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Effectiveness Of Using GIS Technologies In Agriculture

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Abstract: Nowadays, the use of GIS technologies is relevant. Therefore, there is a need to justify the advantages of GIS technologies. This article describes the effectiveness of the use of GIS technology in the agricultural sector.
Keywords: GPS, robotics, drone and satellite.

Nowadays, GIS technology can be used in many fields. This system is also used for environmental protection, deforestation and reforestation, disaster management, etc.

Geographic information systems (GIS) are systems for creating, managing, visualizing and analyzing all kinds of data. GIS links data to a map, combining location information (where objects are located) with all kinds of descriptive information (what those objects are).

Agricultural geographic information systems (GIS) can optimize data collection from field equipment, drones, and satellites. The obtained materials can be used for various purposes: from the development of precision agriculture and crop forecasting to tracking the movement of livestock.

The use of GIS technology in agriculture brings many advantages. Agricultural GIS solutions can optimize the performance of input suppliers. Thus, they allow the quality of their products to be analyzed in the field. With this, you can analyze the results before and after treatment and compare the effect of fertilizers and other additives on the crop.

GIS technology for agriculture allows IT and telecommunications companies to expand their audience by optimizing their offerings, as well as creating infrastructure in previously inaccessible areas. Geographic information systems also help improve market positions by providing customers with access to precise agricultural inputs.

Agricultural managers are using GIS to increase short-term profits and achieve long-term sustainability goals. At the same time, the development of technology increases the availability of geographic information systems for agriculture: today they can be used by both large corporations and small farmers.

GIS is a tool for creating multi-layered interactive maps necessary for complex data visualization and spatial analysis. GIS technology has the following advantages for agriculture: they are suitable for collecting, organizing and analyzing field data, as well as for remote monitoring of crop conditions. Effective use of GIS in agriculture requires modern technology and tools: GPS, robotics, drones and satellites.

By visualizing data, farmers can identify plant development trends and plant growth patterns, detect changes early, and troubleshoot problems. In precision agriculture, GIS allows for optimizing the collection and interpretation of field data sets needed for effective decision-making.

GIS enables farmers to make the most of their land, thereby increasing productivity, optimizing costs and minimizing environmental damage.

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GIS technologies used in agriculture include both hardware and software. The equipment can include anything from laptops and desktops to drones and satellites. The software is used to create maps showing the location and general condition of crops, soil characteristics, soil type, types of fertilizers used, and more. Let's take a closer look at how exactly GIS data is collected in agriculture.

Remote sensing

Remote sensing involves scanning the Earth's surface from the air or space. The best satellite for medium spatial resolution imagery is Landsat 8, which orbits the planet once every 16 days and operates in nine visible light bands as well as thermal infrared (TIR). Landsat 8 is suitable for crop monitoring, disease detection, irrigation planning and more.

Along with Landsat 8, private companies are increasingly launching their own satellites. Based on them, applications are created for specific tasks, such as monitoring water supply or temperature changes. This allows more accurate use of geographic information systems in agriculture.

Combining the capabilities of GPS and GIS in agriculture allows farmers to optimize the use of resources. Thus, maps based on GPS data can help determine the boundaries of fields, monitor the operation of irrigation systems, monitor the development of specific crop varieties, etc.

Agricultural machines

In the context of agricultural GIS applications, agricultural sensors are often used to complement satellite data. For example, various indicators of crop health, such as chlorophyll and moisture levels, can be analyzed in real time using GPS sensors on planters, harvesters and irrigation systems. Some advanced technologies can work autonomously on the basis of collected data, and the rest are used as an additional GIS analysis tool.

An example of GIS software in agriculture is EOSDA crop monitoring.

Agricultural GIS software varies depending on the goals set by the developer. Some instruments indicate crop types, others indicate soil moisture. In general, thanks to the wide range of GIS capabilities, any type of agriculture can be raised to a whole new level. In addition, the software can be used in areas related to agriculture, for example, to analyze the economic benefits and costs of the logging process.

The EOSDA Crop Monitoring digital platform is an example of a versatile GIS application for agriculture. Historical data on field productivity, analysis based on vegetation indices and accurate 14-day weather forecasts are available.

Other features of the platform include:

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• Scouting tool (optimizes task management and allows scouts to create and send real-time reports);

• work log (allows planning, coordination and control of all field operations).

EOSDA Crop Monitoring can work with agricultural GIS data from external sources. For example, the Data Manager tool allows integration of data from agricultural machinery sensors into the platform's database. However, the system is compatible with the two most common file formats, SHP and ISO-XML, and a dataset can contain multiple metrics. Based on the obtained data, we can estimate the yield of a specific crop, analyze the efficiency of fertilizer use, and develop a long-term production strategy.

Assessment of the quality of fertilizer application based on field equipment data processed using the EOSDA Crop Monitoring

Thus, the capabilities of EOSDA Crop Monitoring clearly show the importance of using geographic information systems in agriculture. Let's look at the main areas of their application.

Main areas of GIS application in agriculture

The number of applications for the use of GIS in agriculture has increased dramatically in recent years due to technological advances. Below are the main areas of application of these systems.

GIS software can create detailed vegetation and yield maps to help optimize decisions. Using GIS tools for agriculture, we can determine the level of vegetation in an entire field or a specific area. This information is then used to adjust the application of seeds, nutrients, herbicides and fertilizers.

With the EOSDA Crop Monitoring platform, we can create field productivity maps using data from previous years. They help identify the least effective areas that need additional treatment.

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Productivity map based on historical data, showing the most and least productive areas of the field

Mapping

The use of GIS in agriculture greatly facilitates the analysis of soil and crop conditions. In particular, we can create yield and vegetation maps based on vegetation indices such as NDVI. In addition, mapping helps to optimize field monitoring and overall production management.

Comparing the condition of crops on certain days helps to determine the effect of various factors on the yield. EOSDA Crop Monitoring has a split screen feature that allows you to compare current field conditions with data from the previous week, month or even year. It is also possible to check the performance of a field on a particular day based on two different indices.

Manual inspection is a slow and labor-intensive method of monitoring the condition of crops over a large area. Remote sensing and GIS technologies for agriculture allow solving this problem.

GIS-based precision agriculture makes it possible to determine which crops need special care. For example, with the help of satellites and sensors on airplanes, we can monitor the temperature of plants. Abnormally high readings may indicate disease, pest attack, or dehydration.

Inspection of large areas for pests requires a lot of money. Agricultural GIS technologies based on satellite data combined with deep learning algorithms make the process much easier.

Using EOSDA Crop Monitoring vegetation indices, we can identify threats from weeds to plant diseases. The index map marks specific areas with low vegetation so the scout no longer has to survey the entire area. After analyzing a selected area, it can quickly send images of threatened species via the EOSDA Crop Monitoring mobile app.

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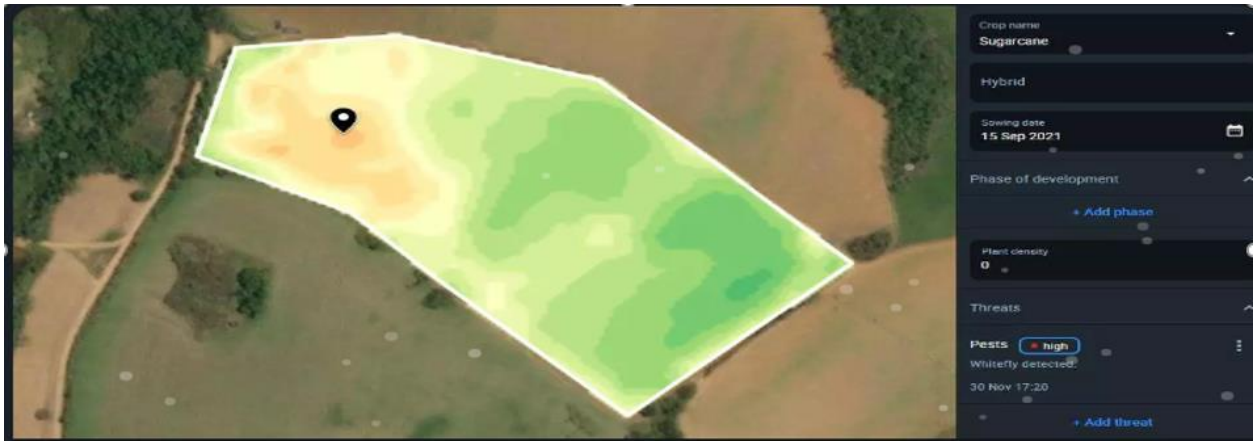
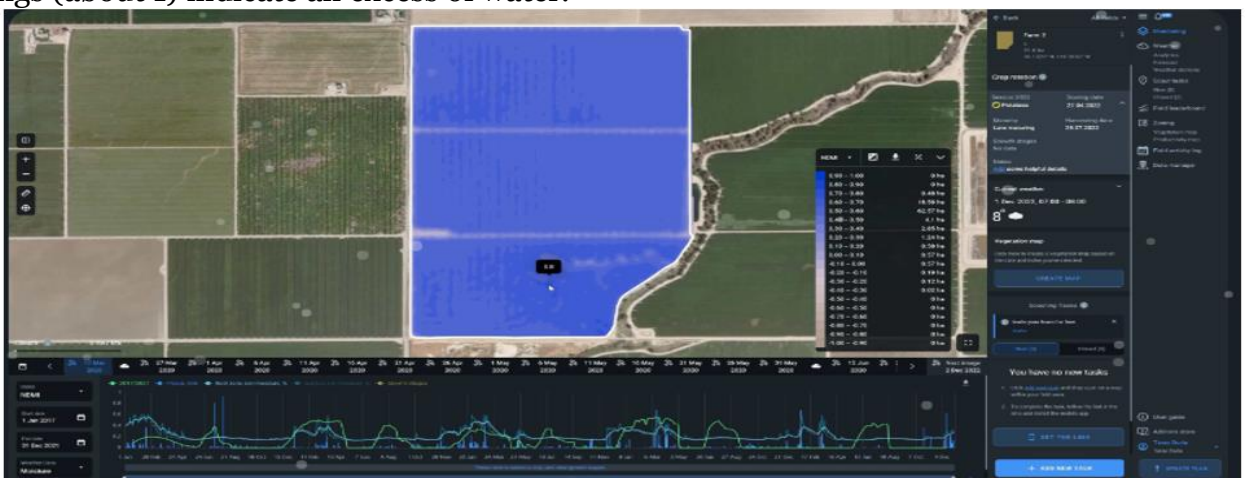


Identification of areas of the field with low vegetation density using EOSDA Crop Monitoring, which allows you to narrow the inspection area

Prolonged drought and rainfall equally reduce productivity. Thanks to GIS technologies used in agriculture, farmers can assess the level of water exposure of each crop and see signs of excess or lack of moisture to further regulate irrigation.

Usually, water stress is determined using the NDWI and NDMI indices. The latter is available by default in EOSDA Crop Monitoring. It works in the range of -1 to 1 and makes the data interpretation process intuitive. Negative readings (about -1) indicate a lack of water, and positive readings (about 1) indicate an excess of water.



Detecting water shortages using the NDMI index using EOSDA Crop Monitoring

In agriculture, GIS can also be used to determine what nutrients are available in the soil and in what amounts. If there is a lack of nutrients, farmers can apply additional fertilizers at the right time.

Productivity assessment is essential for both government and private companies to ensure a reliable food supply, as well as for profit forecasting and budgeting. Advances in agricultural GIS technologies related to satellite analysis, remote sensing, big data and artificial intelligence are making this process more efficient. EOSDA's yield forecasts are based on historical and current satellite data and are more than 90% accurate.

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