Part V

SDGs Perspectives: Current Practices and Case Studies

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Why and How Informal Development Should Be Formalized Quickly, Inclusively and Affordably- Experience From UNECE Region

Chryssy Potsiou

National Technical University of Athens & Former FIG President, Greece

In order to address a selected SDGs goals and indicators, and the fact that there are many informal developments happening worldwide, it is very important to improve the level of land records. In this context, this chapter is discussing about why and how informal development should be formalized quickly, inclusively, and in affordable manner, particularly discussing the experiences from UNECE region.

18.1 Introduction

As a result of a 20-year research by the author, partially in cooperation with FIG, the World Bank, UNECE and government agencies and local authorities in the field of formalization of informal development in the European region, and mainly in Albania, Cyprus, Georgia, Greece, Italy, Kosovo, Kyrgyzstan, Montenegro, North Macedonia and Turkey we have learned to identify the problem of current informality in real estate within the South-Eastern European and Caucasus regions as to its size and definition as well as its causes [15, 12].

"Informal building" is defined as an unauthorized property unit which may be lacking planning and building permits and in many cases may be lacking property titles as well, or real estate built in excess of legally granted permits. In most cases it is residential real estate. Such properties are considered to be illegal, therefore are out of the economic circle. They have been characterized as illegal, are not accepted to be registered and cannot be transferred, rented, inherited or mortgaged.

We have also learned that there are a variety of types of informal buildings in each one of the various countries, varying from good and even multi-story constructions, as shown at Figure 18.1, up to settlements of poor but permanent construction which constitute a considerable investment of labor and revenue and are worth rescuing as shown at Figure 18.2. There are many similarities, as well. We have estimated that about 50 million people live in informal, self-made buildings in UNECE today [15].

FIGURE 18.1
Various types of multi-story informal constructions

Within the UNECE region there are slums, too, as shown at Figure 18.3, but the core research interest so far is not directly focused on how to formalize slums, as this is not the major problem in the region [11]. Past experience from Greece has shown that Roma slums may as well be formalized in a similar manner as other informal buildings. There are many examples in which slums have been formalized by recognizing informal tenure on occupied state or municipal land and providing ownership rights on the land to the occupants, or by providing ownership titles through a judicial procedure based on the adverse possession principle when privately-owned land was occupied illegally by Roma slum dwellers. Planning and structural improvements and integration of the land into a city plan was then provided according to the general practice in Greece [14]. Recent examples of good practice of re-settlement

FIGURE 18.2
Informal settlements of poor quality but permanent construction

projects for slum dwellers have been identified in Kosovo region by providing ownership rights as well as job opportunities to the dwellers[10].

Major political changes coupled with rapid urbanization, poverty, massive internal migration, conflicts, marginalization, natural disasters, cumbersome authorization processes (planning and building permitting) and corruption may be listed as some of the causes. However, corruption should not be considered as a major reason for informality; one cannot claim that 50 million citizens, as well as the authorities who tolerated the phenomenon, were corrupt. Why is informal development not a major issue in western European countries? Human beings are similar, but there the infrastructure makes it easier and more attractive to be and remain legal, while in the regions under study there are weaknesses in the infrastructure and authorization process.

But the list of causes is even longer, including the absence of policies by the states and their failure to adopt pro-growth planning as well as affordable housing policies; serious weaknesses of the private sector and lack of professional regulations; the lack of knowledge and political will to develop land policies which would facilitate the recognition of existing tenure and provision of private property rights and would aid the transition from centrally planned to market economies; and the failure or reluctance of state agencies to implement measures to support structural reforms to facilitate the digital economy and the UN Sustainable Development Agenda 2030.

In brief, so far this research has identified the obvious: that when neither

FIGURE 18.3
Roma informal settlements are common in many UNECE countries (top); example of a formalized Roma settlement (by provision of ownership titles) (bottom).

the state nor the private sector provide the supply of appropriate real estate types and quantities to satisfy the current demand, people build informally. It is also important here to remember that demand in property markets is defined both by the need but also by the desire and the purchasing power of the consumers. In most of the informal cases in this region the state's housing policy is inadequate to meet the demand and people have built informally either because of their need for housing they could afford or because the private sector was not providing such a product (in many places the private sector is interested to serve the high income rather than the low-middle and middle income classes), while at the same time the state had not provided planning and permitting tools for affordable or social housing. In some cases there has been a demand for second housing, or a desire of people to “move up” to larger or better housing. The industry had not planned for an efficient mechanism to provide for such products and services.

Informality however, in the real estate sector and inevitably in real estate markets, is directly related to a general informal culture, a characteristic of development in the so called “frontier markets”; it may also exist in developed economies where its extent is less significant. Much of the building labor is self-provided by the occupants but there is also a great amount of construction material consumed, and services provided, informally. Informality is usually accompanied with fraud and lack of transparency; it affects public revenue, productivity and job opportunity; it creates non-productive capital, dead capital, and construction completion is indefinite.

18.2 Informality Is Considered a Social, Economic and Environmental Challenge

The most important social challenge of the existing informal settlements is *weak ownership rights.* Unclear ownership rights on a property unit are created when people either have built on land: (a) to which they have no ownership titles (e.g., occupied land that belongs to the state, or the municipality, or to a social enterprise, or to a third party); or (b) that they only have the right to use (recognized tenure), but usually the state or the municipality delays or refuses to provide ownership titles; or (c) has been illegally subdivided though they may own legally as a whole but due to zoning regulations parcel subdivision is forbidden or not regulated, and therefore the newly created parcels or property units in general cannot be legally registered; or (d) that they own legally but they have built without obtaining a planning and/or building permit, or they had obtained a planning and/or building permit but they have built beyond the scope of the permit and the newly created property unit cannot be registered.

In all the above cases people finally have weak or limited property rights and the property cannot be registered in the cadastre, transferred legally, taxed or mortgaged. Dwellers in informal settlements, informal land and real estate rarely have ready access to capital. The common practice applied so far in tenure regularization for informal settlement dwellers in other regions is of no value in the regions under research; this process often starts with the delivery of an administrative permit to occupy the land that can be conditionally upgraded to a leasehold and, at a later stage, to a long-term registered freehold. In general, improving tenure security incrementally by recognizing the occupation and providing dwellers with legally recognized tenure reaching from occupancy certificates to full property rights is a long, bureaucratic procedure that cannot directly provide for full exploitation of property assets and cannot help to achieve wealth for the poor. It simply delays the implementation of many SDGs of the UN Sustainable Development Agenda 2030 and therefore it is not recommended for any region when people have already invested a relatively significant part of their labor income to build a house to provide for their housing needs.

Registration improves security of tenure, establishes property rights over investment, minimizes lending risks and provides access to credit and funding mechanisms; it also improves legal protection, as well as legal empowerment of occupants/owners.

According to [2] the great economic divide in the world today is between the 2.5 billion people who can register property rights and the 5 billion who are impoverished, in part because they have no ability to registered their property rights. Private rights provide people the assurance they need in order to invest and protect their properties from abuse. Security of property rights is one of the drivers of economic growth and freedom.

When informal development was identified in large numbers ((e.g., as indicated at [13], in Greece, in 2005, it was estimated that 1M buildings were informal, in Albania about 500,000, in Cyprus about 80% of condominiums and 40% of single family houses, in North Macedonia about 350,000, in Kosovo 450,000 and in Montenegro about 130,000)) the phenomenon demonstrated a systemic failure which shows that a great proportion of the population had no access to clear property rights, property units could not be registered and were kept outside the economic circle. Such a system needs improvement.

Allowing such large numbers of informal buildings as dead capital - that is, property units that cannot become productive for the people who have informal tenure - is contrary to the UN Sustainable Development Agenda 2030. Goal #1 (*end of poverty in all its forms everywhere*), and especially target *1.4.* that "*by 2030, countries should ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance*".

Similarly, SDG 11 (*make cities and human settlements inclusive, safe, resilient and sustainable*) and in particular SDG 11.1 expresses that *by 2030, states should ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums.*

Tenure security is a major step toward provision of adequate housing. The subject of adequate housing, though, is closely linked to a country's general land policy, economic development and to the provision of urban infrastructure. A country's housing policy is connected to its basic infrastructure development policy, such as provision of land for urban development and provision of utility services. It is broadly recognized that almost every country of the world will never have enough public funds to efficiently address the adequate housing issue for all, without the private sector participation, meaning that all countries are borrowing money to lend to their citizens. In order for states to be able to provide credit at low interest there is an urgent need to reduce lending risks by providing clear property titles for mortgaged-backed bonds. Therefore, providing clear ownership rights is a major priority if governments are to facilitate credit at low interest or other affordable housing tools for those in need.

In addition, land is referred to in SDG #2 (*ending hunger*) target 2.3: *By*

2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment, which requires access to credit and funding mechanisms in order to improve agriculture and business, and maximize quality and quantity of products.

In general, the right to adequate housing, good management of land and security of property rights is referred in the New Urban Agenda, and in many other SDGs such as Goal #5 on *gender equality*, Goal #13 on *climate action*, Goal #15 on life *on land* and Goal #16 *on peace, justice and strong institutions*. As it is stated at [3] these goals and targets will never be achieved without good land governance and well-functioning nationwide administration systems in place. In order for society to be able to meet these SDGs within the expected time limit major land reforms are required; to make such reforms successful unity is important. People should understand, trust and be willing to support the necessary activities and should voluntarily participate to provide information and to enhance procedures. In order to ensure unity and fairness and to eliminate conflict among society and the local communities, existing tenure and weak property rights on land, both formal and informal, should be recognized and registered. As mentioned in the [5] Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (Voluntary Guidelines on Tenure) VGGTs, "States should facilitate the operations of efficient and transparent markets to promote participation under equal conditions and opportunities for mutually beneficial transfers of tenure rights which lessen conflict and instability ... states should take measures to prevent undesirable impacts on local communities."

Once property rights are issued and registered the property units should be in the economic cycle. Past policies applied in various countries that required planning and construction improvements prior to formalization are not applicable today because they are time-and-cost consuming and they delay the resulting formalization and expected economic, social and environmental benefits [4]. Improvements of neighborhoods and basic services provision must be made available for social and environmental reasons but also to make such properties more attractive and improve their value for the benefit of the owners and the national economies immediately following formalization. There should not be a general rule and guide on how such planning and construction improvements may be achieved, however, as conditions may vary from place to place and/or from property to property. Such improvements may be initiated and funded according to local needs either by the dwellers (once they have access to credit) in cooperation with the private sector through development of small or medium-sized development and planning projects that will also include consolidation of parcels (as soon as relevant tools and regulations are in place), or by local authorities through urban planning and land readjustment projects; the latter is more complicated, expensive and time consuming, however.

In general, a large number of informal buildings are rather self-made constructions (of 1 or max 3 to 4-story buildings), that may not comply with local planning and construction standards and they are usually built to provide for the housing needs for the next 30-40 years; such buildings once formalized should gradually be improved - if feasible - or replaced by better constructions as the financial situation of their owners and the state policies will improve. Planning and building regulations should be modified accordingly to provide incentives and facilitate such reforms as well as to enable the gradual increase of urban density in such areas and the sustainable development of such self-made cities in the 3^{rd} dimension in order to avoid further urban sprawl; this maybe also valid for urban areas build formally but following such a pattern of construction.

In general, large demolitions and forced evictions are considered to be a serious violation of the international norms for adequate housing and, where demolition is necessary, decent resettlement is required.

In an effort to discourage informal development governments frequently deny basic utility services to informal settlements despite the many years of their existence. Informal settlements' dwellers are then led to proceed to further illegalities such as illegal connection to electricity that increases the risk of disasters in the settlements, or illegal drilling for water, and sewage disposal which has a negative environmental impact in the management of underground waters. Thus, such state policies should be considered to be among the most severe violations of the right to dignity, security, health and life. People living in informally developed areas are constantly at higher risk for fires, flooding and other disasters, and services must be provided to minimize such risks. Depriving informal settlement dwellers of fundamental services is a violation of the international objective of human rights for all. Adopting strategies for enabling the improvement of living conditions in informal settlements should be one of a government's priorities to ensure the fundamental human right to life, health and safety of dwellers.

Informality is an economic challenge, also, because it affects public revenues, productivity and job opportunities. The assets invested in informal real estate represent non-productive, dead capital. As a result of informality the tax base is limited while higher taxes must be levied on a subset of “legal” real estate and related business. Moreover, competition within real estate markets with a great level of informality is distorted due to a lack of transparency; in such markets personal, off-record negotiations matter more than rules-based transactions.

Through this research it became broadly recognized that indeed, informality remains substantial in countries where overregulation and bureaucracy, taxation, fees, penalties and related costs give significant incentives to build and work “under the radar”.

Informality in real estate, its construction and operation as well as its demolition, is also considered a significant environmental challenge especially when it is spread over highly protected lands, or when, for instance, construction methods do not meet current standards for energy consumption.

When demolition is needed, not only is it expensive but it causes environmental impact and should by all means be followed by a special treatment of the debris. Where demolition is indicated it is important to communicate properly and to provide information in a timely manner to the occupants; the occupants should be involved as well as all affected other community members for the agreement for a meaningful and fair solution. Adequate compensation and alternative housing must be provided. It is also important that affected occupants and communities have access to affordable legal assistance.

18.3 Fit-for-Purpose Formalization Policies

As a result of this research and the derived knowledge we have systematically encouraged countries to initiate - where possible - formalization projects, and through cooperation with them we have discovered and assessed the several policies adopted in order to address this problem.

We have together identified policies that require improvements to informal properties in order to be in compliance with regulations prior to formalization. We have considered the high fees imposed upon owners or occupants of informal properties when buying land with missing property titles, and the penalties imposed for having illegally occupied or built thereon. Such policies are seldom affordable and do not provide for quick and inclusive settlement. If it was do-able and affordable to build legally according to existing rules and regulations the majority of people would not have chosen to do it illegally in the first place.

There are also policies that would provide planning amnesty, though accompanied by high penalties. However, in cases where property titles are missing this process seems politically more difficult. Again, such policies are not inclusive and affordable as they fail to solve the most important issue: weak ownership status.

In addition, there are policies that even when well intended, measures become bogged down due to administrative bottlenecks, or there are changes in government or government policy.

As a result, formalization is a lengthy, bureaucratic and expensive process in most places.In the meantime, through this research we have also managed to identify and quantify the annual GDP loss caused by delaying the formalization of the informal real estate sector, and have proved that it can be significant and worthy of serious consideration. The formalization of informal development is the most important step towards formalization in the real property market.

Today we have reached a stage at which we have decided to proceed with the compilation of an FIG/UNECE WPLA guide for the formalization process of informal buildings to assist policy makers, managers and staff of government agencies, as well as private sector specialists and members of civil society organizations. This guide is anticipated to become a mindset changer to provide understanding, inspiration and knowledge and to contribute to the global and national efforts towards the eradication of hunger and poverty by achieving the SDGs within the framework of the UN Sustainable Development Agenda 2030.

The guide spells out the accumulated knowledge and experience in a compact way, and is aligned with broadly recognized WB, UN Habitat, GLTN, and FIG publications such as the FAO VGGT in the Context of National Food Security and the FIG Fit-for-Purpose Land Administration, to mention a few.

A "fit-for-purpose" formalization procedure is giving priority to clearing out weaknesses in property titles and to providing for registration of property titles in an inclusive, affordable and timely manner. Informalities related to zoning, planning and/or construction regulations should never be connected to ownership rights or block property registration and transactions. Such informalities should not have an impact on the provision and registration of property titles, or affect the transaction or mortgaging of a property. It should be possible for a parcel with a damaged or half-finished construction that does not comply with regulations to be in the market for sale or inheritance. Construction efficiency and stability issues should not block the marketing of the parcel and/or building, however this important issue should be considered prior to issuing an occupation permit. Controls must necessarily be imposed upon comparatively large formalized constructions that will accumulate large numbers of people (e.g., for issuing an occupancy permit for multi-story, multi-family residential buildings, or operational permits for commercial real estate such as hotels, restaurants, schools, offices, cinemas). If the construction compliance of such buildings can be guaranteed by the private sector (maybe already involved in the construction of such buildings, as it is the case in some countries) then formalization should be quick, affordable and inclusive.

In the formalization process governments need to go beyond the established policies and practices in order to successfully deal with the property market challenges, the funding challenges, the structural stability challenges, the environmental challenges and the difficult ethical challenges and any hostile reactions to a formalization project. They need to argue for the contradictory concept to "legalize the illegal". The above described rationale provides all the required justification for developing a strategy and a communication policy with all involved stakeholders and society.

A legal framework and administrative and regulatory process should be prepared and tested in pilot studies. As well, ways to raise awareness, when differing priorities among the parties exist; the socio-economic realities must be clearly demonstrated, with the relevant significant data [4].

The clear economic and social benefits of formalization of informal structures must be advertised via public awareness programs demonstrating, also, the economic cost of informality while allowed to continue.

Modern technology and its products (e.g., mobile services, apps, UAVs, satellite images, orthophotos, VGI and crowdsourcing) will help to overcome the lack of transparency and provide the base map and the methodology for data collection and cadastral mapping of informal and unregistered settlements (e.g., identification of constructions, adjudication of occupants, formalization of titles and registration of properties and property rights). [8, 9, 7, 1, 6]. The use of any available cadastral information or development plans is highly advisable in order to identify and register informal real estate and occupants/owners. This may be accomplished by engaging the involved professionals including notaries, constructors, civil engineers, developers and real estate agents as well as the local authorities that may have records, the various state agencies such as the tax office; occupants and society should also be engaged in the recording process.

For the formalization of the informal to be successful it is important that technical advice be employed on how to build inclusively, affordably and in a timely manner an efficient framework. It is vitally important to revise the planning and permitting systems to discourage and eliminate a continuation of informality in order to support market needs and growth while in parallel to define the lands and real estate that should be protected.

In considering formalization of all informal real estate by 2030 it is necessary to determine the duration and the costs of the project in each case and to prioritize needs. This will influence decisions related to title provision, planning amnesty, the requirement for any controls, planning for future improvements, optional future stability controls for issuing operational permits to commercial real estate, inspections, monitoring, demolitions, and resettlement.

Important legal decisions are required on how to deal with occupied private, state and municipal lands as well as land that belongs to social enterprises, and to ensure gender and ethnic equity when possible. Governments should prioritize the provision of good title, when possible, in order to be aligned with SDGs, VGGT, FFP LA and other objectives.

Administrative aspects such as the determination of the responsible authority for formalization and the required fees, the registration of informal constructions into the cadaster using modern and low-cost technology, should be considered, as well. Once registration is accomplished transactions and mortgaging should be facilitated.

Urban regeneration methods and planning improvements - if necessary - for informally developed areas should adopt simplified norms and standards. Similarly, structural stability controls may be classified according to the size and the operational use of buildings and should be adjusted to the limits and abilities of local knowledge and practice.

Information on how to implement a formalization framework based on best practice through country-specific approaches including technical tools and methods, the role of professionals, state agencies and citizens, should be taken into account.

During and following formalization there must also be monitoring of the progress and of the situation especially in environmentally or socially sensitive areas to avoid future informal development. Automated monitoring of protected lands is highly recommended to avoid the need for on-site inspections and costs, while limiting the opportunity for corruption and bribery.

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SDGs and Geospatial Information Perspective From Nigeria-Africa

Muyiwa Agunbiade

University of Lagos, Nigeria

Olajide Oluwafemi

University of Lagos, Nigeria

Oluyemi Akindeju

University of Lagos, Nigeria

This chapter discusses SDGs connectivity by exploring the nature of interlinkages between the SDGs from the lens of geospatial information and geospatial data infrastructure. It also focuses on evolving an integrated framework towards achieving SDGs in developing economies.

19.1 Introduction

To develop further on the achievements of the MDGs and to complete what has not been achieved, the United Nations adopted, in 2015, the 2030 Agenda for sustainable development, setting 17 development goals and 169 targets. The world has witnessed tremendous progress in the living condition of many people, notwithstanding the challenges associated with the implementation of the MDG goals. This progress, however, was uneven. It was anticipated that Africa progress towards sustainable development will have implications on the global achievement. Paradoxically, while many countries in developed world achieved many of the goals and were able to monitor progress, many African countries, including Nigeria, did not make appreciable progress. Nigeria's record in achieving the MDGs has been abysmally low [5].

Like the preceding MDG goals, implementing the *indivisible* SDG agenda by policy actors is faced with challenges [3] especially regarding the nature of interlinkages between the SDGs. The complex nature associated with the indivisible characteristic of the 2030 Agenda also requires an unbundling. In other words, it is important to understand the possible trade-offs as well as synergistic relations between the different SDGs in a way that is enough to achieve long-lasting sustainable development results. Most importantly, in an era when communities and their various challenges are interconnected across different domains and jurisdictions. The implementation of SDGs is challenged by the required science-based analysis that is anchored on robust fit-for-purpose geospatial information. One of the long-standing issues, in this regard, is the lack of reliable data in appropriate format to aid decision-making and monitor progress. Where data are available, they are fragmented among different institutions and agencies (private and public), and as such not integrated and accessible. In addition, the available data are not disaggregated in a usable format. Specifically, it is established that accurate and reliable geospatial data, integrated across sectors, are central to the implementation and monitoring of progress towards the attainment of SDGs [14]. It is also established that geospatial data and urban processes interact in complex and integrated ways to foster sustainable development. While the application of geospatial technologies and Spatial Data Infrastructure in development processes is increasingly emerging globally, the regional spread has not been proportionate, with most developing countries lagging behind.

It has been recognised that the 169 targets, currently being further defined by the measurable indicators, are designed to help evaluate and monitor the implementation of SDGs and determine if the 17 goals are achieved. Indicators are important tools to support decision making process and measure what matters. Indicators are particularly necessary for the monitoring and evaluation of SDGs for quality, consistency and comparability of data over time and space and across sectors and regions [1]. However, Africa, in particular, faces a unique challenge of measuring the attainment of these goals due to the paucity of adequate and appropriate geospatial information that is in the right format and that is fit-for-purpose. This is further compounded by lack of interagency collaboration and uncoordinated policies. This lack of synergy between geospatial data infrastructure and SDGs and clear interactions within the SDGs is evident as there is increasing need for reliable baseline data to monitor and evaluate progress. This identified gap is a huge obstacle to many African countries in their quest for sustainable development [15]. Couple with this challenge, is the lack of clear road map for integration of geospatial data into national development and policy making process.

Most often, the baseline data are "set on the available information, which in many cases, is scanty, unreliable and dubious" ([19], p. 5). Considering this precarious situation, it is apparent that Geospatial information is a requisite prior to the monitoring phase of SDGS. This provides the necessary background to establish the prevailing condition [19]. Currently, there is a general lack of adequate geospatial information policy and governance due to the ineffective and inefficient institutional framework and tools. Africa is also challenged by issues around capacity and knowledge transfer. Yet, there is an increasing array of global challenges, including interregional issues such as peace, security, natural disasters and climate change that needs to be measured, which no nation or region can solve independently. Thus, the justification for calls regarding global coordination that is firmly anchored on good Geospatial Information and geospatial data infrastructure.

While geospatial information is essential, the production of geospatial data infrastructure domain across Africa is subject to particular institutional and knowledge constraints. There seems to be an enduring knowledge gaps between the supply and demand sides of data as demonstrated by the lack of institutional capacity to coordinate. As such, both supply and demand sides are problematic, and they are huge obstacles to development. In this regard, as illustrated by Jerven (2013), one of the challenges is the unstructured nature of interactions between producers and consumers [10]. There seems to be a lack of understanding on the nature of data and how such data should be collected, analysed, disaggregated and integrated for effective policy making and national development. Before now, Riddel (1990) observed that maybe the major challenge with the existing Africa data is that they are generally known to be erroneous, but the extent of inaccuracy cannot be easily ascertained [13]. Even today, nothing seems to have significantly changed in many of the African countries despite the steady improvement in geospatial data technologies globally and despite the urgent need for integrated data platform to support the complex interrelationship of the sustainable development agenda. As noted by International Council for Science (2017), the "SDGs interact with one another as an integrated set of global priorities and objectives that are fundamentally interdependent" [3]. Strategies to understand the range of positive and negative interactions among SDGs is critical to revealing their full potential at any scale.

However, there are different dimensions to the issues of connectivity between, geospatial information and SDGs. The central arguments are that: i) while the 17 SDG goals are broad, they are interdependent, and the success of the 2030 Agenda lies in demystifying the interlinkages between policy areas as presented in the sustainable development goals (SDGs). Meaning that to achieve all the 169 targets it will require, specifically, the development of Geospatial Information infrastructure, to help facilitate the connectivity. ii) It could also be argued that it is important to localize the SDGs by highlighting the role of local institutions and local actors. These are considered as key in achieving and contextualising separate list of targets for respective goals, thus, the perspective from Africa as a region is critical for fit-for-purpose analyses and solutions. In this regard, indicators must be consciously formulated to meet regional needs, aspirations and priorities. iii) the "*leaving no one behind*" principle of the SDGs that is intended to ensure, on the assumption that, a sustainable and smart future will develop a better future for all communities appears high-level and difficult to achieve in Africa. iv) the unavailability of effective and efficient land administration, that is, the lack of matured land information (LIS) and formal land registration systems, can be argued to be the root of most problems in African countries. Thereby incubating insecure land rights and social exclusion, economic regression, and environmental degradation.

This chapter starts by providing insights into the past events at implementing the MGDs, in Africa especially in Nigeria. This is based on the consideration that Nigeria's record in achieving the MDGs has been significantly low and the assessment of current SDGs' level of success or achievements will continually depend on the harmonization and utilization of a whole lot of tremendous data both spatial and non-spatial. As such, it requires the development of a platform like the geospatial data infrastructure. The next section reviews the existing knowledge and discusses the interconnection between the SDGs and geospatial information, taking into consideration: geospatial information, urban and rural resilience; approaches to integrating geospatial information and technologies in the implementation of the SDGs. Considering that all developments have spatial dimension, that is location-based, the key information required is geospatial information ([19], p. 5).

19.2 Existing Knowledge About Interconnection Within SDGs and Between Geospatial Information

This section provides a review of interdisciplinary analysis and multisectoral expertise on the usefulness and application of geospatial information. It reviews the interconnection between the SDGs and geospatial information while drawing inferences as regards the implications for urban and rural resilience. As noted by International Council of Science (2017), the underlying principle is that SDG goals interact with one another [3]. However, the “approaches for how to more systematically identify, characterize and address interactions between all sustainable development policy issues remains a challenge” ([9], p. 1499; [8]).

19.2.1 The Interconnection Between the SDGs, Geospatial Information, Urban and Rural Resilience

As noted by Nilsson, *et al.* (2018), understanding both the negative and positive interactions between the SDGs is essential for decision-making that promotes the implementation of sustainable development[8]. In another words, the interactions across the SDGs should be thought through systematically. Nilsson, *et al.* (2018) provide insights into the mapping and assessing of SDGs interactions, using a defined typology and characterization approach, and summed that negative interactions are outnumbered by positive ones. This suggests that a more integrated policy making has the potential to provide more effective development outcomes. Nilsson, *et al.* (2018) further observed the challenges in identifying and assessing all the key interactions comprehensively at the global scale. They, therefore, argued for context-specific understandings. This argument is consistent with the overarching *premise of the 2030 Agenda that underscores a nationally adapted interpretations and action on the SDGs* ([8], p. 1499).

An essential component of determining integration is the consideration for the contextual meaning of the SDGs targets. There are nuance interpretations of the expectations as to the progress expected from each target. This simply means that, before assessing interactions, one needs to articulate what should be looked out for to articulate progress on a target, especially from the (subnational or national) context of implementation in terms of actual, observable outcomes ([8], p. 1499).

While it is essential to determine the linkages between different targets set for the SDGs, it is also important to consider that understanding the interdependent existence of people and the space they inhabit, is largely determined by the availability of geospatial data. One could infer, in this regard, that the level of connectivity at local, national, and global levels shapes future urban forms. Especially now that there is a noticeable intensification of challenges in our cities due largely to: increase in population growth and human mobility with majority of the world population now living in cities [4]; significant disasters that are weather related traceable to climate impact; limited resources to cope with the unintended consequences of population growth and related disasters. Significant part of this is linked to the lack of a comprehensive spatial data infrastructure, that has been argued to impede the process of strengthening community and infrastructure resilience, thus, preventing the protection of social and environmental sustainability, and narrowing the development gap, especially in the developing countries like Africa.

However, one of the key findings is that there is clearly no one-size-fits-all approach to understanding target interactions and infrastructure resilience. Noting that building on the existing knowledge will require a commitment to continuous iteration and improvement.

19.2.2 Geospatial Information to Support Inclusive Urbanisation, Resilient Development, and the SDGs

The logical question to ask is that how does geospatial information supports and informs inclusive and even urbanisation, resilient development, and the SDGs? Earlier, Feeney *et al.* (2001) linked the increasing need to organize data across sectors and institutions, through the development of SDIs, to the growing need of addressing the complex and multiple challenges associated with sustainable development [2]. The primary aim for developing SDIs is to achieve better outcomes from spatially related development decision-making across economic, social and environmental spheres.

Despite the widespread adoption of digital technology and a high internet penetration rate (highest in Africa), existing databases are isolated, uncoordinated and lack harmony for a holistic policy framework for decision making. The isolation of digital information gathered by various agencies and department on individuals, spatial components and events provides a veritable start point to implement geospatial information framework for a localized connectivity of the global SDG agenda. The domestication of the global agenda is, therefore, necessary to set the stage for effective implementation and monitoring.

As noted by Scott & Rajabifard (2017), the challenges of achieving sustainable development is not only about some sets of significant social, economic and environmental issues that are almost entirely geographic in nature [15]. Rather, it could also be noted that, geospatial information can provide a set of science and time-based monitoring solutions to these challenges, especially those that are driven by spatially enabled data.

Pesch (2014), posited that irrespective of rational interactions and connections over a long period of time, the reality is that there has been a limited connection and integration between sustainable development and geography, geospatial information and associated enabling infrastructure such as National Spatial Data Infrastructures (NSDIs) at both the technical and political levels [11]. This is not peculiar to developing nations but also highly data-rich and technology-driven nations. Wu Hongbo, UN Under-Secretary-General for Economic and Social Affairs, emphasized the role of geo-statistical data in improving governments' ability to 'examine, monitor, manage, propose and predict development and growth options for a sustainable future'. Wu also stressed the importance of geospatial information in decision making, policy formulation, measuring and monitoring development, including the post-2015 agenda.

As an all-encompassing, comprehensive global blueprint, the applicability of the 2030 Agenda in all countries, in all contexts, and at all times earns it the *universality* attribute as one of the core underpinning principles. Other principles include *Leaving no one behind, Interconnectedness and Indivisibility, Inclusiveness and Multi-Stakeholder Partnerships.* The geospatial community is strategically positioned to integrate geospatial information into the global development agenda, specifically in a way that will support measuring and monitoring the targets and indicators of the SDGs, with the core principles at the heart of it.

19.2.3 Approaches to Integrating Geospatial Information and Technologies in the Implementation of the SDGs

This section assesses the existing framework for a more holistic approach to integrating geospatial information and technologies in the implementation of the SDGs, by first reviewing the challenges for achieving the SDGs. Scott and Rajabifard (2017), out of serious concern for the attainment of SDGs, raised a fundamental question: How can geospatial information be implemented and integrated into national information systems, at a policy level, in order to contribute more holistically to measuring and monitoring the targets and indicators of the SDGs at a technical level? ([15], p. 60). This is, perhaps, against the realisation that while the evolution of sustainable development and the development of geospatial information have progressed in parallel period, frameworks for their integration have remained largely undeveloped even in developed countries [15]. In this regard, Pesch (2014) earlier notes that for a very long time, even in a highly data-rich and technology-driven global countries, there has been very little connection between sustainable development and geospatial information at either the political or the technical arena [11]. For example, while global leaders have committed much effort in developing targets and indicators to benchmark progress, there has been little understanding about the strategic direction for the integration of geospatial data information for efficient monitoring the implementation and achievements of the goals [15].

It is even paradoxical that while the United Nations - the proponent of SDGs - report on the '*Future We Want*' acknowledged the value of reliable geospatial data for sustainable development [6], the report failed to clearly demonstrate strategies to mainstream geospatial data infrastructure into sustainable development [15]. For an effective integration, a clear integrated strategic direction, which takes into consideration national realities and regional peculiarities, is required. The challenges of developing such an integrated approach - a fit-for-purpose geospatial data framework - is proving difficult for many decision makers around the globe. This is, however, acute in developing countries, especially the African countries.

In recent times, however, with much international advocacy and dialogues coupled with the need for baseline data to monitor and evaluate progress towards sustainable development goals, the effort for integration is gaining momentum. The research efforts of the global geospatial community have provided useful frameworks, at both the policy and practical levels, to facilitate the integration of geospatial information and technologies in the implementation of the SDGs.

Scott and Rajabifard (2017); UN-Habitat (2016) works on sustainable development and geospatial information offer a useful strategic framework for integration which could serve as building blocks for implementation within the national geospatial strategic framework [15, 4].

19.3 Framework and Methods

This section adopts conceptual and empirical approaches for understanding contextual interactions between the SDGs targets, drawing on SDGs interactions framework as developed by Nilsson et al. (2018) [8]. The interactions depend on the meaning and the transparency of the assumptions associated with the interactions. One of the major benefits of this approach is the ability to critically and systematically navigate the several dimensions of the 2030 agenda, with particular focus on the contextual meaning of the targets. This is important to be able to establish the interactions between the targets. It should also be noted that policy and/or regulatory mandates also have the capability to affect the nature of interactions.

The central consideration for the framework revolves around the typology and scoring of interactions on a 7-point scale to identify causal and functional relations as it relates to the achievement of the sustainable development goals and targets [4]. In addition, key contextual determinants that impact on the interaction are governance and geographical contexts, implementation technologies, policies and time-horizon. This chapter adopts this interaction framework and emphasizes on: governance context, geographical context, spatial data infrastructure as embedded in implementing technology, and the time dimension.

With regards to the governance context, the assessment of the SDGs and targets are critically dependent on good governance. Inappropriate governance measure can potentially impact interactions to the extent that positive interactions can be reversed and turned into negative one. Regarding the geographical context, interactions is reinforced depending on where such interactions take place. Especially where cross-scale and cross-geographical interactions occurs.

Equally important is the '*implementing technology*' that focuses on geospatial data /information. This framework has necessitated a need to set up and monitor policy level mechanism, leading to a harmonious integration of Geospatial and Statistical information for sustainable development in Africa [19]. Interaction is also impacted within the consideration of the time frame for the assessment. Therefore, articulating the trade-offs, synergies and spin-offs between the goals of the SDGs is important to unlocking their full potential. Thus, whatever the scale, it is an important consideration that progress made in some areas is not made at the expense of progress in others.

To expand the spatial data infrastructure as embedded in the '*implementing technology*', it will be important to consider the 5ps Model. This involves the categorisation of SDG goals based on the five critical dimensions of: *people, prosperity, planet, partnership* and *peace*. As such, the geospatial information efforts shall, on the basis of defined spatial limitations or extent (LGAs, States, Geopolitical zones or Geographic regions) be gathered on the basis of the People's demographic characteristics, their economic and industrial prosperity, the state and manner of planet resource utilization, fostered partnership among stakeholders and entrenched peaceful co-existence in the society. The categorisation of the goals based on the 5ps model include: People (goals 1,2,4); Prosperity (goals 3,6,7,8,9, 11); Planet (goals 13, 14, 15); Partnership (goals 17, 12); Peace (goals 6, 10, 16). The next section is structured through this framework and model.

19.4 Findings and Analysis

19.4.1 The Interactions Between Various Elements of GIM and the SDGs in African Context

Going by the mission statement of GI4SD, it is anticipated that "*Africa produces and uses authoritative and evidence-based Geospatial Information for the attainment of its sustainable development goals and agenda 2063 objectives*". The statement went further to provide insight into what is meant by authoritative and evidence-based GI as referring "*to rigorously controlled best quality and "official" - consensus-based - GI, and its attribute of objective, logically-led and uncertainty-free or reduced source of decision making*" ([19], p. 8). However, the reality is different from this expectation. There are few challenges preventing this from happening as anticipated.

The challenge is not only limited to the availability of reliable sources of GI, but also on 'access, quality, completeness, currency, availability of standardized metadata, interoperability of GI datasets, traceability of GI products, rights of data producers, liability of GI service providers, GI products and services pricing' ([8], p. 1490). In addition, it is also about systematically focusing on the means of implementation considering issues like finance, technology, capacity building, trade, policy coherence, partnerships, data, monitoring and accountability.

As documented by UNGGIM (2016), "*efforts to build capacity in GIM in Africa over the past 20 years have been supply driven and have typically reflected the mandates of mostly external actors. Local, national and regional applications of GIM have continued to expand in scope and relevance, but without a strong demand-driven agenda for building capacity in GIM. The outcomes of such efforts will continue to fall short of their true potential*" ([19], p. 37).

19.4.2 Geospatial Information: Strengthening Community, Infrastructure, and Institutional Resilience

The role of geospatial information is twofold, linking the 'where' component of SDGs and make challenges in various locations more visible and assisting with spatially tracking progress. The areas of monitoring and review, focusing on high quality, timely, reliable, and disaggregated data, including earth observation and geospatial information, was captured in the UN 2015 General Assembly text:

> *We will support developing countries, particularly African countries, LDCs (least developed countries), SIDS (small island developing States) and LLDCs (land-locked developing countries), in strengthening the capacity of national statistical offices and data systems to*

ensure access to high quality, timely, reliable and disaggregated data. We will promote transparent and accountable scaling-up of appropriate public-private cooperation to exploit the contribution to be made by a wide range of data, including earth observations and geospatial information, while ensuring national ownership in supporting and tracking progress [7].

It is very essential to integrate information systems at a national level that flow up into a regional and global level. The framework is a national bottom-up approach. In developing countries, the use of data construct framework depends on institutional and architectural arrangements. As the world increasingly moves to rich data paradigm turning data into valuable information to support decision making, regarding development challenges, also requires change. Achieving SDGs requires the use of geospatial information to overcome challenges such as land rights, food production, disaster risk reduction, safe human settlements, and other social, economic, and environmental issues at local, national, and global levels.

As Nigeria reaches for the top global positions in the urbanization ranking in a couple of decades, the myriad of environmental, social, economic, socio-cultural and infrastructural challenges consequent upon this growth trend widens the risk and vulnerability factors and stretches the resilient limits of the cities, thereby posing enormous threats to the actualization of the SDGs. The geographical complexities and the demographic dynamics/socio-cultural diversities of Nigeria portends a huge challenge for fostering implementation of the goals, and therefore requires a more unifying, inclusive and localized approach.

19.4.3 The Role of Geospatial Data Infrastructures and Services in Achieving the SDGs in African Context

Many of the challenges associated with sustainable development can be analyzed, modeled, and mapped within a geographic context [17]. However, while many of the challenges have spatial dimension, at the development policy making level, not much is understood concerning the role of spatial attributes in sustainable development processes [12, 15]. In this regard, one of the most important questions in development community today, which requires evidence, is: "how can geospatial data infrastructures and services enhance the attainment of SDGs?"

In response to this question, the global geospatial community has focused discussion on the role and value of geospatial data for governance and development [12]. This research effort received a major boost, in recent years, with the global adoption of the Sustainable Development Goals and, coincidentally, considerable advancement in the level of awareness of geospatial technologies [15].

Sustainable Development Goals, in its conceptualisation, recognise the complex, interdependent, integrated and indivisible nature of the physical, economic and social systems, and the diverse associated challenges. Its 17 goals and 169 targets, though global, also recognise the need for a diverse range of quality, accessible, timely and reliable disaggregated data for monitoring and evaluating the implementation and achievements at national and regional levels.

The interconnected nature of SDGs and its multisectoral and multilevel implementation approach, for developments that leave nobody or situation behind, call for a holistic approach that integrates spatially enabled data platform into the national development policy framework. Geospatial Data Infrastructure has, therefore, emerged as a valuable platform that enhances access and sharing of geospatial information across sectors and inter-agencies as well as integration for evidence-based decision making and sustainable policy formulation [15]. In essence, geospatial data infrastructure can provide enabling and coherent capability and the needed unifying platform for multisectoral and inter-regional collaboration, consensus and evidence-based decision-making [15]. As argued by Feeney *et al.* (2001), the primary objectives of geospatial data infrastructure is to provide a platform for data coordination across disciplines and institutions for a better development outcome across space and time [2]. Scott and Rajabifard (2017) expressed similar view that the need for geospatial data infrastructure is essentially for achieving 'better outcomes from spatially related economic, social and environmental decision-making' ([15], p. 64).

Geospatial Data Infrastructure is, therefore, increasingly being embraced globally, though with regional variations, as the world gradually coming to terms with the need for an integrative framework for evaluation and monitoring development progress. For instance, in Europe, while policy actors are conscious of the need to standardize geospatial infrastructure in order to enhance data quality, many of the African countries are facing data fragmentation [12]. While it may not be totally accurate to argue that developing countries are data poor, lack of platform to bringing together the existing fragmented data might be a more possible argument. Geospatial data infrastructure offers such a unique opportunity to overcome this challenge, as it provides holistic and sustainable platform to bridge gaps between data, data providers and data users, as well as time and space, thereby enhancing the visibility of data to support policy and development decisions.

Geospatial data infrastructure progressively became one of the valuable components of the infrastructure required for socioeconomic prosperity, ecological management and liveability across levels of human settlements. The United Nations report on the establishment of UN-GGIM stressed the role of geospatial data infrastructure in shaping the formation and implementation of sustainable development programmes and polices [16]. The report of the United Nations Committee of Experts on Global Geospatial Information Management, at its second annual session, aptly captured the many roles geospatial data infrastructure can play in monitoring and evaluating the implementation and outcomes of sustainable development across sectors. It stated that:

> *Perhaps most importantly, there is a strong belief that geography provides the integrative framework necessary to support the requirements of multiple information communities in a timely and effective manner––providing the right data at the right time to the right place. The same geospatial content, repurposed, can support applications ranging from agricultural management, to emergency planning and response, to scientific collaboration on climate change, to transportation planning. All of these applications have implications for sustainable development and liveability* [17].

The absence of National Geospatial Data Infrastructure platform means that governments, at all levels, will rely on unstandardized and fragmented data for decision making. This is the situation in the developing countries, especially African countries, where governments are continually challenged with lack of timely data compounded with poor data quality and a general lack of interoperability between different sources of data [15, 18]. One of the immediate consequences of this is that development decisions are based on inaccurate data. Data have the power to mislead or inform development and policy making. In any context, the capability to implement either national standards or globally agreed goals, such as SDGs, largely depends on the quality of available resources and data. For many reasons, the current data use for development and policy making in many African countries provide little guide for effective development. In general, institutional and structural characteristics of many Africa nations pose huge barriers in collecting and evaluating data to implement and monitor both local and global development goals.

Data essentially influence what is known about the state of development and subsequently shape decision making process. The United Nations report on the achievements of MDGs provided some reflections on the challenges and lessons learned from the implementation of MDGs. It recognises the global achievements of MDGs. It however acknowledges that reliable and timely data in appropriate format, an essential component of any development programme, to effectively prioritise policy agenda and monitor progress were inadequate in the implementation of MDGs. This is particularly acute in Africa. Commenting on these reflections, Scott and Rajabifard (2017) concluded that the implication was that MDGs were largely implemented in many developing regions, especially Africa, without reliable data or a sustainable data platform to aid consistent measure and monitor of implementation progress towards sustainable development [15].

Essential for global agenda, such as SDGs, that seeks to address complex and multiple challenges, is the need to have an adequate understanding of the interrelationship of the challenges in relation to space, time and people.

Equally important is the ability to monitor trends of events, provide timely information, particularly to the population at risk, and prioritise responses and actions. Geospatial data infrastructure can help in these regards, as asserts by United Nations (2015) [7]:

> *Knowing where people and things are and their relationship to each other is essential for informed decision-making. Comprehensive location-based information is helping governments to develop strategic priorities, make decisions, and measure and monitor outcomes. Once the geospatial data are created, they can be used many times to support a multiplicity of applications.*

One of such areas of applications is the possibility to link ecological and socioeconomic data in a way that clearly presents interconnections across the spheres of sustainable development - environment, economic and social - and how they influence one another. Geospatial data infrastructure provides such a unique opportunity to integrate geospatial data into national development framework in a more holistic and sustainable way. Considering the peculiarity of each geographical region and location in terms of environmental configuration and level of development, geospatial data, with standardised indicators as the object of measurement, provide necessary transparency and accountability for development governance and evidenced for policy making. Meeting the numerous goals of sustainable development requires the integration of geospatial data infrastructure platform.

Geospatial data infrastructure is essential for enhancing the political and social engagement of hitherto marginalised people and to shape policy and development outcomes through evidence. Though well-intended, it is proving difficult to be integrated into development framework in many developing countries. Geospatial Data Infrastructure, as an evolving platform, is much more than just data. Achieving SDGs requires conscious and evidence based spatial and socioeconomic decision making. SDI will play a pivotal role in enhancing the efficiency and adequacy of such decision. As argued earlier, the challenge is not limited to the availability of reliable sources of GI, but also on unrestricted access, completeness, currency, quality, availability of standardized metadata, provenance, interoperability of GI datasets, GI products and services pricing.

19.5 Inferences, Future Direction and Conclusion

As noted by UN-GGIM (2016), to achieve the UN-SDGs and AU Agenda 2063 targets, at national, sub-regional and regional levels in Africa, will require good governance and sound policies in Geospatial Information Management

([19], p. 24). As discussed in the preceding sections, these will guide the way African countries, will get organised and operate in order to achieve maximum benefits of GIM efforts. In addition, leveraging the already initiatives such as UN-GGIM, UN-Expert Group on Land Administration and Management, UN-GGIM Private Sector Network and UN-GGIM Geospatial Societies will facilitate the harmonisation and standardisation of data and integration of multi-domain analytics.

Griggs *et al.* (2017), assert that "*the process of systematically identifying and scoring interactions across the 17 SDGS using a common terminology is very valuable*" ([3], p. 8). Consistent with this position, one could argue in support of Griggs *et al.* (2017) that the process allows broad multi-disciplinary and multisectoral conversations [3]. It also allows synthesis and scoping of knowledge needs while providing rational and concrete clustering of targets that need to be addressed together to allow integrated approach for implementation and monitoring. The major limitations, however, is the challenge relating to selecting the important interactions from all the possible alternatives, especially considering the different expert's characterisation of interaction. That is, the contextual meaning of each of the possible interactions.

In conclusion, geospatial information policy is required to effectively manage geospatial information for sustainable development. It should be seen as a compulsory requirement that is anchored on legal and coherent institutional environment, that is set to achieving the most cost-effective and fulfilling impact. Therefore, GI applications should not only be encouraged, but should be layered on political and institutional structure designs to strengthen transparency in governance. A strong political will, built on strong GI policy has capacity to produce good governance that respect objective, fair and equity-driven decision making.

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20

Openness and Community Geospatial Science for Monitoring SDGs – An Example From Tanzania

Maria Antonia Brovelli
Politecnico di Milano, Italy

Maria Ilie Codrina
Technical University of Civil Engineering of Bucharest, Romania

Serena Coetzee
University of Pretoria, South Africa

This chapter focuses on two aspects that enable the monitoring of the United Nations (UN) sustainable development goals (SDGs): openness and community geospatial science.

20.1 Introduction

Openness typically refers to transparency, to free and unrestricted access to information, and to inclusive consensus-based decision-making. Community science is a branch of citizen science that involves a commitment from citizens, not only to collecting data, but also to designing and planning project activities in a more egalitarian (if not bottom-up) approach between (professional) scientists and citizen scientists. When the focus of the research is geospatial, we are dealing with community geospatial science. Examples of this approach are some of the projects related to OpenStreetMap (OSM), where citizens are significantly more than just "active sensors", playing an instrumental role in the definition and shaping of the campaign [5].

Based on the two pillars of openness and community geospatial science, a relevant example for monitoring SDGs was developed for the OSGeo UN

Committee Educational Challenge [22]. In 2018, the Committee sent out a call for the development of educational material, comprising three challenges. The first two challenges were closely related to UN operations. The third challenge was aimed at addressing the current lack of training material for using open source software together with freely available high-resolution global geospatial datasets for environmental, social and economic analysis in support of UN SDGs. The hands-on training material was conceived in such a way to be available and replicable anywhere in the world. These characteristics are especially relevant in developing countries where data is often scarce and resources for buying software are limited. Winners were guided by mentors to ensure that the material met the requirements of the target audience. In this chapter, the material developed for the third challenge is described.

The training material refers to SDG 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), and more specifically to the computation of indicator 9.1.1 (Proportion of the rural population who live within 2km of an all-season road) for a rural area of Tanzania. The methodology and technical tools (data and software) in this use case are presented in detail, so that anybody can replicate the method for other parts of the world. Since it is based on open data and open software, the method is cost effective and completely sustainable. Moreover, the possible lack of data can be overcome by actively involving people and communities in mapping their specific region of interest with freely available tools.

In the remainder of the chapter we present concepts and examples of open data and open software, followed by the concept of community geospatial science with reference to citizen science and volunteered geographic information (VGI). Next, we describe the use case from the training material and then conclude.

20.2 Open Data and Open Software

The principles of openness and transparency are widely advocated these days - as in open data, open software, open knowledge and open government - but what do they really mean?

The architects of the twenty-first century digital age proclaim that openness is their foundational value. The technological foundations that sustain this vision of openness are digital: the internet, mobile telephony and distributed systems. According to Russell (2014), ‘openness’ is a “marriage of technology and ideology and a fusion of technology, democracy, and entrepreneurial capitalism” [19]. The work described in this chapter exemplifies open principles: for the use case, open data is collected and analysed with open source software, and the training material is made available as an open educational resource.

Open source software has its origins in the early days of computing when programming problems were solved through scientific collaboration. Software was shared and each programmer added a new aspect to existing knowledge [4]. It evolved into a software development and licensing approach that ensures transparency through access to the source code and collaboration through a set of rights that protect the copyright to the source code. Through the free redistribution of the software and works derived from it, it is possible to create software products based on each other's work [18].

The interesting point, especially from the point of view of the poorest countries with limited resources for technologies, is that there is at least one mature sophisticated open source product for every geo-technology area and geospatial information need and application - from data collection in the field, crowdsourcing, desktop applications, spatial extensions to database management systems and software stacks. Together, they can be used to create sophisticated free and open Web and cloud-based systems [12, 21]. In developing countries, economic motivations rank high when choosing to use free and open source geospatial software [3].

OSGeo (Open Source Geospatial Foundation) is a not-for-profit organization aimed at fostering the global adoption of open geospatial technology. According to OSGeo, open source starts off with a license that provides royalty free (re)use of software. Next, open source guarantees access to the source code for audit and modification and the ability to redistribute the software with no additional costs[1]. A wide range of open licenses are in use. Creative Commons licenses [2], a set of well-defined licenses that each describe a different permitted use of copyrighted materials by the public at large are widely used for content. The training material described in this chapter is made available under one of these Creative Commons licenses. For source code, OSI-approved licenses, such as the GNU General Public License (GPL), are frequently used [3].

Besides software, open data or knowledge is based on the principle that some information should be shared and available to anyone, without any restrictions to rights of access or use. According to Open Knowledge International, open data and content can be freely used, modified, and shared by anyone for any purpose [17]. Generally, transparency and collaboration are well aligned with the principles that democratic governments stand for and with the principles embodied in the Charter of the United Nations. Organizations, such as Open Knowledge International, promote the use of open data and knowledge, e.g. to support citizens in taking action on social problems. Monitoring SDGs with open data makes it possible for citizens to track the status of SDGs in their countries or cities. It empowers them with an understanding of the challenges at hand so that they can work on addressing these, for example, by supporting or lobbying for appropriate initiatives or by holding governments and other actors to account. OpenStreetMap, started in

[1] www.osgeo.org
[2] https://creativecommons.org/licenses/
[3] https://opensource.org/licenses

the UK in 2004, is the most widely known example of global open geospatial data. The success of its open characteristics is further described in the next section.

Through open education, barriers to education are removed by making educational resources freely available for anyone to study and use or by eliminating admission requirements. Through GeoForAll, OSGeo promotes open education among its members based on the belief that knowledge is a public good and that open principles in education provide opportunities for everyone. Teachers and educators provide open access to their educational resources for teaching related to geo-technologies and geospatial data. Access to education is a challenge in the poorest countries, confirmed by the UN SDG 4 on Education. Open and freely available educational resources contribute to addressing this challenge.

The UN OSGeo Committee works towards identifying and developing open source geospatial software and services that meet the requirements of UN operations, taking full advantage of the expertise of mission partners, including partner nations, technology developed by contributing countries, international organizations, academia, NGOs, and the private sector [4]. The 2018 Challenges were aimed at supporting these goals.

20.3 Community Geospatial Science

Public participation in scientific achievements has a long history but the last few decades have seen more attention and an impressive increase in the number of people involved. Citizen science, i.e. scientific research conducted, in whole or in part, by amateur (or non-professional) scientists, the term used for denoting such an approach, is a diverse practice, encompassing various forms, depths, and aims of collaboration between scientists and citizen researchers and a broad range of scientific disciplines [8].

Different classifications of citizen science projects exist based on the degree of influence and the extent of the contributions by citizens. Haklay *et al.* (2018) distinguish three kinds of citizen science projects [9]:

1. Long-running citizen science, the traditional projects, similar to those run in the past [11, 1].

2. Citizen cyberscience, strictly connected with the use of technologies [6], and which can be subclassified into:

   (a) volunteer computing, where citizens offer the unused computing resources of their computers;

[4] https://wiki.osgeo.org/wiki/UnitedNations_Committee

   (b) volunteer thinking, where citizens offer their cognitive abilities for performing tasks difficult for machines; and
   (c) passive sensing, where citizens use the sensors integrated into mobile computing devices to carry out automatic sensing tasks.

3. Community science, involving a more significant commitment from citizens, also in designing and planning the project activities in a more egalitarian (if not bottom-up) approach between scientists and citizen scientists [10, 13, 2]. Community science is further classified into:
   (a) participatory sensing, where citizens use the sensors integrated into mobile computing devices to carry out sensing tasks;
   (b) Do-It-Yourself (DIY) science, which implies that participants create scientific tools and methodologies for carrying out their research; and
   (c) civic science, which is "explicitly linked to community goals and questions the state of things" [9].

Because of the bottom-up approach, community science is the most interesting when it gets to activities and programs that are closely related to the life and well-being of people. If a geospatial dimension is involved, i.e. location plays a fundamental role in interpreting the phenomena under study, we can refer to this as community *geospatial* science.

The best example of community geospatial science is OpenStreetMap (OSM) [5]. Many people consider it to be an object (i.e. a map or its modern version, a geodatabase): "a free, editable map of the whole world that is being built by volunteers largely from scratch and released with an open-content license" [5]. It is also commonly referred to as a geo-platform or project where as many as 5 million users contribute, edit, download and assess the data that is shared. OpenStreetMap is most of all a community of communities [20], in the sense that the OpenStreetMap community is diverse and incorporates the motivations of many different groups, depending on how they approach their volunteer activity.

Examples of communities are the community "dedicated to humanitarian action and community development through open mapping", the Humanitarian OpenStreetMap Team (HOT) [6]; the community that is "putting the world's vulnerable people on the map", Missing Maps [7]; the community that works to close the gender gap in OSM, GeoChicas[8]; the community of university students, YouthMappers [9]; the community that helps end female genital mutilation and aids community development in rural Tanzania, Crowd2Map[10].

[5] https://www.openstreetmap.org
[6] https://www.hotosm.org/
[7] https://www.missingmaps.org/
[8] https://wiki.openstreetmap.org/wiki/GeoChicas
[9] https://www.youthmappers.org/
[10] https://crowd2map.wordpress.com/

Starting from the community level, OSM has been able to attract the attention of institutional entities, ranging from small local ones (such as the local civil protection agencies) to national mapping agencies and international organisations, like the World Bank and the UN (see for example the Open Cities Africa project[11]) [7]. Universities are often involved in community geospatial science, even if their role is that of co-creators of solutions together with the other involved actors.

Apart from the social ecosystem that has been established in this global community geospatial science experience, the technological ecosystem that has been established is worth mentioning. One of the main reasons for the success of OSM is that the technology behind the project allows everybody to contribute, independently of their level of expertise. The tools and systems, developed by different actors in the social ecosystem of OSM (volunteers; small and medium companies; universities; local, national or international agencies) are generally characterized by being free and open source, i.e. they can be passed on for further development by other people in the community; and by the different applications very often accessible simply through the personal account on the OSM platform.

Apart from facilitating contributions by individuals, the OSM ecosystem is designed to elicit and simplify collaboration. One fundamental tool (the Tasking Manager) for instance allows the subdivision of large areas to be mapped into a set of smaller ones, each of a size that can be mapped by an individual. This facilitates collaboration among mappers and avoids problems of overlap and confusion. Moreover, this tool allows the validation of the mapped data, so that a quality assessment of the mapped area is possible.

Citizen science and community geospatial science represent a new step in the history of science and these examples, like OSM and its communities, are relevant cases of what can be done within the new paradigm of collaboration and openness.

20.4 The Use Case and Training Material

The UN 2030 Agenda defines the challenges to be overcome in order to achieve prosperity for all in a sustainable manner for the entire planet up to the year 2030 [14]. These challenges are embodied in the 17 SDGs that are broadly interdependent and address all aspects, from poverty to peace and justice, from environmental protection to human health, from food security to gender equality. To track progress towards achieving the 2030 Agenda, it is essential to understand the attainment level for each of the 17 SDGs. Progress can be

[11] https://opencitiesproject.org/

quantified by measuring, gathering data and calculating the indicators that define each goal using a consolidated methodology [15].

As the 2030 Agenda fulfilment has a worldwide scope, the monitoring and reporting activities must be done globally. Yet, the quantity, quality, precision and consistency of the necessary data vary significantly across the globe and so do the resources to gather it. However, in the last two decades, we have witnessed a significant increase in the availability of open data, from open public data to citizen science data, and in the case of geoscience, satellite imagery and related products [12] .In this context and within the framework of the third OSGeo UN Committee Educational Challenge related to open geospatial data and software for UN SDGs, we developed a replicable use case to demonstrate that open geospatial data, which very often are contributed by citizens and communities, are available globally; that free and open source solutions for geospatial have sufficiently developed to conduct a global geospatial analysis at small and intermediate scales; and that these data and software can be used to monitor a geospatial SDG indicator.

The selection of the indicator has been done following these guidelines:

1. to have a spatial dimension;
2. to avoid indicators that are already addressed through an advanced initiative, such as the GEO Wetlands Initiative[13], WHO Interactive Air Pollution Maps[14], GEO AquaWatch[15] or ESA CoastColour[16].

Indicator 9.1.1, Proportion of the rural population who live within 2 km of an all-season road (C0901010), was selected, which supports the target of developing quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. In December 2018, the UN published an updated but still in progress work on the metadata for indicator 9.1.1. that includes clear definitions for the terminology, methodology, data sources and their availability [16]. A significant limitation is highlighted: "*The Indicator relies substantially on data collected by road agencies and national statistics offices for their operational work. As such, its update is dependent on the frequency of update of the road condition surveys and national census.*" ([16], subchapter Methodology, paragraph Comments and limitations). This is exactly the type of limitation we aim to address with our use case. In comparison to data collected by a multitude of national agencies, globally produced datasets have the advantage of worldwide coverage and a coherent and consistent technical and logical structure. Yet, both kinds of dataset can have a similar scope. Even though the open dataset is the result

[12] https://wiki.osgeo.org/wiki/Training_Material_for_UN_Open_GIS_OpenData
[13] Retrieved from https://www.earthobservations.org/activity.php?id=122 on 3.02.2019
[14] Retrieved from http://maps.who.int/airpollution/ on 3.02.2019
[15] Retrieved from https://www.geoaquawatch.org/ on 3.02.2019
[16] Retrieved from http://www.coastcolour.org/ on 3.02.2019

of a collaborative community effort, its structure and semantics are described and allow a clear understanding of it. Thus, reliable cleaning of the data can be done, if necessary.

For the present use case, we selected Tabora Region, one of the 31^{st} administrative regions in the central-western part of Tanzania. However, the same use case is replicable for any other region in the world, provided the data are available. This is possible because we based the computation only on open global datasets. In Table 20.1, we show the geospatial information required to calculate the Rural Access Index (RAI) for a region, together with the open global datasets in our use case.

The most challenging geospatial information to obtain is the road network and the road condition. At the moment, the only global dataset that could provide such information is OpenStreetMap. The amount and quality of OpenStreetMap data for various regions around the world can vary significantly. As our region of interest is located in Africa, specific OpenStreetMap developments for Africa must be taken into consideration, namely the Highway Tag Africa Typology of Road Network in African countries[17], a roads classification designed for the context of African countries, and the East Africa Tagging Guidelines[18], which provide guidance for tagging roads in Kenya, Tanzania, Uganda, Rwanda, Burundi, and South Sudan. Even though the road classification is specific to Africa, the clear and consistent definition of each element[19] and tag[20] in OpenStreetMap makes this use case reproducible in any other part of the world. With this in mind, apart from describing the processing steps for the Tabora Region RAI calculation in detail, we present the conceptual workflow for calculating the RAI in Figure 20.1.

The workflow consists of three main stages: (1) preparation of the geospatial data; (2) calculation of the RAI; and (3) presentation of the results. The first stage is the most time consuming as preparing the data implies a thorough analysis, ranging from the structure (i.e. format) to aspects related to consistency, precision, scale etc., and subsequent cleaning of the dataset. The outcome of the first stage is a dataset with only the information necessary for the analysis, any redundant information is removed.

The use case and the training material are based on a well-known free and open source GIS package, QGIS3[21]. For the RAI calculation, a topologically correct road network is desirable, but not necessary. Because OpenStreetMap is an open collaborative mapping project, there may be inconsistencies in the data. After close analysis of the Tabora region road network, a series of in-

[17] Retrieved from https://wiki.openstreetmap.org/wiki/Highway_Tag_Africa on 3.02.2019

[18] Retrieved from https://wiki.openstreetmap.org/wiki/East_Africa_Tagging_Guidelines on 3.02.2019

[19] An element is the basic component of the OpenStreetMap conceptual data model of the physical world

[20] A tag describes the element to which is attached and it is defined by a key and a value that are conventions agreed upon by the OSM community and openly published on the OSM wiki.

[21] Retrieved from https://qgis.org/en/site/ on 3.02.2019

TABLE 20.1
Geospatial information and corresponding open datasets used in the RAI calculation for the Tabora Region. Data from different sources: 1) *gadm.org*, 2) *worldpop.org.uk*, 3) *sedac.ciesin.columbia.edu*, and 4) *openstreetmap.org*

Theme	Geospatial Information	Dataset Used	RAI Layer	Producer / Collector of Data
Administrative Units	Administrative Units	Database of Global Administrative Areas[1]	Administrative Units	University of California, Berkeley, Museum of Vertebrate Zoology, and the International Rice Research Institute (Global Administrative Areas 2009)
World Population	Estimates of numbers of people per grid square	WorldPop[2]	Population Numbers	GeoData Institute, University of Southampton
World Population	Polygon representation of urban areas with city or agglomeration name and time series	Global Rural-Urban Mapping project (GRUMP), v1[3]	Urban Geometries	Socioeconomic Data and Applications Center (SEDAC)
General Geospatial Data	OpenStreetMap is built by a community of mappers that contribute and maintain data about roads, trails, cafés, railway stations, and much more, all over the world	OpenStreetMap[4]	Road Network, Road Condition	OpenStreetMap contributors

FIGURE 20.1
Conceptual workflow for calculating the RAI

consistencies were identified and corrected to eliminate as much as possible any artificial results in the RAI. Even though the use case was developed for a particular region, the types of inconsistencies addressed include the most common situations, thus making the study replicable. The types of inconsistencies and solutions for addressing each one of them are presented in detail in the training material.

The geospatial layer of the RAI is obtained by dividing the rural population within the 2km buffer area around the all-season roads in a specific administrative unit by the total rural population for that administrative unit. The last step of the workflow provides suggestions for presenting the results of the RAI analysis (Figure 2) so that the indicator can be used as the basis for future management and development of the region in question. The complete training material, for those who want to repeat the calculation of the RAI for Tabora or do something similar in other regions of the world is available at the website[22].

20.5 Conclusion

The Tabora region use case for calculating an SDG geospatial indicator proves that through the exclusive use of open global datasets, some of which contributed by citizens, and free and open source software, complex geospatial analyses can be conducted to better understand, manage and protect our environment. The use case was deliberately developed using only global datasets so that it can be replicated for any other region in the world.

[22] https://wiki.osgeo.org/wiki/Training_Material_for_UN_Open_GIS_OpenData

Undoubtedly, the issue of data quality remains when considering an open collaborative environment such as OpenStreetMap. However, this kind of initiative can and should work as a driving force towards improving the open datasets, either by defining new significant attributes - referred to as tags, in OSM – or by cleaning and maintaining the attributes in the dataset.Working with citizens and communities like those surrounding OpenStreetMap, following a community geospatial science paradigm, "will ensure that the challenges are addressed for all populations in different locations, leaving no one behind" (Rajabifard, 2019).

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21

Modernizing Land Administration Systems to Support Sustainable Development Goals - Case Study of Victoria, Australia

Hamed Olfat

The University of Melbourne, Australia; Land Use Victoria, Australia

Davood Shojaei

The University of Melbourne, Australia; Land Use Victoria, Australia

This chapter discusses the concepts of both land administration system (LAS) and sustainable development goals (SDGs) as well as some previous works that have linked these two concepts together. It then recommends the requirements of a LAS that can support SDGs. As a case study, the LAS modernization journey in the State of Victoria, Australia to support SDGs is reviewed next. Finally, the chapter concludes with some recommendations for future enhancements of the Victorian LAS.

21.1 Land Administration Systems

To achieve sustainable development goals (SDGs), countries require access to an effective, efficient and modern land administration system (LAS) based on a cadastre engine that contains spatially accurate land parcels and corresponding rights, restrictions and responsibilities (RRRs).

LAS is a simple tool for managing natural resources, environmental monitoring and protection, disaster management, physical and economic planning [8]. In order to support a land market, LAS is a must for all nation states to support and protect ownership rights. This requires having proper data sets prepared by surveyors to support trading land in the market and having a system to provide access to the ownership information. For many countries, cadastre is the engine of land administration which provides integrity and security to land market.

Cadastre also provides a base map for various other purposes such as utility services, urban planning, and disaster management which facilitates spatial enablement government and the wider society [18].

Many developed countries use land parcel layer as a main component of Digital Cadastre Database (DCDB) and attach required attributes to this layer for managing cadastral information. This layer requires a survey network as a base for maintaining the integrity and accuracy. In addition, a proper process is also necessary to keep this important data set updated. This adds value to DCDB by adding other layers and connecting the processes to it. However, while the concept of cadastre is simple, implementation of that is very complex and changing an established cadastre takes long as it has lots of connections to various business processes and regulations.

Some initiatives started to highlight the role of cadastre and proposed some changes to make it compatible with the current and future needs of land administration. For example, Cadastre 2014 proposed by FIG provided a vision for future cadastre [17] and the United Nations-FIG Bathurst Declaration on Land Administration for Sustainable Development is another example of required changes in the cadastre [3]. In addition, the Intergovernmental Committee on Surveying and Mapping (ICSM) in Australia has developed Cadastre 2034 Strategy and proposed the future cadastre in Australia [7]. Based on Goal 1 of the Cadastre 2034 Strategy, the cadastral system should sustainably manage land ownership. This keeps the integrity and societal benefits of the cadastral systems.

The following section briefly introduces the SDGs developed by the United Nation (UN).

21.2 Selected LAS Works

Land administration theory requires the implementation of the land management paradigm to drive systems dealing with land rights, restrictions and responsibilities towards supporting sustainable development. The land management paradigm, where land tenure, value, use and development are considered holistically as essential and omnipresent functions performed by organized societies, is the cornerstone of modern land administration theory [19].

The land management paradigm makes a national cadastre the engine of the entire LAS, underpinning the country's capacity to deliver sustainable development (Figure 21.1). The cadaster should assist the functions of land tenure, land value, land use, and land development. In this way, within the LAS, the cadastre or cadastral system becomes the core technical engine delivering the capacity to control and manage land through the four LAS functions.

Cadastres are regarded as the foundation for sustainable social, economic and environmental development of societies [13].

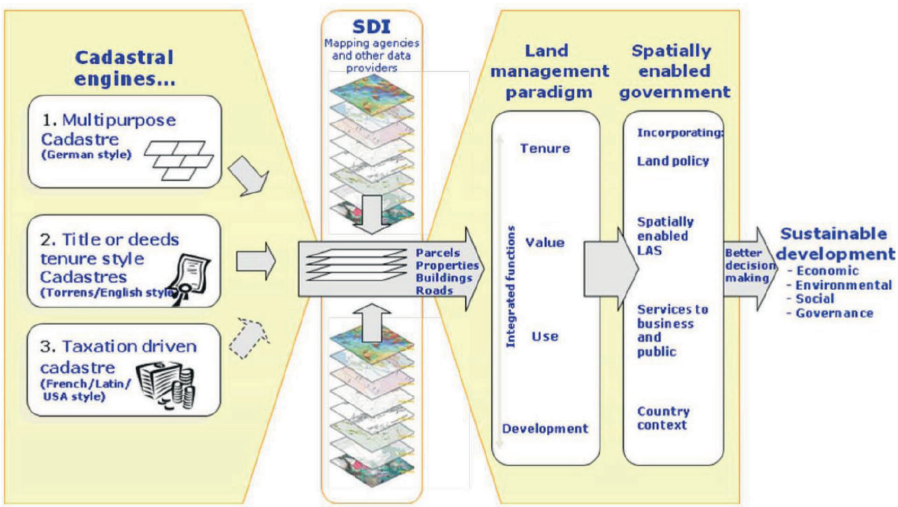


FIGURE 21.1
The cadastre as an engine of LAS - the "butterfly" diagram [19]

The relationship between 17 SDGs and LAS was also reviewed by Dawidowicz and Zrobek (2017) in Poland to build a LAS to support the SDGs [2]. They identified the key challenges that a LAS should address to support sustainable development. In Poland, the Integrated Real Estate Information System (IREIS), is being implemented based on sustainable development.

In the next section, the SDGs with direct and indirect relationship with LAS are identified and the requirements of a LAS to support SDGs are explored.

21.3 Land Administration Systems Related Requirements to Support Sustainable Development Goals

SDGs require access to LAS. However, the relationship between goals and LAS can be direct or indirect. Direct relationship means that a specific goal cannot be achieved at all without a LAS. Whereas, an indirect relationship means that a specific goal might not be efficiently achieved without a LAS. Table 21.1 shows the goals and targets that have a direct link to LAS.

The rest of SDGs and targets have an indirect link to LAS. As an example, Goal 4, "Ensure inclusive and equitable quality education and promote lifelong

TABLE 21.1
SDGs and targets that have a direct link to LAS

Goal	Target
Goal 1. End poverty in all its forms everywhere	(1.4) By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	(2.3) By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment
Goal 5. Achieve gender equality and empower all women and girls	(5.a) Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws (5.b) Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	(11.1) By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums (11.3) By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries (11.6) By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management (11.7) By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities (11.a) Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

learning opportunities for all" does not have a direct link to LAS, however, it can be efficiently achieved using a modern LAS based on a spatially accurate cadastre that demonstrates the distribution of people based on their age as well as educational institutes and their information across a country.

Our study showed that countries should meet the following requirements for supporting SDGs and targets:

- **Requirement 1** - Provide equal access to ownership and control over land and property;
- **Requirement 2** - Provide secure tenure rights to land with legally recognized documentation (title, deed, etc.);
- **Requirement 3** - Develop an accurate cadastral data set (parcel fabric) as a fundamental layer; and
- **Requirement 4** - Utilize information and communications technology for modernizing LAS.

The next section provides an overview of the Victorian LAS modernization journey to meet the above-mentioned requirements for supporting SDGs.

21.4 Case Study of Victoria, Australia

Victoria is Australia's most densely populated state (highlighted in Figure 21.2) and its second-most populous state overall with population of 6,430,000 [1].

FIGURE 21.2
The location of State of Victoria in Australia

The Victorian Department of Environment, Land, Water and Planning (DELWP), through Land Use Victoria (LUV), is responsible for all land information and administration activities in Victoria including registration of land transactions, property information, surveying, valuation, geographic names, spatial services, government land and the government land monitor.

LUV is also responsible for maintaining the Victorian cadastre (VicMap Property), which is currently a 2D analogue representation of the State's property boundaries, based on property title information, and provides the foundation for Victoria's primary mapping and spatial information systems and services.

To support the SDGs, LUV has been constantly modernizing the LAS using the information and communications technology, as recommended by [9]. Figure 21.3 illustrates the Victorian LAS modernization journey. Before the 1990s, cadastral plans were all lodged in paper. VicMap Property was created in the early 1990s from the digitization of paper-based map records held by Melbourne Water (metropolitan area) and the State government (rural area). VicMap Property comprises more than 3 million land parcels and associated property attributes, such as lot and plan number, and crown description, in the State of Victoria.

Land title information was migrated from paper to the Victorian Online Title System (VOTS) in 2000. VOTS contains a record of all Victorian titles registered under the Torrens System [6]. The system is maintained by LUV and is used to accept, create and register land transaction lodgements, and to update land holdings and registered interests on title as well as create new titles.

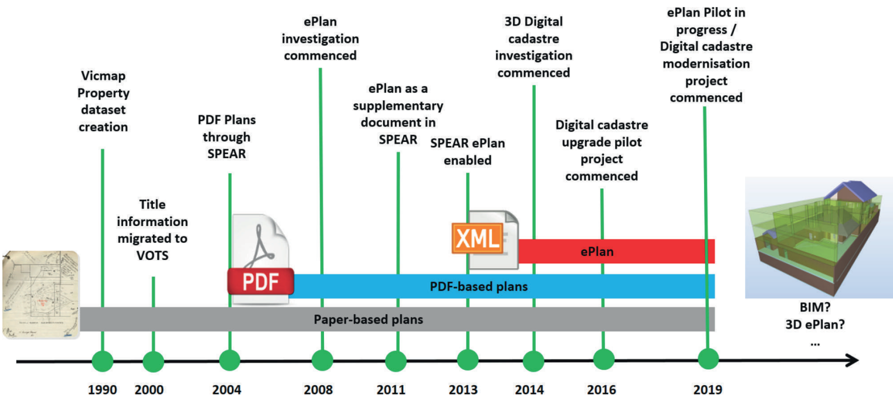
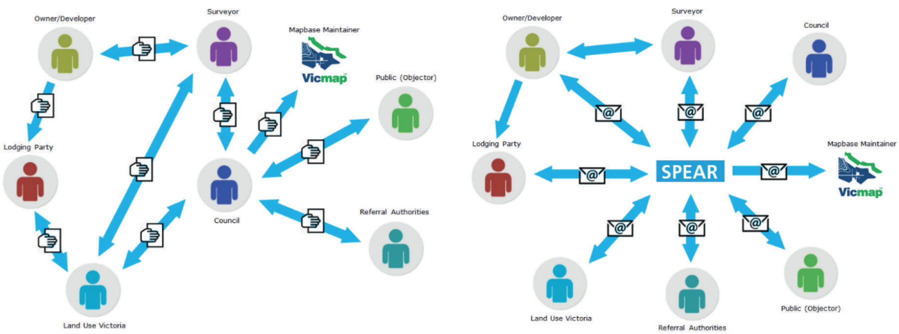


FIGURE 21.3
LAS modernization journey in Victoria (modified after [12])

Prior to the launch of the Surveying and Planning through Electronic Applications and Referrals (SPEAR) pilot in 2004, subdivision applications could only be processed via paper. Diagram (a) in Figure 21.4 illustrates this process. This was generally a lengthy and protracted process that was instigated by the surveyor, on behalf of their client (developer). The process and application milestones are well defined by the Planning and Environment Act 1987 [4] and Subdivision Act 1988 [5], however achieving these milestones, in a paper environment, where there are multiple stakeholders involved in the decision-making process led to delays, errors, and poor transparency between the interested parties.

Although there was a lot of scope to improve efficiencies throughout the life of the application, there was no means of implementing these changes for the benefit of all parties, due to the technology constraints of a pre 'world wide web' era.



(a) Subdivision process before SPEAR (b) Subdivision process after SPEAR

FIGURE 21.4
Subdivision process before SPEAR (diagram a) vs. after SPEAR (diagram b).

SPEAR revolutionized the way subdivision applications were handled, by introducing online end-to-end processing and tracking of plan applications from their initial submission with local government, right through to registration at LUV. Diagram (b) in Figure 21.4 illustrates the subdivision process after the introduction of SPEAR. A surveyor can use SPEAR to apply for any plan-based dealing under the Subdivision Act 1988, and the planning permit to subdivide under the Planning and Environment Act 1987.

SPEAR introduced invaluable transparency and accountability to the subdivision application process by streamlining the approval process for plans of subdivision, and the associated planning permit to subdivide. The system is now being used by all 79 Victorian local governments, 200 surveying firms, 74 referral authorities, and LUV, which, in total, represents over 4000 users to view the progress of applications.

In addition to SPEAR project, the investigations to the ePlan project commenced in 2008 in Victoria (See Figure 21.3). LUV collaborated with the ICSM ePlan Working Group on developing a national data model to cover all Australian jurisdictions' cadastral and survey requirements [16]. In 2011, SPEAR enabled surveyors interested in ePlan to upload an ePlan LandXML file along with their PDF application. From 2011 to 2013, ePlan was piloted in Victoria by LUV, the surveying industry and software vendors. In May 2013, SPEAR incorporated ePlan services including visualization, validation, data viewer and data download [11, 10]. The ePlan road map defined by LUV has the following visions [12]:

- **Longterm vision**: Implement ePlan for all Victorian cadastral plans and surveys by 2025.
- **Short-term vision**: Provide the infrastructure and services to enable the submission and registration of ePlan for all 2D Victorian cadastral plans by 2020.

Recent advancements in the demand for high precision, and data driven spatial information have led to the need to modernize and digitize Victoria's cadastre. The Digital Cadastre Modernization project is underway and will deliver a fully digital state-wide cadastre over the next 5 years. This will unlock significant new capability and innovation in Victoria for next-generation spatial services.

All 2D plans under the Subdivision Act 1988 are supported in ePlan. However, strata plans (building subdivision plans) which include overlapped ownership rights are not yet supported.

As indicated in Figure 21.3, the investigations around the 3D digital cadastre to support the building subdivisions in ePlan format commenced in 2014. Following the release of the ICSM's strategy on Cadastre 2034, LUV has started to investigate the technical requirements for supporting 3D building subdivisions in ePlan including the potential use of Building Information Modelling (BIM), 3D data visualization, validation and storage. As part of these studies, several prototypes were developed and are under development to evaluate the implementation. As an example, Figure 21.5 presents LUV 3D ePlan Prototype.

Currently, a 3D digital cadastre road map is under development in Victoria following the ePlan long-term vision and goal 4 of ICSM Cadastre 2034 Strategy. The road map aims to show the major milestones and timeframes towards the implementation of a 3D digital cadastre by 2025. In addition, the institutional, technical and legal aspects of a 3D digital cadastre should link together to clarify the connection and relationships of the interests of the property industry, to build a comprehensive framework for implementation [14].

In conclusion, the current status of Victorian LAS in terms of addressing SDGs-related requirements is shown in Table 21.2.

TABLE 21.2
Current status of the Victorian LAS in terms of addressing SDGs-related requirements

Requirement	**Victorian LAS current status**
Provide equal access to ownership and control over land and property	The current LAS allows both men and women to have equal access to ownership and control over land and property.
Provide secure tenure rights to land with legally recognized documentation (title, deed, etc.)	Victoria's LAS is based on Torrens title system which works on three principles: • The land titles Register accurately and completely reflects the current ownership and interests about a person's land. • Because the land titles Register contains all the information about the person's land, it means that ownership and other interests do not have to be proved by long complicated documents, such as title deeds. • Government guarantee provides for compensation to a person who suffers loss of land or a registered interest.
Develop an accurate cadastral data set (parcel fabric) as a fundamental layer	The digital cadastre modernization project is currently underway. This project aims to build a spatially accurate 2D digital cadastre for Victoria by 2024.
Utilize information and communications technology for modernizing LAS	Both ePlan and 3D digital cadastre projects are currently underway aiming at providing services to enable the submission of digital cadastral data to LUV. These projects leverage the information and communication technologies to develop required services for land administration stakeholders in Victoria.

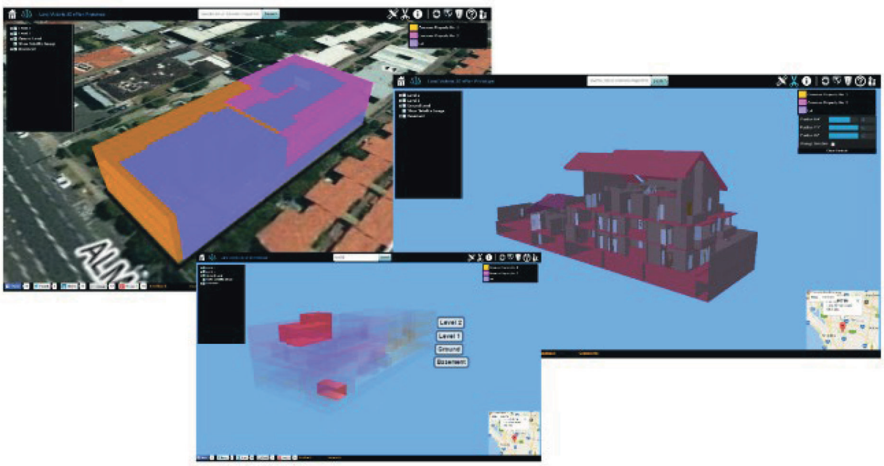


FIGURE 21.5
LUV 3D ePlan prototype (www.spear.land.vic.gov.au/spear/pages/eplan/3d-digital-cadastre/3dprototype/prototype.html) [15]

21.5 Conclusion

This chapter explored the role and requirements of a modern LAS for supporting SDGs. It was discussed that SDGs, depending on their nature, have either a direct or an indirect relationship with LAS. Direct relationship means that a specific goal cannot be achieved at all without a LAS (e.g. Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable). Whereas, an indirect relationship means that a specific goal might not be efficiently achieved without a LAS (e.g. Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all).

The chapter reviewed the LAS modernization journey in Victoria to support SDGs. The study showed that the current Victorian LAS can meet most of the four requirements identified herein. However, to have access to a fully modern LAS in Victoria, the following research and development projects should be considered: a) fully implement 2D ePlan services for all plan-based dealing types by 2020, b) finalize and endorse 3D digital cadastre road map, and c) implement 3D digital cadastre by 2025.

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