Application of geomorphology and geomorphosites in architecture and design of urban spaces
(Reviewing study: Reduction of risks and attraction for tourism)

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Abstract. The growth of cities and the resulting effects on surrounding environments; on the one hand, and the subjects relating to geomorphologic developmental studies in urban construction at macro level; on the other hand, are assumed today as the issues, which have drawn attention in many urban experts and planners. So, with presentation of a perfect, immediate, and direct attitude, the geomorphologic maps put some information about various forms of geomorphic phenomena and land features (roughness) at disposal of architects and civil engineers and interpretation of these maps will remarkably contribute to planners in developmental topography (positioning) of urban space and survey of any region. In this course, the current research was carried out as the reviewing study by aiming at application of geomorphology and geomorphosites in architecture and design of urban spaces.

The results showed that the geomorphologic risks are considered as one of the important subjects in human communities and if they are ignored, they may impose irrecoverable damage to human communities in all points of the world. Hence, it necessitates feasibility for geomorphology of the regions to develop physically and appropriately the urban area as well as to minimize the possible environmental risks (e.g. hazards caused by flood, earthquake, and volcanic eruption etc), and considering standards for urban construction. Lack of adequate knowledge about geomorphic environments and non-observance of geomorphologic principles in developing urban uses and constructions will be followed by irrecoverable damages.

Similarly, on the one hand the review on studies may indicate that with a composition of cultural, historical, and ecologic heritages, the geomorphosites present potential capabilities in line with sustainable tourism so that the geomorphosites may play noticeable role in planning proportional to geomorphotouristic potentials in the given zone as well as civil investments to attract tourists. Thus, the role of geomorphologic locations is deemed as important both from perspective of environmental survey and topography for developing urban construction and in terms of creating touristic attractions.

Keywords: Geomorphology, Geomorphosite, Architecture, Space Construction, Tourism, City

INTRODUCTION

The location for establishment of habitats and other installations, which are created by the human, is affected completely by environmental factors, especially geomorphology and geology. Today, following to fast growth of population, development of constructions is inevitable and the adverse effect caused by human’s requirements on the land and also exploitation from cities and villages surrounding areas is ever-increasingly developed to construct the houses and economic and industrial installations. Industrialization of communities and development of capitalist economy have doubled this problem and many constructions are built on the land with lesser deep thinking. Due to economic bottlenecks in Developing Countries, this problem is more noticeable and Hi-Techs have not been so far employed for resolving the problems of humans appropriately in these regions and/ or for prevention from
their occurrence. This may cause the natural disasters to lead to thousands of human fatalities every year and to inflict enormous damages and losses to economy in these nations. Unlike in countries including Iran and India, occurrence of flood, earthquake, and landslide in some countries such as Japan and USA will not be followed by a lot of damages. Alternately, the adverse ecologic conditions in cities, shortage and defects of recreational spaces and urban touristic areas in megalopolises of the country, necessity for paying attention to parks, touristic spaces, and recreational places have proposed the requisite for such areas in terms of ecologic and social aspects more than past. Affecting on various environmental, economic, and social aspects as the foundations for urban stability, touristic parks and recreational places improve quality of life and livability of cities and they are effective in acquisition of more favorable environmental status in cities with their aesthetic applications (1).

Establishment of cities and residential zones on land creates new landscapes. These perspectives may be examined from different points of view. On the one hand, construction of these buildings causes the major changes in the environment and distorts water, energy, and materials cycle and on the other hand it is under the influence of natural environment. Thus, study and investigation about natural environment in establishment place of cities are particularly important and their construction will not be possible regardless of identifying the situation and location of cities or will encounter a lot of problems. Construction of urban buildings and spaces with different dimensions requires determination of stability of establishment of their location so that in this regard geomorphology is one of the geological sciences, which help the urban directors and planners and other officials in economic and technical fields in selection of favorable locations for establishment and development of settlements and other constructions. Review on the related problems in selection of appropriate location for construction of cities, quality of establishment of buildings inside cities, and the consequences of cities development on land are considered as special geomorphologic and ecologic perspectives about the studied geomorphic subjects, which have always affected architecture and urban planning.

**Presentation of research problem**

The wide lands are devoted to the cities with respect to the available surface areas. These land plots are composed of different topographic and morphologic units. To the extent cities are developed, they are exposed further to their different topographic and geomorphologic units and relevant issues. Hence, the necessity for identifying natural environment features becomes known to determine and recognize appropriate points to construct buildings and constructions from unsuitable regions. It necessitates study on geomorphology to identify the major part of natural environment features. In light of acquiring such awareness, one could take efficient steps in selection of the most suitable location for construction and expansion of cities and take serious measure to prevent from risk of natural phenomena and/ or coping with them (36).

Focusing on standards for exploitation with sustainable tourism approach, the utilization from geomorphologic perspectives necessitates identifying their geomorphologic specifications. Due to morphologic variation, geomorphosites include various conditions in quality of formation of these features and at the same time they comprise of typical attractions relating to educational values, scientific and research tourisms for researchers, recreational attractions (e.g. slippage from sand hills etc) and sporting attractions (including cycling, driving, and strength walking etc) so recognizing them will not be unfavorable to employ them in urban planning and as architectures of cities and to provide high quality environment for citizens and for improvement of tourism industry (37).

Hence, before any type of planning for architectural development and urban spaces, the criteria and standards should be determined and identified for development of urban area. The cities status quo is not only required for construction of wide recreational and more importantly the
planned and provident area, but also it necessitates for wide touristic parks to create ecologic balance versus constructed environments (4). And alternately, the high density of humans and population in cities, which is followed by needs of community to space for housing and transportation etc, has made difficult the conditions for maintenance of Cities Park and recreational places (5).

On the other hand, any planning that is conducted toward regional and area development should initially include infrastructural studies and the foremost class of infrastructural studies is based on geographic studies comprising natural and human researches. As a result, it can be mentioned that the infrastructural studies are implemented in development projects based on geographic studies, which are presented under different titles. Also physiographic studies in any zone may be expressed and proposed under some titles such as geologic land conditions-climatic conditions where inter alia after expressing geologic and climatic conditions, which create geomorphologic phenomena, hydrologic conditions and soil and vegetation of them as effective on geomorphologic developments, are discussed and then geomorphologic conditions are implied.

Unfortunately, despite of this fact that during early time in twentieth century role of geomorphologic studies in civil and development projects was noticed in most of countries of the world, it is seen in many of our national infrastructural projects including road-construction, railroad, hydraulic grids, urban recreational space projects (e.g. parks) etc the geomorphologic studies are no longer deemed as important with respect to importance of role of geologic phenomena while as the geologic studies are more perfect and deeper in an infrastructural project, geomorphologic studies are deemed more important (6).

So that if the climatic studies have been conducted with high accuracy under other natural conditions, the geomorphologic studies play more important role in infrastructural and civil projects as well since geomorphologic conditions in any region are acquired from the impact of different natural factors on land bed and role of these effects has been addressed so with respect to definition of geomorphology that is as follows: ‘It denotes review and identifying natural phenomena (features) on surface of land and effective processes in their formation at past, present, and in the future’; thus, importance of study on geomorphology is in fact characterized as realization of function by different factors on primary phenomena (7). Hence, description and interpretation of space construction geographic factors are not only noticed as fixed and unchangeable factors, but also in the variable and unstable concept of urban architectural projects and design of parks and places it is required in design of spaces to consider the role of geomorphologic and geophysical factors (8). It is emphasized in theory of urban sustainable development on a process during which energy turnover has the maximum efficiency through the city and the hazardous environmental effects to be possibly minimized (9) and what it deemed as important in space constructions (landscaping) and urban architecture, is that in such planning, environmental parameters including climatic factors and regional geomorphologic conditions should be noticed in cities and this is done by merging various cases at different scales (10).

Over the history of human civilization, the human has always beset with environmental disasters and hazard in his/ her living environment. The human has already reacted versus the risks with escaping, roving, and settlement in more secure place; however, today s/he is trying to identify these phenomena and the factors creating such issues. Despite of many efforts in this regard, the environmental factors and hazards, including geomorphologic risks, are still considered as one of the major problems in human communities and they impose irrecoverable damages to human communities in various points of the world. The environmental hazards may originate from human or natural source and/ or they may be due to the mutual impact among human with the environment so that many hazards have been further played up than the past and
since the time when human’s civilization has advanced and some of them have been also created by human. In fact, the geomorphologic factors are not deemed as risks per se; however, if they are accompanied with human’s constructions (including road, residential zones, urban spaces etc) and produce the damage could be converted into the crisis and threat (11).

Today, urban buildings, places, and areas have possessed wide dimensions and the cities have been remarkably expanded and industrial installations have been developed at the outskirt of many cities. Thus, the least procrastination and mistake under current conditions may be followed by irrecoverable damages; thus, several accurate studies and researches should be carried out before construction of safe and resistant civil projects in selection of position for project as well as appropriate location for development of urban space. Study on physical space is one of the paramount tasks for urban planners and it should be done before any other study since next planning should be carried out according to these studies (6). The geomorphologic, climatic, hydrologic, and geologic conditions should be well studied in process of physical study on cities and the mutual relation and effect of such phenomena should be explored on each other. It should be noted of course that some of geomorphologic phenomena are not only always considered as destructive and deterrent factors in establishment and development of cities, but also if the urban planners have adequate knowledge about the all-inclusive geomorphologic type and use of these phenomena, they will convert them into the positive factors in establishment and development of cities and utilized them optimally and reasonably (12). In other words, the specific geomorphologic locations are considered as surface forms, which are employed for perception and exploitation from tourism for human with special values in scientific, ecologic, cultural, aesthetic, and economic fields (21). And as one of the important elements of the natural preservations, they possess natural and cultural values and in general a special natural perspective, which they present the potential capabilities in the course of sustainable tourism for cities separately and/ or in composition with cultural, historic, and ecologic heritages (22).

Given that today finding suitable location or locations for construction of City Parks and recreational areas in certain geographic region is considered as important phases of implementation projects, especially at macro and national level, the finally selected locations for development of City Parks and touristic centers should provide all the needed conditions and requirements as possible so lack of exploring such conditions before execution of these projects will be accompanied with many adverse consequences. For instance, one should refer to lack of cost-effectiveness and inefficiency of projects on the top of such problems. But, with execution of location finding (topology) successfully, all of effective factors in creation of activities can be examined throughout the studied zone and the suitable locations may be put as the output of location-finding process at disposal of directors and final decision-makers. At the same time, this group may select the suitable choices based on the existing policies and priorities for each of the results. The other results, which should be implied along with profitability, include avoidance from selection of accident-creating places and prevention from environmental pollution and destruction (13).

Today, as a group of most effective methods in the related analyses and interpretations to the given subject in urban planning, geomatic techniques have put forward the clear outlooks before the specialists and experts in this field. On the other hand, with ever-increasing progress in geomatic systems and their application in urban planning and orientation of national urban management, the geomatic potentials may be employed as a tool in recognition of urban problems toward use of these systems in urban administration and services based on the related criteria and parameters. Implementation of geomatic system with the attitude toward urban subjects rather than preparation of ground for urban administration in utilization from modern administrative systems may meet the directors’ requirements for recognition of urban textures and positioning of urban spaces in addition to use of wide applications of these system in urban
administration in order to execute urban architectural projects according to various criteria with different parameters (14). Likewise, the necessity for determination of situation and position of features, knowledge about physical and geomorphologic conditions as well as topography of environment in cities, preparation of maps from plan of urban sites, preparation of profiles from different sections of urban features, production of geometric models for repair and reconstruction historic and cultural textures and design models of touristic areas and textures in cities etc are assumed as the items, which can clarify the geomorphologic importance and geomatic methods for users of urban planning (15,16). Thus, with respect to above-said issues, proper, accurate, and comprehensive execution of the process of positioning the buildings and constructions and touristic parks and recreational places are assumed very important with higher necessity in urban projects in terms of geomorphologic situation so we tend to deal with this important subject in this study.

Research history

The conducted studies about urban geomorphology can be generally divided into two fields of risks and geotourism (tourism) so these two topics will be discussed in the following:

1) The conducted studies about risks of geomorphologic location

Several studies have been carried out by the relevant experts, engineers and organizations regarding the subject of this investigation. For example in structural projects at Manchester metropolis in UK, the coal plates within the low lands of that basin, the coal mine areas at high lands, gradient and topography, possibility for occurrence of flood and land slide caused by mining operation have been totally considered as barriers against development of urban space (38). According to backgrounds from the existing pilot wells in Suez Canal in Egypt, with preparation of geomorphologic map the land nature and dispersion shapes of this zone were identified and land features were evaluated for urban planning. The results indicated that assessment of environmental effects in these countries and other countries have been widely accepted before implementation of urban space development and such assessments generally require for geomorphologic intervention and participation to reduce the risks and for proper topography (39).

The investigation showed in Brazil that urban development might lead to land slide due to building of housing units in higher lands and more gradation piedmonts at Rio de Janeiro and particularly in points of forest to provide the sites for housings in which trees and clean area are destroyed. Thus, in order to hinder this type of urban development, some regulations were issued. According to Forest Act (1959), construction of building up to certain height has been deemed as illegal and forbidden. This act contributed to stabilization of forests (land conservation) and thereby building construction was banned beside the water springs. Similarly the law regarding construction license acquisition in uneven lands was approved in 1967 and it regulated the plan for building construction on higher gradient piedmonts and/or the places with possible land instability. According to this act, the contractors shall take the confirmation license for stability of the piedmont area before construction of building on that area (39).

The studies show that physical establishment and development of cities play determinant role in relation to different factors of natural environment including shape of uneven features and their adjacency to natural features such as mount, plain, river, plateau, seashores, and the governing climatic conditions over them in quality of developing of cities at first place so that the cities are formed following to such conditions and they continue to their growth and development in addition to create relationship with each other. These conditions play essential role in determination of size of cities and villages and type of architecture and urban space
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constructions and appropriate nature of geographic environments may essentially and regionally affect in trend of urban space development (19).

In a study, Kamyabi (2004) explored the presentation of various strategies for prevention and reduction of land slide risks in design of linear structures. The results of this study show that the topographic survey on urban space construction and buildings construction is deemed as inevitable necessity from geomorphologic perspective (40).

With conducting investigation in the effects of developing Mashhad City on model of natural drainage system and intensification of urban floodwaters, Hosseinzadeh et al (2007) have concluded that intensification of risk for occurrence of flood and water overflowing in passages, which will be led to increase in urban maintenance costs and possibly further fatal and financial damages, is due to the impacts of urban space development and severe changes created in natural drainage model to great extent. Similarly, findings of their survey show that evaluation of location for urban development may remarkably reduce the risks caused by geomorphologic factors (43). Through exploring in deterrent geomorphologic agents in spatial survey on Lar City, Ganbari et al (2010) came to the result that the foremost deterrent geomorphologic parameters in city included floodwaters, earthquakes, and piedmont movements (44).

In a study that was tended to explore geomorphologic constraints for physical development of Roodbar City, Rezaei et al (2010) indicated that this city was affected by many restrictive factors among them the gradient, piedmont movements of fault, and seismic risks were assumed respectively as the paramount impact in physical development and urban space construction (45).

Similarly, Setayeshi Nasaz et al (2013) showed that in general the impact of geomorphologic phenomena could be classified into positioning, selection of location and evolution of city, physical expansion, and determination of directions for urban development, city morphology and urban constructions (41). In an investigation that was done by Sarvar (2004) under title of location finding for future development of Miandoab City by means of AHP model and through application of parameters of gardens and farming lands, access to water transfer installations, social and environmental tendencies were placed in four sites, they have concluded that the highest preference and weight belonged to Site no 2 in location finding for future development of Miandoab city (42).

II) Conducted studies regarding geotourism and touristic attractions in geomorphologic places

Several efforts have been made in evaluation of quality in geomorphologic heritages and potential of touristic geomorphosites from different aspect during recent decades (23). Overall, these investigations signify that the geosites are the locations with wonderful geologic and geomorphologic forms and processes, which are converted into geosites if the required infrastructures are provided for tourism (24).

With respect to importance of role of landforms and geomorphosites during recent decades, several studies have been carried out in this regard. Of these studies throughout the world, one could refer to the survey of Pereira (2007), who has evaluated the potentials of touristic geomorphosites in Montesinho National Park in Portugal. In this article, 154 geomorphosites were selected for study and finally 26 geomorphosites among them were selected with potential for investment out of which the highest score was acquired 15.37 (21). Likewise, Reynard et al (2007) have posited a new method in assessment of geomorphosites. This technique evaluates (scientific and complementary value) the geomorphosites in Blenio Valley and Licomagno area.
in Switzerland. The results of this study showed that the karst zone in both regions possessed great geomorphotouristic value and they have acquired highest scores in both zones (26).

Serena and Gonzalez Troba have examined the value of geomorphologic locations in National Park (The Picos de Europa). They have determined their values in each of criteria with classification of these sites into certain groups. Likewise, in their investigations Peter et al (2002) have mentioned this is not only the presence of adequate attraction in geomorphic topic and some other attractions should be also proposed along with it in fact in order to develop this attraction. In other words, as a tourist takes his/ her time to attend in a geomorphosite, s/he is also interested in observation of other attractions such as cultural, historic, and ecologic attractions at the same time. Hence, these attractions play the role of free- marketer for the studied site so it necessitates dealing with structure of cultural index and its aesthetic and ecologic value similar to a complementary element (27).

Of other conducted investigations, one can refer to a survey done by Comansecu et al (2011) in assessment of geomorphosites on Vistea Valley and cultural, historic, and recreational potentials of these attractions in absorbing of tourism industry (25).

Fassoulas et al (2011) have formulated a quantitative model for assessment of geomorphosites in Silverites Geopark in Greece that is based on 6 main criteria and finally the scientific, protective, and touristic values were determined and identified separately for any geomorphosite. In their conclusion, they have considered the presented quantitative model as a technique for evaluation of geotourism management and protection from geotourism and Geopark and also a strong tool for evaluation of geotouristic potentials including scientific, cultural, educational, and touristic values (31). Likewise, in addition to their effect on quality of urban environment, touristic parks create services and area for improving social interactions and whereas they cause legibility for city, they are considered as a part of national identity rather than local identity and they play important role in urban sustainable development (2). In other words, in the field of clean environment the touristic parks and geomorphosites are supposed as important element in creating sustainable city. They provide opportunities in different fields such qualitative upgrading of environment, facility for active and passive aesthetic and recreational and environmental fields (3).

Also, various and dispersed researches have been carried out in several sectors in Iran including by Nekooyee Sadri (2009) in a book titled ‘Principles of geotourism’ in which he has dealt with main framework of this branch of tourism and its scientific branches (28). In a survey, Servati et al (2008) studied the impact of geomorphologic forms in creating opportunities for planning in Hamadan Province. Their findings show that the geomorphologic forms and landforms possess various potentials in the field of attraction of tourism and establishment of National Parks (29).

Mokhtari (2010) has assessed the ecotouristic potential of geomorphologic locations in the water basin of Asiab Kharabeh zone at northwest of Iran by means of Pralong technique and concluded that due to the higher value of Asiab Kharabeh zone and lesser value of other geomorphosites, this site was subjected to risk of invasion by tourists so it is required for further planning and protection (30). Similarly, Shayan et al (2010) also in a similar research that was done in Darab Town (Fars Province, Iran), evaluated the geomorphologic potentials of landforms and geomorphologic shapes via Pralong method and they classified and determined the value of the geomorphosites in the studied zone. Their findings indicated that if geomorphologic attractions are integrated into cultural and historic heritages and facilities etc, this might provide the appropriate potential facilities for developing economic, social, and industrial issues etc regarding development of tourism that should be addressed more than ever (22).
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Maghsoudi et al (2011) explored the geotouristic potentials in Maranjab zone using Analytical Hierarchic Process (AHP) and as a result they identified 7.3% of this region as appropriate for ecotourism plan. Likewise, according to two criteria of scientific value and complementary value, they selected lake basins as the best site (32).

Importance of paying attention to urban geomorphology

Geography and urban planning along with a systemic approach may be considered as the basis for urban development studies when the urban key system includes a group of different spaces and uses and the communications networks between them, which are influenced by geographic, climatic, ecologic, and economic systems etc as system environment in the course of providing favorable life conditions for the inhabitants in the given region. Alternately, these systems are transformed under the influence of environmental systems on the one hand and their constituent elements (types of land uses, density in various uses, location finding and local composition or adjacency of users, efficiency or wearing of areas and reduced spatial function) and they are distorted in the course of goal realization (providing welfare facilities and favorable life). Such a condition has caused urban system to exit from balanced state in realization of certain qualitative and quantitative level of the given life and thereby the efficiency of elements or uses or urban spaces have practically receded from this point instead of tendency toward the balance and they have been led to path of reduced quality of life level. Today, this issue is visible in cities in the form of high cost for trips inside the cities, long postponements, environmental destruction, arising of illegal residential zones, creation of unhealthy production centers along with residential regions, design of intensive and non-standard administrative centers near the urban center, the crowded and polluted and unsuitable parks, removal of gardens and conversion of traditional and historic textures into commercial areas, and non-usability and changed function in some urban uses etc (19).

In addition to primary studies, urban geomorphologic bottlenecks play essential role in auditing the zones for urban physical development in sustainable form with a very low risk, relatively stable (low risk), unstable (high risk) states, and also very high risky regions in urban planning and administration. According to viewpoint of Rajaei (1994), the inflicted destructions in buildings and constructions are not usually related to engineering and architectural operation but more than 90% of damages depend on improper geomorphologic replacement and location finding of buildings and constructions (33). As the city is developed, it not only transforms the ground level, but also creates new landforms. Construction of a city creates new perspective with bare high walls and flat, even, narrow, and long surfaces. Appearance of such a landscape has led to wide change and conversion in the balance trend of energy, water, and materials and reflection of their impacts in stimulation and even change in geologic and geomorphologic processes (34). Whereas stability of piedmont is composed of the effect of roughness, drainage, stone bed, soils, surface materials or regolith on stone bed, possibility for earthquake, the residues from previous land features and human activities thus it should be paid attention to the conditions, which may due to type of their activity as the stimulant for massive motion in urban planning and construction of areas in parks and places (34).

In many cases in urban design and construction of areas, unfortunately the relevant parameters have been ignored regarding the land and hydromorphology and environmental risks caused by them. The foremost urban geomorphologic risks mainly include types of quick and slow massive motions, falling, lahar flows, stone and soil falling flows, settlement, laminar creeping, dissolution, and post-loading consolidation. For example, the land slide occurred in Afsaran
Alley and Negin Park locating in Tabriz Vali-E-Asr Town in 1990 and 1991 has destroyed more than 20 housing units and approximately 60 other units were subjected to destruction risk (35). The geomorphologic factors are effective in design of spatial system and formation of cities and this significant issue reveals the importance of geomorphologic studies in urban planning and architecture more than past since the wide and large lands, which indicate urban composition, are the function of topography and deemed as natural deterrent agents per se and this in turn has made more evident the role of geomorphologic units in urban design and for this important reason the roughness units and types of cities have been studied and they denote the role of geomorphologic factors at different levels of urban planning that may be both effective in spatial system and topological distribution of uses inside city and in morphology of city as well. Therefore, recognition of geomorphologic factors and their study is assumed as one of the basic studies in survey of cities. In fact, the geomorphologic and topographic features of a geographic location are not only effective in dispersion and or accumulation of human’s activities, but also they are eventually considered as one of the effective factors in physical form and appearance of spatial structures. In addition, urban infrastructural planning is not free of the impacts by topographic conditions since topography of the site and orientation of uneven features play role undeniably in some issues such as urban construction and/ or organism of population displacement and so forth (36).

On the other hand, rather than positioning of geomorphologic risks in architectural field and urban construction, the geomorphotourism is one of the studied fields in geologic sciences and tourism researches, which emphasize on recognition of geomorphosites or specific geomorphologic perspectives. With integration of cultural, historic, and ecologic heritages, this field may present high potentials in line with planning for sustainable tourism and preparation of recreational spaces in cities and the regions (37).

Hence, specific perspectives of geomorphosites are deemed as new concepts, which have entered in literature of urban geography and tourism with focus on determination of valuable and specific touristic and recreational locations. With combination of cultural, historic, and ecologic heritages, geomorphosites propose potential capabilities in the course of sustainable tourism and creation of standard urban areas so that to meet requirements for the citizens (20).

Thus, protection and study of value in geomorphologic units can be considered from three perspectives: 1) based on natural ecosystems and habitats; 2) as an outlook in general status; and 3) in terms of natural and real value of the natural environment. Currently, the first approach mainly governs and result of this trend is the noticeable destruction of geomorphologic forms, which are supposed as valuable elements for protection, research, and administration. In the second approach, geomorphosites have been defined within the framework of cultural perspectives in which the sites are defined along with cultural and educational factors etc. Paniza (2001) argues that the cross point of these approaches is summarized in a third approach and he notes that environment, history, philosophy, and culture should intervene in study of geomorphosites. The preserved zones and geomorphologic locations also acquire cultural, inherited, and historical values by means of this method (25). Therefore, with respect to the above issues ad conducted studies about the given subject, the role of geomorphologic locations has been/ is deemed important both in terms of environmental survey and positioning development of urban construction and also from the viewpoint for creating touristic attractions so this important subject requires further attention and favor of urban planning directors for exploitation from geomorphic and topographic facilities in selection of position and employing proportional urban architecture.

**Application of geomorphology in positioning of cities and its consequences**

Principally, establishment and arising of a city is a function of environmental conditions and geographic situation more than anything else since natural features and phenomena definitely
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Affect in selection of location, dispersion, influence range, physical development, and urban morphology and the like and they often act as a positive factor and sometimes as a negative and deterrent factor. Dynamism of natural environment, including flood, earthquake, wind, and fault etc should be adequately considered upon construction of buildings and place of establishment of cities; otherwise, the given city will encounter the problem in the future. Thus, it is deemed duly for the related officials before occurrence of bitter, painful, and costly accidents to adequately concern with prediction of the possibly occurred accidents at time of construction of cities and they should feel sense of responsibility in this regard and in addition to attaching importance for geomorphologic studies, they should assign this task to the related experts. Of course, this issue should not be forgotten to mention that rather than geomorphologic studies, other geographic studies are also extraordinarily important in positioning of cities and urban planning and overlooking them will create irrecoverable damages in the future (36).

Wide and large lands are devoted to cities. These lands are composed of various topographic and geomorphologic units. As the size of cities is developed and expanded, they are further exposed to various topographic and geomorphologic units and their relevant subjects. The geomorphologic units are always related to dynamism of natural environment. Making any effort in line with development and architecture of cities may typically cross the given dynamism and as a result with geomorphologic phenomena. The news relating to flood stream is visible in many cities of the world. For instance, on March 1989 and another time on February 1991, the flood has exerted many damages in Sistan and Baluchistan, Kerman, Hormozgan province, and northern Iran and Azerbaijan Province. On fall 1990, a part of northern areas of Iran heavy damages were imposed by horrific stream of floodwaters and many rural areas in western Azerbaijan were entrapped by enormous floods on spring 1993. Other cities in Iran are also occasionally inflicted with a lot of loses due to flood and at least they encounter many problems. Thus, one could prevent from many fatal and financial damages and losses with study on land survey from geomorphologic perspective and employing architecture proportional to the environment (36, 47).

Deterrent geomorphic factors in architecture and urban development

There are mainly two types of barrier and bottleneck against path of urban architecture in which the study on some of barriers is not placed exclusively within the range of geomorphology knowledge but it is typically related to this knowledge e.g. topography, the regions which are submerged during floodwater, the climatic conditions (fogginess, frequent thermal return, humidity, icy conditions, and avalanche), the risks caused by volcanic activities (ash rains, flow of volcanic magmas, blazing clouds flow, and Lahar flow), and variation in tectonic forms upon occurrence of earthquake etc so that although the aforesaid phenomena are often studied in another domain of scientific systems, their intervention in urban development and architecture is sometimes proposed as bottleneck in most of geomorphologic problems. For example, the glacial period, ice- melting, change in temperatures, and avalanches, which are studied within the field of climatology, are also considered as geomorphologic factors with creating a type of destruction and transformation. Or the volcanic flow and ashes and rubbles (ejects) are considered as geomorphologic factors and at the same time related to geology. Thus, many issues can be studied for architectural development and cultivation of city with deeper investigation in various geomorphologic elements (11, 47).

Role of geomorphic units in urban design and planning

Overall, geomorphic units and topographic elements may affect on a city as follows and with respect to them one can plan for urban design and development:

1. Impact in genesis, and creation, and more accurately location finding and replacement of cities;
2- Affection on physical development of urban settlements and determination of direction for their development;
3- Characterization of role in model of dispersion and spatial distribution of cities, influence range, and communication in urban points;
4- Effect on structures, installations, buildings, and servicing conditions in cities;
5- Impact in morphology and urban map (construction and texture);
6- Affecting on economic activities of the city;
7- Application in recognition of recreational and leisure centers (tourism) surrounding the cities; and
8- Use in reclamation and repair of archeological monuments

For instance, geomorphologic methods are employed in very accurate projects regarding cultural heritage in cities including study on erosions, displacements, and other geometric deformations of archeological monuments in urban areas as well as accurate modeling of artifacts and features of cultural heritage. Measurement of invisible elements (curves and lines etc) and characteristics of geometric constituent elements in historic and cultural objects (radius of arches, diameter and thickness of plates, lengths and angles etc) can be explored in accurate documentation of these works over various time periods (17). And or in study of the erosion trend of historic textures of cities, photogrammetry may propose some information to the repair experts including erosion rate, reasons for erosion, and erosion speed so that they can deal with reclamation and repair of the damaged archeological monuments with further knowledge. The photogrammetric technique may extract and measure accurately these features by means of new techniques of image processing. What it deemed as important about results of using these methods, is the precision and quality of perspective models (along with panorama images), which may play important role in presentation of full images of the subject (18).

The effective geomorphic processes on architecture and design of urban spaces

In general, geomorphic processes are divided into two groups of internal and external processes so it is referred briefly to them in the following:

I) Internal geomorphic processes

Compared to external processes, the internal processes usually act very slowly and it may lasts for several million years to reveal their effects and in some of them such as volcano and earthquake etc they may act quickly and immediately so this issue should be taken into consideration in development and architecture of cities by urban planners. The internal geomorphic processes are numerous out of which the paramount ones are as follows:

1- Land motions

The major geomorphologic evident for these motions are settlement, upheaval, stratification, and fault etc and we will mainly discuss about the faults in this article because of importance of faults in urban planning.

The faults are one of the important geomorphologic phenomena, which originate from tectonic motions. Rather than this point that they may create earthquake with their activity and motions, the faults also cause vertical or horizontal displacement in the region and they are followed by destructive consequences on buildings and other structures. Overall, human cannot predict accurately tectonic motions and also reduce these motions or prevent from their occurrence, but can identify the faulty zones in process of selecting location for the cities and be careful perfectly about intensity, quantity, dimensions, age, and origin of these processes in execution of urban projects and consider technical and safety points in construction of structures and installations. Unfortunately, in many points of this country, the cities have been constructed on lines of fault and earthquake belt (e.g. Tehran, Tabriz, Ardebil, Tabas, Roodbar, Manjil etc) and
whereas our country is under horizontal pressures from tectonic plate forces from several directions, the faults of Iran are mainly active and Iran is deemed as active in terms of tectonic motions. Iran is situated on Alp-Himalaya earthquake belt and with several existing faults; the seismic potential of the country is at very high level. The conducted studies in Tehran show that if a fault becomes active and earthquake occurs, dimensions of destructions and human's disaster, which may take place, will be unprecedented in history of human. Thus, paying attention to position of faults in construction of huge buildings, structures, installations, and civil projects such as subway and development of urban spaces seem as necessary (48).

2- Earthquakes

One of the other internal geomorphic processes is the earthquake that is followed by many destructive consequences and it also threatens some cities in our country and overlooking this feature in positioning of cities and non-observance of technical and safety points in construction of installations and buildings may be followed by several hazardous consequences.

Unfortunately, due several reasons, our country is supposed as one of naturally seismic countries in the world in which approximately all types of accidents and natural disasters occur. Thus, the pervasive plans should be implemented in order to reduce noticeably the consequences and features of natural disasters. Iran is included in 10 countries in the first row of seismic countries of the world and about 70% of Iranian land is exposed to risk of earthquake and 50% of them are subjected to flood risk. Therefore, it seems duly for urban planners of our country to consider this important point before construction of any structure and settlement to prevent from fatal and financial damages (13). A brief look at statistics and natural disasters indicates that the earthquake is a well-known phenomenon in Iran and it is led to killing of hundreds of people every year. Iran is situated on one of four global earthquake belts and the earthquakes occurred in Booein Zahra region (1962) with 12000 fatalities; earthquake in Bayaz Plain (1968) with 12000 fatalities; Earthquake in Tabas (1978) with 25000 fatalities; earthquake in Guilan and Mazandaran Provinces (1957) with hundreds of fatalities; and earthquake in Roodbar and Manjil (1990) with thousands of fatalities may totally signify this fact that ignoring seismic nature of Iran in urban planning will be accompanied with irrecoverable damages (48).

Basically, earthquakes create many geomorphologic consequences on ground surface including producing faults, horizontal and vertical displacement, creating fissures with different dimensions, stimulation and intensification of material motions on the piedmont domain, blocking and change in rivers direction, opening and closing of springs, occurrence of tsunami and so forth. Thus, earthquake causes instability in the environment directly and indirectly and this issue should be noticed in positioning and construction of urban buildings (49).

3- Volcano

Volcanoes are also supposed as other internal processes, which always threaten human life seriously. For instance, after a period of inactivation, Vesuvius Mount (volcano) started activity very extremely in 79AD and buried and eliminated three cities of Pompeii, Herculaneum, and Stabis under fire and ash rains from world scene (20). The volcanoes generally affect on residential regions, especially cities, directly by thrown rubbles, magmatic flows, blazing clouds, ash rains etc and indirectly with creation of earthquake, tsunami waves, melting of glaciers, lahar motion, blocking of rovers path, and formation of natural barrier etc. Therefore, volcanoes have both positive outcomes (rich soil, attraction of tourists, water spas, geothermal springs etc) and many negative consequences, which should be adequately addressed in planning for urban construction so that certainly prevention from occurrence of disaster seems less expensive and more logical (23).
II) External geomorphic processes

External processes take place within shorter times with more frequency compared to internal processes and they affect the human and his activities so they are more tangible and important in everyday life. In fact, these factors both determine direction and orientation for urban development and sometimes they act as a deterrent factor in urban planning and design and often play role as destructive and risk factors and they are mainly affected by internal forces so it is referred to role of some of them in positioning of cities in the following:

1- Landslide

Landslide is one the most frequent and risky types of material massive motion on graded piedmonts. This phenomenon mainly occurs in medium- size to coarse- grained sediments and due to absorption of moisture and gravitational force, the materials move along with housings, gardens, and other installation totally and quickly on the given piedmont and they threaten the buildings, trees, and installations etc and lead to blocking of the roads, rivers, and fatal and financial damages (e.g. landslides have led to fatal damages in Chahar Mahal and Bakhtiari Province during recent years). Given that the water is deemed as one of the major factors for creation of landslide; therefore, it should be noticed that construction of water ditches, high buildings, irrigation of farmlands and trees on piedmonts, and also tectonic forces and earthquakes are considered as stimulating agents for them and sometimes dimensions of landslide effects are so high that they may lead relatively slight and local earthquake rather than creation of damages in the region (49). Thus, rather than their hazardous nature, the landslides may often create double risk due to accumulation of water behind them so they may threaten their downstream regions as well. The rate of financial damage caused by landslides is usually at high level. For instance, the rate of this damage has been estimated more than one billion dollars only in USA and up to one billion and one hundred forty million dollars in Italy (39).

2- Falling

The falling takes place mainly due to physical destruction and it is considered as one of the most risky and fatal accidents for the cities locating on the piedmonts. Falling usually acts in piedmonts with a lot of gradient (about 30-90º) so as the quantity of diaclases increases in rocks, the risk of falling rubbles will further threaten the city. Principally, those cities which are situated on the high- gradient piedmonts, suffer from abnormal conditions and they are always exposed to falling of rocks and piedmont falling rubbles. For example, one can refer to Makoo city in western Azerbaijan Province as well as falling rubbles surrounding Manjil due to June 1990 earthquake (49). And this instability of rocks is considered as a great risk for urban settlements, industrial installations, bridges, and roads locating on these piedmonts.

3- Sulfication

Sulfication or clay- slippage is another type of materials massive motion on graded piedmonts, which occur usually in fine- grained sediments with clay, Marne, and limonite origins in which these materials lose their strength due to absorption of moisture and they isolate from their fixed substructure and with respect to piedmont gradient, rate of absorbed humidity, and gravity of materials, they gradually move downward and they sometimes cause destruction in buildings, factories, closing of bridges and access routes etc. The modern and huge buildings and industrial installations should not be constructed in the regions, which are always involved in Sulfication movement. Although, motions of Sulfication are not very fast, it should be noticed that whereas their move massively, they may be risky for city dwellers. Thus, it is expected that urban planners to take this subject into consideration (46).
4- **Creeping**

Creeping is a type of slow movement of materials on low-graded piedmonts, which is done grain by grain and it mainly takes place in temperate and mountainous cold climates. The motion in this process is mainly related to piedmonts without vegetation and prevailed by icy condition and melting that leads to bending of trees, electrical posts, walls, and gravestones etc. Although, creeping motion is slow and without a lot of risks, it can be problematic in long run and led to damages in buildings and installations. Hence, these points should not be ignored in urban planning and positioning of urban structures (46).

5- **Avalanche**

The cities locating in cold and mountainous regions on graded levels are considered as critical places and subjected to avalanche as a result the experts should implemented the needed investigations before creation of urban construction in such regions. The gradient factor is effective for creation of a lot of avalanche so this phenomenon is not created in the gradients with less than 23 degrees angle; unless, the quantity of snow pile becomes enormous or other external factors stimulate this trend. Gradients of 45, 50, and 60 degrees are suitable for creation of avalanche even though the snow level is 10cm in diameter. Some types of avalanches can move a massive pile of snow and fall it on the cities, villages, roads, and bridges locating on their piedmonts and lead to occurrence of irrecoverable accidents and disasters (50). Hence, a lot of attention should be paid to avalanche and the related issues and problems in process of architecture and urban constructions in cold-weather and mountainous countries.

6- **Rivers and change of their beds**

As it also mentioned before, today unfortunately the factors of physical appearance and natural landscape of cities are mainly noticed in positioning of cities and construction of buildings and urban installations while the environmental and geomorphologic forces are not highly addressed. Probably it can be implied that no geomorphologic factor can deform the ground surface similar to ground waters even in dry zones. Namely, the fluvial systems usually create unstable and dynamic environments and cause morphogenesis to prevail over pedogenesis. In many regions and particularly in dry and semi-dry zones, rivers and their littoral lands are assumed as tempting grounds and due to severe need for water, the city is drawn toward river and occupies its surrounding lands. The urban planners should study on periodic and frequent changes of rivers since a river may not flood for several years and is in calming period and even a lot of housing and industrial centers are constructed at the margin of river, but suddenly the flooding period of river starts and inflicts several damages. The rivers may create noticeable risks due to their dynamic conditions. Flooding of rivers causes economic loss as well as erosion in their surrounding regions while river bank retreats and it exerts some damages to the surrounding installations (46). With drilling, loading, and sedimentation of materials, the rivers cause a lot of changes in urban lands and they invade the banks under flooding conditions and leak into the cities due to water overflow that is led to disruption in people’s daily activities and occurrence of heavy damages in cities. Thus, all features of the river, including rate of discharge, flooding periods, stream speed, and protection from limits of river should be noticed when creating structures, installations, and residential buildings since if conducting of accurate studies about this subject is overlooked, many irrecoverable damages will occur (49).

7- **Sand and gravel storms**
Sand and gravel storms are one of the other natural disasters, which are always followed by financial and fatal damages and our country also undergoes a lot of losses for this reason every year so it is duly to consider this issue by urban planners as well. With their invasion to urban and rural residential regions, farming lands, rivers, access routes, airports, economic and vital installations, and water transfer canals etc, sand and gravel storms cause numerous problems for the people and inflict irreversible damages to civil and infrastructural activities in any region (46).

8- **Karstification**

Due to dissolution effect and the existing subterranean caves, the people in karst and limey zones encounter problems for construction of city and urban installations out of which one can refer to the settlement of multi-storied buildings due to settlement of limey lands and barriers of underground caves for construction of subway line and other underground installations, the presence of many caves and corridors under the ground and falling of their ceilings and damage to bridges and other urban installations, pollution of underground waters because of permeability of limey stones, the problems relating to urban wastewater, control of floodwater and drainage models, construction of bridge, tunnel, and dam (46,50). Therefore, it necessitates paying attention to special characteristics of limey lands, which can cause occurrence of irrecoverable accidents in the future and they should be noticed in urban planning.

9- **Higher level of underground waters**

The higher level of underground level can be normally assumed as one of the problems in urban planning since due to higher position of stone bed and fine-grained sediments, the level of underground waters may rise in some regions and thereby it is led to wetting of walls and buildings and filling of swage wells and graves and pollution of waters etc and this trend will be definitely followed by financial losses as well. Thus, urban planners should also notice such issues and even more partial problems since the current partial problems at present will be converted into great and challenging problems for the cities in the future (49).

**Geomorphologic tourism landforms**

Geomorphologic tourism landforms or geomorphologic capitals (12) are defined as geomorphologic shapes and process in which these landforms possess aesthetic, scientific, cultural-historic, and socioeconomic values according to human’s perception of geomorphologic, geologic, historic, and social effective factors (51). There are some features and outcrop phenomena among geologic capitals if they are introduced and recognized to tourists and interested visitors in nature trip, the aforesaid features can be both protected and at the same time it is possible to upgrade important position of nature among the families as well as noticing profitability of this sector of industry.

**CONCLUSION**

Given that providing of welfare for city-dwellers by creation of better, more healthy, and appropriate environment is deemed as the paramount objective for urban planners, it seems duly rather than other studies to notice geologic and geomorphologic researches as well before construction of cities or heavy projects, which need to enormous investments and further secured conditions and at the same time with respect to this issue that the geomorphologic risks are considered as one of the important problems in human communities if ignored they can impose irrecoverable damages to human communities in various parts of the world so it is suggested to urban planners in finding location for construction of installations and buildings as
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well as in design of urban areas to pay further attention to unequivocal role of geomorphologic phenomena including land tectonic motions, earthquakes, volcano, landslide falling and so forth and their effect on urban architecture and development so that with recognition of mechanism for function of geomorphic phenomena and formulation of the needed standards, we can witness the further reduction in these accidents and risks caused by geomorphologic in communities more than ever. This point should be implied in the following that the ecologic effects and consequences and fatal and financial damages have been exerted due to overlooking the geomorphologic knowledge and information in urban architecture and planning that is not only hazardous, but also the evident ignoring of geologic sciences may exacerbate the urban status and make it disastrous.

On the other hand, with respect to aforementioned issues regarding economic, social and cultural importance of geomorphologic touristic attractions and geomorphosites, one can create higher potentials in line with planning for sustainable tourism and providing leisure and recreational areas in cities and the surrounding zones through composition of cultural, historic, and ecologic heritages and this issue requires paying attention by urban authorities and planners.

REFERENCES

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