ISSN 2029-6991 / eISSN 2029-7009

VILNIUS TECH
Vilnius Gediminas Technical University

GEODESY and CARTOGRAPHY

2026
Volume 52
Issue 3
Pages 148–155
https://doi.org/10.3846/gac.2026.23914

UDC 528.9:528.94

DEVELOPMENTS IN CARTOGRAPHY AND GIS IN ALBANIA – THE CONTRIBUTION OF PROF. DR. PAL NIKOLLI

Bashkim IDRIZI[1], Ismail KABASHI[1,2]✉

[1]*Department of Geomatics, Geoinformation, and Earth & Space Observation, University of Prishtina, Prishtina, Kosova*
[2]*ANGST Vermessung, Vienna, Austria*

Article History:
- received 11 May 2025
- accepted 1 April 2026

Abstract. Prof. Dr. Pal Nikolli is a scholar whose academic and research work has contributed to the development of cartography and Geographic Information Systems (GIS) in Albania, with a long and rich career in teaching and scientific research, which has significantly contributed to the development of these disciplines. He has combined theoretical knowledge with practical applications, helping to advance Albanian cartography and promote modern technologies in this field. His contributions include theoretical and practical developments in cartography in general and thematic cartography in particular, in the use of statistics, satellite imagery and aerial photography in the study of the dynamics of the Albanian Adriatic coast, as well as in the application of GIS in spatial planning and environmental studies. These contributions have helped to create a reliable database for various geographical and environmental studies, influencing the development of the Spatial Data Infrastructure (SDI) in Albania. In addition to his research contributions, Prof. Nikolli has played a key role in academic and teaching development, creating curricula and textbooks, as well as mentoring new generations of researchers and professionals. This has helped to form a strong scientific community in the field of cartography and related sciences in Albania.

Keywords: Pal Nikolli, Albanian cartography, GIS, remote sensing, geoinformation, geoinformatics, Albania.

✉Corresponding author. E-mail: ***ismail.kabashi@uni-pr.edu***

1. Introduction

The development of cartography and geographic information sciences has undergone profound transformation during the last decades due to the integration of digital technologies, satellite remote sensing, and Geographic Information Systems (GIS). These technologies have significantly expanded the capacity for spatial analysis, territorial management, and environmental monitoring, becoming essential tools in modern geographical research and spatial planning.

Globally, the evolution of cartography has moved from traditional map production toward digital cartography, spatial databases, and integrated geospatial infrastructures. GIS, remote Sensing, and Geospatial Data Infrastructures (SDI) have become fundamental components of contemporary spatial information systems used in government institutions, research organizations, and private sector applications.

In many countries, the development of geospatial sciences has been strongly influenced by pioneering researchers who introduced modern technologies and methodologies into academic education and scientific research. In Albania, one of the most influential scholars in this field is Prof. Dr. Pal Nikolli, whose academic and scientific work has significantly contributed to the development of cartography, GIS, remote sensing, and geospatial data infrastructure (Figure 1).

Prof. Nikolli has played an important role in introducing GIS education, developing thematic cartography, applying remote sensing in geographical studies, and promoting the use of geospatial technologies in spatial planning and environmental analysis in Albania. His work has also contributed to the formation of new generations of specialists and researchers in the field of geospatial sciences.

The objective of this study is to analyze and evaluate the scientific and academic contributions of Prof. Dr. Pal Nikolli to the development of cartography, GIS, remote sensing, and geospatial data infrastructure in Albania. The paper examines his work in several key areas, including the development of Albanian cartography, the introduction of GIS in academic education, the application of remote sensing in geographical research, and the promotion of geospatial technologies in territorial planning and environmental studies.

Copyright © 2026 The Author(s). Published by Vilnius Gediminas Technical University

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (*http://creativecommons.org/licenses/by/4.0/*), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

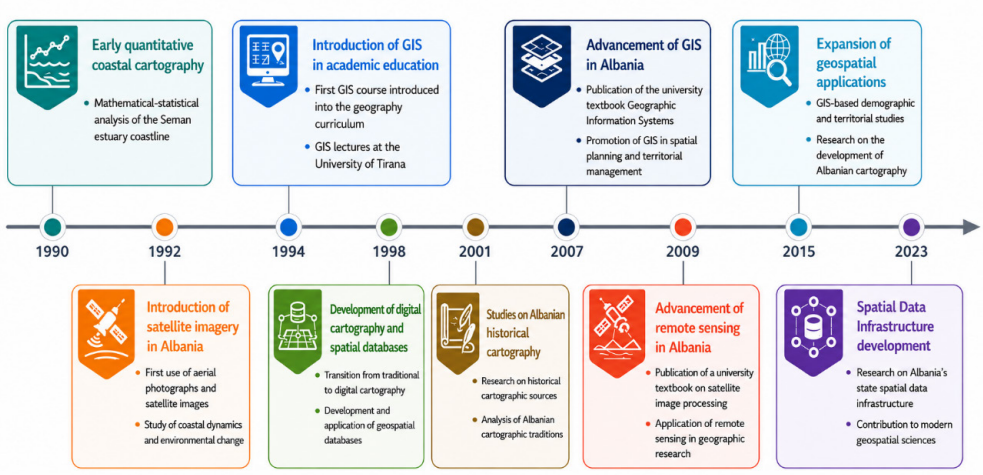


Figure 1. Timeline of cartography, Geographic Information Systems (GIS), and remote sensing development in Albania from 1990 to 2023, highlighting key milestones associated with the scientific contributions of Prof. Dr. Pal Nikolli

Through this analysis, the study aims to highlight the role of individual scientific contributions in shaping the development of geospatial sciences at the national level and to provide a structured overview of the evolution of cartography and GIS in Albania.

2. Materials and methods

This study applies a qualitative analytical approach based on a systematic review of scientific publications, academic materials, and documented professional activities related to the work of Prof. Dr. Pal Nikolli.

The primary sources used in the analysis include scientific articles, conference proceedings, university textbooks, monographs, and institutional publications authored or co-authored by Prof. Nikolli. These sources were examined in order to identify the main thematic areas of his scientific contributions and to evaluate their role in the development of cartography and geospatial sciences in Albania.

The collected materials were categorized into several thematic groups, including:

(1) cartography and thematic cartography,

(2) Geographic Information Systems (GIS),

(3) remote sensing and satellite image analysis,

(4) geospatial data infrastructure and spatial planning applications, and

(5) academic and educational contributions.

In addition to the literature review, the analysis considers the institutional and educational context in which these contributions were developed, particularly the introduction of new technologies and scientific disciplines in university curricula and research programs.

The results of this analysis are presented through a structured overview of the major scientific contributions of Prof. Nikolli and their impact on the development of cartography, GIS, and geospatial sciences in Albania.

2.1. Academic and teaching contribution

Prof. Dr. Pal Nikolli has made significant academic and teaching contributions in the fields of cartography, GIS, and Remote Sensing. He has played and continues to play a key role in the development of curricula and study programs in these fields in the Department of Geography of the University of Tirana and in other institutions. His contributions in this regard relate to the creation of new courses such as "Geographic Information Systems", "Thematic Cartography" and "Remote Sensing and Satellite Images" and the modernization of study programs by including the latest technologies and methods in cartography and GIS (Nikolli et al., 2023b). Prof. Nikolli's work as a lecturer, researcher and mentor has profoundly influenced the formation of new generations of researchers and professionals.

Prof. Nikolli has published a considerable number of university textbooks and teaching materials such as "Introduction to Cartography" (Nikolli, 2019; Nikolli & Shehu, 2000) (a basic text for geography and cartography students, Figure 2a), "Geographic Information Systems" (Nikolli, 2007, 2011) (a complete guide to the use of GIS in geographic analysis, Figure 5), "Acquisition and processing of satellite images for geographic analysis" (Nikolli, 2009) (a specialized text on remote sensing and satellite images, Figure 2b), "Thematic Cartography" (Shehu & Nikolli, 2007) (a comprehensive textbook on the principles, methods, and techniques of thematic mapping and the cartographic representation of geographic phenomena, Figure 2c), "Cartography: Exercises and Practice" (Nikolli, 2012) (a practical textbook providing exercises and applied methods for developing cartographic skills and reinforcing the theoretical principles of cartography) etc., which have become major reference sources for students and researchers and has published a large number of scientific articles (over 100) in scientific journals within the country and abroad.



a) b) c)

Figure 2. University books of Prof. Dr. Ing. Pal Nikolli: a) Basics of Cartography (left); b) Remote Sensing (center); c) Thematic mapping (right)

To share his knowledge and experience, Prof. Nikolli has organized and participated in many trainings and workshops in GIS and Remote Sensing (students and professionals have learned how to use GIS and remote sensing in geographic analysis) and in cartography (participants have learned modern cartography techniques in creating thematic maps, etc.) (Nikolli et al., 2023a).

Prof. Nikolli has also served as a mentor for many students and young researchers for students and young researchers, assisting them in developing their projects and studies, in carrying out their diploma and doctoral projects, in publishing their papers in scientific journals and international conferences, etc.

He has contributed to the development of scientific research in various fields of cartography and GIS such as the study of coastal dynamics (the use of statistical and GIS methods to study changes in the Adriatic coast) (Nikolli, 1990; Gruda & Nikolli, 2000; Nikolli, et al. 2014), the analysis of migration and demography (Nikolli et al., 2013, 2015) and the development of the Geospatial Data Infrastructure (GDI) in Albania (Nikolli, 2009; Nikolli et al., 2013; 2023a).

Prof. Nikolli has been and is an active participant in scientific conferences and publications, sharing his knowledge and experience with the scientific community. He has presented his papers (over 100) at many conferences organized in Albania and other countries, including the conferences of the International Cartographic Association and the European Geosciences Union and has many publications in Scientific Journals of national and international such as "Geographical Studies", "Albanological Studies", "Geoinformatics & Geomatics", etc.).

As a member of the scientific committees that evaluate and approve scientific projects and studies, Prof. Nikolli has played an active role in contributing to the development of policies and standards in the field of geography and cartography. Prof. Nikolli is a member of national and international geodetic and cartographic organizations.

Prof. Dr. Pal Nikolli has brought about a change in the development of cartography and GIS in Albania, combining theory with practical applications. His academic work has contributed to the education of new generations of researchers and professionals in cartography and geospatial sciences and to their integration into the international scientific community.

3. Results

3.1. Scientific contribution and research areas

Prof. Dr. Pal Nikolli has a broad and specialized academic profile, with several fundamental research areas that have been the focus of his career. These areas include a combination of cartography, GIS (Geographic Information Systems), Remote Sensing, geodesy and studies related to geospatial data management (Figure 3).

3.2. Contribution to cartography

Prof. Dr. Pal Nikolli has made a special contribution to cartography, making him one of the most recognized figures in this field in Albania. His work in cartography has not been limited to the academic aspect, but has also included the development of modern practices, the creation of new resources, and the promotion of cartography as an essential tool for geographical studies and spatial planning.

Prof. Nikolli has studied and documented the historical development of cartography in Albania. His work in this field includes the study of ancient maps (he, through a series of articles and scientific references, has analyzed ancient maps depicting the Albanian territory, identifying changes in the presentation of borders, cities and geographical features), the monograph "History of Albanian Cartography" (Nikolli & Shehu, 2001) which is a rich source of information on the development of cartography in Albania, including different historical periods and the influence of political and economic factors, and the

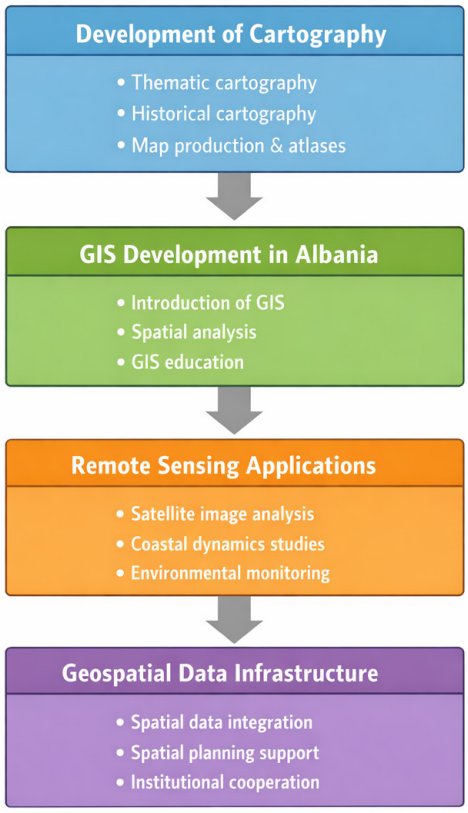


Figure 3. Conceptual framework of the main scientific contribution of Prof.Dr. Pal Nikolli to the development of cartography, GIS, remote sensing, and geospatial data infrastructure in Albania

monograph "Mirdita in a Geo-Cartographic View" (Nikolli, 2006). Thus, Prof. Nikolli writes that cartographic documents prove that Ulcinj and its surroundings have been intensively and continuously mapped by foreign and local cartographers since antiquity; the beginnings of cartography belong to Ptolemy, who also gives us the values of the geographical coordinates of Ulcinj. The toponyms on the old maps confirm the Illyrian origin and antiquity of the Ulcinj region and on the other hand support the historical and linguistic arguments on the different forms of the names of Ulcinj (Olkinium, Colehinium, Ulkinion, Ulcignum, Dulcignum, Dolcegnum, etc.) (Nikolli & Shehu, 2000). On the other hand, through the analysis of the toponyms and geographical content of the Koronel maps, it is clearly proven that the Albanians in the Balkans are an autochthonous people, who lived for centuries in their lands and have a historical continuity since antiquity (Shehu & Nikolli, 2003; Nikolli & Idrizi, 2011b). Also, the analysis of Ptolemy's maps, the Roman Empire (362 and 406 AD), the Peuntigierian Tables (4th century AD), the Catalan Atlas (1375), Pannonia and Illyricum (1590), the Turkish Empire (1639), Hungary (1690), Dalmatia (1690), the states of the Turkish Empire in Europe (1692), the Kingdom of Dalmatia (1696), the kingdoms and provinces of Dalmatia, Croatia and Slovenia (1709), the Turkish Empire (1711), the Danube (1720), the Danube, Hungary and Greece (1740), etc., proves that the geopolitical definition of Albanian lands has changed every time there have been invasions. This rich cartographic material provides us with interesting data that show the systematic fragmentation of Albanian lands by neighboring states (Nikolli et al., 2014).

Prof. Nikolli has extensively studied the old maps representing the Mirdita region. Thus, he emphasizes that Mirdita, with its very interesting name, with continuous habitation since ancient times (the present-day lands of Mirdita were the main settlement area of the Illyrian tribe of Piruste), with its geographical position in the valleys and heights near the Fani i Madh and Fani i Vogël rivers and up to the middle course of the Mat river in the south, with a special social organization, with ethnological phenomena of scientific interest, with a doke organization and a special type of autonomy, etc., has also been the object of cartography at different times. Special elements of this region are reflected in the maps of the Venetian G. Gastaldi (d. 1560). In continuity, Mirdita continues to be mapped mainly by other Venetians such as: Kanteli, Koroneli, etc. During the 18th century, the maps of some authors remained more like reprints of previous maps. In them, Oroshi is most often given, which shows its development as a flag, but also the interests of the Sublime Porte (Nikolli, 2001, 2006). The most accurate cartographic representations of Mirdita and all Albanian lands are from the 1870s, when new surveying and mapping techniques began to be used. The maps of the 19th and early 20th centuries that are of most interest for the geographical, historical, ethnological, cultural, etc. interpretation of the Mirdita region are: a map of 1829 published by F.V. Weisi; "Map of Upper-Gegheria Albania" published by M. H. Hecquard in 1858; "Ethnography of European Turkey" published by G. Lejean in 1861; "General Map of Ottoman Epirus in Europe and Asia" by Henri Kiepert, (d. 1867) (scale 1:300,000); "New General Map of the Balkan Countries Below the Danube with the New Frontiers of Serbia, Bulgaria, Eastern Rumelia - the Turkish Part, According to the Official Surveys Carried Out in 1879"; map by Baron F. Nopcsa, "Journey to Northern Albania" of 1905–1906, scale 1:100,000; "Albania and Neighboring Nations", scale 1:2,000,000; "Albania" by Antonio Vallardi (scale 1:600,000), apparently around 1925; The "topographic map" of scale 1:2,000,000 published by H. Louis in 1928 and the topographic map of scale 1:50,000 – Oroshi of 1932. The content of the maps mentioned above is of interest to researchers in the field of Albanology, as they are rich in geographical, historical, toponomastic, ethnographic, statistical, demographic data for the regions and villages presented (Nikolli, 2002, 2006). Prof. Nikolli has studied the role of cartography in Albanian national identity and culture (Figure 4). He has analyzed ancient maps as a source of information on Albanian history and culture and has contributed to raising awareness of the importance of cartography in geographical education (Nikolli, 1997a, 2020; Nikolli & Kabashi, 2014; Nikolli & Idrizi, 2015).



Figure 4. Scientific book of Prof. Dr. Ing. Pal Nikolli and Agim Shehu: History of Albanian cartography

Prof. Nikolli has successfully addressed modern technologies in Albanian cartography (Nikolli, 1997b; Nikolli & Sala, 2015). He has included the use of GIS Software, mainly ArcGIS and QGIS Software in the creation of thematic maps, geographic data analysis and digital cartography. Prof. Nikolli has contributed to the transition from traditional cartography to digital cartography, facilitating the access and use of maps in studies and projects.

Prof. Nikolli has been responsible for the creation of several important maps and atlases using digital methods, such as the Geographic Atlas of the Population of Albania (Bërxholi et al., 2003), which provides a detailed overview of the distribution and characteristics of the population in Albania, as well as several maps of the Mirdita region (Nikolli, 2001, 2002).

One of the most important contributions of Prof. Nikolli is the development of Albanian thematic cartography. He has been involved in the statistical processing of demographic data (Nikolli et al., 2013, 2015; Nikolli & Brozi, 2022, 2023) and the compilation of maps showing the distribution and characteristics of the population in Albania and in the province of Mirdita (Nikolli, 1999, 2013; Bërxholi et al., 2003); has studied and mapped the changes in the Adriatic coast, using satellite data and mathematical methods (Nikolli, 1990; Gruda & Nikolli, 1995, 2000; Fouache et al., 2001a, 2001b; Nikolli et al., 2010, 2014; Kristo, 2015) and has dealt with maps (Nikolli & Gashi, 2011) showing the distribution of road, railway and other infrastructure networks (Nikolli, 2006). He has successfully used the cartographic method to study the dynamics of the development of the coastline in different periods as well as the evolution of the geographical landscape (Kristo, 2015).

Prof. Nikolli has been part of national and international projects aimed at the development of cartography and GIS in Albania and beyond (Kristo, 2015).

Combining historical traditions with modern technologies, Prof. Nikolli has brought about a change in the field of cartography in Albania. His work has helped not only in the development of cartography as a scientific discipline (Nikolli, 1996, 2020; Nikolli & Idrizi, 2015; Nikolli et al., 2016; Nikolli & Cauli, 2023), but also in its integration into spatial planning (Nikolli et al., 2013, 2014), territorial management (Idrizi & Nikolli, 2010) and geographical and cartographic education (Nikolli & Idrizi, 2010, 2011a; Nikolli et al., 2012; Nikolli, 2012, 2020).

3.3. Contribution to GIS, remote sensing, and the development of geospatial data infrastructure

Prof. Dr. Pal Nikolli has also made a special contribution to GIS (Geographic Information Systems), being one of the first to introduce and develop this technology in Albania. Thus, he is the first to introduce the subject of GIS into the geography curriculum (1994), when this technology was unknown or little known in Albania. Prof. Nikolli has been personally involved in giving lectures on this topic since 1994 onwards. His work in GIS has not been limited to the academic aspect, but has also included theoretical developments (Nikolli, 1996, 1997a, 2000b) and theoretical developments and practical applications in spatial planning (Nikolli, 2009, 2010; Idrizi & Nikolli, 2010), natural resource management and geographical studies (Nikolli et al., 2023b).

Prof. Nikolli has organized and participated in trainings and workshops to share his knowledge and experience with students and professionals. He has also written several university textbooks on GIS (Figure 5), including "Geographic Information Systems" (Nikolli, 2007, 2011), which are an important reference source for students and researchers.

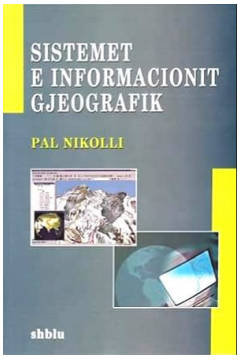


Figure 5. Academik book of Prof. Dr. Ing. Pal Nikolli: Geographic Information Systems

Prof. Nikolli has developed theoretical and practical concepts on the use of GIS in the study of the dynamics of the Adriatic coast and the impact of human activities on the environment (Idrizi & Nikolli, 2010) and in the study of the impact of migration on the demography of Albania through applications such as migration analysis (using GIS to study the causes and consequences of migration in Albania) and demographic projections (using mathematical methods and GIS to predict demographic changes) (Kristo, 2015). He has examined the impact of geodetic measurements in improving the analysis and management of geospatial data in GIS through applications such as territory analysis (the use of geodetic data to analyze and plan the

development of the territory), emergency management (the application of geodetic measurements in the management of natural disasters and emergency situations) and coastal monitoring (the use of geodetic data and GIS to study changes in the Adriatic coast). Prof. Nikolli has been one of the main promoters of the treatment and development of geospatial data infrastructure in Albania and the use of GIS in the integration and distribution of geospatial data between different institutions (Nikolli, 2002, 2009; Nikolli et al., 2021, 2023a). Prof. Nikolli was one of the pioneers who introduced and developed GIS in Albania, treating it in spatial planning, environmental studies, and emergency management.

By combining theory with practical applications, Prof. Nikolli has contributed not only to the development of GIS as an essential tool for geographical studies and spatial planning, but also to its integration into geographical education and territorial management.

Prof. Dr. Pal Nikolli has made a special contribution to the use of remote sensing and satellite imagery in geographical analysis, combining these modern technologies with traditional methods of territorial study. He has been one of the pioneers who introduced and developed the use of remote sensing and satellite imagery in Albania (Nikolli, 2009; Kristo, 2015; Nikolli & Kabashi, 2018). Thus, for the first time in Albania, in 1992, he used aerial photography and satellite images to study the dynamics of the Adriatic coast in the Seman and Shkumbini estuaries and the impact of human activities on the environment through applications such as the study of erosion and accumulation, monitoring of coastal changes, the study of vegetation distribution, land use analysis, migration analysis and demographic projections (Kristo, 2015). Prof. Nikolli has written two university texts on remote sensing and satellite images: "Acquisition and Processing of Satellite Images for Geographic Analysis" (Nikolli, 2009) and "Satellite Images and Their Use" (Nikolli & Kabashi, 2018).

By combining theory with practical applications, Prof. Nikolli has helped not only in the development of accurate methods of geographical analysis, but also in their integration into spatial planning, territorial management, and geographical education.

Prof. Dr. Pal Nikolli has made a special theoretical contribution to the development of the Spatial Data Infrastructure (SDI) in Albania. His work in this field has been essential for the creation of an integrated geospatial data system, facilitating the access, distribution, and use of these data in studies, planning, and management of the territory. He has been one of the pioneers who has addressed, introduced, and developed the concept of the geospatial data infrastructure (SDI) in Albania through university textbooks and numerous publications.

4. Discussions

The development of cartography and geospatial sciences in Albania reflects broader global trends in the transition from traditional cartographic methods toward digital spatial information systems. During the late twentieth and early twenty-first centuries, the integration of Geographic Information Systems, satellite remote sensing, and geospatial data infrastructures significantly transformed the way geographical information is collected, processed, and used in scientific research and territorial planning.

The development of geographic information science and digital cartography has been strongly influenced by several pioneering researchers at the international level. Early theoretical foundations of spatial analysis were introduced by Tobler (1970), while the conceptual development of geographic information science was significantly advanced by Goodchild (1992). In addition, Tomlin (1990) contributed to the development of map algebra and GIS-based spatial modeling, which became fundamental tools for modern spatial analysis. These developments formed the broader scientific context in which geospatial technologies were gradually introduced in many countries, including Albania.

Within this context, the work of Prof. Dr. Pal Nikolli represents an important contribution to the modernization of cartography and geospatial sciences in Albania. His research and teaching activities have played a key role in introducing modern geospatial technologies into academic education and in promoting their application in geographical and environmental studies.

One of the most significant aspects of his contribution is the early introduction of GIS into the geography curriculum in Albania during the 1990s. At that time, GIS technologies were still emerging in many academic institutions in Southeast Europe. The incorporation of GIS courses and related teaching materials contributed to the development of new competencies among students and researchers in the field of spatial analysis. Later, at the beginning of the third millennium, he played an important role in introducing modern technologies and methodologies in Albanian cartography during the period of digital transformation (Figures 6–7).

Another important dimension of Prof. Nikolli's work is the application of cartographic and geospatial methods in the study of demographic processes, coastal dynamics, and territorial planning. Through the integration of statistical methods, cartographic analysis, and satellite imagery, these studies have provided valuable insights into spatial processes affecting the development of Albanian territory.

Furthermore, his work on the development of geospatial data infrastructures has contributed to raising awareness about the importance of organized spatial data management and inter-institutional data sharing. Such initiatives are essential for the development of modern spatial planning systems and for improving decision-making processes based on geospatial information.

From an academic perspective, his role in developing university curricula and producing specialized textbooks has had a long-term impact on the formation of



Figure 6. Award for Prof. Dr. Pal Nikolli: THE PRIDE OF MIRDITA



Figure 7. Award for the best article in cultural journal "MIRDITA"

5. Conclusions

The study of the contributions of Prof. Dr. Pal Nikolli shows that he is one of the most distinguished figures in the development of cartography, GIS, and Remote Sensing in Albania. His work has helped to advance these disciplines, providing a solid foundation for practical applications and scientific research. His contributions to cartography, GIS, geodesy, and remote sensing, as well as his commitment to the development of geospatial data infrastructure, are essential for improving spatial planning and natural resource management in Albania. Furthermore, his role in educating and mentoring students and young professionals represents an important contribution to the development of geospatial sciences in Albania for future generations. In conclusion, Prof. Nikolli's contributions are a testament to the importance of integrating theoretical knowledge with advanced practices in the field of cartography and related sciences, contributing to the sustainable development of Albania.

References

Bërxholi, A., Doka, D., & Asche, H. (2003). *The Geographic atlas of the population of Albania*. ILAR Tirana.

Fouache, E., Gruda, G., Mucaj, S., & Nikolli, P. (2001a). Recent geomorphological evolution of deltas of the rivers Seman and Vjosa, Albania. *Earth Surface Processes and Landforms*, *26*(7), 793–802. https://doi.org/10.1002/esp.222

Fouache, E., Gruda, G., Mucaj, S., Nikolli, P., & Dimo, L. (2001b). Dynamique geomorphologique et évolution de la navigation maritime depuis l'Antiquité dans les deltas du Seman et de la Vjosë (region d'Apollonia, Albania) [Geomorphological dynamics and evolution of Maritime navigation since Antiquity in the Seman and Vjosë Deltas (Apollonia region, Albania)]. *Antichità altoadriatiche XLVI*: *Strutture portuali e rotte marittime nell'Adriatico di età romana*, 107–120.

Goodchild, M. F. (1992). Geographical information science. *International Journal of Geographical Information Systems*, *6*(1), 31–45. https://doi.org/10.1080/02693799208901893

Gruda, G., & Nikolli, P. (1995). Morphotectonic and morphological evolution of the coastal area between Seman and Shkumbin. *Geographical Studies*, *6*.

Gruda, G., & Nikolli, P. (2000). Study of Holocene and historical geomorphological evolution of the Vjosa and Seman deltas using satellite imagery. *Geographical Studies*, *13*, 20–25.

Idrizi, B., & Nikolli, P. (2010). The role of spatial information and GIS in flood management at the local level. *Albanological Studies*, *4*(4), 139–149.

Kristo, V. (2015). Geomorphology at the Department of Geography of the University of Tirana for the period 1960–2000. *Geographical Research*, *17*.

Nikolli, P. (1990). Determination of time fluctuation of the Seman estuary coastline using mathematical-statistical methods. *Geographical Studies*, *4*.

Nikolli, P. (1996). GIS and geographical analysis. *Albanological Studies*, *2*.

Nikolli, P. (1997a). Data sources for GIS. *Geographical Studies*, *10*.

Nikolli, P. (1997b). Mapping of Albanian lands. *Albanological Studies*, *3*.

Nikolli, P. (1999). Mapping of Albanian emigrants in the world. *Albanological Studies*, *4*(1).

Nikolli, P. (2000a). Albanian migrations. *Geographical Studies*, *13*, 153–155.

Nikolli, P. (2000b). Overview of geographic data and information. *Geographical Studies*, *13*, 131–138.

Nikolli, P. (2002). State of geographical information and its infrastructure in Albania. *Geographical Studies*, *14*, 391–401.

Nikolli, P. (2006). *Mirdita in a geo-cartographic view*. GEER.

Nikolli, P. (2007). *Geographic information systems*. SHBLU.

Nikolli, P. (2009). *Capturing and processing satellite images for geographical analysis*. SHBLU.

Nikolli, P. (2011). *Geographic information systems* (2nd ed.). SHBLU.

Nikolli, P. (2012). *Cartography*: *Exercises and practice*. Klean.

Nikolli, P. (2013). Creation of thematic maps using ArcGIS ESRI. Klean.

Nikolli, P. (2019). *Introduction to cartography*. Flamur.

Nikolli, P. (2020). Developments of cartography in Albania. *Micro Macro & Mezzo Geo Information*, *14*, 19–31.

Nikolli, P., & Brozi, M. (2022). A historical and geostatistical analysis of Mirdita's population and some of its characteristics (Part I). *Mirdita*, *36*, 11–17.

Nikolli, P., & Brozi, M. (2023). A historical and geostatistical analysis of Mirdita's population and some of its characteristics (Part II). *Mirdita*, *38*, 18–25.

Nikolli, P., & Cauli, A. (2023). New concepts about map scale. *Albanological Studies*, *1*, 7–23.

Nikolli, P., & Gashi, F. (2011). Koronel's contribution to Albanology. *Albanology*, *1*, 235–255.

Nikolli, P., & Idrizi, B. (2010, June 15–20). Geodetic and cartographic education in Albania. In *Proceedings of the 3rd International Conference on Cartography and GIS*. Nessebar, Bulgaria.

Nikolli, P., & Idrizi, B. (2011a, May, 18–22). GIS education in Albania. In *Proceedings of FIG Working Week 2011*. Marrakech, Morocco.

Nikolli, P., & Idrizi, B. (2011b). The history of cartography in Albania. In A. Ruas (Ed.), *Proceedings of the 25th International Cartographic Conference*. Paris, France.

Nikolli, P., & Idrizi, B. (2015, August 23–25). The developments of Albanian cartography. In *Proceedings of the 27th International Cartographic Conference*. Rio de Janeiro, Brazil.

Nikolli, P., & Kabashi, I. (2014). Assessment of Albanian territories through old maps. *University Research*, *37*, 7–17.

Nikolli, P., & Kabashi, I. (2018). *Satellite images and their use*. GEER.

Nikolli, P., & Sala, S. (2015). Geomorphological mapping and geomorphological maps. *Micro Macro & Mezzo Geo Information*, *4*, 70–92.

Nikolli, P., & Shehu, A. (2000). *Elements of cartography*. SHBLU.

Nikolli, P., & Shehu, A. (2001). *History of Albanian cartography*. Julvin 2.

Nikolli, P., & Shehu, A. (2007). *Thematic cartography*. Progres.

Nikolli, P., Shehu, A., Idrizi, B., Gashi, F., & Kabashi, I. (2012). Development of cartographic thinking. *Geoinformation & Geomatics*.

Nikolli, P., Draçi, B., & Idrizi, B. (2013). Spatial planning in the Republic of Albania and its cartographic basis. *Albanological Studies*, *4*(4).

Nikolli, P., Draçi, B., & Idrizi, B. (2014, June 16–21). Territorial/spatial planning in Albania. In *Proceedings of the XXV FIG International Congress* (pp. 1–10). Kuala Lumpur, Malaysia.

Nikolli, P., Draçi, B., & Doka, D. (2015). Albanian population projections by age and gender (2011–2061). *Geographical Research*, *17*, 99–125.

Nikolli, P., Draçi, B., Kosovrasti, A., & Idrizi, B. (2021). The impact of emigration in the aging of the population of Albania after 1990. *Micro Macro & Mezzo Geo Information*, *17*, 32–44.

Nikolli, P., Gashi, F., & Kabashi, I. (2016). The cartographic projections used in Albanian maps. *Micro Macro & Mezzo Geo Information*, *6*, 121–141.

Nikolli, P., Kabashi, I., & Gashi, F. (2014). Dynamics of the coastline from Shengjin Cape to Drini estuary. *Albanological Studies*, *4*(4), 49–60.

Nikolli, P., Sala, S., Halili, A., & Allaraj, S. (2023a). State infrastructure of spatial data of Albania and European integration. *Geographical Studies*, *23*, 72–103.

Nikolli, P., Xhafa, S., Çaro, E., & Bygjymi, X. (2023b). The place and role of technical geography in the science of geography. *Albanological Studies*, *2*, 41–85.

Shehu, A., & Nikolli, P. (2003, August 10–16). The history of cartography in Albania. In *Proceedings of the 21st International Cartographic Conference*. Durban, South Africa.

Tobler, W. R. (1970). A computer movie simulating urban growth in the Detroit region. *Economic Geography*, *46*(Suppl. 1), 234–240. https://doi.org/10.2307/143141

Tomlin, C. D. (1990). *Geographic information systems and cartographic modeling*. Prentice Hall.