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## ORIGINAL RESEARCH PAPER

### Investigating and explaining the model of urban wastewater management with a decentralization approach by presenting an optimal design model (District 4th of Tehran)

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#### ABSTRACT

Urban management has a fundamental role in the sustainability and development of cities. Currently, with the increase in population and the urgent need for water management, the importance of creating water and sewage management systems is very important. The process of managing water supply and demand, especially in the last half century, has led to excessive exploitation of surface and underground water resources in most of the watersheds of the country, and the continuation of this process has led to the continuous worsening of the water resources situation. In the current research, using the analytical method as well as the use of logical analysis, the existing situation in the 4th district of Tehran metropolis was examined from the perspective of the water and sewage management system, and an optimal model was designed based on its structure. The findings indicate that the optimal model includes the provision of a decentralized system based on the creation of treatment packages by the clustering design method, which due to the lack of a suitable domestic option for wastewater treatment in the 4th district of Tehran with a decentralized approach, the cost of the packages is the currency is calculated and this issue has caused the lack of economic competitiveness compared to the centralized approach. The result is that it is possible to optimize the cost and efficiency of water and wastewater management in Tehran to a high extent by presenting this model.

Running Title: Model of urban wastewater management with a decentralization approach by presenting an optimal design model



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## INTRODUCTION

Today, urban management plays an essential role in the stability and development of urban life in Iran, despite the long history of urban management institutions, we still see the division of management and the division of municipal duties among the various institutions involved in urban management. In the management of urban water and sewage services, currently the provincial water and sewage companies are the main custodians of water supply (transmission, treatment and distribution) and sewage management (collection, transmission and treatment) in the cities of each province, the failure of the country's past water management policies A major part of which has been under the pressure of development programs, it has caused the formation of several paradigms and corrective currents for the review and pathology of past behavior (Bostani, 2018) because the process of managing water supply and demand, especially in the In the last century, it has led to excessive exploitation of surface and underground water resources in most of the country's watersheds, and the continuation of this process will lead to the continuous worsening of the water resources situation and finally the emergence of a serious water crisis in the country. The country's water resources do not have the capacity to accept the trial-and-error risk of implementing such a plan (Almasi, 2018).

Water is an important resource to ensure a sustainable future. Today, developing countries are facing two worrying factors at the same time: the water shortage crisis and the sewage crisis of increasing urbanization. In such a situation, the infrastructure of wastewater treatment and reuse of wastewater is of particular importance; Because, on the one hand, recycling a major part of the consumed water has a significant impact on the management of the water shortage crisis, and on the other hand, by eliminating infectious diseases caused by the presence of sewage in cities, it improves the level of urban health. The most important goals of wastewater treatment

are to maintain public health and safety, prevent environmental pollution, prevent pollution of surface and underground water sources, preserve the appearance of the environment and reuse wastewater. The system or systems that are chosen for this purpose should meet the needs of the society by spending reasonable costs. Depending on population density, climatic conditions, type of topography of the area, the method of reuse of treated wastewater, as well as the shape and area of the covered area and other operational factors, wastewater management systems are classified into two main categories: centralized and decentralized systems. (Karimpour et al., 2010) For nearly half a century, the approach of using concentrated refineries in Iran is being planned, designed, implemented and operated. But the evidence shows that it is not enough to meet the growing needs of the society, so far only a small fraction of the country's population has been covered by centralized systems. The review of various texts related to the subject shows an evolutionary path from the initial definitions of urban management to a clear explanation of the concept and highlighting characteristics such as holistic in its definition. As a simple answer to the highly complex nature of today's rapidly growing cities, he rejects and prescribes a holistic approach to urban management (Baker, 1989). operatives knew that in addition to trying to provide the daily needs for the activity of the city and its residents, it seeks urban development in all dimensions and therefore requires effective interaction with the political, social and economic power domains (Shamma, 1989) Sharma also the success of organizations depends on the definition of general goals and common wisdom, while the priorities of different organizations are often not compatible. Therefore, for the integration of urban management, Sharma suggests that the municipality perform its management tasks in isolation from the development inputs of various service organizations. place a city and be the institution responsible for the integrity of urban management (Sharma, 1989). Davidson

considers integration as a need at the scale of the urban area, the realization of which requires the formation of an organizational framework or structure. According to him, this integration is of two types, horizontal and vertical, therefore, it includes subsystems and the necessity of activities in the decision-making framework of higher levels. and also, to the strategic aspect due to the prolongation and loss of useful time in establishing the sewage collection and treatment system of the city of Tehran on the one hand, and the population loading exceeding the tolerance threshold of the land on the other hand, which leads to the non-responsiveness of the alluvium of the Tehran plain towards Natural assimilation and purification of citizens' wastewater is done by the traditional method of absorption wells. At present, citizens' wastewater in some areas of Tehran is knowingly and illegally directly entering the secondary and main networks of collecting and directing surface water. Some towers and residential complexes have directly connected the absorption well storage to one of the main surface water channels (rivers, canals, surface water tunnels, etc.) during the rains and flooding of the rivers, it has disturbing consequences on public health and threatens the health of the city.

The adoption of decentralization has two main reasons; First, it is a sustainable practice, and secondly, reducing the amount of untreated wastewater will reduce the load on centralized treatment systems. Nevertheless, in Iran, there is still a significant gap between the practices and the decentralization approach. The only way to deal with this issue is to formulate the necessary national policies for the reuse of wastewater along with supporting legal frameworks; in a way that strengthens municipalities and urban governance bodies in the implementation of decentralization processes. (Davidson, 1991) Stren also emphasizes the systemic approach to city management and believes that intervention in the urban system should be done continuously with a holistic and integrated view (Stren,

1993). In the discussion of integration, Harvey's organization evaluates a suitable organization in reducing conflict and maximizing group coordination and efficiency as very useful (Harvey, 2010). On the other hand, McGill, in addition to emphasizing the application of a comprehensive approach, introduced the dimensions of integrated urban management in the three dimensions of urban planning, providing urban infrastructure and management institutions and organizations, hence the integration of urban management means the integration of urban planning. (McGill, 1995, McGill, 1998, McGill, 2001) The summary of McGill's theories is summarized in his definition of urban management. It is an integrated city that focuses on both the city and its institutional development challenges (Barakpour and Asadi, 2008). In a broader examination of McGill's thoughts, his theories can be seen as having a semantic affinity with the urban regime theory that was proposed by Stone and Elkin in the 1980s. The concept of this theory is a system or organizational arrangements to resolve and resolve policy divergence As an informal framework, it organizes the cooperation of governmental and non-governmental stakeholders (Braga et al., 2014). In it, urban decision-making and policy-making tends towards integration through the interaction and participation of beneficiaries and by considering principles such as transparency, accountability and law-abidingness. He believes that urban managers can benefit by adopting an integrated management approach of conflicting interests. respond to various problems and by moving on the path of justice, create a meaningful improvement in the urban environment (Chakrabarty, 2001) Cheema, in a similar perspective, divides the challenges of coordination in the process of urban management into two types, horizontal and vertical. From his point of view, the first group of issues are related to the challenges of coordination between regional and urban central institutions and the second type of issues include challenges related to functional differ-

ences between the related activities of different governmental and executive levels in charge of urban development. (Cheema, 2020) In the analysis of the theoretical knowledge of the research, by placing the concept of division and dispersion at the opposite point of integration, we can talk about two important categories of management division. The first category is the division of policy planning, which includes issues related to horizontal and vertical integration, and the challenges considered by McGill and Cheema are in this field. Vertical integration policies can be defined from large-scale global layers to local levels such as the city (Rivolin and Faludi, 2005). Horizontal integration policies can also be considered related to the coordination between different sectors such as transportation, environment and economy. The second category is the challenges related to functional division, which means the interference of the duties of multiple institutions in charge of urban services as a result of the lack of urban management integration mechanisms. According to Barlow, functional division occurs when, in a city or a specific government territory, such as the area of the city, the planning and provision of urban services regarding the functions and duties of a local nature are divided between several institutions, organizations and other bodies. (Hauvy, 1997) The reasons for the delay in the full implementation of the centralized system are such that it activates a vicious cycle and more efforts to remove the obstacles create new obstacles. Meanwhile, the evidence shows that the designed centralized system is not sufficient for the growing needs of the society. On the other hand, with the change of paradigms governing development, the ineffectiveness of centralized and structural approaches has been clearly explained. Currently, the countless benefits of on-site wastewater treatment and away from a centralized approach have been proven in various experiences of developed cities. The aim of this study is to show that decentralization is a feasible option to implement fresh water con-

sumption reduction policies. This study can be a beginning to encourage the adoption of decentralization in urban wastewater management with public participation; And as a result, it will have a significant contribution in reducing the treatment load in centralized facilities. It should be noted that on-site wastewater treatment ranges from the scale of a single residential unit to the scale of an apartment, residential tower, residential complex, and neighborhood, and therefore, this change of approach requires the participation of local creditors and the design of its legal systems. Investigations carried out in Tehran show that a centralized approach to urban wastewater management alone will not meet the growing needs of the city. To solve this problem, it seems that it is better to use a combined method to disable the vicious cycle that governs the wastewater treatment in Tehran. In other words, a combination of on-site wastewater treatment methods with part of the implemented system is suggested as an alternative approach. Many experts and international organizations consider the water crisis to be the result of improper management, ineffective laws and institutions, and to deal with it, they recommend an integrated water management approach (Bakker, 2010) based on the definition of the Global Water Partnership, integrated management. Water is a process that achieves coordination between the development and management of water, land and other resources in the direction of improving economic results and social welfare while respecting environmental sustainability. Although the concept of integrated management has received attention in many countries in the last two decades, it has not been able to be implemented effectively and achieve its intended goals. Based on the investigations, the main obstacle in achieving integrated management of water resources is the lack of competent administrative structures for the implementation of policies and laws, as well as the lack of efficient laws appropriate to existing and future challenges. such as housing

and urban development, energy and transportation, as well as the cross-sectoral nature and the mutual influence of its integrated management with the economic, social and environmental sectors, causes its double importance in the water governance system in each country, so in order to implement the approach Integrated in decisions, this approach should be taken into account at the macro levels of every country's planning (Ghanbari and Davari, 2014, Philip et al., 2011). Of course, as Rogers and Hall argue in their research, there is not always a general effective water governance model, in fact, the effective water governance system must match the social, economic and cultural characteristics of each country. (Pahl-Wostl, 2015)

## **MATERIALS AND METHODS**

### *Displacement of the first pattern; Centralized management of sewage*

In European and American colonial cities of the 17th and 18th centuries, sewage management was carried out by the users "on site". Residential sewage was generally in the form of a toilet, the outlet of which was built at ground level, and it was usually discharged in the form of raw sewage in the yard, street, stream or an open channel. Due to the low population density, the sanitary facilities that were built in this way did not cause unbearable disturbances or health problems in the cities of that time. Most of the city dwellers of that time had accepted the health problems and annoying conditions caused by the sewage management method as a necessary part of urban life, and it was only in the face of epidemics or outbreaks of diseases that the issue of sanitation and sewage system was considered. (Duffy, 1968) At the beginning of the 19th century, to reduce the annoying conditions caused by the discharge of latrines into the streets and streams, the residents built a latrine pit under it, or discharged its output to a nearby sewage storage. The purpose of building a latrine well and an absorption well (sewage reservoir) was to store the sewage in itself, so

that the sewage gradually seeps into the ground or is manually drained away from the residence. (Burian et al., 2000, Rosenberg, 1962) Another option that was used in the beginning of this century as an alternative to the latrine and absorption well was the "dry sewage" method. The working method was that special containers were installed under the toilet seat to collect human waste, and after being filled, the collected waste was transferred to a suitable place for disposal near the settlement. One of the main advantages of this method was the quick removal of waste from the residence and its possible use as fertilizer in nearby agricultural lands. (Armstrong, 1976, Folwell, 1976)

### *Displacement of the second pattern; Composite network technology vs discrete network*

Combined sewer systems (CSS) are systems that use a single conduit to convey rainwater and other domestic and industrial wastewater to a designated disposal site. Hamburg, Germany is often mentioned as the first city to plan, design and build a comprehensive and integrated sewage system in the modern era. In the United States, the evolution of composite systems from a simple sewer connection to a surface runoff network to a large-diameter designed sewer network occurred in the second half of the 19th century. The first examples of these comprehensive centralized composite systems were built in the late 1850s in Chicago and Brooklyn. (Metcalf, 1928, Tarr, 1984) At the same time as the first centralized composite systems were built in Europe and the United States, many authorities related to wastewater management supported the Separate Sewer System (SSS). The first designs of separate sewage systems included two channels; One to transfer sanitary wastewater to a specific disposal site, and the other to transfer surface runoff to the nearest water body that could receive it. The basic concept of the separate sewage system was the independent management of surface runoff (caused by rain, snow, hail, etc.) and sanitary sewage. (Halliday, 2001)

### *Displacement of the third pattern; Changing the*

#### *approach to a separate centralized system*

By the end of the 19th century, the basic techniques of urban sewage collection had been established, sewage technologies were largely developed, and the necessary construction materials and equipment were available. At that time, most of the big cities in Europe and the United States had also built some kind of sewage system for themselves. For example, in 1909, in American cities with a population of over 100,000 people, 22,912 km of combined sewers, 3,530 separate sewers, and 1,020 km of surface runoff collection networks had been established. These numbers show that the combined sewer network was clearly the dominant option for wastewater management in urban areas. (Hey and Waggy, 1979)

#### *Displacement of the fourth pattern; The re-emergence of decentralized wastewater management*

Over the course of the 20th century, centralized wastewater management steadily expanded in the vast urban areas of industrialized countries. A review of the first half of the 20th century shows that the development of wastewater collection systems has focused on new constructions and expansion or improvement of old systems rather than on the development of new methods and techniques. On the other hand, in order to adapt to changing requirements and regulations resulting from public health and environmental concerns, treatment technologies have advanced and numerous new techniques have been introduced. In the first step, bacterial filtration was invented, and in the next steps, concentrated filtration technologies based on microbiological filtration, which were suitable for larger cities, were developed and used on a large scale. Trickling filters were the dominant technology until the late 1950s, when they gave way to activated sludge technology. (Fair and Geyer, 1954) (Hartmann, 1999) (Bruce, 1982)

#### *Methodology*

The current research is analytical in terms of method, and content analysis method has also been used in the content dimension in presenting

the type of findings. The type of objective is practical and the method of collecting information is documentary and library and using upstream documents and data analysis in the case sample of the 4th district of Tehran. After stating the theoretical foundations and presenting the general framework of the research, using the method of logical analysis of the current models, the optimal design is carried out using the knowledge of the current situation and the problem of the optimal situation. In general, the methodology of this research includes the stage of systematic review and analysis of the existing situation by examining the documents and documents collected, and in the next stage, the future analysis and the final model design are presented.

## **DISSCOUSION AND FINDINGS**

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#### *Decentralized approach to urban wastewater management*

Decentralized wastewater management includes the management, collection, treatment, and disposal/recycling of wastewater at or near the site of wastewater generation. For this reason, they are also known as on-site wastewater treatment systems. In decentralized systems, the wastewater produced in the areas that use this system is treated in a place almost close to the point of origin. Although in this system, sewage must still be collected through the piping network, but the length of the sewage transmission system is much shorter. (Wilderer and Schreff, 2000) In the decentralized approach, the collected wastewater is transported to small on-site treatment plants, where the wastewater and sludge treatment processes are implemented. Treated wastewater may be used to recharge groundwater, discharge to adjacent surface water bodies, or be used for toilet flushing, laundry, irrigation, or firefighting. The produced sludge from the treatment plant is also turned into compost, which can be used as a fertilizer or softener in gardening or landscaping. (Hophmayer, 2006) Decentralized systems are part of permanent infrastructure

and can be managed as independent facilities, or integrated with centralized wastewater collection and treatment systems. These systems are able to use a wide range of purification methods; From simple and passive methods (treatment by dispersing in the soil, which is usually used in the form of septic tanks) to complex mechanized methods such as advanced treatment units that collect and treat wastewater from several buildings and drain surface water sources or soil. (Venhuizen, 1997) (Fig. 1)

*Design and clustering method*

*Wastewater treatment packages on a building scale*

Most of the modern wastewater treatment packages in the building scale treat the wastewater biologically and aerobically in order to reduce energy consumption and also to reduce installation, service and maintenance costs. Among these, the packages that treat wastewater with the modified Lutzak-Ettinger method, due to the addition of an anaerobic treatment chamber in the system, have the ability to remove nitrogen

from the wastewater, which is why they have a higher preference for other systems have a ratio. With the investigations carried out on the packages produced in leading countries such as Japan, Germany and the United States, which have a higher quality and age compared to other manufacturers, these packages in different capacities from at least 1-meter cubic meters per day for an independent residential unit up to 13.5 cubic meters per day for 30-unit complexes have been commercialized. For higher capacities, these systems cover up to 1000-unit complexes by connecting these packages in series or by adding separate septic tanks to reduce the input load to the packages and increase the treatment capacity. They raise. (Tab. 1)

Package capacity (person)	5	7	10	14	18	21	25	30	70
Hydraulic capacity	1	1.4	2	2.8	3.6	4.2	5	6	13.5

Table 1: Various capacities of wastewater treatment packages capable of denitrogenating wastewater

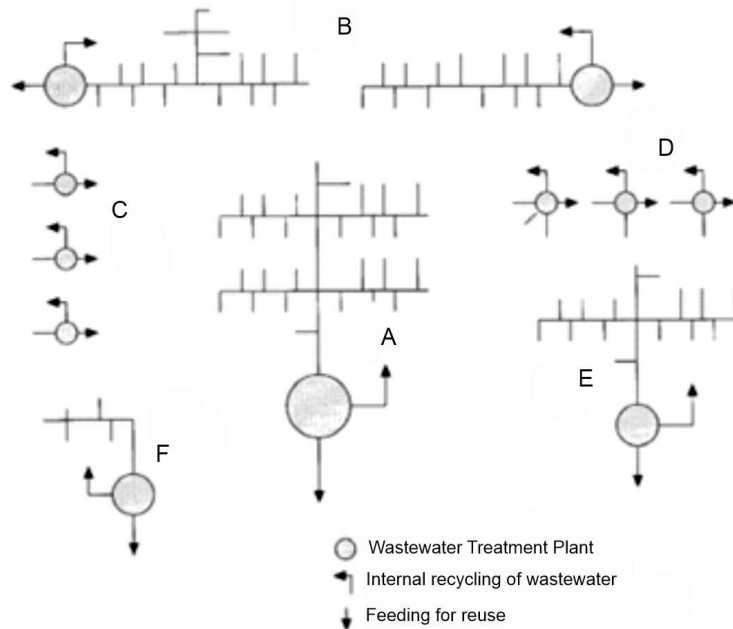


Figure 1: Schematic of the wastewater collection and treatment network in the decentralized management approach; (A) Subsystems of industrial and residential centers, (B) Subsystems of residential areas, (E) Subsystems of industrial areas development, (C) Subsystems of villas and single residences, (F) Subsystems of new urban developments, (D) Subsystems of population scattered centers

During years of research and development, these packages have been commercialized for the treatment of wastewater in residential units, so that by occupying the least possible space, minimum cost and high efficiency, they treat the wastewater according to the standards of the world and recycle the water. They make it possible. These packages are also highly flexible to changes in the input flow rate. So that they can manage the increase of incoming wastewater during peak consumption hours without changing the quality of the effluent, and also due to the presence of return flow, even if the sewage flow is interrupted for a long time, they can maintain their efficiency and as soon as the sewage enters Refine with the defined quality. The flexibility of these systems is such that they can maintain the quality of the effluent for up to 48 hours even with the power cut and the aerator stopped working. These packages are usually integrated and have 5 treatment chambers, which include sedimentation, anaerobic treatment, aerobic treatment, storage and disinfection. The steps of wastewater treatment in these packages are as follows:

- Sedimentation chamber: The sewage from the building enters directly into the sedimentation chamber. Sewage sludge settles in this chamber and floating materials such as oil etc. accumulate on the surface of the tank. The remaining effluent enters the anaerobic treatment chamber from the holes installed below the water level of the tank.
- The anaerobic treatment chamber has a media pack in the middle of the chamber. The effluent is directed to the lower part of the chamber by the flow separator, and by passing through the media pack, it causes the separation and settling of suspended solids, as well as denitrification of the effluent by semi-aerobic bacteria. After the flow passes through the media pack, it overflows into the aerobic treatment chamber.
- Aerobic treatment chamber: after entering the aerobic chamber, the flow passes through

the media pack. Aerobic bacteria grown in these media packs, which are aerated from the bottom of the chamber, are responsible for the BOD purification, and the COD of the wastewater is purified through oxidation. After passing through the media packs, the flow enters the storage chamber from the lower part of the aerobic chamber.

- Storage chamber: the flow with aerobic bacteria enters the storage chamber from the bottom of the aerobic chamber and in an upward flow, the remaining BOD in the effluent is consumed by aerobic bacteria and settles as sludge on the bottom of the chamber. to be in addition to purifying the remaining BOD in the wastewater, this causes a decrease in dissolved oxygen. The settled sludge is transported to the settling chamber by the air force. Returning wastewater to the sedimentation chamber dilutes the incoming wastewater and also creates a circulation cycle that increases the efficiency of wastewater treatment in the system.
- Disinfection chamber: When the water level in the tank increases, the treated wastewater from the surface of the storage chamber is transferred to the disinfection chamber by the pressure of the aerator and after chlorine injection, it leaves the system. The action of transferring water to the disinfection chamber continues until the water level reaches the minimum level.

#### *Design method*

In order to design decentralized wastewater treatment systems, it is necessary to determine the number and capacity of units in each city block. In this case, two issues are important. First, the information on the number and capacity of the units in the city block is not available, and second, there are large areas of worn-out fabric, such as Khak-Sefid, Shemiran No neighborhoods, etc. in district 4. In these areas, the area of urban blocks is very small and open space is rarely found. For this reason, the implementation of “purification systems on a building

scale” in these areas depends on the renovation of the worn-out fabric. (Fig. 2)

Also, during the visits made to district 4, it was found that despite the completion of the sewage collection network in this district, the sewage of many residential units, especially in the areas with worn-out fabric such as Shemiran No, Tehran-Pars East and Khak-sefid, is still It has flowed directly into the surface water collection channels, which in addition to creating unpleasant odors and pollution of the urban landscape, is a threat to public health.

#### Design assumptions

According to the available information and conditions, it was decided to determine the number and capacity of units of each urban block based on the detailed plan of Tehran and use them in the calculations. For this purpose, the density map of urban blocks was prepared based on the rules and regulations of the detailed plan of the city of Tehran and the amount of wastewater production of each unit was estimated based on the type of use.

According to the national statistics of 2015, the population of District 4 of Tehran is 919,001

people, which includes 304,169 households. The size of the household in this area is 3 people, and based on this, the average waste water produced for every 2 residential units is estimated to be 1 cubic meter per day. To estimate the waste water of units with administrative, commercial and cultural use, the amount of waste water produced by each unit is considered to be a quarter of a residential unit. Also, for public sanitary services, according to the location and estimation of the number of springs, the amount of wastewater produced has been calculated.

#### Design criteria and clustering

One of the most important design criteria in decentralized wastewater management is the method of clustering wastewater production points. In the conventional approach to wastewater treatment (concentrated approach), each of the wastewater production points (buildings) is connected to the wastewater collectors with an independent branch, and the collectors direct the wastewater to the main transmission lines to finally reach the treatment plant. In order to avoid pumping, in all stages, the wastewater is transported by gravity and as a result, the treat-

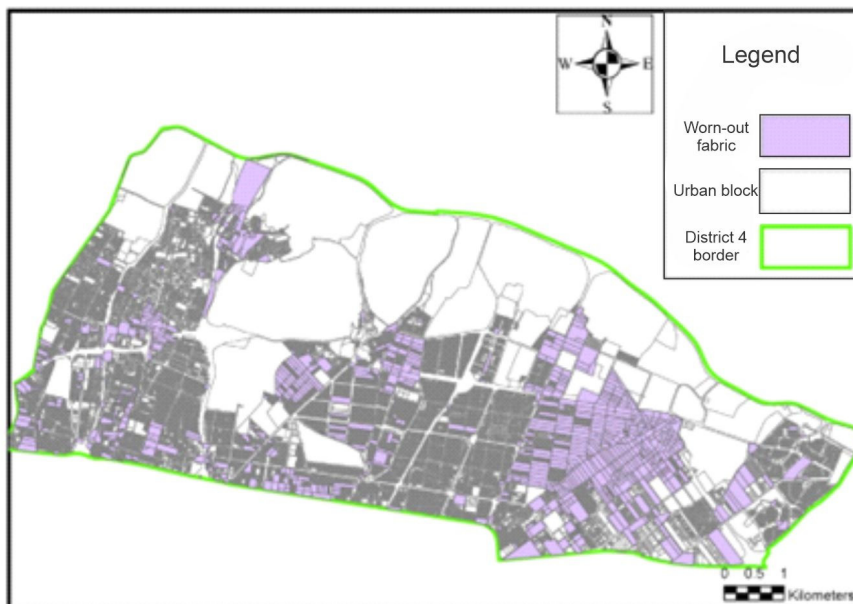


Figure 2: Worn-out fabric map

ment plant must be placed at a lower level than the production points. For this reason, water recycling is not possible and usually the wastewater is treated. Either it is left downstream of the treatment plant or it is reused downstream. (Fig. 3)

The concept of a decentralized approach to wastewater treatment is to bring the point of wastewater treatment closer to the point of its consumption in order to facilitate the recycling and reuse of wastewater. By taking advantage of this concept, the way to connect the wastewater production points to the treatment packages, according to the design criteria, can be individually, in groups, at the neighborhood scale or a combination of them. (Fig. 4)

In order to determine how to connect the production points to the wastewater treatment site, many issues such as the used treatment system, the distance between the wastewater production points, population density, etc. must be considered. Since the environmental and social conditions and the management system that can be used in each place are different, it is not possible to consider the same criteria for connecting the wastewater production points to the treatment site for all conditions, therefore, it is necessary to consider the existing conditions. In the 4th district of Tehran, the clustering criteria for this area should be developed and used to design the decentralized management system.

The clustering criteria are:

Wastewater volume: according to the intended systems for wastewater treatment (building-scale wastewater treatment packages), the limitation of wastewater treatment packages in an independent treatment unit (40 cubic meters per day, which covers a space of about one hundred square meters) buried face) can be used to determine the number of blocks that can be connected to a treatment unit. Therefore, for the blocks whose wastewater production capacity is more than 40 cubic meters per day, an independent treatment package is considered. As mentioned earlier, the sewage production capacity of each urban block is based on the maximum allowed density and the area of the urban block. Dispersion of open space: according to the urban planning structure of each urban block and the amount of access to open urban space that can be used for the implementation of sewage treatment packages, the areas will be classified based on the level of access and the priority of implementation in a collective or individual manner in each region. became. In order to determine the urban blocks allowed to be clustered and also to avoid the construction of sewage transmission lines, blocks with a maximum distance of 50 meters from urban open spaces - which include parks and gardens, green spaces and squares - are considered. (Fig. 5)

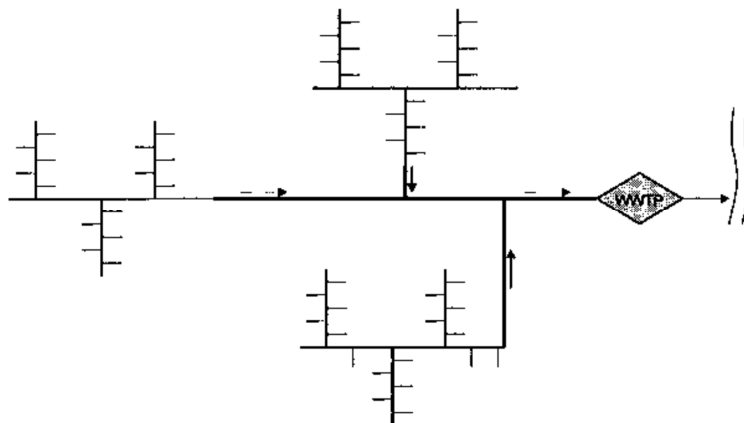


Figure 3 How to collect and treat wastewater in a centralized approach

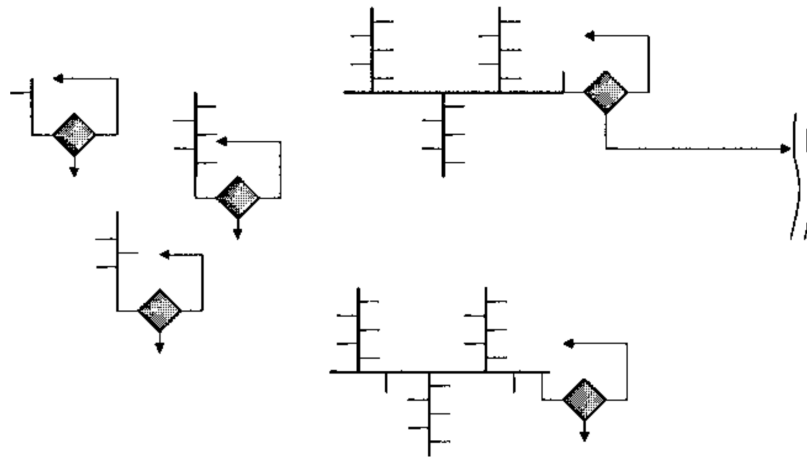


Figure 4 Different methods of collecting, purifying and recycling water in a decentralized approach

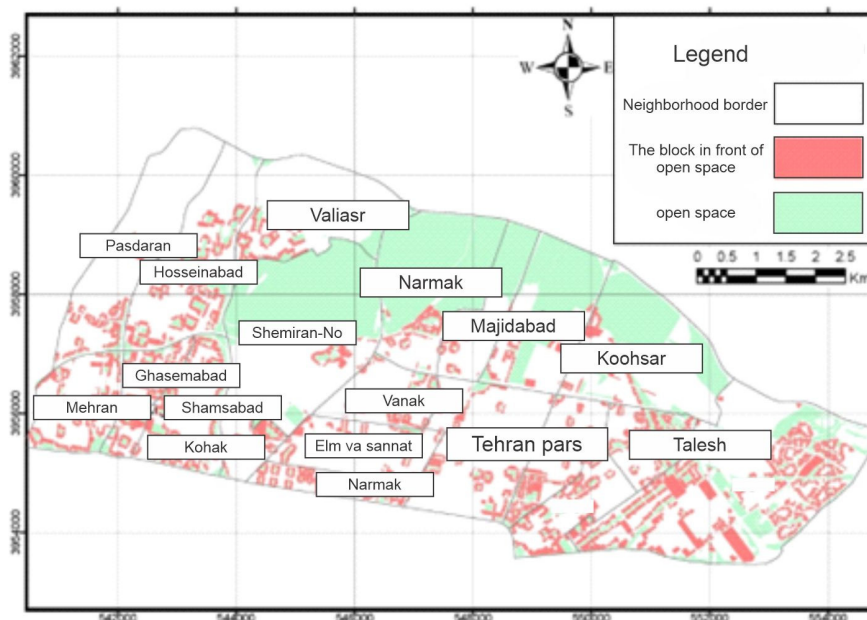


Figure 5 Urban blocks with access to urban open space in the 4th district of Tehran

Land limitation: It is possible to collect wastewater from the units when the dimensions, usage and distance of the available open space are suitable for the implementation of wastewater treatment packages. For example, in order to implement a wastewater treatment unit with a capacity of 40 square meters, at least 100 square meters of open space with a width of at least 8 meters is required, which in case of small land dimensions or immovable obstacles

(city infrastructures, buildings, wells, etc.) in the desired open space, as well as the presence of immovable obstacles in the path of the collector pipe, these spaces are not suitable for the implementation of sewage treatment packages. In this report, due to the lack of information about the complications in urban open spaces, the dimensions of the spaces are sufficient in this criterion. Social participation: Social participation in determining how to connect sewage production

points to the treatment site is important from the point of view that the non-participation of citizens in the management of treatment packages that are shared between several buildings can lead to a decrease The efficiency of the system or its failure. For this reason, the clustering of sewage production points should be done in areas that have higher social participation. Measuring the level of social participation of citizens in different neighborhoods requires the collection of a lot of statistics and information and detailed studies that do not fit in the scale of this report. For this reason, this criterion has been omitted in the design of decentralized systems in district 4.

**Building complexes:** in large residential, office, commercial, cultural, sports, etc. complexes that have enough open space to implement sewage treatment packages, priority will be given to implementing the package in the complex area.

## **CONCLUSION AND RESULTS**

### *Design results*

#### *Estimate the number and type of required packages*

According to the capacity obtained for each building unit as well as the location of urban blocks in terms of access to urban open space required for the installation of wastewater treatment units on site, for urban blocks that are consistent with the criteria of clustering, in the form of up to 40 cubic meters per day is considered for each treatment unit, and for the units that do not meet the criteria of clustering, the treatment unit is considered in the building field. According to the design assumptions, the capacity required to treat the entire area 4 wastewater is estimated at 225 thousand cubic meters per day, which is equivalent to the maximum amount of wastewater produced per day in this area. Since the estimate of the required capacity for wastewater treatment is calculated based on the maximum allowed density in each building block, this estimate is higher than the required capacity in the current conditions. According to the way of clustering (based on the criteria

of clustering, the number and type of packages required for urban wastewater treatment in the 4th district of Tehran is shown in pervious figure, the way of collecting and treating wastewater in a centralized approach. has been (Tab. 2)

Package capacity (person)	Hydraulic capacity	Number of Packages used in district 4
5	1	5
7	1.2	2.750
10	2	4.500
14	2.8	8.300
18	3.6	4.400
21	4.2	5.300
25	5	3.900
30	6	7.500
70	13.5	6.800
Total capacity	235.000 cubic meters per day	
Total	48.500	

**Table 2** Number and type of treatment units required in the 4th district of Tehran

By comparing the costs of implementation, service and maintenance of wastewater treatment systems in two centralized and non-centralized approaches, we come to the conclusion that the centralized approach of wastewater treatment in Tehran is much more economical than the decentralized approach. Meanwhile, according to the studies conducted in the field of comparing the costs of wastewater treatment in centralized and decentralized approaches, by determining the criteria appropriate to the geographical conditions, the costs related to the collection and treatment of wastewater in the decentralized approach are lower than in the decentralized approach. It will be focused. Due to the economic bankruptcy of the country and the sharp decline in the value of the national currency in recent years, the price of imported goods has increased up to 10 times. Also, the wages of workers are not proportional to the decrease in the value of the national currency, which has caused a sharp decrease in the value of the wages received by the workers. Due to the lack of a suitable inter-

nal option for wastewater treatment in the 4th district of Tehran with a decentralized approach and clustering design, the cost of the packages is calculated in foreign currency, and this issue has caused a lack of economic competitiveness compared to the centralized approach. In general, due to the ever-increasing decrease in water resources available for citizens, as well as the decrease in the level of underground water and as a result the phenomenon of subsidence of the Tehran plain, the viability of the city of Tehran is threatened. Since the reduction of the underground water level is not compensable in any way, it seems that even in the current situation, the use of a decentralized wastewater treatment approach is justified even with higher costs.

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