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Evaluation of Relationship of Spatial Planning-Georisks and Urban Risk Analysis: The Case Study of Bartin

Şule TÜDEŞ [1♠], Gültekin YILMAZ [2]

[1] *Gazi University, Faculty of Engineering and Architecture, Department of City and Regional Planning, 06570 Ankara, Turkey*
[2] *TUBITAK, Çaydag Research Group, Ankara, Turkey*

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ABSTRACT

While Turkey is located on a geography having the natural hazards which cause disasters such as earthquake, flood, landslide and the like, a lot of settlement areas are exposed to the risks on various levels caused by these hazards. The spatial planning approach including urban risk evaluation studies for the identification of previously the hazard occurring risks and the detection of the damage levels will help to reduce the losses which will be occurred by the negative social and economical effects of the disaster-sensitive planning approach. The urban planning should be designed as the problem solver and dynamic process to create the healthy, safety and survival urban environment, and the risk decreasing measurements should be necessary in the planning process. In a study carried out in this period, the evaluation related to the geoscientific data was performed on the identification of the disaster risks for the urban planning by the risk analysis method and the least diminishing of the disaster harms by the measurements taken in the planning period. As the sample area, Bartin city was chosen because it includes the earthquake, flood and over flood together. The urban risk evaluation caused by the geological factors in Bartin city was tackled by the analysis input creation for the disaster- sensitive planning approach and disaster risk management. The urban disaster risk and damage level were assessed by analyzing GIS for each risk factor and land use decisions and by relating to the regulatory development plan covering the available land uses of the city to the complied geoscientific data.

Key Words: Disaster, georisk, urban risk, GIS, Bartin.

1. INTRODUCTION

In Turkey having the sensitive geological structure for the disaster hazards, urban and rural settlement areas were exposed to various kind and amplitudes of disasters during the history. The disasters having the destructive effects occur in the urban settlements and constructed areas where the population lives densely.

The planning studies contacted within the construction law issued 3194 number in Turkey are performed by the traditional planning method which the design view of the physical locations in the urban area has been admitted. After the earthquake on 17th August in 1999, it was understood that the decrease of the disaster risks could not be solved by the traditional planning methods.

Researchers who study disaster sensitive planning, disaster management and urban risk analyses emphasize following detections:

Natural and technological disasters of the past have shown that such incidences significantly affect local and regional development. Faced with the task of ensuring economic, human and environmental development as well as insuring physical structures, planning authorities, insurance companies and emergency managers is looking for methodologies to identify highly sensitive areas in terms of their overall risk [1].

The most complex one among the risk identification studies conducted in the different levels is the studies carried out in the urban level. By considering the systematical accompanied of the physical, economical and social characteristics of the city, the identification

♠Corresponding author, e-mail: studes@gazi.edu.tr

of the multiple risks in the urban settling requires the solution of the city by the scientific methods [2].

The urban risk expresses the hazard situations of the population, structures, public services and all social-economical activities versus the disasters [3].

The identification of the risk characteristics of the settlement areas is defined as Risk analysis. The main studies which are necessary in the risk analysis are as follows: the distribution of the population living in the city in different times of the day, the compilation of the data related to the infrastructure and superstructure. Available building stocks, the identification of the risk situation related to the elements which will be damaged primarily such as energy plants versus the disasters; taking into account of all available city plans, the research of the location ground conditions, the length and width of the roads; the construction density, the identification of the warehouses, the amount of the green open areas and the identification of the distribution in the city location [2].

The disaster management can be shortly defined as the management and the coordination of the activities which should be essential to be performed in the disaster stages [4].

Reliable and up-to-date information on the growth and change of big urban agglomerations are an indispensable input for urban risk assessment and for the risk evaluation of insurance companies (i,ii). In case of disasters in places with high population density and dynamics natural and man made disasters have the maximum impact and result very often in loss of lives, but also causing tremendous costs for individuals as well as companies and national economies [5].

Spatial planning normally only needs hazard information; risk and vulnerability are only important in a few extreme situations (e.g. where relocation of existing development is being considered). For risk management (non-structural mitigation activities), only the vulnerability of the different objects to be protected is, in general, of relevance (e.g. different types of land use or different types of buildings)" [6].

Predisaster planning activities are started by the identification of the disaster regions. While, on the one hand, the appropriate degree of the country arising the natural events causing the disaster is researched, on the other hand, it should be considered whether the damage is man-make and gives harm to the environment. Therefore, the risk, maps are prepared for various disasters. The work to be done after this stage is the protective planning study against the disaster [7].

Natural disasters are a typical example of people living in conflict with the environment. The vulnerability of populated areas to natural disasters is partly a consequence of decades of spatial planning policies that failed to take proper account of hazards and risks in regional and land-use planning as well as development decisions. At the same time this shows the important role spatial planning can play in the prevention of natural disasters [8].

The planning studies in the predisaster preparation stage are especially important in decreasing the risks. The view of the disaster-sensitive planning requires for the previous measurements which will be evaluated in the planning system by the geoenvironmental criteria. In the selection, decisions made for the disaster-sensitive planning, geological and geotechnical researches and geoenvironmental evaluations are the essential parameters [9]. The technical aspect of the risk contains the solutions such as physical planning and the decrease of the population density. The natural disasters create the different effects on the cities.

The construction, infrastructure, communication, transportation e.g. as to city are affected in a different manner and the risk decreasing studies which will be performed according to the possible disaster risk make difference in this direction.

The disaster risk management is the measurement serials which are necessary for the hazards caused by various natural or artificial factors in every level. The risk management in the natural disasters is defined as the identification of the risk levels of the settlement areas in predisaster and the developing of the measurements which will reduce them to provide that the settlement areas are more resistive against the disasters.

The 1999 earthquake indicated us that the construction planning system in Turkey and the engineering approaches related as the earthquake-focusing and the disaster phenomena in only construction scale and the disaster management focusing the post disaster studies were insufficient. Also, this situation proposed that the disaster harms should be decreased and multidisciplinary approach related to the measurements which will be taken in predisaster should be improved and the planning system should be reformed by the disaster-sensitive approaches.

The fact that the risks are defined locally and harm-decreasing measurements may be determined in predisaster by predicting the possible damages previously and this work may be performed in decreasing the effects of the possible damages will be able to enhance the success rate. In order to carry out the disaster risk management and disaster-sensitive planning approach, the integration of the geological data into the planning is mandatory during the periods of area selection, settlement and construction decisions.

This study is the evaluation which the urban geology parameters and geoenvironmental assessments are included to be able to decrease the disaster harms in the planning and in detecting the disaster risks for the urban planning and disaster risk management. The geoscientific data of the city was tested on the regulatory development plans. The urban risk analysis for Bartin was achieved by analyzing around GIS of how and what rates the available usage areas and the proposal usage decisions were affected from the georisk influencing the city.

2. THE GEOGRAPHİCAL LOCATION OF THE STUDY AREA

The city is located at 410.53′ North Latitude and 320.45′ East Longitude in the west Black Sea region. There are the Black Sea with the seashore of 59 km in its North and Kastamonu in East, Karabuk in East and South and Zonguldak in West. The city center is surrounded by Aladag Mountain in West, Karasu Mountains in North and Arit Mountains in East. The most important stream of Bartin is Bartin River. Two main branches of Bartin River are Kocacay and Kocanazcayi Streams.

3. STUDY METHOD

First of all, the geoscientific data of the city and the urban planning data were complied from the studies of the researchers working in the region and the related associations and foundations.

For these geoscientific data and planning data, the database was produced by GIS for the use in the urban risk evaluation analysis, for the use in the analysis; topographical maps of 1/25000 scale, Bartin City and around suitable settlement map of 1/25000 scale [10], Bartin and nearest environment geological and morphological characteristic maps of 1/25000 [10], regulatory development plan confirmed 2006 of 1/5000 scale [11], and Ikonos Satellite image performed 1 m resolution ortorectification belonging to 2006, were complied and stored in digital format. The transformation of all data related to the research area was carried out by the data conversion of available numeric data and analysis ArcGIS 9.2 software. By performing the analysis and the integration of the geoscientific data and the planning belonging to the city around GIS, the urban risks caused by the geoenvironment were evaluated. Both input and guide were produced for the predisaster studies in the disaster risk management. By testing 2006 confirmed 1/500 scale regulatory development plan by means of the analysis including the georisk, the planning approach of the city was evaluated in possible disaster aspect. For the disaster risk management, one of the primary elements is that the quality, proportion and location of the urban risks are known. For this, the study will produce the basis of the disaster risk management and disaster-sensitive planning approach. The other important analysis for the disaster risk management is that the pathway analyses are performed and the alternative directions are identified to reach the disaster time in a short period. For this purpose, network analysis was achieved by ArcGIS. 9.2 software around GIS. Database design has been improved as the support of this analysis.

4. GEOLOGIGAL THRESHOLD AND HAZARDS INFLUENCING THE URBAN DEVELOPMENT

4.1 Geological Characteristics

As in the large engineering constructions such as dam, road, bridge and tunnel etc, it is essential to evaluate the geological-geotechnical characteristics of the ground and geological environment conditions and their effects on the designed construction in the city planning site selection, and to take the sufficient measurements [12]. If geoscientific data are not used in the planning process, economical and sociological destructions may arise in future.

The geological and geotechnical data and information used for the Bartin City Risk Analysis were summarized by different researchers and associations as follows [10], [13], [14] and [15].

In Bartin City and its surroundings, the large areas with alluviums and volcanic-originated andesite and basalt magmas with Createase and Eosen aged formation are surfaced. The unit is composed of sandstone-clay, stone-limestone and marn. Eosen aged filiches are in the shape of sandstone-clay, stone-siltstone. Bartin City was located on the alluviums including the levels with clay, silt and gravely which the Bartin River and its branched produced. Volcanic-originated andesite-basalt and aglomeras are surfaced in North of the region.

If we summarize the geotechnical characteristics of these units occurring the city settlement area from the complied studies shortly, the bearing power of the alluvium ground including the levels with clay, silt and groin is rather low. The rising of the underground water affects the attitude of the ground which is already thin. And it causes more decreasing in the bearing power and increases the liquefaction risk during the earthquake. Alluviums carry the landsliding risk in some sections due to the factors such as high topographical slope, the suitable layering toward the slope direction, underground and ground water. The bearing of andesite is rather high. Although, the andesite occurs the suitable ground for construction, they cover fewer places in the city settlement area. And there is a construction ban because there are forests in these ground areas. Createase aged filiches have moderate bearing and occur the suitable areas for construction. They are exposed to the surface weathering owing to the effects of the atmospherically conditions. Their bearings are low in the weathering zones. Eosen aged filiches have the same bearing characteristics in the engineering manner. They have the suitable engineering characteristics for the constructions. Their bearing characteristics in the sections showing the weathering go worsen.

In addition, according to the geological and geotechnical characteristics, [10] Tuysuz et al (2001) divided the city into five zones as the suitable settlement areas, the risky areas for flood, slope, landsliding and soil and flood.

4.2. Topography

The slope and altitude zones produced for the topographical analysis in the study area, were performed as a result of the graphical proceed by the analysis of the TIN data obtained from the topographic curves existing numerically. The morphological structure of the city could be searched in multidirectional manners by these maps. These thematically maps give an idea for the understanding of the topographical thresholds. Ikonos Satellite image ortorectificated with 1 m resolution belonging to 2006 was superimposed with the numerical altitude model by the help of Arc scene interface. And the area model having three dimensions was obtained (Figure 1).

Model provides the perception of the topographical thresholds and the macro form of the city in three-dimensions visually. The city includes the hills which are about 310-320 meters and the valleys among them. The small streams in these valleys supply Bartin River basement. One of the factors enhancing the flood hazard risk for Bartin City is that the city is approximately on the sea level. The altitude of the area where the city is located from the sea level is about 80 m. (Figure 2).

To perform the slope analysis of the settlement area is the important factor in the location of the city settlement functions on that area [16]. In the slope map produced as topographical differentiation from the numerical area model made for the altitude data, five slope groups were defined as 0-5 %, 5-12 %, 12-20 %, 20-30 %, and > 30 % (Figure 3).

When we correlate the city area usage to the slope analysis performed by GIS, Most regions around Bartin stream and its branches are in the level of 0-5 % slope of II and III class agriculture areas and the other regions having II and III class agriculture areas are in the slope group of 5-12 %. The areas around Bartin City are in the 12-20 % slope group in weight. Some of them are used for the forests and the others are used for the dry agriculture aim. The upper section of the forest area is in the areas of 20-30% slope group.

4.3. Flood Characteristics

The researchers from the different disciplines [17], [18], [19], [20], [21], [22], [23], [24], [10], analyzed the studies about flood protection and decreasing harm, risk analysis and the situation of the flood areas in Bartin City by the regional and urban scales. They developed some recommendations for the protection and harm decreasing studies by identifying the parameters leading to the flood.

The literature researches performed have demonstrated that the researchers from different disciplines obtained the results and recommendations supporting each other in the flood analysis studies which they carried out with different methods and techniques. When we synthesize the common aspect of these evaluation results, we may summarize the factors leading to the flood and the protection methods as follows: The synclinal structure presentation having low slope of Bartin Stream, the existence of easily erodible clay units in the basement and the severe flood risk in the city because of the meteorological conditions. The fact that the water tries to produce new bed areas by eroding around itself with the flowing and overflowing in the valley bed, enhances the risk level as a result of heavy downpour. The erosions occurring due to the destruction of the natural flora decrease the water storage capacity of the stream basement. Thus, the erosion protection program should be applied and the natural area structure and ecological balance should not be deteriorated. Especially, the forests in the upper sections of the basement should be improved and available forest areas should be protected. The improvement studies which will organize the water flow in the river beds should be performed and the constructions here should be avoided. These areas should be arranged for recreational and green areas. The mandatory constructions should be maintained over the maximum water level. Drilling the materials for the construction activities from the river bed deteriorates the water flow organization. The deteriorated water flow leads to various destructions in the city area. Flood early warning systems should be developed. The engineering constructions. (dam, lake, pond, etc.) blocking and decreasing the water flow should be built on the river and in the areas having the suitable geological structure during the possible flood period. The natural drainage system of the basement may not accomplish its function due to the effect of the constructing. These areas should be reorganized for their natural usages. The accumulations decreasing the natural carriage capacity should be also preserved in the drainage areas. Increasing the number of canals, the artificial drainage systems should be strengthened. The water flow should be made easier by performing the protective studies of the mass movements.

The accumulation of debris and excavation materials in the stream beds decreases the water carriage capacity of the bed and causes the floods. Construction plans have still been developing on the regions having the flood risk. These areas should not be opened to the new developments. And the available area usage should be reorganized according to the flood risk. Flood analysis studies are the multidisciplinary research field. Therefore, the projects and researches which the experts from the different fields have conducted will provide the most accurate results. The detailed disaster management should be established for the city. The inputs for the system should be provided by the scientific researches performed in the region and natural, economical, technological and social data of the city. While the land use planning is performed, topographical, hydro geological, hydrological and geological factors of the basement should be considered. The suitable land use decisions for the natural potential should be performed. In the different study scales, the flood risk maps which will the subtitle for the city development plans should be produced. The harmful activities in the natural surface of the land such as constructing in the city area and cementing and asphalting of the roads block the water leaking into the underground and cause the accumulated rain water into the surface flow. When the heavy downpour, insufficiency of the water drainage systems and the wind directions are added into all these reasons, the flow of the stream into the sea is blocked by the rising of the tides and the entering of the sea water into the stream. And it causes the flood by increasing the level of the river. At this point, the harm which the flood occurs in the city increases more and more as a result of the wrong land.

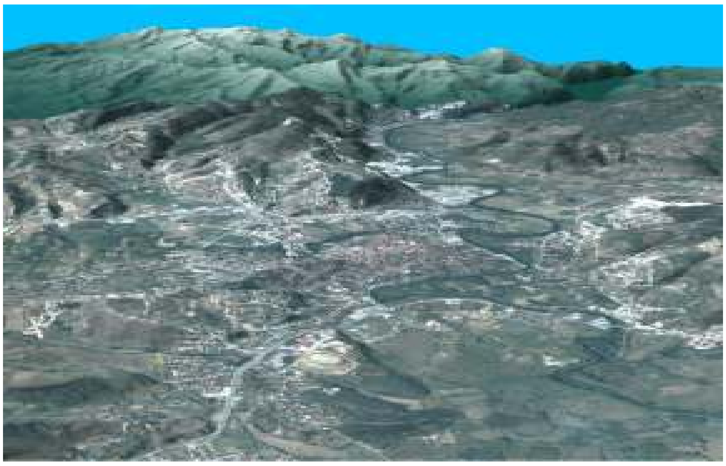

Figure 1. Three-dimentional numerous area model of the city.

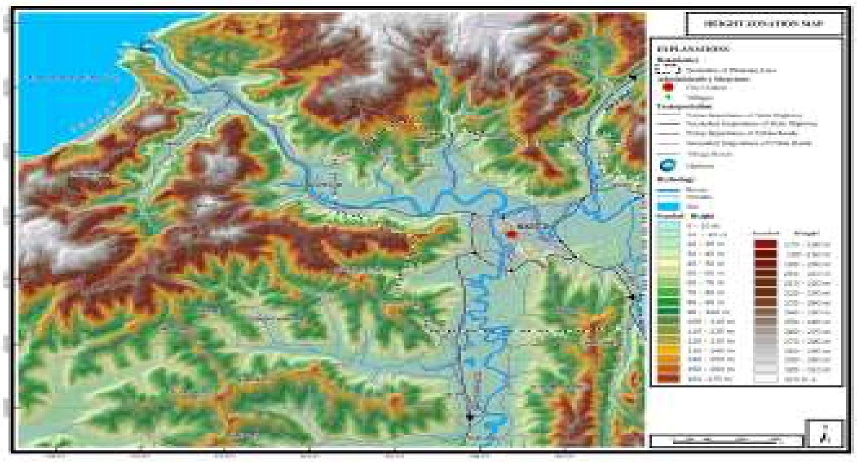

Figure 2. Height zonation map of the city.

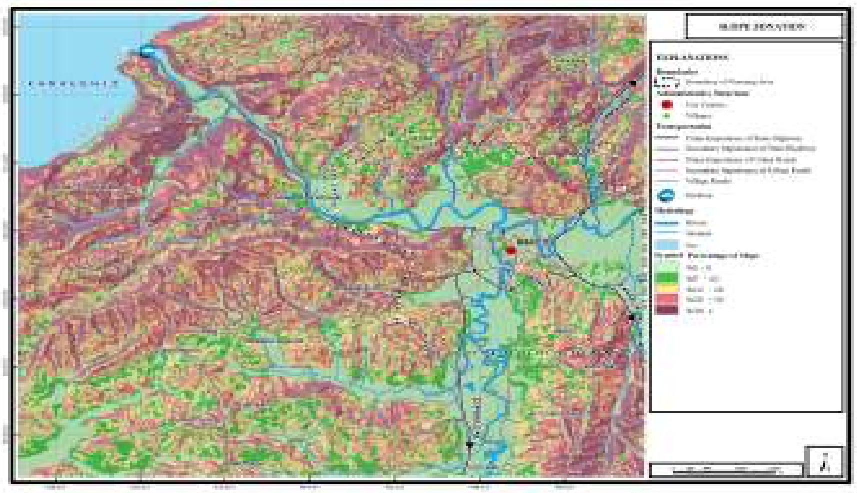

Figure 3. The slope zonation map of the city.

Consequently, these disaster-sensitive analyses and synthesis belonging to the city and the region should produce the available input for the planning studies of the city and for the disaster information system which is mandatory. These integrative studies carried out by the researchers from the different disciplines should be considered in the land use for the city and region, planning and constructing decisions by the coordination.

As well as the demonstration of the flood characteristics of the city by the literature research, the altitude zonation map was produced around GIS by considering that the water level arose at the level of 13 m during the recent flow, and general evaluation was performed for the flood hazard according to the altitudes. For this purpose, seven altitude groups including the areas with 0-6, 6-8, 8-10, 10-12, 12-14, 14-16 m and over 16 m were identified. And these groups were defined as the 1st, 2nd, 3rd, 4th, 5th, 6th and 7th grade risk areas respectively (Figure 4).

4.4. Earthquake Characteristics

Bartin City is located in the first grade earthquake region according to the Turkey Earthquake Map [25]. The largest earthquake to be recorded in Bartin City during the historical period is the 3rd September 1968 earthquake. The magnitude of the earthquake was detected as 6,6 by Alptekin et all [26], whereas, it was detected as 6,1 by Ketin and Abdulsselamoglu [27]. The guilelessness of the city is influenced from the North Anatolia Fault (NAF) line passing 132 km away from the city center. Amasya fault, one of the branches of NAF passes from the east of the city. And there are active faults and surface fragments in the northern border of Bartin City settlement [10].

By living the earthquake, [28] Wedding carried out the study for the earthquake time and post earthquake observation and studies, the intensity of the quake, the damage situations of the building after the earthquake, the dynamic behaviors of the ground during the earthquake, post earthquake ground characteristics and the effects of the construction quality on the earthquake damage distribution.

[29] Kuşçu et al (2004) determined that the most intense value reported in the maps for Bartin City was VIII according to MM (Modified Mercalli) intensity scale despite the small differences.

The data obtained from the researchers expresses that the earthquake risk in high level is not expected for Bartin City.

But because the city center has alluvium sediments, this will enhance the effects of the possible earthquake severely. The building construction analyses should be performed on the constructions locations locating on the alluvium ground. The buildings with low construction quality must be either pulled down or strengthened. The direction of the city development should be toward the sound rocks rather than the alluvium grounds. The geotechnical characteristics of the alluvium grounds should be considered in the land use, planning and construction decisions. And the construction quality should be high in the new buildings which will be constructed on the alluvium grounds and the height of storey should be low.

5. BARTIN CITY RISK ANALYSIS

5.1. The Evaluation of Regulatory Development Plan Of 1/5000 Scale and Available Urban Settlement for Georisk

By considering the formula of "Disaster Risk = hazard x damage", the damage level can be provided by decreasing the risks which will cause the possible disaster for the settlement. For this, the level of damage for Bartin City has been evaluated by considering the city risks.

With the planning decisions related to the future and Bartin City risk factors in the area usage, the input was provided for the establishment of the disaster management system of the city. For this, the local distribution of the city population, the density on the basis of districts, the duty cycle, urban area usages, communication and damage potential levels of infrastructure systems were analyzed.

Bartin City available land use risk analysis was performed for georisk groups reported in the suitable settlement map of the city [10], (Table 1), (Figure 5). While the area calculation was made, legal regulatory development plan borders were considered. All social equipment, trade and communication usages are included into the constructed areas.

In the development plan performed in the map area of 4633 hectares by Bartin Municipality, the constructed land amount in various grades and the construction area 1227 hectares. Some of these areas were constructed either completely or partly but they compromise of the total areas permitted for the construction by the planning decision.

The analysis of the city evaluated in 5 groups for the settlement was performed on the basis of the districts. The distribution of the risk groups on the district level was given in Table 2. The risk evaluation related to regulatory development plan for the city development was carried out by GIS, making overlay analysis spatially of the geoscientific data by the planning decisions (Table 3) (Figure 6).

When Table 3 is searched, the land use decisions in the planning includes the risk in different proportions for each area usage. For instance, whereas most areas are at the level of settlement for the university, all of the small industry sites and office areas except the construction were selected in the risky area.

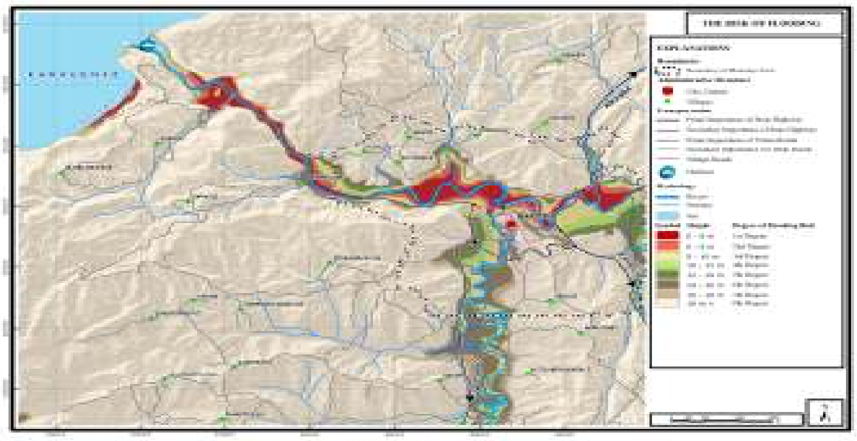

Figure 4. The flood risk grading of the city.

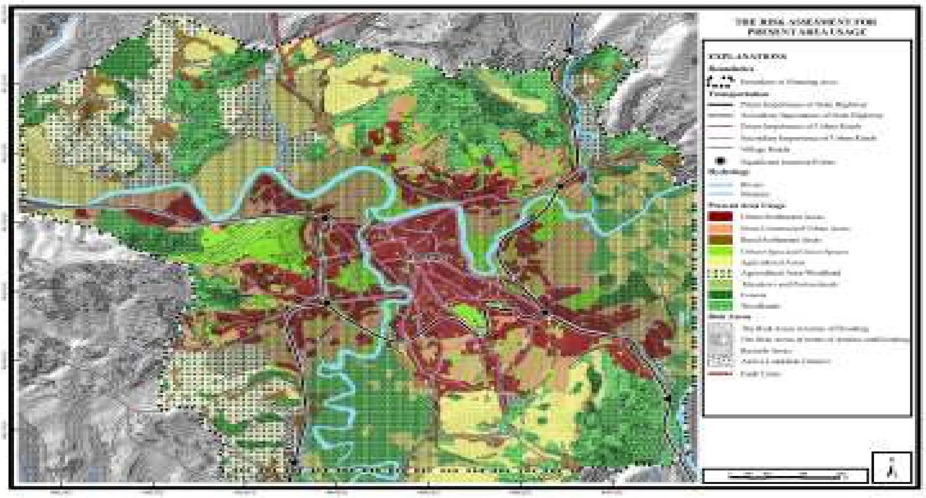

Figure 5. Available land use urban risk evaluation.

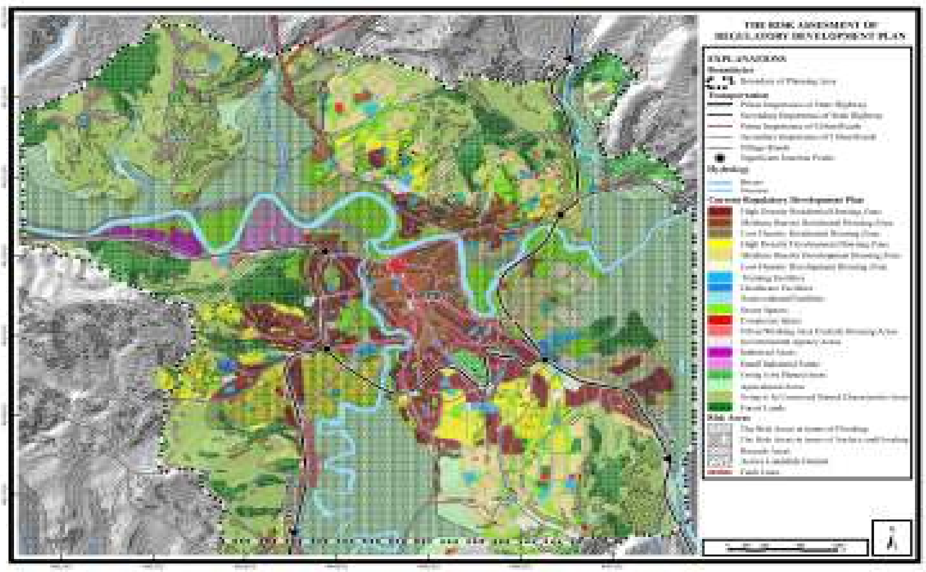

Figure 6. Regulatory devolopment planning risk evaluation of the city.

Table 1. The distribution of the available area use according to the risk groups.

Available land Use	Constructed Areas		Agricultural areas and the other open and green areas	
	Alan (ha)	Oran %	Alan (ha)	Oran %
The risky areas for flood	115	9,37	87	2,55
The risky areas for slope	55	4,48	303	8,90
The risky areas for landsliding	0	0,00	20	0,59
The risky areas for soil and flood	530	43,20	1640	48,15
Toplam	1227*	100*	3406**	100**

*The appropriate settlement areas are included in the proportion of 527 hectare and 42.95 %.
**The appropriate settlement areas are included in the proportion, of 1356 hectare and 39.81 %.

Table 2. The distribution of the area use on the basis of districts according to the risk groups (ha).

District Names	Suitable settlement areas	The risky areas for flood	The risky areas for slope r	The risky areas for landsliding	The risky areas for soil and flood	Total	The proportion of the risky areas in total(%)
Aladağ	59,18	1,36	13,85	0,00	1,12	75,51	21,63
Çaydüzü	27,72	0,00	0,91	0,00	43,29	71,92	61,46
Cumhuriyet	0,51	5,37	0,00	0,00	27,68	33,56	98,48
Demirciler	14,22	7,78	0,14	0,00	0,00	22,14	35,77
Esentepe	47,36	0,00	2,28	0,00	0,00	49,64	4,59
Gölbucağı	4,66	17,65	0,32	0,00	82,39	105,02	95,56
Karaköy	48,53	0,35	3,50	0,00	5,12	57,50	15,60
Kemerköprü	29,54	13,54	0,55	0,00	54,92	98,55	70,03
Kırtepe	12,59	10,47	0,00	0,00	6,40	29,46	57,26
Köyortası	4,09	10,54	0,00	0,00	0,92	15,55	73,70
Okulak	0,00	14,65	0,00	0,00	0,00	14,65	100,00
Orduyeri	75,43	10,05	17,01	0,00	56,70	159,19	52,62
Orta	5,63	8,83	0,00	0,00	0,08	14,54	61,28
Tuna	24,85	4,16	1,87	0,00	80,36	111,24	77,66

Table 3. The distribution of regulatory planning land use decisions according to the risk groups (ha).

Land use	Yerleşime Uygun Alanlar	Taşkın Açısından Riskli Alanlar	Eğim Açısından Riskli Alanlar	Heyelan Açısında Riskli Alanlar	Zemin ve Taşkın Açısından Riskli Alanlar	Toplam Alan	Riskli Alanlar %
Low density settlement area	67,49	6,21	7,40	0,00	16,34	97,43	30,74
Middle density settlement area	70,93	37,58	5,50	0,00	31,33	145,34	51,20
High density settlement area	13,45	32,07	13,23	0,00	79,48	256,23	48,70
Low density devolopment housing area	30,77	1,21	4,21	0,00	35,27	71,46	56,94
Moderate density devolopment housing area	173,75	5,07	17,70	0,00	83,15	279,67	37,87
High density devolopment housing area	98,15	8,14	12,63	0,00	54,12	173,03	43,28
Trade Area	13,96	13,93	0,18	0,00	19,07	47,15	70,40
Social cultural resorts	9,99	0,97	1,52	0,00	6,83	19,31	48,26
Education resorts	25,49	3,88	2,17	0,00	15,34	46,87	45,62
Health resorts	5,94	0,00	1,31	0,00	3,84	11,09	46,44
Industry resorts	0,08	1,35	0,00	0,00	44,30	45,73	99,82
Little industry areas	0,00	0,68	0,00	0,00	0,68	1,36	100,00
Out of housing city working areas	11,53	0,75	0,21	0,00	65,41	77,91	85,20
Governmental areas	28,49	4,90	3,42	0,00	17,26	54,07	47,31
Tourism resorts area	0,20	0,00	0,14	0,00	4,25	4,59	95,56
University area	50,21	0,00	0,35	0,00	0,00	50,55	0,69
Miltary area	0,09	0,00	0,00	0,00	0,02	0,11	18,18
Gren areas	159,59	25,04	30,03	0,00	253,41	468,06	65,90
Forest areas	132,37	4,90	126,60	0,00	474,32	738,19	82,07
Forresteration area	66,10	4,42	17,95	0,00	14,83	103,29	36,00
Natural conservation areas	511,45	1,26	129,60	18,49	42,99	703,80	27,33
Agricultural areas	219,26	50,43	2,88	0,00	950,51	1223,08	82,07
Seashore	0,00	0,00	0,00	0,00	15,19	15,19	100,00
Total	1807,29	202,78	377,01	18,49	2227,94	4633,51	61,00
Proportion in total %	39,00	4,38	8,14	0,40	48,08	100,00	

5.2. Demographical structure of the city and Spatial Distribution of the Urban Risks

According to the 2000 demography results, all Bartin City population is 36274. The population of 72868 averagely is estimated in 2030 for Bartin City center according to the population projections [15]. Considering the building numbering ruler of the present population, the spatial distribution of the density on the basis of district was detected by GIS and demonstrated in the map in Figure 7. The population values which will be affected by the possible disaster were identified by benefiting from the risk proportion data and the distribution of the population according to the districts (Table 4). Multiplying the population values by the risk proportion of each district in Table 4, the population who will be affected by the possible disaster was estimated separately for each district. (The brute density given in Table 4 expresses the density values on the basis of parcels; the gross density expresses the density values on the basis of district. As seen in Table 4, the most affected district for the population in the possible disaster was identified as Golbucagi. Kemerkopru district follows Golbucagi District. Total population of these two districts is about the half of the total population under the risk. While disaster risks for the city are evaluated, the construction density is accepted as the risk factor for damage potential. During the earthquake, the areas whose space level is high include less risk but the heavy areas include more risk. Thus, the construction density of the city was shows spatially in Figure 8 by evaluating for the geological risks around GIS. When district gross population density and the risky area proportion are evaluated together, Okulak District carries the highest risk between Orta, Okulak, Kirtepe, Koyortasi and Demirciler Districts locating in the highest gross density slice respectively. Okulak District settlement is completely under the risk for flood and ground. It is one of the first five districts having the dense population (Table 4), (Figure 7). As a result of this analysis, the areas having the least risk for the settlement have been identified as Karakoy and Esentepe Districts in the southern city. These districts may be accepted as the safest areas with the least loss during the possible disaster. Golbucagi and Kemerkopru Districts have been identified as the areas having the highest risk level by the risk rate of 95.56 % and 70.03 % (Table 4), (Figure 7).

5.3. Transportation and Technical Infrastructure Evaluation

Transportation is a significant parameter in planning process. To access the urban service is preliminary task in planning. Especially, during the disaster, this gains more importance. As [30] Canaran (2001) pointed out, physical space is defined as the organized order in urban environment.

The fact that the alternative road systems are evaluated at the beginning of the planning stage in the possible disaster will enable the conducted studies to be completed on time and safer. For this reason, the transportation system as the component of the disaster management and disaster-sensitive planning approach was analyzed by means of the satellite images, teleperception techniques and city planning. Two districts in the city were illustrated for the accessibility in Figure 9.

Table 4. The distribution of the population under the risk according to the districts.

District Names	Population	Area (ha)	Constructed Area (ha)	Brute density (person/ha)	Gross density (person/ha)	The risky area rate	The population living in the risky area
Aladağ	2.879	115,90	75,51	38,13	24,84	21,63	623
Çaydüzü	2.716	101,65	71,92	37,76	26,72	61,46	1.669
Cumhuriyet	1.597	72,46	33,56	47,59	22,04	98,48	1.573
Demirciler	*2.717*	*33,00*	*22,14*	*122,72*	*82,33*	*35,77*	*972*
Esentepe	1.359	69,87	49,64	27,38	19,45	4,59	62
Gölbucağı	**6.670**	**343,82**	**105,02**	**63,51**	**19,40**	**95,56**	**6.374**
Karaköy	1.358	76,62	57,50	23,62	17,72	15,60	212
Kemerköprü	**6.787**	**145,54**	**98,55**	**68,87**	**46,63**	**70,03**	**4.753**
Kırtepe	*3.697*	*43,53*	*29,46*	*12,49*	*84,93*	*57,26*	*2.117*
Köyortası	*1.855*	*23,13*	*15,56*	*119,22*	*80,19*	*73,70*	*1.367*
Okulak	*1.790*	*20,04*	*14,65*	*122,18*	*89,32*	*100,00*	*1.790*
Orduyeri	3.890	409,16	159,19	24,44	9,51	52,62	2.047
Orta	*2.011*	*19,37*	*14,54*	*138,31*	*103,82*	*61,28*	*1.232*
Tuna	2.718	193,43	11,24	241,81	14,05	77,66	2.111
Toplam	42.044	1.667,53	758,48	55,43	25,21	58,97	24.795

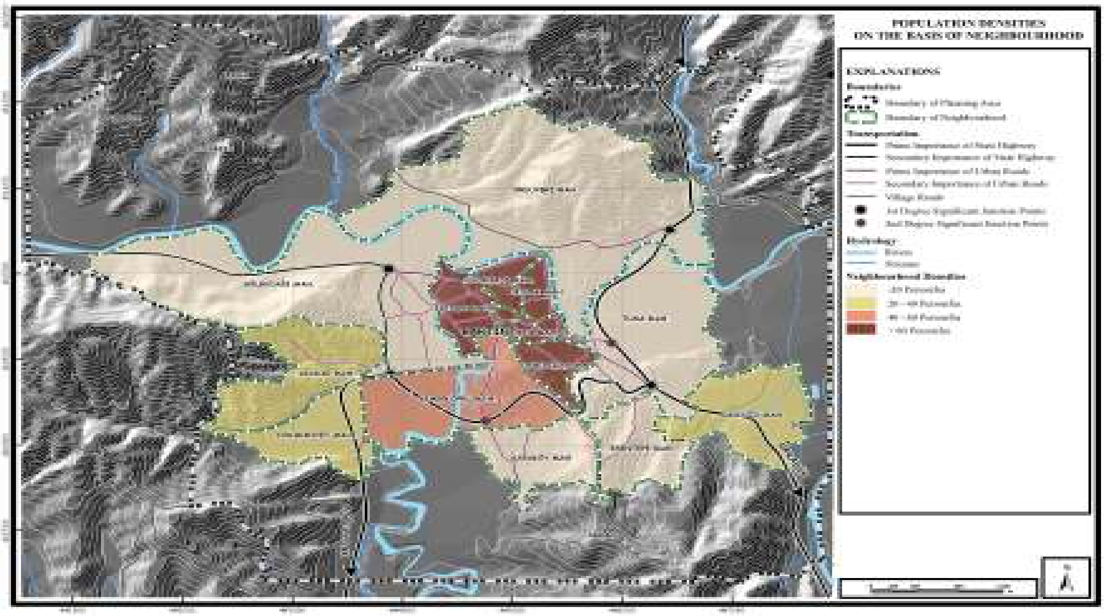

Figure 7. The population density on the basis of districts of the city.

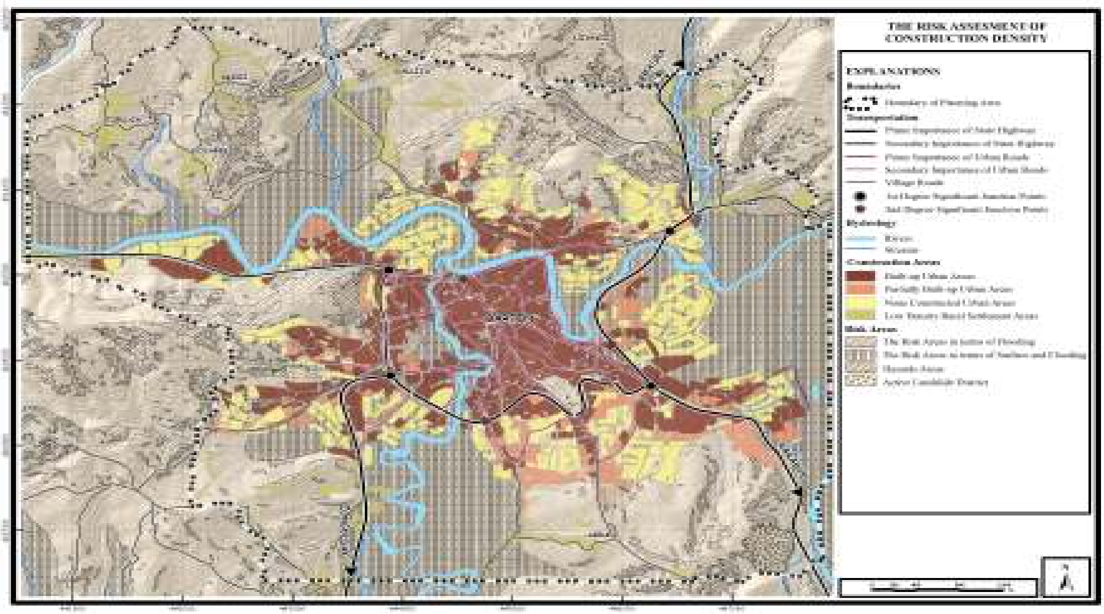

Figure 8. Construction density risk evaluation.

Figure 9. Transportation system accessibility evaluation (from 2006 Ikonos Satalite Image).

When the sample areas selected from the old settlement Kirtepe District as the example A and the new settlement Golbucagi District as the example B are evaluated, in example A, It is expected that the arrival of the road scheme to the buildings will be restricted and the production of the alternative will be compelled in case of the obstruction. In example B, roads enable wide and alternative transition.

The evaluation related to the transportation and the infrastructure systems are important for the land selection stage of "Disaster Support Centers" which are mandatory in the settlements in 1st and 2nd grade earthquake regions. The population of these regions is more than 50 thousands. As Bartin City settlement is in the 1st grade earthquake region and its projection population is about 80 thousands for 2030, the place for disaster support center in regulatory development planning should be detected. In the selection of disaster support center place, the evaluation should be made by considering the technical infrastructure of the city as well as the reachable level of transportation infrastructure. The places detected for disaster support centers have the quality of essential public equipment area and are obtained from the methods such as allocation, publication and construction application.

"The green areas both having the suitable location and used for the different functions, and public areas may be used for this aim in all cities" [31].

During the flood disaster in 1998, the bridges providing the connection of Bartin City were not used; therefore the intensity of the disaster was felt heavier. With the assumption of this kind situation which will occur similar to 1998, this scenario is represented here as the evaluation example. As there is the dense population, the transportation network between the education buildings and the health foundations must be especially open when the bridge is under the risk. In the network analysis carried out by GIS in order to be able to evaluate far more scenarios made as the example for Bartin, the most suitable ways to be used between the education and health buildings have been detected. The open road directions from the event place toward the nearest buildings and their possibilities have been shown in Figure 10. If the similar scenarios are produced and the suitable directions are selected by the network analysis, these will produce the opportunity.

While the risk evaluation of the city is made, the damage potential level of the infrastructure system during the possible disaster is the important component. The less water, canalization and electricity distribution systems damage after the disaster, the quicker the victims return to their normal life.

5.4. Education and Health Foundations Georisk Evaluation

The life loss during the disaster mostly occurs in schools, health buildings and the public buildings where the people work together. The risk situation of health foundations and school buildings, together with the geological hazard factors, were evaluated in Figure 11. To reach the health foundations during the disaster is vital. The recommendation in the development plan and available education and health building area usages on the suitable settlement map [10] were superimposed spatially upon the ArcGIS 9.2 Spatial Analysis Interface. And their distributions within 5 geological risk groups were evaluated. The numerical evaluation distributions according to the risk groups of the usages shown in Figure 9 are given in Table 5. Six of available primary school buildings are within the risky area. Ten of the areas used as the primary school building in regulatory development planning are also within the risky region. Four of the available health foundations and three in the recommendation stage are within the risky area (Figure 11), (Table 5)

5.5. Industrial Foundations and the other Working Areas Georisk Evaluation

Industrial foundations and the other working areas are shown in Figure 12. Bartin City industry settlement lies toward the direction of Bogaz Road in northwest of the city. The region between Bartin Stream and Bogaz Road has the flood risk. Most of the areas used for the industry are under the flood risk. The contaminated substances used in the industry foundations will create the negative effect in the environment as a consequence of the flood during the possible flood. In earthquakes, industry foundations carry the high fire and explosion risks. Compared the damage in these regions to the other city usages, the risk is expected to be in higher level. While the area selection for these regions is made in regulatory development planning, it has been thought that the evaluation was made by ignoring the flood and earthquake risks.

6. RESULTS AND RECOMMENDATIONS

In this study, available land use and regulatory development planning decisions for Bartin City center were analyzed by considering the geological hazard criteria and geoenvironmental evaluations. The damage levels for the future and available urban land use during the possible disaster were evaluated by these geoscientific data documented for the city area. The city risk analyses caused by the predisaster geological factors for the disaster risk management and disaster – sensitive planning approach of the technical infrastructure components such as the development of the construction areas of the city, industry and trade areas, education and health buildings, and city transportation connections were performed by GIS. When the land usages in the planning are assessed individually, the risk rates for every usage area show difference. The settlement areas with the least risk are seen as Karakoy and Esentepe Districts in southeast of the city. They are seen as the safest regions during the possible disaster. In the study, when all risks have been evaluated, the total population under the risk has been estimated as 24795 people.

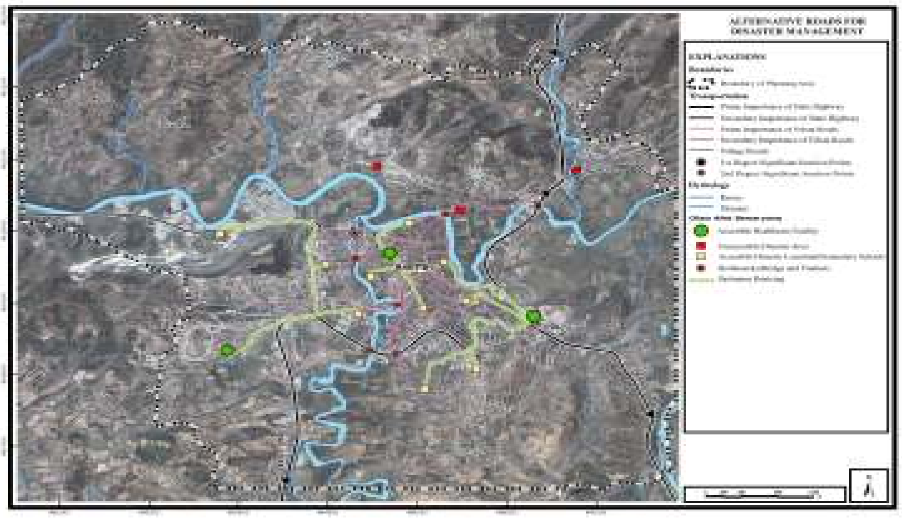

Figure 10. Road network analyses of the city in the possible disaster time.

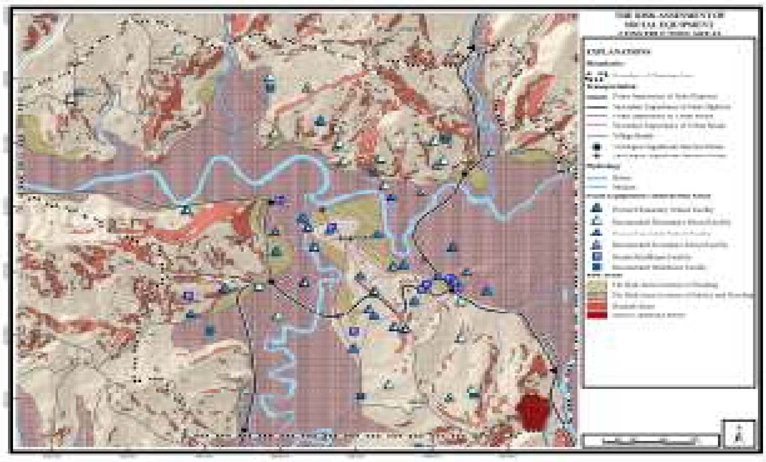

Figure 11. Social equipment areas risk evaluation of the city.

Table 5. The distribution of the Education and Health resorts according to the risk groups (number).

Governmental Use		Primary school	Gymnasium	Health resorts
The risky areas for soil and flood	available	3	5	3
	devolopment	6	3	1
	Total	9	8	4
The risky areas for flood	available	3	4	0
	devolopment	2	0	0
	Total	5	4	0
The risky areas for slope	available	0	0	1
	devolopment	2	0	2
	Total	2	0	3
Suitable settlement area	available	8	5	4
	devolopment	16	4	5
	Total	24	9	9
General total	available	14	14	8
	devolopment	26	7	8
	Total	40	21	16

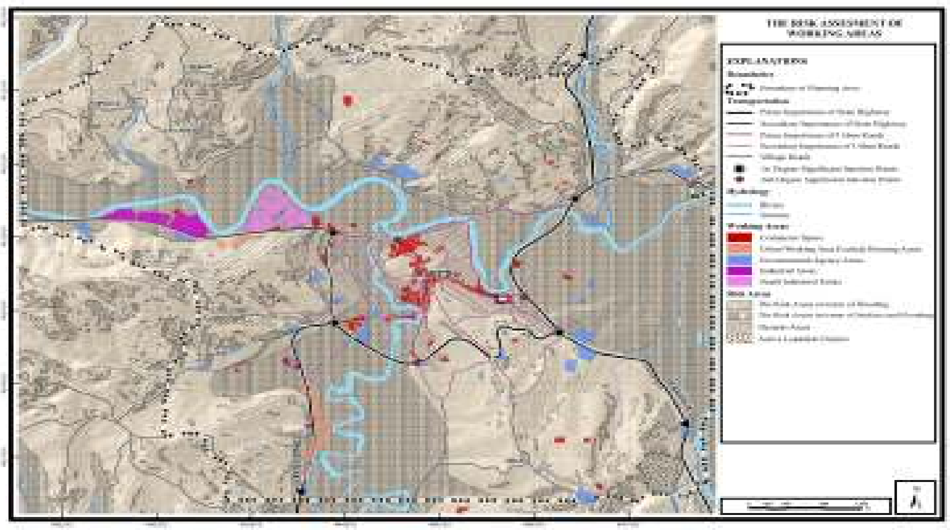

Figure 12. The risk evaluation of the working areas in the city.

The district to be affected the most during the possible disaster is Golbucagi. The second one is Kemerkopru District. The total population under the risk in these two districts is 11127 and this number is about the half of the total population under the risk. In this evaluation, Karakoy and Esentepe Districts in Southeast of the city is detected to have the least risk, for the population.

The distributions of the city population and density are the important analysis evaluations in the risk identification studies. In this study, the spatial distributions of the population density and the population which will be affected were estimated. The population rates that will be affected due to the disaster risk were identified.

The total population in the risky areas in the various levels has been estimated as 24795. When the total population is thought to be 42044, about 60 % of the population is in the risky regions.

While the city disaster risks are evaluated, the construction densities are seen as the risk factors for the damage potential. During the earthquake, the areas with the high space levels have the lower risk but the dense areas have the higher risk. From the point of view of this, the city risk analysis was evaluated on the district gross population density. Between Orta, Okulak, Kirtepe, Koyortasi and Demirciler in the highest gross density part, Okulak District has the highest risk. Okulak District settlement is completely under the risk for the flood and ground. It is between the five districts having the high population density.

The false land use decisions of the city are in the first row for the flood risks. When the old city is evaluated together with the later developed city areas, the old district settlements have the less risk. The new settlement areas are located within the Bartin Stream flood areas. Some factors such as wrong launched bridge pathway and the building wastes into the stream basement led to the natural stream bed to deteriorate in the areas where the river passes. And this enhances the damage potential level of the settlement in an important way after the flood.

While urban planning studies are performed, the fact that the stream beds are not opened to the construction, and the designs which do not supply the water load over the capacity of the available beds are recommend by performing the city drainage evaluation in the analysis studies performed before the planning, will create the important effect in decreasing the urban damage potential level and flood risks.

As a result of the urban risk analyses, Karakoy and Esentepe Districts having the low city risk levels were observed to include the recommended construction area usage in moderate and high densities in the regulatory development plan of the city. In the planning application stage, the privilege is recommended to be given this area by the local management. Although seen within the flood area in the available development planning, the regions opened to the settlement by the planning decision will enhance the damage potential of the city during the possible flood.

There are active faults and surface fractures in northern border of Bartin City settlement. The regulatory development plan border lies toward the region where there is the active fault. And it ends up here. The construction should be banned in the active fault areas and the surface fractures within the city areas. These areas should be used as the open and green areas.

When the damage potential level in such regions is compared with the neighboring regions after the earthquake, it will be higher. By considering the areas having the construction possibility in future, it is recommended that this region should be taken within the development plan border.

There is no decision in the development plan of the city related to the place selection of "Disaster Support Centers" which are obligatory in the settlements in the 1st and 2nd grade earthquake regions whose population is more than 50 thousands. Because Bartin City is in the 1st grade earthquake region and the projection population is expected to be 80 thousands for 2030, the fact that the place is not allocated for the disaster support center in the development plan is seen as the loss.

During the disaster, the life loss mostly occurs in schools, health foundation and the public buildings. For the disaster risk management, the risk evaluation of the health and school buildings was also carried out by GIS.

To reach the health buildings during the disaster is vital. As a result of the analysis performed, six of the available primary school buildings are within the risky area. Four of the available health foundations and three in the recommendation stage are within the risky area.

GIS-based data accumulation produced in the city is qualified to enable the network analyses which are the important input for the disaster risk management to be performed. Therefore, the nearest and the alternative road direction analyses will be able to performed in order to reach the hospitals and the disaster area during the possible disaster.

During the possible earthquakes, the industry buildings could have the secondary risks for fire and explosion. When the damage which will occur in this region is compared with the other city land usages, it is higher level. While the place selection is made in the development plan, the evaluation has been observed to be made by neglecting the flood and earthquake risks.

The disaster-sensitive planning approach should be considered by the permanent environment dimension and evaluated within the integration of the disaster and environmental risks. When the disaster management model integrated within the planning process is applied, the decrease of the disaster risks for both spatial planning discipline and disaster management will be successful by performing the accurate geoenvironmental evaluations of the city.

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