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ЭКОНОМИЧЕСКАЯ, СОЦИАЛЬНАЯ, ПОЛИТИЧЕСКАЯ
 И РЕКРЕАЦИОННАЯ ГЕОГРАФИЯ

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**THE EXPERIENCE IN INFORMATION
 SUPPORT FOR SUSTAINABLE
 DEVELOPMENT OF TERRITORIES
 WITH REGIONAL SPECIFICS**

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Introduction.

The article describes and summarizes the experience of different countries in developing the information systems supporting the management of territories and their sustainable development. Some countries, such as the USA, Australia, Great Britain, and others, made great strides in developing such systems at the national level. The article also provides examples of spatial databases for the territories of Saudi Arabia, Hungary, coastal regions of Spain, etc. The basis for the territorial management support system is the spatial data infrastructure (SDI), which provides data storage, updating, access to data, as well as their visualization in the form of maps, graphs or tables. For a long time, geoportals were considered one of the most effective types of spatial data infrastructures, combining many functions necessary for displaying spatial information and effective management. However, now geoportals are being replaced by information and analytical systems of a new generation that goes beyond the SDI concept and are called geospatial ecosystems.

Materials and research
 methods.

The tasks of information support of territorial development projects from the perspective of sustainable development are set at all territorial levels, from global to local. At the global level, statistical data is collected by countries and regions of the world within the framework of the work of the largest international organizations: The United Nations, the World Bank, WHO, UNESCO, the International Labor Organization, the International Tourism Organization, etc. As a rule, this data is

	publicly available and published on the websites of organizations and in annual reports.
The results of the study and their discussion:	For a long time, geoportals were considered one of the most effective types of spatial data infrastructures, combining many functions necessary for effective territory management (Gamez et al., 2019). However, in recent years, geoportals have been replaced by new-generation information and analytical systems that go beyond the SDI concept and are called geospatial ecosystems. The metaphor "ecosystem" in this case conveys the fundamental concept of a dynamic, complexly organized, stable, adaptive multi-user geoinformation environment (Strobl, 2021; Shao et al., 2012). The transition from SDI to a geospatial ecosystem is driven by a continuous increase in the volume of generated spatial information, an increase in the number of platforms and services based on geodata, and the emergence of new challenges in data management, including in the field of data protection and cybersecurity.
Key words:	territory management, spatial data infrastructure, sustainable development, geospatial ecosystem

Introduction

The management of territories within the framework of the concept of sustainable development is a task that is always based on the monitoring and analysis of spatial data. The effectiveness of management decisions largely depends on the reliability, relevance, availability of tools for analysis and visual visualization of various data sets, the composition of which is determined primarily by the specific characteristics of the territory: its geographical location, social, demographic and economic characteristics, the presence of environmental risks and other features.

The tasks of information support of territorial development projects from the perspective of sustainable development are set at all territorial levels, from global to local. At the global level, statistical data is collected by countries and regions of the world within the framework of the work of the largest international organizations: The United Nations, the World Bank, WHO, UNESCO, the International Labor Organization, the International Tourism Organization, etc. As a rule, this data is publicly available and published on the websites of organizations and in annual reports.

Moreover, data observations under projects that combine the efforts of many countries to achieve the Sustainable Development Goals:

the GEOSS (Global Earth Observation System of Systems), Data4SDGs (Global Partnership for Sustainable Development Data) IAEG-SDG (Inter-Agency Expert Group on SDG indicators), IISD (International Institute for Sustainable Development), SDSN (Sustainable Development Solutions Network), HLPF (UN High-level Political Forum on Sustainable Development), and also European INSPIRE, Danube Region Strategy, EuroGeographics and other programs others.

Often, the provision of government structures responsible for making managerial decisions at various territorial levels becomes a national-scale task. To solve it, information and telecommunications systems are being created, which are spatial data infrastructures that provide data collection, storage, timely updating, analysis and visualization for comprehensive support of public administration both at the level of the whole country and individual regions or cities.

Main body

One of the first national-level spatial data infrastructures was the American NSDI (National Spatial Data Infrastructure) system, created in 2000 by order of US President Bill Clinton on April 13, 1994. The prospects for its development were determined in 1998 in the report of the National Academy of Public Administration (NAPA) "Geographical Information in the XXI century". For direct online access to data in NSDI, six gateways were created with access to the network of national information exchange centers, which unites hundreds of servers in the United States. At the beginning of 2006, the NSDI architecture was a combination of The Federal Committee for Geographical Data (FGDC), the coordinating body of the NSDI, the National Map and National Atlas programs, as well as the geoportal GOS (Geospatial One-Stop) [Koshkarev, 2014]. Since 2009, the service has been used to access NSDI geoinformation resources (www.data.gov), at the moment, it has combined about 230 thousand data sets.

Other examples of national spatial data infrastructures are The Australian AURIN Australian Urban Research Infrastructure Network [Sinnotte et al., 2011], the UK Open Data portal (data.gov.uk), the Russian EMIAS-a unified interdepartmental information and statistical System (fedstat.ru). In this case, the state acts as an aggregator of data from

Spatial Dataset Government Organisation	Geodetic	Road networks	Topography	Hydrology	Administrative boundaries	Utility information	Cadastral information	Geographical names	Transportation	Elevation and Bathymetry	Environment	Aerial or Satellite Imagery	Vegetation	Geology	Zip Codes	Population Census
Ministry of Municipal and Rural Affairs	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
High Commission for the Development of Ar Riyadh		*	*	*	*	*	*	*	*	*	*		*		*	*
General Commission for Survey	*	*	*	*	*	*		*	*	*	*	*	*			*
Saudi Electricity Company		*	*		*	*	*	*	*	*						
Saudi Commission for Tourism and Antiquities		*	*		*	*		*					*	*		
Central Department of Statistics and Information		*						*	*							*
Ministry of Agriculture		*						*				*				
King Abdulaziz City for Science and Technology		*	*		*			*	*	*		*	*			
Saudi Geological Survey	*	*	*	*	*			*				*	*	*		
Saudi Post								*	*						*	*

Fig. 1. Data sets for Saudi Arabia and the agencies using them

different sources in a single information space, the users of which are individual departments responsible for decision-making in different areas. Figure 1 shows an example of a single data management system for various government structures in Saudi Arabia using the same data sets, but in different combinations and for different purposes [Alshehri, 2011].

In some countries, several national-level projects combine spatial data, including sustainable development goals projects. An interesting example is Hungary, where there are several data management systems developed to support and achieve the Sustainable Development Goals. The main ones [Palya et al., 2018]:

National adaptation geo-information system NAGiS (<http://nater.mbfisz.gov.hu/>) – multi-purpose geographic information system to support national policies, development strategies of governance and decision-making related to the assessment of the impact of climate change and the development of the necessary adaptation measures in Hungary, taking into account national strategies on climate change Paris agreement in 2017, as well as programs for the environment and energy. NAGiS is positioned as a multifunctional arsenal for the implementation of the Sustainable Development Goals and the 2030 Agenda. The geo-information system consists of detailed, controlled and structured 15 data sets on demography, climate, forestry, soils, economy, drinking water supply, extreme weather conditions, etc. NAGiS is managed by the Hungarian Mining and Geological Service MBFSZ and its work is based on the cooperation of ten state and academic data provider organizations.

National Environmental Information System OKIR (<http://web.okir.hu>) - contains data on the state of the environment and the load on the environment from administrative bodies performing environmental and water protection functions, including measurement and monitoring data from regional inspections and data provided by the population following legislative regulation. The collected and processed data are entered into a central database under the jurisdiction of the Ministry of Agriculture. The main thematic data sets are “Waste management”, “Emissions of pollutants into the atmosphere”, “Surface water”, “Groundwater”, “European Register of Emissions and Transfer of Pollutants”, “Nature Protection”.

National Information System for Regional Development and State Planning TeIR (<https://www.teir.hu/>) – provides geospatial data and digital maps that serve as a basis for planning and implementing goals aimed at sustainable development of territories at the level of individual settlements and districts.

Examples of data visualization from Hungarian spatial data management systems are shown in Figure 2.

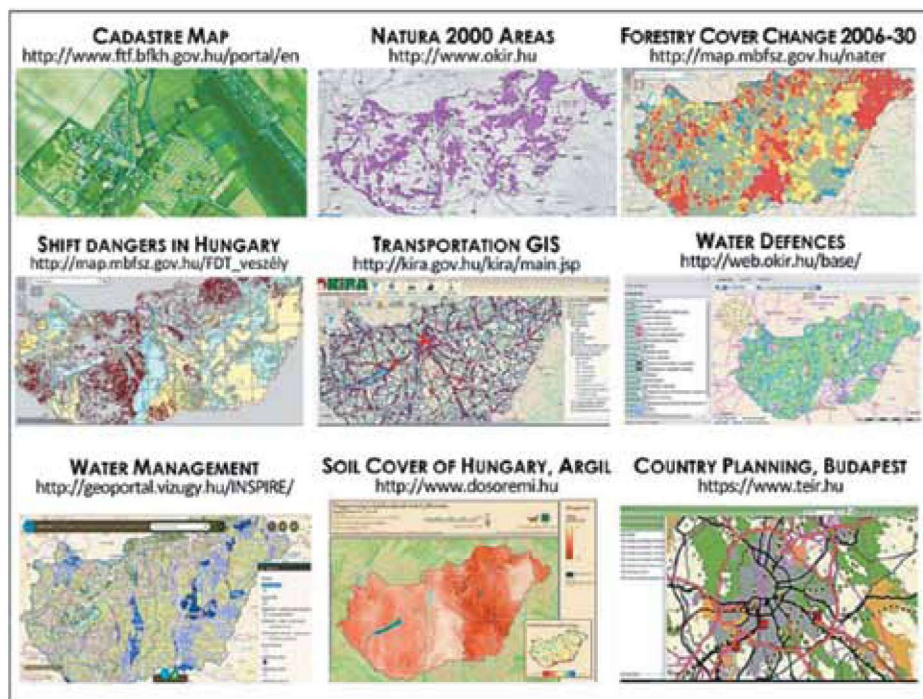


Fig. 2. Examples of cartographic visualization from Hungarian spatial data systems [Palya et al., 2018].

Currently, extensive research has been published on information support for sustainable management and development in different countries: Montenegro [Galli et al., 2018], Poland [Klimach et al., 2018], Malaysia [Samsudin et al., 2011], India [Acharya, Pandey, 2018], etc.

The sources of information used for the management of territories are very diverse. In addition to state statistics and official information from various departments and services, the provision of data by the public has been actively introduced in recent years. This type of data is called Volunteered geographic information (VGI) [Goodchild, 2007]. With the growing popularity of services based on the user's location, the collection of voluntarily provided information from the population is becoming more common and technologically feasible. However, a large number of data sources and formats entails the problem of redundancy and duplication of data, the need to combine them into a single system and ensure the convenience of working with data together.

Many spatial data systems are developed separately for rural areas [Burja, Burja, 2014; Borón et al., 2016, etc.] and urban areas [Tan et al., 2016; Mousiopoulos et al., 2010, etc.]. At the same time, in data sets for rural areas, more emphasis is usually placed on data on nature and climate [Zolfani et al., 2013; Manning et al., 2015], and for urban areas – on the features of urbanization of specific countries and regions. In recent years, the concept of a “smart city” and the use of ultra-large-scale data and BIM technologies have been actively implemented in urban development projects [El-Hallaq et al., 2019; Wang et al., 2019].

Projects for the development of territories that are tourist clusters, as a rule, include data sets not only on the characteristics of tourist flows, but also on their impact on the economy, the social sphere, and the load on the natural environment. For example, the data set for assessing the sustainability of the development of coastal territories in Spain (Figure 3) includes 32 indicators, including 8 social, 8 economic and 16 natural and environmental [Blancas et al., 2010].

Many indicators are directly related to the coastal position of the regions under consideration and contain information about beaches, their attendance, cleanliness, etc.

Even more complex spatial data management infrastructures are being developed for territories that are characterized not only by tourist attractiveness but also by high cultural and historical value and the presence of objects with a special protected status [Kolbovsky et al., 2012; Xiao et al. al., 2018; Ciski et al., 2019].

We also analyzed data systems for the sustainable development of territories characterized by the greatest degree of vulnerability. These are regions with pronounced environmental, economic or social problems, including, for example, problems of desertification and land degradation [Giuliani, 2020], the problem of poverty and hunger of the population [Mhangara, 2018, etc.] The territories of the Far North can also be attributed to this group, the problems of sustainable development of which have recently received a lot of attention [Dudin, Ivashchenko, 2015].

For a long time, geoportals were considered one of the most effective types of spatial data infrastructures, combining many functions necessary for effective territory management [Gamez et al., 2019]. However, in recent years, geoportals have been replaced by new-generation

Indicator	Definition	
IS,	Ratio of tourists to locals	
1S2	Ratio of peak season tourists to locals	
1S3	Sports facilities per inhabitant available to the community in coastal zone	
IS4	Health Centres per inhabitant available to the community in coastal zone	
IS5	Public transport vehicles for travellers and merchandise per inhabitant in coastal zone	
1S6	Ratio of peak season tourism employment to low season tourism employment	
IS,	Percentage of beach area without security devices in coastal zone	
1S8	Number of crimes and misdemeanours made at provincial level	
IE,	Total number of tourist arrivals in coastal zone	
1E2	Daily average expenditures of sun and beach tourists	
IE3	Ratio of peak month tourists to low month tourists	
1E4	Occupancy rate for official accommodations	
IE5	Ratio of average peak season occupancy rate to average low season occupancy rate for official accommodations	
1E6	Percentage of official tourism accommodation establishments which open all year	
1E7	Ratio of tourism employment to total employment in coastal zone	
IE8	Public investments in coastal issues (access, beaches, dunes, defence of coasts, boardwalk, etc.)	
IE <i>Ni</i>	Number of tourists per square metre of beaches in coastal zone	
IE <i>N2</i>	Number of peak season tourists per square metre of beaches in coastal zone	
1EN3	Waste volume produced by destinations in coastal zone	
IE <i>N4</i>	Volume of glass recycled in coastal zone	
IE <i>N5</i>	Percentage of energy consumption attributed to tourism in coastal zone	
1EN6	Percentage of renewable energy consumption attributed to tourism with respect to total energy consumption in coastal zone	
ien7	Consumption of urban supplying water attributed to tourism in coastal zone	
1ENS	Volume of water reused in coastal zone	
ien9	Volume of sewage from coastal zone receiving treatment	
IE <i>N10</i>	Percentage of coastal zone considered to be in eroded state	
IE,,	Percentage of beach area considered to be in high urbanization state in coastal zone	
1EN,2	Percentage of sampling points with good sanitary qualification in coastal zone	
IE <i>N13</i>	Percentage of beach area with Blue Flag Status in coastal zone	
IE <i>N14</i>	Percentage of beach area with cleaning services in coastal zone	
ien15	Percentage of beach area considered to be protected natural area	
IE <i>N16</i>	Percentage of beach area considered to be in high occupation state	

Fig. 3. The system of indicators for the management of coastal areas in Spain [Blancas et al., 2010].

	Dimension	Sign	Evaluation	Weights	
				Dimensional indicator	Global indicator
	Social	Negative	Ratio	0.45586565	0.29421696
	Social	Negative	Ratio	0.49687318	0.32666778
	Social	Positive	Ratio	0.45274317	0.36153059
	Social	Positive	Ratio	0.17682503	0.09788285
	Social	Positive	Ratio	0.36534153	0.0000000
	Social	Negative	Ratio	0.47187854	0.29118418
	Social	Negative	Ratio	0.46075286	0.34952417
	Social	Negative	Direct	0.27440457	0.17793289
	Economic	Positive	Direct	0.35772993	0.0000000
	Economic	Positive	Direct	0.35363137	0.1 1079893
	Economic	Negative	Ratio	0.38398697	0.33362752
	Economic	Positive	Direct	0.33143275	0.0000000
	Economic	Negative	Ratio	0.31438924	0.0000000
	Economic	Positive	Ratio	0.36077562	0.30732436
	Economic	Positive	Ratio	0.36277091	0.25679136
	Economic	Positive	Direct	0.22053323	0.0000000
	Environmental	Negative	Ratio	0.27423134	0.0000000
	Environmental	Negative	Ratio	0.28765545	0.0000000
	Environmental	Negative	Direct	0.35384008	0.35243375
	Environmental	Positive	Direct	0.3608693	0.35229804
	Environmental	Negative	Indirect	0.34070902	0.31265639
	Environmental	Positive	Indirect	0.35030569	0.3232296
	Environmental	Negative	Indirect	0.35564388	0.36325468
	Environmental	Positive	Indirect	0.34116796	0.35522928
	Environmental	Positive	Indirect	0.34869441	0.35437199
	Environmental	Negative	Ratio	0.28742937	0.17668611
	Environmental	Negative	Ratio	0.30114243	0.27347287
	Environmental	Positive	Ratio	0.14037287	0.0000000
	Environmental	Positive	Ratio	0.34862475	0.25777471
	Environmental	Positive	Ratio	0.23627416	0.31907938
	Environmental	Positive	Ratio	0.20579491	0.16881199
	Environmental	Negative	Ratio	0.31405974	0.0000000

information and analytical systems that go beyond the SDI concept and are called geospatial ecosystems. The metaphor “ecosystem” in this case conveys the fundamental concept of a dynamic, complexly organized, stable, adaptive multi-user geoinformation environment [Strobl, 2021; Shao et al., 2012]. The transition from SDI to a geospatial ecosystem is driven by a continuous increase in the volume of generated spatial information, an increase in the number of platforms and services based on geodata, and the emergence of new challenges in data management, including in the field of data protection and cybersecurity.

Conclusions

Thus, summarizing the experience of different countries in ensuring sustainable development of territories with digital information, we can note the following:

1. Currently, different countries have accumulated a wide experience in the development of information systems for sustainable management of territories. The spatial data infrastructures that underlie these systems can be organized in different ways depending on the tasks, functionality and characteristics in a particular area.
2. State participation is one of the most important aspect of the functioning of territorial management systems. Public authorities can support the collection and aggregation of data in a single information space, protect data and coordinate access to data, and act as data users.
3. The composition of datasets uploaded to the information system depends on various features of the territory and may include, in addition to information from official sources, data provided by the population (Volunteered geographic information). Initial statistical data can be supplemented with aggregated indicators, for example, any estimated indices and indicators.
4. One of the most effective is the spatial data infrastructure, organized in the form of a geoportal. However, the increasing complexity of SDI functions and the constant increase in data has led to the emergence of a new

paradigm in geoinformatics: the concept of “geospatial ecosystem”, which is a complex adaptive multi-user data model.

5. The main directions of development of systems designed to support the management of territories may be the processes associated with the transition from ISD to geospatial ecosystems, including increasing the versatility and expanding the range of tasks to be solved, the transition to multiscale, improving the ability to update data, complicating the functions of data analysis, visualization information and its protection.

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