*Abstract*— **The problem of rural villages and slums of the countryside is one of the most critical matters faced by many developing countries as well as some developed countries. In 2021 The Egyptian government launched the National Initiative for the Development of the Egyptian Rural Villages – Decent Life (Hayah Karima). This initiative is the result of a humane responsibility and a social dimension since it has a greater purpose than simply enhancing the daily lives and living situations of Egyptian residents. This paper focuses on developing a model for the determination of the development priorities utilizing GeoAI in the villages of Asuit as it was considered as one of the governorates with the greatest need for development. GeoAI can be construed as an analysis environment to build intelligent computer programs that mimic human perception, spatial reasoning, and discovery of geographic phenomena and dynamics, for advanced knowledge about the determination of development priorities in the study area. Shamya village, which located in Sahel Selim center, Asuit, Egypt; was selected as a study area as it was considered one of the poorest villages according to the development priorities in the Egyptian Rural Villages Development Project, where the poverty rate exceeds more than 70%. This is consistent with the Egyptian government strategy of giving Upper Egypt villages more consideration. GeoAI was utilized for buildings and streets footprint automatic detection and digitizing employing deep learning algorithms. Evaluating the use of classic techniques to create spatial maps, which required 40 working hours, utilizing GeoAI, which produced spatial maps for the same area in 30 minutes with higher precision and with less working and quality control time. It was proven that GeoAI presents a unique and promising approach for automatically detecting objects and mapping them to determine development trajectories.**

***Keywords— Geospatial Artificial Intelligence - Machine Learning - Deep Learning – Internet of Things (IoT) - Geographic Information Systems - Decent Life - Hayah Karima***

## I. INTRODUCTION

A countryside or rural area is a region outside of towns and cities. Rural sites are commonly small communities with low population density. Rural regions are often defined as those that are agricultural or have forests. [1]. One of the most significant matters that many developing countries, as well as some developed countries, cope with the subject of rural villages and slums development [2].

The process of creating development strategies for villages and slums in Egypt necessarily requires different types of interventions since the integration of spatial data analysis with artificial intelligence yields more effective analysis outcome and saves time on field study to discover the most challenging issues associated in slums and villages development.

One of the contemporary strategies for determining development priorities in vulnerable regions and communities in developing countries is the application of spatial artificial intelligence (GeoAI) techniques [3]. Since it provides a reliable depiction of the condition of buildings and streets, as well as detecting deficiencies in infrastructure networks. This enables policymakers to proceed with the places most in need of redevelopment [4].

In recent years, the field of artificial intelligence and Internet of Things (IoT) have been developed significantly, matching, and in some cases exceeding, human competence in tasks such as computer vision, natural language processing, and machine translation. The integration of artificial intelligence (AI) with geographic information systems (GIS) is introducing innovative massive opportunities for data analysis and outputs [5]. IoT is made of all the connected sensors and the storage environment for the data generated by these sensors, The IoT architecture is designed to provide all objects with identification, detection, networking, and processing capabilities, so that they can exchange and share information with each other and develop advanced services over the Internet [6].

This paper investigates the significance of utilizing autonomous GeoAI approaches to determine policy objectives in the national project of Egyptian rural villages development. Since this approach allows policymakers to establish which sectors and zones are most crucial to achieving growth. Shamya village which is located in Sahel Selim center in Asuit government, was selected as study area, as it was considered one of the most vulnerable sites.

## II. GEOAI OVERVIEW

The incorporation of geographic studies with AI is not novel, Theoretical speculations in the 1950s and 1960s led to significant advancements in AI [7]. Nowadays, Geospatial science is undergoing significantly innovative opportunities and challenges because of artificial intelligence. Its significant development is fueled by theoretical innovation, large data, computer hardware, and high-performance computing platforms that enable the development, training, and deployment of AI models in a shorter time [8]. Geospatial artificial intelligence (GeoAI), which combines geospatial studies with AI, particularly deep learning, and machine learning techniques, has made major strides in recent years in both academia and business [9]. GeoAI can be construed as an analysis environment to build intelligent computer programs that mimic human perception, spatial reasoning, and discovery of geographic phenomena and dynamics; for advanced knowledge; and to address issues in human environmental systems and their interactions, with a focus on spatial contexts and roots in geography or geographic information science.

Given the nature of the subject and the intersection between artificial intelligence and many other scientific subjects and disciplines, it is important to define a few key words related to geospatial and artificial intelligence; as shown in figure 1. Artificial Intelligence is known as the development of computational methods and machines that can conduct operations that typically requires human intelligence, such as logic, learning and anticipation that enables it to function properly in its environment [10]. Machine Learning is a branch of AI that leverages mathematics or statistical optimization approaches to model data without explicitly scripting each model parameter or computation step [11]. Deep Learning is A specific approach of machine learning where artificial neural networks, and algorithms inspired by the human brain, identify the patterns and the guidelines for prediction from a large volume of data [12]. GeoAI is a developing scientific discipline that integrates innovations in spatial science with AI/ML methods (e.g., deep learning), data mining, and powerful analysis to acquire information from spatial big data [13].

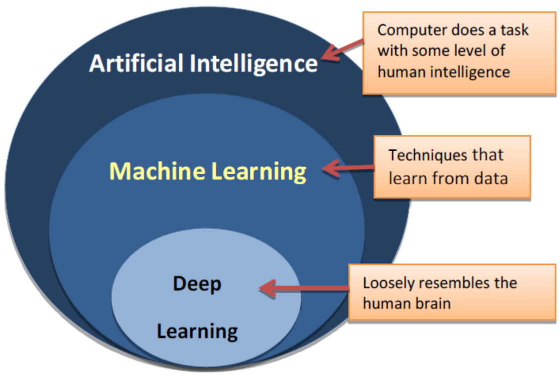



Fig. 1: Relation inside AI. [14]

Artificial intelligence (AI) and machine learning (ML), presents additional approaches for efficient monitoring, interpretation and predicting the development of urban areas. ML approaches are data-driven as relevant information extracted from data processing. The term 'learning' refers to how well an algorithm performs in a certain task [15]. There are two categories of machine learning algorithms: supervised and unsupervised learning. Supervised learning employs a training set of examples with appropriate responses. On the other hand, in unsupervised learning, there are no appropriate responses provided. Instead, the algorithms attempt to discover and categorize similarities between inputs and group them [16]. as shown in figure 2.

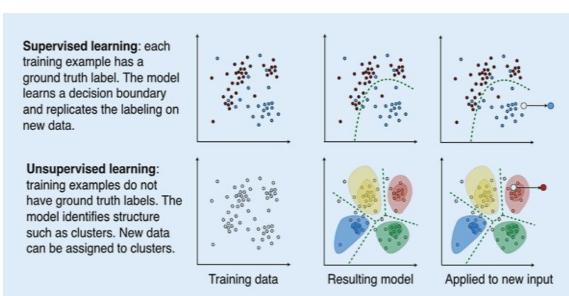



Fig. 2: Supervised Vs Unsupervised learning. [17]

## III. History of GeoAI

Although there is no institutional start timeline for GeoAI, the initial GeoAI instances were estimated by detecting significant events in GIS utilizing statistics. Danie Krige created the first spatial predictive model in 1951, which was later modified and implemented by Matheron in 1963. Therefore, GeoAI originated to the mid-1960s, merely decade after Alan Turing developed his famous AI Test [18]. With the basics of GeoAI constructed, the following question is how GeoAI has developed over time. To address this question, a timeline involving four generations of GeoAI developments is explored, defined by changes in eight major key dependent drivers. Each of these drivers is briefly elaborated within each generation. as shown in figure 3

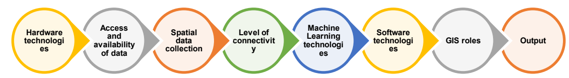
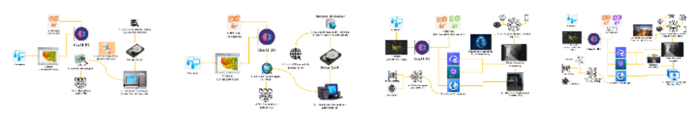


Fig. 3: Key dependent driver of GeoAI

An overview of the evolution of the GeoAI over the span of four generations is presented in figure 4 and table 1, along with information on the key characteristics and technological and communicational constraints of each generation.

1st Generation (Limited Local Intelligence) 2nd Generation (Early Enterprise & Web Era) 3rd Generation (The "Big" Leap) 4th Generation (The Frontier of Intelligence)



1st Generation (Limited Local Intelligence) | 2nd Generation (Early Enterprise & Web Era) | 3rd Generation (The "Big" Leap) | 4th Generation (The Frontier of Intelligence)

Figure 4: The four generations of GeoAI developments [19]

TABLE 1: THE FOUR GENERATIONS OF GEOAI

| Generation | 1st Generation (mid-1960s to late-1990s) | 2nd Generation (2000 to late-2000s) | 3rd Generation (2010 – 2019) | 4th Generation (2020 - ?) |
|---|---|---|---|---|
| Hardware technologies | computers were computationally slow and expensive | Computers become faster, less expensive, and easier to use | Powerful smartphones smaller, cheaper computers | scalability to host "big" data and enterprise solutions with little maintenance required, and the ability to access content remotely |
| Access and availability of data | large physical space for data storage expensive limited capacity and network accessibility | Compact data storage Less expensive Enterprise database management system | Larger data storage (terabytes) "Big" data | Data storage continues to expand, get cheaper, and get faster to transfer and download content |
| Spatial data collection | standard field surveying techniques, satellite and aerial imagery, | enterprise geodatabases | real time collection of vast amounts of data | Drones and IoT are becoming the new "personal devices", which could capture |

| | | | | |
|---|---|---|---|---|
| | manual digitizing | | | and directly transfer real-time data to an analytics platform |
| Level of connectivity | limited | Mainstream internet 3G mobile technologies | High speed internet 4G technology | growth in smartphone and personal device adoption 5G is on the horizon in developed nations |
| Machine Learning technologies | limited | Vector Clustering and unsupervised ML | ML automatically analyze unstructured "big" data faster | generative adversarial networks (GANs) |
| Software technologies | ML analyses by programming | ML methods were implemented as GUI tools | Web and enterprise-based solutions | Web GeoAI ecosystem for geospatial analytics including "big" data |
| GIS roles | GIS analyst | accessing and publishing content through enterprise geodatabases | Enterprise/Online and developing Web maps | Enterprise/Online and developing Web maps |
| Output | Cartographic maps | Cartographic maps | Web maps and story maps | dynamic and interactive Web maps displaying real-time information |

## IV. The National Project for The Development of the Egyptian Rural Villages - Decent Life "Hayah Karima"

Hayah Karima is National initiative endorsed On January 2, 2021, in Egypt. This initiative is the result of a humane responsibility and a social dimension since it has a greater purpose than simply enhancing the daily lives and living situations of Egyptian residents. This initiative seeks an immediate and urgent response to respect Egyptian residents, preserve their rights to a decent life and their sense of dignity. These are the people who persevered through the challenges of the economic reform. Therefore, it was crucial to act on a large scale - for the first time - and within a framework of integration and consolidation of efforts among the national state institutions, the private sector institutions, civil society, and the development partners in Egypt.

### *A. A Initiative Objectives and pillars*

A meaningful improvement in the quality of life for both the targeted persons and their communities was brought about by the state's combined efforts, the expertise of civil society institutions, and the support of local communities. The initiative targets mainly the rural areas most deserving households, older people, special needs, Volunteers, Female breadwinners and divorced women, Orphans and children, young people who are capable to work.

- Reducing the burden on residents in rural and urban slum regions that need it the most.
- Comprehensive development for the most unserved rural regions is needed to end multidimensional poverty and give inhabitants of the Republic a decent and sustainable living.
- Raising the targeted households social, economic, and environmental standards.
- Coordinating within civil society and encouraging confidence in all state institutions.
- Reducing the developmental differences between centers, villages, and the dependencies between them.
- The need to improve social protection for all citizens.
- The distribution of development gains is equitable.
- Providing employment opportunities to encourage people to become more independent and raise the level of living in their communities and families.

### *B. Themes of the initiative*

Hayah Karima initiative aims to offer a comprehensive service package that covers numerous social, health, and lifestyle aspects; this is thought to be a great responsibility. The honor and responsibility of providing these services to Egyptian residents will thereafter be shared by these many groups. Particularly those from the community groups that require help the most, so that these groups can have the better lives they deserve, which ensures that they will live respectable lives, the main themes of the initiative are shown in figure 5


Fig. 5 : The main themes of Hayah Karima Initiative

- Decent housing: such as upgrading houses, building roofs, building housing complexes in the villages most in need, and extending water connections, sanitation, gas, and electricity inside the houses.
- Infrastructure: such as Micro projects and activating the role of production cooperatives in villages
- Medical services: such as building hospitals and health units, equipping them, and operating them with medical staff. The services include launching medical convoys and providing health services such as prosthetic devices (hearing aids, glasses, wheelchairs, crutches, etc.).
- Educational services: such as building and increasing the efficiency of schools and nurseries. The services include equipping them, providing educational staff, and establishing literacy classes.

• Economic empowerment: such as training and employment through medium, small, and micro enterprises

It also includes industrial and craft complexes and providing job opportunities.

• Social interventions and human development: social interventions include building human beings. They target family, children, women, and people with special needs, the elderly and awareness -raising initiatives.

They also include providing and distributing subsidized food baskets. They include orphan marriage concerning preparing marital homes and planning group weddings. They also include childhood development: by establishing home nurseries to save mothers' time in doing their productive role and taking care of their children.

• Environmental interventions: such as waste collection and considering ways to recycle it...etc.

### C. *Stages of Initiative's Work*

The targeted villages most in need were divided to three phases as shown in figure according to the data and surveys of the Central Agency for Public Mobilization and Statistics (CAPMAS) in coordination with the relevant ministries and bodies as shown in figure 6 .

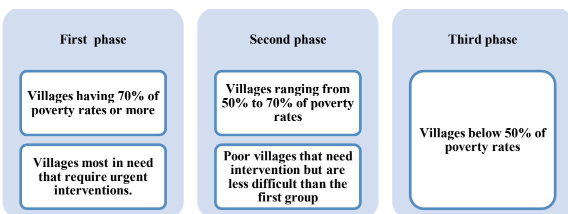



Fig. 6: Phases of Hayah Karima Initiative

### D. *The Basic Criteria for Identifying the Villages Most in Need*

• Poor basic services such as sewage and water networks

• Low rates of education and high density of school classes.

• The requirement for intensive health services to meet the needs of health care.

• Poor conditions of road networks.

• High rates of poverty of the families living in those villages.

## V. STUDY AREA

Asuit Governorate is one of the Egyptian governorates. It stretches across a section of the Nile River. The rate of poverty in Asuit is more than 60%. The governorate is divided into municipal divisions, with a total estimated population of 4,407,335, as of July 2017 according to the Central Agency for Public Mobilization and Statistics (CAPMAS). Al-Shamiya Village is One of the settlements in Sahel Selim center - Assiut Governorate -Egypt with total area 6.48 km2; figure 7.

Fig. 7: Shamya village, Asuit governorate

In 2017, Sahel selim had a population of 180,996 inhabitants (CAPMAS). Sahel Salim is located at the East coast of the Nile at a 24 km distance south from the city of Asuit. It is characterized by its fruit gardens, some of its fruit production is exported abroad. The village of Shamiya was chosen as the study area since it is one of the poorest villages according to the development priorities in the Egyptian Rural Villages Development Project, where the poverty rate exceeds more than 70%. This is consistent with the Egyptian government strategy of giving Upper Egypt villages more consideration.

## VI. CASE STUDY: SHAMYA VILLAGE, ASUIT, EGYPT,

Prioritizing development in Egyptian villages and small communities has historically involved a lot of time and effort, especially when establishing the cases of buildings and roads that needed development urgently required field surveys. This demands a lot of time, effort on stakeholders and decision makers in addition to extra cost. Decision makers can automate most of mapping by building a deep learning model and training dataset with GIS, experiencing immediate benefits in terms of time and cost savings as well as increasing the data accuracy.

Fig. 8: Building footprints digitized manually on the left compared to the

deep learning algorithm outputs on the right.

GeoAI Machine learning model allows decision makers to automatically update Shamya village base maps with streets and buildings, as shown in Figure 8 . As deep learning models that were developed and trained over time produced findings that were ever more accurate.

ML was employed to extract building footprints and street data from satellite imagery with the least amount of human input possible; figure 9. Deep learning is a promising form of AI that includes teaching a computer to find patterns in massive volumes of data and to identify and extract only the necessary information.

Fig. 9: Deep learning algorithms recognize roads.

traditionally, GIS projects required several years to finish projects using traditional techniques of creating and analyzing spatial data, as well as a considerable number of work and quality control teams to complete projects in the appropriate form and time. it is anticipated that GeoAI will provide a breakthrough in the field of Spatial projects, where the process of automatic detection of the necessary data takes several hours to produce data, and the quality control process takes a few days to complete.

While it took 40 hours of manual digitization and quality control to perform the task as required with less quality and more effort, the area under study was processed using GeoAI in 30 minutes. The task was a bit more complex as it required the computer to tell it about anything new across the entire study area. It was necessary to establish a common geospatial framework that would encompass the existing database. GeoAI platform was able to train using 30 objects of data to provide input for the model to scan 1334 objects in the satellite imagery, consequently, The algorithm performs efficiently and successfully, even identifying changes that human intuition would miss an noticed in figure 8. Additionally, the model provided a more accurate representation of the roads in the study area as shown in figure 9.

Although more effective GeoAI applications are being introduced, AI is still in the early stages of development. It's still unclear how interoperable and dependable machine learning algorithms are. Due to a lack of understanding in the algorithms used and the scope of the findings generalization, the level of overall confidence in machine learning outcomes across the geospatial community remains moderate. The continued reliance on cloud storage raises additional questions about data integrity. Within the next five to ten years, it's expected that change detection and pattern identification will be completely automated in geospatial production.

## Conclusion

Over the next ten years, artificial intelligence, particularly image analysis and information extraction, will present some of the biggest potential for geospatial information management. Machine learning is used in the field of artificial intelligence known as geospatial artificial intelligence (GeoAI) to extract knowledge from spatial data. Automation is essential for enabling the efficient processing of an exponentially growing amount of sensed data from the Internet of Things and remote sources. This is necessary to realize the objective of real-time data. Machine learning will be necessary in the long run to handle the expanding demands of a connected world. One of the initial steps in putting artificial intelligence (AI) solutions into practice is automation.

Three factors can be used to summarize the technological developments enabling advances in geospatial artificial intelligence (GeoAI): an increase in low-cost cloud computing, the accessibility of inexpensive sensor technology, the ongoing expansion of geospatial information, and the creation of new algorithms that can leverage multiple data sources. In order to achieve the goals of sustainable development and Egypt's vision 2030, the deep learning algorithm was employed in this study to detect buildings and streets for the village of Shamiya in the Sahel Selim Center, Asiut Governorate. The results showed a promising model for automating the production of maps.

Comparing the use of conventional methods for producing spatial maps, which required 40 working hours, with leveraging GeoAI, which produced spatial maps for the same area in 30 minutes with higher precision and with less working and quality control time, of Shamiya village with an area of 6480 square metres, it was found that GeoAI introduces innovative and promising technique for automatic objects detection and mapping for the determination of development priorities.

The potential use of the technology will eventually benefit a larger range of geospatial applications, even though the current implementations of machine learning for geospatial data concentrate on object extraction and change detection. Digital twins, driverless vehicles, sustainable smart city management, enhanced structures, and energy management are some examples of application areas.

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