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## Research Article

# Assessing Impact of Industrialization on Urban Expansion in Surrounding Cities (Case Study: Assalouyeh, Iran)

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## Abstract

South Pars Special Zone has played a significant role in Iran's economic growth since 1998. The rapid development of this region and government's extreme desire to exploit the gas field shared between Iran and Qatar has led to an unusually rapid urban expansion in the city of Assalouyeh. The objective of this study is to evaluate the impacts of industrial expansion in South Pars Special Zone on surrounding cities and villages, which was pursued by descriptive-analytical method, based on library and field study and data gathered from questionnaires completed by residents. The population of this study comprised of families living in the city of Assalouyeh in 2011, among which 315 were interviewed based on Cochran formula. The time period under study was 1956-2011. Results showed that the effects of industrialization on urban expansion in Assalouyeh are reflected in the form of seven major factors which are as follows: The creation of spatial limitations for the future development of Assalouyeh, the formation of new urban fabrics on agricultural lands, the disruption of development and implementation of comprehensive plan, the diversion and change in the function of streets and urban roads, the creation of urban sprawl, the improvement of infrastructures and amenities and the ecological invasion and replacement.

**Key words:** Assessment of impacts, industrialization, urban expansion, Assalouyeh

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Urban expansion in Iran has always been based on industrial development and therefore a major part of the problems concerning the site selection and establishment of industries around the cities are related to the process of industrialization and urbanization in this country (Moallemi, 2003). In Iran, the natural resources of oil and gas in many areas, has provided the basis for the development of industrial structures and industrial centers in those areas (Anbari and Mallaki, 2011). Political and economic decisions of governments regarding the creation of industrial zones can also have either positive or negative consequences for surrounding towns and villages (Rezaei, 2005). Meanwhile, the physical effects of development of South Pars Special Zone, as the most important and the largest energy project in Iran are largely ignored.

In recent years, the creation of South Pars Special Zone as a regional and national growth pole and the establishment of various operation units in that area have paved the way for the rapid development and expansion of Assalouyeh (Mallaki, 2009). After the foundation and development of South Pars Special Economic Energy Zone in 1998 and unprecedented increase of domestic and foreign investment in the gas industry, petrochemical and related industries (PSEEZ., 2015), which meant the creation of a growth pole with a focus on energy, this area experienced an extraordinary rate of expansion. Assessing the physical impacts of this expansion on surrounding areas is an important issue that will be addressed in this study. So far, many studies have assessed the creation of industrial towns and their effects on geographical areas (Mahbub *et al.*, 2014; Song *et al.*, 2012; Joshi *et al.*, 2009; Deng *et al.*, 2008; Muller, 2001). For example, Dunmade (2002) has investigated the effects, benefits and consequences of these zones in technical, economic, social, political and environmental dimensions (Dunmade, 2002). The creation of job opportunities, the increase in residents income, reduced migration and increased welfare and infrastructure of the surrounding settlements are considered as some of these benefits (Rezvani *et al.*, 2010). Meanwhile, some researchers have focused on negative environmental impacts of such zones. Environmental changes resulted from the establishment of industries and technologies usually cause irreparable damages (Tavakkol, 2011).

However, very few studies have examined the physical effects of industrial development on cities and villages hosting these industries, which indicates the lack of sufficient work in this field. In the case of Assalouyeh, most of studies have been in the field of sociology and have included socio-cultural

studies on the consequences of the establishment of industries for the region and one of the most important studies in this field has been conducted by RCISDE. The other factor necessitating this study is the fact that studies conducted in Iran about this subject have been very few in numbers and very limited in their scope. While, the existence of such mechanism can multiply the success of development projects and programs (Seifolddini, 2009). On other hand, the South Pars projects is in its initial phases, so assessing its impacts can lead to timely identification of its adverse effects and can enable us to propose proper strategies to deal with these issues.

## MATERIALS AND METHODS

This study is an applied research, whose objectives are pursued by a descriptive-analytical methodology. This study is also an ex post facto research, since it uses past information to answer the questions. Data were collected by library and field study and also from questionnaires completed by study population. The population of study comprises families living in the city of Assalouyeh. The Cochran formula was used to calculate the sample size. Given the number of population in 2011, which was 1,752 households (Iran Statistics Bureau, 2011), the sample size was calculated to 315 people, based on Cochran formula:

$$n = \frac{Nt^2pq}{Nd^2 + t^2pq}$$

$$n = \frac{1752 \times 3 / 8416 \times 0.25}{1752 \times 0.0025 + 3 / 8416 \times 0.25} = 315$$

Sampling was performed by Cluster sampling method, which is one of the most reliable and accepted methods, especially in the field of human sciences research (Delavar, 2005). This study was conducted in the city of Assalouyeh. The port city of Assalouyeh is located 75 km South of Kangan city, at a distance of 308 km from the center of the province and has an area of about 230 ha and approximately 3,600 km maritime border in the Southernmost point of the province. Time domain under study is from 1956-2011 (Fig. 1).

The main features of the South Pars Special Economic Energy Zone that led to its selection as industrial growth pole include:

- Proximity to South Pars gas field shared with Qatar
- Coast of this region is suitable for building docks and

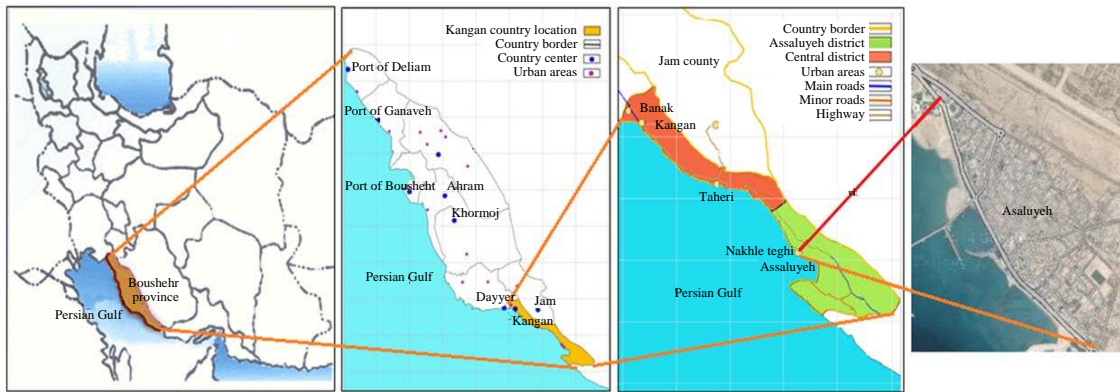


Fig. 1: Location of Assalouyeh

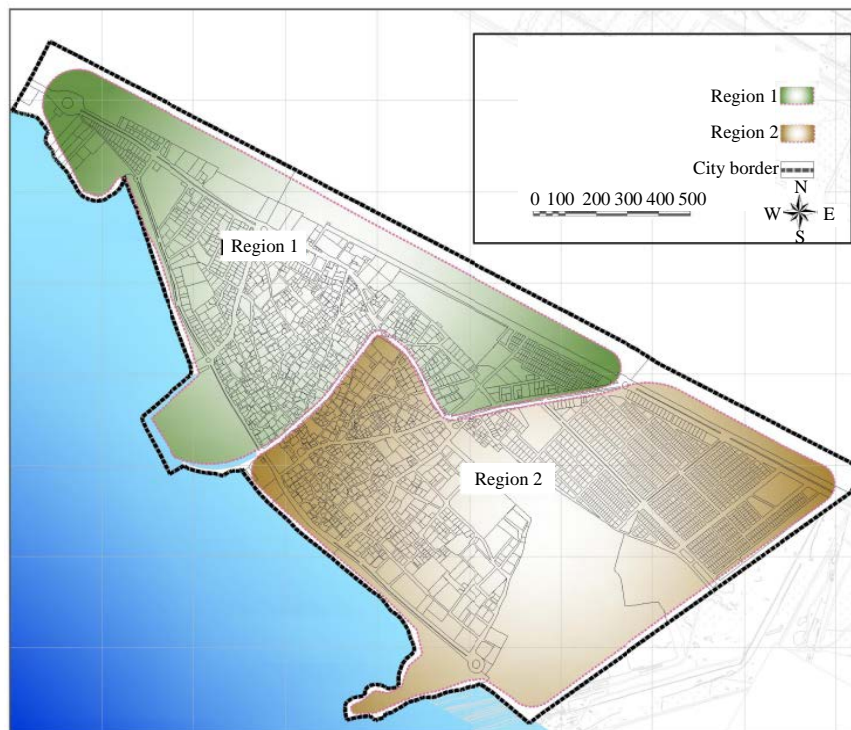


Fig. 2: Physical territory of regions in Assalouyeh city

harbors necessary for the development of maritime activities, which themselves are prerequisite for other industrial and commercial activities

- Apart from some small population centers with traditional activities (fishing and limited trading) there is no major activity in this area that can be regarded as inconsistent with growth pole development plans (RCISDE., 2005)

Overall, in 1998 the political and administrative decision-makers chose this area, in a vision based on growth pole theory, to act as the growth pole of the national industry.

**Physical structure of assalouyeh city:** Figure 2 and 3 show that the city of Assalouyeh is comprised of 2 districts and 5 urban neighborhoods. District 1 includes neighborhoods 1,

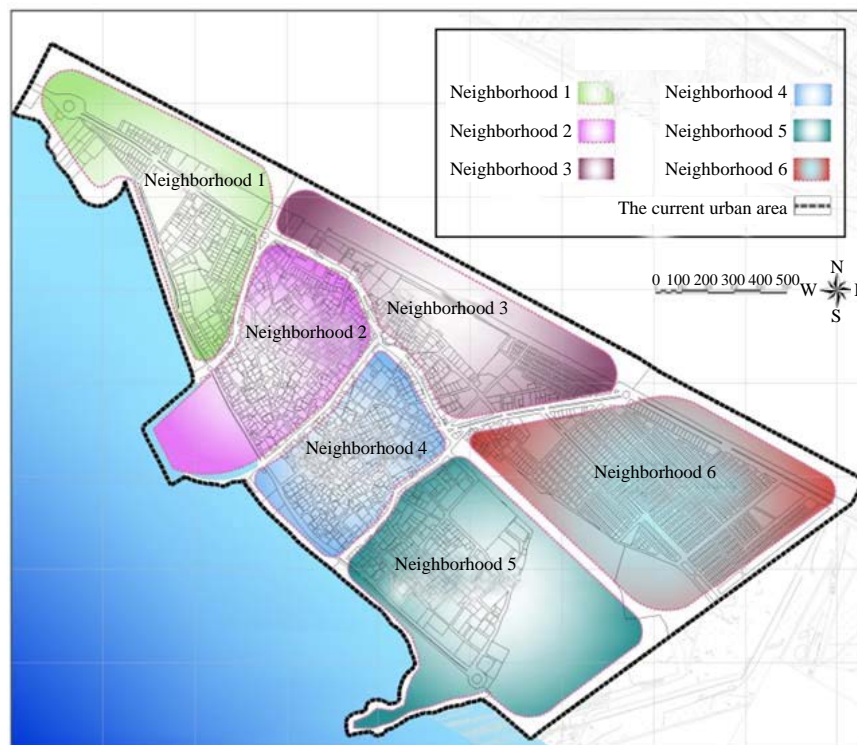


Fig. 3: Physical territory of neighborhoods in Assalouyeh city

Table 1: Developments in households and population in the city of Assalouyeh

Year	Households	Population	Average household size	Annual population growth
1966	195	1091	5.59	-
1976	206	908	4.41	-1.8
1986	302	1979	6.55	7.8
1996	504	3087	6.13	4.4
2006	882	7449	5.42	4.4
2011	1709	7884	4.61	10.5
Average annual growth (1966-2011)				5.06

2 and 3 and has 150.75 ha in area. This district is located in the Western part of the city and has borders with the physical limits of Nakhle Taghi city and with military airport. District 2 is composed of three neighborhoods, including neighborhoods 4, 5 and 6. The total area of this district is 188.67 ha. District 2 is located in the East of the city. Large parts of this district are comprised of undeveloped areas.

### RESULTS

The stages of urban expansion in Assalouyeh from 1956-2011 can be seen in Fig. 4. In 1956, Assalouyeh was in the form of a small rural core with traditional activities and occupations and a population of about 900 people. It can be

seen that the urban expansion in this region took place after the arrival of gas industry, so that in 15 years the territory of Assalouyeh became 7 times bigger than what it was in 1956.

Table 1 shows the demographic characteristics of Assalouyeh during the period under study. The highest rate of population growth in the city was in 2011 which was equal with the rate of growth in big cities of Iran.

The effects of industrial expansion on the physical development of the city have been investigated in the form of 7 factors. The results obtained by these examinations are provided below.

**Creation of spatial limitations for the future development of Assalouyeh:** South Pars facilities are located in the North East of Assalouyeh with a distance of 3-4 km. The main natural



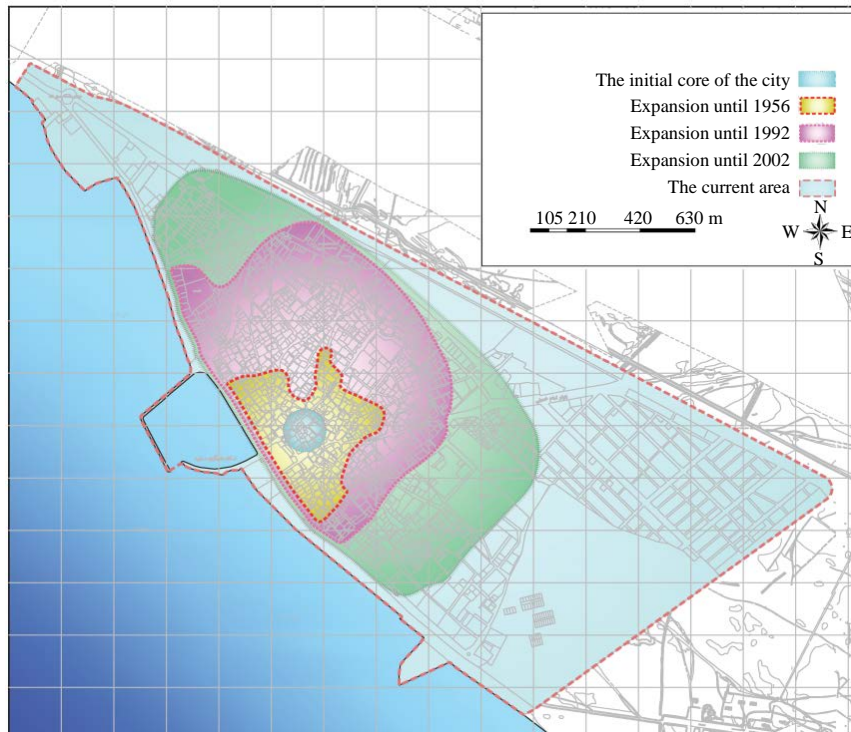


Fig. 4: Stages of urban expansion in Assalouyeh from 1956-2011

features restricting the physical expansion of the city include the coast of Persian Gulf located in the South and West of the city and mountains located in the North of the city. However, there are also other factors obstructing the expansion of the city, these factors include:

- Old airport in the Northern section of the city
- Lands acting as a buffer between Assalouyeh and Nakhle Taghi in West of the city
- Lands belonging to the Army and the South Pars Special Zone located in East and Northeastern parts of the city

Figure 5 shows the barriers obstructing the physical expansion of Assalouyeh city. As can be seen, the possibility of continuous physical expansion is limited to the lands located in Northeastern and Southeastern parts of the city.

**The formation of new urban texture on agricultural lands:**

One of the changes made by the arrival of gas industry was the formation of new fabric in the city, which mainly replaced the farmlands and orchards around the city. The has led to increased land value for these farmlands and orchards which is fueled by the establishment of petrochemical industry and

the growing demand for housing in the city and the unavailability of adequate land for expansion. According to the survey of residents, most buyers of farmland of Assalouyeh are speculators and traders of lands and houses. Firms investing in the energy sector, including the South Pars Gas Complex Company are other major buyers that constantly seek to purchase these types of lands and then apply for a change in their land use. The local residents are the third most frequent buyers of these lands and newly arrived immigrants and investors from other cities hold the next ranks.

Therefore, brokers and investment firms play an important role in the purchase of agricultural lands and changing their land use. The majority of immigrants are from low-income strata of the society, so they are not able to buy vast lands, especially agricultural lands. Investment firms buy these lands to deploy or expand factories, workshops and production-industrial complexes and lands speculators are seeking to make for a quick profit. The current residents buy these lands through housing cooperatives for actual housing purposes. According to the results of the field study, speculators ruthlessly buy agricultural lands, legally or illegally and sell them after fractionation (Table 2).

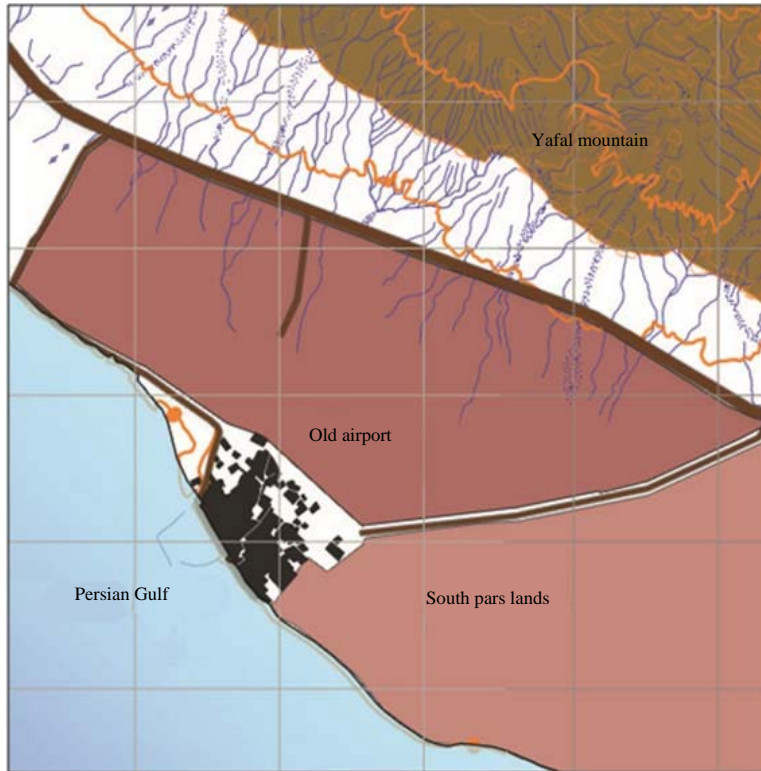


Fig. 5: Main barriers obstructing the physical expansion of Assalouyeh city

Table 2: The major buyers of agricultural lands in Assalouyeh

Description	Frequency	(%)
Immigrants who have entered to the city	15	4.76
Urban capitalists	11	3.5
Investment companies, including South Pars Gas Complex	119	37.77
Residents of the Assalouyeh	40	12.7
Land and housing speculators	130	41.27
Total	315	100

**Disruption of development and implementation of a comprehensive plan:** One of the effects of the South Pars Special Zone is the disruption of process of development and implementation of a comprehensive and detailed plan for the city of Assalouyeh. This is due to the fact that comprehensive plan cannot make any decision that would affect the special zone and should instead adapt to the strong presence of this zone. The strategic importance of energy and gas resources for Iran means that the comprehensive plan has not sufficient authority to control this region. Thus, in many cases, the presence of special zone has forced the comprehensive plan to adapt to issue created by this zone and has created many problems in realization of it objectives; the problems of urban roads described below is a clear example of this conflict.

Comprehensive plan of Assalouyeh proposes three approaches for the construction of urban roads: Inter-city roads, Intra-city roads and Inter-neighborhood roads:

- **Intra-city roads:** The construction of the roads proposed by comprehensive plan, including the construction of Seaside Boulevard and North-South street located in the most Western part of the city requires the relocation of military-related landuses and the acquisition of lands belonging to South Pars project. The construction of the ring road boulevard that links the city center to neighborhood 6 and facilitates the traffic passing through the coastal axis is also subject to the release of these lands
- **Inter-neighborhood roads:** Continuation and extension of one of the streets named Pasdaran requires the acquisition of land from South Pars project and the army which are the main obstacles in completion and construction of this route

Additionally, in the detailed plan of Assalouyeh, ring roads located on the East side of the city and along the Pasdaran

Table 3: Heldern's model variables from 1956-2011 for the city of Assalouyeh

Time period	1956-1996	1996-2011
Population at the beginning of the period (person)	908	3087
Population at the end of the period (person)	3087	8365
Gross per capita at the beginning of the period (m <sup>2</sup> )	198.23	248.07
Gross per capita at the end of the period (m <sup>2</sup> )	248.07	401.67
The area of the city at the beginning of the period (ha)	18	76.58
The area of the city at the end of the period (ha)	76.58	336

street are placed in the second five-year plan due to problems in acquisition of South Pars Lands.

**Undermining and changing the function of streets and urban crossings:** Initiation of the South Pars Energy Zone activities in 1998 followed by industrial developments within the city of Assalouyeh, led to concentration of activities and services in the city, congestion, pollution and labor immigration. The lack of proper planning and approach, the preference of business land uses and a business outlook to private and public spaces have significantly decreased the efficiency of streets and public spaces in this city. Overcrowd, traffic, low width of streets and sidewalks, physical problems of passageways such as ignoring the security of pedestrian, allocation of insufficient public space to pedestrians, lack of access, continuity, comfort and utility are some examples of the problems visible in these streets. In fact, the main functions of the streets and passageways that is the increase of activity and social relations and the prevention of isolation in limited residential space have been disappeared in the light of industrialization. The fact that detailed plan and comprehensive plan of Assalouyeh are newly adopted and have not yet been fully implemented has caused the urban lands to be affected by land speculation and has led to a strong tendency toward industrial-commercial (industrial land) landuses. These issues have caused the road network of the city to become in the form of a collection of narrow passageways overwhelmed with heavy traffic.

**Creation of urban sprawl:** One of the most common outcomes of industrial development is the rapid urban growth in the host society. This expansion often occurs very quickly without any planning and thus, leads to urban sprawl and unbalanced development of lands in urban areas. Various methods can be used to measure the degree of sprawl in a city. Heldern's model is one of these useful methods that can calculate sprawl based on time periods. Using this method, we can determine how much of the urban growth has been due to population growth and how much has been due to urban sprawl. In this study, Assalouyeh city sprawl was calculated over two periods: the period before the establishment of

industry in the region (1956-1996) and after this event (1996-2011). This calculation was performed for these two periods to further highlight the effects of rapid industrialization on urban expansion (Table 3).

Heldern's final formula is as follows:

$$\ln\left(\frac{\text{Population at the end of the period}}{\text{Population at the beginning of the period}}\right) + \ln\left(\frac{\text{Gross per capita at the end of the period}}{\text{Gross per capita at the beginning of the period}}\right) = \ln\left(\frac{\text{Area of the city at the end of the period}}{\text{Area of the city at the beginning of the period}}\right)$$

**Calculation of the sprawl of Assalouyeh in the period before the establishment of industry in the region:** The horizontal distribution of the first period was obtained by inserting the values of the Table 3 in Heldern's model:

$$\ln\left(\frac{3087}{908}\right) + \ln\left(\frac{248.07}{198.23}\right) = \ln\left(\frac{76.58}{18}\right)$$

$$\ln\left(\frac{3.40}{1.2237}\right) + \ln\left(\frac{1.25}{0.2231}\right) = \ln\left(\frac{4.25}{1.4469}\right)$$

$$\left(\frac{1.2237}{1.4469}\right) + \left(\frac{0.2231}{1.4469}\right) = \left(\frac{1.4469}{1.4469}\right) 0.84 + 0.16 = 1$$

**Calculation of the sprawl of Assalouyeh in the period after the establishment of industry in the region:** Steps taken for the calculations of first period must be retaken to calculate the parameters for the next period:

$$\ln\left(\frac{8365}{3087}\right) + \ln\left(\frac{401.67}{248.07}\right) = \ln\left(\frac{336}{76.58}\right)$$

$$\ln\left(\frac{2.71}{0.9969}\right) + \ln\left(\frac{1.62}{0.4824}\right) = \ln\left(\frac{4.39}{1.4793}\right)$$

$$\left(\frac{0.9969}{1.4793}\right) + \left(\frac{0.4824}{1.4793}\right) = \left(\frac{1.4793}{1.4793}\right) 0.67 + 0.33 = 1$$

Results obtained by comparing the amount of sprawl during two investigated periods showed that in the first



Table 4: Improvement of urban facilities and infrastructures in Assalouyeh, as compared to period before the industrialization of the area

Category	Mean	T	Test value	Sig.	Test results
Housing index	3.30	3.52	3	0.001	+
Educational facilities and services	2.67	-2.06	3	0.048	-
Health facilities and services	3.43	3.61	3	0.09	Not significant
Socio-cultural facilities and services	2.47	-2.50	3	0.018	-
Parks and urban green spaces	3.64	3.24	3	0.032	+
Sport facilities and services	2.00	-6.28	3	0	-
Business services	3.17	3.34	3	0	+
Tourism and leisure equipment	1.90	-7.94	3	0	-
Administrative facilities and services	3.79	4.38	3	0	+
Urban equipment	3.50	3.74	3	0.001	+
Urban utilities	3.70	4.37	3	0	+
Improving the quality of municipal services	2.53	-2.31	3	0.028	-
Road network and transport equipment	3.87	3.48	3	0.01	+

period, almost 84% (about five-sixth) of the total area of city had been related to population growth and 16% (about one sixth) had been related to sprawl.

However, these results show that in the second period, 33% (about two sixth) of the city area has been related to urban growth and 67% (about four sixth) has been related to sprawl, indicating the high urban sprawl of Assalouyeh. Thus, industrial development of the second period has increased the sprawl of the small town of Assalouyeh and may lead to more severe urban sprawl in the future.

**Improving infrastructure, facilities and utilities:** One of the effects of industrial development on the host community is the development of facilities and improvement of quality of urban infrastructures in the host society. To assess this element for the city of Assalouyeh, we inserted a question in the questionnaire regarding this subject; the related results can be seen in the Table 4.

According to the results, except for one item entitled "Improvement in the healthcare facilities and services," which did not show a significant impact, the improvement of municipal services was evaluated as higher than average in 7 items level and lower than average in 5 items.

Considering the nature of each item, it can be seen that overall, items that have been improved mostly have a physical spatial nature, such as housing, urban facilities, road network etc. However, items that had a lower than average improvement were mostly social and cultural in nature.

**Ecological invasion and replacement and its consequences:**

One of the effects of industrial expansion in Assalouyeh is the increasing population of workers coming in from other cities, villages and even other countries, especially Afghanistan and Pakistan migrant workers, which can have positive and negative consequences for the residents of the city. The 5-6 km distance of labor camps to Assalouyeh means that

strangers are a common site in all cities and villages in the vicinity of South Pars field facilities and anyone who visits these regions van notice their strong presence in these regions. After business hours, the immediate arrival of these workers gives a special appearance to this city that is similar to that of petroleum and industrial cities. That is why households of Assalouyeh were interviewed in this regard. Accordingly, residents believed that the presence of foreign industrial workers in Assalouyeh has significant adverse effects and cited that the most important consequence is the reduced job opportunities for the local people.

The average wage of local people had been already low, but the arrival of migrant workers, who are willing to work with even lower wages, has removed the job opportunities for local people and has led to their marginalization. In fact, the presence and deployment of industry and pollution of land, air and sea has deprived local people from their original jobs, such as fishing, hunting and agriculture related occupations.

The reduced level of public health is another problem cited by residents. Based on people comments, immigrants do not sufficiently care about the cleanliness and hygiene of their residential area and have created many problems in this regard. Another problem that is clearly evident in Assalouyeh is the excessive purchase and lease of residential units from local people by settlers or investment firms. Currently, a great number of houses, especially in the main passageways, have been leased or bought by different manufacturing and service companies and businesses.

These buildings house the migrants who work in the South Pars. So the city of Assalouyeh has become a place to supply living, recreation, business, administrative, transportation and medical needs of those who are working outside the city. In addition, the appearance of slums and in-car living around the city is another problem that is considered as serious threat to the physical development of city from the residents' perspective.

## DISCUSSION

As mentioned in the introduction, many studies have been done on the effects of industrialization on geographical areas that a little Part of them is related to the physical and spatial effects. For this reason, we want to compare the results of this study are composed with the results of similar studies in terms of these effects.

According to Muller (2001), rapid industrialization has taken place in Pittsburgh from 1870-1920 as massive purchase of land for industrial construction by steel companies that had several negative consequences. The results of this study also confirm the findings of Muller (2001). So that, gas and petrochemical investor companies in Assaluyeh, have been purchased large amount of lands around the city for industrialization. Muller claims that industrial development in Pittsburgh had created a metropolitan area stretching 30-50 miles from downtown Pittsburgh. But unlike his research results, this is not led to a widespread pattern of urban development in Assaluyeh. Instead, this has been acted as a barrier to spatial development of Assaluyeh that perhaps is the most important effect of South Pars project on the development of Assalouyeh. Because Hinterland of Assaluyeh is very smal and limited. So, in the absence of sufficient land for urban development, urban structure has moved to a model of compact city with high-rise modern buildings in the vicinity of city traditional texture.

Study of Panahi and Ziyari (2010) also shows that the development of agro-industrial complex and its related activities had an impact on the development and expansion of newly Pars-Abad city and the city over the past 40 years has been the rapid growth and physical development. As well as industrialization in this area also affected the city development directions and in three periods, has led to the development of the city from a rural core to the East, North and East. The results of this study also showed that South Pars Special Zone adjacent to the city of Assaluyeh from the East has two major effects were:

- The creation of spatial limitations for the future development of Assalouyeh
- Constraints in the process of realization of the recommendations of the comprehensive plan

One of the latest studies on the physical impacts of industrialization is study of Wu *et al.* (2014) that is examines the strategies of industrial development associated with urban land use policies in the state's Jin Yan. The results showed that the rationale of China in the process of rapid industrialization

is deliberate change from an extensive to intensive form of urban land use. One result has been concerted attempts by local government to attract foreign investment by a low industrial land price strategy, which has resulted in a disproportionately large amount of industrial land within the total urban land use structure at the expense of the urban sprawl of many cities. This policy also has been implemented to some extent in Assaluyeh. But, unlike the case of China, that local government had an important role in attracting foreign investment, in the case of Assaluyeh, Iran's central government has attempted to attract foreign investors through buying agricultural land from local people in low prices. These lands that are located in the East and North of Assaluyeh, have been used for the construction of Assaluyeh Airport and also a large part of this lands have been purchased for the establishment of industrial installations of South Pars gas field. There are evidences that in early period of industrialization in Assaluyeh in 1998, these lands are purchased from residents and farmers at very low prices.

According to Rabbani (2010), industrialization is causing spatial-physical development of Nazarabad city. This means that the city from a small village with a population of 799 people in 1956 has been transformed to a city with a population of 97,722 people and an area of 3574 ha in 2006. Industrialization in the city had negative effects. Such as: destruction of agricultural lands and orchards around the city and turn them into residential and industrial applications, incorporation of villages around the city to the main body of the city, increasing land and housing price and speculation. In Assaluyeh, the negative consequences of industrialization including destruction and changing agricultural land use, increasing real-estates in Assaluyeh, increasing cost of land and housing.

Among other studies related to the subject of this research, is the study of Deng *et al.* (2008). According to the results, industrialization has played a strong role in China. These effects are both direct and indirect. Direct impacts include increased immigration and the growth of service sector and indirect effects include increasing and expanding urban area core, increasing the size of cities and finally, urban sprawl that the results of present study verified them. Therefore physical impacts of industrial development on the city happened more indirectly.

The empirical results of Zhang *et al.* (2004) show an inverse U-shape relationship exists between land use intensity and industrialization. In other words, in the early stages of industrial development, agricultural land use changes and it's conversion to industrial uses are very intensive. But over time, the rate of land use change has been decreased and

industrialization acts as a factor to conservation agricultural land area. In this context, specific research has not been done on Assaluyeh and test of this hypothesis requires decades of time.

Also an attempt has been made by Sharma *et al.* (2008) to find out the impact of industrialization on infrastructure development in Himachal Pradesh (India). Results show that the impact of industrialization in the development of different infrastructure facilities in Himachal Pradesh has been positive. The process of industrialization has made significant improvement in the social and economic infrastructural facilities in nearby villages of industrial areas. It has resulted in the increase in number of education imparting facilities, medical facilities, roads network, housing infrastructure, shopping facilities, banking network, insurance facilities, hotel and restaurant, parks and picnic spots and shopping facilities. However, these areas are still lagging behind in respect to higher educational facilities. Hence there is a strong need to improve the higher education facilities. The results of our study showed that improvement in 7 facilities including housing, parks and urban green spaces, business services, administrative facilities and services, urban equipment, urban utilities and road network and transport equipment were higher and in 5 others were lower than average.

### CONCLUSION

As conclusion of this study, the South Pars Special Zone has affected the physical development of Assalouyeh both directly and indirectly. Its direct impacts include the purchase of lands from local inhabitants and the change in their land use and the spread of South Pars Special Zone territory over legal territory of Assalouyeh city, which disrupts the development implementation of a comprehensive plan and improving infrastructure, facilities and utilities for this city. Indirect impacts also include an increase in the population of Assalouyeh due to immigration, creation of workers settlements and change in the land prices, which create major housing problems for the local people, creation of urban sprawl, undermining and changing the function of streets and urban crossings and disrupt the normal flow of real estate market.

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