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Allocation of Forest Roads in North of Iran Using RS and GIS Techniques (Case Study; Lolet District of Mazandaran Province)

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Abstract: Initial Designing of the forest rood paths will be inevitable with respect to basic maps on different layers for comprehensively sensing. In most of cases, lack of mentioned information or being insufficient them would lead to increasing designing expenditures. Hence accurate topology (location - finding) of initial paths by using RS and GIS techniques can approach the assessment of construction expense regarding forest roads further about real numerals and it is able to consider environmental characteristics in operation on initial designing of this type of roads. This study conducted in the forests, north of Iran, locating in Mazandaran province, Lolet district. At the beginning, all the layers and needed maps brought out and updated via utilizing geographical information system and I.R.S satellite image (2006). Then map at stabile area performed by accumulating slope layers, geology and pedology. After that, the study area was reconsidered through using digital Elevation Model DEM as well as employing remote sensing) RS (Subsquinty a guide path designed for making forest road with regard to its long ways and breadth ways standards, 1789 (km) in length, with the help of Pegger software. Eventually this path was controlled and reviewed via determination of 25 points on digital map and utilization of GPS set and compared with existing path inside designing forest management book-let. Consequently this research demonstrated that in comparison with existing facilities RS and GIS techniques have been crucial factors in designing and accurate topology (location - finding) of an optimum road proportional to the north forests of Iran.

Key words: Forest Roads · Optimum design · GIS · Pegger · Wood and Paper Industries of Mazandaran

INTRODUCTION

Iran with an area of 1648195 square meters has 12millions hectares forests in different climates, from which around 1.9 millions hectares on the northern foothills of Alborz Mountains, 30 (km) in average bread that at longitude 48° 30′to 56° 7′ east and at latitude 36° to 38° 3′ north has expanded [1].

Only 7 percent of Iran territory is cover in forest [2]. Due to expansion of forestry designs and their need for designing and building forest roads and also huge sum of the above expenditures along with annually inflation (construction materials expense, worker salary, technician and expert), a gradually change of method is required to draw forest roads [3].

For design forest roads, conducting basic studies including geology studies, pedology, topography features, physiography and factors related to germinative elements (forest type, site capacity) are necessary [4]. In this field, employing new technologies including Geographical Information system GIS and Spatial Data's (SD) is necessary in order to increase and reduce the expense that may used in designing forest roads, making forestry design and its goals [5]. Since Remote Sensing (RS) covers a vast area of the lands, hence it can determine relationship among the roads better and recognize immovable positive and negative points [6].

Road network construction with enough and suitable density is indispensable in the forest in order to justify exploiting the project economically and implement all the operation in line with keeping, reviving and developing natural resources and employing the project constantly [7]. In other words, a forest road has not been under consideration just for the purpose of a forestry program [8].

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GIS is one of important pillars in decision-makings, programming, exact and in time information in which there is a collection of soft ware - hardware in order to enter store, recycle, edit, analyze and extract datas[10].

Tan [11] in Austria forest road, conducting the obstacles in the way of finding out appropriate path in the forest for completing network hinted at this survey proposed compulsory solutions to find relatively optimum paths. The dynamic method of programming along with spatial dates and completed satellite pictures in microcomputer has been involved in this survey for modeling transportation network.

Rogers [12] in another survey carried out a research in U.S. about appropriating a program within the framework of geography information system (GIS) instead of handmade and traditional methods in order to choose the path on the topography map and introduced as a complimentary program. This program is famous as Pegger. Informational different layers particularly (DEM) are usable and practicable in this program. In addition, determination of the forest area and location - finding (topography) are debatable as on appropriate parameter. This program in a short term and accurate precision dedicated for forestry and road construction engineers for network designing of forest road.

Steve [13] performed a project in Minnesota that was untitled Experimental designing of the forest road for provisional forests of Solana. So that the obtained consequences were used for the purpose of classification of expenditures making road-building project and implementation of forest roads project in the mentioned country and it could show that how much expenses allocate for its designing in return for building each kilometer of road.

Luke [14] elaborated on investing Pegger software in order to sketch the guide path and ultimately it led to the conclusion that employing this soft ware would cause the road to designed better. In addition, this software is able to analyze many effective factors in designing the road quickly that it can bee designed carefully by utilizing this software in a GIS system and caused to reduce the expenses.

Erickson [15] in a sensing under the heading of contribution to the owners of the forests in order to manage, the roads in US disclosed that through using pegger software. as well as employing roadEng, gaining access to on optimum design with the lowest expense and furthers precision is possible in case of employing a GIS system and also Engineering software of the road designing

Akay *et al*. [16] In another study on provisional forests of Washington, U.S.A, he could disclose that utilization of Digital Elevation Modeling (DEM) using computer and software lead to designing a guide path and finally this path was controlled by GPS through the ground control Eventually by computing designing expenditures.

Hosseini [18] concluded that getting access to an optimum designing of road paths would be possible by using GIS technique via investigating and designing network of forest roads in NamKhaneh district related to Khiroudkenar (Noshahr) forest with designing method of road network. Additionally it was formed the guide path in the manner that the furthest resistance and optimum designing made for mentioned road through overlaying different digital maps including slope, geology, soil drainage and pedology.

MATERIALS AND METHODS

Research area is located on watershed No. 71; district. No 3 out of section. No 2 pertaining to Wood and Paper Industries of Mazandaran forests. This district is located at the southwestern part of "Sari city" and under control of Sari - Kiasar - Natural Resources Organization. In addition, the aforementioned road under study built in 2005 and it used yet.

The study area is between 53 ° 8 ′ 20′′ to 53 ° 12′ 50′′ eastern longitude and 36° 13′ 40′′ to 36° 17′ 45′′ northern latitude. This area confined to "Verki" from north "Lettalar" from east and "Verki" from west. Full size of the district is 1781 hectares (Figure 2).

The study area has alpine climate from the viewpoint of physiographic, which brought into begging due to peak - generating activities. The aforementioned area divides into different units from the viewpoint of slope, soil, plant covering, foothills and valley sand proportion of the percentage of category regarding district's slope is as Table 1.

Capacity, volume and number of trees per hectare are in accordance with statistically about forest book guide of Lolet district (Tables 1 and2).

The manner of designing the path and network of the forest road related to the area under investigation brought out of Designing Booklet. In the meantime, Cross section profile pertaining to a part of the road network delineated (Figure 7, 8). Until after road making, cross section profile took out via utilizing (GIS) and (RS) techniques, then in comparison with each other, the manner of conforming and observing standard criterions of the roads would discussed.

Table 1: Slope class of study area

Slope class (%)	0-30	31-60	61-80	> 80
Study area slope	32	40	12	16

Table 2: Capacity, Number and volume of study area

Supply in Hectare (m3)	Number in Hectare	Total Volume of standing Trees (m3)	Total Number of standing Trees
207.3	140	370395	248468

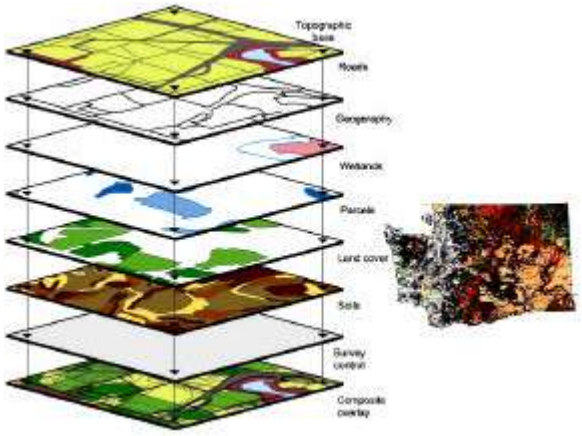

Fig. 1: layers type, information layers and overlapping [9]

In order to provide stability maps, initially geology, pedology layers and slope (percentage) maps gathered altogether to determine joint issue of the maps that represents the rate of the relative earth resistance (stability). After procuring the stability map, all the circumstance of congestion and supply considered as a positive compulsory factor for path selection designing.

Digital Elevation Modeling (DEM) of the area produced through employing (PAN) picture of (IRS) satellite making in 2006 as well as using three - dimensions topography layer of the area. In addition, the road layers, border of the precinct and border of the ridge, valley pertaining to classification extracted from satellite images.

Then the map of slope and perspective of the area established to assess passing the path for road making. A limited rate of topography lines determined with regard to stability map on the study area for recognizing the path by utilizing Pegger soft ware. Then a guide path was created by activating determined topographies out of the aforementioned toned path and by making standard steep slope appropriately based on designing rules regarding secondary forest roads towards software delineated the desire side to connect two points (A and B) related to the aforementioned guide path.

Eventually 26 control points chose upon the guide path equal to 1789 (meters) in length. The way of picking out these points is that on the points of the road in which alteration of slope would appear from positive to negative or vice versa or upon vertical and horizontal curves at a regular distance on the digital map, these points designated.

At the next stage, these points brought under control via employing (GPS) set in nature ultimately after controlling by the ground, accuracy of designed path confirmed by software in the study field. after determination of guide path into Arc view software, measures were taken to make exiting way of software then of road was designed with two software (ALD), (Civil Design) for this purpose, exit file resulting from Arc view software drew to enter into software.

Namely, previous suffix file changed into new suffix in order to identify and analyze entrance file for the new software. At the next stage, cross section profile of the path created by using capabilities of these two software

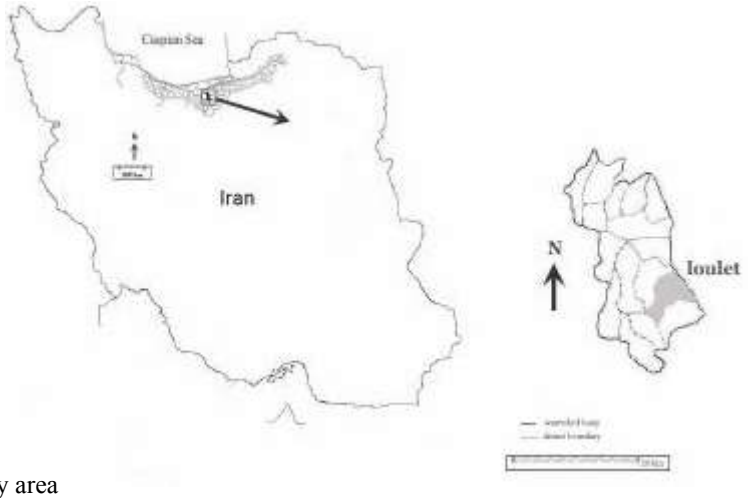

Fig. 2: Map of the study area

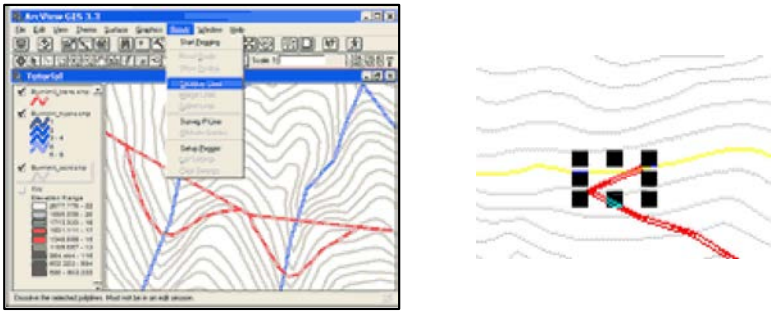

Fig. 3: Implementation of Pegger program into Arc view soft ware

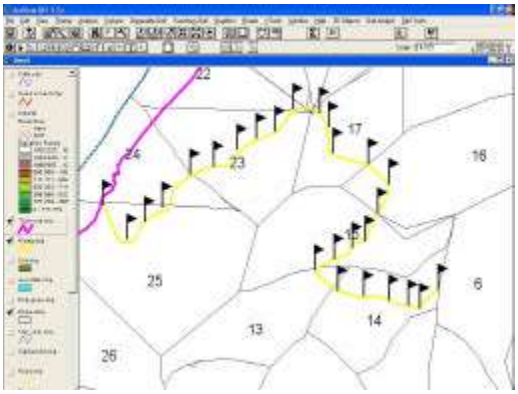

Fig. 4: Establishment of controlling points over the road into Arc view soft ware

and rendering some parameters and coma red with profile of the path and lines of the project to standards of secondary forest roads.

RESULT AND DISCUSSION

A) The conclusions demonstrated that the coordinates of 21 points have been verified with (GPS) set in nature and precision of designing the guide path upon the digital map got acclimatized by what ever really exist there; there fore based on observational statistics, 85 percent of selected points were verified by the same coordinates in nature.

B) Cross section profile regarding to the study area would be correspondent with the below figure (Figures 5and 6).

C) Extraction of numbers (numerals) out of existing road led to the below figures (figures 7 and 8).

D) to becoming shirt designed path by software in comparison with existing path equal to 311 (meters), reduction of growing - location surface performing cutting trees for the purpose of constructing the road is on the basis of Tables 2 and 4.

Table 3: Technical features of designed road [18]

Road Specifications	Values
Road width	5/5(m)
Cut slopes	1:1
Fill slopes	4:5
Minimum length slope	±3%
Maximum length slope	±12%
Design speed	40(km/hr)
Minimum curve radius	17(m)
Width slope	3%
Road length	1783(m)

Table 4: Computation of the tree number must be cut after road making, 311 (m) in length

The number of tree must be cut	Road area (m2)	Road length (m)	Right of Way Width(m)
30	2177	311	7

To plan network of the forest roads to carry out forestry projects, farthest expenditures dedicated to building the road. Here initially designed paths regarding the road should found out in appropriate way. The optimum designing of the guide path and greater quality

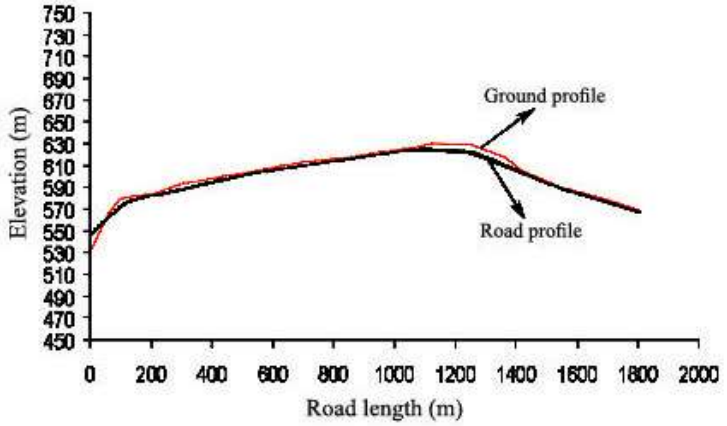

Fig. 5: Cross section profile of designed road by GIS

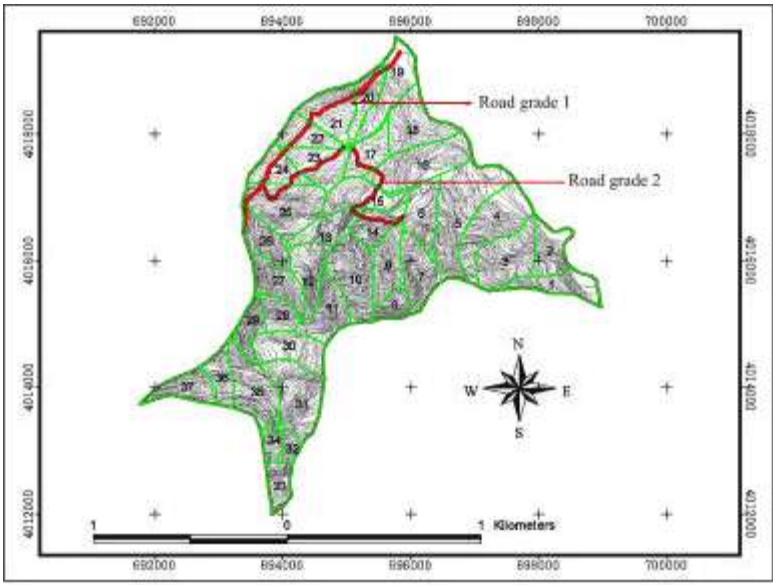

Fig. 6: Map of horizontally profile designed road

of its building would lead to reducing expenditure of the protection of the road. Location - finding (topography) and optimum designing of the guide path related to woodland roads conducted via (RS) and (GIS) techniques regarding the area under study into Arc view software.

This method of designing on investigation carried out and affirmed by the other researchers [12, 16]. After being assured of ground controlling selected points and its conformity to the conditions in nature and carrying out the stage of location - finding (topography), presentation of linear profiles and status of the path over the topography map in network of existing road and designed road by using (GIS) and (RS) would be discussed:

1. The path should be designed initially in the manner of abating volume of soiled operation and secondly the amount of digging well as leveling must be relatively equal in the event that by observing rules and regulations. The amount of digging becomes a little more than leveling and linear slope of the path must not be more than contingent minimum (Table 3).

The topic under discussion, namely getting across lowlands, with regard to the profile of designed path in (GIS) system is need to a bit digging and leveling particularly in comparison to the distance between the project line and linear profile of natural earth, which is conspicuous.

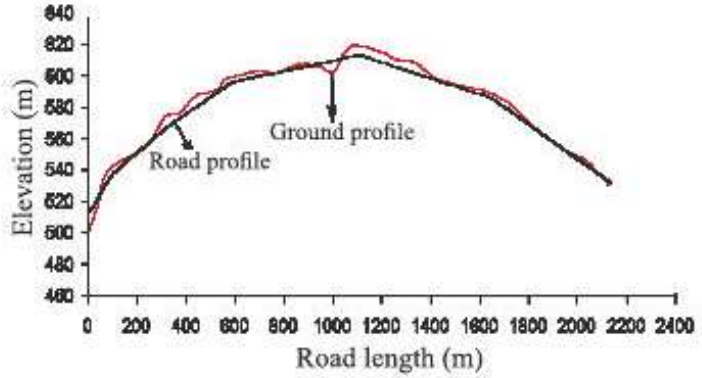

Fig. 7: Cross section profile of existing forest road (Existing Method)

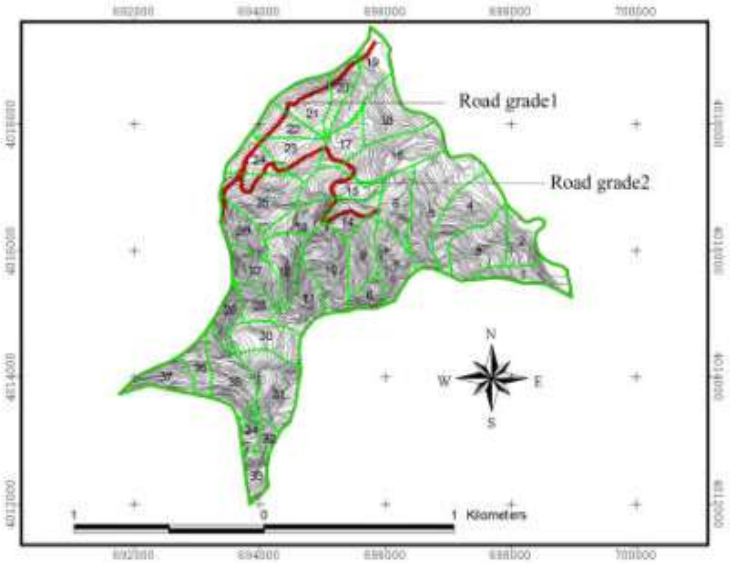

Fig. 8: Map of horizontal road existing

In this regard, it is clear that profile of the woodland road has highly percent of slope for connect two points (more than 10 percent). In conclusion, it will have highly volume of digging as well as leveling which this is sue causes to further relocate the soil and as a result, it would lead to more ruining the environment. In the field of forest, the environmental circumstances should been considered in designing issues as well as building network of the road and the above issue is completely visible in comparison to project line and linear profile of the earth (Figure 5).

2. The switch back, anti slopes and joint covering of the path cannot employ in designing the guide path must not bee employed in designing the guide path via utilizing soft ware. In this regard and therefore the path designed along with 1789 (m) in length which shows 311(m) drop in length in comparison to the existing path 2100 (m) (Figures 6 and 8). The drop in length incurs not to step up amount of slope pertaining to profile of the road in the manner that we had a drop in slope as well as volume of digging and leveling even in profile of designed path into soft ware (Figure 5).

3. The drop in length regarding the guide path could direct to abating cutting trees on the path and also to reducing ecological complications arising from woodland roads and dropping in building expenditures and preserving the roads along with 311 (m) in length.

Since existing forest from the viewpoint of the number of trees and number in hectare is not in a good condition and it needs to bee taken some of protective measures. Hence, drop in cutting 30 trees and these numbers of trees in order to revive natural existing in

the forest can bee an effective contribution to advance forest and nature toward sustainable development (Tables 2 and 4).

Ultimately, based on linear profiles map of path, this conclusion achieved, due to appropriate designing with respect to more accurate data's, designed profile of the path through using (ALD) soft - ware could pass positive and negative slopes appropriately and as a result, it rendered more suitable profile to build road (Figs. 5, 7). The furtherance of the project more rapidly, more precisely designing, drop in expenses regarding field sensing and totally drop in expenditures regarding making project can be performed by utilizing a computer system as well as employing (GIS) and (RS) techniques[15-18].

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