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Geographic Information Systems as a Tool to Support the Sustainable Development Goals

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Abstract**—**Geographic Information Systems (GIS) is a multipurpose computer-based tool that provides a sophisticated ability to map and analyze data on different spatial layers. However, GIS is far more easily applied in some policy areas than others. This paper seeks to determine the areas of sustainable development, including environmental, economic, and social dimensions, where GIS has been used to date to support efforts to implement the United Nations Sustainable Development Goals (SDGs), and to discuss potential areas where it might be used more. Based on an extensive analysis of published literature, we ranked the SDGs according to how frequently GIS has been used to study related policy. We found that SDG#15 "Life on Land" is most often addressed with GIS, following by SDG#11 "Sustainable Cities and Communities", and SDG#13 "Climate Action". On the other hand, we determined that SDG#2 "Zero Hunger", SDG#8 "Decent Work and Economic Growth", and SDG#16 "Peace, Justice, and Strong Institutions" are least addressed with GIS. The paper outlines some specific ways that GIS might be applied to the SDGs least linked to this tool currently.

Keywords**—**GIS, GIS application, sustainable community development, sustainable development goals.

I. Introduction

One of the main challenges of the twenty-first century is to bring about more sustainable development that improves the long-term health of human and ecological systems [1], 2]. In response to this challenge, in 2015 all United Nations member states adopted the 2030 SDGs as a universal call to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity [3]. There are 17 comprehensive and integrated SDGs linked to specific 15-year targets (see Fig. 1).

Even though progress has been made in many areas, implementation of the SDGs is not advancing at the speed or scale required [5]. Hence, the oncoming decade must bring ambitious actions to deliver SDGs by 2030, and that is why there is a high demand for suitable tools to support these actions. As long ago as 1992, the United Nations Conference on Environment and Development suggested GIS as a suitable tool to support sustainable development efforts within the Agenda 21 Action Plan. As a big picture, GIS is "… a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth" [6]. Within a more applied approach, GIS is "… any manual or computer-based set of procedures used to store and manipulate geographically referenced data" [7]. Cowen described GIS as a system for support of geographically based decisions, or a "Spatial Decision Support System", which allows creating a visual overlay of available geospatial datasets to reveal patterns and trends that may not be perceived otherwise [8].

According to Campagna, GIS has strong potential to support sustainability planning, decision-making, and management because of its sophisticated ability to map, combine, and analyze different data into spatial layers [9]. He had highlighted 5 capabilities of GIS for sustainable development: (1) to produce and maintain geographic information; (2) to support distributed access to (environmental) information (spatial data infrastructure); (3) to solve spatial problems (spatial analysis and environmental modeling); (4) to support collaborative decision-making (group spatial decision-making); and (5) to support public participation (public participation GIS). In turn, Kumar et al. have determined 8 capabilities of GIS regarded to any data: (1) to capture; (2) to store; (3) to maintain; (4) to query; (5) to analyze; (6) to manipulate; (7) to display; and (8) to output [10]. As they mentioned, there are 4 major GIS applications only within various disciplines: (1) mapping, (2) monitoring, (3) measurement, and (4) modeling.

Within SDGs, GIS helps to solve complex concerns by creating a geographic-design framework [11]. In 2019, Dangermond, a founder and president of Esri (one of the major companies in the field of GIS), suggested 5 consecutive steps the global development community can take to better leverage GIS in SDGs implementation [12]: (1) to gather geographic information; (2) to visualize the data; (3) to conduct spatial analysis by overlaying different maps and evaluating relationships between them; (4) to create geographic plans; and (5) to take an action. The first step aims to improve decision-making by capturing, organizing, and managing various data. Within the second step, Esri in cooperation with the United Nations had established a Data Hub to map out visually the ongoing work on SDGs. The third step – a spatial analysis - helps to determine the cause-and-effect relations in a particular phenomenon within any analyzed SDGs. The fourth step allows developing a scope of decisions about what to do where. During the fifth step, users can (1) verify relationships, complexity, and patterns, (2) map out different options, and (3) evaluate their benefits and risks to make the best possible decision.

In this paper we ask how researchers have applied GIS to the SDGs to date, and speculate on ways that GIS might be applied to SDGs for which it is still not used widely.

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Fig. 1 The United Nation SDGs [4]

II. Methodology

We assumed that the frequency with which GIS was used in the context of a specific SDG directly corresponds with the number of research papers on the same topic. In other words, the greater the number of research papers discussing GIS in conjunction with some specific SDG, the more frequently GIS is applied in the area of this SDG.

We utilized internal search engines of 2 major bibliographic databases: (1) Elsevier's Scopus [13] and (2) Clarivate Analytics' Web of Science [14]. Initially, we also planned to use data from Google Scholar [15] - a less formal and selective database of research papers. However, search results were not accurate and constant, and so we did not include that source.

The search covered the period from 2000 to 2020. We utilized a three-stage search process for every database (see Fig. 2). As the first stage, we determined the number of papers dedicated to sustainable development in general by utilizing "sustainable development" as the keyword for search engines. Next, we added into the search the keyword "GIS" to select papers considering sustainable development in interrelation with GIS. Finally, we added the precise title of every SDG to narrow the search results to papers considering GIS in relation to specific SDGs. To check the method's accuracy, we reviewed randomly selected papers from each group to make sure that its content corresponded with what was expected, as well as to determine more precisely how GIS had been applied. Based on the collected data, we ranked SDGs according to how frequently GIS has been used in conjunction with them.

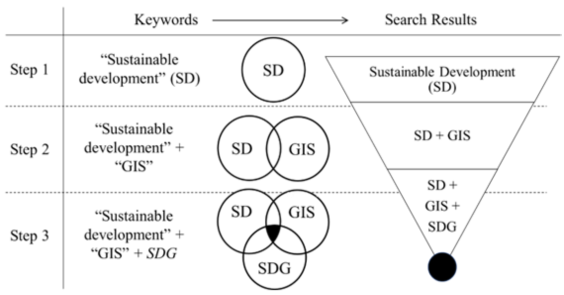

Fig. 2 The Model of Quantitative Literature Review

III. Results

A. Elsevier's Scopus

In total, 187,965 papers in Scopus [13] used "sustainable development" as a keyword (see Fig. 3). On average, 9,398 such papers were published annually. The number of such papers in 2019 was 14.1 times higher than in 2000, with an average growth rate of 16.5% a year. Since 2015, the year when SDGs were adopted, 87,632 such papers were published, 46,6% of the total. Geographically, most of the papers have affiliation with China (18.3%), the United States (16.6%), and the United Kingdom (8.8%).

In the second stage of literature selection, we used "sustainable development" and "GIS" keywords together. In total, we found 9,435 papers (see Fig. 4). In other words, in Scopus only 5% of papers in the field of sustainable development utilized GIS as a tool of research. More than half of these papers were published in 2015-2020, indicating a recent increase in research linking the two. Again, most of the papers had affiliation with China (30.8%), the United States (15.4%), and the United Kingdom (6.5%), along with Italy (6.1%) and India (6.0%).

Finally, we added the exact name of each SDG into the search, e.g. "Climate Action". In total, we found 6,244 papers related to all SDGs and including keywords "GIS" and "sustainable development," with 4,213 of them (67.5%) published since 2015 (see Table I). The average annual number of papers increased from 135.4 in 2000-2014 to 842.6 in 2015-2019. The number of papers increased from 16 in 2000 to 1,377 in 2019, with the annual increasing rate of around 30%.

Not surprisingly, SDG#15 "Life on Land" is the one where GIS was applied most frequently. GIS is, after all, very frequently used in land use planning. This was following by SDG#11 "Sustainable Cities and Communities" and SDG#13 "Climate Action". In aggregate, these three SDGs accounted for around 74% of the total papers. The SDGs associated with the least number of GIS-related papers were SDG#2 "Zero Hunger," SDG#8 "Decent Work and Economic Growth," and SDG#16 "Peace, Justice, and Strong Institutions."

B. Clarivate Analytics' Web of Science

Analysis of the Web of Science [14] showed very similar results, though overall numbers were different. This research database held 128,998 papers in the field of sustainable development, with 66,693 of them (51.7%) published since 2015 (see Fig. 5).

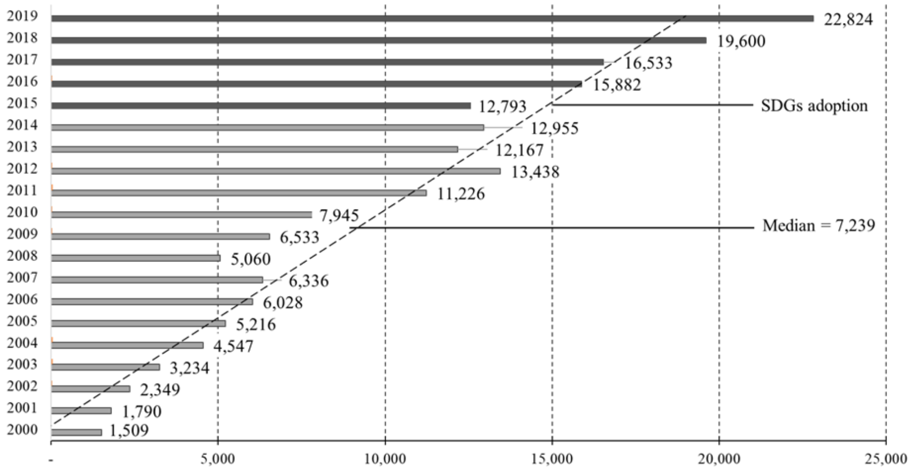

Fig. 3 The Number of Papers in Scopus with the Keyword "Sustainable Development"

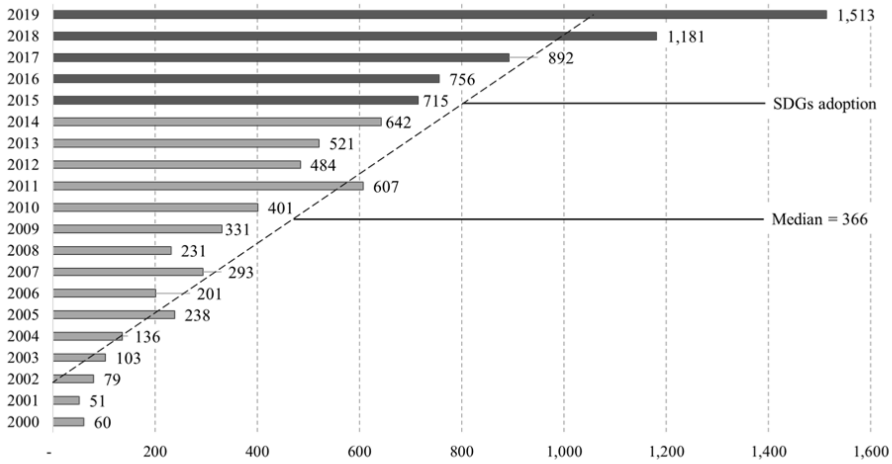

Fig. 4 Scopus Search Results with "Sustainable Development" and "GIS" Keywords

TABLE I
THE NUMBER OF PAPERS IN SCOPUS IN WHICH GIS APPLIED IN THE CONTEXT OF SDGS

Rank	The Title of the UN SDG	Number of Papers	% of the Total
1	SDG#15 "Life on Land"	1,701	27.24
2	SDG#11 "Sustainable Cities and Communities"	1,576	25.24
3	SDG#13 "Climate Action"	1,201	19.23
4	SDG#4 "Quality Education"	667	10.68
5	SDG#1 "No Poverty"	262	4.20
6	SDG#9 "Industry, Innovation, and Infrastructure"	210	3.36
7	SDG#3 "Good Health and Well-Being"	204	3.27
8	SDG#17 "Partnerships for the Goals"	156	2.50
9	SDG#14 "Life Below Water"	68	1.09
10	SDG#12 "Responsible Consumption and Production"	65	1.04
11	SDG#6 "Clean Water and Sanitation"	44	0.70
12	SDG#7 "Affordable and Clean Energy"	26	0.42
13	SDG#5 "Gender Equality"	26	0.42
14	SDG#10 "Reduced Inequalities"	21	0.34
15	SDG#2 "Zero Hunger"	9	0.14
16-17	SDG#8 "Decent Work and Economic Growth"	4	0.06
16-17	SDG#16 "Peace, Justice, and Strong Institutions"	4	0.06
	In Total	6,244	100.00
	The Top-Three Goals	4,478	71.72
	The Bottom-Three Goals	17	0.27

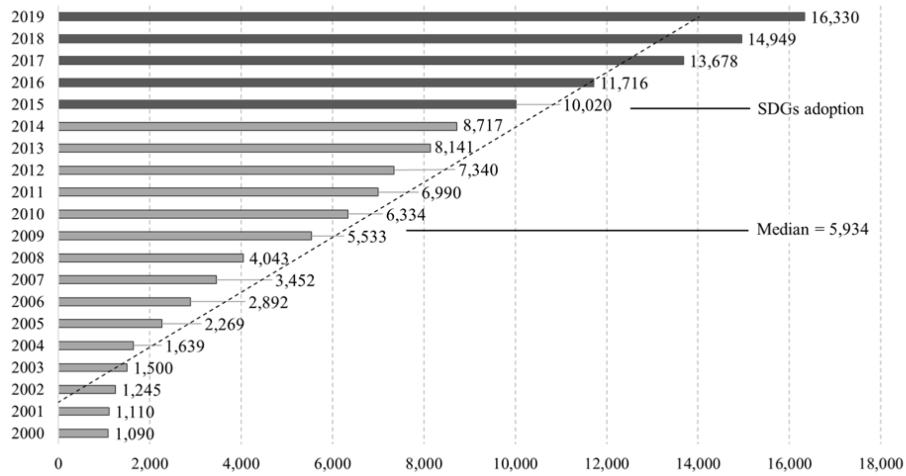

Fig. 5 The Number of Papers in Web of Science with the Keyword "Sustainable Development"

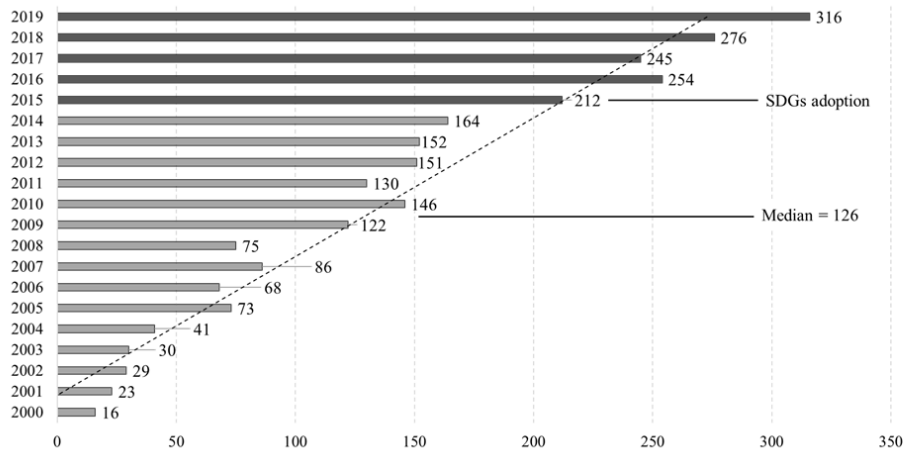

Fig. 6 Web of Science Search Results with "Sustainable Development" and "GIS" Keywords

In 2019, the number of papers published annually was 15 times higher than in 2000, for an average growth rate of 15.7% a year. On average, 6,449 papers were published annually. Most of the papers came from researchers in China (18.5%), the United States (13.6%), and the United Kingdom (7.9%).

In Web of Science we found 2,609 papers with both "sustainable development" and "GIS" as keywords (see Fig. 6). As in Scopus, around half of the papers were published in 2015-2019, and a very small number (2%) of papers considering sustainable development discussed GIS as well. In 2019, the number of papers addressing these topics jointly was 19.8 times higher than in 2000, representing an average annual growth rate of around 19.1%. Geographically, China produced the largest number of these papers (24.5%), followed by the United States (9.9%), India (8.3%), Italy (6.5%), and Germany (5.0%).

The number of Web of Science papers using of "sustainable development", "GIS", and an exact phrase from each SGD are presented in Table II. Since 2015, 101 of 179 papers (56.4% of the total) had been published. On average, there were around 9 papers published annually, and the average number increased from 5.2 papers a year in 2000-2014 to 20.2 papers a year in 2015-2019.

The same three SDGs as in Scopus - SDG#11 "Sustainable Cities and Communities", SDG#15 "Life on Land", and SDG#13 "Climate Action" - are at the top of the list. They contributed 82.8% of the total papers, and the top 8 goals contributed about 98%. There were no papers related to SDG#12 "Responsible Consumption"; SDG#9 "Industry, Innovation, and Infrastructure"; SDG#2 "Zero Hunger"; SDG#8 "Decent Work and Economic Growth"; and SDG#16 "Peace, Justice, and Strong Institutions". Five more SGDs have a single GIS-related paper only.

C. General Findings

The SDGs most and least studied by researchers also discussing GIS are very similar for both databases (see Table III).

Researchers have sought to link GIS to individual SDGs most frequently in the case of SDG#15 "Life on Land," SDG#11 "Sustainable Cities and Communities," SDG#13 "Climate Action," and SDG#4 "Quality Education." These

SDGs contributed 82.4% of the total number of papers in Scopus and 92.7% of the total number of papers in Web of Science. Researchers have linked GIS least frequently to SDG#2 "Zero Hunger," SDG#8 "Decent Work and Economic Growth," and SDG#16 "Peace, Justice, and Strong Institutions." Two additional U.N. sustainability goals, SDG#9 "Industry, Innovation and Infrastructure" and SDG#12 "Responsible Consumption and Production," have no GIS-related papers in Web of Science but do have small numbers of papers in Scopus (3.36% and 1,04% of the total respectively).

TABLE II
THE NUMBER OF PAPERS IN WEB OF SCIENCE IN WHICH GIS APPLIED IN THE CONTEXT OF SDGS

Rank	The Title of the UN SDG	Number of Papers	% of the Total
1	SDG#11 "Sustainable Cities and Communities"	65	36.31
2	SDG#15 "Life on Land"	63	35.20
3	SDG#13 "Climate Action"	20	11.17
4	SDG#4 "Quality Education"	18	10.06
5	SDG#10 "Reduced Inequalities"	4	2.23
6	SDG#3 "Good Health and Well-Being"	2	1.12
7	SDG#14 "Life Below Water"	2	1.12
8-12	SDG#17 "Partnerships for the Goals"	1	0.56
8-12	SDG#1 "No Poverty"	1	0.56
8-12	SDG#6 "Clean Water and Sanitation"	1	0.56
8-12	SDG#5 "Gender Equality"	1	0.56
8-12	SDG#7 "Affordable and Clean Energy"	1	0.56
13-17	SDG#12 "Responsible Consumption and Production"	-	0.00
13-17	SDG#9 "Industry, Innovation, and Infrastructure"	-	0.00
13-17	SDG#2 "Zero Hunger"	-	0.00
13-17	SDG#8 "Decent Work and Economic Growth"	-	0.00
13-17	SDG#16 "Peace, Justice, and Strong Institutions"	-	0.00
	In Total	179	100.00
	The Top-Three Goals	149	82.68
	The Bottom-Three Goals	-	0.00

TABLE III
JUXTAPOSITION OF SEARCH RESULTS FROM SCOPUS AND WEB OF SCIENCE

The Title of the UN SDG	Papers in Scopus		Papers in Web of Science	
	Rank	% of the Total	Rank	% of Total
SDG#15 "Life on Land"	1	27.24	2	35.20
SDG#11 "Sustainable Cities and Communities"	2	25.24	1	36.31
SDG#13 "Climate Action"	3	19.23	3	11.17
SDG#4 "Quality Education"	4	10.68	4	10.06
SDG#1 "No Poverty"	5	4.20	8-12	0.56
SDG#3 "Good Health and Well-Being"	7	3.27	6	1.12
SDG#9 "Industry, Innovation, and Infrastructure"	6	3.36	13-17	0.00
SDG#17 "Partnerships for the Goals"	8	2.50	8-12	0.56
SDG#10 "Reduced Inequalities"	14	0.34	5	2.23
SDG#14 "Life Below Water"	9	1.09	7	1.12
SDG#6 "Clean Water and Sanitation"	11	0.70	8-12	0.56
SDG#12 "Responsible Consumption and Production"	10	1.04	13-17	0.00
SDG#7 "Affordable and Clean Energy"	12	0.42	8-12	0.56
SDG#5 "Gender Equality"	13	0.42	8-12	0.56
SDG#2 "Zero Hunger"	15	0.14	13-17	0.00
SDG#8 "Decent Work and Economic Growth"	16-17	0.06	13-17	0.00
SDG#16 "Peace, Justice, and Strong Institutions"	16-17	0.06	13-17	0.00

A second finding is that adoption of SDGs in 2015 by the United Nations is correlated with a large increase in the number of papers linking sustainable development, GIS, and specific SDGs. For example, in Scopus the average annual number of papers corresponded to "sustainable development", "GIS", and an exact phrase of SDG was 6.2 times higher in 2015-2019 than in 2000-2014. Researchers certainly used SDG labels such as "Climate Action" and Gender Equality" as keywords for papers prior to the establishment of the SDGs. However, the rapid increase in their use post-2015 shows that the SDGs have been highly influential and have motivated substantial amounts of study.

Finally, we found that GIS is mainly utilized in the area of sustainable development by researchers from China and the

United States which are far ahead of the following countries (Great Britain, India, Germany, Australia, Canada, France, and Italy). We suggested that (1) the extent of aerospace technologies development along with (2) researchers' population engaged in sustainable development issues could explain their leadership. For example, United States (#1), China (#2), Great Britain (#5), India (#6), and Germany (#8) are in the list of the 10 Countries Most Active in Space [16]. Moreover, United States, United Kingdom, and Germany retain their top positions as the leading geospatial-prepared countries according to the 2018 Countries Geospatial Readiness Index [17], where China is 6th, Canada is 7th, and France is 10th. This index includes 5 pillars for assessment, such as (1) data infrastructure; (2) policy framework; (3) institutional capacity; (4) user adoption; and (5) industry fabric [18].

IV. Discussion

Initially, we believed that differences in the number of papers discussing GIS in relation to different SDGs would be primarily caused by the nature of each topic. Some SDGs, such as SDG #15 related to land use, are more intrinsically spatial, benefitting from sophisticated geographical mapping and analysis. Other SDGs, for example "Gender Equality" and "Decent Work and Economic Growth," are probably often seen as policy issues without an explicit spatial orientation. However, the range of issues within every SDG is very wide. GIS can be applied to virtually all sustainability goals, even those that might seem less spatially oriented at first. It appeared in relation to some SDGs where we did not expect it, and vice versa. For example, researchers linked GIS in more than 10% of papers from both databases to SDG #4 "Quality Education." Conversely, the spatially oriented SDG "Life Below Water" accounts for only about 1% of papers, and "Clean Water and Sanitation" even fewer than that. Hence, we concluded that linkage between GIS tools and SDGs does not depend exclusively on the spatial nature of the subject.

TABLE IV
THE REVIEW OF TOP CITED PAPERS ON SDG#11 "SUSTAINABLE CITIES AND COMMUNITIES" AND SDG #15 "LIFE ON LAND"

Title of a Paper (number of citations / references)	Paper's Content	
	An Issue That Had Been Addressed by GIS	GIS Application
	SDG#11 "Sustainable Cities and Communities"	
Planning for Sustainable Urbanization in Fast Growing Cities: Mitigation and Adaptation Issues Addressed in Dhaka, Bangladesh [19], (87/85)	GIS allowed to form and analyze spatial data of two development scenarios – (1) constrained and (2) unconstrained - to tackle urban climate change within fast-growing cities by the concept of sustainable urbanization. Finally, the constrained scenario with some development limitations had been determined as best sustainable to address mitigation and adaptation issues.	Modeling
GIS-Based Framework for Supporting Land Use Planning in Urban Renewal: Case Study in Hong Kong [20], (45/45)	A GIS-based framework, including (1) land information, (2) planning and policy control, and (3) land-use suitability analysis model, had been used in urban renewal as an integrated quantitative approach to assessing land-use suitability and supporting land use planning. In the absence of other tools, GIS was found to be useful for both practitioners and researchers involved in sustainable land use planning.	Mapping Modeling
How to Reach the 'Hard-to-Reach': The Development of Participatory Geographic Information Systems (P-GIS) for Inclusive Urban Design in UK Cities [21], (30/18)	Local authorities had utilized GIS to visualize and analyze particular viewpoints of specific groups (by age, mobility, etc.) on urban design within three approaches: (1) on-street engagement, (2) structured queries and (3) participatory mapping. That methodology (participatory GIS) allowed to overcome the barriers in groups' engagement and to assess their specific concerns individually to address them in urban development plans.	Mapping Measurement
Land Resource Sustainability for Urban Development: Spatial Decision Support System Prototype [22], (27/47)	GIS had been utilized as the decision-support system to facilitate proactive and collective public policy determination of land resources for future sustainable urban development. Specifically, GIS helped to assess urban environment thematically by multiple indicators of sustainability as spatial criteria.	Measurement
Using GIS to Assess Potential Biofuel Crop Production on Urban Marginal Lands [23], (22/46)	Based on GIS, soil classification data had been combined with urban development data to identify the amount and location of urban marginal land in Pittsburgh, Pennsylvania, which can be used to cultivate biodiesel feedstock.	Mapping Measurement
Landslide Susceptibility Mapping Using the Weight of Evidence Method in the Tinau Watershed, Nepal [24], (60/73)	GIS allowed to make landslide susceptibility maps by integration of field observations' data of (1) geology, (2) land use, (3) topography, and (4) hydrology. The spatial analysis showed that about 30% of the observed area is highly susceptible to land sliding.	Mapping Measurement
Loss Estimation in Istanbul Based on Deterministic Earthquake Scenarios of the Marmara Sea Region (Turkey) [25], (53/29)	The GIS-base loss estimation model had allowed researchers to combine the data on (1) deterministic hazard scenarios and (2) time-dependent probabilistic hazard assessment. Based on spatial analysis, they found that 30% of the buildings in the metropolitan area may need either strengthening or demolition to achieve an adequate degree of life safety.	Modeling
Development of an Urban Green Space Indicator and the Public Health Rationale [26], (42/35)	GIS had been utilized as a tool to develop and test an urban green space indicator for public health. Particularly, the model integrated (1) population data, (2) distance to green spaces, and (3) size and some other parameters of green zones. Based on spatial analysis, researchers determined the maximum linear distance of 300 meters to the boundary of urban green spaces of the area no less than 1 hectare as the default option. Also, the model allowed them to track the urban green space indicator.	Modeling Monitoring
An Application of GIS and Coastal Geomorphology for Large Scale Assessment of Coastal Erosion and Management (Ghana) [27], (21/44)	GIS had been utilized to provide a large-scale assessment of coastal recession in Ghana by spatial analysis of the field data on coastal geomorphology. Based on research results, specific education programs and land-use planning techniques had been implemented. Eventually, Ghana has kept the coastline clear of major developments and avoided the temptation of engaging in costly cycle of development-risk-defense.	Measurement
Integrated Modeling for Exploring Sustainable Agriculture Futures [28], (18/20)	Based on GIS, authors developed and applied a decision-support tool to explore alternative futures for agricultural sustainability in the Lower Mainland of British Columbia. This tool enabled the researchers to (1) simulate different scenarios of future land-use changes and (2) to assess its social, economic, and environmental consequences.	Mapping Modeling

To illustrate how to apply remote sensing and GIS to some specific SDG, Kumar et al. [10] described a case-study of

Land Use Modelling for Micro-Level Planning (Blocks) as an example of SDG#15 "Life on Land". Specifically, GIS had provided the researches with the ability to support decision making with unbiased information for spatial analysis and management of natural resources. Also, they had integrated thematic maps, spatial and non-spatial databases to suggest alternative land-use models for agricultural land, wasteland, and forests of the Ferozpur Jhirka block of Mewat district in Haryana, India. In turn, we examined the five most frequently cited papers on SDG#11 "Sustainable Cities and Communities" and SDG#15 "Life on Land" according to Clarivate Analytics' Web of Science Core Collection by Kumar's major applications of GIS: (1) mapping, (2) monitoring, (3) measurement, and (4) modeling. As a result, (1) modeling along with (2) measurement and (3) mapping were the kinds of most frequently GIS applications in highly-cited papers (see Table IV).

To get more accurate findings, the same method could be utilized to analyze the larger number of papers in the field of each SDG. However, it will be a part of our further research on the topic. On the other hand, a suitable methodology should be developed to apply GIS into the area of SDGs from the bottom of Table III. We assumed that the critical point here is to determine the types of GIS major applications to SDG's specific area or indicators. In such a case, the combination of Kumar's major GIS applications [10] with Dangermond's steps to better leverage GIS in SDGs implementation [12] seems to be a reasonable universal approach (see Table V). In other words, this combination shows the ways of GIS applications that most likely could be useful for the analysis of any SDG based on a stage of its analysis. Besides, to determine possible GIS applications more precisely, the SDG's sub-targets could be considered separately, within specific analysis needs and sub-target's indicators.

TABLE V
JUXTAPOSITION OF 4 MAJOR GIS APPLICATIONS [10] WITH 5 STEPS TO BETTER LEVERAGE GIS IN SDG IMPLEMENTATION [12]

Four Major GIS Applications	Five Steps to Better Leverage GIS in SDGs Implementation				
	(1) Gather Information	(2) Visualize Information	(3) Conduct Analysis	(4) Create Plans	(5) Take Actions
(1) Monitoring	×				×
(2) Mapping	×	×			
(3) Measurement			×	×	
(4) Modeling				×	×

V. CONCLUSION

In general, GIS implementation to support sustainable development is still very limited, even the number of corresponded papers is increasing. Based on a quantitative literature review, we determined that different actors utilize GIS mainly to address the following SDGs: "Life on Land"; "Sustainable Cities and Communities"; "Climate Actions"; "Quality of Education". In opposite, GIS is still not addressed widely to the rest of SDGs, and the least frequently GIS had been utilized in the context of SDGs "Zero Hunger", "Decent Work and Economic Growth", and "Peace, Justice, and Strong Institutions".

Future research on the topic could be focused on specific issues in the field of sustainable development GIS could best contribute, as well as on application of GIS to track some specific indicators in the field of sustainable development, including the development of recommendation about how different actors can apply GIS more fully to SDGs planning and implementation. Another perspective area for research is to determine why some GIS portals is far more transparent to the public and more clearly linked to policy in some locations than in others.

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