

# 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



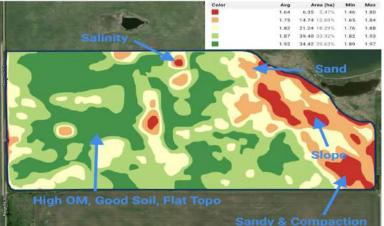
**Carbon Dioxide** is the main greenhouse gas

Simplify complexity

GeoPard Agriculture



Nitrous Oxide is the most potent ag greenhouse gas



### 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



### Automated Platform for Sustainable and Precision Agriculture



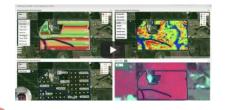
### How It Works

Automated powerhouse for sustainable and precision agriculture

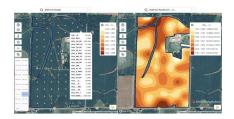
- · Flexible agronomic logic: apply any math/formula/equation to calculate recommendations
- Support of all common data types: satellite imagery, radar imagery, machinery data, scanners and sensors
- Automated solution for recommendations >> Hyper-Automation of agronomy
- · Simple UX for fast manipulation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

Simplify complexity

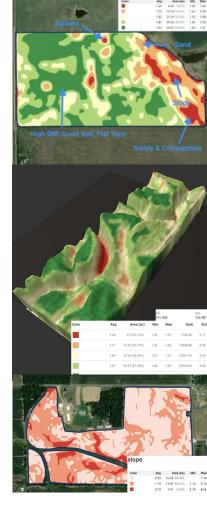
- Powerful flexible API for integration into customer solutions and business processes
- Enabler for transition into Sustainability and Carbon efficient practices
- A.I. & Big Data
- Mobile apps with offline mode



GeoPard Agriculture







### **Demo & Documentation**

### https://docs.geopard.tech



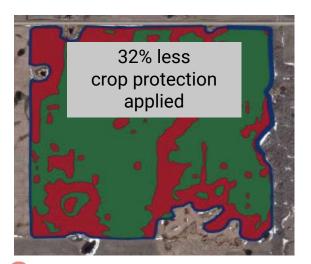


### **Use Cases**

#### VR fungicide application

Data: Current vegetation & bare soil

Crop: wheat



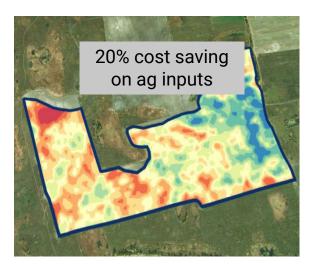
GeoPard Agriculture

Simplify complexity

#### **VR** seeding

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

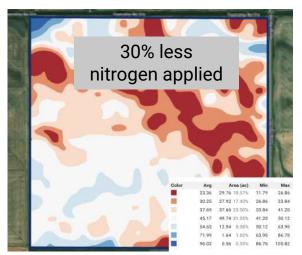
Seeding rate:  $60\kappa$ - $85\kappa$  / hectare/ corn



#### **VR fertilizing**

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

Crop : Canola

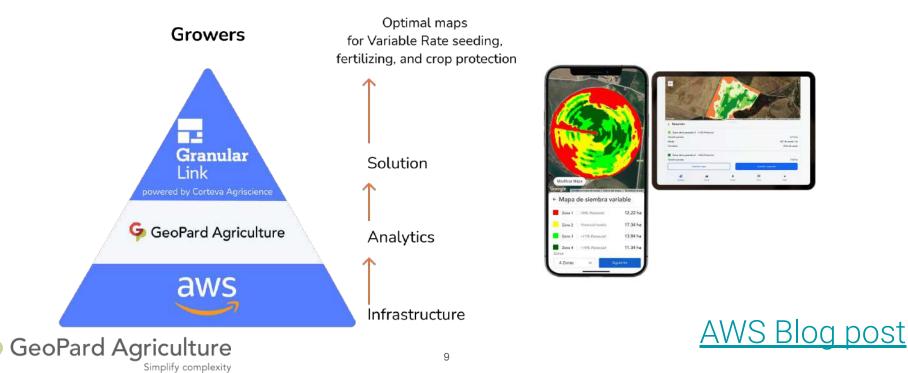


### Corteva Use-case

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



### **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

GeoPard Agriculture

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## Multi-layer Maps

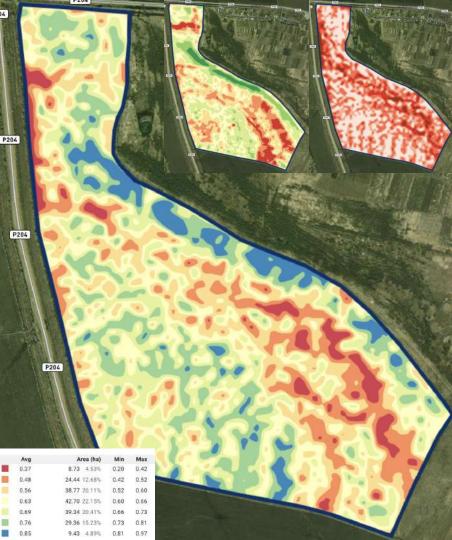
Delineation of management zones based on a <u>combination of any data layers</u> available in GeoPard with the flexibility to set a weight for each layer.

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

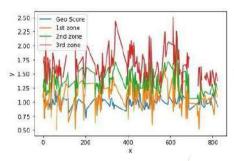
### GeoPard Agriculture



### **Automated Field Potential Maps**

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

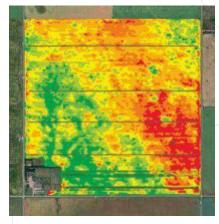
The heterogeneity index helps benchmark fields and prioritise ag operations. <u>Blog: Multi-Year Zones</u> <u>Blog: Heterogeneity Factor</u>

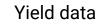




GeoPard Field Potential

maps





VS

### **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

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 =  $[37.6 \times (7.1 \times \text{soil pH})] + [(\text{target pH}-5.3) \times 5.0]$ . When the Target pH is greater than 5.3 and the soil pH is > 5.3, then the LR =  $[(\text{target pH}-\text{soil pH}) \times 5.0]$ 

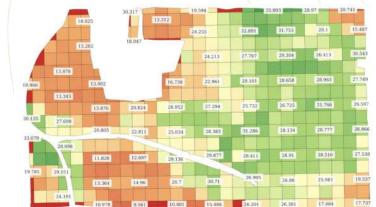
#### Equation in Python

Variables from datasets

targetpH soilpH

PDF

PDF Source





### Equations: Use Cases (1)

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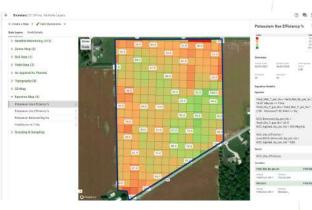
Select an equation to create prescriptions.

#### Create New Create and save your own equation with the parameters you need. Select from existing Category Predefined Equations V Search equations Corn Total Boron Removal in KG/HA Source URL 0 This formula estimates Boron (B) uptake and removal for Corn (Grain and Stover) crops grown in different countries of the world in metric units. Last modified: March 2022 Corn Total Nitrogen Removal in KG/HA Source URL $\bigcirc$ This formula estimates Nitrogen (N) uptake and removal for Corn (Grain and Stover) crops grown in different countries of the world in metric units. Last modified: March 2022. Corn Phosphorus Recommendations South Dakota State Source URL 0 University in LB/AC SDSU Extension fertilizer recommendations are based on field research in South Dakota and neighboring states. Phosphorus soil test results in this quide are stated in parts per million (ppm) and not pounds per acre. Interpretation for the Olsen phosphorus soil test procedures is listed here. Banding P near the seed as a starter frequently results in more efficient use of these fertilizers. The P205 recommendation can be reduced by one third if applying as a starter. If the previous "crop" was fallow or potatoes. The growth of corn after fallow or potatoes is sometimes not satisfectory. To correct this, apply 20-30 lbs/ac of P2O5 as a starter. Revised September 2005. Corn Total Magnesium Removal in KG/HA Source URL This formula estimates Magnesium (Mg) uptake and removal for Corn (Grain and Stover) crops prown in different countries

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of the world in metric units. Last modified: March 2022.

Owner Traded Theory Documental Strategy and



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#### Potassium Use Efficiency



### Nitrogen Use Efficiency

### The Party Name **Your Formulas**

. . .

### Equations: Use Cases (2)

#### Lime Rate Ibs/A Iowa State



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elif Target p		0.007))
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else:	. (Debtu"inches -	0.10(7)
Lime_Rate	= 0	

Simplify complexity

### Lime Rx based on SoilOptix pH

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Phosphorus Corn Recommendations (South Dakota State University)





#### Potassium Removal based on Yield

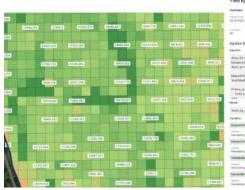


Nitrogen: Target vs Applied

#### Lime.Rate = round(\$8776 - (8244 \* Buffer.ph/) \*(Depth\_Inches \* 0.167)) efse:

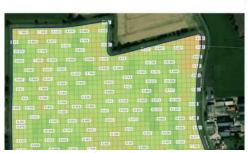
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### Equations: Use Cases (3)



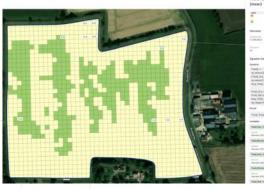


Dry Yield Calibration based on HarvestMoisture (%) and YieldWetMass (lb)





### Yield Trend above/below Average



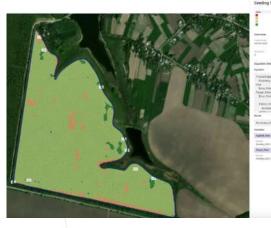
### Yield Trend for 4 Datasets

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

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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



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### Equations: Use Cases (5)

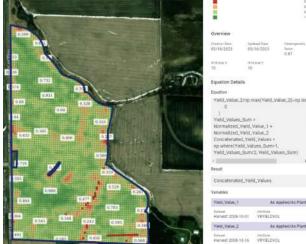


Clusters with and without Data for Yield Dataset



### **Combining 2 Yield Datasets**





### Combining 2 Yield Datasets including Normalization step

VEVIE: DUO

### Equations: Use Cases (6)





Yield Distribution (Statistics) including Total Collected Yield



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



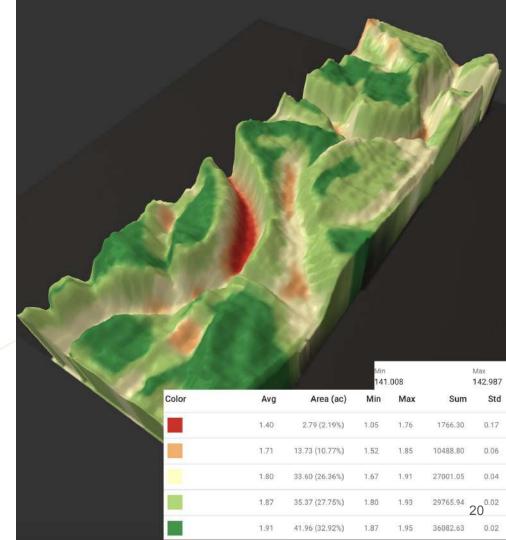
### 3D Maps

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





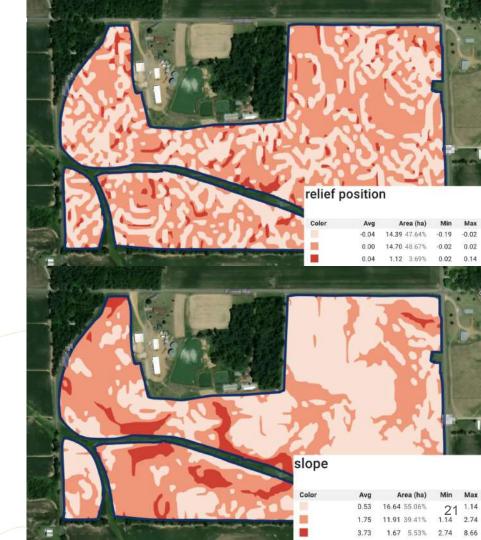
# **Topography Profile**

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

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

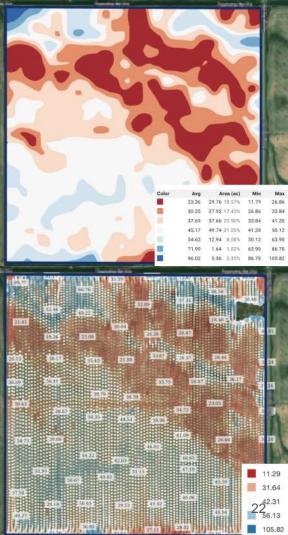
VR fertilizer maps: Based on scanners data

#### 30% less Nitrogen applied

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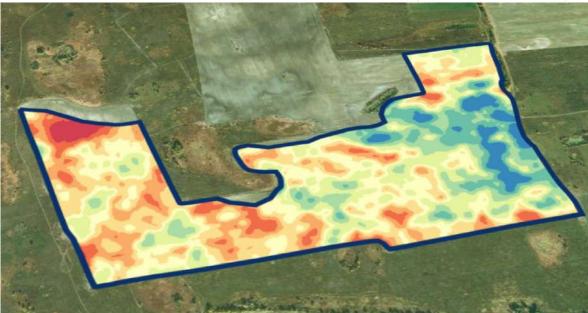




### **Use-Case: VR Seeding**

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

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



### **Use-Case: VR Fungicide Application**

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



### **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.

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v	Zones Map (7)	and the second
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	Jun 30 2022 WORVI	1
	Variation of Vegetation 10 years	
	Soil Brightness 2022	
	5 Years 2015-2021	
	31 Years 1989-2022	· Skat
>	Soil Data	9
>	Yield Data	Task1
>	As Applied/As Planted	
>	Topography (1)	And and a second
>	3D Map (1)	
>	Equation Map (1)	
>	Scouting & Sampling (1)	

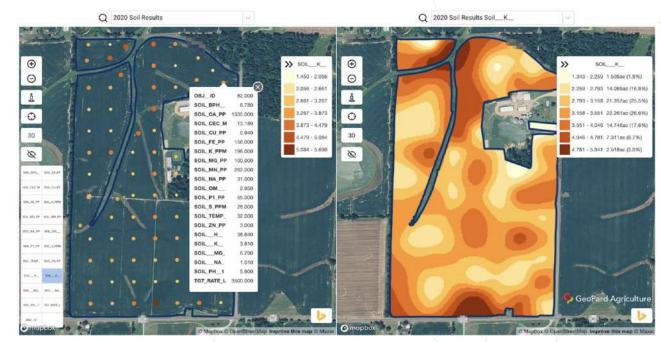




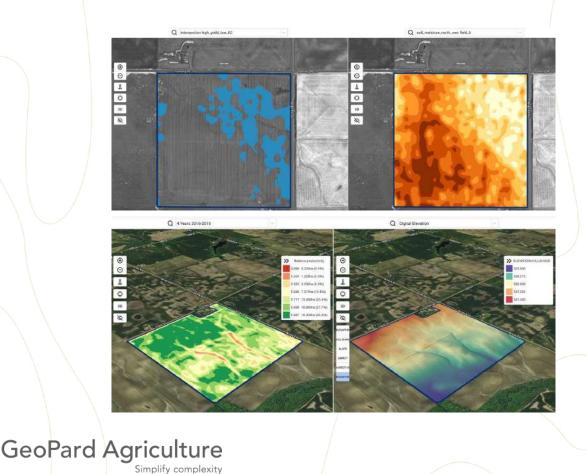
### Soil sampling

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**.

SO RUS

.....

JOHN DEERE

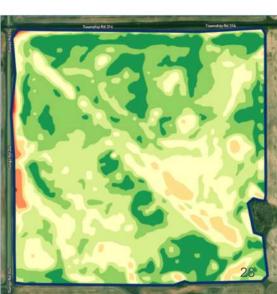
CENTER

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Simplify complexity

**OPERATIC** 





### **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

<u>Soil brightness</u> 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.



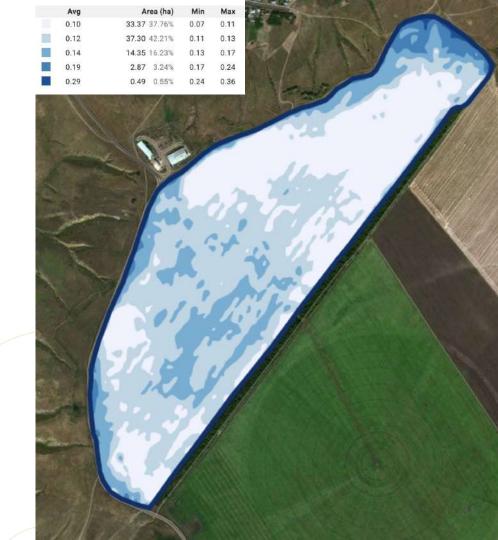


# Stability Maps / Change Detection

Detect <u>the most changeable and stable spots</u> 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.





# Intersection of Data Layers

<u>Overlapping among management zones</u> 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.





# 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.



Osnova\_Factual\_Azot actual\_rat as applied

mapbo

Osnova\_Factual\_Azot





### **Yield Data Analytics**

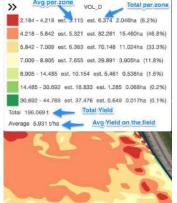
Import of harvesting data

Automated Processing & Cleaning

Read an article in our blog







eoPard Agriculture

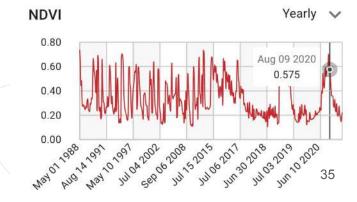
G

# 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)

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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

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Simplify complexity



 NUML
 Image: Constraint of the state of t

Jul 06 2022 NDMI

# **Best-In-Class Clouds And Shadows Detection**

GeoPard provides <u>high accuracy of clouds and</u> <u>shadows</u> 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.

Cloud	Month	Year	
All images 🗸 🗸	June $\times$ July $\times$	✓ Select ✓	
Jun 25 2020	0.366 ndvi   S2	RGB	
Jun 24 2020	A 18		
Jun 20 2020	and the second se	GeoPard detected that	
Jun 15 2020	📥 S2	the field is partially loca	ated
Jun 10 2020	0.180 ndvi \$2	under shadows	
Jun 08 2020	🐽 L8		
Jun 05 2020	- 100 H		
Jun 01 2020	termine and the second s	SAVI	
Jul 31 2019		GCI	
Jul 28 2019	CONFERENCE OF CONTRACTOR	NDWI	
Jul 26 2019		WDRVI	
Jul 24 2019			
Jul 23 2019	0.805 ndvi S2		
Jul 21 2019	🛆 S2		the second
Jul 18 2019	G 52		
Jul 17 2019	a 18	and the second sec	State of the local division of the local div
Jul 11 2019	G 52		Statistics of
Jul 08 2019	a 5.	tange Rd 242	
Jul 06 2019	🚓 S2	Kange	
Jul 03 2019	s2	The icon represents clou	d cover
Jul 01 2019	0.724 ndvi S2	for a particular field and	
Jul 01 2019	0.738 ndvi 1.8	nor a per de alta fiera alta	3
Jun 28 2019		mapbox	3 OpenStreetMap Improve this m

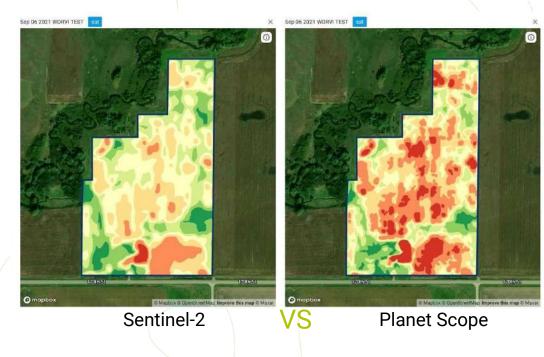
# Planet Labs Imagery Analysis and Rx Creation

Automated data processing includes:

Clouds/shadow detection

Data normalization and cleaning

Analytics products creation





## **Mobile Application**

### Sync between mobile and web apps

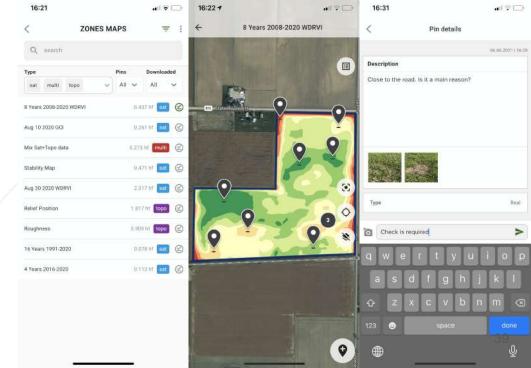
Online access to all field datasets and zone. Offline zones and soil maps and scouting capabilities including planning and executed actions with **comments and photos**.

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

Platforms: IOS, Android. Mobile and Tablets

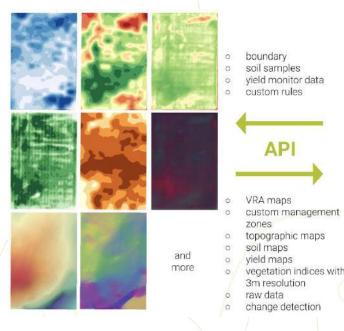
Simplify complexity

While Label applications



# **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



Farm Management Software Ag Service Providers Crop Production Companies Digital Marketplaces R&D Departments Insurance Platforms

Ag Inputs and Machinery Producers and Distributors



# 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 <u>blog post</u>
🧭 AGCO	ISOXML and shapefiles
Син	ISOXML/shapefiles supported
Copcon/TAP	Shapefile supported
O Mueller	ISOXML/Shapefiles supported, details here
SOXML	Claas, Topcon, Dickey John, CNH and others
AgLeader Monitors	Shapefile support, <u>details here</u>
Amazone / Amatron	Shapefile, ISOXML, <u>Amatron 3 details</u> , <u>Amatron4 details</u>
Contraction Geolson	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.	

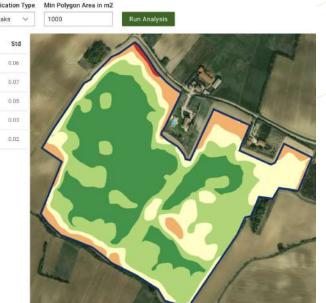
### **Statistics for Zones**

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

### Statistical metrics:

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

2016-2021 Potential		Number of Zones		Data Classification Type			
		5		~	Natural breaks 🗸 🗸		
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





# **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

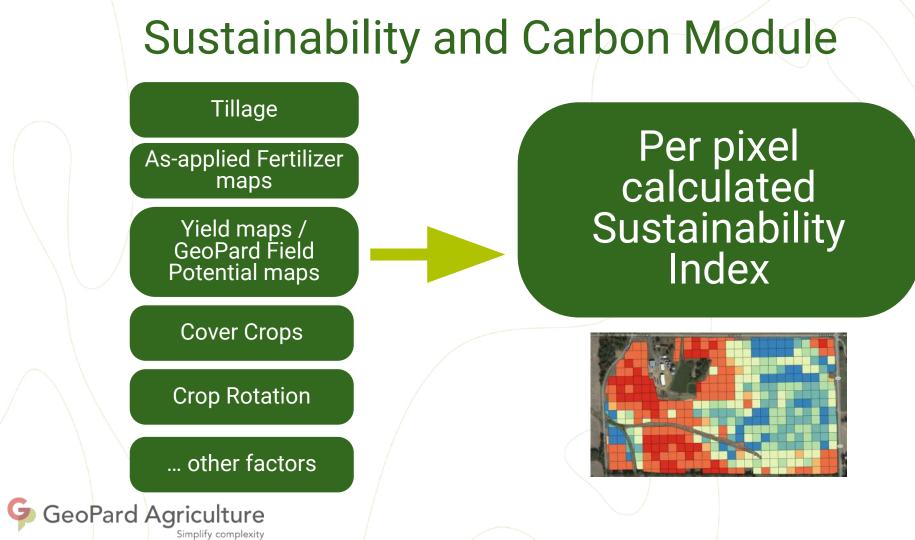




### Automated Heterogeneity index

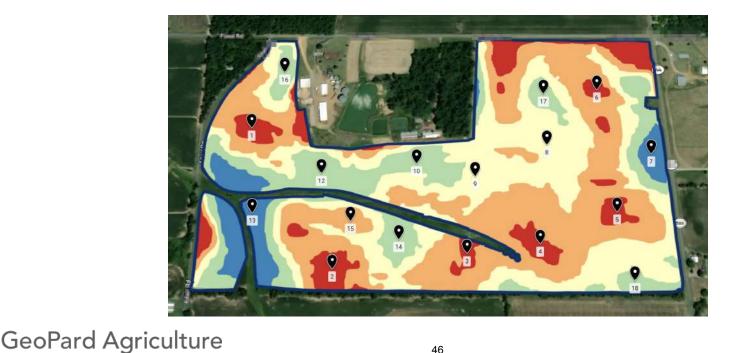
Decide which fields to target first with precisionAg





# **Recommendation on Carbon Soil Samples**

Basis to start carbon measurements



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Simplify complexity

# Web, Mobile, API, Widgets, White-Label

WEB: Online access to all features.

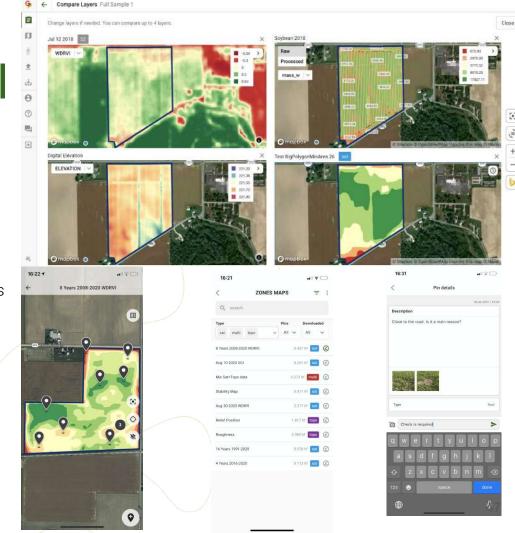
Example: Compare 4 data layers (satellite image, yield dataset, elevation, historical zones), create VRA map on a live map.

**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.



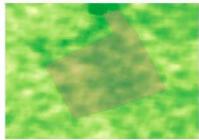


# Vegetation on Cloudy Days, Tillage & Cover Crops Detection

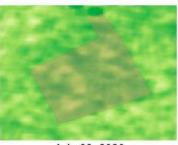
### **PRE-PRODUCTION**

### Products:

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







July 03, 2020



# 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.



#### **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.



#### Clients

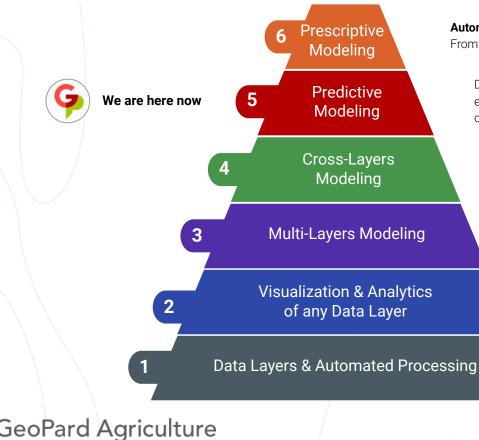
All clients who enter your referral code, follow your redirect link for registration or inform us of your recommendation will be identified as a referral sale. Clients receive a special bonus for registering with the referral.



#### 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 <u>here</u>.

## **Product Vision**



Simplify complexity

**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**

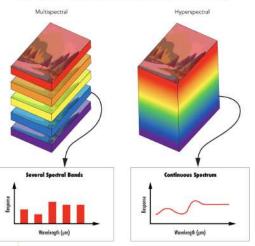
GeoPard managed to successfully preprocess (clean, normalize), upload, calculate statistics, various indices and spectral signatures for HYPERSPECTRAL Imagery (±250 bands in comparison to ±10 bands from multispectral imagery).

Use-cases:

- Remote detection of sustainable & <u>regenerative farming practices</u>
- 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 <u>project partially funded</u> by the EU and the Ministry of the Environment of North Rhine-Westphalia

#### MULTISPECTRAL/ HYPERSPECTRAL COMPARISON







### Thank you!

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tel: <u>+4917636322391</u>



