

Population Growth, Employment and Municipal Solid Waste Pollution in Mosul city

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المخلص

شهدت مدينة الموصل، خلال العقود الخمسة الماضية، زيادة سكانية كبيرة. فقد ازدادت القاعدة السكانية لهذه المدينة من نحو 179,650 نسمة عام 1957 إلى ما يقرب من 1,400,000 نسمة عام 2008. هذه الزيادة السكانية كانت، ولم تزل، السبب الرئيس لزيادة القوى العاملة في المدينة، من نحو 41,320 شخصاً عام 1957 إلى ما يقرب من 360,000 شخصاً عام 2008، بمعدل نمو سنوي طويل الأجل لا يقل عن 3%. وقد صاحب ذلك جهود تنموية غير منتظمة نتج عنها -من بين الأشياء الأخرى- زيادة مستوى التوظيف في المدينة عن ما يقارب 41,320 شخصاً عام 1957 إلى ما يزيد على 275,000 شخصاً عام 2008، على الرغم من أن معدل البطالة للفترة 2003-2008 تجاوز عن المتوسط 25%. ونتيجة لزيادة فرص العمل (والنتاج المحلي الإجمالي الحقيقي) في المدينة، ازداد المعدل اليومي لتوليد المخلفات الصلبة بشكل عام والسكنية والتجارية منها بشكل خاص. فقد ازدادت الكمية الأخيرة من أقل من 114 طناً يومياً عام 1957 إلى 289.8 طناً يومياً عام 1988 وإلى أكثر من 725 طناً يومياً عام 2008. في هذه الدراسة يجد القارئ أو القارئة أن "الجسر" الذي يربط بين عدد السكان والقوى العاملة من جهة، ومستوى التوظيف وكمية المخلفات الصلبة بشكل عام والسكنية والتجارية منها بشكل خاص، من جهة أخرى، هو معدل البطالة (U). بناءً على ذلك، فإن معادلة الصيغة المختصرة التي تربط بين كمية المخلفات السكنية والتجارية الصلبة كمتغير تابع وعدد السكان كمتغير مستقل، مبنية على افتراض ثبات (U). وقد توصلت الدراسة إلى عددٍ من الاستنتاجات أهمها ما يأتي: ما لم تكن معالجة مشكلة البطالة متزامنة مع تقديم الدعم لمديرية بلدية الموصل لإنشاء (والتشغيل بفاعلية وكفاءة عاليتين) منظومة للإدارة المتكاملة للمخلفات الصلبة، في مواجهتها لمشكلة تلوث المدينة بالمخلفات الصلبة بشكل عام والسكنية والتجارية منها بشكل خاص، فإن بذل الجهود الجادة لمعالجة -أو التخفيف من حدة- مشكلة البطالة السائدة في مدينة الموصل اليوم يحمل معه المزيد من المخلفات السكنية والتجارية الصلبة بشكل خاص، والمزيد من التلوث. وقد تم اختتام الدراسة بعدد من الاستنتاجات وتوصيتين.

كلمات مفتاحية: النمو، القوى العاملة، معدل البطالة، الصيغة المختصرة، المخلفات السكنية والتجارية الصلبة، مؤثر سكاني.

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Abstract

The phenomenal population growth in Mosul city, from 179,650 people in 1957 to nearly 1,400,000 in 2008, has been the driving force behind the corresponding growth in the labour force, whose size increased from around 41,320 people in 1957 to nearly 360,000 in 2008. The annual growth rate of the labour force, following population growth mainly, has been 3%. The associated uneven developmental efforts over the same period led to, among other things, an increase in the level of employment, from less than 41,320 employees in 1957 to over 275,000 in 2008, even though the city's average rate of unemployment over the period 2003-2008 passed 25% . As a result of the increased job opportunities, and the city's real Gross Domestic Product, the daily quantity of residential and commercial solid waste (R & CSW) generated in the city increased from less than 114 tons in 1957 to 289.8 tons in 1988, and over 725 tons in 2008. The central argument of this paper is that under conditions of rapid population growth and employment promotion policy the "bridge" between population-labour nexus, and the employment-R & CSW nexus is the rate of unemployment, with the latter being policy variable. The main conclusion to which this work leads is the following: Local Government and Mosul University should address the two problems of unemployment and solid waste pollution in general, and R & CSW in particular, simultaneously. Otherwise, any efforts aimed at alleviating the problem of unemployment prevailing in Mosul city today will exacerbate the problems of solid waste pollution in the city. The paper was concluded by two recommendations.

Keywords: growth, labour force, landfill, university office, generation rate, population conference.

1. Introduction:

The estimated population of Mosul city today (November 2008), is around 1,400,000¹ people, compared with 179,650 in 1957² (Table 1). This enlarged population base, which is

¹ An update of population estimate of Mosul city for 2005, based on an annual growth rate of 3%. See: CSOIT [35], Table (2/5).

² See: Republic of Iraq [27], Table (4).

expanding at a staggering annual rate of 3%¹, embodies a corresponding labour force of around 360,000² people, compared with some 41,320 in 1957. Needless to say that, if the newly created job opportunities do not match the number of new entrants to the city's labour market (expected to be more than 10,000 in 2009), the rate of unemployment, whose average for 2003-2007 passed 28%³, will certainly rise. Moreover, there is preliminary evidence that **the city's** rate of unemployment, for 2008, was greater than 25%⁴. This means that the number of unemployed people (in the strict sense of the turn) in Mosul city, as of the beginning of 2009, may well be greater than 80,000 (Table 2).

On the other hand, apart from the **pathetic and difficult-to-solve** problem of unemployment, Mosul city is having a problem with solid waste management (SWM) in general and residential & commercial solid waste (R&CSW) in particular. The Directorate of Mosul Municipality (DMM) is doing what it can to provide the city with minimum collection, transfer, and "sanitary disposal" services. However, it seems to the author that dealing with the current problems of SWM in Mosul city, in an effective and efficient way, is beyond the current capacities of

¹ This is the implicit annual growth rate for urban population of Ninevah Governorate. See: CSOIT [36], Tables (2/7) A and (2/7) B.

² According to the Employment and Unemployment Survey for 2005, the "refined economic activity rate" for the urban population of Ninevah Governorate, 15-years old and more, was 45.15% .See: CSOIT [36], Table (2/13); UNDP [44], P.168.

³ For the 15-years old and more, excluding the underemployed .For details and references, see Table (2).

⁴ In a TV interview with Ninevah TV Channel, broadcast on 17 November 2008, the spokesman for the Council of Ninevah Governorate announced "...[in **Mosul City**] we have more than 150,000 unemployed...". See also: CSOIT [38], Table (3-1).

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the DMM. Pictures (1-3) give some idea about the challenges facing the DMM today.



Picture (1)

Mosul city Center, a dump at the back wall of Nabi Jarjeece Mosque (photo taken on 26/12/2008)



Picture (2)

Mosul city, a dump on the bank of River Al-Khosar (photo taken on 26/ 7/2008).

Source: Al-Wattar [21], P.238.



Picture (3)

Mosul, AL–Gogjali "sanitary" landfill, located 10 kilometers to the east of River Tigris (photo taken on 9/8/2008).

Source: Source: Al-wattar [21], op. cit.

The three Pictures above reflect three important MSW management problems, one of which is the **many decades old** unsanitary way of municipal solid waste disposal in the outskirts of Mosul city, which is (population-wise) the second largest city in Iraq.¹

¹ Mosul City is the provincial capital of Ninevah Governorate, which is, population-wise, the second largest governorate in Iraq. In 2005, the **city's**

A Composite Problem:

The above data - though limited - on population, labour force, and unemployment **on the one hand**, and the figures on R & CSW dumps in the city together with the uncontrolled disposal sites¹ **on the other**, are evidence of the fact that Mosul city is facing two seemingly unrelated problems: A widespread unemployment **and** R & CSW pollution, in particular. However, from environmental economics perspective², and since alleviating the unemployment problem, other things being equal, exacerbates the city's solid waste pollution problem in general and R & CSW in particular, we have in fact **a composite problem**. As it is argued below, this problem has to be addressed from a wider perspective, in a scientific way, and in the spirit of **cooperation among all parties** concerned, **especially** the DMM and Mosul University (MU).

In the remaining part of this section the aim of the study is set. Section (2) presents a theoretical analysis on the relationship between population size, unemployment rate and C & RSW generation (in particular). In section (3) we present some evidence in support of the theoretical argument put forward in section (2); while section (4) contains the main conclusions, and two recommendations.

population was nearly 47% of the total population estimate for Ninevah Governorate. See: CSOIT [35], Table (2/5); CSOIT [37], Tables (2/5) and (2/7), respectively.

¹ Apart from Al-Gogjali "sanitary landfill" referred to above, there is AL-Sahaji landfill. The latter is located some 12 kilometers from the city center, in the western side of River Tigris. Moreover, there is AL-Arabi "provisional landfill" (close to AL-Arabi district), north of Mosul City in the eastern side of River Tigris.

² See: Tietenberg [17], especially chapter 18. See also: Runner [13], PP. 5-11; Miller [9], Ch.13.

The Aim of the Study:

The aim of this study, which may be taken as an exploratory, is to present simple and coherent theoretical argument, with non-econometric empirical content, to the following hypothesis:

Under rapid population growth and employment promotion policy, the link between population-labour force nexus and employment-C & RSW generation nexus is the rate of unemployment. The relevant data from Mosul city, though limited, tend to support that hypothesis.

We say "the" link, mainly because **population growth per se** is neither necessary nor sufficient condition for C & RSW growth¹. The relevant set of question to which this composite hypothesis leads is:

- 1) Theoretically, what are the basic **causal relationships** who are reduced – form is a linear (and proportional) relationship between the quantity of C & RSW as a dependant variable, and population size as an independent variable?
- 2) Does the aforementioned relationship apply, in one way or another, to Mosul city? If so;
- 3) What use can MU, the DMM, and the Council of Ninevah Governorate (CNG) **make** of that relationship, as far as the **composite problem** at hand is concerned?

The remaining sections of this paper are devoted to the answers to these questions. The research method adopted in dealing with them is, to a certain extent, descriptive. However, the reasoning is mainly mathematical, while the empirical part of

¹ Analytically, **we can abstract from per capita income growth of the already employed labour force**. See footnote 2 page 7.

the study is **based on** both cross-sectional and other data, all of which, of course are specific to Mosul city.

2. Population, Residential and Commercial Solid Waste: Theoretical Analysis:

On the theoretical level, we have **two relationships** in the first of which population size (and growth) plays a direct role, while in the second its role is an indirect one.

- a)** There is a direct and positive relationship between the size of the labour force as a dependent variable, and the size of the population base as an independent variable.¹ For simplicity, this relationship was assumed to be proportional.² Mathematically

$$Z_t = \alpha F_t \dots \dots \dots (1)$$

With Z_t being the labour force in period (t), F_t being population size in period (t), and α is a constant. As for the time-path of F_t , it can be expressed in the following form:

$$F_t = F_0(1+n)^t \dots \dots \dots (2)$$

With (n) being the algebraic value of population growth rate.

Equations (1-2) together means that population growth, at whatever rate, brings about a corresponding growth in the labour force.

- b)** An economic policy **with employment promotion**³ as one of its main objectives, embodies an implicit objective of

¹ See: Robinson [11], PP.7-11; Brown, et al. [1], PP. 53-56; ESCWA [42]; ESCWA [43], PP.47-49.

² An increasing relative share of women in the labour force makes this relationship nonlinear.

³ See: Waterston [18], PP.144-156; Republic of Iraq [29], especially PP. 11-12. The implications of this employment policy are, of course, different from the implications of an economic policy whose main objective is to

achieving a target–minimum rate of unemployment (U^*). This means:

1. An increasing level of employment.
2. An increasing level of real investment, including real commercial and residential investment expenditure.
3. An increasing level of real **Gross Domestic Product** (GDP), disposable income, and personal consumption expenditure.

As a result, the local economy witnesses an increasing quantity (measured in weight or volume) of solid waste in general, and R & CSW in particular.¹

The preceding argument **may be formalized**, assuming a linear relationship between the quantity of R & CSW and the level of employment, **as follows**²:

$$N_t = (1 - \frac{U^*}{100})Z_t \dots\dots\dots (3)$$

maintain "...a high and stable level of employment...". This was the case for post-war Britain, and all the other advanced capitalist economies until early 1970s. See: Robinson [12], especially PP.254-257. As for the relationship between employment and economic growth, see: e.g. Domar [4]; Satterfield [15], especially PP.94-96.

¹ See: Tchobanoglous, et al. [16], P. 6, 21; Brown, et al., Ibid, PP.53-56, 93-96.

² **Proof of equation (3):**

From the definition of unemployment rate(U), we have:

$$U = \{(Z - N) / Z\} \times 100 \dots\dots\dots (3a)$$

$$100N = (100 - U)Z \dots\dots\dots (3b)$$

Dividing through by 100, we get:

$$N = \{1 - U/100\}Z \dots\dots\dots (3c)$$

Since $U = U^*$ by assumption we end up with:

$$N_t = \{1 - U^*/100\}Z_t, \text{ with } U^* \text{ being a policy determined variable.}$$

$$S_t = \lambda N_t \dots\dots\dots (4)$$

With $\lambda = \left(1 - \frac{U^*}{100}\right)$, (N) and (S) being the level of employment and the quantity of R & CSW respectively. Equations (3-4), together with equation (1) lead to the following reduced-form¹ relationship between the quantity of R & CSW as a dependent variable, and population size as an independent variable:

$$S_t = \gamma F_t \dots\dots\dots (5)$$

With $\gamma = \lambda\alpha$. Equation (5), simple as it is , has the following interpretation: if the government were to adopt an economic policy aimed at achieving a target rate of unemployment (U^*), then, **other things being equal**, population growth (in our case population explosion) would bring about a corresponding residential and commercial solid waste growth. Thus, the argument leading to equation (5) provides the answer to the first question addressed earlier.

¹ The reduced-form equation(s) is a commonly used concept in econometric literature. See: e.g. Gujarati [6], PP.653-656; Johnston [7], PP.6-8. As for the reduced-form equation (5) , it may be obtained as follows:

From equations (1,3) we get:

$$N_t = \alpha \{1 - U/100\} F_t \dots\dots\dots (5a)$$

By substitution in equation (4) we get:

$$S_t = \lambda \alpha \{1 - U/100\} F_t \dots\dots\dots (5b)$$

By setting $U = U^*$ (since U is a policy variable by assumption), we can re-parameterize equation (5b) as $S_t = \gamma F_t$, with:

$$\gamma = \lambda \alpha \{1 - U^*/100\} \dots\dots\dots (5c)$$

It may be mentioned that, given λ and α , any change in U^* brings about a change in γ in the **opposite direction**. Thus, a sufficient increase in the value of U^* would bring about a lower value of S even though the value of Z were to remain constant.

This means that, the first part of the hypothesis put forward on page (4) is logically consistent.

3. Some Relevant Facts:

Let us go back to the second question raised on page (4), whose answer determines the acceptance, or for that matter rejection, of the second (complementary) hypothesis: Is there any relevant data set that supports the central causal relationships developed in the previous section? Unfortunately, the available and relevant data, on the variables concerned are so scanty that they do not qualify for more than a descriptive, general, and conditional answer to the question at hand.

As for the relationship between population size (growth) and the labour force (growth) in Mosul city, we have the following data (Table 1).

Table 1
Population and Labour Force in Mosul City: 1957- 2008
(selected years)

Year	Population	Labour Force	Year	Population	Labour Force
1957	179,646 ^a	41,320 ^b	2005	1,232,768	327,920 ^e
1965	264,146 ^a	60,750 ^b	2006	1,269,000 ^f	337,550 ^e
1977	429,883 ^a	98,900 ^c	2007	1,310,000 ^f	348,460 ^e

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1987	664,221 ^a	160,090 ^d	2008	1,350,000 ^f	359,100 ^e
1997	906,986 ^a	241,260 ^e			

a. Census data; b. The ratio of labour force to population was assumed 23%; c. Based on population census data for 1977; (d, e). The ratio of labour force to population was assumed 24.1% and 26.6%, respectively; f. Estimates based on an annual growth rate of 3% (see footnote 3 Page 2).

Source: CSOIT [39], P. 45 and Table (2/1), earlier issues; CSO [31], Table (2), P. 2 and Table (45), P. 92; CSO [28], Table (1), P. 3; Republic of Iraq [25], Table (4); CSO[30], Table (1).

Table (1) shows that, the phenomenal population growth in Mosul city brought about a corresponding increase in the labour force, from some 41,320 people in 1957 to 359,100 person in 2008.

One may add that¹, a city-population base of nearly 1.4 million in 2008, and growing at an annual rate of 3%, has many implications. One of them is that: from mid 2008 to mid 2009, Mosul city should expect to have an additional population of over 40,000. The latter is little more than the current estimated population of the densely populated area of Al-Zahraa districting (eastern side of Tigris River). From mid 2009 to mid 2010, given the population growth rate, the city should expect to receive an **additional** 42,000 "visitors", little more than the estimated population of AL-Nahrawan district (western side of Tigris River). The corresponding numbers of the **new entrants** to the city's labour market are as follows: around 10,000 people for 2008, and some 11.000 people for 2009.

¹ Assuming no net migration.

On the other hand, and since the establishment of the **Development Board** in 1950¹, the Iraqi government² conducted an important developmental efforts aimed at, among other things, creating job opportunities for those who are already unemployed, as well as for the new entrants to the city's labour market. The result of these efforts, which were (are) taking place in an environment of rapidly increasing population, and labour force, **is** an increasing level of employment and a varying rate of unemployment, ranging from 3.2% in 1977 to 34.4% in 2007 (Table 2):

Table 2
Employment and Unemployment in Mosul city, 1957-2007
(Selected Years)

Year	Number of Employees	Rate of Unemployment %	Number of Unemployed
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¹ Established under the monarchy according to Law No.23 for 1950. See: Government of Iraq [24], PP.1-4.

² Excluding the period of the first Gulf-War, from 22 September 1980 to 8 August 1988, as well as the whole period of the "economic embargo" imposed on Iraq according to the Security Council resolution No. 661 (6 August 1990), as a result of the well known invasion of Kuwait by the Iraqi Baath régime on 2 August 1990. The lifting of the embargo took place according to the Security Council resolution No. 1483 (22 May 2003). These two events, in particular, led the Iraqi society to go through what may be called "**development in reverse**". As for the developmental efforts undertaken since the establishment of the Development Board, see: Government of Iraq [25], [26]; Penrose [10], chapters 7, 18, and 20; Gottheil [5]; see also AL-Wattar [19].

1957	Less than 41,320
1977	95,735	3.2 ^a	3,165
1987	154,650	3.4 ^a	5,440
1997	201,930	16.3 ^b	39,330
2003	231,910	24.9 ^c	76,890
2004	220,490	30.7 ^c	97,680
2005	271,520	17.2 ^d	56,400
2006	223,800	33.7 ^d	113,750
2007	228,590	34.4 ^e	119,870
2008	278,300	22.5 ^f	80,800

.. Data are not available; a. Based on population census data for 1977 and 1987; see: CSO [31], Tables (51, 87) and CSO [32], Tables (1,21 urban); b. Worked out from CSOIT [36], Table (4/2), and Loony [8], Table (1); c. For urban centers of Ninevah Governorate. See: CSOIT [35], Table (2/8), and CSOIT [36], Table (2/12); d. CSOIT [35], Table (2/6); e. Based on a (small) sample survey conducted under the author's supervision; f. For the first quarter of 2008, and for all urban centers of Ninevah Governorate. See [38], Table (3-1)..

Data in Table (1) shows that the number of employees in Mosul city was more than 278,000 in 2008 **compared with** 154,650 in 1987, some 96,000 in 1977, and less than 41,320 in 1957. No doubt, the **increasing level of employment** in Mosul city is an indicator of a corresponding increase in the city's GDP, and disposable income. These increases, led in turn to an **increase in solid waste generation in general, and R & CSW** in particular.

Residential and Commercial Solid Waste in Mosul city:

Needless to say that relevant and reliable data on R & CSW generation in Mosul city is scanty.¹ However, the authors were able to profit from the following:

- a. A relatively recent study on **residential solid waste generation** (RSWG) in Mosul city, conducted by the author in 2004-2005, according to which RSWG rate was estimated as 0.3 kg/capita/day.²
- b. A study on **solid waste management** in Mosul city, conducted by Yousif [23] in 1988, which included an estimate of RSWG rate of 0.45 kg/capita/day.³
- c. Some other relevant studies of regional nature.⁴

Based on a number of assumptions, including the assumption that commercial solid waste is 40% of the quantity of RSWG in the city, it was possible to arrive at what may called

¹ During 2004, at least, the DMM adopted a largely unrealistic **residential** solid waste generation rates for the various municipal sections of Mosul City. For example, per capita **residential solid waste** generation rates for Al-Maamoon and Al-Hadbaa municipal sections were 0.99kilogram and (slightly more than) 1kilogram, respectively. See: DMM [39], and Yousif [23], especially the **Summary** and P.3, 35, 105. One may add that, **non** of the 390 M.A. dissertation, and of the 90 Ph.D. thesis completed at the Faculty of Administration and Economics ,Mosul University, over the period 1979-2007, **dealt in one way or another** with residential (or residential and commercial) solid waste in Mosul City. See: Mosul University [40].

² Al-Wattar [20], PP.89-108. See also: Al-Wattar and Mahmood [22], Table 2.

³ See: Yousif [23], especially PP.52-53.

⁴ Cointreau-Levine and Gopalan [2] especially Table (A1.1); AusAid [41]. In the latter work, the implicit **domestic and commercial** solid waste generation rates, worked out by the author, for 2001 (actual) and 2005 (projected), in the main metropolitan area of Bangalor City, Karnataka, India, **are**: 0.420 kg/capita /day and 0.420 to 0.510 kg/capita/day, respectively. See: Ibid. PP. xi-xiii, 6, Table (2-7), and Annex A. See also WHO [46] especially PP.3-5, 11.

conservative estimates of the daily and weekly quantities of R & CSW generated in Mosul city for 1957, 1988 ,2006, and 2008 (Table 3).

Table 3
Quantities of R&CSW Generated in Mosul city: 1957 2006^a
(selected yeysrs)

Year	Population (million)	Employment (persons)	Residential solid waste generation rate (kg/capita/day)	Quantity of residential and commercial solid waste (tons)	
				Daily	Weekly
1957	0.18	Less than 41,320	0.30 0.45	75.6 113.4	529.2 793.8
1988	0.69	154,650 ^b	0.30 0.45	289.8 434.7	2028.6 3042.9
2006	1.30	223,800	0.30 0.45	546.0 819.0	3822.0 5733.0
2008	1.40	278,300	0.37 0.45	725.2 882.0	5076.4 6174.0

a. The construction of this table was based on Table (1) above; AL-Wattar [20]; Cointreau and Gopalan [2]; AusAid [41], together with the assumptions made in the text. See (footnote 4, Page 10); Al-Wattar [21], P.239; and Al-Wattar and Mahmood [22], Table 2; **b.** For 1987.

Considering the lower limits in the above table (of the 40% commercial) as a basis for comparison, we see that in 2008 the quantity of R & CSW generated in Mosul city was 725.2 tons daily (5076.4 tons weekly). The corresponding quantity for 1988 was 289.8 tons daily (2028.6 tons weekly). In 1957 R & CSW generated in the city was 75.6 tons daily (529.2 tons weekly). The significant increase in the quantity of R & CSW generated in Mosul city, over the period 1957-2008, may be explained as follows:

The increase in the city's population, from nearly 0.18 million in 1957 to nearly 1.4 million in 2008, brought about an

increase in the labor force from 41,320 people in 1957 to 359,100 in 2008. **The government's developmental efforts, aimed to keeping the number of unemployed as low as possible,** led to an increase in the level of employment, from less than 41,320 in 1957 to over 278,000

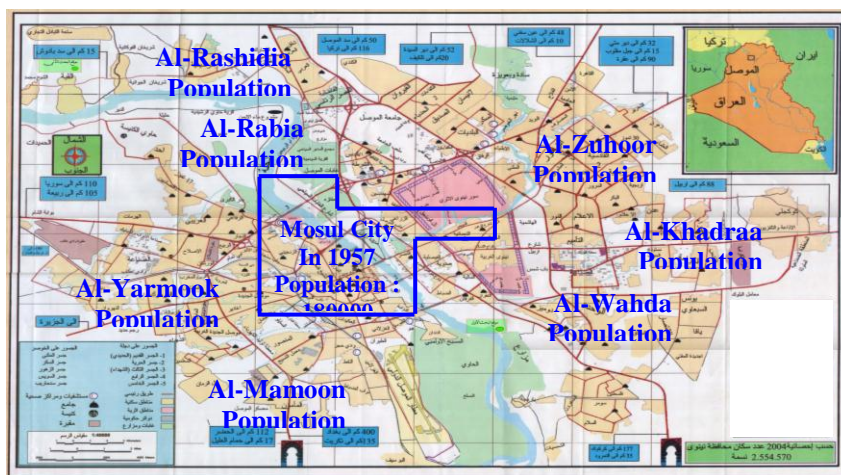


Figure (4)

Mosul city: Population and Daily Quantities of R & CSW in 1957 and 2006.

Source: Al-Wattar [20], Table 3; Al-Wattar [21], P.240.

The map, though limited in scope as far as the number of (DMM) municipal sections is concerned, shows:

- The approximate borders of Mosul city as of 1957, with population of (nearly) 180,000 people, and estimated daily quantity of R & CSW of 75.6 tons, **as minimum**.
- The City, as of 2006, with eight important municipal sections, including the unnamed municipal section of the inner city.

It may be noted that, in 2006, the daily quantity of R&CSW generated in AL-Zuhor municipal section **alone**, was

much greater than the corresponding quantity **generated in 1957 for Mosul city as a whole.**

Clearly, the diffusion of the city's population **determines** the diffusion of the total quantity of R & CSW generated in the city.

Moreover, the **growing volume** of municipal solid waste (MSW) in Mosul city, particularly R & CSW, and its management (see Figs.1-3), are indicative of the largely ignored fact, by Mosul University, that the DMM with its **current** finance, staffing, and municipal solid waste management system **units**, can't cope with the problem at hand.

Therefore, based on the available data and the preceding analysis, we would argue that the evidence from Mosul city, though limited in details, provides positive answer to the second question raised in the first section of this study. Thus, the analysis of the previous section, together with what we have arrived at in the present section, imply that the basic hypothesis put forward in the first section of this study, may be accepted.

4. Conclusions and Recommendations:

Conclusions:

The main conclusions, to which these preliminary investigations lead, are the following:

1. On the theoretical level, it may be argued that, given the rate of unemployment as a policy variable (U^*), there exists a logical relationship between the quantity of R & CSW generated as a dependent variable, and population size, as an independent variable.
2. Though limited in details, the relevant data available for Mosul city seem to support that hypothesis (Table 4):

Table 4
from Population to R & CSW, Mosul city: 1957 & 2006

Year	Population	Labour force	Number of employees	Quantity of R&CSW (tons)	
				Daily	weekly
1957	180,000	41,320	Less than 41,320	75.6	529.2
2008	1,350,000	359,100	278,300	725.2	5076.4

Source: Tables (1-3).

Table (4) shows that the phenomenal population growth, labour force, and employment in Mosul city, over the period 1957-2008, was (and is being) accompanied by a corresponding growth in R & CSW. The data (Tables 1- 4) seem to provide (non-econometric) support to the basic hypothesis which led to the present investigation.

3. Even if it were possible to **gradually** eliminate compulsory unemployment¹ which exists in Mosul city today, **together with the quick removal of R & CSW which already exists and being generated** in the city, the two problems would still need to be addressed simultaneously. Moreover, given U*, **the dependence** of MSW generation in general, and R & CSW in particular, on a rapidly growing population base (equation 6) **makes matters worse...**

Recommendations:

¹ Compulsory unemployment exists "[i]f the existing level of aggregate demand is insufficient to create employment opportunities for all who are willing to work at the going real wage..." See: Davidson [3], P.82.

The analysis of the last two sections, and the conclusions thereafter, warrant a number of recommendations. As far as population explosion and R&CSW problem in Mosul city are concerned, the author would submit the following two recommendations:

Recommendation (1)

Any **serious efforts**, on the part of the local government in particular, **aimed at** creating job opportunities¹ (temporary or otherwise) for the unemployed in Mosul city should be associated with enhancing the current capacities of the DMM: a) financially², b) qualified man power, and c) solid waste management system **units**. As far as MU is concerned, and in order to create some degree of positive integration between this university and the DMM³, it is **strongly recommended that MU establishes in the DMM what may be called "The University Office"**. **The head of this office may be directly responsible to the University President on the one hand and directly linked with the Director General of Mosul Municipality, on the other**. The membership of the aforementioned office may be restricted to 3-4 qualified academics, headed by a relatively young, active and scientifically minded member of the teaching

¹ As it is the case for "Um Al-Rabiain" provisional employment contracts launched in Ninevah Governorate in May 2008.

² In the DMM, the number of employees on short-term contractual basis, directly engaged in providing MSW services to the city went down from 6,400 strong (1/6/2004 -31/12/2004) to 1,408 strong (1/2/2008-29/2/2008) . By the end of 2008, the number of employees (in this category) went up to 5,000. The reason for this dramatic change in numbers, as reported to the author by the DMM officials, has been **budget changes**.

³ As for the recommendations specific to the technical staff of the DMM, and the nature of the related postgraduate research work at (MU), in particular, see: The Proceedings of the forum on "The Problem of Residential Solid Waste in Mosul City" held at the Faculty of Engineering, Mosul University, on 8 December 2005 (in Arabic).

staff of MU. The role of the university office, assumed to be working e.g. full two-days a week, is to provide technical assistant (engineering and economic in particular) to the DMM in the form of oral advice, technical memorandums, and special scientific studies related to the short-term and the long term problems facing the (DMM) in its efforts to provide Mosul city with continuously improving collection, transfer, and disposal solid waste services.

Recommendation (2)

Since **population explosion** is one of the major causes for the current unemployment problem in Mosul city, whose solution (in one way or another) brings about more MSW in general and CSW in particular, it is **recommended that a well designed population conference¹ should be organized in the near future by MU. The conference may be held in 2011, under e.g. the title "Population Explosion in Mosul city: Facts, Consequences and Family Planning from Islamic²**

¹ One may add that the Directorate of Research and Development, MHI & SR, Iraq, does support the organization of such a conference (letter No. DT/4886 dated 4 September 2007). Moreover, this conference goes along the lines suggested by Brown et al. [1], chapter 21, especially P. 127.

² Over the period 1970-2006, the two Islamic States, Iran and Turkey succeeded in lowering their total fertility rate (TFR) and - as a result - population growth rate (PGR), considerably.

See: UNDP [45], Tables (5, 1a); UNDP [42], Table (23); CSOIT [37], P.45, and Table (1/2); CSO [30], Table (2/10).

It may worth mentioning that, **in stark contrast** to the recommendation of the World Commission on Environment and Development for "[e]stablishing a sustainable relationship between human numbers and resources...", the Iraqi government at the time (1987) launched the so-called "National Campaign for the Promotion of Fertility", **to accelerate population growth**, which was running at an annual rate of 3%. See: the proceedings of the forum **"Early Marriage: Its Virtues and Privileges"**,

Perspective". It is important that the "zero population-growth" option be **taken seriously and adopted**, if LG and MU in particular were to be a leading force for economic and social progress in Mosul city, and Ninevah Governorate.

The authors hope that the above two recommendations receive due consideration by MU and LG, at least.

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- * This work, particularly section 2, overlaps with another work conducted by one of the present authors. See: Al-Wattar [21], PP. 229-252.
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