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The use of GPS and GIS in the management of precision agriculture

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Abstract: In this paper, topographic map of potato crop performance has been presented for different ratios of soil compaction by using Arc Gis 9.3 software. Precision farming is a developed system of agricultural management which includes development of management's technical system with the centrality of knowledge and main objective of profit optimization. One of the most effective methods for obtaining and collecting the observations in precision farming is the use of GPS. Information obtained based on GPS can be entered in GIS environment and carry out required processes with other topographic data. The purpose of this research is to use the geographic information system for comparing the obtained data from soil more quickly and easily than before and also the crop yield in order to make precise decisions for agriculture progress and applying the appropriate inputs. For this aim, a piece of land was under cultivation of potato crop and topographic maps related to soil compaction and crop yield have been drawn in three modes of non-traffic and with 5 times passing by Massey Ferguson and Romania tractors. Based on obtained results, the crop yield is reduced by increasing the soil compaction which means the tillage should be done appropriately and unnecessary traffic of agricultural machinery that increases soil compaction have to be prevented. By drawing topographic maps, data can be compared with each other in a higher level of precision and speed and the information from different points of the field can be obtained which has an important role in the management of precision agriculture.

Key words: Precision farming; Topographic maps; GIS; GPS. GPS system; Tractor; Guidance system

1. Introduction

The U.S. Department of Defense's (DOD) GPS is a navigational system made up of 24 satellites. GPS uses satellites and computers to determine positions anywhere on Earth 24 hours a day. The orbital patterns and spacing of the GPS satellites (their constellation) provide nine to 12 satellites above the horizon at any point on the Earth. This allows every point of the Earth's surface to have a unique address.

There are essentially three parts that make up GPS: the space segment, user segment, and control segment. The space segment is based on the constellation of 24 active and 3 spare satellites orbiting the Earth. The control segment is a system of five monitoring stations located around the world, with the master control facility located at Falcon Air Force Base in Colorado. The user segment, which is the fastest growing segment, is made up of GPS receivers and the user community. GPS receivers convert the satellites' signals into position, velocity, and time. This information is used for navigation, positioning, time dissemination, and research. Precision agriculture is an evolved system of agriculture management which includes lots of technology. These technology instruments are often included Global Positioning System (GPS), Geographic Information System (GIS), the system of efficiency's sensing and control, Variable Rate Application (VRT), Remote Sensing (RS). Position sensing means detecting, recording and store the location of an object or person on earth and the device that can do this is called global positioning system. A device like this is useful for modern agriculture and in fact is the basis of the satellite agricultural labor. With the help of this instrument the farmer can determine the exact location of agricultural tractors, combines, sprayers or any machine anywhere in the field. The global positioning system makes it possible to record the field variables like encoded information as correct positions and steadily. This technology deals with wider surface of the field and higher accuracy.

In June of 1993 the last of the 24 satellites of the Global Positioning System was placed into orbit, completing a satellite network capable providing position data to locate you anywhere on Earth within 30 meters. The satellites carry up to four cesium and rubidium atomic clocks which are periodically updated from a ground station in Colorado. The satellites transmit timing signals and position data. A GPS receiver, which can be a small, hand-held device, decodes the timing signals from several of the satellites, interpreting the arrival times in terms of latitude, longitude, and altitude with an uncertainty which may be as small as 10 meters. In differential mode, accuracies of less than a centimeter can be obtained for distances of hundreds of kilometers. Hand-held units read out longitude and latitude to a thousandth of an arc minute and change in the last

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decimal place in a couple of paces while walking. The satellites are in orbits much lower than the syncom satellites, orbiting around 17.7 million meters (11000 mi) above the earth, with orbit periods on the order of 10 hours (Hurn, 1993).

Therefore, more data is available for using and farm analysis. For storing and analyzing these data GIS application is necessary. GIS is a special computer database which includes the geographic coordinate and place certification of relevant information which has been designed for receiving, storage, making information and providing their results to be different, maps, graphs and charts.

he positioning information from GPS satellites in sent in the form of repeating codes which identify the sending satellite, give locations of the other satellites in the system, and give the navigation data. The codes which form the GPS signal structure are superimposed upon two carrier waves in the L-band , a frequency range set aside for satellite communication. Both the carrier frequencies and the signal frequencies are derived directly from the onboard atomic clock oscillator frequency of 10.23 MHz. The coded signals are repeated regularly in epochs on the order of 15 seconds. The codes used are referred to as "pseudo-random codes", a name applied by early radio astronomers who were the first to make wide use of such codes. The codes are well suited to decoding a message embedded in noise signals which may be orders of magnitude larger than the signal itself. Such techniques were valuable in picking up radar echoes off the moon and asteroids. Use of these codes facilitates the sorting out of signals which arrive simultaneously from several GPS satellites (Rusten and Ramirez, 2003).

2. **Materials and methods**

The studied land is related to the agricultural lands of Shoushtar university of Khuzestan with an approximate area of 8000 square meters (Fig. 1) which is under the cultivation of potato crop and in order to compare the amount of the crop yield against soil compaction three distinct pieces: without tractor traffic, Romania tractor traffic and Massey Ferguson tractor traffic (each with five passing) were considered (Pfost, 1998). Each of these pieces is divided into three parts and for measuring the soil apparent density (gr/cm^3) two points were randomly selected in each area. In order to use the data in the environment of Arc Gis 9.3 software. The points Longitudinal and transverse coordinates were determined by GPS device. Finally, for preparing the crop yield map, the potato yield was measured related to each section. The map of soil compaction and also the map of crop yield were drawn in the Arc Gis 9.3. The obtained data was related to eighteen points of the land that in order to achieve levels of soil density and the crop yield in different parts, statistical method of interpolation (kriging) was used.

Fig. 1: The earth picture by using Google earth

3. Discussion and conclusions

For simplicity in performing the analysis and data comparing that in this study are soil compaction and the crop yield, at first the map of the earth and its various parts as shown in Fig. 2 were plotted (Balaselvakumar, 2000). Then, with the help of data related to obtained coordinates from earth points, soil apparent density was determined in the points and the performance of potato crop in each part, maps of soil compaction (Fig. 3) and crop yield (Fig. 4), by the statistical method of interpolation (kriging) which is the most accurate method to find the values of the unknown points from known data was drawn (Robert, 2000).

By comparing maps of land, soil compaction and crop yield, it is observed that where the soil has a higher amount of compaction we were faced with lower crop yield which is caused by high traffic of agricultural machinery and applying wrong way of tillage. Tillage operations have to be modified and excessive and unnecessary traffic of agricultural machinery on the soil of the farm have to be prevented (Pecze et al., 2001).

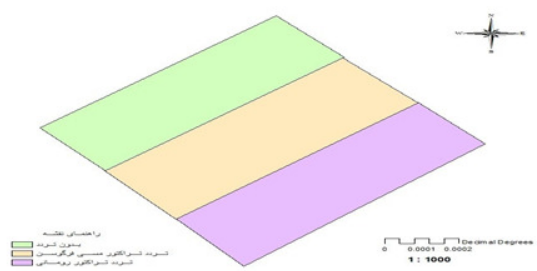

Fig. 2: Drawn map of land parts

Map guide (respectively from green to purple): without tractor traffic, Massey Ferguson tractor traffic and Romania tractor traffic

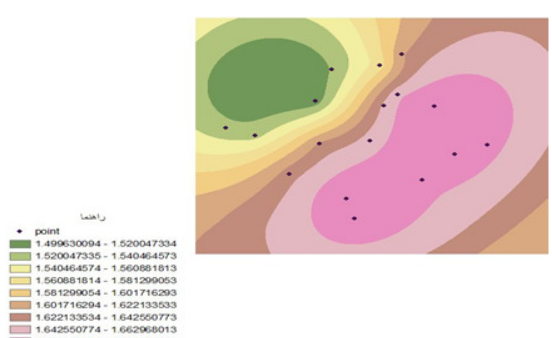

Fig. 3: Drown map of soil density (gr/cm^3)

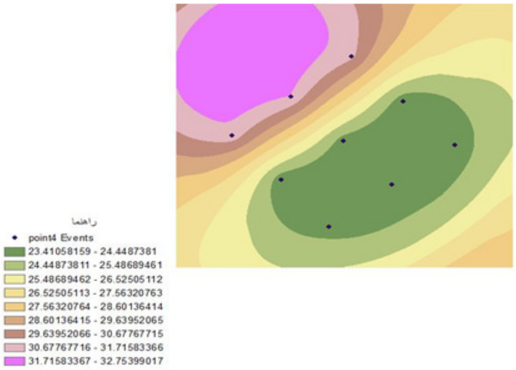

Fig. 4: The yield map of potato crop (ton / ha)

4. Conclusion

Data can be compared with each other in a higher level of precision and speed by using topographic mapping and also it can obtain related information for different points of the farm that can have an effective role in agriculture management which is known as precision agriculture.

References

Abstracts, Odense, Denmark, July 11_/15, 1999.

Hurn, J. 1993. GPS A Guide to the Next Utility. Trimble Navigation. Sunnyvale, Calif., http://www.trimble.com/gps/index.html

Pecze, Zs., Neme´nyi, M., Debreczeni, B., Csatho´ , P., .A´ renda´s, T., 2001. a. Helyspecifikus ta´panyagvisszapo ´ tla´s kukorica no¨ve´nyne´l (Site-specific nutrient replacement in case of maize). No¨ve´nytermele´s (Plant Production) 50 (2_/3), 269_/284.

Pecze, Zs., Neme´nyi, M., Kiss, E., Petro´czki, F., 1999. Investigation of the accuracy of the RDS yield mapping system. In: Proceedings of the Second European Conference on Precision Agriculture

Pfost, D. 1998. Precision agriculture: global positivning system (GPS). Missouri Precission Agriculture Center, University of Missouri-Columbia.

Pfost, D., Casady, W., and Shannon, Kent. 1998. Precision Agriculture: Global Positioning System (GPS), WQ-452, University Extension, University of Missouri-System, Columbia, Mo., http://muextension.missouri.edu/xplor/envqual/wq0452.htm

Robert, P.C. (2000). Site- Specific management of the twenty- firs century. Hort Tech 10: 448-451

Rusten, E., S, Ramirez. (2003). A Future Directions in Agriculture and Information and Communication Technologies (ICTs) at USAID, Prepared for USAID/Economic Growth, Agriculture, and Trade/Agriculture and Food Security, Version ٤,٠, The Academy for Educational Development And Winrock International

S. Balaselvakumar, S. Saravanan, 2000. Remote Sensing techniques for Agriculture suvey, , Mapindia, India

Siva Subramanian, K.S., R.S, Paul, (2005). Remote Sensing and GIS Applications for Agriculture, In New Delhi, India

Stombaugh, T.S. and Clement, B.R. 1999. Unraveling the GPS Mystery, AEX-560-99, Ohio State University Fact Sheet, Food, Agricultural and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210-1058.