

**The Effect of Volcanic Structures on Residential Areas (Between Nevşehir-Konya), Central Anatolia, Turkey**

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**Abstract**

This study aims at analysing the relationship between settlement areas and topography in the volcanic areas around Aksaray, Ereğli, Karaman, Karapınar and Niğde between Kayseri and Konya where the Central Anatolian Volcanics are spread.

Lava and pyroclastic materials from different periods constitute a significant part of the geological structure. Working morphodynamic and morphoclimatic denudational processes led to the emergence of diverse topographic appearances. Settlement areas established in this neighbourhood face natural risks that often reach to the extent of disaster.

From past to the present, the fundamental problem of the settlement areas is not to consider the adequacy and sustainability capacities of the topography. Floods and various mass movements (landslides, dislocation, stone block flows) are important incidents that often occurred recently. Revealing potential natural risk areas in the geography means solving a significant part of the settlement areas problems.

In the study, the settlements were categorized in terms of natural risk areas, and data on housing areas were synthesized and assessed in the digital environment.

In the studies, the active role of mass movements and rain and flood waters that could reach the extent of disaster was taken into consideration, particularly in the selection of spatial locations. Certain predictions were developed in terms of different risk factors between the settlements and possible risks that may arise in the future.

**Keywords:** Land Use, Natural Risk Areas, Settlement, Sustainability, Volcanic Topography

**INTRODUCTION**

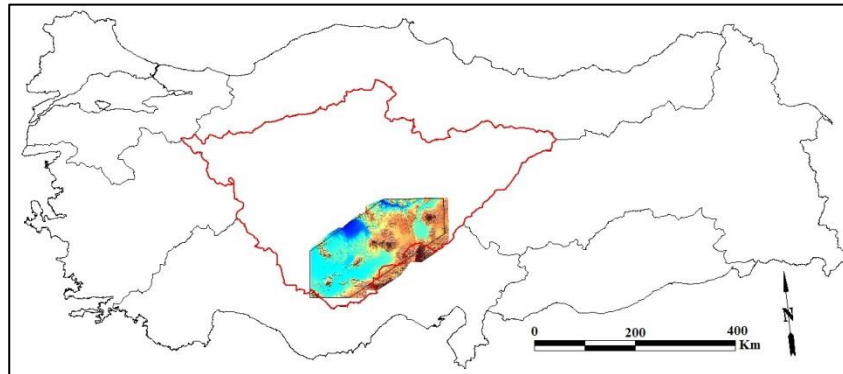
The studies were conducted in a region that has various definitions such as "Central Anatolian Volcanic Region", "Cappadocia Volcanics" and "Central Anatolian Volcanics" (Arcasoy & Toprak & Kaymakci, 2003; Sungur, 1970, Sür, 1992; Ardos, 1992; Ercan, 1986) (Figure 1).

Many volcanic colonies in the region came into existence in the Neotectonic period Tertiary areas. They were shaped by morphodynamic and morphoclimatic processes and formed the present topography. Since the early times of the human history, Anatolian people have benefited from opportunities provided by the topography and still continue to do so.

Although people have lived in settlements such as Çatalhöyük and Kömürcü village since the earliest times, environmental developments happening since then induced settlement areas to relocate to a great extent. However, today, addressing the needs of a growing population has become more dangerous for the future, because the topography has a significant impact on human activity.

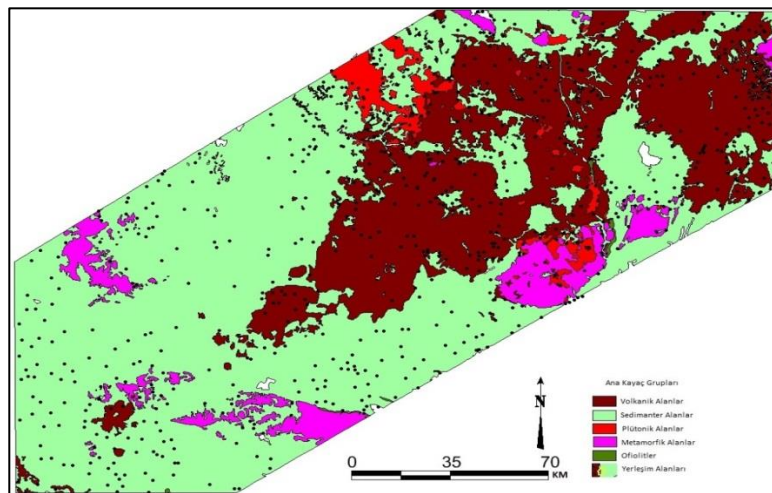
The dynamic processes in the nature are not stable. Changing environmental conditions have determined all living conditions for people who have been using this geography. For people, adapting to a location that they settled and continue their economic activities is only possible when

they know about the place. Changing environmental conditions and the present topography required the residents to take certain measures.



**Figure1.** Locational map of the study area

A great part of the current problems stems from the fact that humans "have become distanced from sustainable policies" and have not known the environment well enough. Volcanic materials and sedimentary fills are areas preferred for agricultural activities and settlement purposes. When the distribution of settlements is analysed on the geological map of Turkey at a scale of 1: 100.000 drawn by MTA, it is seen that the majority of the settlements are located in basins that volcanic and other transported materials were stored (Figure 2).



**Figure 2.** Distribution of settlement areas geological units

In plutonic and metamorphic areas, settlements are generally seen in lower slope lines. In areas that slope is above 20 degrees, stone-block falls pose serious risks. On the other hand, plains near such areas are under the influence of waters with surface flow.

Climatic changes in the natural environment cause to the beginning of chain incidents and serious disruptions in the economic structure. Today, the movement from rural areas to the cities actually results in a significant decrease in the use of agricultural lands. Such movements can be defined as anthropogenic pressures (Bayer Altın, 2008, 2016). Urbanization has quickly moved to the plain bases. Groundwater level has fallen and there is a shortage of irrigation water. Also, the drying of lakes and wetlands has disrupted the ecological balance of the region.

Sands in former lake beds were moved by the wind and have become a threat for agricultural areas. The negative impacts of cities on the atmosphere, the lack of rain and increasing temperature averages (Bayer Altın, 2012) have increased salinization in the soil. Dune invasions are witnessed.

On the other hand, as result of the fall in groundwater level as in Karaman and Karapınar neighbourhoods, swallow holes are formed and affect living areas in the region. During the past 10 years, the formation of more than 100 swallow holes was recorded.

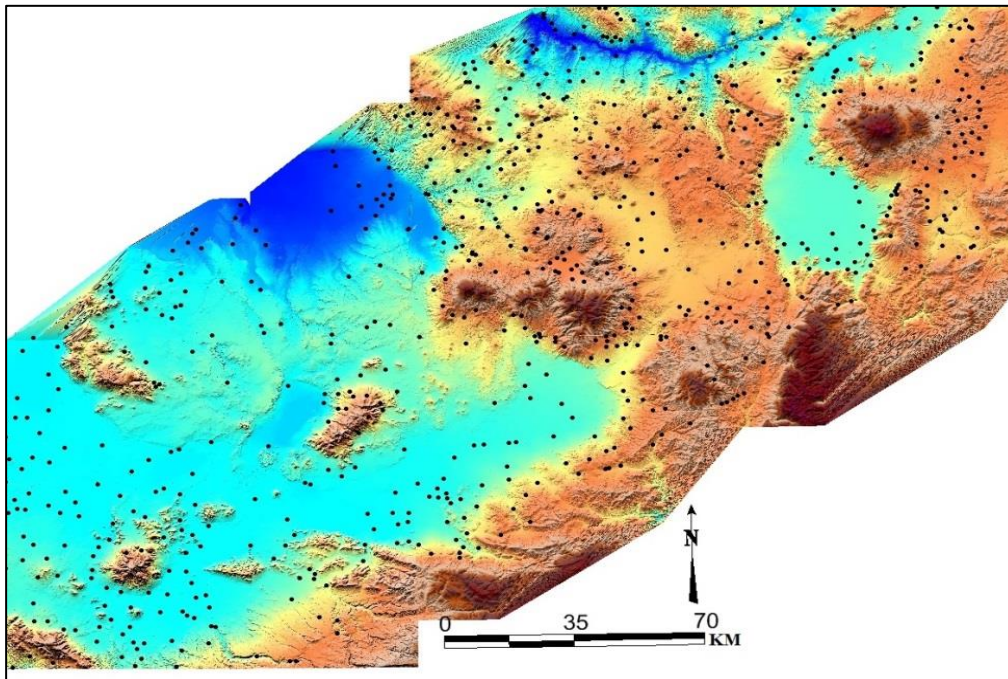
Today, people move from rural settlements to urban settlement areas at a great pace. Human pressure on the environment has increased widely. The percentage of available agricultural areas in the region is no more than 18%.

Within the scope of this study, existing or potential "natural risk areas" that are directly "under the control of the volcanic structure" were examined. The correlation and classification of data were conducted in digital environment. Results obtained by the authors with regard to the land use in the same region (Altın & Kahvecioğlu, 2016) were evaluated in the study in terms of mutual interactions between settlement areas and topography.

### **TOPOGRAPHIC CONSTRAINTS**

Plains that are considered as the remains of the former lacustrine areas in the Central Anatolia and volcanic mountainous and hilly areas constitute two important topographical units. Another topographical unit is plateau areas cut by streams (Figure 3). High volcanic masses are primary topographical constraints. Mt. Kara and Mt. Karaca draw attention with their calm topography despite the fact that they are important volcanic exits. The settlements were usually established on slopes, ridge or alluvial fans.

Mt. Hasan, Mt. Keçiboyduran, Mt. Melendiz and Mt. Erciyes volcanics have serious risk areas for neighbouring settlements with their faulty and high topography. In the region, floods as well as numerous disaster-sized incidents including rock-block falls occurred and the settlement areas were altered to a great extent. Therefore, many settlements obtain such preceding names as "upper (Yukarı) - lower (Aşağı)" or "old (Eski), new (Yeni)". Eski Gümüş, Aşağı Tepeköy, Yukarı Bozköy are some examples.

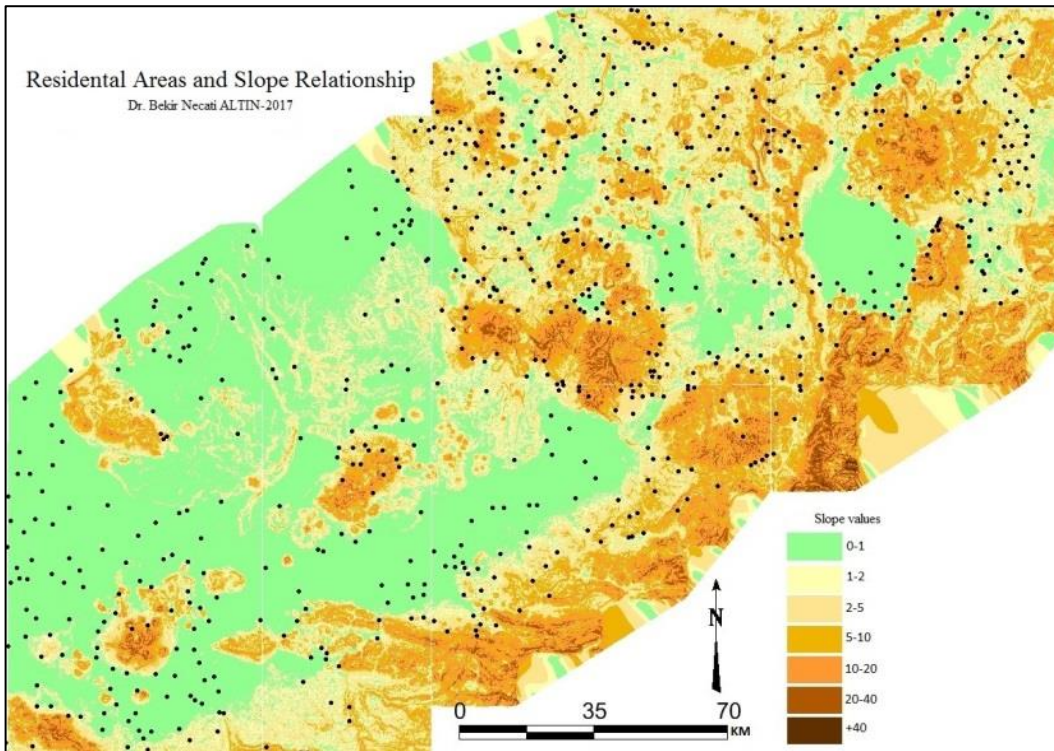


**Figure 3.** Distribution of settlement areas in the topography

As in the southern part of Aksaray-Ortaköy neighbourhood, settlements in areas dominated by plutonic rocks are scattered as slope settlements although they are few. The majority of them are located on flat ridges reaching to plain bases.

Important sedimentary fill areas such as Konya Plain, Bor (Emen) Plain and Misli Plain should be considered as agricultural areas. However, 60% of these plain areas are out of agricultural use or they need to be irrigated. The biggest problems for settlements in these areas are changes in bottom water and subsidence and swallow holes created on the ground. In this respect, Karaman, Karapınar and Niğde- Sazlıca, Bahçeli, Emen neighbourhoods are noteworthy.

River valleys are important in terms of floods and overflows. Although many settlements were established on valley slopes and structural plains, adverse events were recorded many times (Figure 4).



**Figure 4.** Distribution of settlements according to the topographic slope

In the study area, 34 settlements were established in plutonic areas while 268 settlements were established in volcanic areas. 242 settlements are located on the volcanic structures of Mt. Hasan and Mt. Erciyes. Other settlement areas are located on sedimentary rocks. While 673 settlements are below 1500 m altitude, 80 settlements are above 1500 m altitude. Only 8 settlements are above 1750 m altitude. The slope value of 362 settlements varies between 1-5 (%) while it is between 10-20 (%) for 370 settlements and above +20 degree for 24 settlements. Although the general outlook seems to present no negative aspect for the settlement areas, actually more than 70% of the settlement areas remain as part of "partial-field" risk areas.

When the settlement and agricultural areas are examined in terms of natural risk areas, some notable common elements are discovered. For this reason, the study addresses the relationship between the topography and settlement areas after they are categorized. The categorization is based on 5 different morphological units. They are a) Assessment of areas dominated by volcanic pyroclastic materials b) Assessment of alluvial cone areas and slopes c) Assessment of river valleys d) Assessment of dried wetlands e) Assessment of sedimentary circular or elliptical fill areas.

### **Settlements and Risk Assessment**

Undoubtedly, no one would like to live or keep their property under threat. However, in nature, unexpected disaster-sized incidents can sometimes occur unexpectedly. The important point to consider is observing the nature before, understanding traces they left in the past, developing a foresight that similar events may occur in the future and being prepared for unexpected incidents.

In fact, it should not be forgotten that the settlement areas evolve in time or certain risks are ignored to create practical living conditions. Actually, the view emerging from the study area is a result of such approaches.

### **Assessment of Areas Dominated By Volcanic Pyroclastic Materials**

Niğde, Aksaray and Nevşehir neighbourhood covers a large part of settlement areas located on pyroclastic volcanic materials such as ash, tuff and ignimbrite. Ürgüp-Göreme plateau, Göre, Mt. Göllü, Nargölü, Selime and Yaprakhisar neighbourhoods are areas that are extensively cut by streams. Not only surface erosion but also mass movements occurring in the cornices and slopes of flat structures are frequently seen here. As loose material is easily solved in such areas, it is easier for disintegrated materials to be carried. Block disintegration is common due to the abundance of cooling grikes in the structures. Thus, mass movements are widely seen in the region.

### **Assessment of Alluvial Cone Areas and Slopes**

Alluvial fans and accumulation cones formed at the outfalls of rivers descending from volcanic mountainous areas were mostly preferred as settlement areas. Settlements lining up on mass slopes peripherally face the blocking of flow channels or sudden rain-wash in many places. Moreover, the slide of many settlements into cone slopes increases the risk.

Almost all rivers are temporary seasonal streams in the region. In wet periods, they carry from higher areas to lower areas the materials that are disintegrated depending on the amount and duration of the precipitation. Therefore, irregular rainfall may cause flash floods or slides. Here, the actual risk stems from the construction of residences on cone slopes or terraces.

### **Assessment of River Valleys**

Settlements in river valleys are usually located in valleys with relatively broad bases. In areas that the structure is horizontal and hard-soft rock intercalation is seen, flowing surface waters descending from cornice slopes are a dynamic factor in badlands topography. Particularly Ürgüp-Göreme plateau and the area of fairy chimneys are such examples.

Valley slopes and structural platforms that mostly have a narrow space are not preferred for settlement. However, today it is seen that residences are moved to the upper parts of the slopes. It is also known that these areas were preferred as underground settlements in the past. Notwithstanding the empty valley bases, settlements remaining within flood lines are common. Some settlements such as Kayırlı, Sultanpınarı, Yaprakhisar, Nar village descended from valley slopes down to the base.

### **Assessment of Dried Wetlands**

Former wetlands like Konya Plain, Hotamış Reeds, Sultan Reeds are usually non-agricultural plains that dried or were dried. They are dry, salty areas that are out of use due to changing climatic

characteristics in the past 15 years. Although surrounding settlement areas are located on former lake or flood slope lines, they occasionally suffer from floods.

It is no different in Bor-Emen Plain, between Niğde-Nevşehir, Gölcük, Misli Plain and the northern parts of Mt. Hasan and between Niğde and Aksaray. Such places with irrigated farming also suffer from floods.

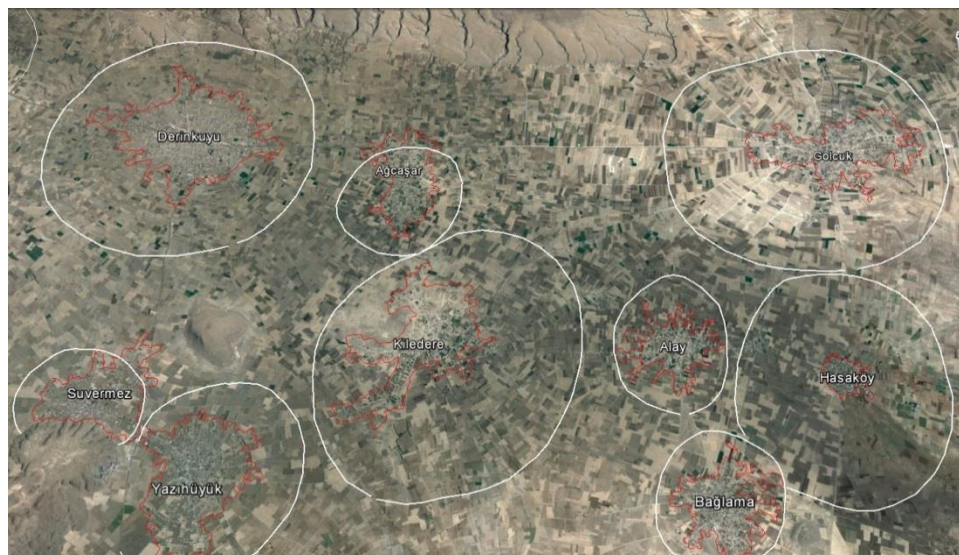
The biggest problem for such areas is flooding impacts of temporary seasonal streams descending from the mountainous areas. Many settlement areas are affected by flood waters. Human efforts to canalize normal drainage make the situation worse.

### **Assessment of Sedimentary Circular or Elliptical Fill Areas**

In the east and north of Mt. Hasan-Mt.Melendiz volcanic extension, agricultural areas range in a framed space to form a circle or elliptical line. These enclosed bowl areas that are usually inclined to the centre from peripheral areas suffer from frequent floods in sudden and violent rains.

Settlement areas such as Derinkuyu, Suvermez, Yazıhöyük, Ağcaşar, Alay, Kiledere, Hasaköy, Gölcük, Bağlama, Konaklı, Belkaya near Mt. Karaca are located in the central parts of these agricultural areas ranging on circular lines between Nevşehir and Niğde.

Such areas are bowl-shaped areas with broad lava exits in lands with lower bases probably from the early Miocene period. These areas were filled with materials stemming from subsequent volcanic activities or other materials carried from the environment, and became covered. The existence of an old flattened mass in the immediate vicinity of each unit also increases the doubts. They are separated from each other by 3-10 metres elevation difference in the surface of erased topography. Surface flow usually tends towards the settlement areas in the central parts. This might be the reason why these settlements frequently suffer from floods (Figure 5). Apart from these, settlements like Keçikalesi, Obruk near Mt. Hasan, Gölören, Kutören, Beyören near Mt. Karaca were established in former volcanic bowl-shaped areas.



**Figure 5.** General appearance of settlement areas with notable circular or elliptical patterns

### **Wrong Anthropogenic Approaches**

Most of the settlements were established on andesitic and basic lava and pyroclastic materials. Near or above such settlements, unpredictable natural process depending on climatic conditions and slope sensitivity always poses risks. The source of problems settlements have faced from the past to

the present is faulty site selection and practices in the topography. The protection of geographical structure and adaptation to these geographical conditions are as important as points considered in the site selection (Bayer 2008; Altın, 2016) (Figure 6).

The preference of river valleys, river terraces, steep slopes, the areas with heavy mechanical disintegration due to the impressive scenery; the destruction of natural vegetation protective cover of the ground – and the canalization of stream drainage are frequent mistakes. In addition, roads reaching from valley slopes to higher areas disrupt the slope balance and lead to slides.

Among significant mistakes by humans are ignoring the working of topography and faulty site selection for residences. When other human activities such as irrigation lagoons and drying of wetlands are added to such mistakes, it is not unusual to face undesirable consequences.

### **RESULTS and DISCUSSION**

Since the settlement areas are controlled by geologic structure and topography, changes in natural environmental conditions and sudden disasters affect the loss of life and property of the residents as well as economic structures.

Therefore, economic assets, new housing in the settlement areas, previous local projects and current land use in the Central Anatolia need to be reassessed. It is highly important to consider all aspects of the Geography” in projects that are implemented by Konya Plains Project Regional Development Administration (KOP) under the Ministry of Development in cooperation with regional universities and accordingly develop future projects. The mapping of numerical land use of the settlement and economic activity areas, and identifying natural risk areas are critical for the future.



Figure 6. Some examples of first-degree risky settlement areas

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