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GPS AND REMOTE SENSING APPLICATION FOR RANGELANDS MONITORING

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***Abstract*— In range management planning access to accurate and up-dated information is important. Furthermore, separation of changes trend and its causes can be obtained by a monitoring program. Application of advanced technologies such as Remote Sensing and Global Positioning System and other usable instruments for range management purposes is essential in a range monitoring program. In this research, from range monitoring point of view, capacity of GPS in according obtained data from ground samples with related satellite information was studied. Before verifying feasibility of GPS usage in according digital and ground data, proper time, correct method of usage and also GPS models were tested. In two provinces of Tehran and Markazi, six reference points were selected and in each point, eight GPS models including Etrex Vista, Silva, Meridian Platinum, Tracker, Magellan 2000 XL, Magellan 3000 XL, Magellan MLR and Promark X were tested. The results showed that the best time of GPS application in regions was in the morning. Among, GPS type, Etrex Vista had less error than other models. Also, differential method was appointed as better method for geographic coordinate's estimation. After selection of suitable method for coordinates measurement, coordinates of quadrats along four transects in six sampling sites were determined. The results showed that GPS receivers could be used to accord accurately ground data with satellite data.**
***Keywords*—: GPS, Rangelands, Markazi province, Monitoring, Proper time, Model, Method.**

I. INTRODUCTION

Range ecosystems constantly are changing because of management practices and climatic variations. So monitoring is essential for better planing. Monitoring is conducted several times over time (Holechek et al. 1989). A range ecosystem components and its products are shown by figure of 1 of Holechek et al.

Range management is the manipulation of rangeland components to obtain the optimum combination of goods and services on a sustained basis. Range since is the organized body of knowledge upon which range management is based. For accurate range management it is necessary to integrate different information. Several studies have been undertaken using satellite imagery to assess the quantity and quality of rangelands. Arzani (1994) evaluated the potential for estimation of vegetation parameters for use in stocking rate estimation. Also Folving (1989) developed a method of monitoring that would give information about the amount of vegetation to assess the range carrying capacity using Landsat MSS data. Maxwell (1979) also claimed that frequent monitoring of range and crop conditions is a prerequisite to effective management and planning decisions. Arzani et al. (2007) showed the efficiency of satellite data in estimating vegetation parameters and developed a model for a range assessment program. They concluded that remote sensing data can be used in a monitoring system using a double sampling procedure. In addition Arzani et al. (2006) conducted investigated on suitability of rangelands for sheep grazing in Backan plane, Ardestan, Lar and Taleghan. They used both GIS and remotely sensed data to produce and integrate several information layers. They found that both GIS and RS facilitated range suitability assessments. Application of GPS for natural resources management planning was tested by (Steede and Terry, 2000). Reduction of its price and development of software's related to GPS have increased interest of its application (Van Sickle 1996). GPS equipment is useful tool for determination of location and creating map from details of resources.

Its information also can be used in conjunction with GIS for analysis and interpretation of the information (Ginsburg 2002). It can help to determine boundary of vegetation types, owner's boundary, erosion location, watering points, grazing behavior of livestock, etc, (TNL, 1994, Farahnak et al. 2004, Dubey et al. 2005).

In a range monitoring program determination of changes trend in the specific location during the time is the objective. So data should be regularly collected in the same locations. Therefore GPS can be a useful tool for coordinate measurements of ground data to correspond with satellite data which was the main objective of this research

II. Material And Methods

Research was conducted in two provinces of Tehran and Markazi in conjunction with research project of range assessment in different climatic zones of Iran. In each province some Geodesy stations (Bench marks) established by Cartography organization were selected. Various available brands of GPS in terms of accuracy were tested. At the same time methods of location determination in two cases of absolute and paired were examined. The GPS brands those were examined in this research included Garmein (Vista, Etrex and Silva), Magellan (Meridian, Platium, Tracker 2000XL and Tracker 3000XL), and Paired receiver of Promark xcm. For determination GPS models accuracy and suitable method of coordinate measurements in monitoring sites, Geodesy stations (Bench marks) were used. These stations have known coordinates and as the second types of bench marks their distances from each other is 15- 25 Km with 35 cm accuracy. Six bench marks were selected. Their distance in Tehran province was 5 km. The first bench mark was near to Olympic village in a park in 51◦ 16' 2.9" east longitude and 35◦ 44' 23.7" north latitude and 1310 m elevation. The second bench mark of Tehran province was located in Chitgar Park over a hill in 51◦ 12' 47.3" east longitude and 35◦ 43' 43.3" north latitude with 1320 m elevation.In the Markazi province the first bench mark was Arak station located in 49◦ 41' east longitude and 34◦ 5' north latitude on the roof of Medicine University dormitory in 1770 m elevation. Davood Abad station was located in 49◦ 51' 23.7" east longitude and 34◦ 17' 22.6" north latitude with 1640 m elevation. Morad Abad station was located in 49◦ 55' 6.7" east longitude and 34◦ 7' 22" north latitude with 1630 m elevation. Saveh station was located in 35◦ 7' 35" north latitude and 50◦ 23' 53" east longitude with 1237 m elevation. Coordinate of the sites was based on both UTM and LAT/LON systems.All brands of GPS were tested in the stations in terms of range of error, comparison of methods for coordinate measurement, comparison of brands and suitable time of GPS application. Application of GPS was conducted with two methods of "Absolute method" and "Differential method". Handy GPS were used with absolute method. They applied in the same time in reference point. In differential method paired receiver (Promark x) were used. One of them was installed in known position (bench mark) and another one in unknown point at the same time. They determined coordinate each 2, 3, 5, 10, 15, 20, 30, 45, and 60 minutes.GPS were applied in two reference points with assumption of unknown coordinates for one of the points. In the first point all GPS models were turned on at the same time and coordinate showed by each model was recorded. For installation of paired receivers they connected to an external antenna longer than operator height. Hand receivers also were put in the reference point level. When they were constant for few minutes, coordinates were recorded. Then they transferred to the second reference point as an un-known point for recording coordinates. Also different models were put in both points and coordinate was recorded in various times. Paired GPS (Promark x) were used in both points at the same times for testing paired receivers. Examination of models in reference points were occurred in different times of a day (in the morning, noon and afternoon) and different months (July, August in Tehran province by 3 replicates) and (July, September and October with four replicates in Markazi province). They used in different month to find effects of cloud and rain in time of year that application of GPS in rangeland is more common. Data obtained from the models was tested in terms of accuracy, suitable time of GPS application and determination of proper method with acceptable accuracy.

III. Data Analysis

Factorial plan based on complete random design was used for data analysis. Minitab software was used for data analysis. Effects of time, location and GPS type on rate of error and their interaction was determined using Variance analysis and GLM methods. The means were compared using Duncan test.

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IV. Results

Difference of recorded data from actual coordinates of references points indicated the rate of error for each receiver. After determination of error involved with each receiver in different times and different reference points, for all types of GPS in each reference point, for each reference point in different times of data collection, considering time of observation rate of error was calculated. The results obtained in trig station located in the park were illustrated by table 1 as example. In this location from 112 observations in three times, maximum error in x and y directions were 7 and 8 m respectively. In most suitable cases GPS had no error. The amount of error in the morning for both directions was less than in the afternoon. Brands of Meridian and Silva showed highest error and Promark x had lowest error.

In Chitgar trig station maximum and minimum error in x direction were 6 and 0 m respectively. In y direction were 8 and 0 m. In this station also error in the morning was less than in the afternoon observation. The best results obtained from promark x.Maximum error in Arak station in x and y directions were 5 and 8 meters respectively. Better results were obtained before noon.In Davood Abad station data was collected at the same time of first data collection in Arak. Error in this station for two models of Garmin and Promark x in x and y axis was 4 meters. GPS models at the same time of second observation in Arak station were tested in Morad Abad bench mark too.

V. Rate Of Error Of Different GPS Models

In all cases model of promark x showed lowest error. Among handy GPS Garmin model compared with other models was better. Maximum error for Magellan was 8 meters in y axis and 7 meters in x axis. Table 2 illustrate statistical test on observation of models in Park station as an example. Model of promark x compared to other models had higher accuracy and Garmin among hand receivers also showed higher accuracy and lower error. Effects of observation time on procession of GPS have been illustrated by table 3. Accuracy of observations in the morning was better than afternoon observations. Table 4 shows the results for paired GPS with differential method. This method had high accuracy. Its maximum error was 0.86 meter. In most cases the error was few cm and not considerable. Period of recording was different. The most period of observation was 5 minutes. With increasing time of observation the error was reduced. So in cases of high accuracy requirement 30 minutes observation is recommended.

Comparison of techniques of observation with GPS models in various period of recording and comparison of techniques without considering GPS models have been shown in tables 5 and 6 respectively. Accuracy of Promark x using paired method compared with handy receivers was much different. Although applied receivers compared with other handy receivers have higher accuracy, but compared with paired receivers had high error.Effects of models, time location and date also were investigated. Obtained results showed that in x and Y axis among factors, GPS models and time had significant effects. Other factors had no significant effects on accuracy.In all trig stations Promark x is able to reduce error of each other. Similar GPS models and similar times showed interactions. The high accurate GPS was Promark x and then Etrax Vista (Garmin). In terms of time of observation error in the morning was lower than other times. For paired GPS models increasing time of GPS establishment in a point showed error reduction. Since error of x and y axis was different, effects of various factors including GPS model, month, location, times and their interaction were investigated. In x axis only model of GPS was effective and other factors had no significant effect on error. However in y axis both month and location had significant effect on mean of errors of GPS.

VI. Discussion

Possibility of GPS utilization in different times of a day and different climatic zones is its advantage for natural resource officers. Availability of various GPS models with acceptable accuracy has caused increase of its utilization in range management. Users should consider that it is important to know which, how and when it should be used.In range assessment that measurements occur for one time using hand receivers would be enough. However in monitoring program that regular measurement in the same place is objective higher accuracy is required.Rate of error depends on time of measurements; it was lowest in morning observations. Month of observation also had effect on accuracy of observations. Error of observations in August was higher than July. Variation of temperature and solar radiation can cause differences of error in different months. Baes (2001) reported that error in mid day of summer was higher and minimum error has been happened during night in winter when sun was absent.Promark x model had lower error than other models. It has external antenna and is able to record accurately and frequently.

At the same time recording in known and unknown positions showed the similar error in both receivers, because they may contact with the same satellite at that time. The same finding was reported by Jamour (1999).Based on differential method, period of recording are more effective than time, location and month. Jamour (1999) believed that as in a DGPS system base is common error in both trig station and other point of observation the best distance between the receivers is less than 30 km. This method depends on distance between receivers has small error which can be minimized to zero (Baes 2001).Paired method is more accurate than absolute method (hand receiver). Errors in x and y directions were different. Various GPS models had different effects on rate of error in X axis while location and month performed differently for Y axis ($P<0.01$). As in a monitoring program the objective is determination of cause and trend of changes, observation should be done regularly in the same points with high accuracy. In this case application of hand receivers based on absolute method is not recommend.The rate of error for all receivers in Park bench mark in both x and y axis were higher. It can be because of existing of tall trees around this station causing Multipath error. Such effect but smaller was experienced in Chitgar. So it is important to choose which trig station is used. Shamani (1999) believed that Multipath error is because of vertical and horizontal levels or curve of buildings, street, …etc that send other waves in addition to direct waves of satellites toward receivers. Receivers in morning gave better records than other times of day because of atmosphere conditions. Unespher and troposphere layers break the waves and considering various layers in unespher and their ionization because of ultra-violet radiation, increasing electrons would cause increasing of satellite waves break index which results higher errors in the receivers (Allnut, 1989). Effects of sun radiation on unespher in the beginning of day are small and the error is lower than other times of day.

VII. Conclusions

Among the GPS models examined in this study, Etrex Vista and Promark x showed better performance. Error involved with Etrex Vista was ± 5 meter while in Promark x using differential method can be reduced to cm. Period of coordinate measurement is also important and 3-5 minute for each receiver is required. The mean value of coordinate records during the period of measurements should be considered as the coordinate of each point. It is important to check receivers in a trig station before be used in the filed. Time of observation has effect on accuracy of observation and differential method reduce error which is recommended for corresponding ground samples with their relative pixels in range monitoring using satellite data.

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