UNITED NATIONS

E

ECONOMIC AND SOCIAL COUNCIL

Distr.
LIMITED
E/ESCWA/C.1/2019/4
5 January 2019
ORIGINAL: ENGLISH

Economic and Social Commission for Western Asia (ESCWA)

Statistical Committee
Thirteenth session
Beirut, 29-30 January 2019

Item 5 of the provisional agenda

Prospects of innovation and technology in official statistics

Summary

The 2030 Agenda for Sustainable Development and the 2020 Round of Population and Housing Censuses are principal foundations for building capable national statistical systems in the current data revolution era. Harnessing the data revolution to achieve the ambitious Sustainable Development Goals depends greatly on how national statistical systems develop their capacity to monitor systems, design relevant indicators, and provide technical assistance on data collection and analysis. The Economic and Social Commission for Western Asia (ESCWA) secretariat aims to play a coordinating role in promoting the strategic use of geospatial and other innovative technologies to support statistical systems, and to advocate for their adoption and implementation in accordance with United Nations recommendations, while taking into account member States' national circumstances.

To better assess the status and readiness of the Arab region in that regard, the ESCWA secretariat prepared a questionnaire on the experiences and practices of Arab countries in the use of geospatial methodologies and technologies, and the dissemination of statistical data. The questionnaire was sent to all 22 Arab countries in August 2018, and 16 responses were received by the end of October 2018. The survey results were used to inform the present document and to identify priority technologies for the Arab region.

The present document outlines a set of methodologies and technologies to support census and statistical activities. It also stresses the basic foundations for building a statistical geospatial information infrastructure for evidence-based decision-making and sustainable development.

CONTENTS

		Paragraphs	*Page*
Introduction		1-4	3
Chapter			
I.	**TECHNOLOGIES AVAILABLE TO NATIONAL STATISTICAL OFFICES**	5-47	3
	A. Geospatial information technologies	7-17	4
	B. Mobile data capture: hand-held devices	18-24	6
	C. Internet-based data collection	25-29	7
	D. Cloud computing	30-32	8
	E. Web mapping and web GIS	33-36	8
	F. Mobile applications	37-40	9
	G. Geoportals	41-43	9
	H. Open data and big data	44-47	10
II.	**PRIORITY TECHNOLOGIES FOR THE ARAB REGION**	48-61	11
	A. Building statistical geospatial infrastructure	50-51	11
	B. Satellite imagery	52-55	13
	C. Point-based data collection	56-57	13
	D. Mobile technology and hand-held devices	58-59	13
	E. Internet-based technologies	60-61	14
III.	**INTEGRATION OF STATISTICAL AND GEOSPATIAL INFORMATION**	62	14
IV.	**INSTITUTIONAL ARRANGEMENTS AT THE NATIONAL LEVEL AND WITH NATIONAL STATISTICAL OFFICES**	63-65	15
V.	**ROLE OF PARTNERS AND OTHER STAKEHOLDERS**	66-68	15
VI.	**CONCLUSIONS AND RECOMMENDATIONS**	69-71	16

Introduction

1. In 2015, the international community adopted the 2030 Agenda for Sustainable Development as a universal approach towards a new framework for development policies over the next 15 years. Earlier that same year, the United Nations Statistical Commission endorsed the 2020 Round of Population and Housing Censuses (2015-2024). In 2016, it recommended that the design and development of census products for the 2020 round of population censuses should take into account the global indicator framework for the Sustainable Development Goals (SDGs) and targets of the 2030 Agenda.[1]

2. The United Nations recommended that countries keep abreast of technological advances made since the previous round of censuses, especially in the area of geographic information systems (GIS) and global positioning systems (GPS); and that the adoption of GIS should be a major strategic decision for the 2020 Round of Censuses.[2] Moreover, there is an increasing recognition that the adoption of a geographic-based approach with full integration of statistical and geospatial information in support of the SDGs offers an opportunity for countries to modernize their official statistics.

3. The present document focuses on recent methodological and technological developments to help national statistical offices modernize their statistical systems, and provide support for SDG implementation, measuring and monitoring. It also aims to guide member States in using appropriate technologies to improve the quality of and access to their statistical data for evidence-based decision-making and sustainable development.

4. Feeding into a larger forthcoming study commissioned by the secretariat of the Economic and Social Commission for Western Asia (ESCWA) on the prospects of innovation and technology in official statistics, the present document is also directly linked to the Beirut Consensus on Technology for Sustainable Development in the Arab Region. Adopted by member States at the thirtieth ESCWA ministerial session held in Beirut in June 2018, the Beirut Consensus underlined the need to share experiences and best practices in technology transfer and adaptation for sustainable development. It is presented to the Statistical Committee at its thirteenth session in order to provide an overview of emerging technologies used to support statistical activities. It also seeks to launch a discussion on the technical cooperation activities that member States may require to integrate those technologies in their statistical processes.

I. TECHNOLOGIES AVAILABLE TO NATIONAL STATISTICAL OFFICES

5. Recent technological developments, including high-resolution sensors, GPS, GIS, Internet services, cloud computing, big data and data visualization are revolutionizing data collection, analysis and dissemination. Greater access to and use of geospatial technology has significantly increased the quantity and quality of geospatial data collected from various sources. For example, users today have easier access to Earth observation data that would have been expensive and limited to specialists in the recent past. Similarly, there is an increasing demand for location-based information about places, people, businesses, including information on small geographic areas to monitor development goals and indicators at the local and community levels.

6. Many national statistical offices are already transforming their statistical systems, using several well-established technologies, and are attempting to build a statistical geospatial information infrastructure to contribute to the modernization of their statistical systems. The following sections provide an overview of emerging technologies that support national statistical offices in data collection, processing, analysis and dissemination, with an emphasis on geospatial information technologies.

---

[1] A/RES/71/313.

[2] https://unstats.un.org/unsd/publication/seriesM/Series_M67Rev3en.pdf.

A. GEOSPATIAL INFORMATION TECHNOLOGIES

7. Geospatial technologies cover all the means used to measure, analyse and visualize features or phenomena that occur on Earth. They include the following three core technologies that are used to map features of the Earth's surface: remote sensing, GPS and GIS.

1. *Remote sensing and Earth observation*

8. Remote sensing refers to the science and techniques used to remotely obtain information about a phenomenon, without being in contact with it. Remote sensing technologies are used to gather information about the Earth's surface from a distant platform, usually a satellite or airborne sensor. The data, which is processed and interpreted into digital aerial photography and satellite imagery, are referred to as Earth observation data.

9. This technology provides census cartographers with recent and detailed base maps of countries, suitable for use as enumeration area and supervisor area maps, thus eliminating problems associated with outdated base maps. Emerging technologies, such as high-resolution sensors and small or miniature satellites, drones and unmanned aerial vehicles (UAVs), offer new sources of data that have reduced costs and improved accuracy. Moreover, the Earth observation data they provide are considered of paramount importance to the SDG indicator framework.

2. *Global positioning systems*

10. GPS is a satellite-based navigation system, operated by the United States Department of Defense. There are other global navigation satellite systems such as the Russian GLONASS and the European Galileo. Satellites give out signals that can be picked up by GPS receivers for positioning and navigation. GPS enables users to accurately determine locations anywhere on the Earth's surface except where it is not possible to receive signals, such as inside buildings, underground sites, caves and under water.

11. Although GPS is a complex and sophisticated technology, user interfaces have become easily accessible and user-friendly for non-technical users, with direct use of GPS data in GIS. Once expensive and complicated, GPS have become commonplace. Simple and affordable GPS units are available with metric accuracy, but more sophisticated precision agriculture systems, for example, can achieve centimetre level accuracies.

12. GPS devices are useful for capturing the coordinates or location of point-based features like physical addresses, housing units, buildings, landmarks and other points of interest. They are especially used for navigational and tracking purposes to ensure that the right enumeration area on the ground is visited, and that field teams are in areas where they are planned to be. GPS use in fieldwork is highly effective, as collected data can be fed directly into GIS databases thus avoiding intermediate data entry or data conversion.

3. *Geographic information systems*

13. GIS is generally defined as a digital system for capturing, storing, checking, integrating, manipulating, analysing and representing data, which are geographically referenced to the Earth.

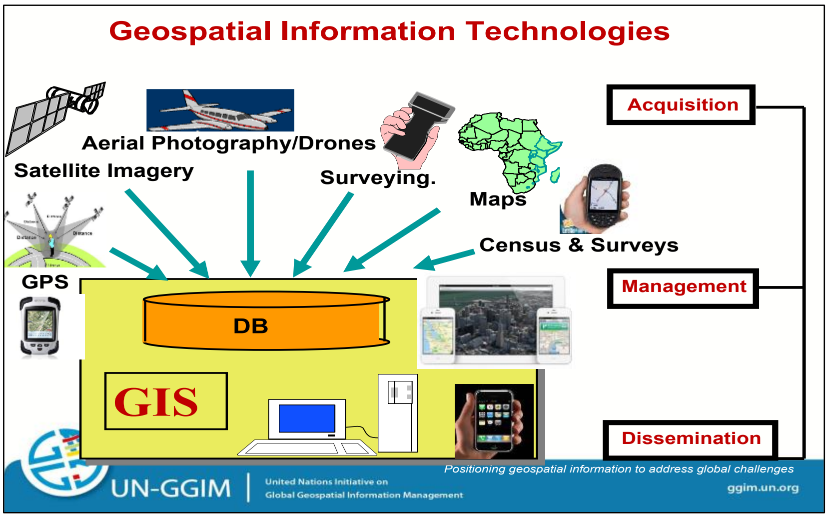
14. The Environmental Systems Research Institute (Esri) provides the following exhaustive definition: GIS is a framework for gathering, managing, and analysing data. Rooted in the science of geography, GIS integrates many types of data. It analyses spatial location and organizes layers of information into visualizations using maps and three-dimensional scenes. With this unique capability, GIS reveals deeper insights into data, such as patterns, relationships and situations, thus helping users make smarter decisions.[3]

[3] https://library.owu.edu/c.php?g=431854&p=5466232.

15. GIS offers many benefits to the census process. It is used at all stages of pre-enumeration (for example, delineating enumeration areas and building the census geographic database), enumeration (providing enumeration area maps, and supporting field work in managing field operations, including optimizing workloads and routes), and post-enumeration (conducting spatial analysis and creating products for dissemination with advanced visualization tools, dashboards and other smart/story maps).

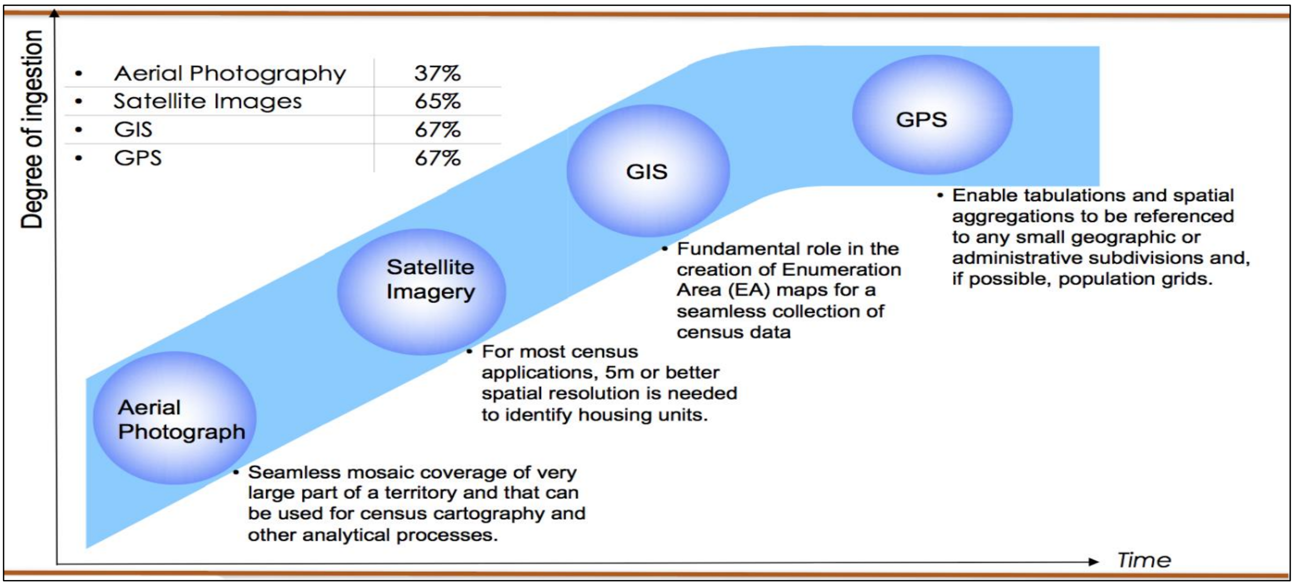
16. GIS plays a central integrative role. As illustrated in figure 1, satellite imagery and GPS, among other traditional tools like censuses, surveys and maps, are used for geographic data acquisition. Once data are collected, they are processed and analysed using GIS, through a geographic database, to provide sound information for users and the general public.

Figure 1. GIS used in census activities



Source: Adapted from ESA/STAT/AC.98/14.

Figure 2. Mainstreaming geospatial information technologies in census processes



Source: Andre Nonguierma, "Leveraging the enabling capabilities of geospatial information technologies in all stages of statistical processes", presentation made at the United Nations Regional Workshop on the 2020 World Programme on Population and Housing Censuses: International Standards and Contemporary Technologies, Dar es Salaam, Tanzania, May-June 2017. Available at https://unstats.un.org/unsd/demographic-social/meetings/2017/dar-es-salaam--regional-workshop-on-2020-census/docs/s10-01-UNECA.pptx.

17. The Economic Commission for Africa conducted a survey-based study on the degree of integration of aerial photography, satellite imagery, GIS and GPS in census processes (figure 2).

B. MOBILE DATA CAPTURE: HAND-HELD DEVICES

18. Technological developments in mobile technology, coupled with increased connectivity and network coverage, have contributed to the emergence of computer assisted personal interviewing (CAPI) as an alternative to pen-and-paper methods for census data collection, through the use of increasingly powerful hand-held devices such as such as personal digital assistants (PDAs), hand-held computers, tablets and smartphones. Although PDAs are not entirely obsolete, their popularity has decreased with the prominence of tablets and smartphones.

19. A mobile device is a small hand-held electronic device with computing power, a mobile operating system, and a display screen with a keyboard. It allows census data to be captured and stored electronically, replacing traditional census forms with a series of sequential questions appearing on device screens where enumerators enter answers by either selecting from a predefined list or entering a variable.

20. Most mobile devices can be equipped with GPS capabilities, Wi-Fi and Bluetooth, which can connect to the Internet and other Bluetooth capable devices. Many can also access the Internet over-the-air using a service provider subscription. Handheld devices have a number of other technical features that can aid the enumerator and census process, including camera and video playback, telephone calls, and data transmission.

21. In general, captured data can be stored locally on a device’s memory and/or transmitted to a central location if the appropriate communication infrastructure is available. Locally stored data can be transferred using the device download function in various ways, including through direct syncing to the host computer, transfer of data to a memory stick/card, or device-to-device transfer.

22. However, consideration should be given to data security, which is a legitimate concern. A number of procedures and measures can guarantee that individuals’ data are not compromised if a device is lost or stolen, such as ensuring that data are not stored locally by immediately transmitting them over a communications network, or by encrypting data so that they cannot be accessed without a decryption key.

23. A hand-held device is a typical integrative tool, as it can combine an electronic questionnaire with maps and imagery. Enumeration area maps can be loaded onto the device with aerial or satellite photos to help enumerators find the correct housing units to visit. Through built-in GPS, tracking can be undertaken to assist enumerators in finding their current location, and capture the geographical location where census data were collected.

24. Several country experiences highlight that the advantages of hand-held digital methods outweigh the disadvantages, thus promoting their increasing use by many national statistical offices. This is mainly due to their integrated data collection approach, where data collection, entering, coding and editing are carried out simultaneously and automatically. In addition, many country experiences show that this method of capturing and processing census data is faster, leading to timely availability of census information results.[4]

[4] For example, back in 2005, the United Arab Emirates used PDAs for census data collection, improving the timeliness of census releases to three months compared with a year for previous censuses. The same applies to Jordan in 2015, and Egypt and the State of Palestine in 2017.

C. INTERNET-BASED DATA COLLECTION

25. Pervasive Internet use has contributed to the emergence of Internet-based data collection, initially as a complement to other established methods but its success in facilitating censuses is making it increasingly popular.[5]

26. Unlike the mobile data method, Internet-based data collection directly involves households by requesting that they complete the census questionnaire online (self-response), thus eliminating the need for enumerators with hand-held devices as intermediaries, but requiring that respondents have the necessary equipment, reliable Internet connectivity and a minimum level of computer skills. Moreover, the Internet questionnaire, or computer-assisted web interview (CAWI), requires a user-friendly interface and functionalities to assist respondents in accessing the online form and completing it with minimum technical support.

27. The design of the online questionnaire can be customized to respondents' needs, offering language options, for example. In contrast to paper forms, online forms do not limit respondents to a set space for textual answers and, once completed, a copy can be printed out and saved by respondents. Like many other web-based applications, several functionalities are possible, but require technical skills and resources for their development.

28. A key advantage of Internet-based data collection, similar to mobile technology, is real-time data capture; interactive control of responses such as online checking of completeness, automated skips, interactive help and explanations; and immediate data transmission, thus providing more reliable information. Countries that have utilized the Internet questionnaire option reported that data quality was higher compared with other data collection methods, and that edit failure rates were much lower than those of the paper-based questionnaire. Another benefit, contrary to mobile or paper-based data collection methods, is a significant reduction in running costs since enumeration is based on self-response, thus eliminating the need for large numbers of enumerators.

29. However, there are numerous challenges that need to be addressed by national statistical offices, including the following:

(a) Internet-based data collection requires that respondents have basic computer skills and computers with reliable Internet access, thus excluding those who do not – such challenges limit the viability of this method;

(b) Using an Internet-based questionnaire requires a level of authentication control to validate and grant access to respondents so as to avoid fraud. This also requires a mechanism to check for omitted and duplicate submissions;

(c) Extensive tests of security systems should be carried out to ensure safe data transfer, using encryption, for example, to avoid data being stolen during transmission. Specific tests should be carried out to simulate heavy traffic, as a high response rate might crash the central website and disrupt the data collection process;

(d) While running costs for data capture are relatively low, setting up a sophisticated control system and adequately testing its security requires significant resources. Savings in data capture costs are therefore likely to be offset by the costs of developing and implementing the Internet system;

(e) If national statistical offices opt to outsource the Internet-based operation, or parts of it, to a company or another national agency owing to a lack of in-house technical skills, security testing should be extended to the third-party's site.

---

[5] For example, Canada went from an Internet-based use rate of 17.8 per cent in 2006 to 53.9 per cent in 2011, and to 68.3 per cent in 2016.

D. CLOUD COMPUTING

30. Cloud computing is a type of Internet-based computing where different services, including servers, storage and applications, are delivered to an organization's computers and devices through the Internet. Cloud providers charge for cloud computing services based on usage, similar to other utilities like water or electricity. Cloud computing is becoming increasingly popular for data dissemination, and organizations and end users are turning to cloud computing services for the following reasons:

(a) Cost benefits, as it reduces the up-front costs for information technology (IT) resources and operational expenses, including the need for IT administrators to manage computer resources;

(b) Speed, as organizations can acquire and operate resources, delivered in almost real time, instead of having to plan, acquire and set up their own resources;

(c) Global scale, with the delivery of a scalable amount of IT resources in terms of computing power, storage, and bandwidth commensurate with demand, at the right time and the right geographic location;

(d) Productivity, as IT teams can focus on completing tasks other than IT resource management;

(e) Performance and reliability by allowing users and organizations to store and process data in a privately-owned cloud or on a third-party server located in a secure data centre.

31. There are three types of cloud computing services, namely: infrastructure-as-a-service (IaaS),[6] platform-as-a-service (PaaS),[7] and software-as-a-service (SaaS).[8] Similarly, there are three different ways to deploy cloud computing resources: public cloud, private cloud and hybrid cloud.[9]

32. While traditional GIS is installed on a desktop or on-site server of national statistical offices, cloud GIS makes use of the flexibility of the cloud environment for data storing, visualization and sharing. With respect to census operations, since GIS-as-a-service is online without any on-premises deployment, providing less control and customization than an on-site server solution, it may be preferable for the dissemination phase of the census rather than the operational phase.[10] However, national statistical offices may need an enterprise GIS that can be deployed in the cloud, as it offers many benefits to census operations in terms of better human resources management and cost effectiveness, and better control of data as GIS runs on the organization's infrastructure.

E. WEB MAPPING AND WEB GIS

33. The popularity of Internet technology is revolutionizing GIS in many ways: GIS is no longer confined to specialists, it has become more accessible and affordable. Web GIS is evolving rapidly as an emerging technology to access, process and disseminate geospatial information over the Internet, covering a much wider audience than traditional GIS.

34. According to Esri, web GIS is a type of distributed information system, comprising at least a server and a client, where the server is a GIS server and the client is a web browser, desktop application or mobile

---

[6] Examples of IaaS include AWS, Microsoft Azure and Google Compute Engine.

[7] Examples of PaaS include AWS Elastic Beanstalk, Google App Engine and Heroku.

[8] Examples of SaaS include Salesforce, NetSuite and Concur.

[9] https://azure.microsoft.com/en-us/overview/what-is-cloud-computing/.

[10] https://unstats.un.org/unsd/publication/seriesF/Series_F83Rev2en.pdf.

application. The server has a URL so that clients can find it on the web.[11] Simply put, web GIS can be defined as any GIS that uses web technology to communicate between a server and a client.

35. Web GIS is conducted through web mapping, which is the process of using maps delivered by GIS where the web map is both served and consumed. Web mapping is more than traditional mapping: users can choose and customize what a map shows through smart mapping, using computation and analysis to automate the creation of maps, so as to accommodate users who are not familiar with GIS.

36. Web mapping caters to the needs of users who want to create interactive web maps that communicate meaningful and relevant information from their data. Therefore, instead of web GIS systems that try to cover everything, the now accepted best practice is to build a ‘story map’ that answers a specific data-related question or workflow. A survey-based study has shown that the global trend in the use of GIS web-based mapping tools is growing, and that half of countries in the 2010 round of censuses expressed intentions to move ahead in this domain.[12]

F. Mobile applications

37. Mobile technology has spread worldwide over the last 10 years faster than any other technology. Mobile applications, defined as computer programmes designed to run on a mobile device such as a phone, tablet or watch, have become the backbone of this user-oriented and interactive technology. Mobile devices provide users with an array of applications on almost every aspect of daily life, which can be easily accessed on the go.

38. There are three categories of mobile applications: native mobile apps, mobile web apps and hybrid apps. Native mobile apps are developed for a specific platform (a particular mobile device working with a specific operating system such as Android or iOS), are installed on the device itself, and can be accessed only from the dedicated application store (such as Google Play or Apple’s App Store). Web-based apps run in mobile web browsers rather than directly on the mobile device, and hybrid apps combine elements of both native and web apps.[13]

39. With cloud technology maturing and increasingly used to design cloud-based mobile apps, users may turn to web-based apps to get data without overloading their internal mobile device memory. Latest trends show an increase in cloud driven mobile apps (Dropbox, Google Drive), and experts agree that low cost is the determining factor favouring web-based and hybrid apps. Cloud-based mobile apps are especially attractive for enterprises, which can be assured that their data are safe in the cloud.

40. Since nearly all smartphones come with GPS and Bluetooth capabilities, mobile apps providing location-based services have become mainstream. For example, Google Maps has popularized mobile mapping apps, and has encouraged other providers to offer publishing tools and libraries that make developing such apps easier.

G. Geoportals

41. Country experiences in recent census rounds have clearly shown that national statistical offices should take advantage of existing and new technologies to enhance the dissemination and sharing of census/statistical data to reach a wider audience, including the media and the general public. Geoportals are a cost-effective mechanism for marketing and continued delivery of useful census and geography products and services to a diverse user base.

---

[11] http://enterprise.arcgis.com/en/server/latest/create-web-apps/windows/about-web-gis.htm.

[12] http://jmstat.com/publications/SINAPE%202010.pdf.

[13] See https://searchsoftwarequality.techtarget.com/definition/hybrid-application-hybrid-app; https://www.nngroup.com/articles/mobile-native-apps/.

42. A geoportal is an essential component of a modern GIS, and an inherent part of the web GIS pattern. It provides a framework for sharing and using maps, apps and data, and the needed infrastructure to manage users and how they collaborate.[14] Modern web-based geoportals provide a single point of direct access to and sharing of multi-source data in multi-formats, complete metadata and online visualization tools so users can create (story) maps with data in the portal.

43. After President Clinton signed an executive order in 1994 mandating the establishment of a federal spatial data infrastructure depository, the first geoportal concept underpinned the development of the United States National Spatial Data Infrastructure (NSDI), and spearheaded the creation of hundreds of geoportals by government agencies (e.g. data.gov), as well as commercial GIS companies such as Esri with its ArcGIS Open Data effort, and universities (e.g. OpenGeoportal.org). At the regional level, there has recently been a proliferation of geoportals for sharing geospatial information by region or theme. Examples include Infrastructure for Spatial Information in the European Community (INSPIRE), which was initially established to provide geographic information for environmental applications, but now covers over 30 major geospatial data themes.[15]

H. Open data and big data

44. The ‘open data’[16] movement is gaining popularity with the spread of the Internet, and the need to access and use data that citizens consider part of the public domain. Open data are freely available for anyone to use and republish without restrictions or control. Most definitions of open data include the following basic features: availability (machine-readable) and access (preferably online); re-use and redistribution (open-licensed); and universal participation (everyone must be able to use, re-use and redistribute, free of charge or at minimal cost). In recognition of the importance of open data and their interoperability for national statistical systems, the United Nations Statistical Commission encourages national statistical offices to embrace open data initiatives and ensure the participation of stakeholders in the national statistical system.

45. There are significant benefits related to the use of open data for citizens and society, in terms of the economy, government transparency and social accountability. However, Governments have expressed concerns about data security and confidentiality issues, especially with respect to census and statistical data at the individual level. In this regard, the United Nations Statistics Division (UNSD) states that open data platforms can only achieve public support and success if proper precautions are taken to protect the privacy of individual persons, business and civil society organizations, and that data generated by administrative, civil and business registers can be made public by matching access with strict ethical and security protocols and secure technology platforms.

46. Big data are defined by volume, velocity and variety. The United Nations Global Working Group on Big Data for Official Statistics[17] has been working with member States and their private sector partners to demonstrate the use of unconventional data sources to supplement official statistics; and that insights can be obtained by combining data from traditional sources, such as censuses, surveys or administrative data, with information from new big data sources.[18]

47. In general, GIS data is about geographic locations and features, such as addresses and coordinates, rather than about specific individuals. Modern GIS platforms have the capability to publish data openly and securely based on organizations’ needs. While there are legitimate concerns involving the disclosure of confidential

---

[14] https://blogs.esri.com/esri/esri-insider/2016/06/10/web-gis-simply/.

[15] https://inspire.ec.europa.eu/Themes/Data-Specifications/2892.

[16] Open data are digital data with technical and legal characteristics that allow them to be freely used, reused and redistributed by anyone, anytime and anywhere.

[17] https://unstats.un.org/bigdata/.

[18] https://www.oecd-ilibrary.org/docserver/dcr-2017-8-en.pdf?expires=1542917837&id=id&accname=guest&checksum=E8C3F202464ED4360C50762C421F9BA4.

information through spatial display, methods of aggregating spatial data can mitigate those concerns, particularly disclosure methods that should be applied when data are at the point/individual level.

TRADITIONAL VERSUS NEW DATA SOURCES AND TECHNOLOGIES

Traditional data sources	New sources and technologies
Census	Geospatial information
Surveys	Integration of geospatial information with statistics and other data
Civil registration and vital statistics	Mobile devices
Administrative records	Earth observations
	Other sensors and social media
	Citizen-generated data

Source: Presentation made by the United Nations Statistics Division to the fourth meeting of the Inter-agency Expert Group on the Sustainable Development Goal Indicators (IAEG-SDGs) Working Group on Geospatial Information, New York, December 2017. Available at http://ggim.un.org/meetings/2017-4th_Mtg_IAEG-SDG-NY/documents/Session_3_Benjamin_Rae.pdf.

II. PRIORITY TECHNOLOGIES FOR THE ARAB REGION

48. For ESCWA to better assess the status and readiness of the region to mainstream technology in its statistical processes, a written questionnaire on the "Experiences and practices of Arab countries regarding the use of geospatial methodologies and technologies, and the dissemination of statistical data" was prepared in August 2018. The ESCWA secretariat sent the questionnaire to national institutions responsible for producing official statistics in the 22 Arab countries,[19] and 16 countries[20] responded by the end of October 2018. The results[21] of the survey, in addition to global trends in technology and statistics, were used to inform the present document and identify priority technologies for the Arab region. Assessments of Arab countries' capacity to use technology in official statistics will also be used to identify their needs in terms of capacity-building programmes and technical assistance activities. Moreover, the questionnaire complements information collected by ESCWA in 2017 from a short questionnaire on "Assessing the status and needs of Arab countries to produce and utilize geospatial information as a data source for the SDGs".[22]

49. A more specialized European Union-designed survey on environment-related SDGs was conducted in 2018 by the ESCWA secretariat for selected Arab countries, in collaboration with the European Topic Centre of the University of Malaga in Spain, mainly on population, human settlements and infrastructure; land use and land cover; biodiversity; water; air quality and marine ecosystems. The results of the survey[23] provided an overview of geospatial data availability, and paved the way for ensuring efficient SDG indicator monitoring and coordination at the national and regional levels. National scoping and training workshops were hosted and coordinated by national statistical offices.

A. BUILDING STATISTICAL GEOSPATIAL INFRASTRUCTURE

50. The survey's findings (figure 3) indicate that national geospatial infrastructure to support census and statistical activities in many Arab countries are still in their infancy. For example, in response to the question "Could you describe the geospatial framework that you use in the organization's activities?", only 2 of 16 countries (12 per cent) state that they have a national statistical geospatial framework in accordance with the Global Statistical Geospatial Framework.

[19] The questionnaire can be accessed in English at: https://www.unescwa.org/events/statistical-committee-13th-session and in Arabic at: https://www.unescwa.org/ar/events/13-لجنة-الإحصاء-الدورة.

[20] Algeria, Bahrain, the Comoros, Libya, Somalia and the Syrian Arab Republic did not respond.

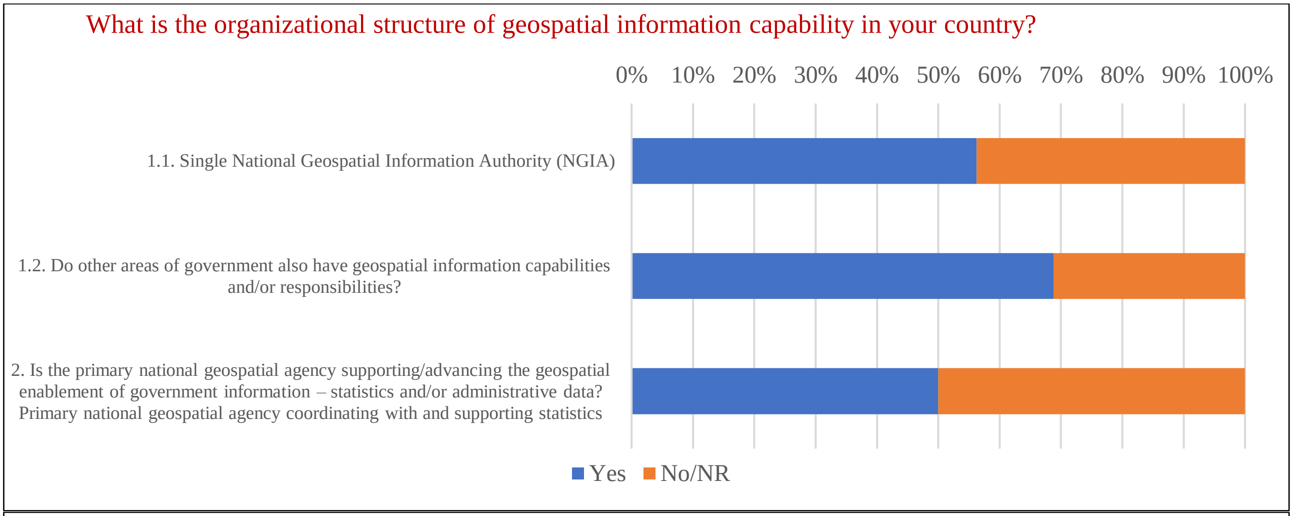
[21] Survey results can be accessed in English at: https://www.unescwa.org/events/statistical-committee-13th-session.

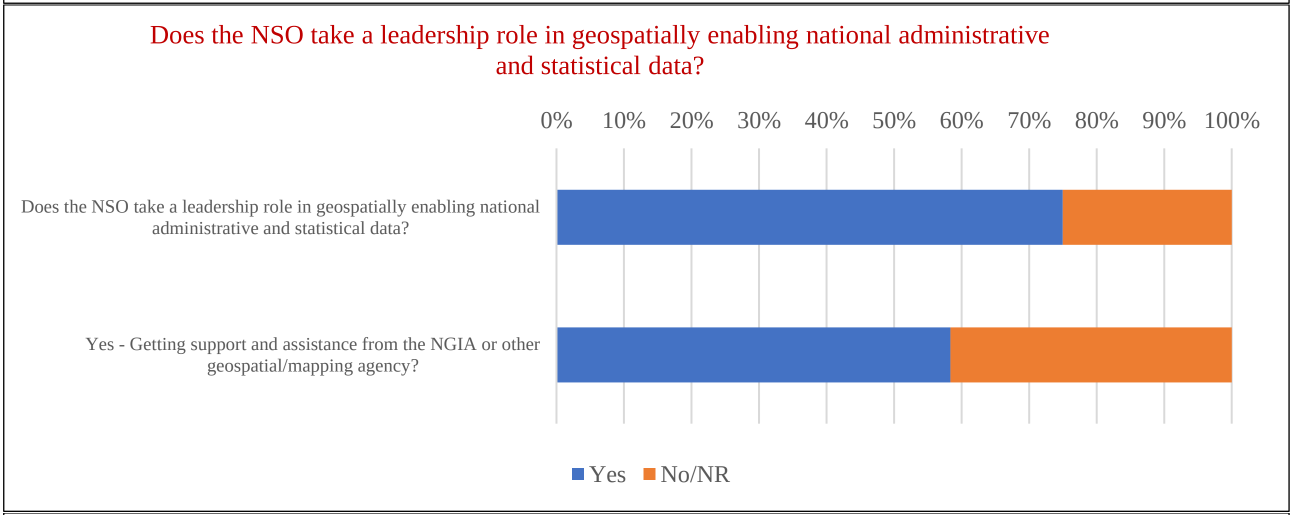
[22] The survey can be accessed at https://bit.ly/2LP2Ghq.

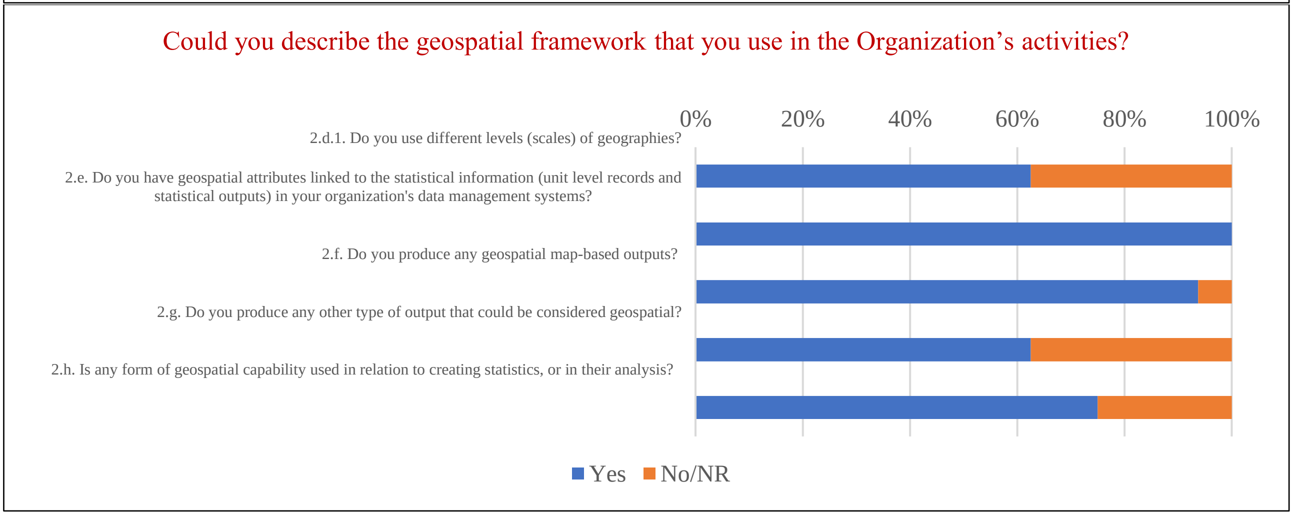
[23] http://www.etc.uma.es/un_escwa_etcuma/.

51. The geospatial community and the statistical community are both striving to develop national statistical geospatial information frameworks, as they provide a reference framework to integrate various data for evidence-based decision-making and sustainable development. They also enable data exchange capability and improve country level data to support the 2030 Agenda. Arab countries are recommended to build, develop and strengthen their geospatial information infrastructure to modernize their national statistical systems and official statistics.

Figure 3. Responses to selected survey questions







B. Satellite imagery

52. Based on the ESCWA survey responses, only 3 of 16 countries (19 per cent) mentioned imagery as a basic layer of their geospatial framework. Imagery is considered a fundamental layer of any national spatial data infrastructure. Its importance is increasingly recognized as an additional source of data for conventional maps, or in some cases as the only relevant data source, particularly in the context of SDG implementation, evaluation and monitoring.

53. Satellite images are more accessible and less limited to specialists. In contrast, aerial photography was traditionally captured using cameras on low-flying planes; today, it can also be obtained by using UAVs or drones, if permitted by the Government.

54. Up-to-date imagery, particularly high-resolution satellite imagery, is a critical source of information to support national statistics offices. For example, satellite imagery, digital aerial photography and GPS, combined with GIS, are increasingly used to overcome a lack of appropriate base maps for demarcating enumeration areas, updating existing base maps and other feature layers, and supporting the entire enumeration framework. Imagery and remotely sensed data can also be used to cover large areas, particularly dangerous or inaccessible places, thus saving countless and costly hours of fieldwork.

55. There are however some concerns about the cost of high-resolution satellite images. It is therefore worth investigating a cost-sharing mechanism with other national partners, especially in the context of the National Spatial Data Infrastructure. Since fieldwork can be relatively costly and time consuming, a good compromise has to be found between office work and field work.

C. Point-based data collection

56. Another approach dealing with higher spatial resolution of statistical data is point-based data collection. It consists of geocoding statistical units associated with implicit location-based information (address, property or building) to the level of single coordinates (X, Y, Z coordinates). The point-based approach directly captures, using GPS, the coordinates (latitude and longitude) of point-based features such as dwellings, land parcels, buildings or other features of interest. Some countries are embarking on capturing a latitude-longitude for all housing units, thus building their geospatial infrastructure at the point-based level, known as the Dwelling Frame.

57. This point-based location allows considerable adaptability to changes in geographic areas over time. A crucial advantage of a point-based location of people and dwellings consists of increasing the spatial resolution and relevance of statistical information, particularly in crisis management, such as in cases of floods, storms and fires.[24] Point-based data collection is the way forward for many other applications, as it provides the most precise location-based information. Mobile technology offers the most appropriate tools for this approach.

D. Mobile technology and hand-held devices

58. In a survey on national experiences of population and housing censuses for the 2010 round, conducted by UNSD in 2012, most countries reported that the implementation of new technologies was the most successful aspect of the census-taking in the 2010 round, with 56 per cent of countries responding to the questionnaire.[25] In addition, based on the ESCWA survey, 6 of 16 Arab countries (37 per cent) confirmed the use of innovative technologies, which include hand-held devices/mobile technology for data collection, integrated systems for field management, geospatial technologies for mapping, and GIS-based maps and Internet for dissemination.

---

[24] https://www.unece.org/fileadmin/DAM/stats/documents/ece/ces/2016/mtg/CES_7-In-Depth_Review_Geospatial_adv_copy.pdf.

[25] https://unstats.un.org/unsd/censuskb20/KnowledgebaseArticle10706.aspx.

59. CAPI is a viable alternative to traditional paper-based methods for census data collection. Hand-held devices with GPS are emerging as powerful tools, improving the timeliness of census releases and data quality. Several Arab countries, including Egypt, Jordan, Oman and the State of Palestine, have had successful experiences in the use of mobile technology, which should be considered by other countries that are planning censuses or surveys.

E. INTERNET-BASED TECHNOLOGIES

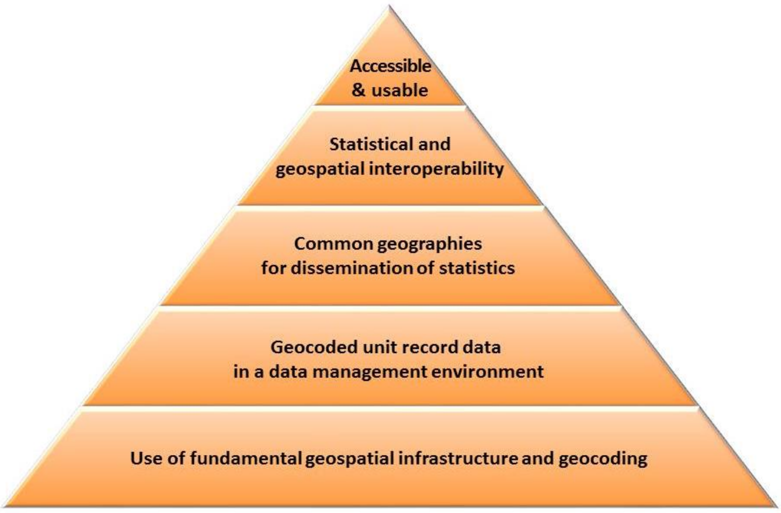
60. Based on the results of the ESCWA survey, 12 of 16 national statistical offices in the Arab region have a geographic/cartographic unit (88 per cent), with trained human resources and the requisite IT infrastructure dedicated to managing GIS. The current trend is to use various Internet-based technologies for data collection and dissemination.

61. National statistical offices can use the following tools: web-based mapping and interactive atlases, web GIS, cloud computing, dashboards and infographics, smart maps and story maps, and geoportals. There is much to gain from using modern GIS platforms, including web GIS, which have the capacity to publish data openly and securely based on country needs.

III. INTEGRATION OF STATISTICAL AND GEOSPATIAL INFORMATION

62. There is increasing recognition of the value of linking socioeconomic information to location, rather than looking at each in isolation. In recognition of this important shift, the United Nations Statistical Commission and the United Nations Committee of Experts on Global Geospatial Information Management have established the Expert Group on the Integration of Statistical and Geospatial Information, tasked with developing and advancing the implementation of a global statistical geospatial framework as a standard for integrating statistical and geospatial information, especially in the context of the 2030 Agenda. The Statistical Commission adopted the Global Statistical Geospatial Framework at its forty-eighth session held in March 2017. The Committee of Experts on Global Geospatial Information Management endorsed the Framework at its seventh session held in August 2017 (figure 4). Many countries, using a country-oriented template prepared by the Australian Bureau of Statistics for each of the five principles, are adapting the global framework to their national specificities and producing similar frameworks for national use.

Figure 4. Principles of the Global Statistical Geospatial Framework



Source: United Nations Expert Group on the Integration of Statistical and Geospatial Information, Global Statistical Geospatial Framework: Linking Statistics and Place – Current Status and Plans for Development (July 2018). Available at http://ggim.un.org/meetings/GGIM-committee/8th-Session/documents/Global-Statistical-Geospatial-Framework-July-2018.pdf.

IV. INSTITUTIONAL ARRANGEMENTS AT THE NATIONAL LEVEL AND WITH NATIONAL STATISTICAL OFFICES

63. The integration of geospatial and statistical information will continue to evolve at a fast pace, driven by commercial interest and user demands, and by the 2030 Agenda. This requires the establishment of a national geospatial infrastructure. However, national statistical offices ought to be aware that major barriers and impediments to using innovative technologies, including GIS and other geospatial technologies, are not only technical but are often also institutional and organizational.

64. Institutional arrangements within a country and coordination between geospatial and statistical communities are required to adopt and implement common standards, which underpin basic foundations for enabling interoperability, accessing and sharing datasets, and ultimately building and developing statistical geospatial information infrastructures. In addition to institutional arrangements, using and sharing technologies to produce timely and reliable data and statistics requires increasing the capacities of national statistical offices.

65. The following is needed to develop institutional arrangements with national statistical offices and at the national level:

(a) Enforcing a basic principle stating that geospatial information should be collected once and shared by many: national statistical offices should establish agreements and mechanisms for data sharing;

(b) Encouraging national statistical offices to participate actively in building the NSDI, since population datasets and geocoding systems, for which they are custodians, are considered basic components of NSDIs;

(c) Developing a one-stop geospatial information portal that makes government geospatial information accessible to agencies and the user community: national statistical offices can benefit from using this one-stop portal to disseminate their census information and extend their outreach to a larger user community;

(d) Strengthening the institutional and human capacities and capabilities for implementing, monitoring and following up on progress towards the SDGs is of vital importance. This was reflected in the ESCWA survey responses and in the needs assessment to produce and utilize geospatial information as a data source for that purpose.

V. ROLE OF PARTNERS AND OTHER STAKEHOLDERS

66. Building statistical geospatial information infrastructure requires effective partnerships and cooperation among a wide variety of multi-disciplinary stakeholders in the public and private sectors and end-user communities. A permanent geospatial information unit is needed within national statistical offices to develop partnerships, data standards and interoperability, agreements and contracts for data collection and sharing, and cooperate with other major actors in building a country’s NSDI.

67. Increasing cooperation among all stakeholders and building partnerships, starting from the census planning phase, is essential to implement a census geography programme that caters to the needs of all major users. For example, since producing base maps is not a core competency of national statistical offices, developing a partnership with the National Mapping Agency (NMA) can be mutually beneficial: the NMA provides national statistical offices with base maps that are updated and appropriate for census operations and, in return, it may benefit from improvements provided by field work undertaken by national statistical offices and the geographic products derived from the census. Other examples concern the construction of a national census geospatial database that can be employed beyond the census, in many different national contexts for numerous purposes.

68. Institutional arrangements facilitate partnerships for data standards and interoperability, for agreements and contracts for data collection and sharing, and for collaboration across government at a variety of levels, including national, regional and local, thus contributing to the building and development of a country's national geospatial information infrastructure.

VI. CONCLUSIONS AND RECOMMENDATIONS

69. The present document has described the strategic use of geospatial and other innovative technologies to support modernizing statistical systems, and to advocate for their adoption and implementation in accordance with United Nations recommendations. The importance of such technologies is paramount for official statistics in the region ─ a practice commended and supported by the United Nations for its potential in achieving the 2030 Agenda.

70. The ESCWA secretariat aims to play a coordinating role in promoting the strategic use of geospatial and other innovative technologies to support the modernization of statistical systems. In addition, the ESCWA secretariat is committed to strengthening the capacity of national statistical offices to improve the production of official statistics by harnessing geospatial and other innovative technologies for evidence-based decision-making and sustainable development.

71. The Statistical Committee is invited to consider the following recommendations:

(a) Countries in the region are adopting innovative approaches to census-taking and are increasingly using emerging technologies, including GIS, GPS and other geospatial tools. The implementation of those technologies is recommended for all national censuses in the region in the 2020 Round of Censuses. Such activities are also crucial for many applications other than censuses and official statistics;

(b) Arab countries should recognize geography as key to statistics, to provide a structure for collecting, processing, storing, aggregating and disseminating data, and to significantly improve the quality of official statistics. By embedding geography in their national systems and processes, many national statistical offices are transforming their statistical infrastructure and modernizing their statistics. It is recommended that the ESCWA secretariat support Arab countries in building and developing their statistical geospatial information infrastructure for the 2020 Round of Censuses and the 2030 Agenda;

(c) Many Arab countries are building census geographic databases, recognizing that they are fundamental for a full digital census geography programme. It is recommended to maintain those geographic databases as they offer a basis for spatial analysis, which is a core competency in census offices. It is also recommended to diversify the means for census data dissemination by using web-based mapping, cloud applications and services, and mobile technology to reach a wider audience;

(d) Earth observation and its support to digital mapping is increasingly recognized by national statistical offices as important additional sources of data. In addition, mobile technology, including hand-held devices equipped with GPS, is increasingly used for data collection. However, since high-resolution satellite imagery, aerial photos, GPS and hand-held devices can be costly, it is recommended to develop acquisition mechanisms to reduce their costs, such as grouping acquisitions of satellite imagery or borrowing hand-held devices;

(e) The ESCWA survey has shown countries' interest in adopting innovative approaches to census-taking, including the use of mobile devices for data collection and the Internet for dissemination. However, this requires strengthening capacities and the allocation of adequate resources. It is recommended that study visits be conducted to enhance the sharing of national experiences and practices, and to receive guidance on handling mobile devices for data collection and other supporting software applications;

(f) Point-based data are relatively easy to collect and manipulate on handheld devices. The use of handheld devices equipped with GPS can contribute to the geocoding of schools, hospitals and other important reference elements as a side benefit of census operations. It is recommended to use mobile technology, GPS, satellite imagery and UAV, as they facilitate data collection at the individual level as long as privacy/confidentiality issues are taken into account;

(g) National statistical offices are often not custodians of base maps and other mapping products that may be difficult to acquire, but are much needed for census cartographic operations. National statistical offices are therefore encouraged to collaborate with respective national mapping agencies and partner with other national authorities to develop national geospatial information capacity, including NSDIs. However, building a national geospatial infrastructure to support census activities requires technical and human capacity that may not be available in some Arab countries. It is therefore recommended to explore other mechanisms for building capacity through bilateral exchanges between countries, study visits, regional coordinated training and contact networks;

(h) Coordination and institutional integration between statistical and geospatial agencies within a country is vital. However, institutional coordination to support statistical and geospatial integration in some Arab countries is still underdeveloped, requiring a strong political commitment. The benefits of linking socioeconomic data to a location and of the value-added from their integration should be stressed to decision makers and policymakers, thus raising their awareness of national institutions' need for adequate resources to achieve integration;

(i) There is a strong geospatial dimension to environmental economic accounting, which can benefit from the integration of statistical and geospatial information. Integrating statistical data into NSDIs opens new horizons, based on the possibility of correlating those data with all other data layers, such as the ones related to natural resources and the environment. It is therefore recommended to develop national environmental statistics, using innovative methodologies and geospatial technologies;

(j) Standardization and data interoperability are central development challenges, since any progress in geospatial information management and sharing of authoritative geospatial data depends on them. Arab countries are encouraged to develop a common regional framework of standards and tools, taking into account their specificities (e.g. same language), but in line with internationally agreed standards;[26]

(k) The United Nations Expert Group on the Integration of Statistical and Geospatial Information[27] has developed an overarching statistical spatial framework, which can significantly improve the quality of official statistics and population censuses, and support progress towards the SDGs.[28] However, its implementation at the national level is still a challenge in most Arab countries. Therefore, Arab countries are encouraged to develop their national statistical geospatial framework in accordance with internationally agreed guidelines and principles.

-----

26 http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_from_Wiki_2012_update.pdf.

27 http://ggim.un.org/UNGGIM-expert-group/.

28 Decision by the United Nations Statistical Commission at its forty-ninth session held in March 2018 to establish a federated system of national and global data hubs for the SDGs. Four Arab countries are participating in this initiative conducted by UNSD and Esri.