation** of agronomy
- Simple UX for fast manipulation with complex agricultural data
- Powerful flexible **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

Team

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

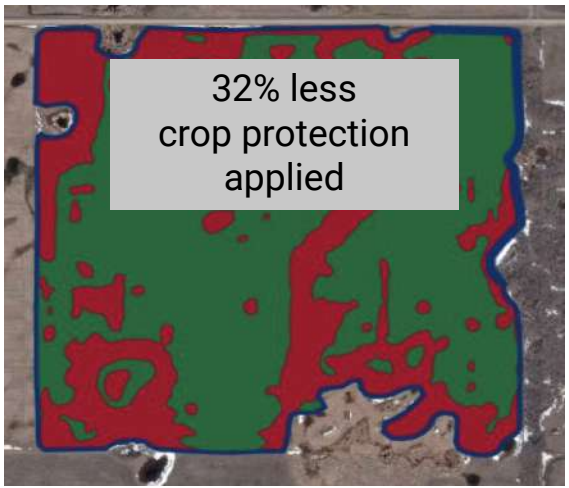
2012	2015	2019
Co-founders of Zoner, acquired by Bayer in 2015	Technical Managers of Bayer Xarvio DF, acquired by BASF	Co-founders of GeoPard Agriculture
Developed VRA maps engine widely used in the US, Canada, Europe	Mastered integration and developed foundation of Xarvio Field Manager, incl. GIS engine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

Use Cases

VR fungicide application

Data: Current vegetation & bare soil

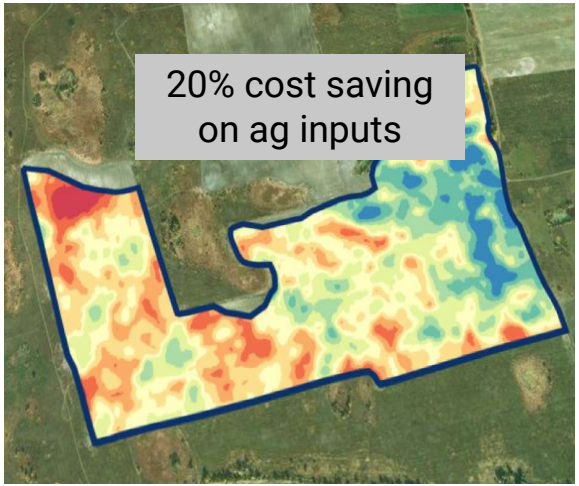
Crop: wheat



VR seeding

Data: Soil sampling (OM) & Topography & Last 15 years vegetation

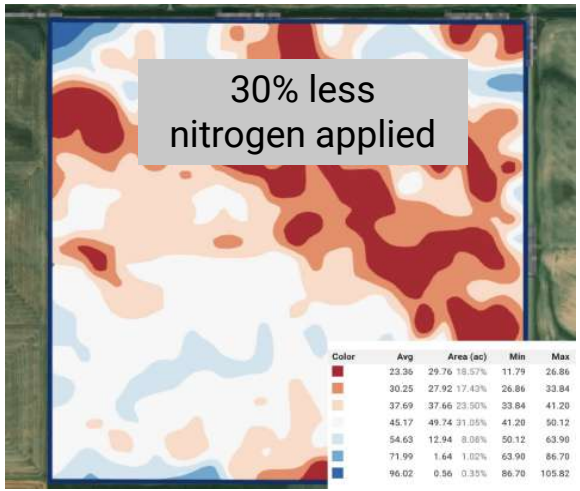
Seeding rate: 60κ-85κ / hectare/ corn



VR fertilizing

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

Crop : Canola



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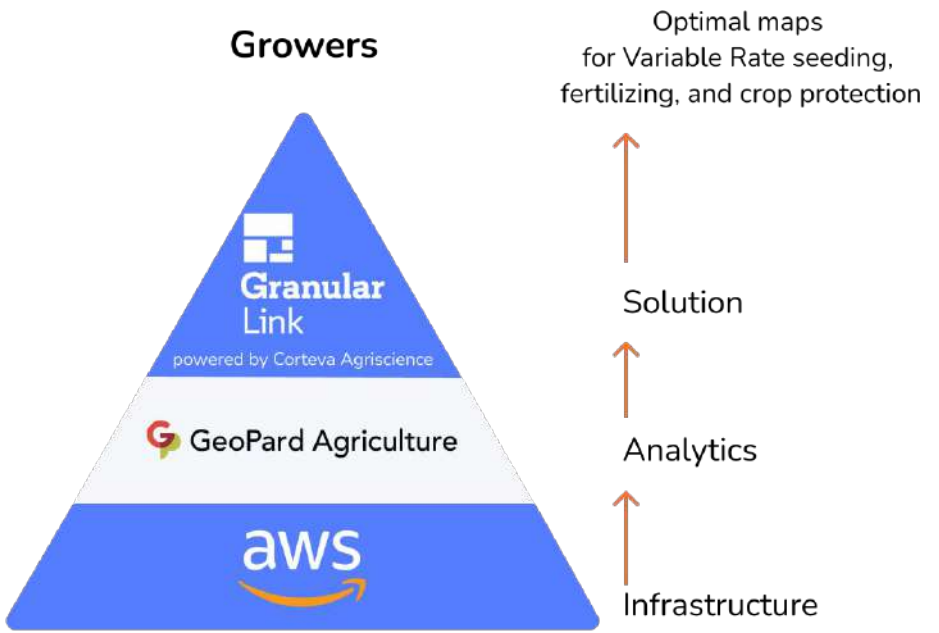
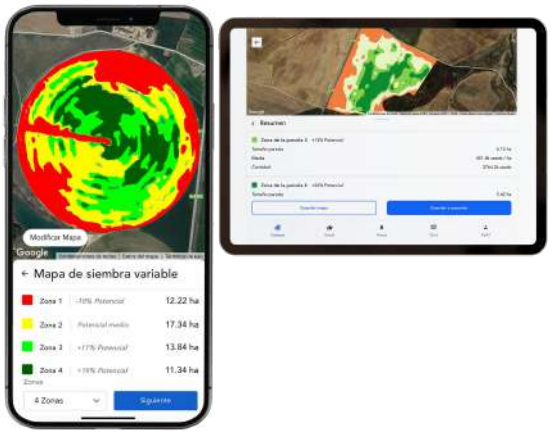
Corteva Use-case

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





[AWS Blog post]

MyJohnDeere Ops Center Integration

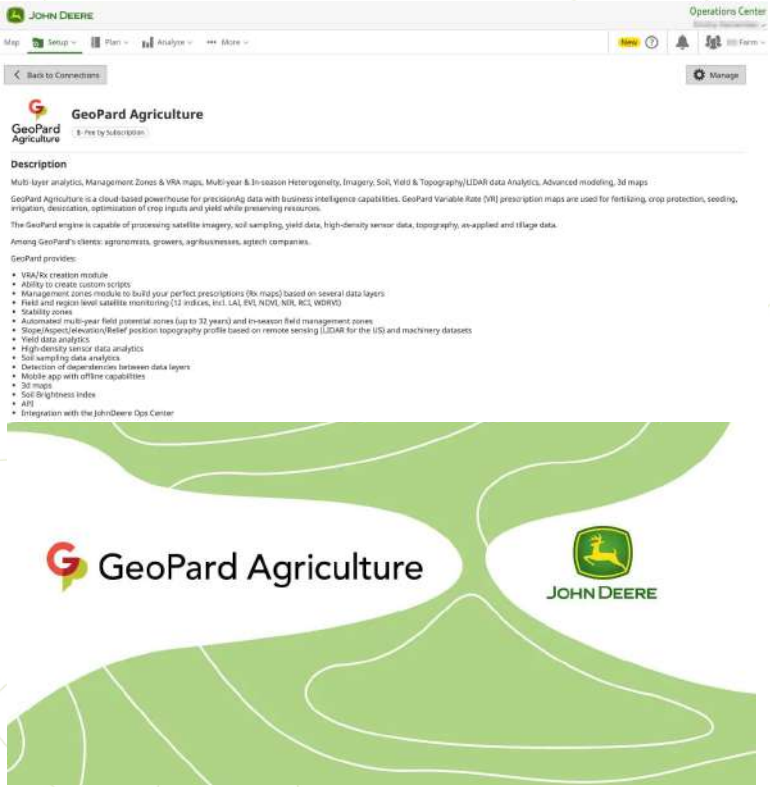
Wireless Import of boundaries, as-applied, as-planted, harvesting & tillage data.

Sending of VRA maps to the Ops Center.

Creating of Analytics Map Layers in the Ops Center: topography, soil, multi-layer maps.

[Blog: Integration with MyJohnDeere Ops Center]

[Integration Overview and Tutorial]



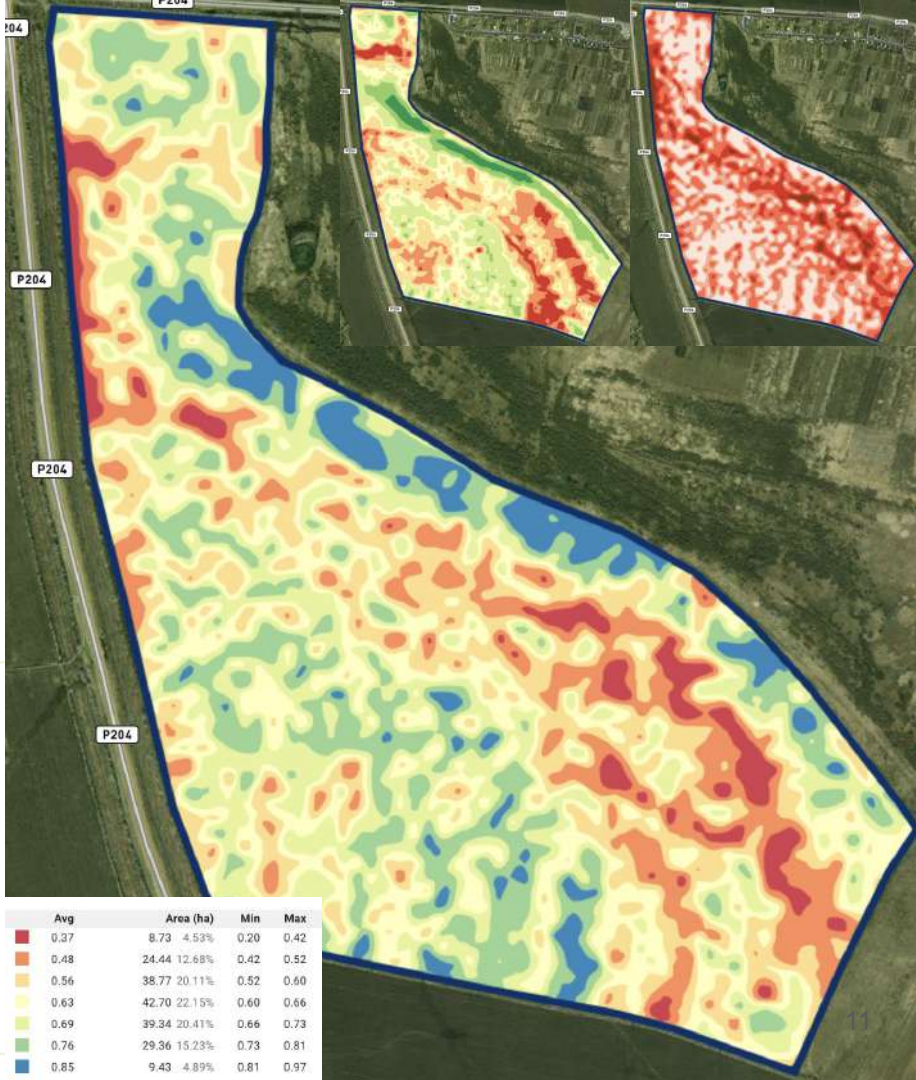
Multi-layer Maps

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



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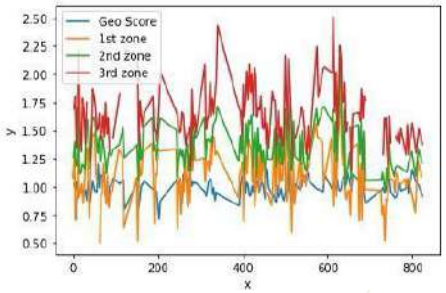
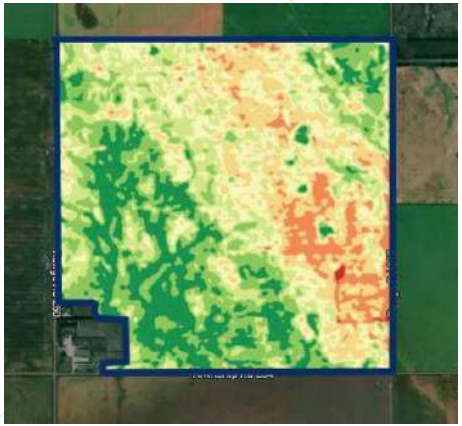
Automated Field Potential Maps

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

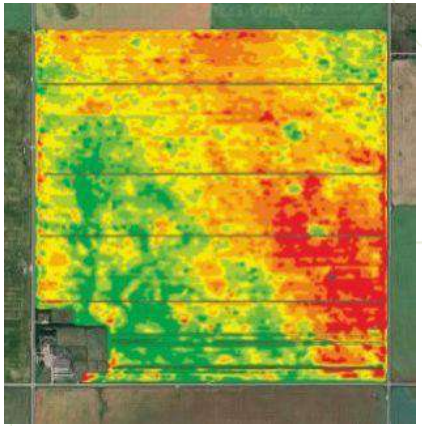
The heterogeneity index helps
benchmark fields and prioritise ag operations.
[Blog: Multi-Year Zones]
[Blog: Heterogeneity Factor]





GeoPard Field Potential maps

VS



Yield data

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Equation based Analytics

Use any math/formula for fertilizer/seeds/crop protection recommendations

Calculate carbon related derivatives

Multiple data layers integrated into a custom formula

Use default GeoPard templates or create your own to reflect your agronomic logic

Calculate economic efficiency, and ROI on a sub-field level

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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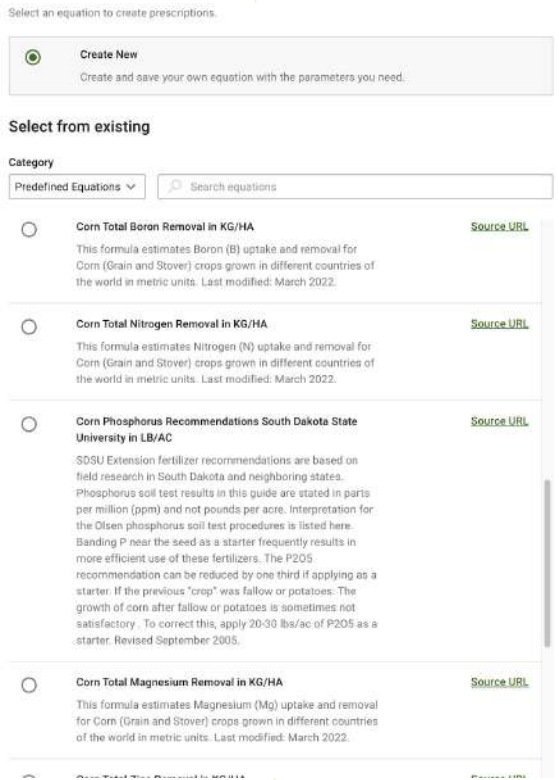
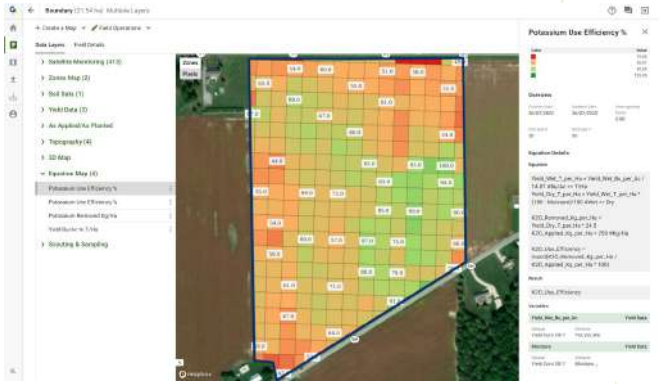
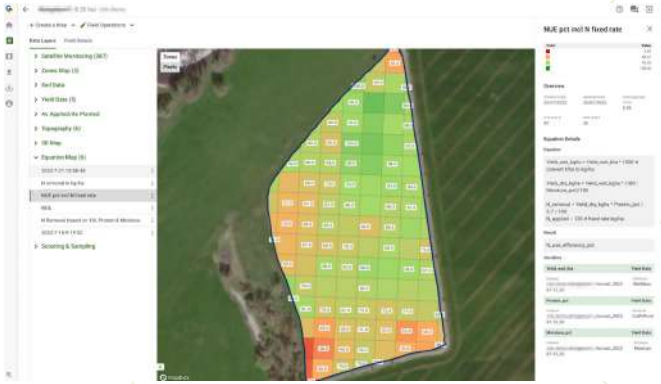
Equations: Use Cases (1)





Potassium Use Efficiency



Nitrogen Use Efficiency

...

Your Formulas

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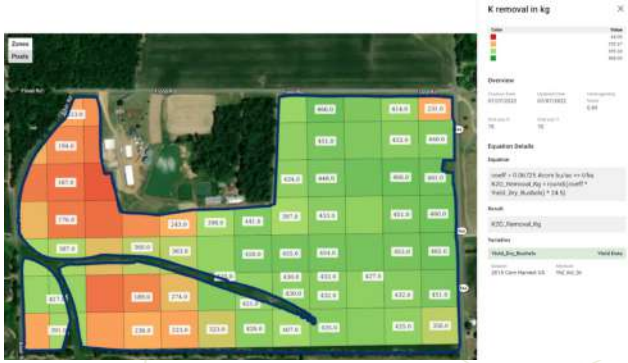
Equations: Use Cases (2)

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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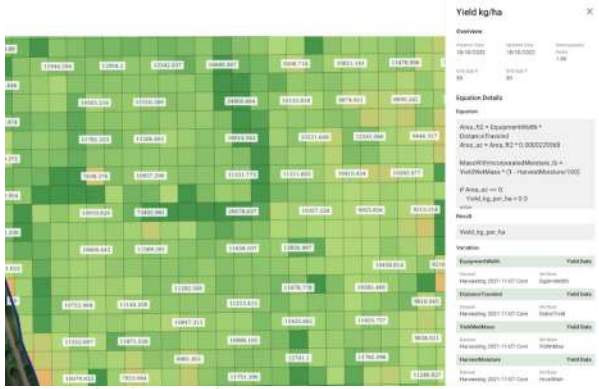
Equations: Use Cases (3)



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

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

Yield Trend above/below Average

Yield Trend for 4 Datasets

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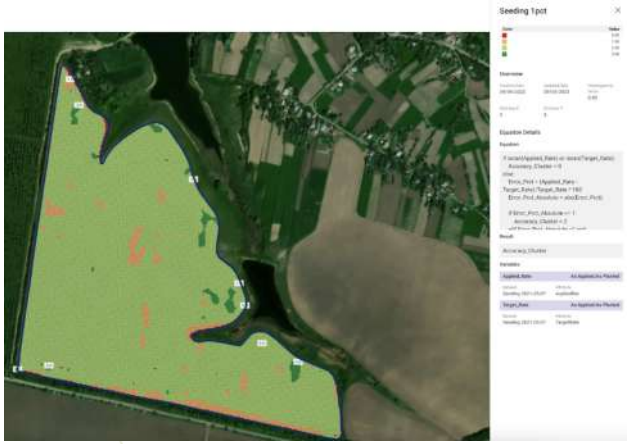
Equations: Use Cases (4)



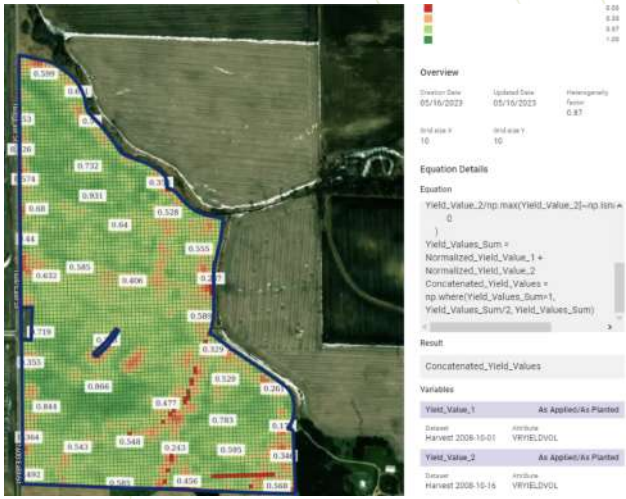
Cluster AsSeeded Data to evaluate the Application Accuracy:
no data [0],
below acceptable range [1],
in acceptable range [2],
above the acceptable range [3]

Vegetation Index (GCI) Difference between Two Satellite Images

Equations: Use Cases (5)

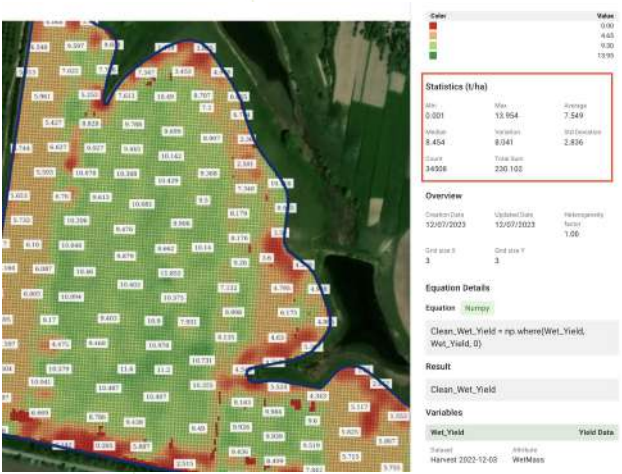
Clusters with and without Data for Yield Dataset

Combining 2 Yield Datasets



Combining 2 Yield Datasets including Normalization step

Equations: Use Cases (6)



Yield Distribution (Statistics) including Total Collected Yield

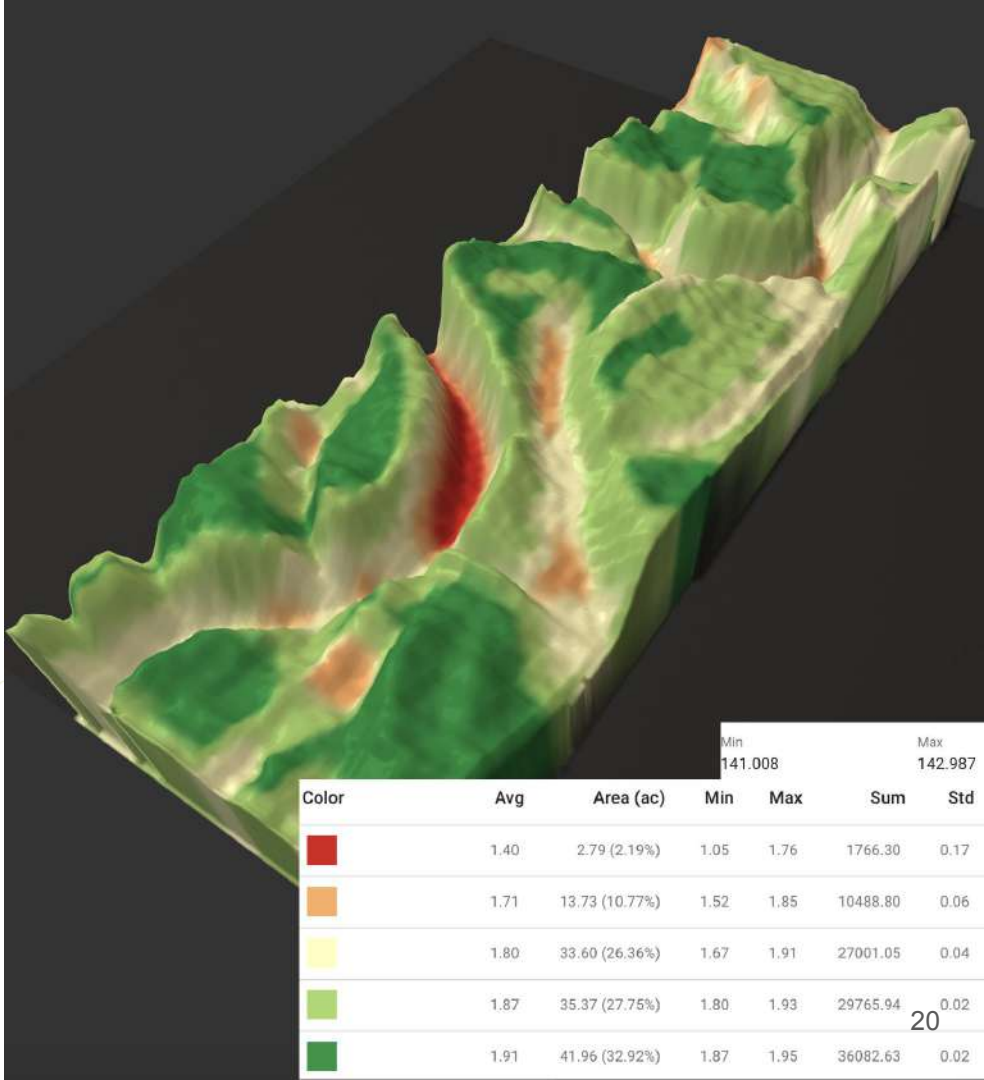
Convert Slope into Factor for VRA Fertilizing, Seeding, Crop Protection

3D Maps

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.

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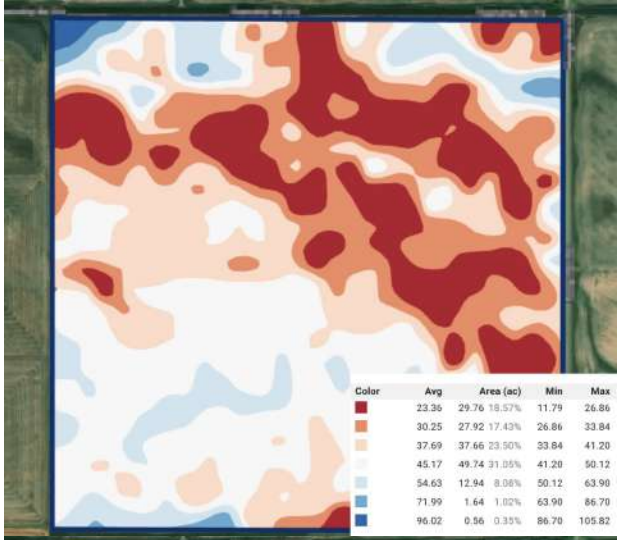
Use-Case: VR Fertilizing

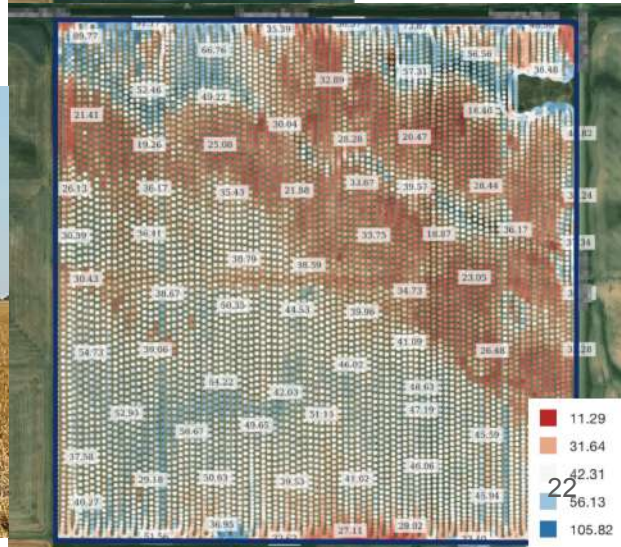
Data from **ground scanners** are automatically analyzed in GeoPard

SoilOptix, GeoProspectors/TopSoilMapper, FarmVU, Veris, EM38

VR fertilizer maps: Based on scanners data

30% less Nitrogen applied





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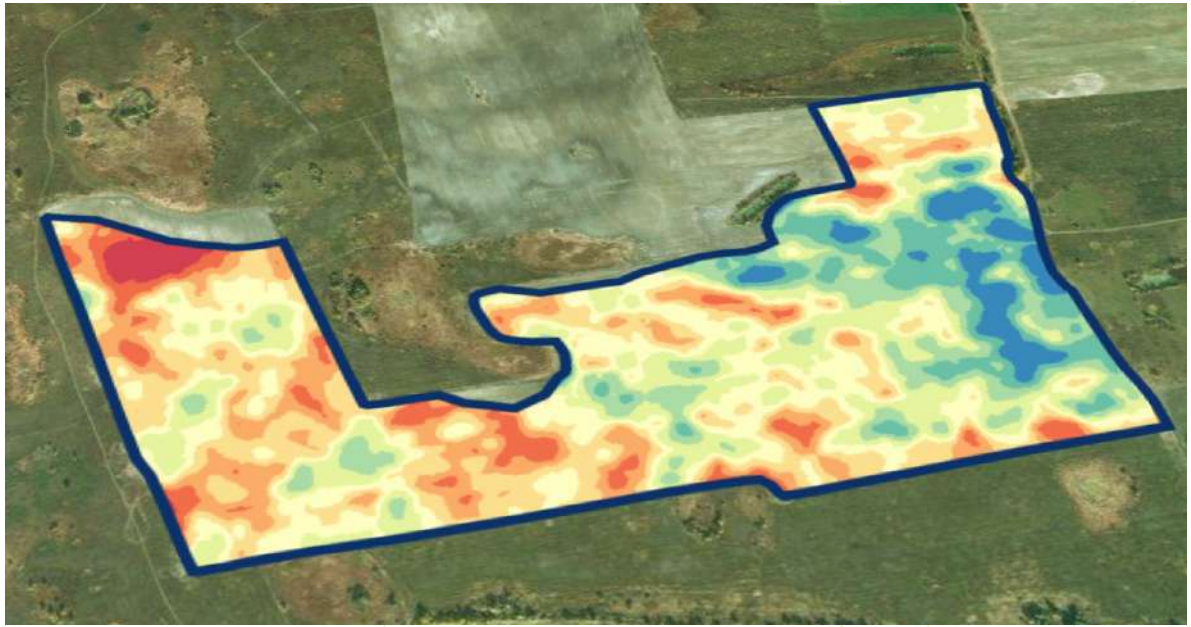
Use-Case: VR Seeding

Soil sampling (OM) + Topography + Last 15 years vegetation

Seeding rate - 60к-85к / hectare/ corn - **20% cost saving**



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Use-Case: VR Fungicide Application

Current vegetation & bare soil. **Saving on Fungicides costs 32%**.

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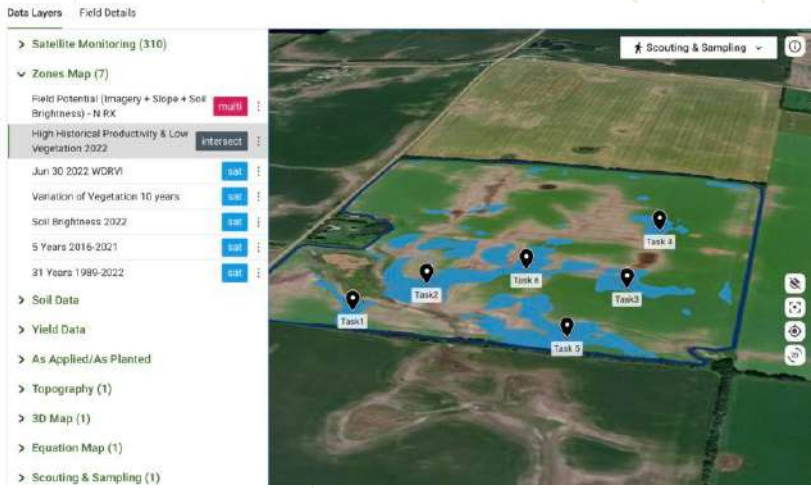
Use-Case: Automated Scouting

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

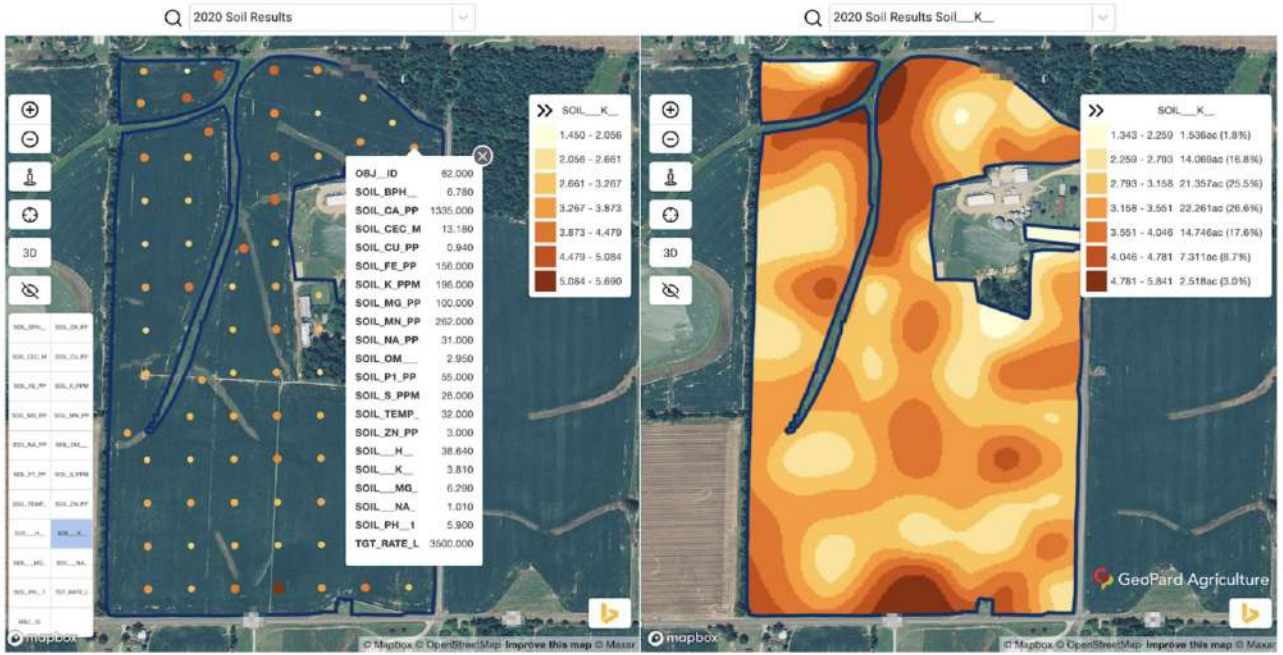
Based on GeoPard unique maps such as field potential, stability, current productivity, multi-layers maps & cross analytics.



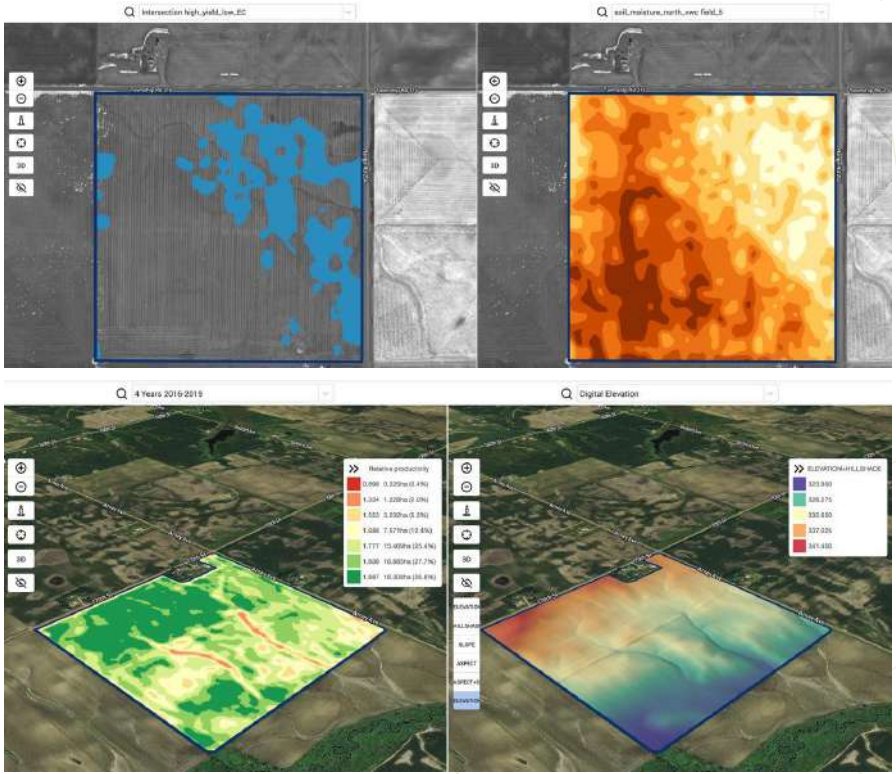
Soil sampling

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

[Blog: Soil data analytics]



Use-Case: Detection of Yield Limiting Factors



Yield / Soil Moisture correlation

LIDAR topographic analysis

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 **MyJohnDeere Ops Center**.

JOHN DEERE OPERATIONS CENTER

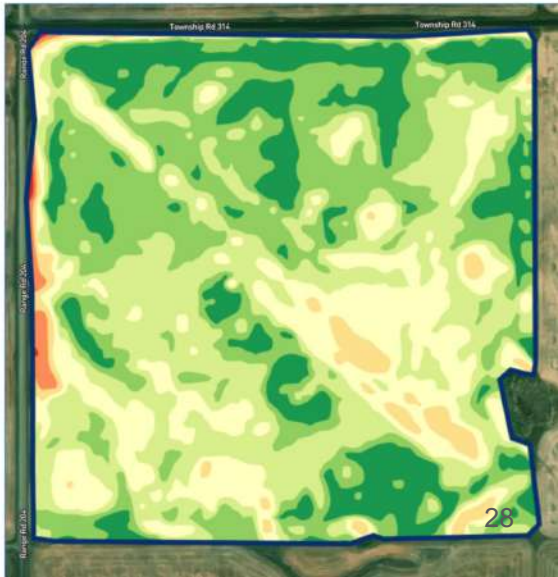
ISOBUS

Description | Rates

Ensure the units you are using match the rate controller requirements:
- sprays will use l/ha or gal/ac;
- fertilizer, lime, etc. will use kg/ha or lb/ac.

Purpose: Fertilizing

Color	Area (ac)	N	P	+ Product
	0.31 (0.20%)	4	3	
	1.47 (0.94%)	6	4	
	6.22 (3.98%)	7	5	
	32.43 (20.72%)	8	7	
	48.15 (30.77%)	9	9	
	44.12 (28.19%)	11	11	
	23.80 (15.21%)	13	12.5	
Total Product Volume		1 541.20	1 481.17	
Average Product Rate		9.85	9.46	
Price per Unit		0.21	0.34	
Cost per Product		323.65	503.60	
		Total Product Cost	827.25	



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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

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	5284.84
	0.74	5.58 11.33%	0.72	0.75	1836.29

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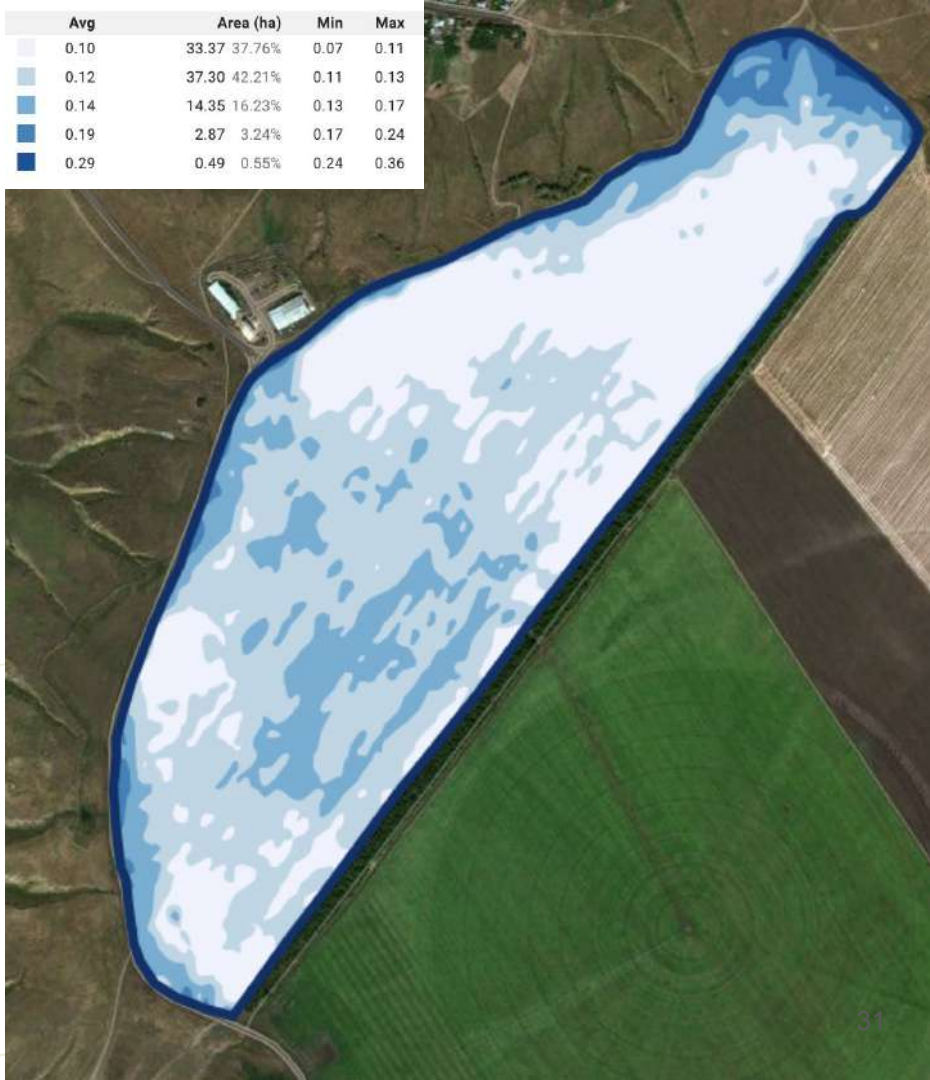
Stability Maps / Change Detection

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.



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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.

Coming: Automated correlation between data layers.

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As-Applied and As-Planted Data Analysis

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

Example: Comparison planned and executed VRA maps.

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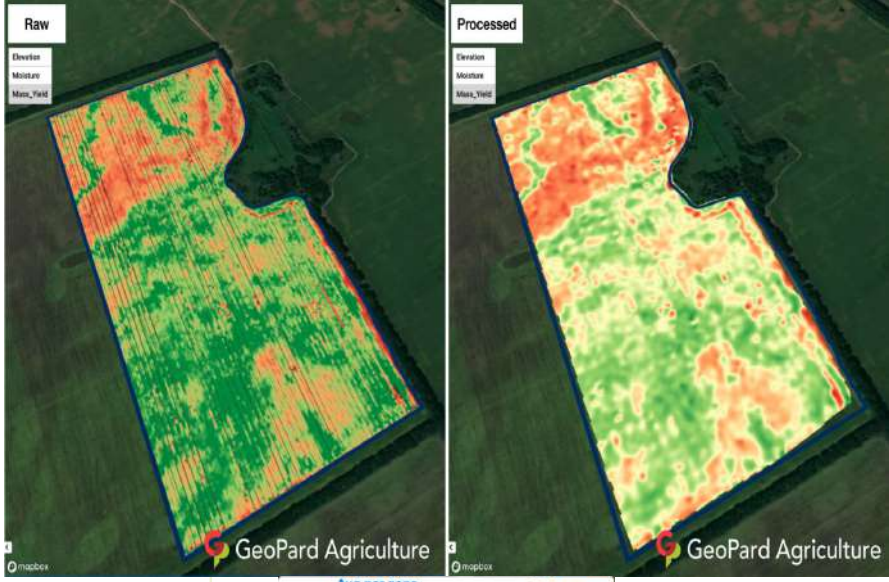
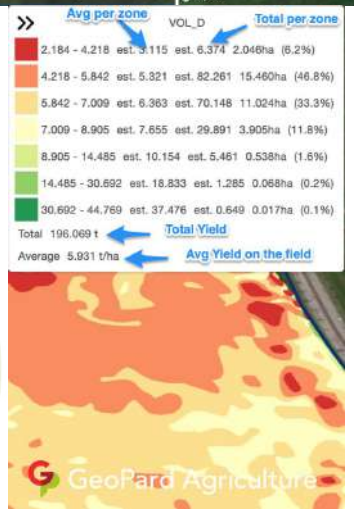
Yield Data Analytics

Import of harvesting data

Automated Processing & Cleaning

[Read an article in our blog]





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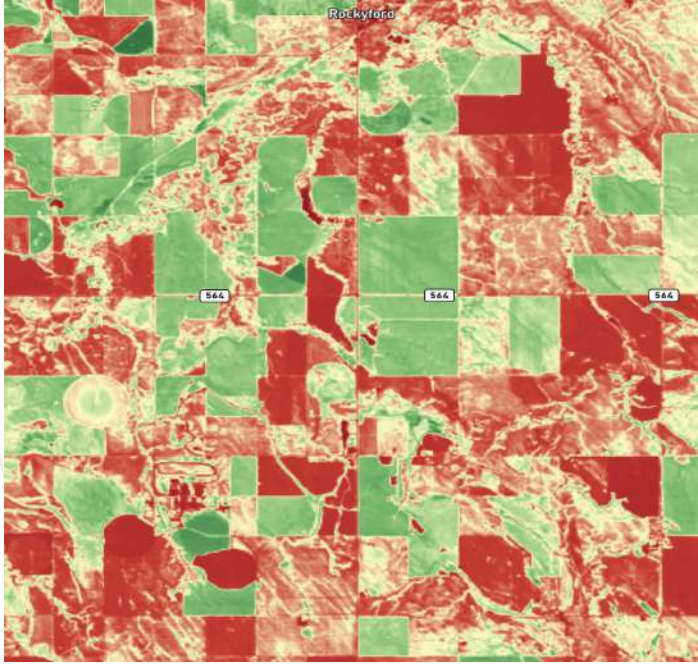
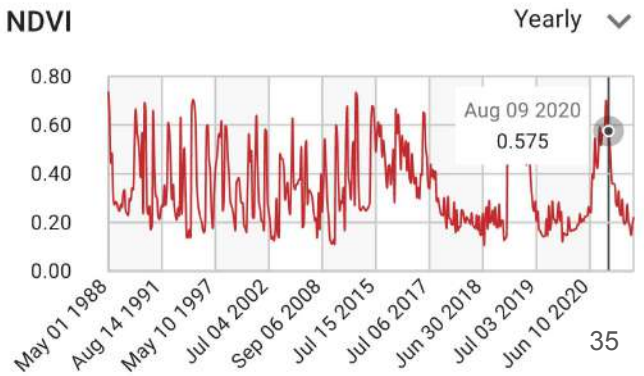
Current and Historical Imagery

- 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 - ...)
    - Radar data (2022)
    - Hyperspectral imagery (2022)

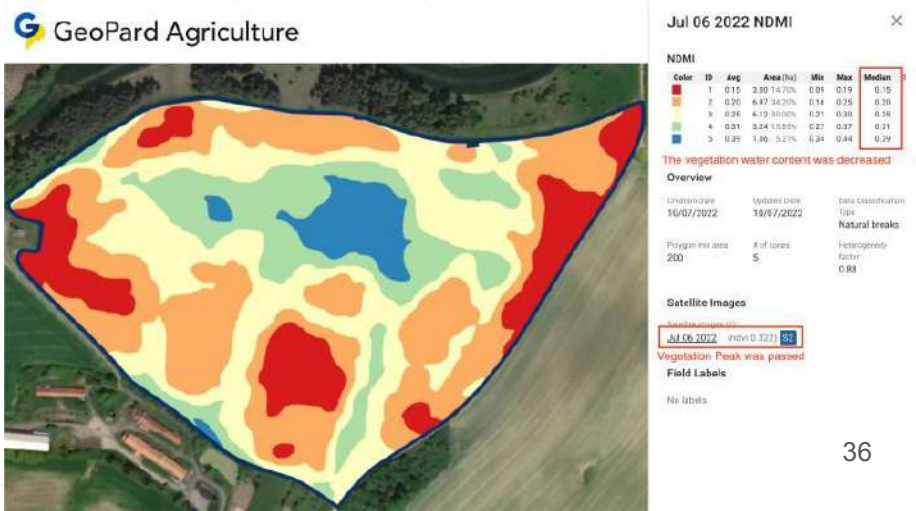




GeoPard Agriculture
Simplify complexity

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



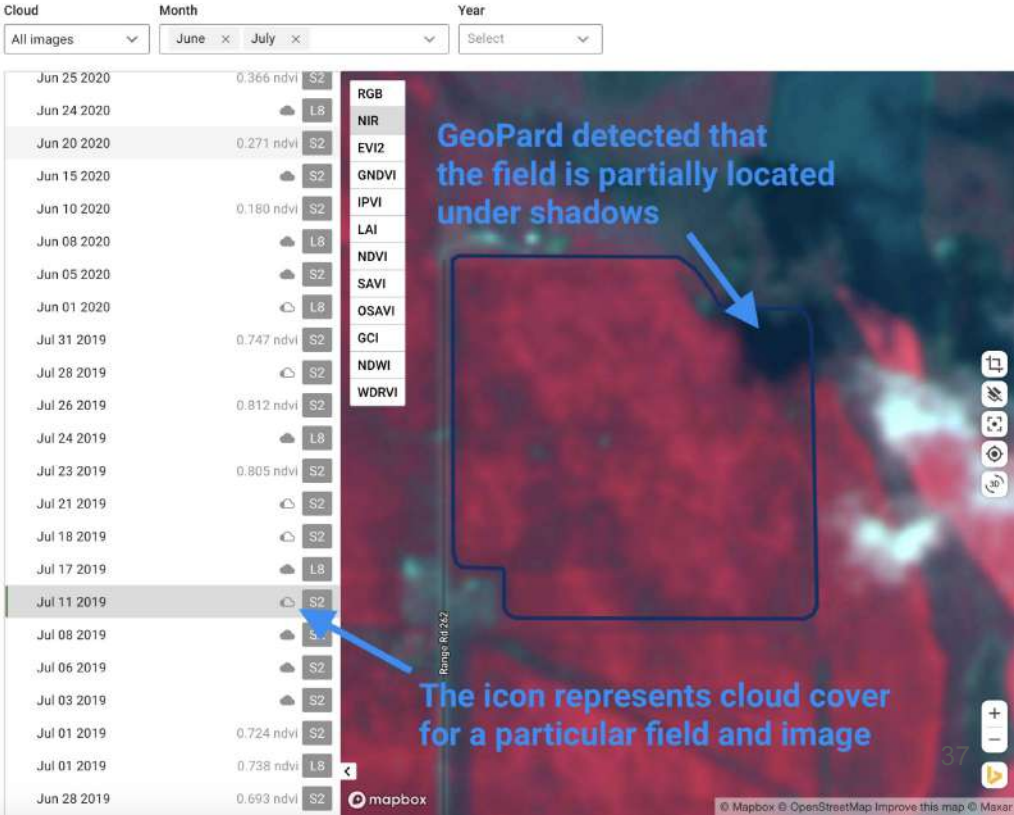
Best-In-Class Clouds And Shadows Detection

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**

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



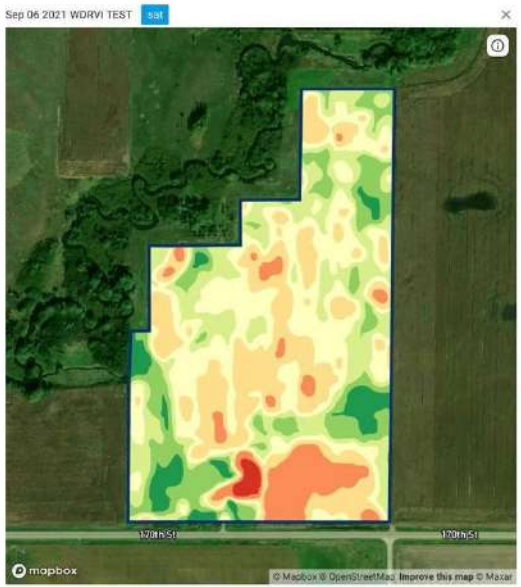
Planet Labs Imagery Analysis and Rx Creation

Automated data processing includes:

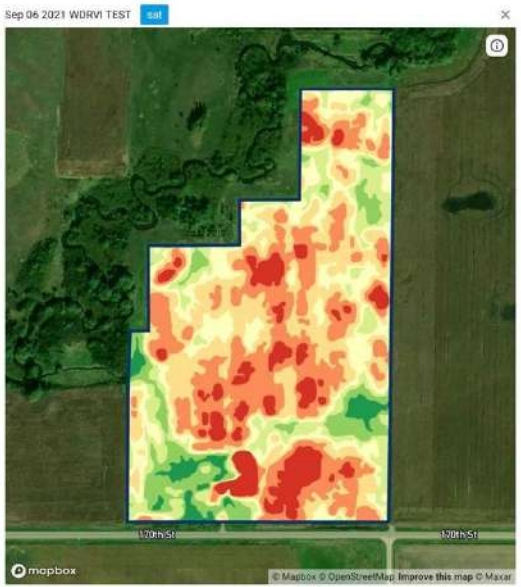
Clouds/shadow detection

Data normalization and cleaning

Analytics products creation



Sentinel-2 VS Planet Scope



GeoPard Agriculture
Simplify complexity

Mobile Application

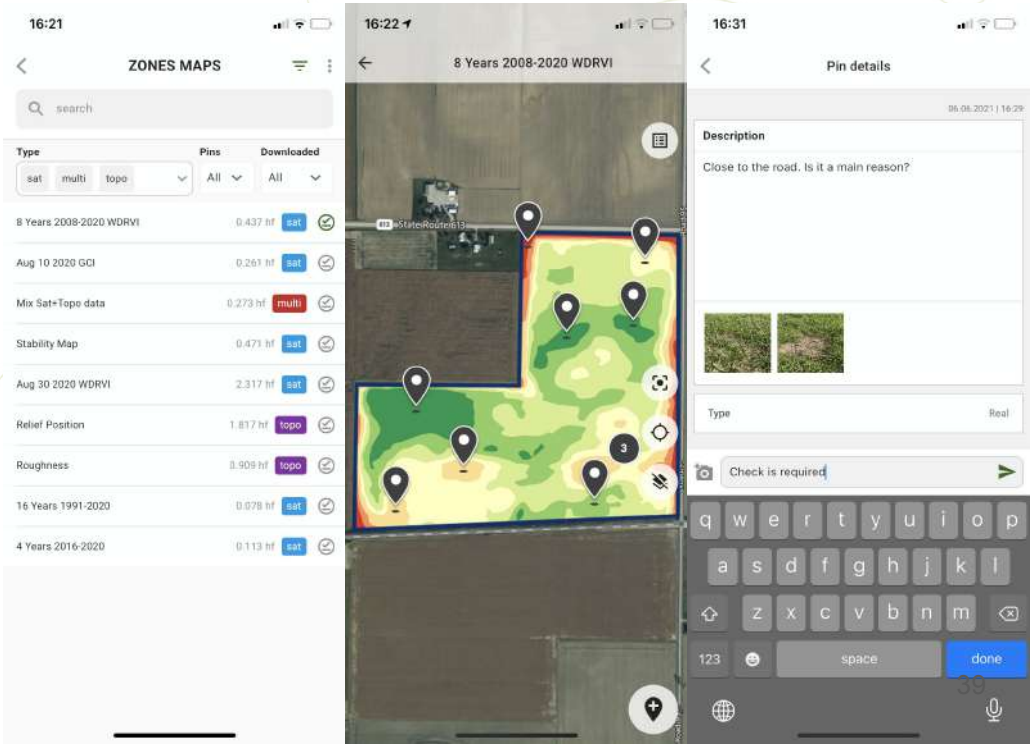
Sync between mobile and web apps

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**.

Example: Access to field data layers, offline map with pins and notes.

Platforms: IOS, Android. Mobile and Tablets

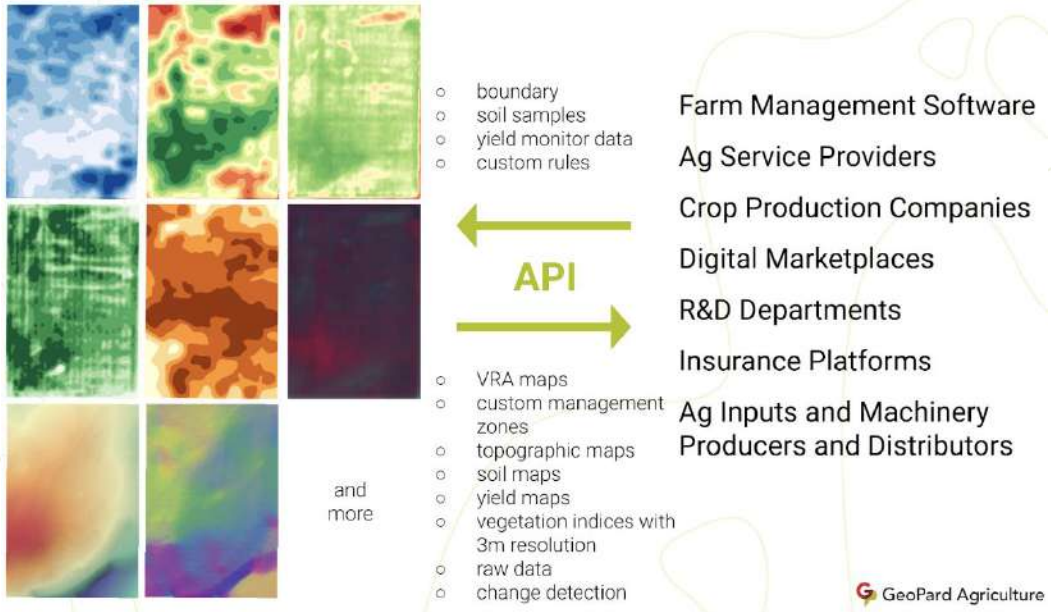
While Label applications



GeoPard Agriculture
Simplify complexity

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



Data Compatibility

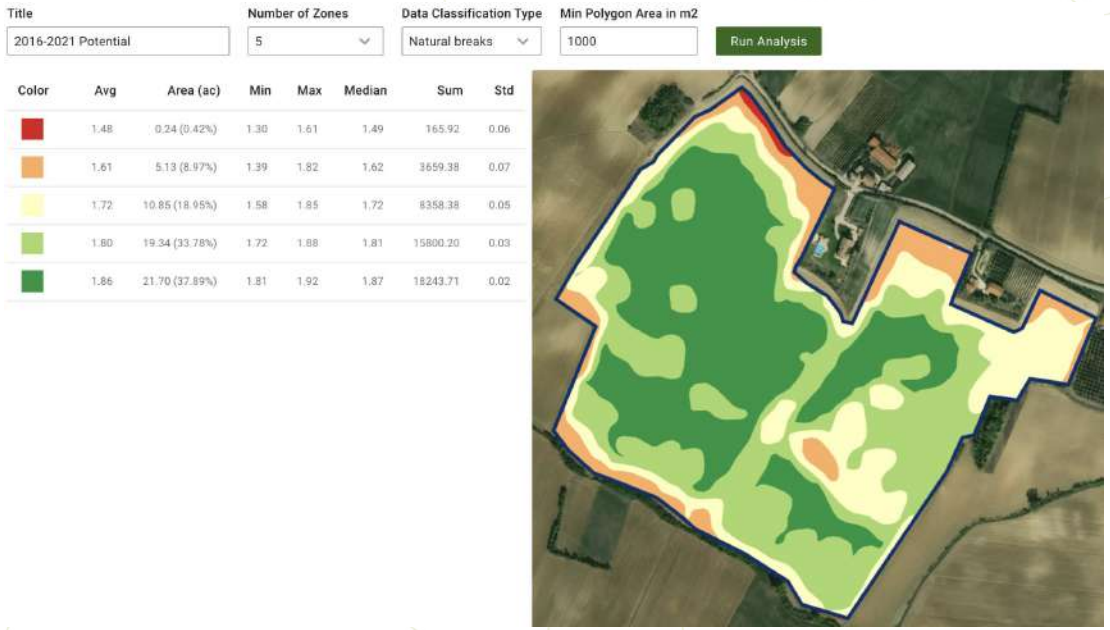
Raven Slingshot and Viper Pro 4	Shapefiles
Trimble	Shapefiles and Isoxml
John Deere GS3 and GS4 data	GS3 details, GS4 details
John Deere	MyJD Ops Center integrated, see details in our blog post
AGCO	ISOXML and shapefiles
CNH	ISOXML/shapefiles supported
Topcon/TAP	Shapefile supported
Mueller	ISOXML/Shapefiles 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.	

Statistics for Zones

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

Statistical metrics:

- minimum
- maximum
- average
- median
- sum
- standard deviation



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

Automated Heterogeneity index

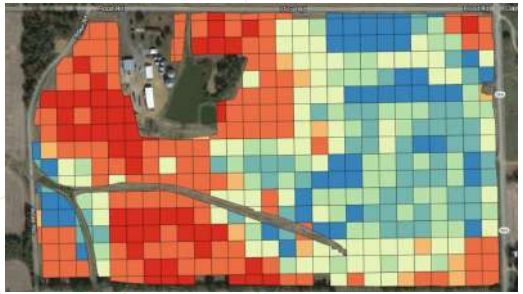
Decide which fields to target first with precisionAg

GeoPard Agriculture
Simplify complexity

Sustainability and Carbon Module

- Tillage
- As-applied Fertilizer maps
- Yield maps / GeoPard Field Potential maps
- Cover Crops
- Crop Rotation
- … other factors

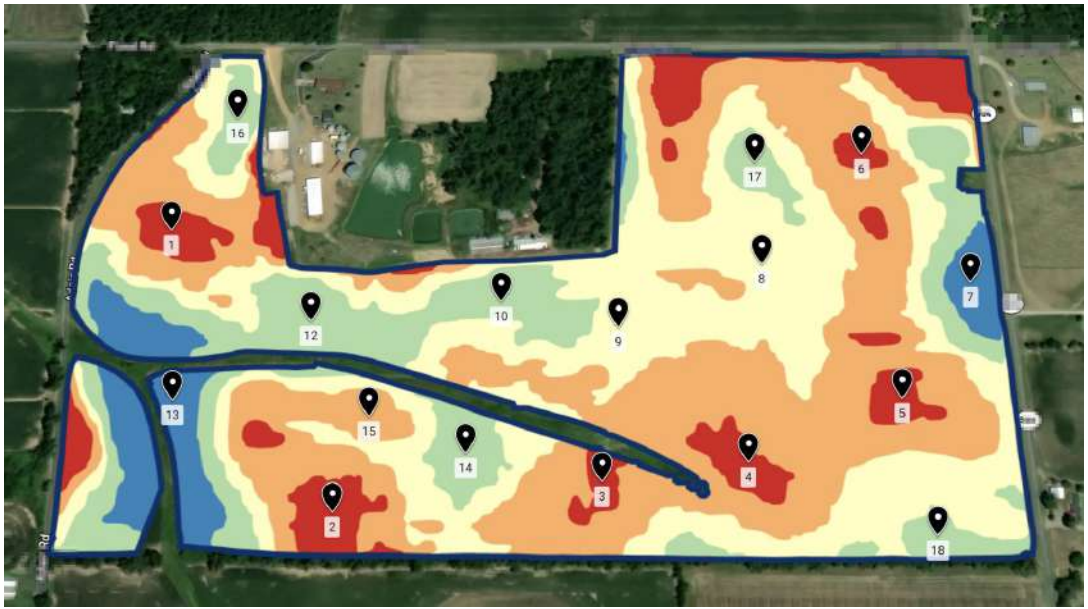
→ **Per pixel calculated Sustainability Index**



GeoPard Agriculture
Simplify complexity

Recommendation on Carbon Soil Samples

Basis to start carbon measurements



GeoPard Agriculture
Simplify complexity

Web, Mobile, API, Widgets, White-Label

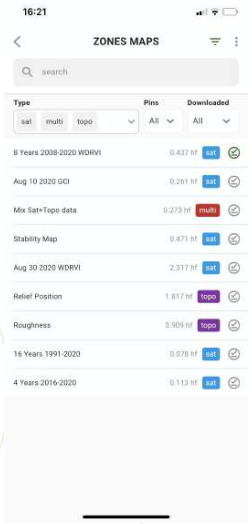
WEB: Online access to all features.

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.



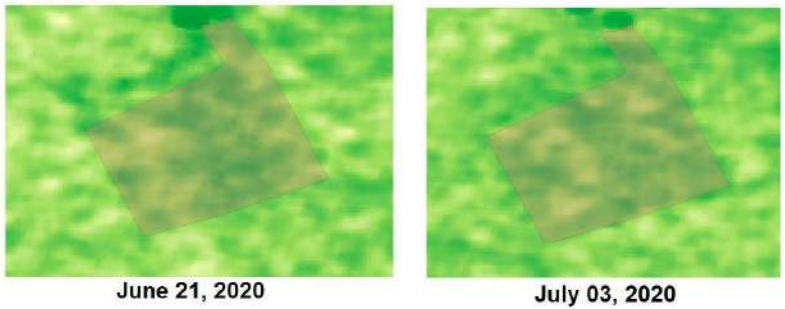
GeoPard Agriculture
Simplify complexity

Vegetation on Cloudy Days, Tillage & Cover Crops Detection

PRE-PRODUCTION

Products:

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



GeoPard Agriculture
Simplify complexity

Join our community Partner Program and earn with us!

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.

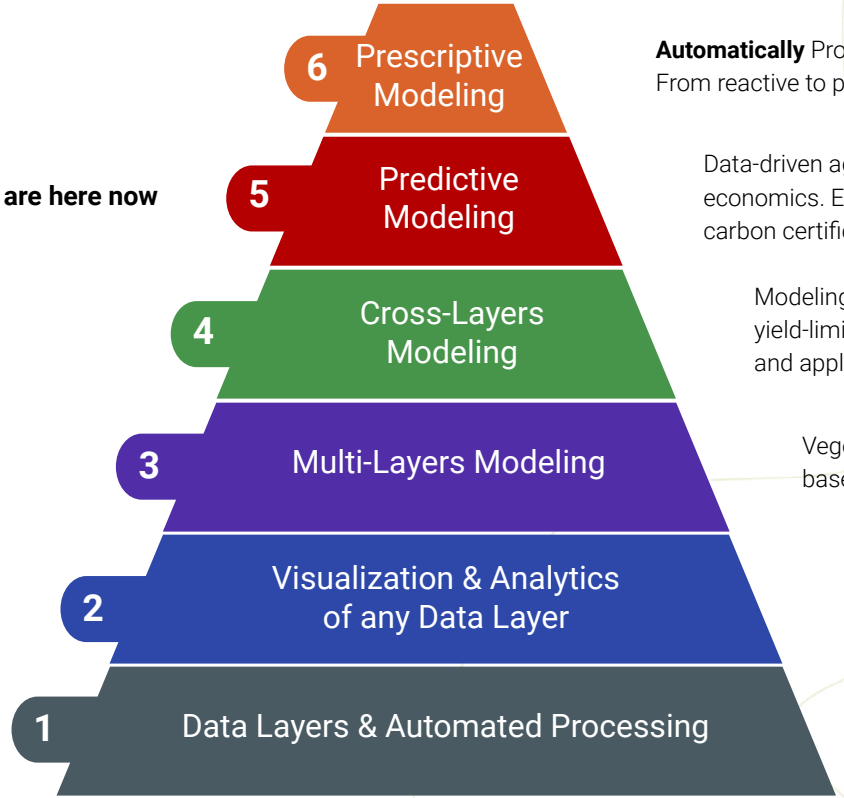
Promo materials

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.

Product Vision



We are here now

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.

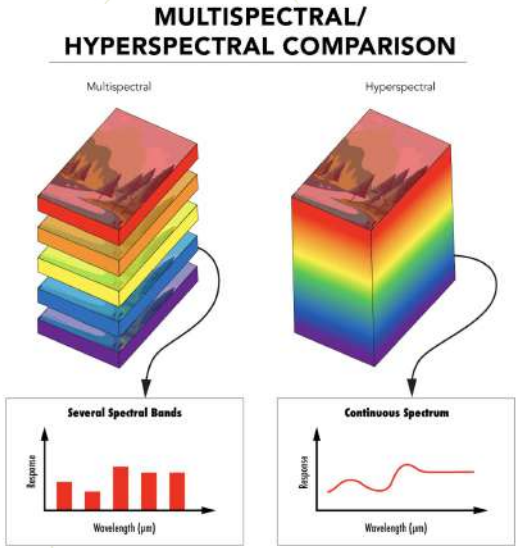
R&D: Hyperspectral Imagery Analytics

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



GeoPard Agriculture
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GeoPard Agriculture

Thank you!

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