Research in Marine Sciences
Volume 8-Issue 4- 2023
Pages 324-341

A scientific review article

Crisis management of cities with emphasis on floods

Massoud Taghvaei[1, *], and Fahimeh Soleimani[2]

[1]Associate Professor, Department of Geography, Faculty of Geography, University of Isfahan, Isfahan, Iran.

[2]Senior expert in geography and rural planning, Isfahan, Iran

Received: 2023-10-05 *Accepted: 2023-12-02*

Abstract

A flood is an exceptionally intense water flow that can overflow the natural river bed and occupy the surrounding land. Floods can be the result of heavy rains, rapid melting of snow and ice, or destruction of dams. Whatever the reason for the existence of this process, when it enters urban areas, it causes damages and sometimes many casualties, because the city encroaches on natural hydrological spaces (channels and riverbeds) during its growth and development. Over the past few decades, new methods have been invented to deal with floods, and these methods are mostly preventive in nature and not curative. By implementing specific plans for the use of urban land, establishing regulations and laws, as well as educating people, the damages caused by floods can be reduced and minimized. Also, he avoided spending heavy and exorbitant expenses for the construction of flood control facilities, which are very capital intensive. In this regard, the present research, deals with the identification of the effect of natural factors (rainfall) and the creation of crises arising from it in urban planning. The results are paying attention to crisis management in urban planning in order to prevent floods and reduce rain damage. Expand the optimal use of rainwater in various dimensions.

Keywords: Crisis management; City management; Flood.

1. Introduction

1.1. Design and statement of the problem

Today, under the influence of many conditions and factors, the increasing growth of urban complexes are observed, and in many cases, these complexes are dealing with the problem of flooding as a natural disaster. In fact, flood has become one of the most destructive

* Corresponding Author's Email: m.taghvaei@geo.ui.ac.ir

phenomena all over the world (Haghroosta and Ismail, 2017). Various conditions and factors affect the occurrence of floods, which include natural and human factors. Although natural factors have been identified as the main cause of flood and damage caused by it, and the role of human factors and their interventions are not only not less than the role of natural factors, but they have also been the main cause of flood and damage at times. In order to reduce as much as possible, the effects of floods on urban areas, various measures can be taken, including construction and management measures, each of which is implemented by factors and in specific time periods. Of course, extreme care must be taken in the use of these measures, because sometimes they act as factors of crisis and damage if they are not properly monitored and implemented.

Management and construction measures can be less useful and effective if they are used alone, while the combination of these two methods with each other multiplies the success and efficiency of plans and methods to deal with urban floods. Actions to deal with urban floods should be carried out in three periods of time: short-term, medium-term and long-term, and the introduction of these methods is short-term, long-term and medium-term planning (Abdullahi, 2004; Rebally *et al*., 2021).

1.2. Importance and necessity

Due to the rapid growth of population and urbanization, urban crises will increase alarmingly. Although advanced technology has provided comfort and facilities against natural disasters such as floods and earthquakes, cities are very vulnerable to such disasters. What is certain is that the large and dense population of cities will eventually lead to an increase in damages caused by these accidents (Kawata, 1994).

The geographical location of Iran's cities shows that due to the location of the cities on the path of different watersheds, the necessity of forecasts for floods is felt, and city planners and urban planners, geologists and geographers should carefully examine the causes and factors. address the creation of these natural disasters in urban areas and predict the necessary solutions to reduce their effects (Tehran Studies and Planning Office. 1993).

1.3. Research history

In many countries of the world, for several years, measures to deal with the risk of flooding and water inundation have been used in the design and implementation of buildings and the location of settlements, and even though most of the cities and population centers of the country have always been subject to destruction caused by floods and Still, every year, a long list of the frequency of floods and the magnitude of the damages caused by them can be prepared, in the meantime, except for the scattered measures of relief and rescue after the accident and limited to local and temporary measures, there is no comprehensive plan for The preparation of cities against flood risks has not been prepared and implemented (Taheri Behbahani and Bozorzadeh, 1997) and even the impact of types of precipitation, volume, distribution and quantity of precipitation on urban systems and the lives of citizens and urban institutions and services has not been seriously investigated.

2. Floods and urban crises

2.1. Flooding of cities

Normally, the flooding of cities is the result of two types of actions by Residents of the city:

- Establishing the ancient structure of some cities on the edge of rivers.
- When cities are developed on lands that are impenetrable

They are very suitable and do not have visible surface currents network due to the infrastructure and asphalt placement of the lands. Therefore, the water resulting from the rainfall is not able to penetrate the ground and first collects in the low areas and pits of the city surface and then flows in the form of streams on the level of the roads and moves towards the lower areas. Such currents can cause a lot of damage to urban constructions and facilities.

A primary and old method for flood disposal is to direct the urban floods into the urban sewerage network and from there it is emptied into the nearest nearby rivers or directly into the sea without any treatment being done on them. This method's disadvantages are that the water from heavy rains flows on the surface of the city without penetrating the ground and then enters the sewerage network and is removed from the reach. On the other hand, as the aforementioned water cannot be purified, it becomes heavily polluted due to mixing with sewage and eventually causes pollution of the rivers and the banks of the sewage network of the cities during heavy rains. Also, it usually does not have the ability to pass all the water, so in some buildings and passageways, sewage rises up and causes pollution of the urban environment (Asghari Moghadam, 2018).

Over the past few decades, new methods have been invented to deal with floods, which include zoning flood plains, establishing flood insurance and installing flood warning systems. These methods are mostly preventive and not curative. Establishing and implementing specific plans for the use of urban land, founding regulations and laws, as well as educating people can reduce and minimize the damage caused by floods. At the same time, spending heavy and exorbitant costs for the construction of flood control facilities should be avoided, which take a lot of capital. For example, in some cases, low-lying lands and depressions in big cities are turned into parks and green spaces, thus preventing the construction of buildings in such lands. By connecting these lands to each other, continuous networks of open space can be created in the cities, and by directing urban floods into them, the damages and problems of urban floods can be reduced to the as minimum as possible (Adedeji *et al*., 2012).

Due to the heavy investments required for the construction of dams, the non-structural methods of flood control undoubtedly attract more attention due to their lower costs. Deciding and choosing the best method is often a complicated and difficult task, because the benefits and resources resulting from such actions cannot always be expressed with numbers and figures (Kundzewicz, 2002). For example, reducing discomfort and problems caused by the accumulation of water in the streets and crossings, the beauty and cleanliness of the environment, the removal of unpleasant views, and creating a sense of security can

be considered as intangible benefits of the flood control project, which cannot be explained with numbers and figures. Obviously, it is not possible to simply set a price for the feeling of insecurity of the residents in a flood-prone neighborhood or area, but there is no doubt that this feeling is real. There are some tangible benefits by the construction of dams; reduction of damage to public facilities, decreasing of casualties and number of flood victims, and increasing the price of flood-prone lands.

This is one of the issues that should be carefully considered by the officials of cities and towns. The conversion of free land into streets, buildings and huge parking, and lots of shopping malls caused after a heavy rain, the resulting water does not have the opportunity to penetrate the soil and accumulates as runoff on the impermeable surfaces of the city, joins together and then they rushed towards the hollow and low areas of the city. Although, such floods may not be as big and severe as river floods, it is not impossible to flood the underground buildings and streets of the city. In some of the reports, it is mentioned that people drowned in the sewer wells, who died due to the lack of capacity of the collection and disposal network of urban floods and the density and accumulation of water. One of the early and old ways to solve the problem of urban flooding was that the rainwater was directed into the city sewer network and after passing through the city sewage treatment plant, it was emptied into the nearest river. In this method, streams and streams for collecting surface water were connected to the city's sewage network by means of a pipe, thus creating a mixed system for collecting and disposing of sewage and runoff (Osti and Nakasu, 2016).

The disadvantages and harms of this solution are obvious today. The amount of water that flows in the city due to heavy rains is usually the capacity of the treatment plants, and as a result, a part of the rainwater runoff must be directed to the river or the emptying place without being treated. In addition, the use of the urban sewage network to transfer rainwater to the river means that less water penetrates into the soil and does not reach the consumption of underground water resources. Another disadvantage of this method is that rainwater is naturally very polluted and if it is directly discharged into the river without being filtered, it may degrade the quality of the river water (Loucks and Van Beek, 2017).

When the disadvantages of the mixed system for collecting and disposing of floods and urban sewage became clear, researchers and water engineers, especially in Europe and America, started their research to find a more suitable solution. The result of their work can be summed up in the concept that the necessary measures to control urban floods should be in such a way that interference and manipulation in the existing hydrological environment is avoided as much as possible. The basis of this concept is that, the urban runoff should be kept in the same urban area and avoided its discharge and left from the relevant hydrological area. The important result that was achieved was that the control and management of urban rivers is a serious and dangerous task, the realization of which requires a lot of efforts and financial support and a significant budget. The experts came to the conclusion that in order to reduce and minimize manipulation and interference in the hydrological environment. It is better to infiltrate the rainwater runoff into the soil of urban areas wherever possible. Parks and green belts can facilitate this work (Moalemi, 1996).

The occurrence of successive rainfalls, flooding of rivers and water flowing in flat plains are among the factors that are considered in the foundation of different residential environments. The establishment and attention of cities in steep slopes, low and floodplain areas should be avoided and the necessary forecasts should be made regarding the possibility of flooding of rivers and streams. Furthermore, the development of the city in the direction of lowland and floodplain areas should be avoided as much as possible (Shieh, 2002; Chegini and Li, 2022).

Unfortunately, the newly arrived immigrants to the cities for various reasons, including arbitrary habits in choosing a place, select their residence on the roads and in their sanctuaries. Such a wrong replacement causes that sometimes when the very severe and destructive floods happen, a lot of loss of life and money occurs. For example, in June 1992 a damaging flood happened in Noh Darreh, Mashhad that destructed several houses on the road and the death of many people (Zomorodian, 1996).

One of the most important environmental issues is flood forecasting. According to the common methods of hydrologists to predict floods, there is not enough time for preparation operations after the start of a possible shower, and in any case, flood damages are usually unavoidable. However, if the generating circulation patterns are identified, it is possible to predict the occurrence of floods at least one or two days in advance by seeing the beginning of the sequence of sealed patterns leading to flooding, and in this case, there is enough time to make the necessary preparations (Alijani, 2003). Overcoming the flood on the water collection and disposal system caused by rainfall and the failure of the inner city floodgates occurs when the floodgates do not have enough capacity to remove the maximum momentary flood water. As a result, the water flows on the surface of the streets or the direction of the water flow in the buried culverts is reversed. United Nations studies in the economic and social fields of hydrology in urban areas have clarified such cases.

- Collecting and disposing of runoff from rainfall in urban areas can be considered a type of safety, health and welfare services offered to the urban community.
- The benefits and benefits of such services include reducing the damage to property and assets, reducing the interruption and slowness of income, reducing the risk and damage to health and improving and increasing the beauty and increasing the quality of the urban environment (Abdullahi, 2004; Rebally *et al*., 2021).

One of the important reasons for the occurrence of floods in urban areas is the lack of precision in the implementation of urban flood control plans, and in many cases, the structures and facilities that are supposed to control floods are themselves the cause of floods. Flooding and overflowing of many flood control structures, such as earthen flood walls, or the destruction of these structures due to foundation settlement or water washing and erosion, as well as the incorrect implementation of these structures, have clearly caused damage in urban and non-urban areas. On the other hand, the rise of the bottom of the canals is due to the large amount of sediments that are carried out by the flood and settles at the bottom of the canal. Therefore, even the irrigation of the canals and rivers is not useful and

cannot have the high efficiency, many cases are caused the water to flow back and flow into the surrounding areas should be drained and flooded in urban areas (Chiti, 1993).

2.2. Risks caused by water

During the research to find solutions for water supply in urban and rural planning and design, it is necessary to foresee the problems caused by water. The main problem or rather the dangers caused by water are discussed as follows.

Every year, many unfortunate incidents caused by floods and their casualties in cities and villages happen. If there are enough knowledge about the watersheds of rivers and waterway networks leading to cities or villages, the researchers will be able to take into account the characteristics of the weather and other features. It should be carefully identified the environment of the basin's runoff and, if necessary, prevent damage caused by floods in the settlements by curbing and controlling it.

In order to control and contain floods, it is necessary first of all to know the causes and effective factors in floods. The main factors are:

Climatic factors: Among the climatic elements and factors, rainfall plays the most important role in the occurrence of floods and floods. In this regard, the amount of rainfall and type of rainfall and other characteristics of rainfall are worthy of attention. It is obvious that as a result of heavy and prolonged rainfall, the soil becomes saturated and surface runoff increases. For this reason, cyclonic rains, despite being of low intensity and fine-grained, lead to floods due to their continuity. However, it should be known that because of the high intensity and coarseness of rainfall, they do not get a chance to penetrate the ground, and instead of flowing deep, they flow on the surface of the ground and increase the volume and intensity of the runoff. The result is that huge and destructive floods are caused by this type of rainfall. This kind of precipitation is more specific to the climate of dry and desert regions where there are lack of sufficient vegetation and the soil is fine-grained and less permeable. Therefore, the cities and villages of these regions such as Zahedan, Zabul, Bushehr, etc., are seriously threatened.

In addition to the above issues, during the transition from the cold season (winter) to spring when the snows are melting, a rainfall, especially warm rain, accelerates and intensifies the melting snows in mountain. As a result, the flow of rivers and waterways increases rapidly, and with the help of the high slope of the mountain surfaces, they cause spring floods. Considering these concerns, it is necessary to carefully analyze the rainfall statistics at least for 30 years, and calculate the maximum amount of rainfall and the maximum intensity of the return period according to the rainfall (Zomorodian, 1996).

2.3. Urban runoff

The most important issues of water management in the country's urban and natural systems are the control and containment of accidental floods and its storage for dry and low water seasons and reducing the risks due to floods as a natural disaster. Water storage can be done on the surface or underground. In natural systems, this is done by sloping, digging special

wells, artificially impregnating groundwater slabs, creating earthen and concrete dams along the valleys and exits of watersheds. By doing this, through proper planning and design of the surfaces of streets, squares, and buildings, in addition to containing water and preventing floods from flowing, the contained water can be used for irrigation of urban green spaces and even for drinking (Sadrzadeh and Gholikandi, 2010).

2.4. Wastewaters (sewage) caused by rainfall

After reaching the ground and its flow towards the sewage canals, the rainwater is under the influence of a series of factors that need to be taken into account in calculating the amount of sewage.

1) Factors of the first category:

After reaching the ground, part of the rain water penetrates into it and joins the underground water tables. Another part of the rain water returns to the atmosphere as steam after reaching the ground. This evaporation may be done directly (surface evaporation) or it occurs in the form of transpiration of plants or in the form of evaporation from wet lands. Factors such as the degree of permeability of the ground, the altitude and slope of the rained ground, the degree of heat and humidity of the environment and finally the intensity of the wind in the place are the factors that are effective in the intensity and weakness of the mentioned phenomena. Considering that the permeability coefficient of the earth is higher at the beginning of a rainfall and after some time it decreases due to the increase in the degree of saturation of the earth with respect to water and also due to the increase in the humidity of the air after the beginning of the rainfall and the decrease in the degree of evaporation, practically the effect of the factors First, it does not remain constant even during the rain.

2) Factors of the second category:

After each drop of rainwater reaches the ground, it needs a time called concentration time to collect with the second raindrop that sits on the ground at a distance. Therefore, it is necessary that the duration of the first drop flow is equal to or shorter than the duration of rainfall. If the duration of precipitation is less than the duration of the flow of drops, these two drops will never gather together.

3) Factors of the third category:

Due to the movement of clouds, the showers resulting from them are also moved, therefore, due to the unevenness of the intensity of rainfall in wide watersheds, and depending on the extent of the area, the probability of raining with the maximum intensity decreases in all areas. Of course, in the case of small cities, this phenomenon can be ignored.

The methods of urban waste collection can be done in a mixed way with the help of one sewage line to direct domestic sewage and surface water, or separately and by creating two different channels, one to direct domestic sewage and the other to direct surface water from designed rainfall. In the combined method, the cost of creating a collection network is less, but the cost of building a treatment plant and environmental pollution is more, while in the

separate method, the cost of building a network is more, but the environmental pollution is less (Monzavi, 1995).

The facilities of a sewage collection network consist of sewers or sewage collecting channels which are divided into the following groups:

- Branching of houses
- Sewage sub-channels that are made with a circular cross-section.
- The main channels and sewer main pipes are usually circular in cross-section, and in interlaced networks, they can be chosen in the form of an egg or a compound circle.
- Special rainwater channels that are usually made of reinforced concrete with different sections.
- Under pressure pipes to transfer sewage from pumping stations in cities that do not have enough natural slope.
- Special buildings: Due to the characteristics of sewage, in addition to the sewers, many special buildings must be built along the network route, the most important of which are:
    - Drains that are made for cleaning and repairing canals,
    - Rainwater and street washing drains that are placed on beside of the streets.
    - Snow valves
    - Rainwater overflows that are made in interlaced networks.
    - Drainage valves for cities that have a lot of natural slope.
    - Underpasses and overpasses to lay sewage pipes under the rivers.

The duty of a sewage network is to expel any urban wastes. The collection network should be designed in such a way that it does not require much maintenance from the opinion of manpower, especially from the point of view of the slope of the channel floor, the necessary predictions should be made in the design so that the suspended and floating materials do not settle and the surface Do not reduce the flow rate (Monzavi, 1995).

At the beginning of the 20^{th} century, the wastewater of most communities was directly discharged into streams, rivers and rainwater networks. The result of this work was the accumulation of sludge, the creation of unpleasant external conditions and disturbing smells. To deal with these issues, the construction of separate sewage collection and treatment networks became legal. With the use of more intensive methods of wastewater management, it became legal. With the use of more intensive methods of sewage treatment, which was associated with the production of large amounts of mud, the problem of sludge disposal arose. As a result of the unauthorized connection of rainwater drains to the domestic sewage network and also through the manholes on the street floor, some rainwater enters the domestic sewage network in a separate system. Depending on the number of holes in the mentioned valves and the intensity of rainfall for each valve, it varies from 0.1

to 3 liters per second. The total amount of rainwater that enters the domestic sewage network in this way in the city varies between 10 and 30% depending on the level of culture of the people and the structure of the network (Monzavi, 1995).

One of the major problems and bottlenecks in most cities is the lack of urban sewage systems and the lack of necessary forecasts in urban planning based on the creation of a surface water collection network and even tabulation with a suitable width and slope to direct surface water. This has caused once the descent of the first rainfall, while disrupting the flows of various systems of the city, caused the flood to cover most of the different areas of the city. In addition, the lack of such systems has caused many parts of urban lands to become unusable due to the high surface water and domestic and industrial wastes, as well as many parts of the environment face the risk of contamination caused by these pollutants (Zare, 1993).

2.5. How to dispose of surface water and rain water in the city and its roads

In general, the pipes, streams, and rainwater channels in a city should work together in a coordinated manner so that in times of severe flooding, they can pass a large volume of surface water without harming the city. The surface water disposal of rainwater in the city needs certain studies, related to the exact volume of rainwater. The essential changes in a city should be monitored and considered, and then the volume of drains and streams should also be taken to be match each other. To prevent surface erosion, runoff should be less than 25 mm and its speed should not be more than 0.8 to 0.9 m/s. If these two factors do not match, the drains and streams should be widening through certain solutions, and other solution such as flood reservoir pools should be used in certain places for disposing of surface water (Mojtahedzadeh, 2001).

Another important and vital issue of cities is the continuous controlling on the underground water level. Due to impenetrable constructions and soil compaction, at the level of the city, it becomes difficult for water to penetrate into the lower layers of the earth. Therefore, there are some problems in the cities, water supply in one hand, and on the other hand its restoration. Controlling surface water in cities is important because they provide a part of underground water. By increasing its penetration into the soil, the level of underground water may rise and the undergrounds, underpasses, and sewers may be threatened. The reduction of its penetration in the soil also brings biological damages and special effects caused by the descending of the underground water level (Rahnamaei, 1991).

3. Methods to solve the problem of urban floods

3.1. Artificial nutrition

One of the methods to prevent the wastage of rivers and excess surface water is to feed them underground and store them in aquifers, which is called artificial feeding. Artificial feeding is done in different ways, which depends on the conditions of the place and available facilities. In surface spreading method, excess water is diverted to ponds or pools to seep into the ground through their permeable bottoms. Of course, before entering these

ponds, it enters a sediment catchment pond so that most of the sedimentary materials are spread and settled. This method has been implemented in some parts of Iran such as Qazvin Plain, Garmsar and Varamin. Artificial feeding is also done using a well. "Feeding well" is a well that transfers water from the surface of the earth to underground aquifers. In fact, the water flow in these wells is the opposite of the usual drainage wells. Artificial feeding by wells is used to feed aquifers under pressure or when there is a wide impervious layer between the ground surface and the aquifer, and also when there is not enough land available. In fact, in artificial feeding operations, instead of storing water in surface tanks, water is stored in underground tanks. According to the conditions, different methods may be more efficient (Sedaghat, 2001).

3.2. Dangers of artificial nutrition

The areas that are considered for infiltration of rainwater into the soil and artificial nutrition should be selected with great attention and precision. The soil layers between the bottom of the underground aquifer and the surface of the ground can largely determine the efficiency of this storage system. Of course, it should be noted that infiltrating polluted runoff in the soil is not harmless and without problems. If the underground reservoirs are contaminated, their treatment becomes almost impossible both scientifically and economically.

Therefore, it is necessary that the rainfall runoff be treated in the city's sewage treatment plant or in other separate treatment plants before being transferred to the artificial feeding place. Retention ponds are actually open concrete pools that are used to store runoff from rainfall until it is possible to treat them.

Sometimes, ponds can be used for longer storage of floods, in which case these ponds act like artificial lakes. Both types of ponds should be dredged from time to time and the materials that have settled in their bottoms should be removed.

Another way to solve the problem caused by urban floods is to convert existing mixed systems for collecting and disposing of runoff and sewage into two separate and independent systems. Unfortunately, this method may be the most expensive and complicated solution (Moalemi, 1996).

The rainfall-runoff trend in rural areas is basically determined by the level of rainwater. The characteristics of infiltration from the surface and the drainage pattern formed by the natural branches of the stream. In these areas, rain water creates a suitable capacity for its passage while breaking and eroding the soil. In addition to this natural drainage system, an artificial drainage system is also added. Urban areas generally include impenetrable or low-permeability areas such as roofs, roads, and parking lots, which have far less water retention and infiltration capacity than rural areas. Furthermore, flooding occurs at a high speed in urban watersheds on flat and water-resistant surfaces that have been created by man-made artificial drainage systems. According to these factors, the urban state of finding natural resources causes an increase in the occurrence of floods in the downstream areas.

The volume and intensity of the runoff and possibly this phenomenon can also cause erosion in the water channels downstream. The development of urban areas has also had adverse effects on the quality of rainwater. Accumulated pollutions in impervious urban areas caused by different sources on dry days are washed away by rainwater and these pollutants are quickly carry away by runoff and join to water resources.

In these areas, rain water creates a suitable capacity for its passage while breaking and eroding the soil. In addition to this natural drainage system, an artificial drainage system is also added. Urban areas generally include impenetrable or low-absorbency areas such as roofs, roads, and parking lots, which have far less water retention and infiltration capacity than rural areas. Moreover, flooding occurs at a high speed in urban watersheds on flat and impermeable surfaces that have been created by man-made artificial drainage systems. According to these factors, the urban state of finding natural resources causes an increase in the occurrence of floods in the downstream areas. The volume and intensity of the runoff and possibly this phenomenon can also cause erosion in the water channels downstream.

The development of urban areas has also had adverse effects on the quality of rainwater. Accumulated pollutions in impervious urban areas caused by different sources on dry days are washed away by rainwater and these pollutants are quickly washed away by runoff and join water resources. The most important sources of pollution in urban areas are: dust and garbage, dumping or storing urban or industrial garbage, waste from domestic or wild animals, oil spilled from vehicles, waste from domestic areas, pesticides and composts related to parks and green spaces and soil eroded from construction areas. Moreover, urban runoff may contain various toxic substances that can be considered as the most important threat to water resources. (Broumand Nasab, 2003; Singh *et al*., 2022)

4. Results

4.1. The role of slope in urban planning

The set of unevenness of the earth's surface mainly consists of three elements, which are: "vertical line", "concave line" and the sloping surface between them, i.e. "domain". The element of slope or range, which exists in all forms of macro and micro, even if it is small, is considered one of the most important factors of change and transformation of the unevenness of the earth's surface, and in this way, it directly or indirectly affects human life and activities.

Although the sloping surfaces and domain are less occupied by humans, some of the human activities such as transplanted agriculture or rain fed cultivation, communication roads and intercity roads, masts related to power transmission lines, water supply projects, part of the structure of mountain cities, hillside or valleys and other constructions are established on the slopes. On the one hand, the construction of each of these facilities requires a certain amount of slope, and on the other hand, it is strongly affected by slope changes and domain instability. Because these surfaces are very dynamic due to the influence of initial processes (weathering and destruction), gravity and surface runoff. Therefore, they suffer from all

kinds of domain movements (falling, creeping, sliding, flow, etc.). Therefore, in urban planning, the role and performance of the slope should be carefully considered.

suburban (inter-urban) projects cannot be outside the scope of urban planning, because industrial, agricultural or construction projects in any form can be related to the city and citizens. To identify the required slope thresholds, topographic maps, slope maps or maps of surface features have the necessary efficiency. Mountainous cities are hilly or sloping cities, and while they are located on the slopes of valleys and cones, usually their general slope is in one direction, but they also have slopes in different directions. Although the existence of these slopes is important from some aspects, such as the beauty of the city, preventing the accumulation of destructive materials on the city, or the natural erosion of roads by runoff (during rains), etc. However, the slope of the city (especially critical and excessive slopes) can cause problems such as flooding, difficulty of intra-city transportation, disturbances in the construction of buildings and facilities, destructive domain movements and dynamics, and etc.

Smooth and low-slope surfaces, such as large flat plains, which have complications and a low slope, are suitable for the establishment of cities. In this regard, the maximum slope on which the city structure is supposed to be based should not exceed 11 degrees. Of course, depending on the environmental conditions, it usually changes a little, for example, in the period of Connecticut in USA, a slope of 8 degrees or 15% is considered as the upper limit of the applicable slope for the construction of official houses or conducting concentrated urban experiments. By carrying out a series of topographical studies, the direction of the city's street network and passages can be determined according to the slope of the land. In this sense, by choosing the best possible route in terms of slope, the efficiency of the streets and passages of the city will be improved. This action can prevent the accumulation of destructive materials, the movement of running water, destruction caused by floods, and the placement of streets in spaces facing the sun and other problems. One of the most important issues, especially in the mountainous cities of Iran, is the lighting the city streets and staying away from the sun. Therefore, in cold areas and in the winter season, snow and ice remain on the surface of the streets for a long time and in this way traffic in the city faces problems.

According to what was stated, the following points should be paid attention in urban areas for designing and planning in general, especially when providing a way to build new streets.

- The direction of the street should not be perpendicular to the direction of the slope. Rather, it should make an obtuse or acute angle with the direction of the slope (extension of horizontal lines). Because in the case of the slope of the street, it will be increased, and therefore, urban transportation will be slow and waste a lot of energy and time, secondly, the southern sides of the streets are often filled with water, snow, or ice.
- The capacity of discharging canals on the side of the street and the urban sewage network (Ego) should be increased from the top of the slope to the base. By observing these points and other things, it is possible to ensure a relatively efficient and low-risk transportation on the sloping surfaces, especially in the mountainous cities of Iran (Zomorodian, 1996).

- The slope of the streets is very important, so that rainwater does not remain on the street. It is usually 5% and this is related to the length of the street. Due to topographical considerations, the slope of the main streets may be between 6% to 7% and the side streets 10% to 12%. The width of the asphalt street is usually 1.5 to 2% (Shieh, 2002).

Moreover, the watersheds areas around the cities sometimes wash the material from the slopes and carry it to the downstream areas due to heavy rains. In addition to the physical changes on the surface of the earth, these erosion materials sometimes change the lands' quality near the cities from their natural state and turn them into rocky lands.

In steep slopes, a series of physical changes may be created in the face of the earth under the influence of destructive operations and displacement of materials. Among these changes, the movement of mud and sediments, sliding of slopes and its collapse (soliflexion), movement and falling of slopes (creep phenomenon) and finally subsidence can be mentioned. All these movements can change the natural landscape of the suburbs and even the inner city. The most vivid example of this type of damages resulting from the movements of erosive and destructive materials in the summer of 1988 happened in the city of Tehran, in Tajrish area and the southern slopes of Tochal, after which a lot of erosive materials moved in the river bed and blocked the city passages.

4.2. Determining the direction of city streets

Considering topographical features, the direction of the street can be determined according to the slope of the domain. In this way, choosing the best possible route in terms of slope can prevent the accumulation of destructive materials, the movement of flowing water, and the destruction caused by floods.

One of the most important issues that the mountainous cities of Iran are facing is keeping away from the sunlight in the northern slopes of the mountains that makes difficulties to build streets. Basically, they are not suitable crossings. Ordinary people, regardless of these points, build their houses on the slopes facing the sun in some mountain cities.

As a result of this action, especially in cold areas, snow and ice remain on the street surface for many months of the year, and in this way, transportation is faced with problems. In urban planning, especially when proposing the construction of new streets, one should pay attention to these points:

- The direction of the street should not be perpendicular to the direction of the slope, but should make an obtuse or acute angle with the direction of the slope. Even if it is vertical, the southern part of the streets is often filled with water or snow and is not emptied.
- The drainage capacity of the canals on the side of the street from the top of the slope to the base should be increased.

It is possible to determine relatively efficient and low-risk traffic on the sloping streets in the cities of Iran, which are not few in number (Guideline 2019).

Villages and cities do not develop in high places. Most of the cities and villages were created in plains and places that did not have a high altitude. As well as being effective in

climate changes, altitude also plays an important role in cities. In constructing the network of urban facilities such as water and sewage network, it is tried as much as possible to take help from the natural slope of the earth in order to develop such networks.

Low and high lands are worthy of consideration in terms of urban development. The low-lying areas, including high-quality land for creating low-lying neighborhoods, are usually not considered especially in flood-prone areas. While there is a possibility of flooding, they also face problems in developing the water and sewage network and collecting and disposing of surface water. The role of low and high lands and suitable slope is significant in the construction of roads, the height of buildings, and finally the appearance of cities.

The location of the city or village and the uneven shape of the land may completely prevent their growth or cause their growth and development. For example, if cities or villages are located at the border of mountains and plains, or at the valleys that separate the mountains, or at the point of convergence and junction of the valleys, their creation and development will not face many problems. While the places that are surrounded by mountains cannot be developed, as the mountains themselves are considered as important obstacles for growth (Shieh, 2002; Chegini and Li, 2022).

4.3. Urban management

Atmospheric precipitation in different seasons of the year exerts different effects on the dispersion of human groups and the provision of their livelihood resources. In the areas that have a dry summer with little rain, human groups settling down around permanent water resources such as headwaters, rivers, or wells, and in other areas where there is rainfall throughout the year, such concentration is on a wider level and in a greater region.

The type of housing in humid and dry climates is fundamentally different. The amount of rainfall has a direct relationship with the type of roof and their material in the building, the length and width of the alleys and the natural slope of the urban areas and even the shape of the buildings (Lake, 2011).

From another point of view, the amount of temperature and atmospheric precipitation is related to the quality of asphalt and surface covering of streets and alleys, and the amount of water infiltration in the soil in terms of surface water disposal and the type of road surface covering should be studied in relation to temperature.

High or low humidity percentage is also one of the effective factors. The amount of humidity can be considered in relation to the type of building materials and its compactness or extensiveness. Considering the effect of wind and humidity in increasing or decreasing the temperature, it is necessary to remember that a hot day with a clear sky and no humidity can be a comfortable day for humans, while the same hot day with high humidity can cause human discomfort. In every city, the investigation of the amount of rainfall and the total volume of rain and the capacity of the drains and how to empty them are considered important institutional programs. Surface waters usually pass through a certain path (Shojaei et al., 2017).

The width and length of the pipes and ditches next to them indicate the maximum amount of water flow in them. Therefore, protecting the sanctity of channels and their maintenance, preventing garbage from being dumped in them, is one of the important factors of urban management. In the absence of this type of urban management, the urban drains of a city may create important problems for it, an example of such urban issues is the Gulabdareh drain in Tehran, which caused severe damage to the fabric surrounding this drain in 2016. The damages of this event have been evaluated much higher than the damages of a 6-magnitude earthquake (Shieh, 2002; Chegini and Li, 2022).

One of the axes of physical planning of cities is attention to natural disasters. Natural disasters are one of the important factors in locating settlements and activities and determining land use. Iran is one of the most dangerous countries in the world in terms of natural disasters such as earthquakes, landslides, floods and storms. A look at the preliminary map of earthquake relative risk zoning in Iran indicates that most of the country's residential areas are in the high relative risk range. Almost the entire country is in the medium to high relative risk range. In general, physical planning should be an important tool to reduce the devastating effects of natural disasters such as floods and also to provide assistance after the accident. With physical planning, it is possible to reduce the amount of the above risks and reduce the vulnerability of the space. From this point of view, it is important to choose the place of implementation of construction projects. For this purpose, high-risk areas in terms of geophysical accidents such as earthquakes, faults, flood plains, etc. should be guaranteed in advance. Therefore, the purpose of physical planning in this field can be summarized as follows:

- Reducing the probability of an accident that human activity is effective on their severity.
- Creating relative resistance against primary and secondary destructive forces.
- Reducing the vulnerability in the context, components and structure of the city's function.
- Establishing a permanent alertness system in the city for times of accidents.
- Facilitating emergency measures and relief operations for the post-accident period.

The national physical plan of Iran started in the middle of 1992 in the vice-chancellor of urban planning and architecture of the Ministry of Housing and Urban Development, and its studies were completed in 1997. The goals of this project were:

- A place to expand the existing cities and create new cities.
- Proposing a suitable city network.
- Recommending the framework of construction regulations in the permitted uses of all the lands in the country.

Body design studies are divided into three levels: national, regional and local. National studies cover the entire country, regional studies are carried out with greater precision and

accuracy in the areas specified at the regional studies, and local studies are carried out with greater scale and accuracy in the areas specified in the local level (Ziyari, 2000).

Conclusions

To manage flood, it should not be directed into the urban sewage network, because firstly, the water resulting from rainfall cannot penetrate the ground and the underground aquifers are deprived of nutrition. Secondly, due to mixing with urban sewage, it is heavily polluted and led to the rivers and beaches. Thirdly, the urban sewage system does not have the ability to pass all the water, so the water rises and is caused the pollution of the urban environment.

It is necessary to prevent as much as possible the conversion of free lands into streets, buildings and huge parking lots, shopping malls, because after a heavy rain, the water cannot penetrate to the soil and accumulates in the form of runoff on the impermeable surface of the city. They join together and then rush towards the hollow and low areas of the city. In fact, in order to decrease and minimize manipulation and interference in the hydrological environment, it is better to infiltrate the runoff caused by rainfall into the soil of urban areas, such as parks and green belts.

The sewage collection network should be designed in such a way that it does not require much maintenance from human power side, especially from the slope of the channel floor. The necessary predictions should be made in the design so that the suspended and floating materials settle and the cross-sectional area of the flow should be reduced. Urban sewage system should be designed separately and by creating two sewer lines to direct domestic sewage and surface water caused by rainfall. In this way, although the cost of building the network will be more, the pollution of the environment will be less.

For disposal of surface water, the information related to the exact volume of rainwater and its changes in a city should be collected, and then the volume of watercourse and streams should also be taken and these two should be clearly matched.

In urban land use, paying attention to the prediction of open spaces such as parks, playgrounds and parking lots for the purpose of surface water infiltration and the prediction of water supply and sewage system is essential. Their construction and pay attention to the slope of the street is necessary to preventing rainwater accumulation on the street.

Establishing refinery plant and using sewage and effluent treatment devices for factories is an effective help in reducing water and environmental pollution.

References

Abdullahi, M. 2004. Crisis management in urban areas, Publications of Iran's Municipalities Organization, second edition.

Adedeji, O.H., Odufuwa, B.O., and Adebayo, O.H. 2012. Building capabilities for flood disaster and hazard preparedness and risk reduction in Nigeria: need for spatial planning and land management. Journal of sustainable development in Africa, 14(1): 45-58.

Alijani, B. 2003. Synoptic Climatology, Samet Publications, first edition.

Asghari Moghadam, M. R. 2018. Natural Geography of the City, First Edition, Masa Publications, Tehran: Iran.

Broumand Nasab, S. 2003. Rainfall hydrology in urban basins (2end edition), Shahid Chamran University publications, Ahvaz: Iran.

Chegini, T., and Li, H.Y. 2022. An algorithm for deriving the topology of belowground urban storm-water networks. Hydrology and Earth System Sciences, 26(16): 4279-4300.

Chiti, M. H. 1993. Flooding from the natural disasters point of view, collection of articles of the first international conference on natural disasters in urban areas, 401-402, Tehran, Iran.

Haghroosta, T., and Ismail, W.R. 2017. Typhoon activity and some important parameters in the South China Sea. Weather and Climate Extremes, 17: 29-35.

Kawata, Y. 1994. Characteristics of urban natural disaster and its scenarios toward catastrophe. Kyoto, Japan.

Kundzewicz, Z.W. 2002. Non-structural flood protection and sustainability. water International, 27(1): 3-13.

Lake, P.S., 2011. Drought and aquatic ecosystems: effects and responses. John Wiley & Sons.

Loucks, D.P., and Van Beek, E. 2017. Urban water systems. Water resource systems planning and management: an introduction to methods, models, and applications. Springer, Cham. https://doi.org/10.1007/978-3-319-44234-1_12.

Moalemi, B. 1996. Water and the City by Lindh Gunnar in 1983 (Translated in Persian-first edition), Urban Planning and Architecture Research Center, University of Technology.

Mojtahedzadeh, Gh. 2001. Urban Planning in Iran, Payam Noor Publications.

Monzavi, M.T. 1995. Collection of urban sewage, University of Tehran Press.

Osti, R., and Nakasu, T. 2016. Lessons learned from southern and eastern A Sian urban floods: from a local perspective. Journal of flood risk management, 9(1): 22-35.

Rahnamaei, M. T. 1991. Collection of topics and methods of urban planning-geography, Center for studies and research urban planning and architecture, Ministry of Housing and Urban Development, Tehran.

Rebally, A., Valeo, C., He, J., and Saidi, S. 2021. Flood impact assessments on transportation networks: a review of methods and associated temporal and spatial scales. Frontiers in Sustainable Cities, 3:732181.

Sadrzadeh, M. and Gholikandi, G.B., 2010. Five thousand years of irrigation history in Iran: rituals and methods. Sustainable Irrigation Management, Technologies and Policies III, 134: 11175.

Sedaghat, M. 2001. Iran's water resources and issues, Payam Noor University Publications, third edition.

Shieh, I. 2002. An introduction to the basics of urban planning, Iran University of Science and Technology Publications, 10th edition.

Shojaei, P., Gheysari, M., Myers, B., Eslamian, S., Shafieiyoun, E., and Esmaeili, H. 2017. Effect of different land cover/use types on canopy layer air temperature in an urban area with a dry climate. Building and Environment, 125: 451-463.

Taheri Behbahani, M. T., and Bozorzadeh, M. 1997. Urban flooding. Publications of Iran Architecture and Urban Planning Research and Studies Center, Tehran, Iran.

Tehran Studies and Planning Office. 1993. Forecasting natural disasters in urban areas and providing methods to reduce their effects. Papers' booklet of the first international conference on natural disasters in urban areas, 1371: 401-402 Tehran, Iran.

Zare, J. 1993. Causes and factors of floods and flooding in urban areas of Iran and ways to prevent them, collection of articles of the first international conference on natural disasters in urban areas, Tehran Studies and Planning Office.

Ziyari, K. 2000. Principles and methods of regional planning, Yazd University Publications, first edition.

Zomorodian, M. J. 1996. The use of natural geography in urban and rural planning, Payam Noor Publications.