The Utilization of System Dynamics in Concluding Policies for Greater Cairo Sustainable Development

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ABSTRACT

Consistent with the world global phenomenon, the majority of Egypt population is now moving into urbanized areas. Therefore, Egypt cities and towns stagnated and are currently suffering from overcrowding problems such as degradation of all services including education and healthcare, environment, transportation, etc.

This paper aimed to build a system dynamic model that would assess the policies that are currently adopted by the Egyptian government and give insight about other policies that can improve the quality of life for Egyptians, especially in Greater Cairo. The main finding of this study is that increasing the government expenditure in Greater Cairo would not improve the living conditions of Greater Cairo residents. The model confirmed that the concentration of economic activities in Greater Cairo has increased its attractiveness. The increased attractiveness has increased population growth in Greater Cairo much more than the capacity of its utilities, which resulted in a degradation of the quality of life in Greater Cairo.

The findings of this study recommended that the government should direct its investment into new nuclei whereby there are many underused resources. However, the model indicated that these nuclei would not succeed unless the government implemented other measures that would encourage the community to respond positively towards the policy of establishing new nuclei. Such measures include strict enforcement of the existing laws, especially those laws that organizing construction. The model indicated that the establishment of new nuclei strategy would not succeed with a weak government. The findings also addressed the need to adjust the renting laws.

KEYWORDS - Urban planning, system dynamics, government policies, sustainable development, informal settlements, poverty rates, renting laws, slums.

AN OVERVIEW

The increased urbanization in Egypt had resulted in overcrowding conditions at all cities. In Greater Cairo, the population is currently more than double of the capacity of GC available utilities. This increased population without a prorate increase in enterprises has resulted in increase underemployment and poverty rates. The increased population has also resulted in increased pressure on all existing utilities. Satellite images of Greater Cairo indicate that the informal expansion is an increasing phenomenon and mostly on the rich agriculture lands. Egypt statistics indicate that the unemployment and poverty have been increased during last years, and the percentage of population that lives at or below the poverty line has reached around 45% of the overall population. Besides, the main services such as education, transportation, healthcare, etc., are all deteriorating due to the overcrowding conditions.

Most of these problems that is suffered by the Egyptian communities can be referred to the lack of urban planning studies and/or lack of implementation of the designed urban plans during last decades. Has the government adopted successful urban policies, the population densities in the Egyptian cities would had been consistent with the number of jobs that can be available in an area and consistent with the capacity of the established services. In impact, the standard of living in the Egyptian cities would have been properly maintained at good levels and certainly the average income

per capita would have distributed in a reasonable and fairly manner, which would have reduced Egypt poverty rate.

The impact of the overcrowding conditions in cities is illustrated in several symptoms such as the skills of the graduated students, the quality of healthcare services, the increased environmental pollution, etc. Also and due to the limited supply of affordable houses, many had to live in informal settlements under very poor living conditions. According to statistics, more than 50% of Greater Cairo population lives in informal settlements. In the same time, poverty rate in Egypt are increasing. While the official poverty rate is 25% at 2012, many studies estimated that the poverty rate in Egypt is much higher than the official percentage. Moreover and in Upper Egypt, poverty rate reached 69% according to the official statistics (CAPMAS, 2012).

During the last decades, the government has adopted several policies in order to improve the living conditions such as the low income housing programs, development of informal areas, issuing laws that prevent the construction on agriculture land and the construction without building permit, new renting laws, and the major projects for the establishment of new towns. However, these interventions could not reduce the immigration into Greater Cairo, eliminate the expansion of the informal settlements, eliminate the reduction of the agricultural lands or even reduce the population that lives at or below the poverty line. The failure of the government policies to achieve its targets may be referred to the short term nature of the selected policies, the selection of inappropriate policies or maybe due to inadequate implementation of the selected policies, maybe due to the budget limitations of such programs. The failure of urban policies can also referred to the lack of coordination between GC three governorates, which hindered the implementation of long term strategies.

Many studies demonstrated that the people in informal settlements are great human assets. In addition, economists estimated that the dead assets of these slums in informal settlements with around 248 billion USD, which is 30 times greater than the market value of the registered companies in Cairo and 55 times greater than the direct foreign assets since Napoleon invasion in Egypt (De Soto, 1997). These assets are huge and significant and the government should take careful measures to transfer these assets into profitable organization that work under our legal system. With proper policies, informal settlements can be transferred into a better and advanced living area.

Now, with the failure of all above described policies, no one can imagine the situation after around 40 years. All the subject matter experts estimated that situation will be disaster in case the government and population trends have not been changed in the future. The aim of this study is to utilize the system thinking of urban dynamics to conclude better policies to be applied by the government that would improve the living conditions of the population either in Greater Cairo or in Egypt other cities and towns and achieve sustainable development. However, with the absence of database concerning Egypt, the preparation of this study and the creation of the model were not an easy task.

THE OBJECTIVES OF THE STUDY

This study was developed to design a system dynamics model that aims at helping Egyptian political leaders and decision makers to define the appropriate policies that would improve the living conditions of Egyptians and hence, poverty rates can be enhanced.

LITERATURE REVIEW -- URBANIZATION

Associated with the population growth, urbanization became a global phenomenon. According to the World Bank statistics, over 90 percent of the world urban growth is occurring in the developing countries, which adds around 70 million of residents to urban cities yearly. Using the same rate of growth, it is expected that the urban population of the two poorest regions in the world, which are South Asia and Sub Saharan, shall be doubled during the next two decades. The UN estimates that 60% of the population in low/middle income countries will live in urban areas by 2030. At the beginning of the 20th century, only 16 of the world's cities that were in advanced industrial economy contained one million people. Today, maybe due to globalization, the number of cities reached 400 cities and 75% of those cities are in low/middle income countries. In fact, almost half of the world's total population and over three quarters of high income countries population live in urban areas (Cohen, 2004).

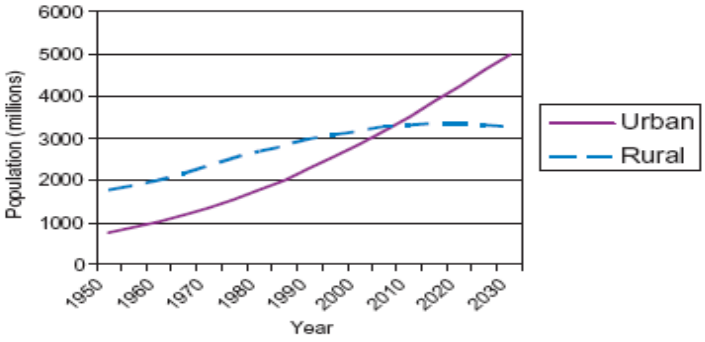

Figure 1 - Estimated projected urban and rural population in the world (1950-2030). Source; United Nations (2002)

Contrary to developed world, whereby urbanization was not associated with industrialization, urbanization in the developing countries is resulted from the massive migration, natural organic growth as well as the lack of a proper urban planning. In impact, cities sizes grew over the capacity that its utilities can accommodate, which led to a decline in the cities living conditions and deterioration of all its facilities. At the same time, the increased unplanned urbanization had series consequences such as reduced job opportunities, degradation of the environment, reduction of the agricultural land, economic issues, global climate change, etc., which all would certainly affect the sustainable development of the world.

Several developed countries, particularly USA, have made advanced interventions in urban planning in order to maintain cities conditions. Such interventions included demolition of slums, building laws, limitation of the cities areas, etc. With such interventions, the quality of life in USA cities could be maintained. The situation can be quite the opposite in the developing countries where most of the large cities reached deteriorated conditions. In such cities, a great portion of the populations had to live in slums with poor access to the main utilities of water, sanitation, etc. For decades, governments in these countries delayed in implementing adequate policies to improve the situation, which made the situation even worse, however, when they started they faced two main challenges. The first challenge that governments met is the centralization of the public services such as education, water and sanitation grids, health, which hindered renewal plans. The second challenge is the socio spatial segregation resulted from the difference of the quality of services and life between sub-areas and metropolis, which led to increased migration into cities. In the following part, some of governments' urban planning practices in sustaining the quality of life of their countries shall be briefed.

Urban Planning

"Urban planning is the technical and political process concerned with the control of the use of land and design of the urban environment, including transportation networks, to guide and ensure the orderly development of settlements and communities. It concerns itself with research and analysis, strategic thinking, urban design, public consultation, policy recommendations, implementation and management." (W. Reps, 2002).

Urban planning can take many forms such as establishing the strategic & detailed plans, or historic preservation plans for the purpose of protecting the historical constructions. Urban plans should include a recommendation for the policies that should be followed by the political leaders to support them in the implementation of the produced plans. Such policies should consider the sociopolitical factors and then be implemented in full participation with the community at the city to avoid political turbulences or any instability by the population. It is believed that urban planning can occur when government have the capacity to achieve economic balance. When urban planning could deliver efficient and useful services to all sectors including land and infrastructure, this could attract investors and improve the economy of that city. Indeed, the economic improvement can be the only way for achieving environmental and growth sustainability of a city (Watson, 2009).

Urban Spatial Structure

The urban spatial structure refers to "a cluster of concepts concerned with the arrangement of public space. The way that urban public space is arranged affects many aspects of how cities function and has implications for accessibility, environmental sustainability, safety, social equity, social capital, cultural creativity and economics" (Jacobs, 1961). Urban development also includes the transition from non-built to urban and functional changes, which is the change in major activities or land uses (Amin, 2007).

In Egypt, the urbanization can be described as irregular and unplanned. In cities, the land use at the margins of the city and along the highways is continuously changing, creating sprawls. These sprawls are caused by the population growth, economy, extension of public utilities of water, roads, etc. without plan or government control. The availability of utilities encouraged the unplanned and informal development and a change of the land use. This change in the land use has unfortunately caused a great consumption of the rich agricultural land that existed at the margins.

Sustainable Development

The term "Sustainable Development" has appeared in the late of the 20th century for the goal of reaching the ideal outcome of the planning policies (Wheeler, 1998). Wheeler defines sustainable urban development as "development that improves the long-term social and ecological health of cities and towns". Wheeler has described the characteristic of the ideal sustainable city as the city that is compacted with efficient land use, less transportation needs, efficient use of resources; minimum negative impact on the environment; the preservation of the natural systems; perfect housing and living environments; a healthy social ecology; a sustainable economy; community participation and involvement; and preservation of local culture and wisdom" (Wheeler, 1998).

Developed countries had applied some successful policies to sustain the development of their cities. In Oregon, Portland, for example, government had issued laws in 1973 that set boundaries to limit the urban growth. Such boundaries were to be able to accommodate the growth of the city for 50 years with full protection of farms and rural lands. Any construction beyond these boundaries was to have limited access to all utilities including water, sewage, education, health, etc. Furthermore, developed countries understood that successful planning is the one that takes into consideration a number of interrelated factors, long term and clear objectives, encourage the participation of all stakeholders with full government commitments (Shandas, Vivek; Messer, W. Barry, 2008).

However, the situation in the majority of the developing countries can be quite the opposite where most of the selected policies are characterized by its short term targets, did not take into consideration the interrelated factors or the opinions of the stakeholders and above all there were no adequate control on the implementation of the decided policies. In Egypt for example, this situation can be illustrated by the government inability to enforce major laws that organize expansion and control the loss of agriculture land. This government inability can be demonstrated by

the uncontrolled expansion of the informal settlements that is still an ongoing phenomenon. The government could not enforce even simpler decrees that organize the buildings standards such as those stipulating the maximum building height in an area or the replacement of villas by high rise buildings, the violations of these decrees can be considered as a major contributor to the expansion of the informal settlements.

URBAN DYNAMICS

One of the most important researchers in the topic of urban dynamics is by Jay Wright Forrester. In his book (Urban Dynamics, 1969), Forrester suggested many theories about the factors that affect the city sustainability. He further suggested that the relations between these factors are not linear and interrelated in a city or a government system due to the complex nature of that system. The following paragraphs would give insights about urban dynamics theories, the analysis thereof and some other related theories that can add to the topic under discussion. Forrester suggested that complex systems are counterintuitive as they give indications that may suggest corrective action which will often be ineffective or even adverse in its results. While the cause and effect are closely related in time and space in simple systems, in complex system the apparent cause to a symptom is usually found to be another coincident symptom. This theory would clarify the ineffectiveness of some of the government interventions that deals only with symptoms rather than causes of problems and therefore leads to frustration.

A city has been considered by many researchers as a highly complex social, economic and spatial system as it consists of two complex processes; the spontaneous development process and self-organization process (Amin, 2007). In cities, many components act on each other such as the land use, economics, transportation, etc. without clear or even linear relationship. With the understanding of the nature of the city system, we may be able to understand, for example, the expansion of the informal settlements, despite of the government low cost housing programs or the development of informal areas program. The failure of these programs may be referred to the complexity of the city system as the programs have apparently treated symptoms of houses unavailability rather than the main cause of the problem, which is the population growth.

- **The Attractiveness Principle**

The attractiveness principle states that, the population movement from unattractive areas to areas of greater attractiveness drives down the characteristics that it made it initially attractive such as prices, job opportunities, the environmental, the available housing, and the governmental services, as an equalizing process. This theory may explain the high rate of immigration from Egypt other cities into Greater Cairo, derived by the dream of job availability, better education and health care, etc., however, this movement into Greater Cairo has overloaded its utilities of water, health, sewerage, education, etc. and deteriorated the quality of the services offered by the city to its residents. If the attractiveness theory is true, the government should not provide more low-cost housing to solve the problem of informal expansion as this would only lead to an increase in the immigration into the city leading to an increase in the city population without improving the quality of life of that population. Instead, government should solve the main problem that led to the increased attractiveness of GC, from the first place, in order to maintain the quality of life in GC.

- **The Stagnant Conditions**

Forrester suggests that a city can exhibits a set of characteristics called "stagnant conditions" which include reaching excessive housing/industry ratio after a phase of population growth without prorate increase in the employment opportunities., which decreases the economic potential of the area. Forrester further suggests that governments should enforce laws that prevent excessive immigration of the poor into a city to avoid reaching the point where urban areas begins to collapse economically

and all population classes decline. Cities reaching stagnant conditions are those who apply policies that are attractive for the short run and inefficient in the long run. Forrester suggests as well that the two main components in determining mobility into a city are **jobs** and **housing.** These factors are major especially in developing communities like Egypt where almost half of the population are below poverty line. Attracted by the concentration of the economic activities in Greater Cairo and the associated generated jobs, population from other areas in Egypt could find their way to low cost houses that are available in the informal settlements to overcome the problem of houses affordability. This excessive immigration into the city has overloaded Greater Cairo utilities.

- **Maintaining Economic Balance**

Forrester suggests that leaders are responsible for taking necessary actions that would lead to a continuous renewal of the buildings, business, industry and the whole city. This can be achieved by selecting the proper policies and tax structure that would ensure that. In Egypt, for example, if leaders created a tax and legal systems that would encourage land and building owners to properly maintain their buildings, or even to demolish the degraded buildings, probably such systems would eliminate the informal expansions phenomenon.

- **Failures in Urban Programs**

During last decades, the Egyptian government introduced many different urban management programs such as creation of jobs (eg. public jobs programs), job training programs, subsidizing programs and low-income-housing programs (limited income programs), however, most of these efforts have failed to achieve the targeted results and even worsened the situation.

Forrester model, has shown the impact of introducing job programs, training programs and financial aids program. It was obvious that despite the short term positive impact of such introduction, however on long term the situation has gone through unfavorable results.

- **Urban Revival**

Instead, Forrester model favored some policies that would, in his opinion reverse urban decay. For example, the model simulation indicated that the construction of new enterprise would improve the underemployed/job ratio, however, it will not be sufficient alone to correct the economic imbalance. Another preferable policy is the demolition of the declining industry by establishing land clearing programs or a tax structure system that provide incentive for removal of aging structures as this measure would decrease the population of the declining enterprise and the new enterprise will increase. The model also indicated that a slum-housing demolition program can cause favorable change as land becomes available, new industrial construction will be established, which would create more jobs and reduce the underemployed/job ratio. On the same bases, some government policies such as discouraging housing construction and encouraging industry can prevent or reduce urban decline. However, this policy can face high resistance from the community.

- **Determining the Future Quality of a City**

Forrester further suggests that cities can influence its future by choosing between attractiveness components, which are; i) the quality of life in the city, or ii) inward migration and growth. These two are the "diffuse" and the "compartmentalized" characteristics of a city. He recommends that leaders should set constraints in respect of maximum population, permissible building height and number of jobs and housing units. In Greater Cairo, the government increased the quality of life, the diffuse characteristic, but did not pay much attention to the compartmentalized characteristics, by not offering the same quality of life level to Egypt other cities.

Urban Growth Patterns - Egypt

In Egypt, for example, around 45% of population lives in urban areas, and in case this is continued, it is expected that the Nile Delta will be an urban agglomeration of about 35 million inhabitants by 2025 (MOP and GTZ, 2004, page 4). In Cairo, the population growth is higher than the government ability to expand its infrastructure and provide basic services, therefore, the city is very dense with problems in transportation, drainage, sewerage and lack of usable spaces. As such, understanding the urban growth patterns is crucial at this stage for concluding the most appropriate policies for future sustainable development.

Urban growth patterns differs between developed and developing countries according to varying factors such as demographics, culture, level of economic development and political structure. At the same time, there are many similarities among the underlying dynamics that shape these patterns (Amin, 2007). Therefore, understanding how urban growth patterns change over time and space is critical to the understanding of a host of socioeconomic, natural and technological phenomena associated with the trends of urbanization.

There are two fundamental patterns of urban growth namely; **outward extension,** which is the spatial extent of city growth or urban sprawl mostly on agriculture land, and **internal reorganization** when existing elements deteriorate and new ones are introduced (Amin, 2007). In large cities, especially in developing countries, the speed of internal reorganization tends to be much slower than outward extension of the city (From Amin, 2007, based on Bayat and Denis 2000, Perlman 1990, Knox 1995, Sutton and Fahmi 2001, Myllyla 2001, Batty and Longley 1994). In fact, the major informal expansion in Egypt is at the peri-urban areas that exist at cities margins, which is consistent with the above theory.

There are many approaches used to model the historical pattern and accordingly forecast the future, which can be divided into two categories; 1) bottom-up models such as the GIS and the cellular automata that became more popular as it can impose dynamics to the collected data that can be used to test future scenarios, and 2) top-down models such as system dynamics model which is suitable for the investigation of socioeconomic models and the simulation of complex systems. This model can be used in analyzing the forces beyond the land use changes and testing policy implications for sustainable urban development (J. Han et al. / Landscape and Urban Planning 91, 2009).

Possible Scenarios for Future Growth Forecasts

The increased urbanization has caused series problems to the community, including loss of agricultural land, increase of sprawl settlements, increased transportation congestion and deterioration of the environment. This is in addition to the social, economic and political impacts that have been resulted from the emergence of mega-cities that accommodate more than 10 million people.

In his paper, Amin has used SLEUTH, a pattern extrapolation model, to envisage the possible future urban growth pattern change under three different scenarios with different conditions and during the same time frame from 2005 to 2030, all at Giza city. The three scenarios and results can be summarized as follows:

- First scenario "current trends": assumes that no development action will take place and that the current growth trend will continue at the same rates during the period from 2005 to 2030. The results indicated that the urban area at 2030 would be 103 sq. km with an increase of 25.5 sq. km., representing 132% increase over 2005 area which will result in a loss of 34% of the total agricultural land by 2030, i.e. around 6100 feddan (6344 *acres*) of rich agricultural area. The

results further indicated that the agricultural land around the ring road will be fully urbanized due to such growth.

- Second scenario "managed growth": it assumes future road development, parallel to the existing Mehwar road, with full environmental protection such as protection of canals. Based on the model, the projected urban area in 2030 would be 93.80 sq. km making a net increase of 15.67 sq. km., representing 120% increase. Accordingly, the agricultural land would be reduced by 21% by 2030, i.e. around 3750 feddan (3900 acres) of rich agricultural land.

- Third scenario "anti growth"; it includes the adaptation of anti growth strategy, by hindering the natural organic growth and increasing the development of urban settlements in undeveloped areas with more control on the growth of informal settlements. Under this scenario, the projected urban land will be 88 sq. km. in 2030, with a net increase of 10 sq. km. representing an increase of 113%. Under this scenario, the agricultural land is expected to be reduced by 13.6% by 2030.

The conclusion of the simulation results of the three scenarios, indicate that Giza governorate would lose around 1/3 of its rich agricultural area in case the current trends remained to prevail without any alteration from the government. Extrapolating the results of the simulation indicate that we might lose more **than 60% of our** rich agricultural land by 2050 that exists at the margin of Greater Cairo by 2050 in case the current trends were further continued.

Landscape and Urban Planning

In a study for urban growth assessment using an integrated system dynamics (SD) and cellular automata (CA) model for the purpose of assessing two main aspects; areal change of urban land driven by socioeconomic due to GDP, migration, etc. and spatial pattern of urban expansion affected by physical factors. The study was prepared for China government to reduce disparities between regions and urban-rural areas in order to achieve sustainable development. The study was principally made to understand the environmental impacts caused by urban growth to support the urban sustainable development by accurate estimation of the urban growth patterns (Ji Han, Yoshitsugu Hayashi, Xin Cao, Hidefumi Imura, 2009). Having nearly same overcrowding conditions, it is predicted that the outcome of this study can also be applied for GC. Already, most of the expansion of informal settlements is at the peri-urban areas (World Bank, 2008), which are at the margins of the existing urbanized areas. In case the government did not do any action to minimize this phenomenon, expansion of the informal settlements is expected to continue at high rates.

Relationship between Population Density and Development

Though many believe that the unemployment is an unavoidable consequence to the overcrowding conditions, many studies concluded the opposite. In a comparative study between the two unique areas in the Mekong Basin, the Tonle Sap area of Cambodia and the Mekong Delta of Vietnam, this relationship was extensively discussed (Keskinen, 2008). In this study, it was concluded that while the higher population density puts higher pressure on the natural resources and it can cause environmental degradation, it can provide large human resource base and a source for the creation of new ideas and innovations, which can reinforce the economic and social development, if these human capital were properly used. However, this would need the government intervention to support the education and scientific researches, otherwise these resources would overburden the country utilities and resources, making the development and growth of this country doubtable.

Cairo History: An Overview

Egypt is the most populous country in the Arab world and the second-most populous on the African continent. Nearly all of the country's 80 million people live in Cairo, Alexandria, on the sides of the

Nile, in the Nile delta and along the Suez Canal. In Greater Cairo (GC), the sum of the population in the three governorates is around 20 million persons. These regions are among the world most densely populated reaching to over 1,540 person per sq. km., compared to about 80 persons per sq. km. for the country as a whole and the population density in Cairo is around 45,000 person per square kilometer (CAPMAS, 2012).

Cairo was founded in AD 969, on land adjacent to Fustat and by the 14th century, Cairo become a metropolis dominating regional trade center but by the 17th century, Cairo had entered into a long period of decline. Only in the 19th century Cairo began to reassert itself politically and to enter into a process of economic growth and modernization. To accommodate the increased population, Cairo was subjected to several expansions, however and unfortunately, the newly extended areas could not be of the same style and quality standard of the old Cairo.

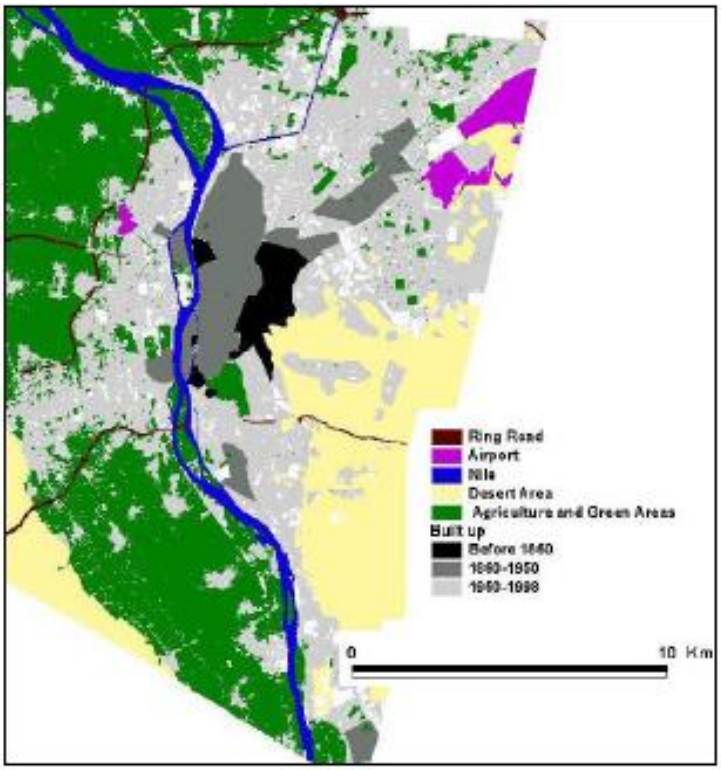

Figure 2 - The map shows the expansion of the main built up areas of Greater Cairo from before 1860 to 1998 ***Source: (Sims, 2003, p2)***

The population of Greater Cairo is currently around 20 million, which almost half of the country's urban population. The population of Cairo is characterized by its youth as over 33% of its population is less than 15 years old (CAPMAS, 2012). Greater Cairo is ranked the 7th largest metropolitan area in the world and one of the highest population densities (World Bank, 2008). Though it contains about 25% of Egypt population (CAPMAS, 2012), it contains the majority of economy activities. This can be demonstrated by the relative concentration of facilities and services in Greater Cairo, as 60% of Egypt cars, 50% of buses, 55% of university places and 46% of hospital beds, etc. exist in Greater Cairo serving around 25% of Egypt's population (World Bank, 2008).

The high population density has overloaded Greater Cairo facilities which resulted in a degradation of the main services such as health, transportation, environment, education, etc. Throughout the last decades, Egypt government has failed to implement adequate political actions as well as urban development policies that would improve the quality of life or, at least, improve the unemployment and poverty ratios in Egypt, which have reached very high rates. In Greater Cairo, more than 50% of the population lives in informal settlements under very poor living conditions. On the other side, the dominating government policy was the construction of new towns hoping that it can accommodate the residents of the informal settlements. However, the very high standard of the buildings together with the lack of mass transportation facilities at the new towns restricted these new establishments on the high and medium income population.

Slums in Cairo

The informal settlements accommodate between 50% and 60% of Greater Cairo population (World Bank, 2008). In a study made in the late 1990s, it was estimated that the dead assets of the urban

informal areas is around 248 billion USD which is 30 times greater than the market value of the registered companies in Cairo and 55 times greater than the direct foreign assets since Napoleon invasion in Egypt (De Soto, 1997). The significance of these investment amounts should force the government to seek solutions to best serve these communities.

Taking into consideration that the informal settlements posses social capital and high economic value which is underestimated and underused because of their illegal status, the government is in need to establish efficient policies to benefit from these underused resources (Khalifa, 2011). In the mean time and despite that the natural organic growth in Egypt is around 1.8% annually, the natural organic growth in the informal settlements are much more higher than this rate as it reaches 7% in some settlements (World Bank, 2008).

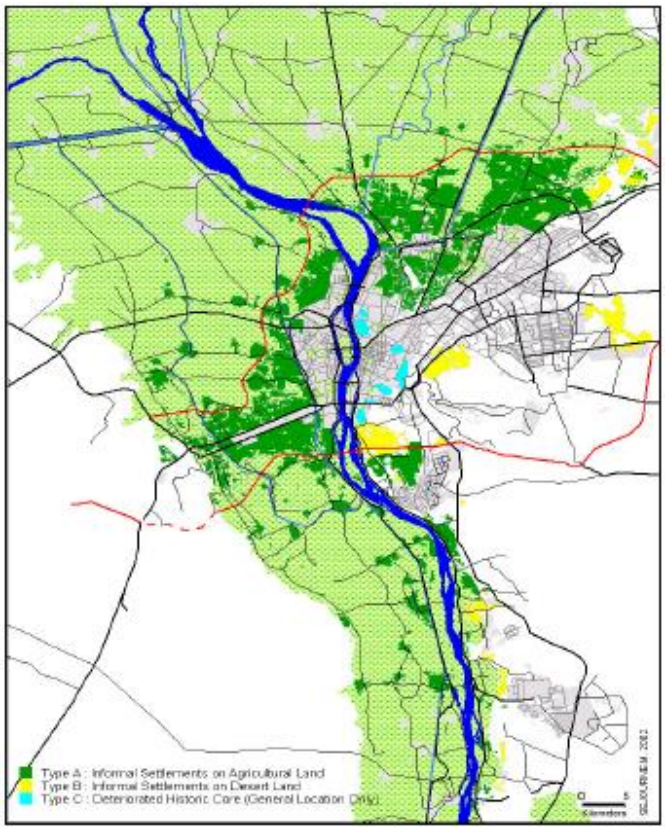

Figure 3 - Slums expansion. Source Sims 2003

In 2003, satellites images indicated that the construction on agricultural land is triple the formal expansion (Sims, 2003). During the period from 1996 to 2006, the informal sector produced around 45% of the new urban housing in order to accommodate the low income population (Paulo, 2008). Though there is no accurate statistics, this rate of growth of the informal sector is expected to have been continued at same rate. In the past, Ministry of Urban Planning in Egypt has divided the slums into four main types as follows:

- Type A (represents around 80% of the informal settlements according to the World Bank study of 2008), which are the informal settlements on private and former agricultural lands. Residence has purchased the land formally from farmers and constructed houses without building permits, though the houses are generally of a good condition. Since the issuance of **Military Law in 1996**, building on an agricultural land has become a criminal act.

- Type B (10% of total informal settlements); is the informal settlements on state owned land. While this can be considered as land invasion and construction without permits, this action can be accepted under the laws of customary rights. In this type, houses are of lower quality and very crowding conditions.

- Types C & D; these are the deteriorated sections of the old city core, which composed of the buildings that were constructed pre-1860 of old Cairo and urban pockets. The buildings are often in a bad condition due to ownership disputes and lack of maintenance resulting from rent control law. The majority of these slum types are in unsafe conditions, however, this group is very insignificant.

However and as a trail to prioritize its interventions, the government has redefined the slums in 2009 according to the severity of risks on the residents of these slums. They categorized them into two groups, "unplanned" and "unsafe" areas. The Informal Settlement Development Facility "ISDF"

established the presidential decree no. 305/2008 (ISDF, 2009) that defined the unplanned area as areas developed in contradiction to planning and building laws and regulations and unsafe areas that posing risks to life, health or tenure or having inappropriate housing condition (General Administration of Planning and Plan Monitoring, 2008).

These risks might be due to the buildings experiencing several deterioration over time, being located in hazardous site or exposed to damaging health conditions such as lack of safe drinking water or basic sanitation" (ISDF, 2009). ISDF has further categorized the unsafe areas into four grades according to the severity of the risk that these buildings impose. According to this categorization, there are 404 unsafe areas in Egypt that contain 212,201 housing units and accommodate around 1.1 million of population (ISDF, 2009). Those inhabitants are obviously in need to an urgent support to improve their living conditions.

Origin of Slums & Dynamics of Informality

Unfortunately, the most dominant types of slums in Greater Cairo are Types A and B, which contain over half of Greater Cairo's population. The following historical part will give insight about the dynamics of the informality phenomenon in Greater Cairo over the last decades.

- In late 1940s, there were no local urban affairs and the central ministries were controlling without planning mechanism or guiding master plan. Urban development was controlled by the Subdivision Law (52 of 1940), which stipulate quite high standards for any construction that were inspected before sales could begin. Up to 1950, the Egyptian Government did not undertake any public housing project. In 1947, population in the Greater Cairo was around 3 million people and was increasing at 4% annually due to the internal migration and natural organic growth, while construction activities were frozen during the war years (Sims, 2003). Thereafter, the city's economy had enjoyed a boom, and Cairo's industrial projects soon started to increase rapidly benefiting from the high import tariffs, and supported by the existing infrastructure of roads, bridges, railways, trolley lines, water and wastewater systems and electricity. Accordingly, Cairo expanded out of the historic Eastern Town "downtown", mostly to the north and to the south. At that time, there were sub-standard houses (Slum Types C and D), especially in Rod el Farag, Boulaq, and historical parts of Cairo. Unplanned extensions were very limited in some regions such as Mit Okba, Embaba, Kom el Gharab, etc.

- From 1947 to 1967, the majority of Cairo expansions were at the expense of agricultural land, examples of Mohendesiin, Dokki, Hadaek el Quba, Abbassia and Shobra. By 1960, Cairo population reached 4.9 million inhabitants, with a growth rate of more than 4% per annum. Growth continued to be to the north, encouraged by the newly established industrial areas of Shobra el Kheima and by numerous public housing projects and factories located adjacent to agricultural land (Ameria, el Wayli, Zawia el-Hamra, etc.). The first Master Plan of Cairo was published in **1956**, which indicated the need for east west expansion into the desert flanks. Accordingly, in 1958 the Government launched the Nasr City scheme, and by 1965 almost 15,000 units for low-income families were constructed (Abu-Lughud, 1971, p. 231). However and according to the maps, informal settlements phenomena began to increase in the **mid-1960s** as the case of Boulaq el Dakrour, Basatiin, and Embaba (slum Type A) and Manshiet Nasser (slum Type B), all are in the margin of existing villages. At that time, building permit was not required for construction outside city premises, so there were not any control on these buildings.
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Figure 4 - Example of El-Qanayat city, Sharqya governorate where unsafe areas are not parts of unplanned areas. *Source: ISDF, 2009*

- During the 1967 war with Israel, the war of Attrition, and the 1973 war, formal development activities in Cairo were completely ceased as all funds went to the war budget while demographic growth has continued due to natural growth and internal migration, in addition to over one million people evacuated from the Suez Canal zone into Cairo. Accordingly, the informality has further increased to accommodate such population growth without much resistance from the government. These fringes include all of Dar es Salaam & Basatiin, vast areas of Embaba, and most of Boulaq el Dakrour, , Zawia el amra, Amrania - South Giza etc. Also, significant outward expansion from core villages was registered, as the case of Saft el Leban and el Baragil.

- As of 1974 and after the "infetah", the economic conditions in Egypt improved, the financing of infrastructure resumed (the 6th October Bridge for example). Also and with the oil boom in 1973 (and later 1979), neighboring countries (Saudi Arabia, Libya, and Iraq) became rich and started to hire Egyptians to do their work. However, most of the Egyptian earnings accelerated the development and expansion of informal areas in Cairo as during the period from 1971 to 1981, **80% of the constructed houses were informal** (ABT Associates, 1981). The series of decrees that were issued by the government as of 1978 to control this phenomenon could not have real impact.

- In 1977, the government launched the new towns and started the establishment of 10th of Ramadan City and formalized the Law of New Communities in 1979. The new towns movement was (and still) dominating Egypt's urban development and budget plans as there are 39 new towns in Egypt.

- Between 1982 and 1987 informal development had slowed, maybe due to the government control, the drop of the world oil prices in 1983-84, the restrictions that were applied to Egyptian

workers at the neighboring countries, or the reduction in the growth rate to 1.9% during the period 1986-1996 and decreased migration into the city. The slow down of informality may also be due to the issuance of two decrees in 1996, which stipulated that any new building on agricultural land and any urban construction without a construction permit, would be significantly punished through military courts. However, this slowing down of the informal expansion did not continue as illustrated by the satellite images from 1991 to 1998 which indicate that informal expansion on mostly agricultural land is ongoing **three times higher than expansion of** formal settlements (CEDEJ 2002). Also satellite images during the period from 1996 to 2006, indicated that the informal settlements produced around 45% of new urban houses (Paulo, 2008)

Impact of Urbanization

The growing urbanization especially along the highways and city margins led to increased population density in Egypt cities, putting high pressure on cities utilities. Also, the lack of urban planning and lack of enforcement of building laws have led to changes in land use of cities lands.

A comparison for the satellite images in 1984, 1990 & 2006 was made for the purpose of detecting the distribution of the urban areas, cultivated areas, cultivated to land, desert, base soil and water bodies (Hassan, 2011). The following outcome was concluded:

Table 1 - Percentage of LU/LC classes in the study area. ***Source Hassan, 2011***

LU/LC (Land use/cover)	**1984 (%)**	**1990 (%)**	**2006 (%)**
U (Urban areas)	12	25	29
CL (Cultivated land)	24	17	11
CU (Cultivated to urban)	23	22	25
D (Desert area)	35	32	30
BS (Bare soil)	4	3	4
WB (Water bodies)	2	1	1

The increased urbanization throughout the years increased the demand on the housing, which consequently increased the cost of houses. Some recent studies indicated that the demand for houses is between 400,000 & 500,000 housing unit per year while the supply of the private and public sectors together is not more than 200,000 housing unit per year, which is less than half of the demand (USAID Prime Research, 2011). As such and with the lack of enforcement of building laws, the informal houses remained the affordable solution for the urban poor residents.

The Ministry of Planning, with the German Technical and Financial Cooperation described that the reasons beyond the informal urbanization of the agricultural land as follows (MOP and GTZ, 2004, p5) and further confirmed by (Madbouly, 2005).

- The land prices for houses built on agricultural land are higher than the value of the agricultural products.
- The existence of ground water in the agricultural area
- The private ownership of the agricultural land
- The control of law in not so strict
- Proximity of the agricultural land to the city premises
- The unavailability of alternatives for informal houses within the new towns
- Low trust level in governmental policies

Administration and Centralization

Greater Cairo is currently consists of three governorates which are Cairo, Giza & Qalubia. Despite that there are no borders between the three governorates, there is no administrative entity for the due coordination and the implementation of the urban development plans in these governorates. Many experts argue that the urban problems in Cairo have not been caused by the absence of proper urban plans but rather due to the lack of implementation of the drawn urban plans. During the last decades, all the authorities were centralized at the hands of the government, with very limited authorities left to the governors for the applications of policies suitable to the situation at the governorate that they administer. With this administrative organization, no policies were decided at the level of the governorate. In such situation no one can anticipate development by the application of unique decisions.

Symptoms of Greater Cairo Decline

It is clear that high population density of the Egyptian cities, over than the cities facilities and utilities can accommodate and without adequate control from the government are the main cause for the deterioration of the cities conditions. The high population density, without enough jobs, drives prices up and overloads the job opportunities, the environment, the available housing, as well as the governmental services.

Poverty

In Egypt, the number of households that live at or below the poverty line has been increased dramatically during the last years. Unfortunately, statistics about poverty are not consistent while the official published data is inaccurate and underestimating the poverty rates. It is estimated that around 8% of population are extremely poor (living on less than 1$ per day) while the overall poor people who are unable to have minimum adequate diet is estimated to be 44% of the population (Pfeifer, 1999). According to the World Bank poverty measures, 44.4% of the Egyptian population is classified between extreme poor and near poor, assuming that they spent all their income on food (Abdel-Hameed, 2007). Despite the increase in the GDP, it is estimated that the poverty has significantly increased in the recent years due to the extremely high inflation rates (15.1%). Consumer prices particularly increased by 25.6% between 2007 and 2008 (CAPMAS), and as the poor spent around half of their income on food, the poverty must have been increased during last years.

Table 2 - Food Subsidies Distribution between the Poor and the Better-off

Total (%)	Better Off (%)	The Poor				Items
		Total (%)	Near Poor (%)	Moderate Poor (%)	Extreme Poor (%)	
100	62	38	20	14	4	Baladi Bread
100	96	4	3	1	0	10-piaster Bread
100	57	43	23	16	4	Ration Cards Subsidies
100	62	38	20	14	4	All Food Subsidies

Source: World Bank. 2007. Arab Republic of Egypt: Poverty Assessment Update. Washington, D.C.: The World Bank.

Notwithstanding the foregoing increase in the poverty rate, the average GDP per capita in Grater Cairo is relatively higher than the average GDP per capita in Egypt (UNDP). This may be referred to the concentration of the economic activities in Greater Cairo which can generate jobs to GC residents and to residents of the neighboring governorates. The imbalanced income distribution can be the main contributor beyond the relative decrease of the poverty rate in Cairo (around 10%) than Egypt other cities and towns with a high poverty rate that reach to 69% in some governorates, (CAPMAS, 2012).

Unemployment

Egypt Human Development Report, UNDP, Egypt, 2010, estimated that the overall unemployment rate is 12% while 46.1% of population aged between 15 to 25 years are unemployed. Statistics also indicate that the unemployment rates are higher in urban areas than in rural and, surprisingly, higher among the educated than among the uneducated population. In addition, around 31.2% of working population is working in the public sector.

Degradation of the quality of services

The degradation of the quality of life can be illustrated by many indicators such as the transportation over congestion, pollution, education and health care services, etc. As Greater Cairo was designed to accommodate less than half of the current population, the degradation of the quality of life can be considered normal phenomenon. In transportation, statistics indicated that less than 15% of Greater Cairo population own private car (Sims, 2003), and transportation congestion is expected to get even worse overtime. While the streets in Greater Cairo can accommodate not more than 450,000 vehicles, the number of vehicles in 2007 was around 1.2 million vehicles (UNDP, 2008).

GOVERNMENT INTERVENTIONS

Several interventions were introduced by the Egyptian government as trails to improve the quality of life in the major cities like Cairo.

The New Towns and Urban Extensions

One of the major interventions of the Egyptian government was the development of new towns as urban extensions such as 6th October, 10th Ramadan, Badr, etc. For these new towns, the government provided the roads and infrastructure while the private land owners/companies were responsible for the construction of the buildings. However, the self-sufficiency objective of these new establishments was not reached as its residents are actually working in other parts of the metropolitan area while many others from elsewhere in the metropolitan area work in the new towns.

As a matter of fact and based on the outcomes of the new towns during the last ten years, these new developments has caused more pressure on the city transportation facilities, increased the transportation costs and wasted a great portion of the fuel causing an even more deterioration to the environment. Besides and due to the high price of the houses at the new towns, one can say that these new towns could not, in anyway, solve, or at least improve, the living conditions of the poor who live in informal areas (around 50% of Cairo population). As a matter of fact, all new towns around Greater Cairo accommodated only around 14% of the population increase from 1996 to 2006 (World Bank, 2008), which would illustrate the failure of the new towns policy.

Table 3 - Peri-urban share of Greater Cairo's Population and Growth 1996-2006

Greater Cairo Region	1996 Population	2006 Population	% Annual Increase	Absolute Increase	Share of Absolute Increase
Core Agglomeration	10188333	11748240	1.43%	1517102	50.3%
Peri-urban areas	2857468	3942262	3.27%	1084794	35.9%
New towns	184695	601767	12.54%	417072	13.8%
Total GC	13230496	16292269	2.1%	3018968	100%

Source: CAPMAS, derived from 1996 Census and preliminary results of 2006 Census

In the meantime, Egypt urban planners argues that new towns could have achieved some success if the urban plans were implements as designed. Urban planners have actually referred the failure of

the new towns policy to the non construction of railway lines to connect between the new towns and the city, as it was planned (Dr. Omr El-Hoseiny, 2012).

Low Cost Housing Program

In 1958 the Government launched the Nasr City scheme, and by 1965 almost 15,000 units for low-income families were constructed by the Egyptian government (Abu-Lughud, 1971, p. 231). Thereafter, several National Housing Programs were released by the government to support the low income groups and youth, and the following main programs were released.

- NUCA constructed 237,000 public housing unit during the period from 1982 to 2005, 80% of these houses were constructed in the new towns,
- Mubarak Youth Housing Program constructed 68,400 public housing unit during the period from 1996 to 2005, 83.3% in new towns, and
- NHP program (2005-2011) targeted 500,000 units within a six year period and as of end of December 2009, 235,000 units and land plots have been built or delivered to beneficiaries, while some 190,000 units were still under construction.

However, these programs are very expensive for the government. According to studies, the government spent around USD 5 billion during the past 25 years, which is around 0.7% of the GDP (Paulo, 2008). Besides, it was not appreciated by the poor as it required a contribution from the low income groups and the youth beyond their financial capabilities.

Further other different forms of government interventions have been deployed such as:

- **Laws for Rent Control & New Rent Law**
- **Programs to Improve Informal Areas**
- **Enforcement of laws**

However, the situation is too complicated to be solved by such above mentioned interventions without having the appropriate integrated views of all related aspects.

Impact of Government Policies

In order to resolve the apparent problem of Greater Cairo which is the lack of availability of affordable houses and the continuous expansion of informal settlements, the government believed that the best course of action to resolve this apparent problem is to establish programs for the provision of affordable houses. From the other side, the government also started many programs for the development of the informal settlements by connecting these settlements with the utilities network. In doing so, the government did not take into consideration the illegal situation of the houses constructed in the informal settlements.

In the long run, these programs can be considered that have increased the expansion of informal settlements. Has the government enforced the prevailing laws related to buildings and removed illegal buildings, many would have refrained from constructing any building prior issuing building permit. Maybe if the government has instead re-distributed its expenditure into all Egypt governorates in a balancing manner, the internal immigration into GC would have been minimized or even reversed into the other way round. In this case the re-distribution of the government expenditure may act as pushing factor to GC residents to push them to immigrate into other places.

The System Thinking Model (Causal Loop Diagram)

In the light of above discussed issues, a causal loop diagram was developed as an attempt to understand the complexity of the urbanization in Egypt, specifically with respect to Greater Cairo GC. The model is shown in figure 5. The model shows different feedback loops which contribute to the development of the GC problem, such as:

- Attractiveness Balancing Feedback Loop
- The Quality of Life in GC Balancing Feedback Loop
- Slums Expansion Reinforcing Feedback Loop
- Economic Balancing Loop

The Simulation Model

The model indicates the stock and flow structure of the urban dynamics of Greater Cairo together with the government policies that were adopted during last decades as possible solution for the socio-economic and environmental problems that are suffered by the Egyptian community and the residents of Greater Cairo.

The simulation model shows that when the gap between the demand and the supply increases, the expansion of the informal settlements increases, which hence increases the population who live in informal settlements. The expansion of the informal settlements with the absence of any constraints on the building heights, width of roads etc. increases the population density in GC, which puts high pressure on all existing utilities and facilities and causing degradation in the quality of life. This degradation in the quality of life is highly felt by all Greater Cairo residents.

Beside the gap between the demand and supply of affordable houses, the model also indicates that the factors that have encouraged the expansion of the informal settlements are the profitability of the conversion of land into building lands, the lack of enforceability of laws and the culture of the Egyptian community that tends to avoid uncertainty. The model also indicated that the establishment of new satellite communities can be one of the solutions for the elimination of the expansion of the informal settlements.

The model also indicates that the concentration of the economic activities in GC has relatively increased the quality of life and per capita income in GC, when compared with other governorates. Attracted by the relatively higher income in GC, population from poor governorates, who suffer high poverty rates, migrated into GC hoping better income. Different assumptions and limitations of the model can be consulted in the original work (Fahmy, 2012).

SIMULATION MODEL FORMULATION

Table 4, shows the assumed parameters, initial values and ranges used in the stock and flow diagram.

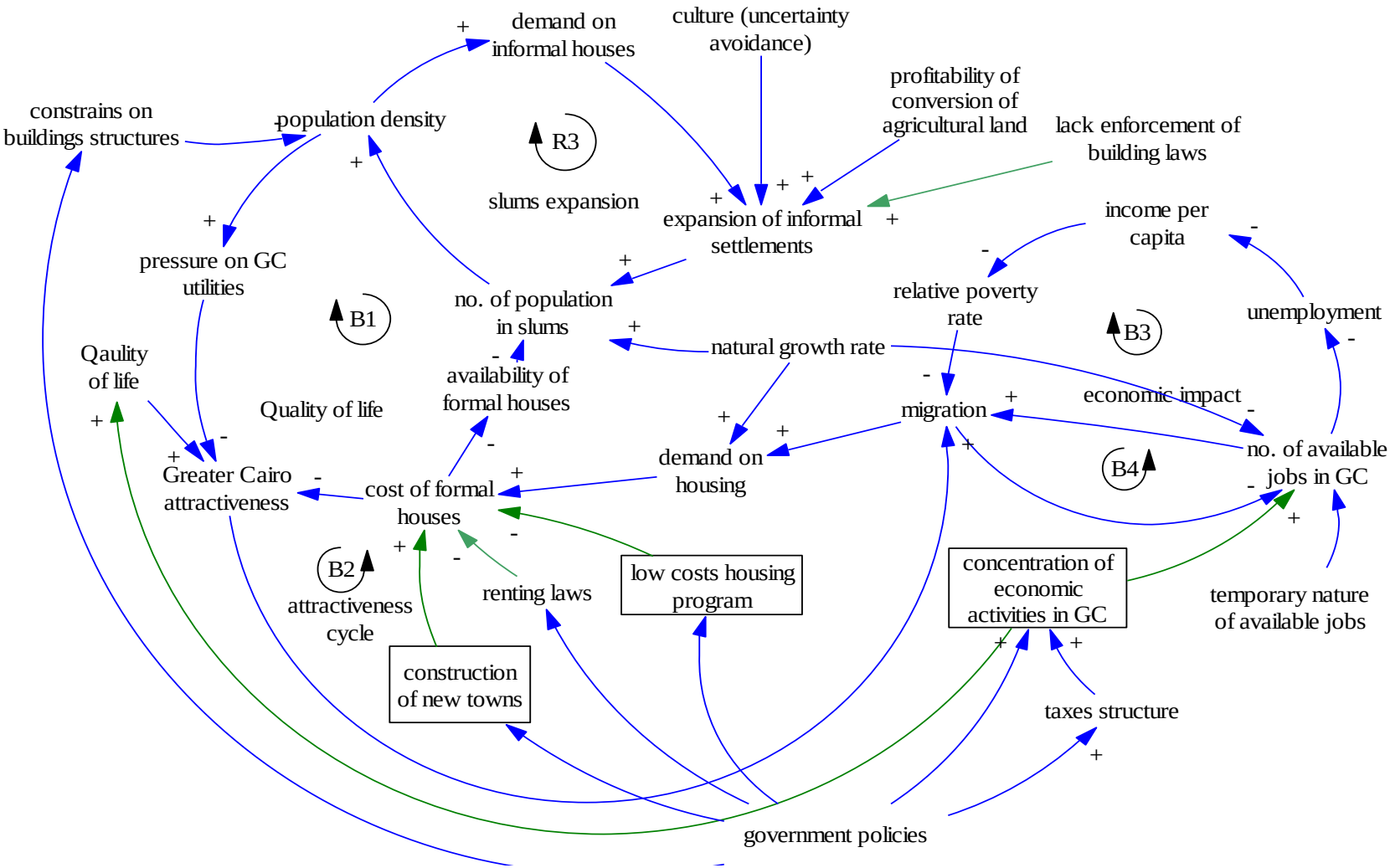

Figure 5 - The Overall Model with the impact of government polices on urban dynamics

Table 4 - Reference Mode Input Parameter s

No.	Parameter	Units	Value / Range
1.	Greater Cairo Population	Person	20,000,000
2.	No. of population in slums	Person	10,000,000
3.	Official poverty rate in GC	Percentage	16%
4.	Official poverty rate in rural areas at upper Egypt	Percentage	69%
5.	Current area of informal settlements	Km2	200
6.	Profitability of agriculture land	Dimensionless	6-8 times
7.	Enforcement of Laws	Dimensionless	3.9 /10
8.	Culture (uncertainty avoidance)	Dimensionless	80%
9.	Demand on formal houses	Housing Units/year	500,000
10.	Supply of formal houses	Housing Units/year	200,000
11.	Concentration of economic activities	Dimensionless	60%

Model Validation and Initial Run

The model was first reviewed and validated by the subject matter experts in the field, through semi-structured interviews. Then, the model was tested using initial runs with extreme initial conditions values for the relative concentration of economic activities. The output of the initial runs confirmed that the model behaviour over time is consistent with the assumed relations between the different parameters.

The model was tested under the following cases:

- Under the normal trends of 60% concentration of economic activities
- In case the concentration of economic activities increased up to 90%
- In case the concentration of economic activities decreased to 40%

POLICY ANALYSIS AND SCENARIOS

Proposed Scenarios Planning

In order to analyze the effect of changing certain parameters on the behavior of the system and to conclude the best scenario for sustainable development of the quality of life of GC residents, the following scenarios were examined and the analysis of the outcome is included hereinafter:

- Scenario 1: Increase the supply of low costs houses from 50,000 housing unit per year to 150,000 housing unit per year, without changing any other parameter: in this scenario, we will assess the effect of increasing the supply of low or limited income houses from 50,000 housing unit per year to 150,000 housing unit per year on GC population, shortage of houses units and expansion of informal settlements, based on the outcome of the model run.
- Scenario 2: Reduce the concentration of economic activities, without changing any other parameter: in this scenario we will assess the effect of reducing the concentration of economic activities from 60% to 50% on GC population, shortage of houses units and expansion of informal settlements, based on the outcome of the model run.

- Scenario 3: Increase the enforcement of law, without changing any other parameter: in this scenario we will assess the effect of increasing the enforcement of laws on GC population, shortage of houses units and expansion of informal settlements, based on the outcome of the model run. It will be assumed that the government shall strictly enforce the law, especially those laws that prevent any construction on agricultural land or any construction without building permit.
- Scenario 4: Adjust renting laws, without changing any other parameter: in this scenario we will assess the effect of adjusting renting laws on GC population, shortage of houses units and expansion of informal settlements, in view of the outcome of the model run. For adjusting the renting laws, the government can cancel the old renting law "rent control law", or any other possible solution that will convince owners to offer their houses for rent.
- Scenario 5: Establish new nuclei without changing any other parameter: in this scenario we will assess the effect of establishing new nuclei on GC population, shortage of houses units and expansion of informal settlements, according to the outcome of the model run.
- Scenario 6: apply set of policies, including; establish new nuclei, reduce the concentration of economic activities, adjust renting laws, increase the enforceability of law and shift the population culture. In this scenario we will assess the effect of establishing new nuclei on GC population, shortage of houses units and expansion of informal settlements, according to the outcome of the model run.

DISCUSSION AND FINDINGS

The first scenario is based on the analysis of what if the government increased the supply of affordable low costs houses. The outcome of the model run indicates that the adaptation of this scenario would have no impact on the population growth rate. The increased supply of low cost houses will eventually reduce the shortage of the affordable houses. From the other side, the increased supply of the low costs houses (limited-income houses) has increased the attractiveness of GC that resulted in increased population growth. This increase in the population at GC has further increased the population density, making more pressure on all GC utilities and increasing the demand on the houses. In impact, the reduction of the expansion of informal settlements will not be significant. Beside of the foregoing, this strategy can consume a great deal of the government budget that would hinder the establishment of the mega productive projects, which can be the main approach for reducing the poverty rates in Egypt. Accordingly, this scenario is proven to be inefficient.

The second scenario is based on the analysis of what if the concentration of economic activities in GC is reduced from 60% to 50%. The savings from this reduced expenditure can then be used by the government in improving other parts of Egypt, whereby the poverty rates is very high. The outcome of this scenario indicated slight favourable results in the long run in terms of population growth, shortage of affordable houses and expansion of informal settlements area. The figures indicate that the reduction of the concentration of economic activities has actually reduced the relative poverty rate and therefore reduced the attractiveness of GC. Thus, the population growth rate was slightly reduced and the demand on affordable houses was reduced which reduced the expansion of informal settlements. However, the impact of this scenario alone is very insignificant as the natural organic growth in GC is already causing an increase in the population growth rate.

The third scenario is based on the analysis of what if the government managed to increase the enforceability of laws that are related to the construction regulations, such as these laws that prevent any construction without permits and any construction on agricultural land. However, in this scenario, no other parameters were adjusted or any alternative were considered for the population who seek affordable houses. As indicated in the output of the simulation run, all the selected parameters will not be changed due to the increased enforceability of laws. As Greater Cairo

population growth will continue at nearly the same rate, the demand on housing units will not be changed. Without increasing the supply or giving alternative places for the population natural organic growth, the community will resist the enforceability of laws and will have no alternative but to continue in the expansion of informal settlements.

The forth scenario is based on the analysis of what if the government managed to adjust renting laws. As explained earlier, the existing renting laws are reducing the availability of the houses units that are available in the supply market. The goal of the adjustment of renting laws shall be to encourage the houses owners to offer their houses for rent. As can be concluded from the output of the model run under this scenario, the adjustment of renting laws would increase the supply of houses and reduced the shortage of affordable houses and accordingly, the expansion of the informal settlements would be slowed down. Though Greater Cairo population growth would continue at same rate, but the quality of life would relatively be improved due to the expansion of the informal settlements.

The fifth scenario is based on the analysis of what if the government has established new nuclei at new locations. The selection of the new nuclei locations shall be based on resources that are available at these locations and has not been used previously. The goal of these nuclei is to best utilise these underused and undiscovered resources in the establishment of new productive communities that can self-sustain. Sinai or the Western and Eastern Desert whereby there are many undiscovered resources can be good locations for the new nuclei. The model run indicated that the implementation of this scenario would not make any difference for Greater Cairo population growth, the shortage of houses or the expansion of informal settlements. In fact, the community non acceptance to move into these new nuclei can prevent the success of these new nuclei. Apparently, the current community culture of high uncertainty avoidance and the low enforcement of laws that fastened the expansion of informal settlements have discouraged the community to try out these new nuclei.

The six and final scenario is based on the analysis of what if the government has adopted a set of policies for the reduction of the population growth, the shortage of affordable houses and the expansion of informal settlements. These set of policies include the reduction of the concentration of economic activities in GC, adjusting renting laws, increase the enforceability of laws and the establishment of new nuclei, together with some measures that would lead to shift of the culture. While these set of policies appear to be significant but it appears to be the only effective approach for improving the escalating problems of Greater Cairo. As can be concluded from the related figures, the creation of new nuclei could achieve successful results and attract GC population with the support of the government policies of reduction in the concentration of economic activities and shifting the community culture of high uncertainty avoidance. Also the increased enforcement of construction laws with the availability of alternative living area at the new nuclei for the population has reduced the expansion of informal settlements. The outcome of the model run under this scenario showed very favourable results, in both the short run as well as the long run.

In fact, the findings of the model runs confirm the model assumptions and relations. The findings confirm that the government can improve the quality of life at Greater Cairo, not by increasing expenditure in the city but rather by supporting the establishment of new nuclei. Government support of new nuclei should not be only financial but rather, with the strict implementation of laws in all community. Also and for this strategy to succeed, the government should take measures to shift the community culture of favouring the uncertainty avoidance which preventing the population from trying out new places or new life style at the new nuclei. This culture change can be achieved by the cooperation with the NGOs, encourage the participation of the community and increase the community awareness by enhancing education services.

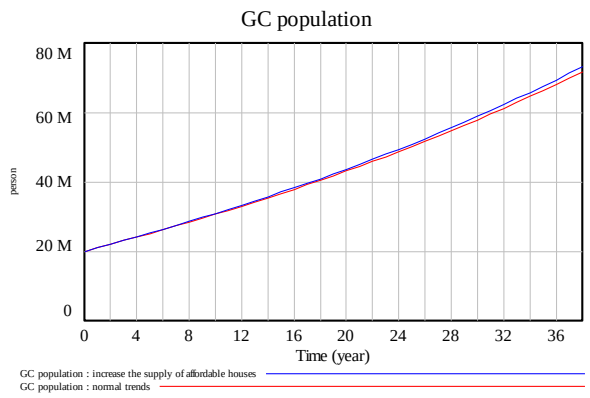

Figure 6a – [Scenario 1] The effect of increasing the supply of affordable houses on GC population (2012-2050)

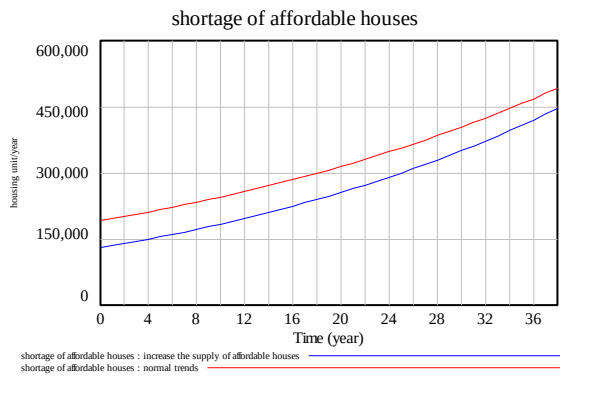

Figure 6b - [Scenario 1] The effect of increasing the supply of affordable houses on the shortage of affordable houses (2012-2050)

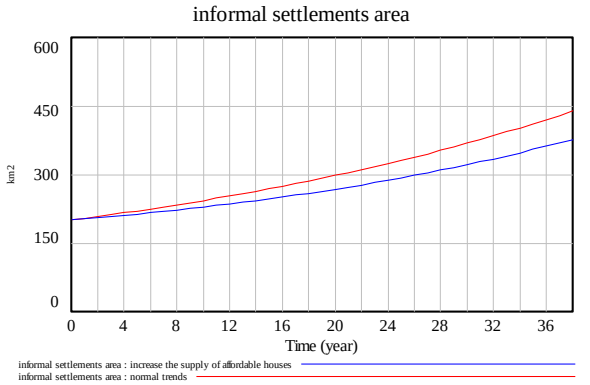

Figure 6c - [Scenario 1] The effect of increasing the supply of affordable houses on informal settlements area (2012-2050)

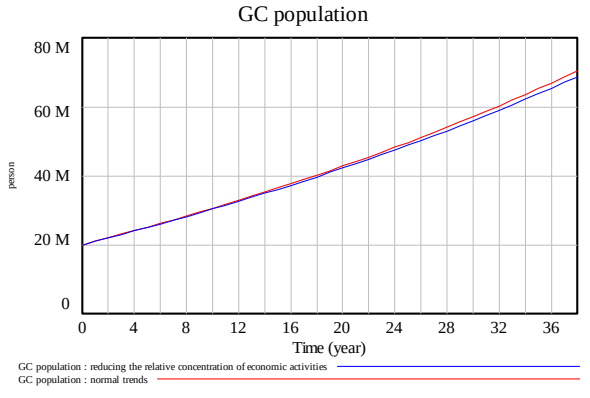

Figure 7a - [Scenario 2] The effect of reducing the concentration of economic activities on GC population

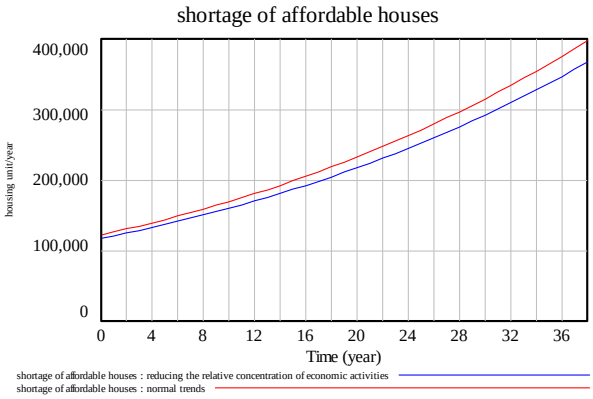

Figure 7b - [Scenario 2] The effect of reducing the concentration of economic activities on the shortage of affordable houses (2012-2050)

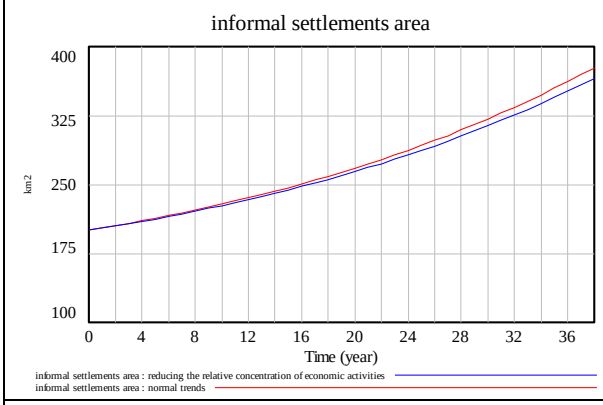

Figure 7c - [Scenario 2] The effect of reducing the concentration of economic activities on the expansion of informal settlements (2012-2050)

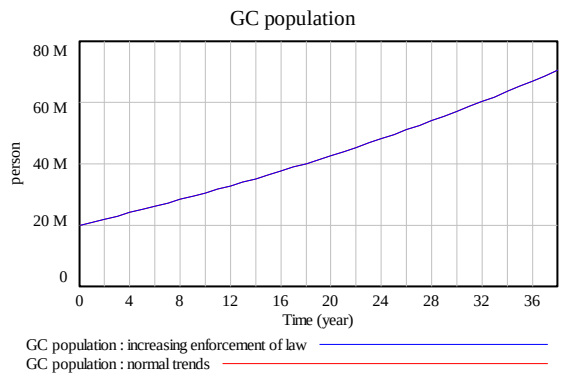

Figure 8a - [Scenario 3] The effect of increasing enforcement of law on GC population (2012-2050)

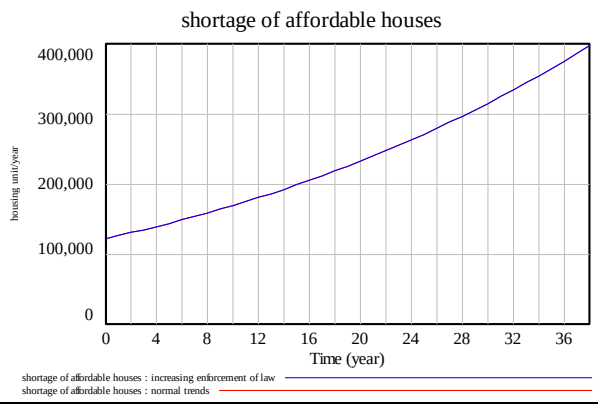

Figure 8b - [Scenario 3] The effect of increasing enforcement of law on the shortage of available houses (2012-2050)

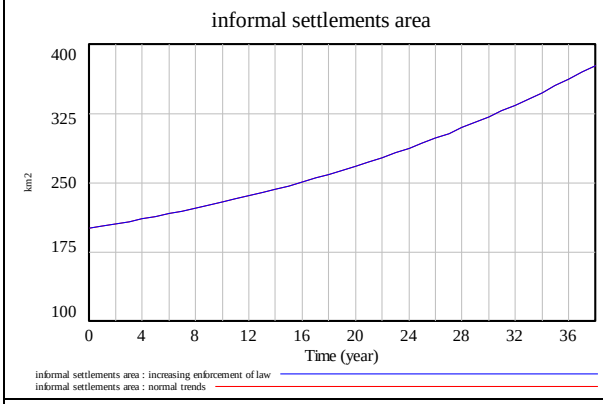

Figure 8c - [Scenario 3] The effect of increasing enforcement of law on the expansion of informal settlements (2012-2050)

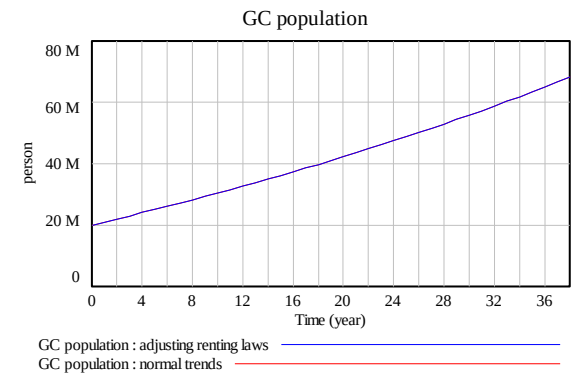

Figure 9a - [Scenario 4] The effect of adjusting renting laws on GC population (2012-2050)

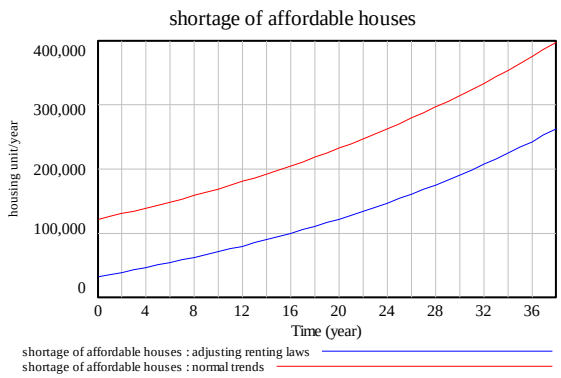

Figure 9b - [Scenario 4] The effect of adjusting renting laws on the shortage of affordable houses (2012-2050)

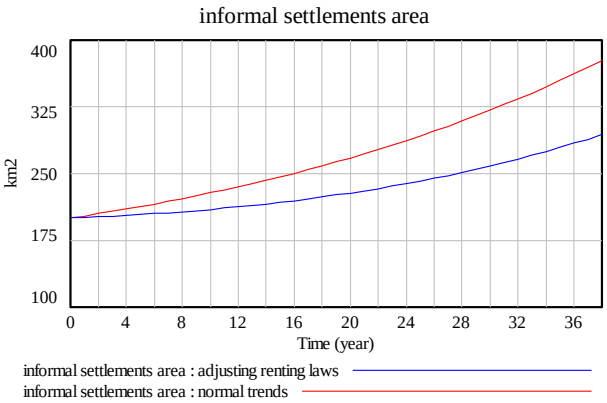

Figure 9c - [Scenario 4] The effect of adjusting renting laws on the expansion of informal settlements (2012-2050)

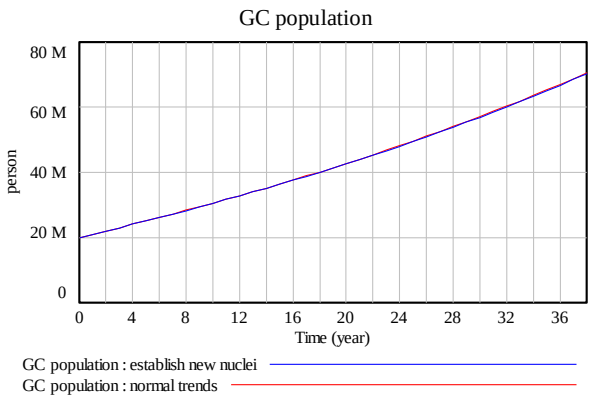

Figure 10a - [Scenario 5] The effect of establishing new nuclei on GC population (2012-2050)

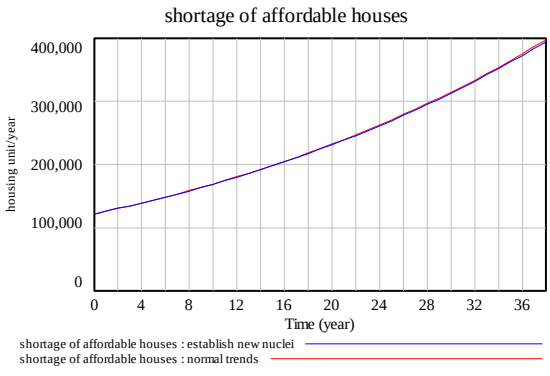

Figure 10b - [Scenario 5] The effect of establishing new nuclei on the shortage of affordable houses (2012-2050)

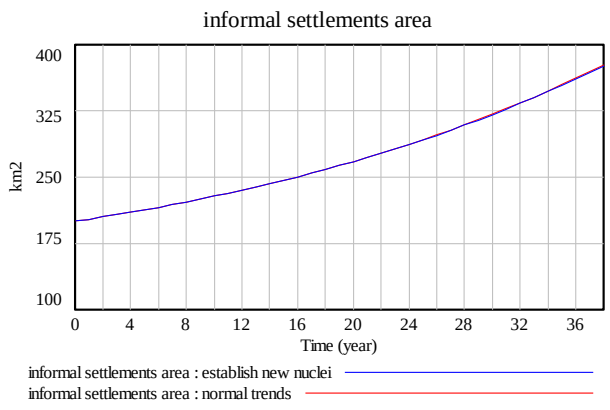

Figure 10c - [Scenario 5] The effect of establishing new nuclei on the expansion of informal settlements (2012-2050)

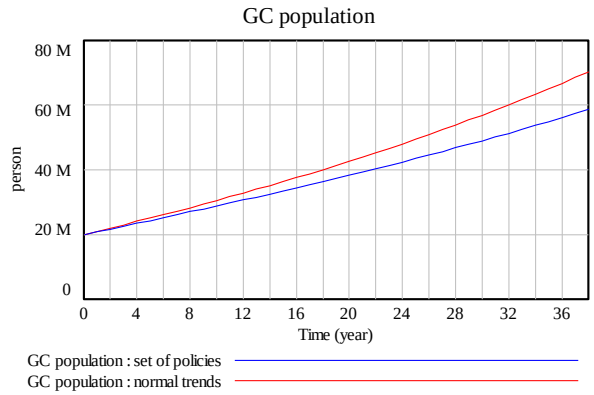

Figure 11a - [Scenario 6] The effect of implementing set of policies on GC population (2012-2050)

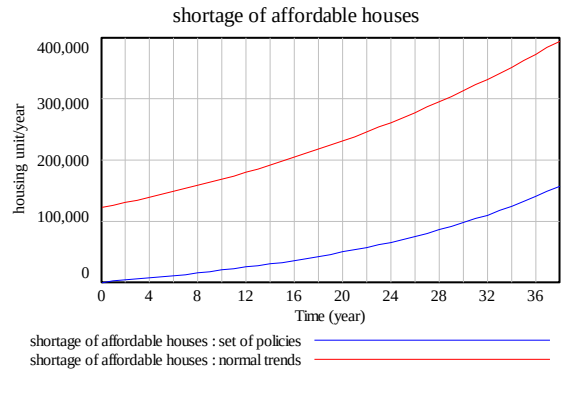

Figure 11b - [Scenario 6] The effect of implementing set of policies on the shortage of affordable houses (2012-2050)

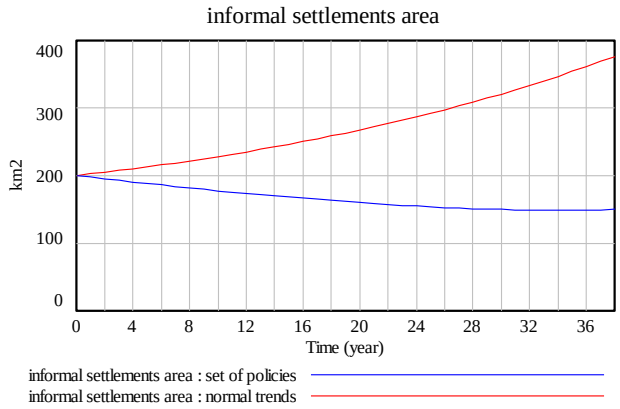

Figure 11c - [Scenario 6] The effect of implementing set of policies on the expansion of informal settlements (2012-2050)

CONCLUSION

The conclusion of this research is that the policies that are currently adopted by the government are unfavourable in the long run for Egypt population quality of life. The system thinking of the urban dynamics indicate that some policies are giving impact that is contrary with the expectations. For example, the introduction of low costs housing programs appears attractive as it partially reduces the

gap between the supply and demand of affordable houses. However, it gave unfavourable results on GC quality of life in the long run, as it increase the attractiveness of GC and thus increases the population growth.

Accordingly, the intuitive decision of increasing the supply of low cost houses in GC, though it appear attractive in the short run, but, in the long run, it give an impact opposite than the intended impact. As a matter of fact, the increased supply of affordable houses, increase the pressure on GC utilities, which reduce the quality of the services that is available for GC residence. Based on the foregoing, the decision makers in Egypt need to reconsider their adopted policies and start the implementation of new policies that are better suit the Egyptian community.

The objective of this research was to develop a system dynamics simulation model that can help decision makers and political leaders to take strategic decisions for the best interest of the Egyptian community.

After verifying the model from different urban planners, the model was tested by applying different values for the concentration of economic activities in Greater Cairo. The results of the initial runs were compatible with the model rational. The model proved that the increase in the concentration of economic activities in Greater Cairo is not for the best interest of the Egyptian population or the residents of GC. The model proved that increasing the concentration of economic activities in GC add more pressure to GC utilities and increase the attraction of GC which increase the population growth, and visa versa.

Then the model was used in evaluating possible policies or scenarios that can be implemented by decision makers. The target of the model is to evaluate the impact of each scenario on the growth of population density, the shortage of affordable houses and the expansion of informal settlements. It was found that these parameters would give insight about the quality of life of Greater Cairo population.

Also, the selected strategy should reduce poverty rates of the Egyptian, reduce the population of slums, reduce the expansion of informal settlements and reduce the pressure on all GC utilities in order to improve the human welfare and quality of life. Comparing to the current situation, any of such achievements could be a great challenge.

RECOMMENDATIONS

Based on the literature review, the urban dynamics theories and the analysis and the interpretation of the model runs, the following recommendations for the political leaders can be summarized:

First: Short Term Policies

1. Data-base: start the creation of an accurate and comprehensive data-base system covering all Egypt characteristics including data about poverty, average income, extent of agricultural land, land use at cities margins, locations for water, locations of row materials, etc. This data base can enable decision makers to conclude better policies.

2. Renting laws: an adjustment of the existing and contradicting renting laws is essential. The laws should put pressure on houses owners to offer their houses for rent. For example, the government can cancel the old renting laws, or set taxes on the owners of a second housing unit, or any other laws. Houses owners should be given incentive to offer their houses for rent rather than closing it for security. If the renting laws are adjusted more than 30% of the current houses units will be offered for rent in the houses market, which would show

immediate favourable results such as the reduction of renting costs and the reduction of the shortage of affordable houses.

3. Gradual enforcement of laws: the government should start to strictly enforce laws that impose constraints on the maximum buildings heights, minimum spaces around the buildings, minimum roads width, etc. Then laws related to the construction regulations should be gradually applied, after offering alternative places for those who are searching for houses.

4. Define Egypt locations that are characterized by its richness of resources, such as availability of raw materials, unique location, touristic attractiveness, etc.

5. Establish a proper financial and legal structure that would, for example, offer incentive for investors and businessmen who agrees to relocate their enterprises at the new defined locations.

6. Similar to the taxis experience that were applied years ago, the government can establish financial and legal structure that would give incentive to buildings owners to either maintain their buildings or demolish and reconstruct it. This policy can grant sustainable development of the existing buildings.

7. Increase the community awareness and encourage the participation of the community in the established strategic plans. With the community participation, political leaders can avoid political unrests.

8. Though subsidization is essential to support low-income population, the government should re-assess its related approaches. Studies indicated that the government expenditure in subsidizing do not reach to the people who really need it.

9. Decentralization of decision making in the governorates. This will enable each governor to take decisions that are convenient to the resources that are available in its governorate.

Second: Long Term strategies

10. Economic activities should be distributed in a balancing manner. Government should create policies that would give incentives to investors to relocate in governorates of high poverty rates. All Egypt existing governorates should be of nearly equal attractiveness in order to reduce the internal migration from a governorate to another.

11. Government should focus in enhancing the education. This is a focal step for the use of human capital as a source of innovation and creation. Without proper education programs, the human capital will overburden Egypt development.

12. Reinforce the legal system to ensure strict enforcement of laws. A weak government will not be able to implement any plan.

13. Plan for the establishment of new nuclei at the identified locations that are characterized by its richness of resources, such as availability of raw materials, touristic attractiveness, etc. Then the government should focus all its investments in such locations for the best use of their uniqueness and competitive advantages. Every new nuclei should be unique in its

characteristics, for example, we can have industrial, agricultural, educational, touristic community, etc.

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