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CHANGES OF MICROENVIRONMENT IN GILAN CITY DUE TO LANDSLIDES

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Abstract: The Gilan territory is situated at the north of Iran, between Alborz Mountains and the Caspian Sea. The natural features of this territory are essentially are an extensive combination of the west Alborz mounts and the coastal plains of the Caspian Sea, thus having an eternal magnificent statue. This territory, due to its natural conditions, has suffered from natural disasters including earthquakes, floods and land mass movements, even in recent centuries. The combination of these natural factors as the basic cause, unintelligent human intervention as an intensifying enforcer, has resulted in "landslides" in many parts of the Gilan territory. In this paper, after introducing the Gilan territory with its geographical and natural particularities in Iran, care has been taken to discuss a number of important points including the effect of natural factors in developing the land slides, the impact of unintelligent human intervention as a reinforcing element, disturbance of the environmental balance and the impact of these landslides on the environment.

Key words: Landslide, land destruction, land utilization, landuse changes, environmental balance, land structure layers.

1. Introduction

Landslide is a global problem and is the most common type of land surface forming phenomenon. This occurred at all geological ages. Landslide is exerting excessive and extensive damage to natural forests, roads, cities, towns, villages and important installations every year (Fig. 1). With regard to the abundance of land sliding incidents at some parts of Iran, which had forest coverage before, the investigations done by a number of foreign researchers in this field, to a considerable extent, reflect gloomy prospects in near future, at the destroyed and transformed lands by previously occurred landslides, within the area that is researched in this paper pertaining to the Gilan region.

2. The Natural Features of the Gilan Region

Gilan territory is situation at the north of Iran and the southwest of the Caspian Sea. It has a surface area of 14711 square km, and is located between 36^0 36′ and 38^0 27′ of the northern latitude and from 48▫ 43′ to 50▫ 34′ in geographical eastern longitude (Fig. 1).

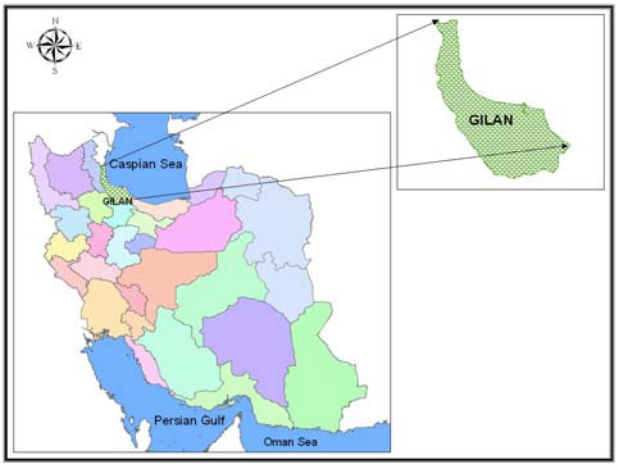

Figure 1: Location of the Gilan territory in Iran.

The Talesh mounts and the western Alborz range are located between this territory and Iran inland, as a gigantic barrier. This is the only natural

connection of the Gilan territory with Iran inside plateau, and is through the Sefidrud valley. Gilan territory is composed by two following regions: The lowlands, adjacent to Caspian Sea and the mountainous region. The coastal lowland places comprise a small portion of Iran surface area and its width, at some points, would reach not even one kilometer.

The agricultural geography of Gilan can be divided into coastal lowlands; plain areas with rice, tea and tobacco cultivation; foothill lands with tea cultivation and fruit trees and mountainous lands with grains as well as forage plants; based on the altitude parameter. However, the most importants agricultural activity centers are the coastal lowlands, lands and plain areas situated at less than 100 m elevation at open sea level (Fig. 2).

Forests of the Gilan region comprise an important part of massive and humid woods of the Caspian Sea water drainage area. Many previous researchers relate the origin of these forests to the Cenozoic age (Zaheri, 2001). The thinnest forest region is located at Astara with a width of 6 to 10 km, and the width of forest belt amounts 30 to 40 km at Asalem and Rezuanshahr

3. The Landslides of the Gilan Region

The combination of serious natural incidents such as abundant rainfalls; earthquakes; and unintelligent human interference such as destruction of woodland areas, occupation of unstable foothills, construction of improper roads and inefficient exploitation of mines has increased the occurrence of landslides in the Gilan region. Figure 3 shows the photograph of a typical landslide affected area in the Gilan region. Varnes et al. (1984), has categorized the land sliding factors into two groups:

a) The substantial conditions, including geological, geomorphological, climatic and those due to vegetation coverage

b) The altering factors favoring instability are loading, earthquakes, slope or altitude change, water level fluctuation, erosion, gradual sedimentation, seasonal fluctuation of subterranean waters. The factor which is more effective towards mass movement is the change in the foothill slope.

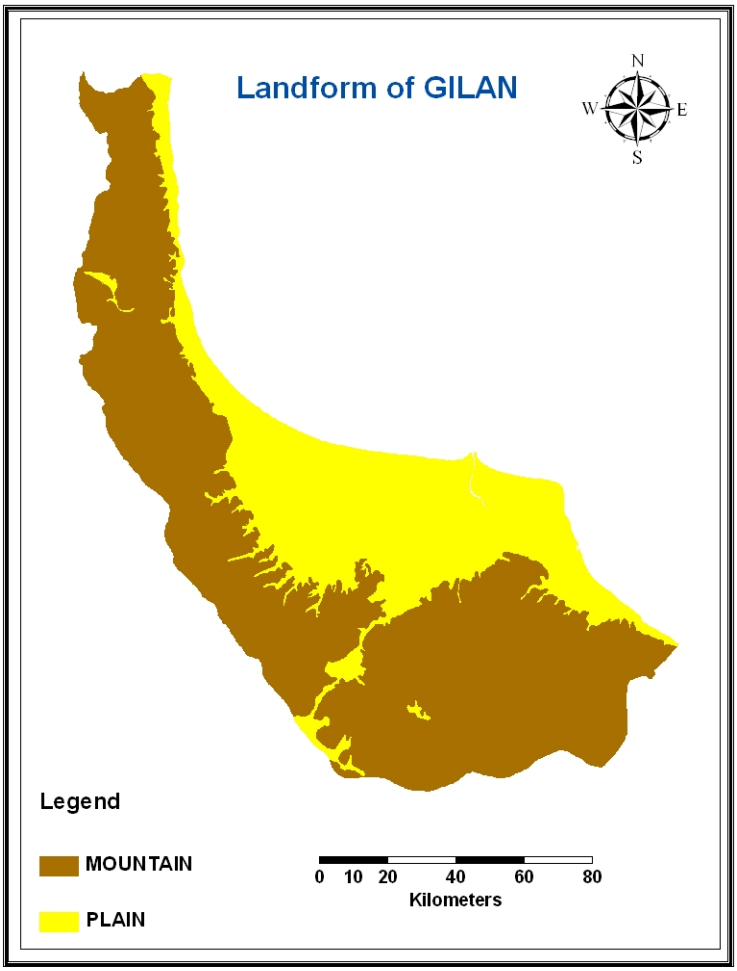

Figure 2. Altitude based agricultural geography of the Gilan region.

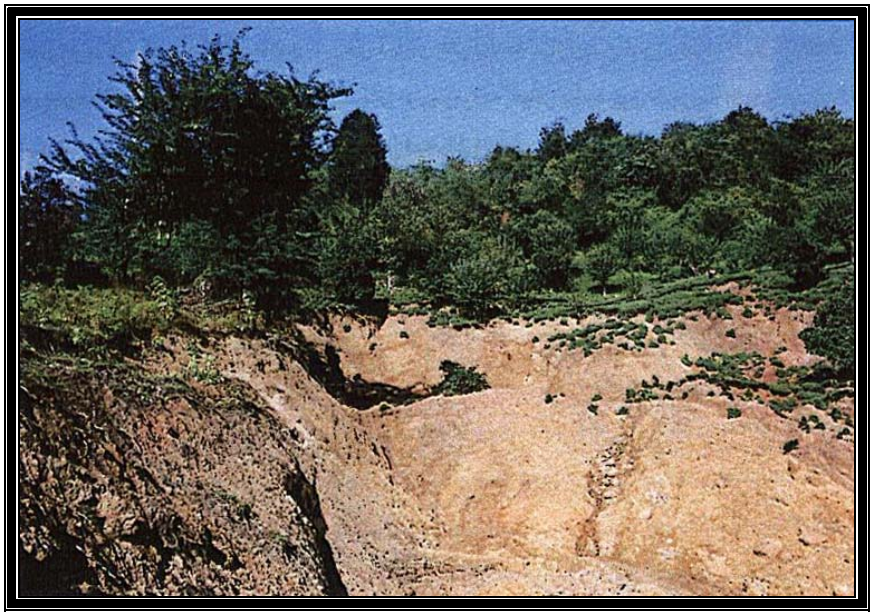

Figure 3. Photograph of a typical landslide affected area in Gilan.

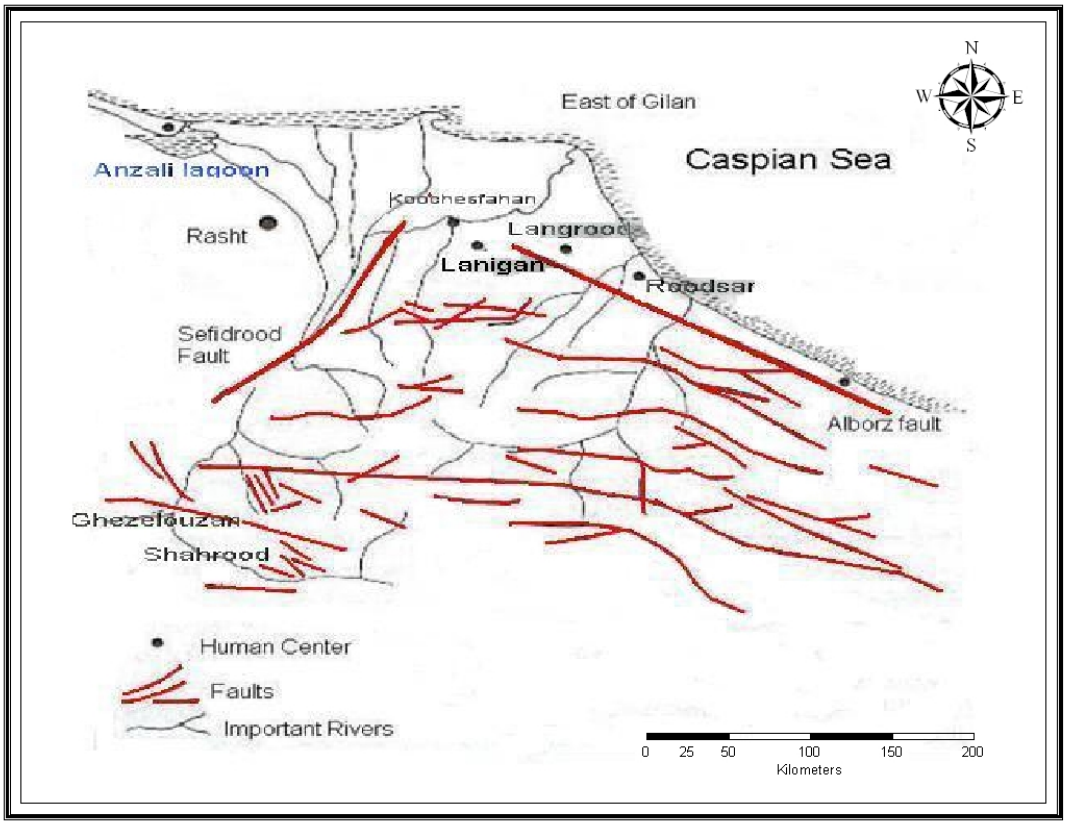

Figure 4. Faults in the Gilan region.

Some researches in water drainage basin in Tajan and Sari (East Caspian Sea region) have indicated that the minimum occurrence of landslide belongs to the region of intense forest usage. Its landslide index is put at each 100 km 2, is 5.5 landslides. The maximum occurrence is at orchard and farming usage with its index, at each 100 km 2, is 118 land slides.

4. GEOLOGY OF THE GILAN REGION

The skeleton of the Gilan region was formed at the end of Pliocene, around 2 to 3 million years ago, at the last and most important tectonic plate motion called passadenine. At Pleistocene, tectonic and climatic changes as well as erosion had the most effective impact on the external shape alteration

(Geological Map., 1990) of the Gilan region. Most part of the Gilan territory is covered by present age sedimentation with river, delta and coastal deposits and samples of older stones. This indicates or reflects the unstable nature of this region. Presently existing faults at this region are effective in the creation of landslides and instability of soil masses. In addition to the recent landslides, there were old landslides too around these faults. The big Alborz Fault that has an east–west direction at north of Gilan and the Astara Fault that has a north–south direction which extends up to Caucasus, and many other minor faults have great importance in the tectonic processes and seismic coefficients of the Gilan region (Fig. 4).

Earthquakes of 1990 that occurred at Rudbar in the Gilan region have a great impact at weakening of the soil masses of the region. Following this earthquake, partitions were created in some areas and the courses of the fountains have changed. Consequently this has accelerated the occurrence of land sliding. Granite, ultra basic masses, limestone and grit are forming the stones of this sedimentation area.(Darwish, 2002).

The upper cretaceous had a big extension at the forest region which mostly consists of lime, marn and volcanic stones. In east Gilan, most of the landslides were exerted on cretaceous volcanic stones. Presence of many minerals at those volcanic stones, which are also transformed to clay thick soil due to decomposition at humid climate, is capable of becoming an important factor for substantial instability in that region.

The change in the volume of marn stones is due to the impact of water absorption by the land's clay mineral contents. This, due to weathering and creation of cracks and cleavage, can loose its stability in future, and, because of the increase in its topographic slope, their sliding character would increase (Fig. 5), (Darwishzadeh, 1985).

5. GEOMORPHOLOGY

The Alborz Mounts have embraced the Gilan territory in the form of a semicircle. The geomorphology of this region has been formed under the impact of neighborhood with the Caspian Sea heights, local climate, geology and earth structuring. The northern foothills of this mountain range, overlooking the Caspian depression, are covered by forest and have been cut by many rivers. Relatively parallel arches and synclines created at the beginning of the Alborz Range have their altitude decreasing towards Caspian Sea.

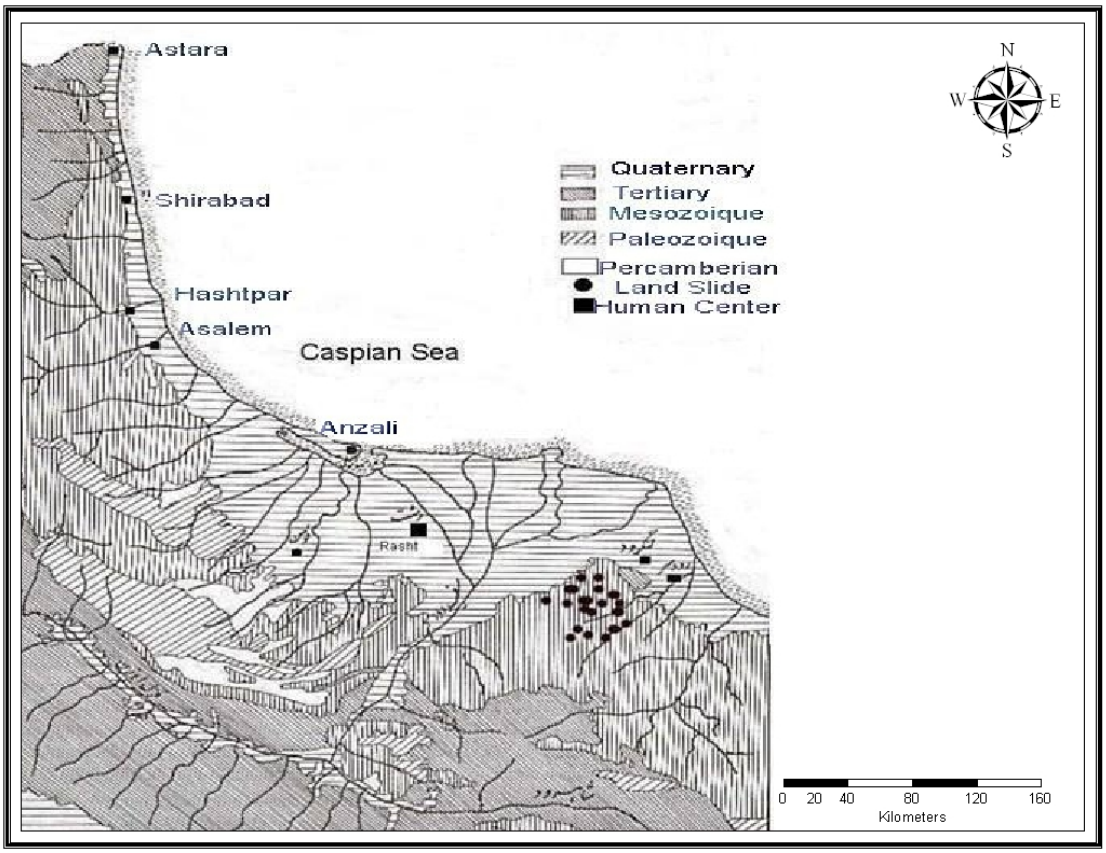

Figure-5. Geology of the landslides in the Gilan region.

At these foothills, due to the precedence of chemical erosion, the valleys became deeper, foothills are sloppier and the erosion coverage is thicker. The coastal plains between the Alborz Range and Caspian Sea have started their actual life, after stabilization of the Caspian depression, as the base surface of adjacent rivers. The start of erosion is due to many factors, in particular, the flowing waters from Cenozoic age and by compilation of destructive and washed-out sediments, have extended its water basis. The relatively sharp slopes of the heights, the existence of abundant fountains and water basins, with regard to upward erosion mechanism and the presence of thick clay sediments, due to chemical weathering, are among the topographic and geomorphologic elements which had had a significant role in emergence of mass motions, in the form of downfall at the heights and sliding at the foothills and mount footages.

6. THE CLIMATE OF THE GILAN REGION

Like other regions of Iran, the Gilan territory is exposed to continental masses and currents. External factors influencing the weather in the Gilan region include the Siberian anticyclone, polar masses and the Mediterranean cyclones in the cold season and, southwestern Asian cores in the hot season. These are more influencing to the Gilan weather than any other atmospheric phenomenon. Due to the neighborhood of sea and land on one side and the vicinity of coastal plains and mountains on the other side, and with the presence of extensive farms, there are always many possibilities for the air current movement and winds.

At the vast and leveled Gilan Plain, evaporation of an abundant quantity of water from rice farms, orchards and woods and its direct ascendancy has been an important factor for the creation and producing of accessional rain. The vicinity of Alborz and Talesh Mounts at the Gilan Plain, as well as extension of the mounts, which are exposed to the winds originated from Caspian Sea, result in ascending of humid masses and the formation of orographic rain. The rainfall of the southern regions of Caspian Sea is of unstable type and climatological stations indicate that the rainiest months of the year are from October to December and the least rainy months are from March to June. Table 1 gives the distribution of the seasonal precipitation in the Gilan coast, as recorded by the climatological stations, (Kawiani, 1989).

7. WATER RESOURCES OF THE GILAN REGION

The most significant water resources of the Gilan region are rain and snow falls. The probability of snowfall at all months of the year is quite high. At hydrological side, the rate of rain is higher in all rivers. The important and interesting particularities of Gilan rivers include, a massive hydrographic network with a large number of rivers as well as large range of water quantity in the rivers, shortness of the flow course and flooding condition at their place of origin. The inundating rivers, by transporting circular stone pieces and blocks and by under-washing the ridges overlooking the farms and orchards, threaten the cultivated areas and gardens. The uncontrolled water flow courses can result in water penetration, weight increase as well as sliding condition of soil masses. These conditions could cause the houses located at the foothills to crack or to fall down, (Ibrahim 2001)

1.The Subterranean Waters: The mountainous part of the Gilan region, from its geological structure and vegetation coverage characteristics, has no significant appropriate conditions towards forming subterranean water aquifers. But the rivers' cylinder shape-throws and the sedimentary plains possess more suitable conditions towards forming water aquifers. The thick layers of cretaceous lime stones and layers of basalt stone and the sedimentary materials of the Caspian shore, which were deposited over millions of years by rivers, consisting of grit clay soils that are older and sediments of sand and gravel, cobblestone and clay, which are newer, along with clay-silicate layers together, are forming good aqueous aquifers, (Monavari, 1992).

Table-1: Distribution of seasonal precipitation as recorded at some coastal stations of the Gilan region

Station	Winter precipitation	Spring precipitation	Summer precipitation	Autumn precipitation	Annual precipitation mm
Bandar Anzali	22.0%	11.2%	26.8%	40.0%	1761.2
Rasht	27.3%	15.4%	21.7%	35.6%	1260.2
Astara	26.7%	14.1%	29.1%	34.8%	1259.4

Figure 6. A village house based on wood, affected by landslide.

Feeding of these aquifers at the highlands are accomplished by the precipitation and at the plains, supplies by the rivers, direct penetration of rain and water infiltration resulting from rice farms irrigation. In general, in some areas which have been studied, the control of fountains as well as the waterway trenching towards the main rivers, can be one way for reducing the aggravation of landslides, (Morgan, 1988).

8. LOADING ON THE FOOTHILLS

Sedimentation process and concentration of water that have resulted from precipitation at suitable foothills would cause a mass increase, weight and stress on the foothills and would enhance the intensification of water penetration, at clay stones and soils. This would result in the decrease of the resistance. Loading caused by unintelligent human actions can aggravate this process. By erection of heavy buildings in recent years and increasing the load on the foothills of this region by other means such as transportation, the equilibrium of the foothills is disturbed. The native architecture of the villages is based on wood work, mostly (Fig. 6).

1. This process of using wood is most popular for wall making, in the rural architecture in the Gilan region. Using Cheaper (wooden primitive fence) and Parchin (fence made of plants), instead of wall, for partitioning of the house space, was predominant in the earlier customs. But, these days, due to the availability of facilities, walls are made of brick and stone. Plant filaments and dried branch of the rice also have an important role in coverage of the roofs. There were other types of buildings in which the roofs were covered by wooden tufal (small little rectangular pieces of oak tree or zirfon placed side by side in the form of tinsels). Native architecture, in recent years at Gilan, has undergone extensive changes some of which can be termed as unintelligent human intervention that can add to the feasibility of landslides due to erosion. The occupancy of unstable foothills as a result of increased population, especially the rural population, and the utilization of the cement blocks, iron beams and heavy raw materials of building in general, has increased the foothills loading. This aggravates sliding and other mass movements. Vulnerability of old houses in case of land slide has decreased and its repair is easier than heavy buildings with new style (Fig. 6), (Riazi, 1995).

Erection Of Improper Roads: In Gilan, erection of roads has been made without considering the hydrological, geological and topographical interrelation and without attention to its pros and

cons. This is again unintelligent human interaction. This results in sloping of the foothills and thus increasing the latter's instability. Erection of improper roads at some sliding foothills can result in deformation of the foothills and creation of horizontal cleavages on the moving foothill surface. For example, at the village known as Latar in East Gilan, after erection of the road, a full-of-water fountain, overlooking the village houses, has dried out. Its path has disappeared and it has reappeared behind the village houses. Thus, while this shifted fountain was running under the houses, it has emptied their foundations which has already caused sliding and a significant damage to village houses (Land slide report, East Gilan, Ministry Of Jahad-e-Keshavarzi). At the beginning of Lahijan city, a new road connecting Lahijan to Shir Nesa, due to loading during the process of erection of the road and under-washing of lower river, has slided towards the foothills and has disturbed the area's slope equilibrium.

9. THE CHANGING LAND USE OF THE GILAN REGION

The Gilan Forests: The south Caspian forests have covered the coastal plain up to 2700 m altitude at Alborz Range, and are propagated from Astara to East of Gilan. The first estimation of present south Caspian forests' area based on aerial pictures of 1942 is 3.6 million hectares, and 3.4 million hectares in 1958. In accordance with the official estimation in preceding decade, the extent of North Forests, was up to 1.8 million hectares (Varnes 1984). This continuing declining trend implies the increasing destruction of the natural forests. The main reasons for this destruction of the natural forests is for getting the supplies of wood as fuel, clearing of forests for erecting the roads, construction of lodging and other dwellings and creation of cultivable lands as well as tea and citrus trees gardens (Fig. 7).

While abundant precipitations in some years have been an important cause, or first cause for land slides, the instability of forest lands and the large numbers of land slides even at cultivated lands, clearly indicate that destruction of forests and other unintelligent human interventions are the severe aggravating factors for the phenomena of landslides. Though the natural causes for landslides have an increase or decrease that are rather small and almost beyond the human control, what is most worrisome is that the increase in the unintelligent human interventions is not natural but clearly a societal, governmental and even an international problem. The forestation projects and the inappropriate changes in vegetation coverage would empty out the soil protective coverage from native species such as anjili (Parrotia), toskad (Alnus), and would result in spontaneous motion of the masses. Such a forestation can also become unintelligent human intervention, (Sabeti, 1978).

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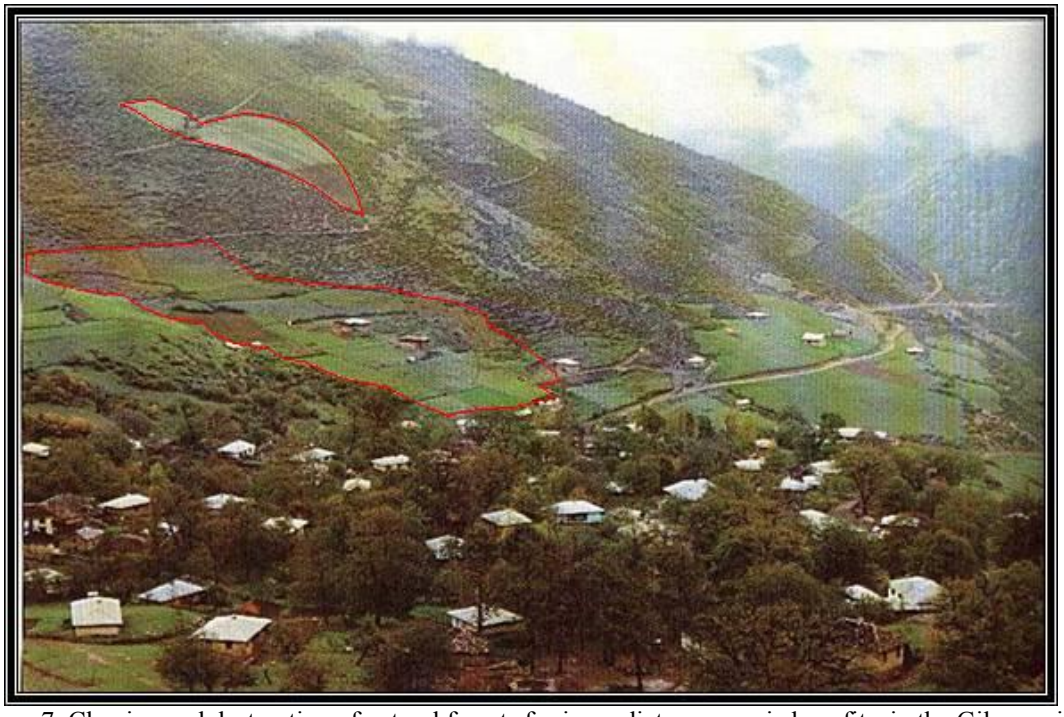

Figure 7. Clearing and destruction of natural forests for immediate economic benefits, in the Gilan region.

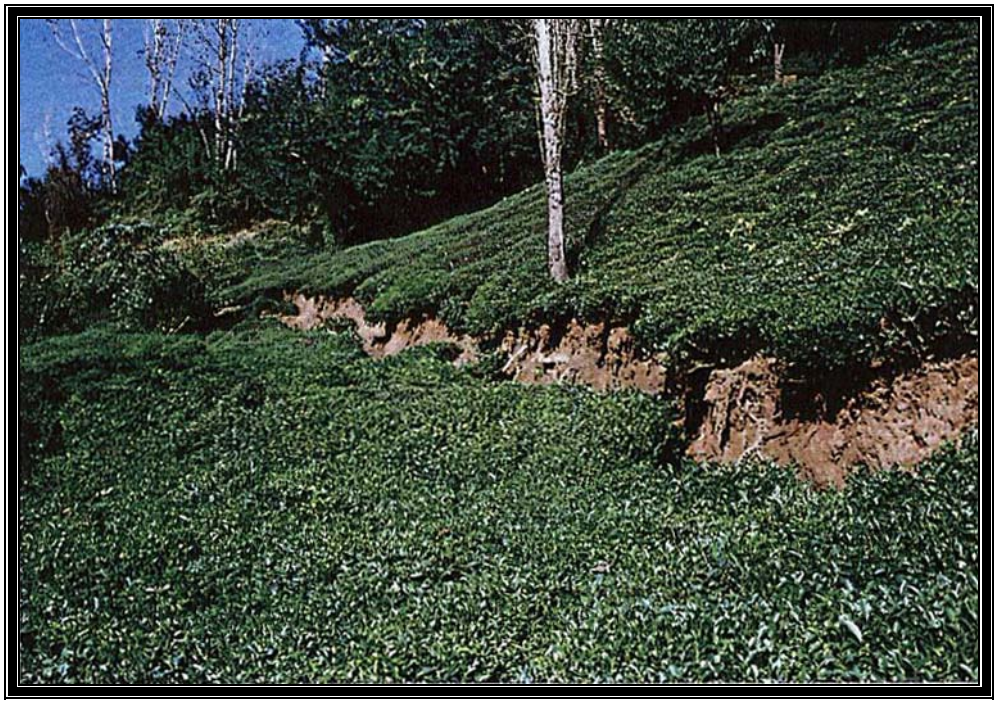

Figure 8. Landslide in a transformed land for commercial cultivation.

Many studies of the land slides at Gilan indicate that most of the landslides have occurred in those lands which are transformed to tea and citrus trees gardens, (Rahnamayi, 1991). This is clear because, despite the uniform intensity of precipitation at all of this region, there is a significant discrepancy in the stability of the foothills with forest coverage and the stability of these transformed lands. This problem, indicates the very little good effect of shallow roots of tea with their low water absorption potential, as compared with forest vegetation, such as Oak (Quercus), Rash (Fagus) and Anjili (Parrotia), (Asri, 1992).

Impact of Transforming Forestlands into Tea Gardens in Aggravation of Landslide: Tea is a semitropical plant which is evergreen in commercial terms and color too (Fig. 8). Its height ranges from 50-70 cm usually, which crops in 5 to 6 years. This plant in Gilan, is cultivated on highly varied level fields, say from 2 m lower than open sea level up to 2000 m above sea level. The best soils for its cultivation are clay and sandy earth, with a high range of humus, without lime. The tea shrub consists of three parts: root, stem and leaf. Its root is of spreading superficial type and it penetrates maximum 3m inside the soil. It is not able to penetrate at the deeper or extreme soil depth, and this fact results in lowering the mechanical impact of the root as well as leveling and protection of thick soil. In the meantime, lack of deep development of the root will result in a decline of evaporation and sweating, as compared with previous natural forest coverage. These factors increase the levels of the subterranean water. This, combined with the reduction of soil cohesion, has an important impact on aggravation of land slides.

Harvesting the tea gardens takes place from April to October yearly, October is is the most rainy month of Gilan. By harvesting the fourth leaf of the tea, the shrubs coverage becomes thin and results in the acceleration of water penetration inside the soil, which subsequently, will cause the superficial decomposition of the soil and increase in the level of subterranean water. The tea shrub, needs a lot of water for its growth in summer, while in winter which is the rain season and root growth stops, it utilizes the precipitation, (Kelarsaqi, 2002).

Table 2. The damages due to land slide in tea gardens

Province	Number of villages	The surface area in the course of damage m^2	The damaged surface area m^2
Lahijan	3	72340	4000
Langrood	13	1664230	344470
Roodsar	21	3800000	550000

*courtesy of National Tea Organization, Iran,1993

Figure 9. Destruction due to landslide in a tea garden.

Figure 10. Landslide in a 30% sloppy area.

The tea shrub is cultivated at a slope of 30%, which when correlated with the fact that most of the land slides are taking place at 30 to 50% slope, clearly shows the destructive effect of transforming the natural forests into commercial tea gardens (Fig. 10). Consequent to the land usage alteration from forest coverage to tea gardens, aggravation in land instability and lack of soil equilibrium follow. Important centers of tea cultivation in Gilan are Lahijan, Langrud, Roodsar, Fuman, Somaeh Sara and Astara cities. Following the unprecedented low precipitation of 1993, many areas of Gilan suffered damages; and a lot of losses were inflicted on tea gardens and villages (Fig. 9). The damages in tea gardens in various provinces of the Gilan are recorded and some results are tabled below (Tab. 2), (Razayi, 1999).

10. CONCLUSIONS AND PROPOSALS FOR FUTURE

The land usage change include, transforming of natural forest lands and slope forest areas to agricultural farms, commercial gardens, roads and building, high ways. This also involves altering the sloppy areas to lodgings and lodging units. This results in loading of the foothills and changes of foothills slope. These mechanical reasons are aggravation factors in hampering of foothills equilibrium and increasing the occurrence of land slides. Changing the fauna and flora of the forest areas by destroying the forests and transforming them into commercial plantations such as tea plantations, introduce hydro-biological reasons towards weakening and instability of the foothills, because of altered and unfavorable water retentions in the soils, (Monavari, 1993).

The preservation of forests is valuable for all the people, even for those farmers, who are transforming the forests into lodging units. But crop harvesting several times per year from these lands encourages them to do so. Certainly, pert of the soil at an extensive level as well as pert in the agricultural crops and economic damages to the farmers, are not a pleasant matter. So, there is a need to search for a process, in which, while exploiting nature, it shall also consider the preservation of equilibrium of nature as well as reliable and long-range development. For attainment of this objective, the following points shall be considered (Sabeti, 1978).

1- Avoiding the cultivation on sharp sloppy lands exposed to sliding and to prevent any disturbance in the natural coverage of such foothills.
2- Mahmoodi, Farajollah, 2001, Gilan Geology
3- Reinforcement of sloppy heel, which is weakened by erection of the roads and loading, and those which are emptied by under-washing by rivers, by providing barrier walls and piling (utilizing Chapar(wattle) and wooden nails, at regular intervals, on foothills).
4- Applying an appropriate method in trenching of water for avoiding penetration effect and discharge of surplus water (Fig. 8).
5- Use of shadow spreading trees, with deep roots, such as Albizzia tree, between tea shrubs. This is going back to nature, with understanding and respect.
6- Studying the geological and soil situation as well as hydrological conditions and impact of the forest trees, at soil stability, prior to transformation of lands to gardens. This can lead to intelligent human intervention, in place of unintelligent human intervention.

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