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Journal of Forest Research

Research Article

The Functional Management of Internet of Things (IoT) in Calculating of the Carbon Sequestration in the Caspian Forests

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ABSTRACT

The Internet of Things (IoT) has increased in the development of management sciences and the speed of production of scientific resources. The purpose of this research is the function of the management of the internet of things in the estimation of carbon sequestration In the Iran forests. This research was conducted in the educational research forest of Tehran university. Tehran university's educational and research forest is located in Khyroud forest. In this research, was used to systematic random method and also were established 30 samples in the study area. Then, by using a drone, the temperature of the center of the sample area was measured. In this research, the temperature was considered as the independent variable and the carbon sequestration variable was the dependent variable. In this study, the tree density was estimated using a linear model. The obtained results showed that the use of drones based on the Internet of Things (IoT) has a unique ability to estimate the amount of tree. The results obtained from this research showed that the internet of things has a high ability to analyze the characteristics of the growth periods of trees in different thicknesses by classifying information.

Keywords: Internet of things; Carbon sequestration; Temperature characteristic; Tree thicknesses; Growth period

INTRODUCTION

Temperature changes are an important issue in the present era and it is a new issue for climatologists all over the world and it will have countless effects that are proportional to the region and the length of the time period and the return period of the variable phenomenon. The increase in temperature will occur due to human activities as a result of the emission of pollutants in industries, and the consequence of the increase in temperature is that in many areas, the sea level will rise and cause sudden climatic phenomena and will lead to serious damage [1]. In the past years, the temperature of the environment has warmed excessively at the global level, and the temperature of the environment is increasing day by day, and the management principles are in line with reducing the gases that cause the increase in the environment and will intensify the increase in temperature. Climate change is one of the most complex issues that humanity is facing now and the future generation as well [2]. One of the most important issues that have exacerbated the phenomenon is the lack of recognition of environmental issues that have exacerbated climate change and related issues. The seas have warmed by 0.5°C and the retreat and melting of the polar ice is proof of this claim. Warming and climate change will show. Among the other issues are sudden and heavy rains, which cause a lot of damage to the production and flooding of buildings every year. According to the predictions made, the average temperature of the global surface from the years 2081 increased from 0.5 degrees Celsius to 2.7 degrees Fahrenheit the years 1986-2005 has probably increased from 0.5 degrees Celsius to 2.7 degrees Fahrenheit and has the ability to convert from 4.8 degrees Celsius to 8.6 degrees Celsius degrees Fahrenheit and in the period of 2101 to 2151, only between 75 billion dollars and 110 billion dollars in damages per year. The United Nations announced in a statement that the United Nations has estimated that temperature changes will cost adaptation and this cost will be borne by the industrial sector, and by 2030 the cost of climate adaptation is 60 billion and in some cases 190 billion dollars. The predictions of the damage caused to the US economy due to severe changes in the normal and normal world in 2025 were about 270 billion dollars [3]. Temperature change in different regions varies depending on the

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Received: 20-Jan-2023, Manuscript No. JFOR-23-21483; **Editor assigned:** 23-Jan-2023, PreQC No. JFOR-23-21483 (PQ); **Reviewed:** 06-Feb-2023, QC No. JFOR-23-21483; **Revised:** 13-May-2025, Manuscript No. JFOR-23-21483 (R); **Published:** 20-May-2025, DOI: 10.35248/2168-9776.25.14.569

Citation: Babaei S, Torkaman J, Abedi T (2025) The Functional Management of Internet of Things (IoT) in Calculating of the Carbon Sequestration in the Caspian Forests. J For Res. 14:569.

latitude, and recently there has been seen very x>80 temperatures in Europe and the North of the United States, which will disrupt biological cycles on a large scale and will have a harmful effect on biodiversity. In research, it was proved that the limits of human activities have had a significant impact on climate change, so that the only effective factor in intensifying climate change is human activities. Forests play an important and practical role in relation to temperature changes and carbon cycles. Quantitative and estimated characteristics in natural biosystems will be calculated in different ways [4]. The most important characteristic of the forest in the North is the density of trees. To measure the density using a direct method and the use of statistics, requires financial resources and the time of the statistics, and the accuracy of the statistics in this method is not very high, so it is necessary to use a method and manage the resources. To have women and financial management, in addition to the mentioned items, should be highly accurate. Therefore, taking into account that in most of the studies only the issue of heating has been mentioned and the method of predicting the temperature of the environment has been discussed and the function of the temperature variable in the estimation of other biological characteristics such as has been paid attention to. The purpose of this research is to determine the of trees using the characteristics of environmental temperature in forest systems. In research, it was shown that the increase in temperature in the environment will cause the rainfall regimes to be disturbed and will cause the biological systems to lose their natural functions and will be affected by phenomena such as the increase in the temperature of the environment [5].

MATERIALS AND METHODS

In this research, parcel 307 was studied. This parcel is located at an altitude of 960 meters to 1080 meters. These areas are always humid and have a Mediterranean climate. The soils of this region have moved towards development [6]. In parcel, 307 is covered with the following types of trees:, *Q. castanifolia*, *F. orientalis*, *A. subcordata*, *Acer cineracea* and other trees. The form of the trees of parcel 307 is mainly form: Stand, individual, group, individual. According to Dumarten's climagram, the climate of Groz-Ben district is humid and x>80 climate category of type B. The main and natural communities of this part are *F. orientalis* and *Carpinus betulus*. The rare species of this parcel are van, oja, baranak and wild cherry. Parcel 307 mainly the stands in this parcel are two to three layers, with middle layers trees that form young stands. Breeding is seen in scattered and spotted forms, which are mainly from *F. orientalis*. These young standes are made up of *Q. castanifolia*, which require breeding operations in them. The Trees of *F. orientalis* trees can be seen on the edges of the valleys. In the upper part of the parcel, there are some hawthorns, which indicate the destruction of the stand in the past. *F. orientalis* trees can also be seen individually. The presence of *F. orientalis* trees is an indicator of the forward movement of transformation and sequence, and the possibility of increasing *F. orientalis* in the future under the border trees. The quality of the stands improves from the Northwest side of the parcel to the middle and West, and the density of trees increases. Most of the stand is in the state of two clumps, and a small amount of *F. orientalis* reproduction is seen among the bordering trees with less density. As it approaches the lower road, the stands become younger. In these areas, there are *A. subcordata* trees and several other shrub species. The forests in this area are mainly broadleaf. The stand in the part adjacent to the upper road is all or most of the parts with a density of mulberry trees with a large distance from each other and young mulberry trees with scattered *Q. castanifolia* [7].

Systematic Random Sampling method (SRS)

In the systematic random method, the sample units are not randomly distributed in the region, but the sample pieces are uniformly distributed in the region based on a systematic process. In the systematic random method, first, the maximum number of sample plots (N) in the population is obtained by dividing the total area of the population by the area of the sample plot. Then, based on Cochran's relationship, n samples are selected from the maximum number of samples (N) in the limited population. The beginning of the first sample in the systematic random method (systematic random) is random, then other sample pieces are selected systematically. It is impossible for the random systematic method variance to be unbiased. The grid in which the sample pieces are selected is square, rectangular, hexagonal, rhombus or other systematic geometric shapes that are implemented according to the physiographic characteristics of the area. One of the biggest advantages of the systematic random method is that it is easier to access the sample pieces in the field and the area is uniformly covered, and there is no risk of concentration of sample pieces like the simple random method [8]. The probability of selecting sample pieces in this method is equal for all sample pieces. Another feature that distinguishes the systematic random method from the simple random method is that it can be used in national statistics. Another distinction from the systematic random method is that there is a list of maximum sample plots (N) available in the field to be selected. When statistics are based on rows and columns. In this method, the samples are selected on the two-dimensional axis with specific distances from the first sample. When it is the axis of statistics. It is one-dimensional. By dividing the level of the sample pieces selected for statistics (n) by the total level of the forest area, the intensity of statistics is obtained when systematic statistics are done on the map.

Characteristics of trees using drones to measure biophysical

In this research, 30 sample areas were implemented using a systematic random method (systematic-random) in the specialized system (UTM). The area under study is located in the geographical area (N39 zone-). An ADS-B drone was used in this research. Then, using a drone, the temperature characteristic of the sample area centers at a specific height was obtained in July of this year 1401. Using regression relationships, the above-ground of trees was determined using allometric relationships. In the allometric model, the temperature characteristic of the trees is considered as the main variable and the Stand characteristic as a secondary or dependent characteristic. In this research, using prepared models, the carbon stock of trees was calculated in the vegetative stages of d<30, 30<x<60, 60>x>80, and x>80 (Table 1 and Figure 1) [9].

Table 1: Classification of trees at multiple vegetative ages during evolution trees.

Diameter (cm)	Process of growth
d<30	I
30<x<60	II
60<x<80	III
x>80	IVI

Figure 1: ADS-B drone of the study area, parcel 307.

RESULTS

The results of the distribution of the weight of *F. orientalis* trees in the growing stages of d<30, 30>x>60, 60>x>80 and x>80 showed that the weight distribution of *F. orientalis* trees in terms of pounds is different in different growing stages. The weight of *F. orientalis* trees in the 60>x>80 vegetative stage of *F. orientalis* was higher than other vegetative stages of *F. orientalis* trees. The lowest weight of the *F. orientalis* trees was related to the vegetative stage of the d<30. The results of this research showed that the dry weight of *F. orientalis* trees is different from the heavier trees, so that the highest dry weight of *F. orientalis* trees was related to the 60>x>80 stage of the trees in the study area. The lowest dry weight of *F. orientalis* trees in the vegetative stage of the trees was related to the vegetative stage of the d<30 trees. The results of carbon storage in trees showed that *F. orientalis* trees have the highest carbon sequestered in the x>80 vegetative stage, and the lowest amount of carbon stored in the d<30 vegetative stage [10]. The results showed that the carbon stock of trees is different in many stages and will make the habitat conditions of the trees stable. The results of the measurement of the weight distribution of *Q. castanifolia* trees during the growth stages of d<30, 30<x<60, 60>x>80 and x>80 showed that the heavier trees in the x>80 growing stage were higher than the heavier trees in other different stages. The lowest weight growth phase of *Q. castanifolia* trees was related to the 60>x>80 growth phase [11]. The results of this research showed that the dry weight of *Q. castanifolia* trees is different from the heavier trees, so that the highest dry weight was related to the x>80 stage of the trees in the region under study. The lowest dry weight of *Q. castanifolia* trees was related to the vigorous growth stage of the trees. The results of carbon accumulation in trees showed that *Q. castanifolia* trees will accumulate a certain amount of carbon in all vegetative stages. The results showed that the carbon accumulation of trees in many stages was similar to other growing periods and caused *Q. castanifolia* trees to be removed in the field of competition and the communities of Rosh Mamarzostan will be replaced by trees. The results of the distribution of the weight of *A. subcordata* trees in the vegetative stages of d<30, 30<x<60, 60>x>80, and x>80 showed that the weight distribution of *A. subcordata* trees in terms of pounds is different in different vegetative stages. The weight of *A. subcordata* trees in the vegetative stage of x>80 *A. subcordata* is higher than in other vegetative stages of *A.subcordata* trees. The lowest vegetative stage of *A. subcordata* trees was related to the vegetative stage of the d<30. The results of this study showed that the dry weight of *A. subcordata* trees is different from the heavier trees, so that the highest dry weight of *A. subcordata* trees was related to the x>80 stage of the trees in the study area. The lowest dry weight of *A. subcordata* trees was the vegetative stage of the d<30 trees. The results of tree carbon storage showed that *A. subcordata* trees have the highest carbon sequestration in the x>80 vegetative stage, and in the d<30 vegetative stage, *A. subcordata* trees had the lowest amount of carbon storage [12]. The results showed that the carbon stock of trees is different in many stages and will stabilize the habitat conditions. The results of the distribution of the weight of the deciduous trees in the growing stages of d<30, 30<x<60, 60>x>80, and x>80 showed that the distribution of the weight of the deciduous trees in terms of pounds is different in different vegetative stages. The weight of nemar trees in the d<30 growth stage was higher than other d<30, 30<x<60, 60>x>80 and x>80 growth stages. The lowest heaviest vegetative phase of the deciduous trees was related to the 60>x>80 vegetative phase. The results of this research showed that the dry weight of *F. orientalis* trees is different from that of heavier trees, so that the highest dry weight of deciduous trees was related to the d<30 stage of the trees in the area under study. The lowest dry weight of the deciduous trees in the growing stage of the trees was related to the vigorous growing stage of the trees. The results of carbon accumulation in trees showed that deciduous trees have the highest accumulated carbon in the vegetative stage of the d<30 (Tables 2-9).

Table 2: Allometric model of beech trees in the vegetative stages of the forest mass sequence.

r	b	a	
0.96	0.0003	0.04	d<30
0.97	0.006	0.05	30<x<60
0.96	0.0004	0.15	60>x>80
0.64	0.0007	0.05	x>80

Table 3: Elometric model of oak trees in the vegetative stages of the forest stand sequence.

r	b	a	
0.79	0.0002	0.02	d<30
0.81	0.0007	0.02	30<x<60
0.96	0.0004	0.15	60>x>80
0.64	0.0007	0.05	x>80

Table 4: Allometric model of alder trees in the vegetative stages of the forest stand sequence.

r	b	a	
0.75	6.86	0.005	d<30
0.99	0.0001	0.015	30<x<60
0.99	0.0004	0.03	60>x>80
0.41	-0.04	0.14	x>80

Table 5: Allometric model of deciduous trees in the vegetative stages of the forest stand sequence.

r	b	a	
0.86	7.06	0.005	d<30
0.99	0.0001	0.01	30<x<60
0.98	0.02	0.01	60>x>80
0.85	4.90	0.003	x>80

Table 6: Show the allometric relationships for *Q. castanifolia*.

Carbon sequestration	Dry weight	Fresh weight	
0/80	1/53	2/11	d<30

0/82	0/52	0/71	30<x<60
0/82	0/36	0/50	60>x>80
0/82	12/14	19/48	x>80

Table 7: Show the allometric relationships for *F. orientalis*.

Carbon sequestration	Dry weight	Fresh weight	
0/33	0/61	0/84	d<30
0/41	0/76	1/5	30<x<60
0/41	4/6	6/3	60>x>80
0/82	2/52	1/11	x>80

Table 8: Show the allometric relationships for *T. subcordata*.

Carbon sequestration	Dry weight	Fresh weight	
0/82	13/23	18/26	d<30
0/19	0/36	0/50	30<x<60
0/19	0/35	0/49	60>x>80
0/19	9/16	12/64	x>80

Table 9: Show the allometric relationships for *A. subcordata*.

Carbon sequestration	Dry weight	Fresh weight	
0/12	0/22	0/49	d<30
0/26	0/49	1/6	30<x<60
0/82	4/27	5/29	60>x>80
0/90	5/89	9/21	x>80

DISCUSSION

The results of the moisture coefficient of *F. orientalis* trees in the growing stages of d<30, 30<x<60, 60>x>80 and x>80 showed that the moisture coefficient of the of *F. orientalis* trees is different in different growing stages. The moisture coefficient of the Stand of *F. orientalis* trees in the x>80 growing stage of *F. orientalis* trees was higher than in other growing stages of *F. Orientalis* trees. The lowest moisture coefficient of *F. orientalis* trees corresponds to the 60>x>80 vegetative stage. The results of the moisture coefficient of the trees showed that the surface moisture coefficient of the trees was different in different growing stages [13]. The results of the moisture coefficient of *Q. castanifolia* trees showed that the moisture coefficient of *F. orientalis* trees in different vegetative stages is affected by the vegetation conditions of the environment. The results of this research showed that the humidity coefficient of *Q. castanifolia* trees in the vegetative stage of 30<x<60 was higher than in other vegetative stages of *F. orientalis* trees. The lowest moisture coefficient of *F. orientalis* trees is related to other plant. The results of the humidity coefficient of the trees showed that the humidity coefficient of the trees was different in different growing stages. The highest humidity coefficient of the trees in the vigorous vegetative stage will create the conditions for reproduction in the field of evolution of the sequence stages. The results of the moisture coefficient of *A. subcordata* trees showed that the moisture coefficient of *A. subcordata* trees in different vegetative stages is affected by the vegetation conditions of the environment. The lowest humidity coefficient of *A. subcordata* trees is related to the vegetative stage. The results of the moisture coefficient of trees showed that the moisture coefficient of *A. subcordata* trees was different in different growing stages. The highest humidity coefficient of the trees in the vigorous vegetative stage will create the conditions for reproduction in the field of evolution of the sequence stages. The humidity coefficient will always be affected and similar to the habitat environment. The high humidity coefficient of *A. subcordata* trees in the x>80 age stage indicates the use of these trees from the underground aquifer of the geographical area under study [14]. The results of the humidity coefficient of deciduous trees showed that the humidity coefficient of deciduous trees in different vegetative stages is affected by the vegetative conditions of the environment. The results of this research showed that the moisture coefficient of the deciduous trees in the d<30 and x>80 growth stage of the deciduous trees was higher than other vegetative stages of the deciduous trees. The lowest moisture coefficient of deciduous trees is related to the trunk of deciduous trees. The results of the humidity coefficient of the trees showed that the humidity coefficient of the trees was different in different growing stages. Considering that the humidity coefficient of trees is affected by the environmental conditions in which the base of the tree is in the yard. The results of this research showed that the high humidity will provide the conditions for the reproduction of the bases of the deciduous trees and the completion of the evolutionary stages of the forest [15,16].

CONCLUSION

The internet of things has increased in the development of management sciences and the speed of production of scientific resources. The results obtained by the internet of things show that the internet of things is an easy way to process and analyze the statistical data of the vegetative period of the d<30, the 30<x<60, the 60>x>80, the x>80, so that the monitoring. The information of vegetative courses which was time-consuming and expensive using the common method, but with the use of the internet of things, this method has become easy and convenient, so that the use of the internet of things will quickly reduce the time of taking statistics in the field and this factor will increase the accuracy of the work and create a reliable method for statistics. The use of the internet of things as a generator of the industrial revolution has been mentioned. The use of advanced technologies in the science of management will make the right decision in the science of management so that we do not make mistakes in the decision-making process and planning for the future of trees and forest ecosystems. The use of the internet of things will make the decision-making process done move towards sustainable management. The use of the internet of things will allow managers to have easy access to information on the classification of the vegetative periods of the d<30, the 30<x<60, the 60>x>80 and the x>80, and this factor itself has been particularly important in increasing the speed of work. Using the common method in forest logging without the use of the internet of things will cause more use of limited environmental resources and this factor itself will be a threat to remembering the tree seedlings in the vegetative stages and will cause damage to the breeding areas. It will help the seedlings. One of the advantages of the internet of things method is that it has made it possible to plan for the mourning of trees in the field or at a high speed without the harvesters being a threat to the tree seedlings in the field. Another disadvantage of the common methods is that the trees in the lower layers will prevent the researcher from getting statistics, and this factor will cause us to have a lot of time in the field and the speed of our progress in the field will not be great. Using the internet of things will cause it to be possible for the researcher to study the field of statistics more carefully without the obstacles of environmental surveying. The results obtained from this research showed that the characteristics of the internet of things has caused the of forest trees in the field to be easily measured. The results obtained from this research showed that the humidity coefficient of *F. orientalis*, *Q. castanifolia*, *A. subcordata*, and *T. subcordata* trees in the vegetative stage, d<30, 30<x<60, 60>x>80 and x>80 trees can be easily measured. One of the other advantages of drones using the internet of things in the forest is that the position of trees in the center of the sample plots in the forest can be easily retrieved. In such a way that the location of the samples according to the Arc Gis 9.3 geographic information system in the UTM geographic coordinate system, each piece has a specific question and latitude, which in the common method, the recovery time is, more, but with the use of the internet of things, the recovery time is very fast. In such a way, managers and decision makers will have access to a larger amount of information in a shorter time and this amount of information is not possible in this time efficiency using the common method. Another advantage of using a drone using the internet of things method is that other internet of things methods will not have errors in these sample centers, because in this method, the number of the samples will be divided using fishnet functions in the advanced environment of Arc Gis 9.3, but in the common method, the number of samples will be determined manually and this factor will cause the error of the center of the samples.

REFERENCES

1. Chen J, Hu T, Wu JH, Si HP, Lin KY. Applications of internet of things in facility agriculture. Appl Mech Mater. 2014;685:517-523.
2. Cook J, Oreskes N, Doran PT, Anderegg WR, Verheggen B, Maibach EW, et al. Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. Environ Res Lett. 2016;11(4):048002.
3. Dalal RC, Allen DE. Turner review no. 18. Greenhouse gas fluxes from natural ecosystems. Aust J Bot. 2008;56:369-407.
4. Walter A, Finger R, Huber R, Buchmann N. Smart farming is key to developing sustainable agriculture. Proc Natl Acad Sci USA. 2017;114(24):6148-6150.
5. Rose K, Eldridge S, Chapin L. The internet of things: An overview. The internet society. 2015;80:1-50.
6. Mehta A, Patel S. IoT based smart agriculture research opportunities and challenges. Int J Technol Res Eng. 2016;4:541-543.
7. Tzounis A, Katsoulas N, Bartzanas T, Kittas C. Internet of things in agriculture, recent advances and future challenges. Biosyst Eng. 2017;164:31-48.
8. Rajalakshmi P, Mahalakshmi SD. IOT based crop-field monitoring and irrigation automation. In 2016 10th international conference on intelligent systems and control, Coimbatore, India, 2016.

9. Ray PP. Internet of things for smart agriculture: Technologies, practices and future direction. J Ambient Intell Smart Environ. 2017;9(4):395-420.
10. Ruiz-Rosero J, Ramirez-Gonzalez G, Williams JM, Liu H, Khanna R, Pisharody G. Internet of things: A scientometric review. Symmetry. 2017;9(12):301.
11. Sivamani S, Bae N, Cho Y. A smart service model based on ubiquitous sensor networks using vertical farm ontology. Int J Distrib Sens. 2013;9(12):161495.
12. Sreekantha DK, Kavya AM. Agricultural crop monitoring using IOT-A study. In 2017 11th International conference on Intelligent Systems and Control (ISCO), Coimbatore, India, 2017;134-139.
13. Talavera JM, Tobon LE, Gomez JA, Culman MA, Aranda JM, Parra DT, et al. Review of IoT applications in agro-industrial and environmental fields. Comput Electron Agric. 2017;142:283-297.
14. Wang W, Van Gelder PH, Vrijling JK. Trend and stationarity analysis for streamflow processes of rivers in Western Europe in the 20th century. In Proceedings: IWA International Conference on Water Economics, Statistics, and Finance Rethymno, Greece 2005;810.
15. Wang TC, Lee HD. Developing a fuzzy TOPSIS approach based on subjective weights and objective weights. Expert Syst Appl. 2009;36(5):8980-8985.
16. Zarifian S. Factors affecting the adoption of trickle irrigation by palm cultivators of Dashtestan. Iranian J Agric Econ Devel Res. 2018;48(4):647-655.