Relationship between forest road length and village development during three decades in Neka-Zalemrood forest

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ABSTRACT: Forest roads are built to facilitate the transport of personnel and wood, and so to promote village development. In this study 18 development indices of village in relation to increasing forest road density were evaluated during three decades for the villages of Aryam, Estakhrposht, Hosein Abad, Daram, Sarm and Darzikola in Neka-Zalemrood forest. According to the National Population and Housing Census of Iran (NPHCI), the rank of zero was considered for cases when a village did not have a specific facility and the rank of one was considered for cases when a village had a specific facility and service. The total length of forest roads was measured on maps from the years 1986, 1996 and 2006. Results showed that the total length of built roads at the end of 1986, 1996 and 2006 was 7, 25 and 36 km, respectively. Index of development in the village of Estakhrposht and Daram was positive at the end of the second decade whereas the villages of Estakhrposht, Daram, Aryam and Darzikola with ranks of 1.494; 0.053; 0.293 and 0.053 had positive development index in the third decade. The index of development in other villages was still negative at the end of 2006. The villages of Sarm and Daram enjoyed 5 and 7 services and facilities, respectively, in the second decade. So, their development index increased from −0.3 to 0.06 for Sarm and from −0.3 to 0.17 for Daram. 7.5 km of forest roads in the village of Estakhrposht were asphalted in the third decade (1996–2006) and the village of Estakhrposht enjoyed 18 development indices in total.

Keywords: road length; village; development indices; Neka-Zalemrood forest (Iran)

The construction of forest road network is the most expensive human activity in forests both in terms of economics and environmental effects (Demir 2007). Forest road network planning have been affected by many factors such as ecological conditions of the region, forest type, economic conditions of the settlement area, market demand for forest products, conditions for forest transport vehicles, topographical attributes, goals of forest exploitation etc. (Aricak, Acar 2004). In opening forests through forest roads, i.e. in trying to find the best possible solutions, forestry experts have to maintain the balance between economic, technological and technical, ecological, social and aesthetic requirements (Pičman, Pentek 2005; Liu, Dong 2008).

Different statistics have been presented as to the area of the Hyrcanian forests of Iran. Amongst the reported statistics, the initial 3,600,000 ha surveyed in 1942; 3,400,000 ha in a study carried out in 1964; and 1,920,000 ha published in 1990 can be considered. The area of Hyrcanian forests is 1.2% of the whole country area with 1,648,195 ha (Poorzady, Bakhtiari 2009). The total length of Hyrcanian forest roads in Iran was about 10,000 km at the end of 2009. Road network planning and standard methods for their construction are performed according to principles of Bulletin No. 131 (Sarikhani, Majnonian 1994) and 148 (Sarikhani, Majnonian 1999), published by the Plan and Budget Organization of Iran (PBOI).

Demands on the social and ecological functions of forests are increasing due to the development of society (Vyskot 2003). Forest roads must adapt themselves to these demands. They perform many non-productive tasks which are a consequence of the modern way of living. The consequences of

these trends indicate that traffic on forest roads will still increase and they will have to be able to meet this additional demand (Kašková 2004). A higher share of non-forestry uses of forest roads will require higher standards of transportability, road equipment and maintenance. According to the Slovenian legislation, forest road uses are divided into opening up of villages and farms, opening up of mountain cottages and hunting cottages, military, police and transit, forestry, hunting, tourism, sport, recreation and opening up of wildlife reserves, seasonal uses for agriculture and gathering (Potočnik 1998). Variation in forest road density can be explained in relation to land use, land cover, environmental factors and village development indices.

Hawbaker et al. (2004) showed that housing density and soils with excellent suitability for the road subgrade were positively related to road density while the wetland area was negatively related. Landscape indices showed greater fragmentation by roads in areas with higher housing density and agriculture, grassland, and coniferous forest area, but less fragmentation with higher deciduous forest, mixed forest, wetland, and lake area. These relationships provide an insight into the complex relationships among social, institutional, and environmental factors that influence where roads occur in the landscape.

In Turkish forestry, Analytical Hierarchy Process (AHP) was used to prepare the forest road evaluation form with 13 factors. Factors in the form and their respective significance rates were defined as vertical slope value 12.73%, condition of superstructure 6.89%, structure compliance with the drain-

ing system 5.71%, availability of continuous access 5.17%, transportation costs 3.94%, availability of fire protection 12.37%, proneness to develop erosion and any water quality problem 11.45%, the risk of landslide due to high hillside slope 12.55%, proneness to make pressure on water-courses 5.97%, risk to damage or annihilate the wild habitats 5.63%, eligibility for forestry works 2.64% and eligibility for utilization for security 6.45% (Gumus 2009). After the analysis of 48 Austrian forest roads (built between 1995 and 1999), the construction of forest road networks leads to change silvicultural strategies and forest regeneration. The number of forest tending operations in the areas has increased since the completion of forest roads (Steinmüller 2003).

While several studies have demonstrated that public roads can act as infrastructure to village development, the relationship between forest road density and village development has not yet been investigated for Hyrcanian forests of Iran. Village development in Iran has been affected by many factors such as forest road network, settlement area, economic and political conditions, goals of forestry exploitation etc. The purpose of this study was to evaluate the effects of increasing forest road density in Neka-Zalemrood forests on village development during three decades.

MATERIAL AND METHODS

Study area

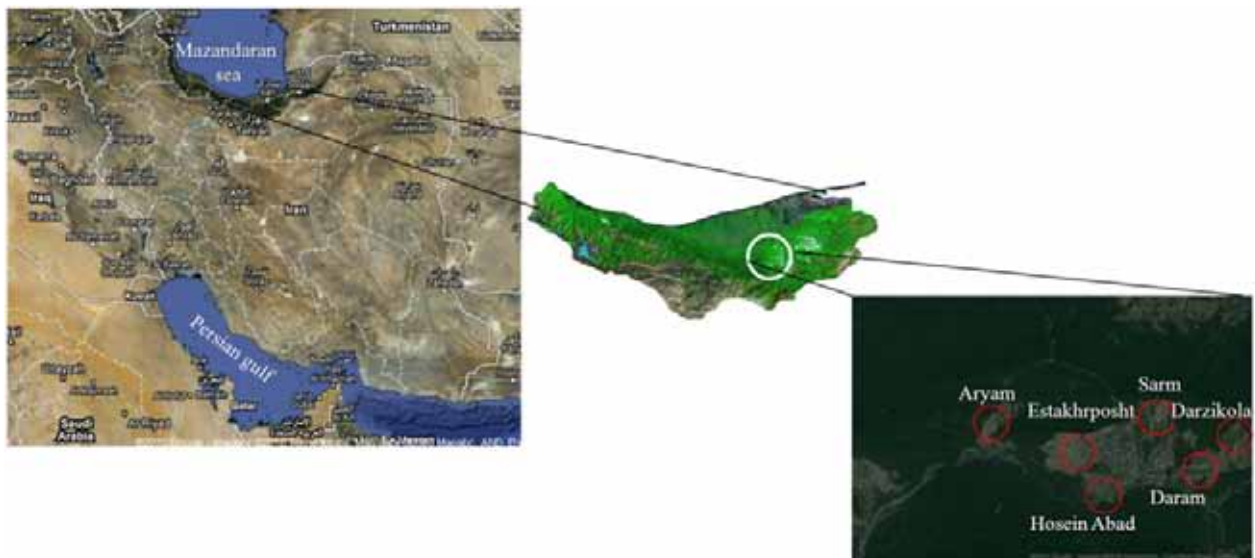The study area is located within the northern broadleaved forests of Iran (36°25' to 36°29'N lati-

Fig. 1. General state of viewed region and the people of resident village

tude and 53°25' to 53°31'E longitude), in the south to southeast of the city of Neka (Fig. 1) and covers an area of 13,511 ha. 1,817 ha of total area is field land and villages and 11,694 ha is forest. This zone is composed of marl, sandstone, siltstone, claystone and limestone bedrocks. Soil types of the study area are brown and washed brown forest soil with pseudogley. Minimum altitude is about 350 m above sea level and the maximum is 1,430 m. The surveyed villages are Aryam, Estakhrposht, Hosein Abad, Daram, Sarm and Darzikola.

Data acquisition

In this study, village development from 1986 to 2006 can be described by 18 services, economic and social indices including access to boarding school, high school, elementary school, telephone, electricity, water plumber, bathroom, rural centre, cooperative company, clinic, public health centre, hygiene house, public vehicle, dentist, medicine assistance, medicine, pharmacy and bakery. These indexes are useful in calculating a road network efficiency and connectivity. According to the National Population and Housing Census (NPHC), the rank of zero was considered for cases when a village did not have a specific facility and economic and social service and rank of one was considered for cases when a village had a specific facility and economic and social service. In Iran, based on Article 4 of the Act of the Statistical Centre of Iran (SCI), the census shall be implemented once every 10 years according to the Presidential Decree. The total length
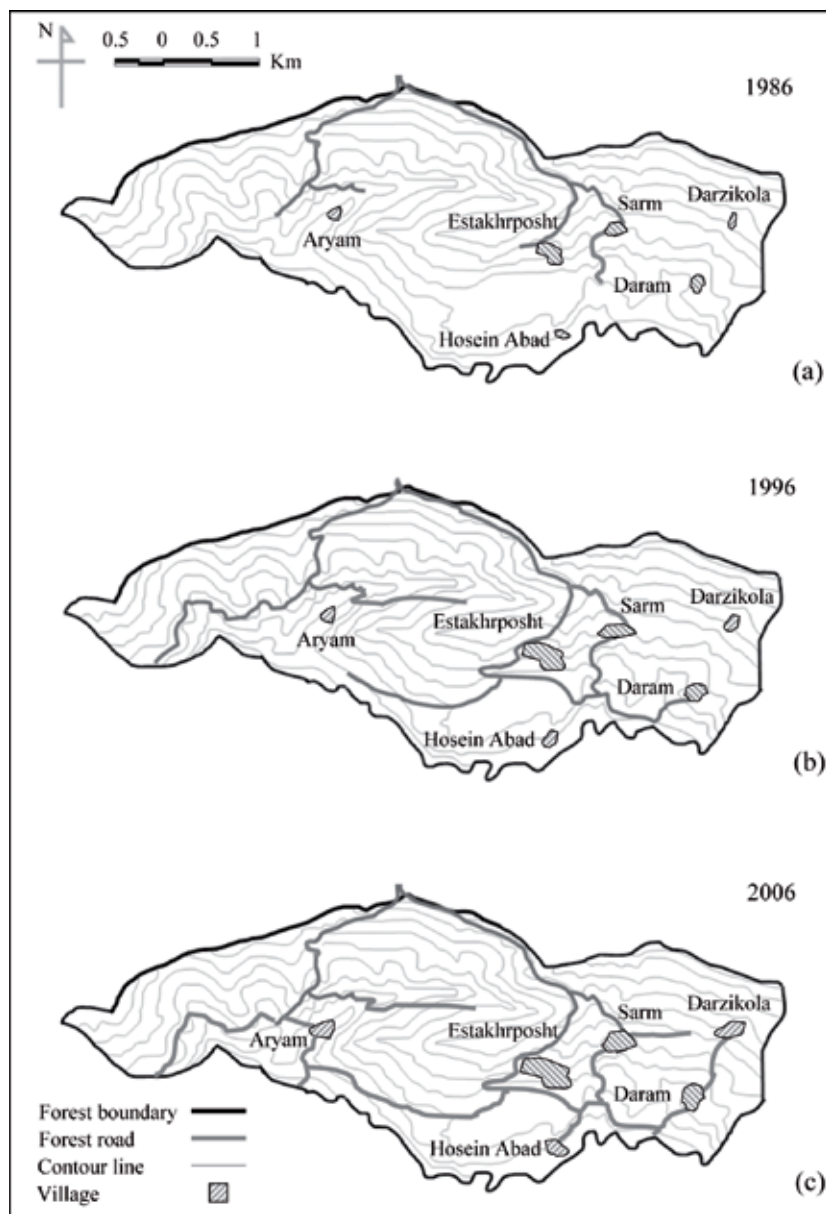

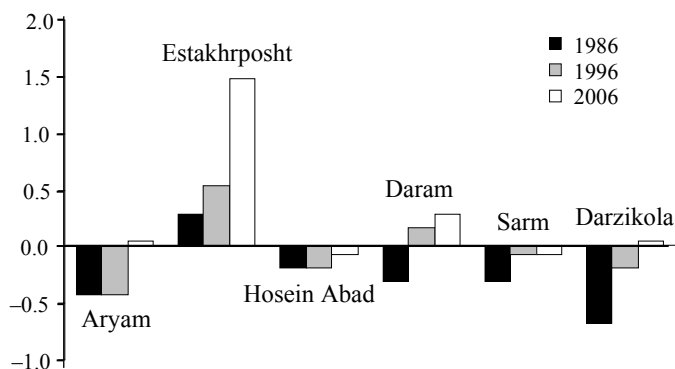Fig. 2. The map of forest road development from 1986 to 2006

Fig. 3. The development index of villages in years 1986, 1996 and 2006

of forest roads was measured on maps from the years 1986, 1996 and 2006. The mean level of development in each village was calculated based on development indices marked with 0 or 1 (Equation 1). Standard deviation was obtained from Equation 2. Development index for each service in villages (Z_{ij}) was calculated by Equation 3. Moreover, standard grade of Z (development index) was calculated from the sum of Z_{ij} in each village.

$$\bar{X}_j = \frac{\sum x_{ij}}{N} \qquad (1)$$

$$Sd_j = \sqrt{\frac{\sum x_i^2 - \frac{(\sum x_i)^2}{N}}{N-1}} \qquad (2)$$

$$Z_{ij} = \frac{x_{ij} - \bar{X}_j}{Sd_j} \qquad (3)$$

where:
$\bar{X}_j$ – mean of the column j
x_{ij} – index grade
Sd_j – standard deviation of the column j
j – total rank which was obtained from the sum of index ranks of each village (Mohammadi, Kiani 2007).

RESULTS AND DISCUSSION

The village people were living in forests before performing the forestry plan and construction of forest roads. Animal roads were the main transportation

Table 1. The exploitation of village services in 1986

Village name	Year	Water plumbers	Electricity	Telephone	Elementary school	School	Boarding school	Healthy center	Hygiene house	Clinic	Cooperative company	Rural services	Bathroom	Bakery	Pharmacy	Medicine	Medicine assistance	Dentist	Access to public vehicle
Aryam	1986	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Estakhrposht	1986	1	0	0	1	1	0	1	0	0	1	0	1	0	0	0	1	0	1
Hosein Abad	1986	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Daram	1986	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Sarm	1986	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Darzikola	1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$\bar{X}_j$	1986	0.5	0.0	0.0	0.8	0.2	0.0	0.2	0.0	0.0	0.3	0.0	0.8	0.0	0.0	0.0	0.2	0.0	0.3
Sd_j	1986	0.5	0.0	0.0	0.4	0.4	0.0	0.4	0.0	0.0	0.5	0.0	0.4	0.0	0.0	0.0	0.4	0.0	0.5

Table 2. The exploitation of village services in 1996

Village name	Year	Water plumbers	Electricity	Telephone	Elementary school	School	Boarding school	Healthy center	Hygiene house	Clinic	Cooperative company	Rural services	Bathroom	Bakery	Pharmacy	Medicine	Medicine assistance	Dentist	Access to public vehicle
																	Variable		
Aryam	1996	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estakhrposht	1996	1	0	0	1	1	0	1	0	0	1	1	1	1	0	0	1	0	1
Hosein Abad	1996	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Daram	1996	1	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	1
Sarm	1996	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	1
Darzikola	1996	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
$\bar{X}_j$	1996	0.8	0.3	0.0	0.8	0.2	0.0	0.2	0.2	0.0	0.3	0.2	0.8	0.2	0.0	0.0	0.5	0.0	0.8
Sd_j	1996	0.4	0.5	0.0	0.4	0.4	0.0	0.4	0.4	0.0	0.5	0.4	0.4	0.4	0.0	0.0	0.5	0.0	0.4

system in this region. These roads can be used only during the dry months of the season. Until 1986, numerous unpaved forest roads were built in the study area that enable access to forests, farms and villages in forested areas. In 1986 there were 7 km of forest roads in Seri 2 of district 6 in Neka-Zalemrood forestry plan (Fig. 2a). The new built forest roads for the period 1986–1996 were 18 km. In 1996 the total length of built roads reached 25 km (Fig. 2b).

11 km of new forest roads were built in the period 1996–2006. So at the end of the year 2006, the total length of built forest roads in Seri 2 of district 6 in Neka-Zalemrood forestry plan was about 36 km (Fig. 2c). The rate of village development based on access to socio-economic services in different road densities is shown in Tables 1 to 3.

Forest roads are built to facilitate the transport of personnel and wood, and so to promote village

Table 3. The exploitation of village services in 2006

Village name	Year	Water plumbers	Electricity	Telephone	Elementary school	School	Boarding school	Healthy center	Hygiene house	Clinic	Cooperative company	Rural services	Bathroom	Bakery	Pharmacy	Medicine	Medicine assistance	Dentist	Access to public vehicle
																	Variable		
Aryam	2006	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Estakhrposht	2006	1	0	0	1	1	0	1	0	0	1	1	1	1	0	0	1	0	1
Hosein Abad	2006	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Daram	2006	1	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	1
Sarm	2006	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	1
Darzikola	2006	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
$\bar{X}_j$	2006	0.8	1.0	0.5	1.0	0.2	0.2	0.3	0.2	0.2	0.2	0.2	1.0	0.2	0.2	0.3	0.5	0.2	1.0
Sd_j	2006	0.4	0.0	0.5	0.0	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.0	0.4	0.4	0.5	0.5	0.4	0.0

development. Development theory is a systematic conceptualization of the conditions that determine the change in the third world societies. It is concerned with the process of development rather than with the achievement of a particular state of development (Robinson, Thagesen 2004). The access road networks ensure permanent transport links between the forests and public roads. They serve for transport from villages to the forests and from forests to the wood-processing sites. In some countries, wood of up to 100,000 m³ or more may be transported annually on these rural access roads (Sessions 2007).

Ranking of village development in our study area showed that the index of development in the village of Estakhrposht (0.533) and Daram (0.173) was positive at the end of the second decade or in 1996. Whereas the villages of Estakhrposht, Daram, Aryam and Darzikola with the rank of 1.494, 0.053, 0.293 and 0.053 had positive development indexes in the third decade (end of 2006). The index of development in other villages was still negative at the end of 2006. Fig. 3 shows the increase of development index in villages from 1986 to 2006. The village of Estakhrposht enjoyed 10 services and facilities in the second decade of our study (1986–1996). In addition, the statistical evaluation showed that there was a significant correlation ($P < 0.01$; $r_{pearson} = 0.866$) between the forest road length and the development of the villages. The villages of Sarm and Daram enjoyed 5 and 7 services and facilities, respectively, in the second decade. So, their development index increased from −0.3 to −0.06 for Sarm and from −0.3 to 0.17 for Daram. 7.5 km of forest roads in the village of Estakhrposht were asphalted in the third decade (1996–2006) and the village of Estakhrposht enjoyed 18 development indices in total.

CONCLUSIONS

In summary, we found that there was a relation between the forest road length and the development of the villages. Indeed, forest roads in villages are the backbone of socio-economic development. In our study area, many road networks were constructed since 1986 to facilitate the transport of personnel, services and wood, and so to promote village development. Therefore, the road density has become too high and this has increased the index of development in villages as the villages of Estakhrposht, Daram, Aryam and Darzikola with ranks of 1.494; 0.053; 0.293 and 0.053 had positive development indexes in the third decade.

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