International Cartographic Association
Association Cartographique Internationale

Synthesis of Geospatial Database and Interdisciplinary to Achieve NSDS for Downtown Alexandria, Egypt Vision 2030

Mohamed Soliman 1 [a, c, *], Tomoyuki USAMI 2 [a], Satoshi IMAMURA 3 [a], Keiji YANO 4 [a], Hrishikesh Ballal 5 [b], Abbas Mohamed Abbas 6 [c], Tharwat Abdel Fattah 7 [d], Sameh El-Kafrawy 8 [e], Hossam El-Sayed 9 [f], and Amr El-Shafie 10 [g]

[a] *Inst. of Disaster Mitigation of Urban Cultural Heritage (DMUCH)-Ritsumeikan university, msoliman8@yahoo.com 1, tusami@fc.ritsumei.ac.jp 2, imamurarumami285@gmail.com 3, yano@lt.ritsumei.ac.jp 4*
[b] *Geodesign Hub hrishi@geodesignhub.com 5*
[c] *National Research Institute of Astronomy and Geophysics (NRIAG), msoliman8@yahoo.com 1, dr.abbas.ali@gmail.com 6*
[d] *Faculty of Science- Alexandria University, tfattah_15@hotmail.com 7*
[e] *National Authority of Remote Sensing and Space Sciences (NARSS), s_elkafrawy@yahoo.com 8*
[f] *National Institute of Oceanography and Fisheries (NIOF), geo_hossam@yahoo.com 9*
[g] *Egyptian Company for Space Applications & Remote Sensing (ECSARS), aeamrahmed@hotmail.com 10*

* Corresponding author

Abstract: Natural hazard and over than 2300 of human activities impacted on Alexandria, causing a deep topographic and urban transformation. In integration with cosmopolitanism, the cultural heritage diversity of Alexandria has been generated that is still surviving although hectic development of its contemporary potentiality, basically as the main harbour of Egypt, tourism, commercial and industrial activities.

Team of DMUCH- Ritsumeikan University has constructed geospatial database of Alexandria using historic map and satellite imagery in integration with interdisciplinary basically, remote sensing and geophysics, aiming to figure out the historical context of the land use and urban evolution of the city, so far. Meanwhile, geodesign approach was adopted to innovate a change model. So, the adopted synthetic approach supports stakeholders and decision makers to outline action plans to achieve SDGs for Downtown Alexandria within NSDS, Egypt vision 2030.

Keywords: Geospatial database, Alexandria, NSDS Egypt 2030, GIS, GPR

1. Introduction

Egyptian government adopted National Sustainable Development Strategy (NSDS) to achieve SDGs aligned to the world plan. Alexandria's promising capabilities accelerates the implementation of NSDS 2030 plans, potentially. Cultural heritage diversity distinguishes Alexandria over than 20300 years of successive human activities. Furthermore, developable existed infrastructure that accelerates achieving SDGs. However, problematic of authenticity and modernization conflict would hinder implementation of ambitious plans of sustainability. Hence, a comprehensive vision is required to harmonize this relation with priority given to the local community.

Adoption of synthetic approach of a geospatial database in combination with interdisciplinarity has become requirement, due to the abundance consultation that supports the decision maker. Accordingly, DMUCH-Ritsumeikan University has created a geospatial database based on old maps, where historical data were processed using GIS superimposed satellite imagery. From integrative perspective DMUCH team extended the collaboration to relevant Egyptian institutions, basically NARSS, NRIAG, MoTA, and E-JUST, so the database combined with geophysical contribution and other updated data. In addition to, cohesive collaboration with Geodesign Hub has formulated the acquired data to create change model of NSDS, Egypt vision 2030, as well as building capacity of young responsible and researchers.

This contribution reflects efforts made to adopt a synthetic approach that formularized sustainability to preserve the authenticity of Downtown Alexandria utilizing its capabilities based on an interactive database.

2. Alexandria: authentic and modern potentiality

Cosmopolitanism, outstanding location, and over than 2300 years of human activity have formulated the cultural heritage diversity of Alexandria since its foundation in 332 BCE.

2.1 Cultural heritage diversity

Rhacotis, a village of ancient Egyptian fishermen, occupied an (E/W) strip of land locates on north Egypt overlooking the Mediterranean Sea, while Lake Mariout borders it to the south.

Alexander the Great recognized Rhacotis as an excellent strategic location to build his new city, Alexandria. Hence, he appointed one of the best architects of the time to that mission in 332 BCE: a Greek named Deinocrates of Rhodes. Deinocrates planned Alexandria in Hipodamic (crisscross) pattern and divided it into five quarters attributed to the first five letters of the Greek alphabet. The first two Ptolemaic kings, the heirs of Alexander, erected many splendid buildings in Alexandria. Pharos

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-101-2021 |

Island, opposite to the mainland, was joined by the overpass, a thick wall built in the sea called the Heptastadium, creating “Portus Magnus” or “Great Harbour” to the east and “Potus Eunostus” or “Harbour of Safe Return” to the west (Escoffey 2012). A 17 km long canal that carried fresh water to Alexandria from the Canopy branch, the closest branch of the Nile River to Alexandria, which is connected to a complex underground water network (Soliman 2014).

Human and natural hazard generated 2-10 m of multi-archaeological layers beneath the contemporary city, furthermore submerged antiquates. The battle of Actium 30 BCE transformed Alexandria to be capital of Romanian province instead of independent empire of Polemics. However, the urbanism of the city has begun to collapse, due to the ideological conflict of Christianity against the Roman paganism during C. 3rd and 4th CE (Mahmoud 1961). Alexandria declined after the Islamic conquest in 641 CE (Abouseif 1989). However, Alexandria was growing steadily during the successive Islamic periods (c. 9th-16th CE). After the civilization collapse during the Ottoman period (1517-1805 CE) as described in Napoleonic maps (1798-1801 CE), Alexandria expanded once again during Mohamed Ali’s dynasty (1805-1952 CE), as a result of the European modernization trend that trespassed the city to meet the desires of the Egyptian elite and the European community.

Seismic hazard, destructive earthquakes, and tectonic movements, in particular, were shocking Alexandria, frequently. Between 320 and 1303 CE, twenty-two destructive earthquakes were recorded. The massive one of 396 CE split the shoreline and submerged the northern strip of the city that contains the Ptolemaic Royal district and naval platforms (Samir *et al.* 2005).

2.2 Contemporary potential for development

Alexandria Governorate covers 2.818 km^2 and extends 25 miles (40 km) east to west along a limestone ridge, 1–2 miles (1.6-3.2 km) wide, that separates the Salt Lake of Maryūṭ, or Mareotis-now partly drained and cultivated-from the Egyptian mainland. The population of Alexandria is now estimated at 5,280,664 / 2020, an anticipated growth rate 2.02% (610,333+) / 2030 (Table1), (Fig. 1).

Year	Population	Growth Rate (%)	Growth
2030	6,417,384	2.02%	610,333
2025	5,807,051	1.92%	526,387
2020	5,280,664	1.97%	491,302

Table 1Growth rate of population of Alexandria in 80 years (2020-2030) (Central Agency for Public Mobilization and Statistics (COMPAS), Cairo, 2020.

Alexandria’s industrial and commercial activities-manufacturing, shipping, warehousing, banking, food processing, and the production of petrochemicals and cement-indicate the importance of the city’s output for the national economy. Alexandria and its environs account for roughly two-fifths of Egypt’s industrial production. Other industrial development has taken place still farther west in al-Dukhaylah. To the south lies the area of al-‘Amiriyyah, the site of two more refineries, including the Middle East Oil Refinery (Midor), which was designed to meet stringent environmental standards. Lighter industry is concentrated on the banks of al-Maḥmūdiyyah Canal.

Agriculture is an important economic activity in the hinterland, and land reclamation has been attempted with some success.

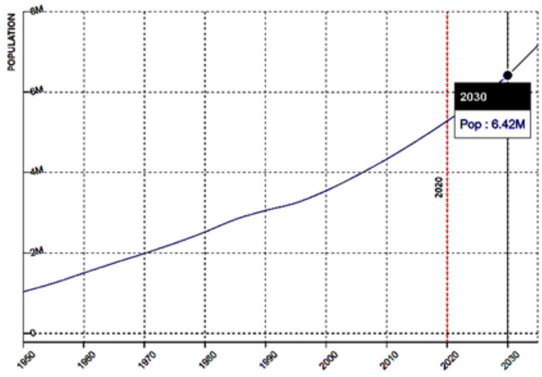

Figure 1 Growth rate of population of Alexandria over 80 years (1950-2030) (Central Agency for Public Mobilization and Statistics (COMPAS), Cairo, 2030).

Alexandria is linked to other Egyptian cities by railway, road, and air service. It also is connected by canal with the Nile. Transport within the city is provided by tram service, as well as a system of taxis and buses. More than half of Egypt’s foreign trade passes through the city’s two main commercial harbours, Alexandria and nearby al-Dukhaylah. Much of the country’s oil, gas, and cotton are exported through these ports. The revival of the city’s ancient library, a project first proposed in the 1970s, materialized with the opening of the Bibliotheca Alexandrina in 2002 (Rowlatt *et al.* 2020).

3. Construction of the geospatial database of Alexandria

DMUCH team constructed geospatial database for Alexandria, aiming to publicize it for scholars and stakeholders use. The database contains twelve historical maps that record Alexandria over five centuries, derived from several sources, add to most recent satellite images (Tables 2 and 3).

3.1 Digitizing old maps

Despite the abundance of historical maps on Alexandria, criteria of chronology and accuracy have been taken into consideration (Fig. 2).

On the occasion of the anniversary of *“La Société Sultanieh De Géographie”* of Egypt. M. Gaston Jondet, the engineer and chief of the maritime utilities of Egypt, edited a special issue of an Atlas of historical maps of Alexandria entitled: *“Atlas Historique de la ville des ports d’Alexandrie”* that published by *“L’Institute Français D’Archéologique Orientale”* in Cairo, (MD CCCC XXI) 1921 CE. Jondet’s atlas preserves old maps

30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-101-2021

of Alexandria date back to the late medieval and modern ages from 1472 CE until 1920 CE. (Jondet 1921).

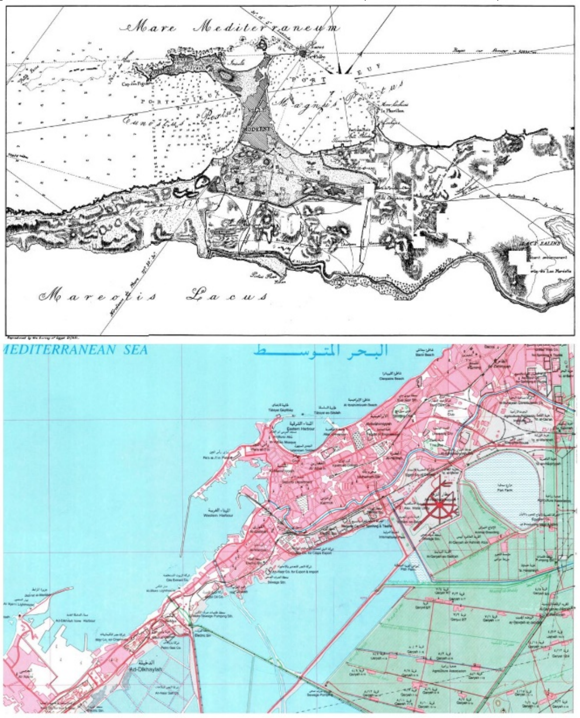

Figure 2 LULC change of Alexandria-the Napoleonic map, 1798 CE (Up) and aerial survey E.M.A.S. 1996 (Down)

The atlas contains fifty-five historic maps that conclude attempts of mapping Alexandria by foreign explorers, officers, and spies for civil or military purposes, some of which were not accurate enough, due to technical reasons or speed implementation. In addition to, an Egyptian contribution of Mahmoud Pasha al-Falaki (the Astronomer) in 1866 CE, who was appointed by Khedive Ismail (1863-1897 CE) to survey Alexandria to identify the ancient city. Al-Falaki's map is one of the most accurate historical maps recording the LULC of Alexandria in the middle C. 19th (Fig. 3). The Egyptian Authority of Survey had carried out systematic mapping of Alexandria in 1935. Subsequently, the indexed "Atlas of Alexandria" includes (1:10000) sixteen maps that had been published in Arabic edition for the first time in 1935 (Table2) (Fig. 2). (E. A. S. 1935).
Digitizing the old maps of the database count on maintained historical landmarks, which represent the eras of Alexandria, ancient, medieval, and modern. The utilized landmarks were identified according to their locations in terms of covering the centre and outskirts of the city, add to chronology, ensuring high accuracy for the old map itself (Table 2).

No. on ArcGIS Online		Cartographer	Attribute	Scale	Date	Source	Cart No.		Remarks
1		A Lyon, chez Horace et Georges Remeus Boissat	Vue d'Alexandrie	Unknown	1665	Jondet, 1921. (CE-Alex. http://www.cealex.org/	Planche VI		Journal de Voyages de Monsieur de Montcony
2		François Cassas	Alexandrie	Unknown	1785	CE-Alex. http://www.cealex.org/			
3	1	MM. Les ingénieures de l'armée d'orient	La Ville Moderne et de Ville des Arabes	Unknown	1798	Jondet, 1921. (CE-Alex. http://www.cealex.org/	Planche XVII		Description de l'Egypte (3 cards)
	2		Carte Générale des côtes, rades, ports, ville, et environs d'Alexandrie				Planche XVIII		
	3		Chenaux d'accès au port d'Alexandrie				Planche XIX		
4		Charles Muller	Comprenant toutes ses fortifications, rue et édifices principaux	Unknown	1855	Jondet, 1921. (CE-Alex. http://www.cealex.org/	Planche XXXV		
5	1	Mahmoud Pasha al-Falaki	L'Antique d'Alexandrie et de ses faubourgs	1 :5000	1866	**'' L'Antique d'Alexandrie''** Ses faubourgs et environ découverts, par les fouilles, sondages, nivellement et autres recherches			26 Cards
	2		خريطة الإسكندرية في سنة 1282 هجرية						
6		Direction Générale du Tanzim	La Ville d'Alexandrie	1:10000	1887	Jondet, 1921. (CE-Alex. http://www.cealex.org/	Planche XLVII		NOT HD
7		Chas et Goad, Civil Engineers, London	Insurance plan of Alexandria	1in:120ft	1898-1905	The Harvard Geospatial Library (HGL) https://iiif.lib.harvard.edu/manifests/view/drs:15525296$1i			
8		Egyptian Survey			1917	CE-Alex. http://www.cealex.org/			
9		Egyptian Authority of Survey	Atlas of Alexandria	1:10000	1935	Atlas of Alexandria (1935)	11	12	Split to 7 sheets
							15	16	
		Total					12 Maps		

Table 2 Index of database of historical maps.


Figure 3 Al-Falaki original map of Alexandria, 1866 CE

Integrated three landmarks dated back to different eras were utilized, which are: 1) Pompey's Pillar of the Roman period (C. 3rd CE), which is the remained archaeological feature of Serapis Temple in the south eastern suburb. 2) Qai'tbay Fort of the Mamluk period (1479 CE) locates on the north cape of Pharos peninsula. 3) The estuary of al-Mahmoudiya Canal that was developed by Mohamed Ali (1820 CE) and empties into the western harbour (Fig. 4).

No. on ArcGIS Online	Item	Source	Description	Resolution
1	2	Pléiades-B	Stereo_DS_PHR1A_201205280854224_FR1_PX_E029N31_1205_00822	Stereo/60cm
2	1	Pléiades-B	DS_PHR1B_201911190848364_FR1_PX_E029N31_1106_02862	Ortho/60cm
3	3	ALOS-2	ALPSMLC30_N031E029_DSM	DSM/30m
4	1	LANDSAT/USGS	L1C_T35RQQ_A014533_20191218T084754	DEM/30m
Total	7			

Table 3 Indexed satellite images.

3.2 Satellite imagery for tracing urban change

Since the last terrestrial survey of Alexandria in the 1940s, there are no updated survey that could reflect the situation in almost one century. As a result, to realize the contemporary status of Alexandria, the database includes most recent satellite imagery used to investigate the changing average of the existing LULC of Alexandria. Pléiades-B satellite provides orthorectified images of two different years (May 2012/Nov. 2019), which record the variation in the urban change of Alexandria after the 2011 revolution. Additionally, ALOS-2 digital surface model (DSM) and LANDSAT/USGS are used for the same objectives (Table 3).

However, this is the first stage of the uploaded historical maps of Alexandria to this database that will be followed with successive contributions. Now, the database is available via these links:

https://arcg.is/1GPSqT0

https://experience.arcgis.com/experience/bf21972568934 19d888874f85fd3af88 (Soliman *et.al* 2021)

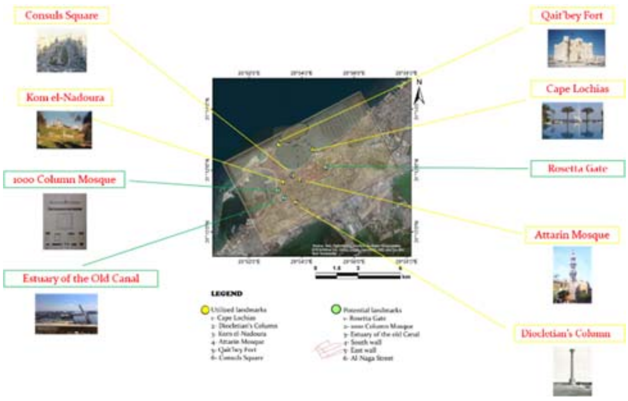

Figure 4 Maintained and potential historical landmarks of Alexandria based on al-Falaki map, 1866 CE

4. Integration methodology of interdisciplinarity and old maps

4.1 Combination of GIS and remote sensing

The old maps in TIFF format were processed via ArcGIS (ArcMap/10.5.1) and (Arc Pro.) that were used to produce this phase according to datum (WGS84/EPSG 3857), which was adopted for Egypt (Fig. 5).

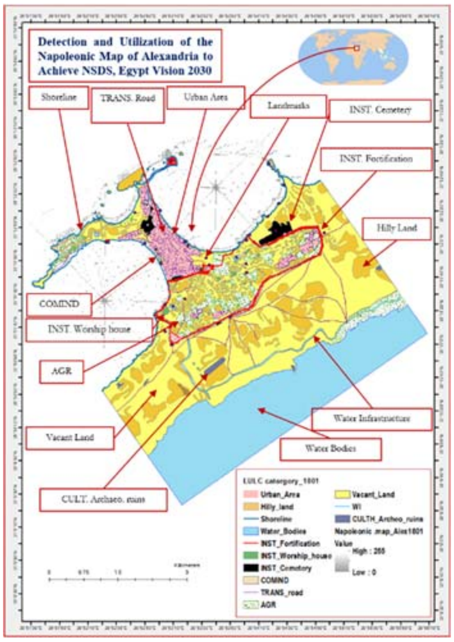

Figure 5 Classifications of the digitized Napoleonic map 1798 CE via ArcMap.

ArcGIS (Arc Map/10.5.1) 3D analysis had carried out for Alos-2 satellite images to classify Alexandria digital surface model DSM 30m (Fig. 6).

All data is publicized via ArcGIS Online, which opens new gates for the public use. Access to this database requires creating an ArcGIS Online account in the same way for similar software. All maps in the database have

30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-101-2021

an ascending order according to the year of the survey, where each of them has a legend that includes the cartographers' names, map attribute, and the year of the survey, which facilitates to recognize its references.
ArcGIS Online database, based on ArcGIS Experience Builder, includes an upper matrix of historical maps and satellite images icons, which are displayed in the lower section of the screen by clicking on each, while the navigation panel appears directly on it (Fig. 7).

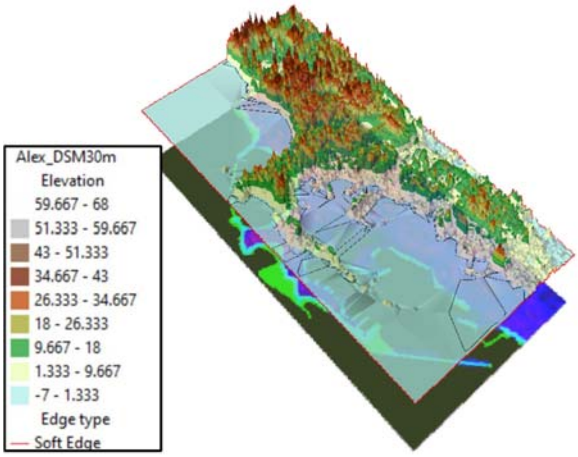

Figure 6 ALOS-2 DSM 30m via Arc Scene.

Figure 7 The gallery of the ArcGIS Online database

On the other hand, the collected satellite images of Alexandria were analyzed via TerrSet, which was an integrated geospatial software system for monitoring and modelling the earth system, TerrSet System incorporates "IDRISI GIS Analysis" and "IDRISI Image Processing" tools along with a constellation of vertical applications (Fig. 8) (Soliman *et.al* 2021).

4.2 Contribution of geophysical approach

The past few years, Alexandria has witnessed dozens of accidents of land subsidence and buildings collapses in dispersed areas, which threaten the security and safety of citizens. Among those accidents in 2010 at Khartoum Square, a huge land subsidence that almost caused a catastrophe had it not been for the street being empty, which had saved cars and pedestrian from falling inside, likewise occurred in al-'Attarin area and Sultan Husain Street. However, six years later, that hectic phenomena were repeated in these areas specifically in front of Shalalat Park, Fouad Street, and al-Raml Station in Downtown Alexandria, causing a hole a meter deep.

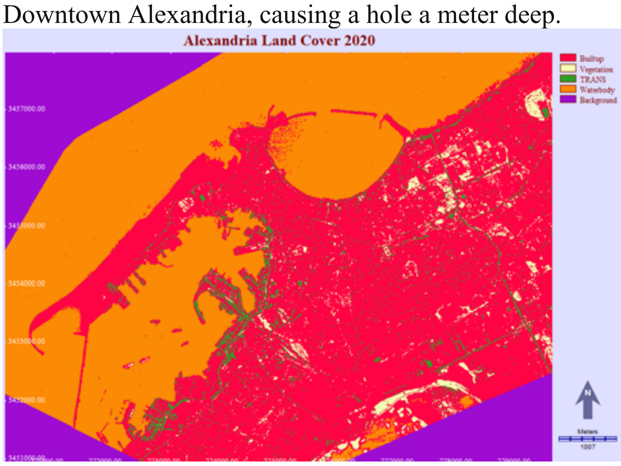

Figure 8 Land cover analysis of Pléiades-B Satellite image 2019 via Terrset.

GPR application in archaeological assessment is quite known procedure. Three areas have been examined using GPR technique at Alexandria. These areas are Sultan Husain Street, Khartom Square, and Nabi Danial Street. The investigated sites were selected based on the previous archaeological information. Accordingly, the utilized GPR device is the unique Russian system model LOZA-V. The system was attached to 200 MHz bi-static antenna operated is point mode. The data was significant and has indicated the possibility of archaeological remains.
The acquired data was significant and has indicated the possibility of archaeological remains. Some other features were analysed, which require integrated geophysical techniques as the main objective was not to explore the archaeological layers to investigate the subsidence phenomena in perspective of disaster management and sustainability (Fig. 9).
The data assures that the land subsidence in Alexandria lies for two reasons: the first) Contemporary Alexandria is completely erected on the ancient historical city, and one of the main reasons for the land subsidence is the cavity below associated with the ancient history of Alexandria, especially the central and western areas, including Shatbi, al-Raml Station, al-Mansheya, Khartoum Square, Sultan Hussein Street and Fouad Street. Such cavity is the most influential in terms of land subsidence phenomena. Subsequently, in 2016 a land subsidence occurred on Ghalbouni Street in al-Qabbari area, in two meters diameter, and approximately twelve meters depth. By inspection, the Antiquities Authority found an archaeological cistern below the subsidence area. While, the second reason is the dilapidated sewage networks resulting water leakage, which affects in different ways according to the nature of the soil, as the

clay soil that is located in the East Alexandria region swells when saturated, which leads, significantly to building or road collapses. Likewise, the limestone rocks that formulated most of the soil in the areas of al-'Ajami, Kom al-Dikka, and Mina al-Basal, and because of the cracks that lead to water leakage, whether its source is rain or sewage networks, it occurs with gradual melting, erosion, speculation, and then subsidence.

Figure 9 GPR 3D modelling at Khartoum Square at the Latin Quarter.

4.3 Alexandria geodesign approach to innovating a change model

Geodesign changes geography by design. It is the development and application of designing intended to change the geographical study areas in which they are applied and realized (Steinitz 2012). Consequently, geodesign is a field of work that tackles the future of a place in a systematic and analytical fashion. Now-a-days we have sophisticated collaboration tools to facilitate these interactions and the geodesign workflow.

The framework for geodesign consists of six questions that are asked (explicitly or implicitly) that have sub-questions that are modified as needed by the geodesign team (Fig. 10). The answers to those questions are models, and their content and levels of abstraction are particular to the individual case study. Some modeling approaches can be general, but data and model parameters are local to the people, place, and time of the study (Steinitz 2014).

Every change model goes through four common and hierarchically organized phases, all of which are essential for a successful decision and implementation: vision, strategy, tactics, and actions. Geodesign change models frequently combine "offensive" development-oriented allocation strategies and "defensive" conservation strategies. All change models combine decisions related to allocation, organization, and expression, and all require visualization and communication (Steinitz 2012).

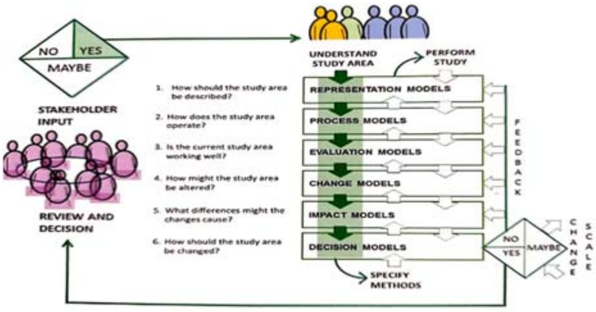

Figure 10 The stakeholders, the geodesign team, and the framework for geodesign. (source Steinitz C. 2012)

The contents of the evaluation models are derived from the decision models. Geodesign evaluation system consists of five categories that are adopted to allocate the appropriate intervention action based on constraints, stakeholders and decision makers' needs, and existing land use of study areas (Fig. 11).

	Existing	Not appropriate	Capable	suitable	Feasible
classification	is where the system is "existing" already and in a healthy state, meaning that it is feasible to remain....a constraint in terms of information but not a total Constraint.	is lowest priority for change... "not appropriate" or not capable of supporting the system, meaning don't put it there, e.g. too wet or steep or....unless you provide change to the basic area conditions e.g. fill in the ocean for new land, regrade the mountain, etc.. (all very risky projects). This is also a constraint in terms of information.	is low but higher priority ...."capable", meaning that you can place it here IF you also provide the technology and market to make it feasible, e.g. water and sewers, access roads for mechanical harvesting, etc., and the market comes...	is higher priority...."suitable", meaning that the area is capable of supporting the project and it already has the appropriate technologies to support the activity taking place e.g. septic tank soil or sewers, access roads for mechanical harvesting, etc. BUT there may not yet be a market for the change.	is the highest priority for change...."feasible", meaning that it is suitable AND there is a demand or market to provide the new land use change, e.g. that someone wants to buy the product or new house (and at a profit) OR that the government wants to protect and improve an historical landscape.

Figure 11 Geodesign evaluation system (source Steinitz C. 2012).

5. Synthetic approach contribution for developing Alexandria within NSDS

Integrating utilization of the constructed geospatial database with interdisciplinary supports stakeholders to construct project and policies that lead to achieve SDGs. On the other hand, adopting synthetic approach for building capacity of young responsible and researchers to create new generation of decision makers. Nevertheless, that is not the only outcome of this approach, but it could be a foundation for changing the traditional mindset of planning and management, fundamentally.

NSDS, Egypt vision 2030 outlines the timeline of the Alexandria Geodesign project, so two integrated scenarios were adopted. Acoordingly, the first scenario achieves highly demanded projects until 2025. Cultural heritage projects identify a protected zone and develop tourism projects. Transportation projects develop bike tracks and upgrading the historical tramway to mitigate the traffic density. Other systems, HDH/LDH, WI, AGRI, GI, and COMIND, attract population surplus outside Alexandria Downtown (Fig. 12). While the second

30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-101-2021

adopted scenario accomplishes projects that had been begun in the first scenario of 2025 until 2030, add to develop other prioritized projects. Cultural heritage projects aimed to list outstanding prosperities and developing other existed listed. Transportation projects resumed upgrading the tramway infrastructure to mitigate the traffic density. HDH/LDH, WI, AGRI, GI, and COMIND projects are developed to accomplish achieving SDGs of NSDS, Egypt vision 2030 (Fig. 13).

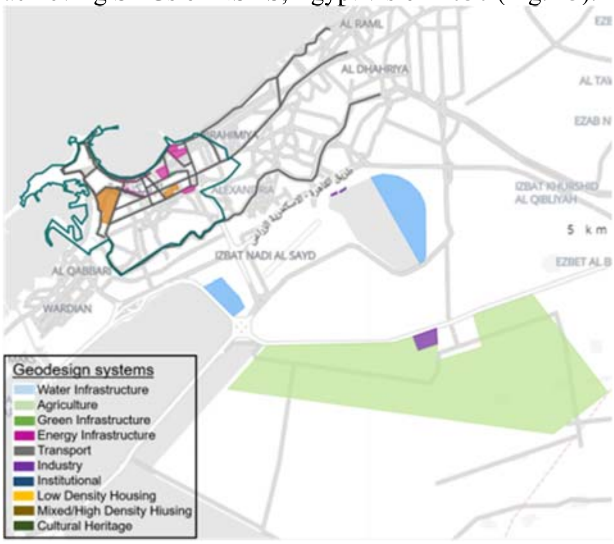

Figure 12 Adopted scenario 2025.

Figure 13 Adopted scenario 2025.

Urban mobility represents one of most headache problematics of Downtown Alexandria, due to its topographic structure as a narrow strip of land bordered by waterfronts and high intensity of institutional, commercial, and industrial activities there. Adopting public transportation policy by service improvement in reasonable fee. Potential transportation heritage, Tramway (yellow tram), can handle the solution to this quandary in terms of upgrading infrastructure, providing maintenance, and promoting public transportation concept. Accordingly, the database diagnoses and indicates to highly requirements represented in identifying buffer track to facilitate passenger arrival according to accurate operating time. In the same context, promoting environmental private transportation policy is another aspect of sustainable solution.

Consequently, “Your Bike ...Your Health” is a governmental initiative compatible with this approach as Ministry of Youth and Sport provides the purchase of bicycles in easy instalments to all segments of the community, especially university students, to support the initiative. Certainly, that decent initiative improves the transportation behaviour of the Alexandria community, although it requires an appropriate intervention in terms of developing bicycle lanes and smart traffic lights, which therefore requires a review of the related laws and regulations to adopt this, in parallel with raising community awareness.

The synthetic approach promotes an integrated intervention to maximize the benefits and preserve the diversity of Alexandria cultural heritage in the framework of NSDS. Consequently, challenge of preserving Alexandria cultural heritage is summarized in the multiplicity of governmental institutions that manage and protect the cultural heritage of Alexandria according to various laws, Ministry of Tourism and Antiquities and National Organization for Urban Harmony, and others that occupy them, in addition to the multiple possessions of the cultural property. As a result, cultural property being exposed to misuse or even entire deterioration. Accordingly, the identification of a protected core zone (PCZ) that regulated by a unified law and empowering an integrated local agency has become an urgent necessity and represent a sustainable framework to receive successive interventions for preservation processes.

The relevant fields that deal with preservation of the cultural heritage; the digitized old maps and most recent satellite imagery visualize the historical human activities of Alexandria, moreover integration to geophysics applications that lead to new discoveries, which is one of the main objectives for archaeologists. On the other hand, pragmatic development plan and individual human activities threaten Alexandria cultural heritage provoke to adopt an interactive monitor policy connected to the geospatial database, basically GIS and satellite imagery. Preservation of Alexandria cultural heritage is an ultimate goal. So, sustainability will be achived through adopting site management plan, utilizing the database and aligned to geodesign approach, fundamentally. Subsequently, the adaptive reuse concept of identified historical buildings, at misuse or neglect, achieves SDGs, taking into consideration the community needs in terms of mitigating intensive official institutions in favour of cultural, educational, and micro-economical uses and transferring the governmental complexes outside the protected core zone, parallel to adopting sustainable policy for the existing commercial and industrial activities to serve Downtown Alexandria.

From an integrative perspective; government reports indicate the intention of the Alexandria Governorate to develop a subway that penetrates the cultural urban fabric

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-101-2021

and archaeological layers. Regarding that, the geospatial database in combination with geophysical applications could harmonizes the viability of the proposed railway and protecting the authentic value of Alexandria. Meanwhile, adoption of the synthetic approach promotes developing unconventional tourism projects. So, visualization of the potential archaeological settlement under Downtown Alexandria represents an outstanding value added to the tourism industry in Alexandria.
As a result of the anticipated growth rate of Alexandria population 2.02% by 2030, the southern cultivated area is being corrupted in favour to random urban expansion (Table 1) (Fig. 1). Consequently, adaptation of the high-density construction (HDH) to low-density (LDH) (max. 7 floors) within the proposed protected zone, considering historical urban regulations and a specific code of practice. Meanwhile, a new urban area should be developed to accommodate gradually the surplus of a population outside the proposed protected zone, with priority given to the local community of Downtown Alexandria.
Nevertheless, in the light of the utilized synthetic approach, geodesign contribution extends to developing other targets to innovate an integrated change model to achieve SDGs for Downtown Alexandria (Fig. 14).

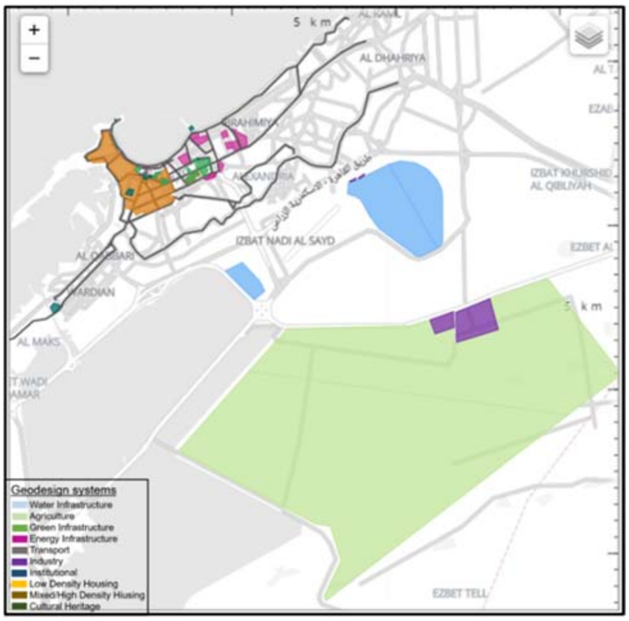

Figure 5 Final change model.

6. Conclusion

Natural and human hazard, add to cosmopolitanism have generated the authenticity of Alexandria since foundation in 332 BCE. Contemporary Alexandria Governorate has promising potential to achieve SDGs, in the framework of NSDS, Egypt vision 2030.
Problematic of cultural heritage is contrasted with pragmatic development requires innovation of synthetic approach that integrates geospatial database and relevant interdisciplinary. Accordingly, DMUCH team at Ritsumeikan University has constructed geospatial database based on digitizing old maps of Alexandria and satellite imagery. Successful collaboration with Egyptian institutions was conducted to combine the constructed database with other disciplines, basically geophysical applications. Geodesign approach has been adopted in collaboration with Geoedsign Hub to accommodate the acquired data to innovate change model according to NSDS to achieve SDGs for Downtown Alexandria, add to building capacity of young stakeholders.
Eventually, the synthetic approach harmonizes the authenticity and modernization of Downtown Alexandria in terms of preservation, management, and development of its cultural heritage for sustainability in integration with potentiality of Alexandria Governorate.

7. Acknowledgment

The authors greatly acknowledge the Japan Society for the Promotion of Science (JSPS) for supporting this contribution, which comes out within the first author mission as International Research Fellow of (JSPS) postdoctoral fellowship for Research in Japan. Furthermore, National Authority for Remote Sensing and Space Sciences (NARSS), Faculty of Sciences-Alexandria University, and Egyptian Company for Space Applications & Remote Sensing (ECSARS) are acknowledged to provide valuable data that enriches this contribution.

8. References

Abouseif, D. (1989). Islamic Architecture in Cairo. The American University in Cairo Press. Cairo.
Egyptian Authority of Survey E.A.S (1935). Atlas of Alexandria. Giza.
Escoffey C. (2012). Ancient Alexandria. Bibliotheca Alexandrina, Alexandria.
Jondet G. (1921). Atlas Historique de la ville des ports d'Alexandrie. L'Institute -Français D'Archéologique Orientale, L'Caire.
Mahmoud H. (1961). Alexandria during the Byzantine Period, History of Alexandria since Ancient Ages. Alexandria.
Rowlatt M. *et al.* (2020). Britannica Online Encyclopedia, London.
https://www.britannica.com/place/Alexandria-Egypt
Samir R. *et.al.* (2005). Ancient Earthquakes from Some of Arabic Sources & Catalogue of Middle East Historical Earthquakes. National Authority of Remote Sensing and Space Science (NARSS), Cairo.
Soliman M. (2014). Water Installation in Alexandria from the Islamic Conquest to Mohamed Ali's Dynasty. PhD diss., Helwan University, Cairo. #
Soliman M. *et.al* (2021). Construction of GIS Database of Alexandria Based on the Old Maps" in ARC 21 vol. Pp. 33-44.
Steinitz C. (2012). Changing Geography by Design. esri Redlands, California.
Steinitz C. (2014). Which way of designing, Geodesign by Integrating Design and Geospatial Sciences. springer, USA, pp. 11-40.

30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-101-2021 |