

## Evaluation methodology to determine most influential indicators of water resources management in new cities in Egypt

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### Abstract

The development of future plans and visions for the sustainable development of new urban agglomerations in Egypt in light of the current and future challenges to face the issue of scarcity of water resources and in light of the current trend of urban development in new settlements, this calls for a statistical analysis of indicators of sustainability of development in light of this issue in order to identify and evaluate the strengths and weaknesses of water resources management with such gatherings, to find out the number of developmental directives needed by decision-makers, which help in achieving the sustainability of urban development in different dimensions, whether urban, social, economic and environmental.

The research presents the most important findings of the evaluation and statistical analysis results to determine the most influential indicators to be used when setting development plans and programs through an analysis of common indicators to determine the status of water resources management in these new cities. The research starts from analyzing and evaluating the current situation of water resources management in new cities by measuring development sustainability indicators that take into account the scarcity of common water resources and identifying the most influential indicators in achieving sustainable development in new cities in Egypt using the SPSS statistical program. This is in order to direct policies and decision-makers to deal with water resources in new cities in light of water scarcity to achieve sustainable development in these cities.

**Key words:** Statistical analysis – indicator system - new cities - water scarcity -Water Resources Management (WRM) - The Egyptian Code for Water Networks.

### Introduction:

Egypt is witnessing a reduction in its share of the Nile water due to the ambitious development plans of the Nile Basin countries in light of the increased demand for water resources resulting from the increase in population and demand for agricultural and industrial development, which resulted in the state's tendency to establish new communities and cities to meet the increasing demand for urban development. In light of the issue of water scarcity (Al-Aziz, ٢٠٢٠). As water resources constitute one of the axes of development in Egypt, and the biggest problems currently facing Egypt are narrowing the widening gap between available water resources and the increasing demand for water (Environment, Fresh Water, ٢٠٠٥).

Egypt is also considered one of the arid regions that is very sensitive to its limited water resources, as it relies on the Nile River as its main source of water, with ٩٣% of the total traditional resources and ٩٧% of the fresh surface water. As Egypt's share of the Nile water,

which is ٥٥.٥ billion cubic meters annually (according to the ١٩٥٩ agreement), the limited quantities of rainwater, torrents and groundwater, in addition to non-conventional resources, such as reuse of agricultural, sanitary and industrial wastewater (Raza Radi, Mohi Omar, ٢٠١٨).

Drinking water management in the current new urban communities suffers from major problems that greatly affect the increase in the issue of water scarcity, and the most important of these problems is the high loss of drinking water in the main networks, where the loss is estimated at about ٥٠% of this water, which leads to wasting the water resource, and thus the impact on the development of agglomerations and the delivery of water to deprived areas in the assembly (Environment, The State of the Environment Report in Egypt, ٢٠١٢). For example, we find that the distribution of water consumption in Al-Shorouk city shows that the amount of wastage in drinking water reaches ٣٠% of the total amount of water consumed (New Urban Communities Authority, ٢٠٢٠).

### **Research problem**

In light of the proposed projects in the National Urban Development Strategy 2052 towards the establishment of new urban agglomerations, we note that there is a gap between the proposed development projects and the challenges of reality for water security, and thus the importance of the research in analyzing sustainable development indicators that helps assess the sustainability of development in new cities in light of the scarcity of water resources.

### **Research importance**

Activating indicators of sustainable development of water resources in the new cities as a basis for defining a comprehensive vision of how to manage water resources in light of water scarcity and the state's directions for decision-makers and identifying the most influential indicators in the management of water resources in Egypt.

### **Aim of the research**

A presentation of the status of new cities in Egypt and how they are managing water resources in light of water scarcity through standard indicators to help decision-makers to achieve sustainable development in these cities and achieve livelihoods and well-being for the community, and take these points into consideration when proposing any new gatherings.

### **To achieve the objectives of the study, the research follows the following structure:**

- Analyzing and evaluating the current status of water resources management in new cities in Egypt.
- Defining theoretically recognized indicators for measuring the sustainability of water resources.
- Evaluating current indicators for dealing with water resources in new cities and managing them.
- Comparing the indicators of the current situation with the Egyptian code for water networks to determine the status of new cities in light of the scarcity of water resources.
- Conducting statistical analysis to determine the most influential indicators to achieve sustainable development.
- Findings and recommendations.

### **Data sources and research method**

To achieve the objectives of the research, the methods of quantitative and descriptive analysis were relied upon, through statistical analysis, through the identification of recognized indicators and according to the data available by government agencies and interviews for decision-makers in the New Urban Communities Authority.

### **Research Methodology**

A study of sustainable development indicators that have a direct relationship to water resources management at the level of international organizations and initiatives, and then identify the most common indicators, identify the research sample from Egyptian new cities in which statistical data are available or that can be obtained through personal interviews, identify indicators for analyzing and assessing the situation. The current analysis of the water sector in the new cities, analysis of sustainable development indicators appropriate to the issue of water degradation by comparing them with the Egyptian code and later using the analysis with a statistical program to determine the indicators most influencing the management of water resources in Egypt.

- **Analyzing and evaluating the current status of water resources management in new cities in Egypt.**

- **Water Resources Management**

Water Resources Management (WRM) is the process of planning, developing and managing water resources, in terms of water quantity and quality, across all water uses. Water resource management also entails managing water-related risks, including floods, droughts and pollution (bank, 2017).

Water Resources Department aims to continuously improve the development and use of water resources to meet the growing socio-economic demand for water. Future water resources management aims to coordinate the tripartite relationship between the recycling capacity of the water resource system, the social and economic demand for water, and the proper functioning of the ecosystem (Fan He, Shan Jiang, 2020).

- **Defining theoretically recognized indicators for measuring the sustainability of water resources.**

The indicators are one of the mechanisms for achieving the environmental sustainability of urban communities and determining the degree of management of water resources through these standard indicators and by tracking initiatives and global indicator systems in determining sustainable planning standards and indicators at the city level, whose dimensions take into account indicators for measuring the sustainability of water resources.

**Based on these systems, indicators for measuring the sustainability of common water resources have been identified, and they are:**

Community consumption rate, residential areas consumption rate, total water per capita (population consumption rate), per capita water consumption, industrial sector consumption

rate, green and open area consumption rate, recycled water percentage, wastewater rate, per capita share of green areas.

**A case study of (17) new cities will be evaluated, figure (3) that provides them with data. The city samples include (17) cities that represent all environmental patterns in Egypt, and most of them have different economic functions.**

- First-generation cities (6 October - Tenth of Ramadan - Sadat - May 15 - New Burj Al Arab - New Salhia - New Damietta).
- Second Generation Cities: - (Sheikh Zayed - El Obour - Badr - New Nubaria - New Beni Suef - New Minya).
- Third Generation Cities: (Shorouk - New Cairo - New Assiut - New Tiba).

• **Data collection (the current status of the water sector in the new urban settlements)**

Data were collected for 17 cities under evaluation and study in a number of elements to include the economic function of the community, the number of residents, the gathering area, the flatness of residential areas, the flat of industrial areas, the surfaces of green and open areas, the amount of water specified for the gathering, the source of water, the amount of water consumed in the industrial sector, the amount of water consumed in the residential sector, the amount of water consumed in green and open areas, the amount of wasted water and finally the amount of recycled water.

The data of analyzing the current situation of the water sector in the new urban communities under study were collected by dividing the table into three main elements (basic data about the community - the areas of different uses in the community - the quantities of water consumed in the communities) and coding of the elements of the table was made for ease of analyzing the table and measuring development at sustainable new urban settlements in light of the scarcity of water resources.

• **The current situation of the water sector in the new urban communities in Egypt can be analyzed and evaluated, compared to the Egyptian code, and it appears in a number of indicators**

- It is the amount of water that this individual uses throughout the day for the various living purposes and is loaded with all the human consumption of all the different activities in the city. Of course, this rate is not constant throughout the day but varies from hour to hour and reaches its lowest value in the period of sleep at night, and its maximum value in daytime periods according to the different activities in the city or the residential community, and it varies from day to day according to the different seasons, summer and winter. The quantities of water consumed in any population group depend on several factors, the most important of which are the population census and consumption rates. The rates of water consumption depend on the prevailing climate, the individual's standard of living, the quality and price of water, the presence of a water network with adequate pressure, the spread of water meters, and finally the presence of a sewage network. The consumption rates also depend on the endemic uses of the region. According to the Egyptian Code for the Design and Implementation of Pipelines for Drinking Water and Sanitation Networks, the per capita consumption of water in the new urban cities ranges between 280-300 liters / person / day.

- The industrial zone consumption rate indicator is estimated by the amount of water consumed in the industrial sector / the area of industrial areas, and we find that all the communities under study fall below the industrial zones consumption rate line stipulated in the code, due to the difference in the quantities of water required for the industrial zones, due to the difference in the quality of industries and the method of preparing the product. The final uses of water in this industry, as water is an essential component of the product such as (food industries - beverage industry) or an auxiliary factor such as washing and cooling water (engineering industries - textile industry - paper industries - heavy industries).
- The green and open area consumption rate indicator estimates the amount of water consumed in agriculture / the green areas area.

Sheikh Zayed City comes first in terms of water consumption in green areas at 37 m<sup>3</sup> / acre, followed by New Cairo City. Most of the new urban settlements are considered to have an incomplete network for irrigating green areas due to the lack of a water source.

• **What are the indicators of sustainable development that have the most impact on the issue of scarcity of water resources?**

The research at that stage is based on the use of a (descriptive approach) to describe sustainable development indicators appropriate to the issue of water scarcity in the new cities in general, and the tools used in this stage, the SPSS program, and the Factor Analysis system is used to determine the influencing indicators.

- According to the SPSS statistical program, the previous indicators were reduced to 6 indicators that are the most influential in Egyptian cities. It was made clear that the indicators (consumption rates), whether residential or industrial consumption or irrigation of green areas, are the most influential in this issue of water scarcity in addition to the per capita share of either, as for social indicators such as (the illiteracy rate - the percentage of undergraduates), they are not significantly influential in the issue of water scarcity.
- The construction of treatment plants and gray water networks must be incorporated into the planning and preliminary design of the community as there is no new urban agglomeration. Consideration has been taken to separate the gray irrigation network from the main water network, and the use of gray water must also be expanded according to the type of use where gray water is used as primary treatment or in irrigation, its use has not been expanded according to the degree of treatment, as most of the new urban communities do not have or have not completed the gray irrigation water network, and therefore most of the treated water is wasted, and potable water is used to irrigate green and open areas, which increases water waste.
- Water considerations must be taken into account in choosing plants and crops that consume less water, expanding the use of modern irrigation methods such as sprinkler and drip irrigation, and using modern water-saving design methods, Xeriscaping, in designing and coordinating sites in clusters that do not comply with the code.

- The illiteracy rate and the percentage of university graduates are among the indicators that affect the issue of water poverty, as the social level of the population is reflected in their style and the extent of understanding the efficiency of water consumption and rationalization.
- An integrated management system for traditional and non-traditional water resources must be defined to confront the issue of water scarcity in new cities and guide decision-makers.

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