Landscape as a Geosystem

László Miklós · Erika Kočická
Zita Izakovičová · Dušan Kočický
Anna Špinerová · Andrea Diviaková
Viktória Miklósová

Landscape as a Geosystem

Springer

László Miklós
UNESCO-Chair for Sustainable Development
Technical University in Zvolen
Zvolen, Slovakia

Anna Špinerová
UNESCO-Chair for Sustainable Development
Technical University in Zvolen
Zvolen, Slovakia

Erika Kočická
UNESCO-Chair for Sustainable Development
Technical University in Zvolen
Zvolen, Slovakia

Andrea Diviaková
UNESCO-Chair for Sustainable Development
Technical University in Zvolen
Zvolen, Slovakia

Zita Izakovičová
Institute of Landscape Ecology SAS
Bratislava, Slovakia

Viktória Miklósová
Institute of Landscape Ecology SAS
Bratislava, Slovakia

Dušan Kočický
ESPRIT Ltd.
Banská Štiavnica, Slovakia

ISBN 978-3-319-94023-6 ISBN 978-3-319-94024-3 (eBook)
https://doi.org/10.1007/978-3-319-94024-3

Library of Congress Control Number: 2018946602

Printed on acid-free paper

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Acknowledgement

The publication is the result of the research supported by the grant agency KEGA Project No. 013TU Z-4/2016 and by grant agency VEGA Project No. 1/0096/1614-0735 and VEGA Project No. 2/0066/15.

Contents

1 The Material Base of Sustainable Development—The Landscape 1
1.1 Key Aspects of the Relation Geosystem versus Ecologization of Landscape Management 2
1.2 Landscape and Its Integrated Management in Planning Processes 5
References 7

2 Landscape as a Geosystem 11
2.1 The Approaches to the Definition of the Landscape 12
2.2 The System Theory and the Landscape as a Geosystem 16
2.3 Models of Geosystems—Geosystems and Geocomplexes 18
2.3.1 Topical Model of a Geosystem 19
2.3.2 Choric Model of a Geosystem 22
2.4 Elements and Relationships in Geosystems 24
2.5 Structure of Landscape as a Geosystem 26
2.5.1 Primary Landscape Structure 26
2.5.2 Secondary Landscape Structure 28
2.5.3 Tertiary Landscape Structure 29
2.6 Interrelationships of the Individual Landscape Structures 30
2.7 Definition of the Landscape and Its Reflection in the Law 32
References 34

3 Construction and Mapping of Geocomplexes 43
3.1 Framework Approach for Assignation and Delimitation of Geocomplexes 44
3.1.1 Landscape-Ecological Analyses 45
3.1.2 Landscape-Ecological Syntheses 51

3.2 Types of Geocomplexes 63
3.2.1 Abiotic Complex 64
3.2.2 Physical-Geographical Complex 64
3.2.3 Complex of the Current Landscape Structure: Land Cover and Real Vegetation/Habitats 65
3.2.4 Landscape-Ecological Complex 65
3.2.5 Socio-economic Complex 66
3.2.6 Integrated Geocomplex 66
3.3 Integrated Spatial Information System—An Imperative Necessity for Researchers 67
3.3.1 Methodological-Practical Problems—The Use of GIS in Solving Analytical and Complex Problems 69
3.3.2 Geometrically Unified Projection System and Unified Topography—Unified System of the Surface and Objects 70
3.3.3 The Elements of Georeferencing 72
3.3.4 Content of the System—Indicators 74
3.3.5 Monitoring and Its Information System 74
3.4 Creation of the Database of Geocomplexes in Slovak Republic 75
References 81

4 Characteristics of the Indicators of Geocomplexes 85
4.1 Indicators of Properties of the Primary Landscape Structure 86
4.1.1 Sub-complex Re: Georelief 87
4.1.2 Sub-complex Ge: Geological Base (Bedrocks)—Soil-Forming Substrate Complex 91
4.1.3 Sub-complex Wa: Ground Water 92
4.1.4 Sub-complex So: Soil 98
4.1.5 Sub-complex Cl: Relief—Climate 102
4.1.6 Sub-complex PNV: Potential Natural Vegetation 106
4.2 Indicators of Properties of Current Landscape Structure 106
4.2.1 Sub-complex CLS—Current Landscape Structure: Elements of Current Landscape Structure as Land Cover 108
4.2.2 Sub-complex BAC—Biotic-Anthropic Complex: Elements of Current Landscape Structure as Real Vegetation and Habitats 109
4.3 Indicators of Properties of Tertiary Landscape Structure 111
4.3.1 Sub-complex NAC: Socio-economic Factors for Nature and Landscape Conservation 114
4.3.2 Sub-complex NAR: Socio-Economic Factors of Protection of Natural Resources 116

4.3.3 Sub-complex URB, CAT, IND, AGR: Socio-Economic Factors of Urbanisation, Industry, Agriculture Production, Transport and Communal Activities 118
4.3.4 Sub-complex DET: Socio-Economic Factors Bound to the Deterioration of the Environment 119
4.3.5 Sub-complex GDP: Geodynamic Phenomena with the Character of Stress Factors 121
4.3.6 Sub-complex ADM: Socio-Economic Factors of the Character of Administrative and Sectoral Boundaries 124
References 125

5 Application of the Spatial Information System of Geocomplexes in Model Territory 127
5.1 Characteristic of Geocomplexes in the Model Territory of the Ipel' Basin 128
5.1.1 Building and Hierarchical Arrangement of Databases of Geocomplexes 129
5.1.2 Content of Information Layers of the Database 132
5.2 Spatial Projection of Database onto Maps 145
References 157

Conclusion 159

Cited Regulations and Conventions 161

Abbreviations

ABC	Abiotic complex (abiocomplex)
B.p.v.	Baltic vertical reference system
BAC	Biotic–anthropic complex
BM	Basic map
BSEU	Bonited Soil-Ecological Unit
CLS	Current landscape structure
CSD	Commission for Sustainable Development
CSFR	Czechoslovak Federal Republic
DTM	Digital Terrain Model
EC	European Commission
EIA	Environmental Impact Assessment
ELC	European Landscape Convention
EU	European Union
FAR	Folk Architecture Reservation
FH	Forest habitats
FMP	Forest Management Plan (recently FCP—Forest Care Programme)
FMU	Forest Management Unit
GEOIS	Geological information system
GIB-GES	Complex geological information base for the needs of protecting nature and landscape management
GIS	Geographic Information Systems
HGT	Hydrogeological type
HNC	Hydrological number of catchment
HPZ/SZ	Hygienic Protection Zone/Safety (buffer) Zone
IFM	Integrated flood management
IGEC	Integrated geocomplex
ILM	Integrate landscape management
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
ISTB	Information system of taxons a habitats

KEGA	Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of Slovak Republic
KPP	Complex Agricultural Soil Survey of Slovakia
LANDEP	LANDscape Ecological Planning
LEB ILM	Landscape ecological basis of integrated landscape management
LEC	Landscape ecological complex
LGIS	Forest geographical information system
LTSES	Local Territorial System of Ecological Stability
m a.s.l.	Metres above sea level
MAB	UNESCO's Man and the Biosphere Programme
MCR	Memorial City Reservation
MoE SR	Ministry of the Environment of the Slovak Republic
MPRV SR	Ministry of Agriculture and Rural Development of the Slovak Republic
MS	Microsoft
NATURA 2000	Network of Sites of Community Importance and Protected Bird Areas
NFC	National Forest Centre
NFH	Non-forest habitats
NISI	National Infrastructure of Spatial Information
NM	Nature Monument
NNM	National Nature Monument
NNR	National Nature Reservation
NP	National Park
NR	Nature Reservation
OECD	Organisation for Economic Co-operation and Development
PA	Protected Area
PBA	Protected Bird Area
PESD	Programme of Economic and Social Development
PGC	Physical–geographical complex
PLA	Protected Landscape Area
PLS	Primary landscape structure
PNV	Potential natural vegetation
POVAPSYS	Flood warning and prediction system
PT	Protected Tree
PWMA	Protected Water Management Area
PZ	Protection Zone
REPGES	REpresentative Potential GEoecoSystems (Research Institute for Soil Fertility)
SAS	Slovak Academy of Sciences
SCI	Site of Community Importance
SEA	Strategic Environmental Assessment
SEC	Socio-economic complex
SEF	Socio-economic factor (phenomenon)
SGIDŠ	State Geological Institute of Dionýz Štúr

S-JTSK	Coordinate system—Uniform trigonometric cadastral network
SkEA	Slovak Environmental Agency
SLS	Secondary landscape structure
SNC SR	State Nature Conservation of the Slovak Republic
SR	Slovak Republic
SSCRI	Soil Science and Conservation Research Institute (previously RISF—Research Institute for Soil Fertility)
STN	Slovak Technical Norm (standard)
TLS	Tertiary landscape structure
TSES	Territorial System of Ecological Stability
UNESCO	United Nations Educational, Scientific and Cultural Organization
USDF	Unit of Spatial Division of Forest
WRI	Water Research Institute
ZB GIS	Fundamental Database (of topographic objects) for Geographic Information

List of Figures

Fig. 2.1 Landscape as the material section from the geographical sphere and its models 18
Fig. 2.2 Topic model of a geosystem 20
Fig. 2.3 Model of ecosystem from the geosystem perspective 21
Fig. 2.4 Socio-economic factors in the landscape. SEF bounded to: I, D—industry and technical objects, U, R—urbanisation and recreation, V—protection of water resources, P—protection of high quality soils, L—forest resources protection, OP—nature conservation, ZSJ—administrative borders 22
Fig. 2.5 Choric model of a geosystem 23
Fig. 2.6 Structure of the landscape as a geosystem 27
Fig. 2.7 Definition of landscape as a geosystem 33
Fig. 3.1 **a**,**b** Schema of synthesis by superposition of analytical documentation 61
Fig. 3.2 Most frequent applications of the elements of georeferencing 73
Fig. 3.3 Comparison of the course of boundary of geological substrate on geological map at 1:50,000 and boundaries of soil types on soil map at 1:50,000 and their comparison to the relief. Boundaries of depicted units of both elements should be the same and should be bound to morphographic type of alluvial plain (dotted line), which usually does not exceed 3° slope. Superimposing these layers without modification results in absurd combinations of parameters 79
Fig. 3.4 A visualized illustration of a map of partial abiocomplexes of Slovakia (cut). The map is processed on original scale 1:10.000 in GIS. Each polygon displays homogenous area defined by values of four abiotic indicators (morphographic type, slope angle, geologic-substratum complex, soil texture). The violet line is the border of watershed 80

Fig. 5.1 Schema of groups of indicators of properties of elements of geocomplexes for GIS of the Ipel' basin 129
Fig. 5.2 Basic map—unified cartographic basis for all other thematic layers 146
Fig. 5.3 Slope inclination. Thematic layer "SLOPE—slope inclination". Values according to Tables 4.2, 5.2 and 5.6. 147
Fig. 5.4 Income of solar energy. Thematic layer "RADIATION—sun power". Values according to Tables 4.12, 5.2 and 5.6 148
Fig. 5.5 Soil texture (grain size). Presented within the thematic layer "KEK_Sk—Landscape ecological complex" attribute "Podny_druh—soil texture (grain size)". Values according to Table 5.4 149
Fig. 5.6 Potential natural vegetation. Thematic layer "POTVEGET_Sk—potential vegetation". Values according to Table 5.3 (according to Maglocký 2002). 150
Fig. 5.7 Current landscape structure/land cover. Thematic layer "RL001_Sk—land cover". Values according to Tables 5.3 and 5.7. On map reduced information. 151
Fig. 5.8 Morphographic- positional types of the relief. Presented within the thematic layer "KEK_Sk—Landscape ecological complex" as attribute "Morfo_pol—morphographic-position type of relief of LEC". Values according to Table 5.4 152
Fig. 5.9 Synthetic map of landscape-ecological complexes. Thematic layer "KEK_Sk—Landscape ecological complex" Each polygon is defined by values of all indicators listed in Tables 5.1 and 5.2 153
Fig. 5.10 Retention capacity of the landscape. Thematic layer "R—retention ability of territory". Values according to Table 5.4 154
Fig. 5.11 Air pollution. Thematic layer "ZNECISTO_Sk—air pollution". Values according to Table 5.5. 155
Fig. 5.12 Soil contamination. Thematic layer "KONTAMP_Sk—contamination of soil". Values according to Table 5.5 156

List of Tables

Table 3.1a Frequently used state variables and typological characteristics of the primary landscape structure: complex substrate–groundwater–soil and complex relief–dynamics of the surface–dissection–position 47
Table 3.1b Frequently used state variables and typological characteristics of the primary landscape structure: complex relief—surface waters, complex relief—climate, abiocomplex—potential vegetation 49
Table 3.2 Frequently used state variables and typological characteristics of the secondary landscape structure 50
Table 3.3 Groups and typological characteristics of the tertiary landscape structure 52
Table 3.4a Relationship of elements of the secondary landscape structure: SEF related to the landscape as a whole and greenery 53
Table 3.4b Relationship of elements of the secondary landscape structure to the tertiary landscape structure: SEF related to forests—waters—soils 55
Table 3.4c Relationship of elements of the secondary landscape structure to the tertiary landscape structure: SEF related to recreation—municipalities—transport 57
Table 3.4d Relationship of elements of the secondary landscape structure to the tertiary landscape structure: SEF related to industry—agricultural objects—exposed substrate 59
Table 3.4e Relationship of elements of the secondary landscape structure to the tertiary landscape structure: SEF related to the deterioration 60
Table 4.1 Domain values of attribute of morphological-morphographic-position type 88
Table 4.2 Domain values of attribute of slope angle 89

Table 4.3 Domain values of attribute of orientation of the relief to the cardinal points (aspect). 89
Table 4.4 Domain values of the attribute of profile curvature in the direction of gradient curves 89
Table 4.5 Domain value of attribute of horizontal curvature in the direction of contour lines 90
Table 4.6 Characteristics of domain of geological base (bedrock) – soil-forming substrate complex 93
Table 4.7 Thickness of quaternary sediments. 95
Table 4.8 Category of depth of level of ground water under the surface 97
Table 4.9 Categories of soil types and subtypes. 99
Table 4.10 Categories of soil texture (grain size). 101
Table 4.11 Categories of soil depth 101
Table 4.12 Categories of soil skeletality 102
Table 4.13 Categories of the amount of the sun radiation on georelief 103
Table 4.14 Climate geographical types and subtypes 103
Table 4.15 Characteristics of domain values of climate geographical types 104
Table 4.16 Categories of communities of potential natural vegetation 107
Table 4.17 Categories of most frequently used land cover elements 108
Table 4.18 Categories of forest habitats (types of real forest vegetation) 110
Table 4.19 Categories of non-forest habitats (types of real non-forest vegetation) 112
Table 4.20 Selected socio-economic factors of nature conservation declared in acts and other planning and development documents 115
Table 4.21 Selected socio-economic factors of protection of natural resources declared in acts and other planning and development documents 116
Table 4.22 Selected socio-economic factors of urbanisation, industrial, transport, technical and communal activities declared in laws and other planning and development documents 118
Table 4.23 Selected socio-economic factors bound to the deterioration of the environment declared in acts and other planning and development documentation 120
Table 4.24 Types of slope deformations 123
Table 4.25 Degrees of susceptibility to landslides and to re-location of loess sediments 124
Table 4.26 Selected socio-economic factors of the character of administrative and sectoral boundaries declared in acts and other planning and development documents. 124

Table 5.1 Overview of information layers at the "component" level 132
Table 5.2 Overview of information layers at the levels "Component" and "Thematic layer" Primary landscape structure 133
Table 5.3 Overview of information layers at the levels "Component" and "Thematic layer" Secondary landscape structure 134
Table 5.4 Content of thematic layer **K**EK_Sk—Landscape-ecological complex 134
Table 5.5 Overview of information layers on the levels "Component" and "Thematic layers" for Tertiary landscape structure 135
Table 5.6 Information layers on all levels—selected secion (exúlanation of the content in Tables 5.1–5.5) 137
Table 5.7 List of topographical layers (Geodatabáza db2.gdb) relating to thematic layer RL001_Sk—Areas of land cover 141
Table 5.8 List of indicators related to thematic layer TU001_Sk—Cadastral area of municipality 145

Introduction

Landscape is a common word, everybody knows what it is, there is no need to explain it. Is this statement true? Of course, we have no right to prevent anybody from having their own opinion about how to perceive the surrounding material reality in whatever way. On the other hand, we know that the landscape is a very complex entity influencing all our activities, and, in order to understand its functioning and its reactions to our activities, we need an amount of knowledge. Subsequently, when we have gained the knowledge, we wish to implement our scientific knowledge about nature and landscape into social practice.

The landscape is a very diverse entity, but at the same time it is a whole in its diversity, in which its individual components cannot exist without others. This view of diversity and holism at the same time might be addressed by a holistic approach. However, the holistic approach is insufficiently specific, and it permits very free interpretations of the landscape, most often as an image, as an ensemble of its visible elements, especially the elements of the land use, which forms only an aesthetic framework for human activities. What about the invisible elements of the landscape? Are the geological base, soils, georelief, ecosystems, climatic indicators and their interrelationships important for planning? Of course they are! In fact, they determine human activities more specifically. If we really want to define them globally, in complexes, in interrelationships, we need a systematic approach, which could be considered a specific concretization of the holistic approach. Such an approach resulted in the understanding of the landscape as a geosystem presented in this book.

It is to be emphasised that this approach has been motivated as mentioned in first sentences—in an effort to promote scientific knowledge of the landscape into practice. An essential aspect of this advance is the understanding of the landscape as a geosystem.

The landscape is the spatial setting and the material base for all the activities of humans. These activities meet in the same spatial–material entity, and therefore it is essential to regulate them. Regulation might have different bases but we consider that the principles of sustainable development undoubtedly prescribe the harmonisation of those activities with the given spatial–material entity as with the object

where all the activities take place. This approach needs first of all a systematic *definition and description of this object*, as well as development of scientific methods transferring scientific knowledge to decision-making processes on the utilisation of this material basis for human development, through to multiple and multipurpose integrated landscape management.

The book defines this spatial setting and this material basis for human development as *landscape as a geosystem*. This book analyses the landscape as a geosystem in all its complexity (from the abiotic environment, through land use to its socio-economic character) as an integrated natural resource, as society's life space, as well as an object of planning and decision-making on sustainable land use. The landscape properties are presented in a form of databases usable for a variety of purposes relating to the Directive INSPIRE 2007/2/EC (INSPIRE—Infrastructure for Spatial InfoRmation in Europe) requirements to enable these databases to serve as a national spatial information database for the needs of applied landscape ecological researches and real spatial planning processes. The properties of the geosystem included in spatial information systems should then serve as the regulatives for the optimum spatial organisation of the activities in this setting as well as for the optimum mode of the utilisation of all points of this space.

In general, this book describes the landscape as a geosystem from a **purpose-oriented point of view**. The whole theory and methodology regarding the goals given by planning practice—to apply the scientifically defined material object to the legally supported planning processes.

Accordingly, the main themes of the book are as follows:

- a brief overview of the role of the landscape as a geosystem in planning, projecting and integrated landscape management;
- theoretical approaches to the landscape, describing different definitions from the physical–geographical definitions through geosystem theory up to the approach to the landscape as a picture;
- a definition of the landscape as a geosystem, its models, structures, elements and relations. This is the substantial part of the book;
- construction, assignation, delimitation and mapping of the geosystems, including the creation of the spatial information system;
- detailed characteristics of the partial geocomplexes, their elements and properties;
- application of the geosystems in a model territory—using the example of the Ipeľ basin (Slovak Republic).

Except for the theoretical–methodical approach to the geosystem, the other main objective of the book is to present a real applicable procedure for the creation a complex spatial database of the model territory as an objective, manifold usable, scientifically sound foundation for regional studies, programmes, planning, projecting and management of the sustainable organisation and utilisation of the landscape. The book presents an overview of map legends with complete domain values of selected attributes of all three landscape structures (primary, secondary and tertiary) routinely used in Slovakia. At the end, the publication presents an

example of the construction and mapping of geocomplexes as well as the creation of the database on the model territory at the regional level. So, the book in its each part devotes a little bit broader attention to the players in landscape research in Central and Eastern Europe than it is usual in mainstream works in recent decades.