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A review of the main research-lines and research productivity of the Faculty of Natural Sciences, University of Shkodra "Luigj Gurakuqi"

M. Rakaj[1,6], Z. Shabani[2], N. Bushati [1,6], S. Duraj[3], A. Neziri[1], J. Bushati[5], F. Mandija[4*]

[1]*Department of Biology-Chemistry, Faculty of Natural Sciences, University of Shkodra, Shkodër, 4001, Albania.*
[2]*Department of Nursery, Faculty of Natural Sciences, University of Shkodra, Shkodër, 4001, Albania.*
[3]*Department of Mathematics, Faculty of Natural Sciences, University of Shkodra, Shkodër, 4001, Albania.*
[4]*Department of Physics, Faculty of Natural Sciences, University of Shkodra, Shkodër, 4001, Albania.*
[5]*Faculty of Education, University of Shkodra, Shkodër, 4001, Albania.*
[6]*Water Research Centre of the Shkodra Region (WRCSHR), University of Shkodra, Shkodër, 4001, Albania.*

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florian.mandija@unishk.edu.al
Phone: +355692272755;
Fax: +35522242235

Abstract

Today, scientific dynamics and academic performance are fundamental elements in determining the quality of a university. As one of the major faculties of the University of Shkodra "Luigj Gurakuqi" (USH), the Faculty of Natural Sciences has a substantial contribution in the scientific field at the institution level. In this review we are focused on key research parameters, such as scientific publications, research projects, international cooperation networks, degrees and titles acquired abroad, to assess the research output of this institution. Based on the database of the major research platforms such as Scopus, Science Direct, Microsoft Academic, Google Scholar, etc. are determined the publication rates and their citations for each field of study of the faculty. The results obtained from these platforms emphasize that the Faculty of Natural Sciences (FNS) has the highest research productivity compared to other faculties of this university. The main areas of research are those applied, with a leading orientation in natural sciences such as Biology, Physics and Chemistry. The institution, with the closest cooperative relationship is the University of Tirana, but there are ongoing collaborations with research institutions in and outside the country.

1. Introduction

The Faculty of Natural Sciences (FNS) is a major unit of the University of Shkodra "Luigj Gurakuqi" started its teaching and scientific activity, with the establishment of the Higher Pedagogical Institute, on September 2, 1957. The development of this unit has gone through several stages:

Since 1957, the Faculty of Natural Sciences was organised in three branches: Mathematics - Physics, Biology - Chemistry - Geography and Biology – Chemistry. Furthermore, in 1991, Mathematics - Physics was divided into two separate departments: Mathematics and Physics.

Since 1991 onwards the faculty have been enlarged with new branches. In 2000, the branch of Nursing was formed in 2002, the branch of Informatics in 2007, the branch of Midwifery in 2007 and the branch of Physiotherapy in 2007. Currently, the Faculty of Natural Sciences is composed as the basic unit with four departments: Biology-Chemistry, Physics, Mathematics-Informatics, Nursing and Water Research Centre of the Shkodra Region. Students graduate in Bachelor studies in 7 branches: Biology-Chemistry, Mathematics, Informatics, Physics, Nursing, Midwifery, Physiotherapy.

The FNS offers different Master's studies: A Scientific Masters in "Environmental Biology"; A Scientific Masters in "Teaching"; A Professional Masters in "Teaching" in some disciplines; A Professional Masters in "Health Psychology for Studies in Nursing and A Masters in Midwife and Physiotherapy".
The Faculty of Natural Sciences offers to the students the opportunity to study and work with a qualified academic staff and modern teaching programs with a high scientific level.
Today, the Faculty of Natural Sciences has 42 lecturers, 4 with the title "Professor", 7 "Associate Professor", 6 "Doctor" and 4 Docents.

2. Material and Methods

The quality assessment and the level of scientific research in this faculty are based on several aspects;

- Identification of the subject-areas and subject-categories of research across the departments and the research institute
- Determination of key cooperative institutions
- National and international projects
- Scientific degrees obtained at institutions outside the country
- Bibliometric analysis of publications and citations

Identification of the subject-areas and subject-categories of scientific research are based on the publication data. Also, the definition of major cooperative institutions is also based on publications in prestigious journals. Both these, together with bibliometric analysis are based on platform databases from those of a scientific nature, such as Scopus, Science Direct, to those of a scholarly character such as Microsoft Academic and Google Scholar.
In this way, this bibliometric analysis takes into account only publications in peer-review journals and conference proceedings reports provided by Scopus as well as publications in peer-review journals in the OECD area provided by Google Scholar.
The methodology for evaluating publications and citations is based on the use of programme Publish or Perish (PoP) (https://harzing.com/resources/publish-or-perish).
Scopus (https://www.scopus.com) is a database of publications and citations, launched in 2004, which encompasses over 36,000 different journals. Science Direct (https://www.sciencedirect.com) includes information from around 3,500 magazines and 34,000 books. Both databases are managed by Elsevier, an Anglo-Dutch publishing company, founded in 1880.
Google Scholar (https://scholar.google.com) is a browser that indexes journals, conference proceedings and doctoral theses that are accessible online. Google Scholar was created in 2000, and contains about 400 million works, becoming the world's leading browser in academic fields. Microsoft Academic (https://academic.microsoft.com/home) is a search engine for literature and academic publications, launched by Microsoft Research in 2016. Microsoft Academic covers over 375 million documents, of which 170 million are scientific articles.
The analysis of publications in prestigious journals is based on the impact factor data provided by Journal Citation Reports (JCR) published by Thomson Reuters, as well as by rankings of journals in relevant subject categories provided by the Scimago Journal & Country Rank (https://www.scimagojr.com). In this paper are presented the journals with the highest impact factors ranked in the top 25%, authored or co-authored by the FSN's staff.
Similar efforts and different methodologies for the examination of the research productivity of research organizations, such as universities, faculties or institutes are very common [1-6].
This study did not undertake to analyse publications not included in the above databases as well as those written in Albanian.

3. Main subject-areas and subject-categories

The designation of the subject-areas and subject-categories of scientific research at the FNS units has happened based on the most important publications of staff members affiliated from this faculty. In this analysis, scientific research is investigated over the subject-areas, such as; Mathematics, Physics, Informatics, Chemistry, Biology, Nursing and Water Research Center of Shkodra Region.

3.1. Mathematics

Publications in the field of mathematics have been infrequent compared to other fields. However, a good part of these publications has been applied in the field of didactics of learning, a direction which has not been addressed in this study. However, in recent years the scientific publication, also in foreign peer-review journals or in international conference proceedings was significantly enhanced.

In the process of completing two PhDs, during 2016, there was a more intensive activity in the field of scientific publications. Very interesting research papers with a focus on the theoretical "fixed point theorem" for different metric spaces have been published that year [7-8]. Also, studies on mathematical applications, especially in the economy, such as. macroeconomic studies etc. were published during the same year [9-10].

During this period, Zlaticanin, A. co-authored in two papers [11-12] published two theoretical papers related to "Quasi conformal Mappings".

The process of finalizing Master's studies at Agder University, Norway, is accompanied by the publication of her thesis [13], a didactic orientation study. Before, Shkupa, T. has published a series of papers related to math didactics [14].

3.2. Physics

Research in the field of Physics is mainly directed at atmospheric, environmental and medical physics. Also, and other subject-categories related to physics are covered, especially those related to didactics of physics.

Publications in the field of atmospheric physics are mainly related to the natural tropospheric phenomena of atmospheric electricity and to the balance populations of group atmospheric ions [15-22]. Theoretical models of electrostatic interaction of ultrafine aerosol groups have been constructed [23-26]. In recent years, the work on atmospheric physics has also been directed at the identification of mineral desert aerosol resources and their penetration scenarios [27-31]. Their significance is that these studies doesn't only take into consideration the region of our country, but they extend even more broadly by analysing the maps of aerosol load on the Balkan Peninsula region [31], the Iberian Peninsula [27], the central European region [28], up to the European level study [30].

The methodology of these studies lies in the processing and analysis of databases through remote sensing techniques. There are analysis of satellite data of Moderate Resolution Imaging Spectroradiometer-MODIS [32] on NASA-Earth and NASA-Aqua data, such as numerical computer model satellites, of the international network of Aerosol Robotic Network-AERONET data [33] and The European Aerosol Research Lidar Network-EARLINET data [34], as well as BSC Dust Daily Forecast-Earth System Service-BSC_DREAM_8b [35], Global Aerosol Model-NAAPS [36-37], NOAA Hybrid Single Particle Lagrangian Integrated Trajectory Model-HYSPLIT [38], etc. Recently, in cooperation with several foreign universities, we are working on determining the "aerosol indirect effect" and the influence of different types of aerosols on the solar radiation budget, giving so a substantial contribution to climate change research.

Studies in environmental physics have been directed at the monitoring of urban pollution from particulate matter PM_1, $PM_{2.5}$ and PM_{10} [15, 39-41], from electromagnetic fields, radioactive radiations [42], as well as the identification of areas with high radon levels [16, 43]. These studies are mainly concentrated in the region of Shkodra, but also in different regions of our country.

An important direction for USH has been the study of the effects of exposure to different electric and magnetic fields of different frequencies as well as X-rays [44-50].

There have been other interdisciplinary works, especially related to applied physics, in collaboration with other departments [51-53].

It should be emphasized that an important part of the work in this department has been related to didactics and teaching methodology of physics, the creation of a laboratory base and the creation of the start of international collaborations in the case of the Universities of Graz (Austria), Bari (Italy), etc. where among the most important contributors can be mentioned Kolombi, Gj, former rector of the University of Shkodra. To-date, the department of physics operates the Special Laboratory, which has modern facilities for environmental analysis, such as PMx particulate matter monitoring, air ionization, instruments for measuring electromagnetic fields, static electrical

and magnetic fields, radiation assessments (α, β and γ), radon gas, etc. This expertise was used in the implementation of various projects by Mandija, F. as well as for the mentoring of students' diplomas.
Also, efforts on teaching new practices, ICT learning in physics and more was done during these years [54-55].

3.3. Informatics

The research activity in the field of Informatics was focused on Programming in Parallel Systems, in Information Technology in Teaching, in System Recommendations, on Process of Modelling Systems, as well as the Semantic Web. PhD studies abroad have its focus on Recommendation Systems, Parallel Programming, and Analysis of Information System Architecture. In her PhD thesis, Duli, S. [56] analyses four implementations in Parallel Programming of the Weibull distribution parameter evaluation. An implementation accomplishes parallelization using the MPI library. In the second implementation, the PThreads technique was used. The third implementation has happened with OpenMP. The fourth version is a hybridization of MPI / Pthreads. In all four cases, the performance of the application is discussed compared to the serial version. Data on which measurements are made are data of wind speed measurements in Shkodra and Podgorica.
During his doctoral studies, Çoba, L. is analyzing two categories of experiments that are designed to find out how many metrics of distribution affect the decision making, such as the total number of estimates, the arithmetic average, the variance, the bi-modality and the origin of the estimates. Also, in this study, an R-package is implemented in Prototype Algorithms in the Recommendation Systems
Publications in the field of Parallel Programming, related to the implementation of MPI, Pthread and OpenMP evaluation of Weibull statistical distribution parameters [57, 58], implementation of OpenMP and MPI of Gram-Schmidt algorithm [59] and studies about parallel programming trends [60].
Information Technology Teaching studies focus on the role of Information Technology in Preschool Education, as well as the role of Information Technology in 9-Year Education [60-62]. In the area of the Semantic Web, there is the studying the integration of the Semantic Web with Web Mining. The study in the field of Information Systems Architecture and Process Modeling is the focus of L. Berberi's PhD studies, where a model for Process Warehouses is also proposed [63]. An important direction of publications in Informatics is the Systems Recommendation. An R-packet for the prototype Recommendation algorithms [64], as well as user perception in collaborative explanations [65-66] has been implemented. A visual performance analysis of the recommendation systems was also performed [67]. The most recent study is an analysis of decision-making [68-70].
A cross-disciplinary work is related to the methods of implementing virtual labs in teaching, mainly in physics, which was carried out in collaboration with the Physics Department. The process of obtaining doctoral degrees abroad has further stimulated the publication activity in journals, and especially at international conferences [65, 67, 71-73].

3.4. Chemistry

The main publications in the field of chemistry related to the evaluation of physical-chemical parameters, and chemical contaminants (nutrients, organic pollutants, heavy metals) focused on the Lake Shkodra basin [74-75].
There is some research on the determination of air pollution from Shkodra and Durrës cities [75-77] as well as in different urban areas of our country [78].
Several papers have been focused to determine physic-chemical parameters and organic pollutants in Lake Shkodra waters [79], in Buna and Drin rivers [80-83], on the coast of Velipoja, as well as determining the level of nutrients in these ecosystems [84].
In addition to the studies of surface water [79-80, 82-86]), even for groundwater had happened in the first chemical analysis [87-89]. Several specific papers have evaluated the influence of chemical agents on different species of Lake Shkodra [90-93]. Other studies have addressed a wide spectrum of environmental pollution issues, especially those related to health [94] and other health issues related to cigarettes and alcohol abusers [95]. A more specific research was addressed to the parameters of contaminants in drinking milk in the Shkodra region [96-97]. Moreover, teaching methodology papers have also been carried out in the Biology subject [98].

3.5. Biology

The research work of the Biology staff is focused on biodiversity and the environment, mainly in the study of the microflora of water, flora and fauna. Publications in the field of Biology mainly concern the vascular plants flora studies, fauna, malakofauna, protists and water ecology [99-102]. Studies in the field of biology and ecology have focused mainly on the ecosystem of Lake Shkodra [102-105], and other aquatic ecosystems in the Shkodra region, such as the Buna River [80, 106-109]; Drin River [80, 102, 111], and the Albanian coast [99, 111-112]. Some members of the Department of Biology have also conducted biogeographic studies on the flora and fauna at national level, either on their own or with co-authors [109, 112, 113-122]. Scientific work has also been carried out in the fields of biochemistry, histology to fisheries, entomology, plant bioassays [123-125]. Studies have also been performed on the flora of vegetation for the regions outside borders of our country [109, 126].

The assessments of the degree of toxicity in some areas, such as in Nën-Shkodër, Malësi e Madhe, Lake Shkodra, etc., were presented in several publications [127-131].

There has conducted some research on finding new species and assessing their prevalence such as diatomaceous (phytoplankton), aquatic macrophytes, genera Oenothera, Hyacinthella, Scilla, etc., for Shkodra region Albania, which have been published by some authors [102, 109, 114-117].

Identification of Anaplasmosis as a rickettsial disease from domestic animals in Northern Albania has been investigated by [131] and also the estimation of different species of Coleoptera have been reported by authors [105, 113], etc.). An important contribution to the study of flora and fauna is the compilation of the list species for vascular plants and molluscs at regional and national level [99, 111-112, 122]. Such studies, with the participation of researchers from our faculty, have been extended to the European scale [133]. Several studies focused on microbiological analyses of surface and groundwaters, which were carried out mainly in microbiological laboratory at the Faculty of Natural Sciences [79-80, 103]. The subject of the study of some authors has also been the case for pets' domestic animals as indicators of Anaplasma Species Infections in Northern Albania [132].

The social impacts of environmental problems and their impact on tourism have also been analysed [107, 109, 134]. Also, studies have been conducted in the field of environmental education, in cooperation with the nursing staff [135]. Works related to strengthening cross-border cooperation on biodiversity protection are coordinated with foreign co-authors [136-137].

3.6. Nursing

The main subject-categories in the field of nursing are primarily related to morbidity and hospital mortality, especially in the Shkodra Regional Hospital, Internal and Cardiovascular Diseases [134], diseases in Children, such as autism [139-140], respiratory diseases and problems with asthma [140], etc. There are also general studies on the health situation of Shkodra region, quality of life, ecological aspects of the environment, etc. [141-143]. Studies on the level of environmental responsibility of the population and working staff, as well as the public awareness issues are presented in several publications [135, 142, 144-148]. Socio-economic morbidity problems have been addressed in several studies [139, 142, 149-150]. One of the highlights of the activities of the nursing staff has to do with blood donation. Monitoring of this process is also addressed through several papers [148]. Applied performance studies of athletes were presented in many collaborative papers with our University's Faculty of Education [151-152]. Recently, joint studies have also been carried out in collaboration with foreign authors [153].

3.7. Water Research Centre of the Shkodra Region (WRCSHR)

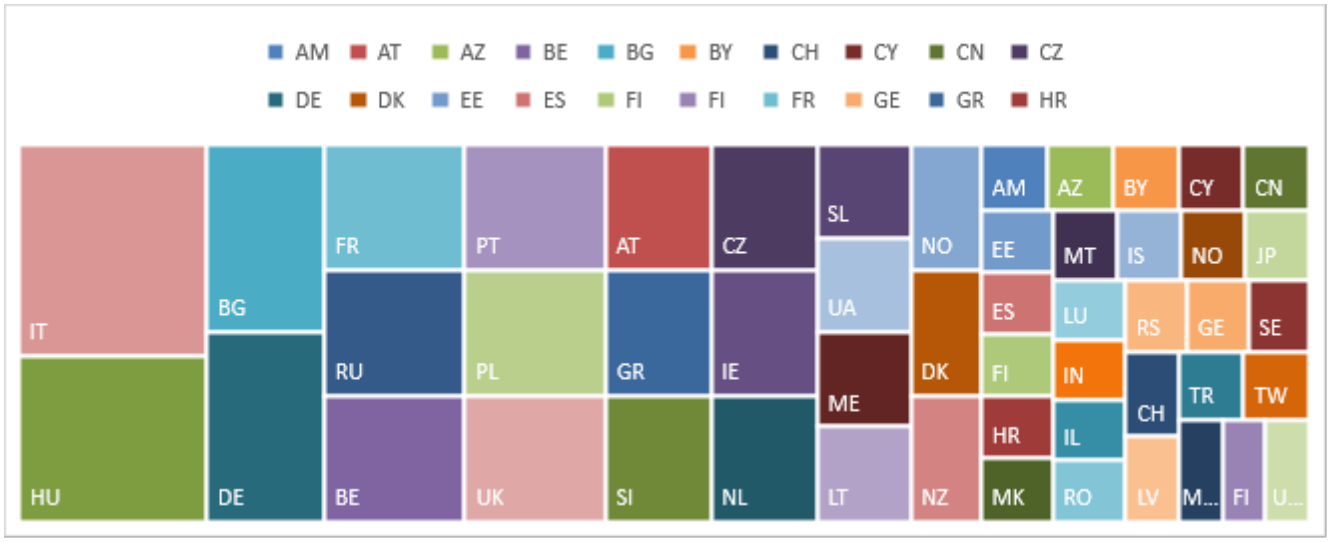
The scientific research activity of the Water Research Centre of the Shkodra Region (WRCSHR) is mainly of applied character. It is focused on the study of biodiversity, chemistry, microbiology and ecology of the waters of Lake Shkodra and the rivers of the surrounding region.

The most important publications are related to the study and evaluation of physic-chemical, chemical and microbiological parameters, chemical quality, and chemical contaminants (nutrients, organic pollutants, heavy metals) and microbial contamination of Lake Shkodra and Drin and Buna rivers [75-76, 79-81, 84, 87-88, 93,

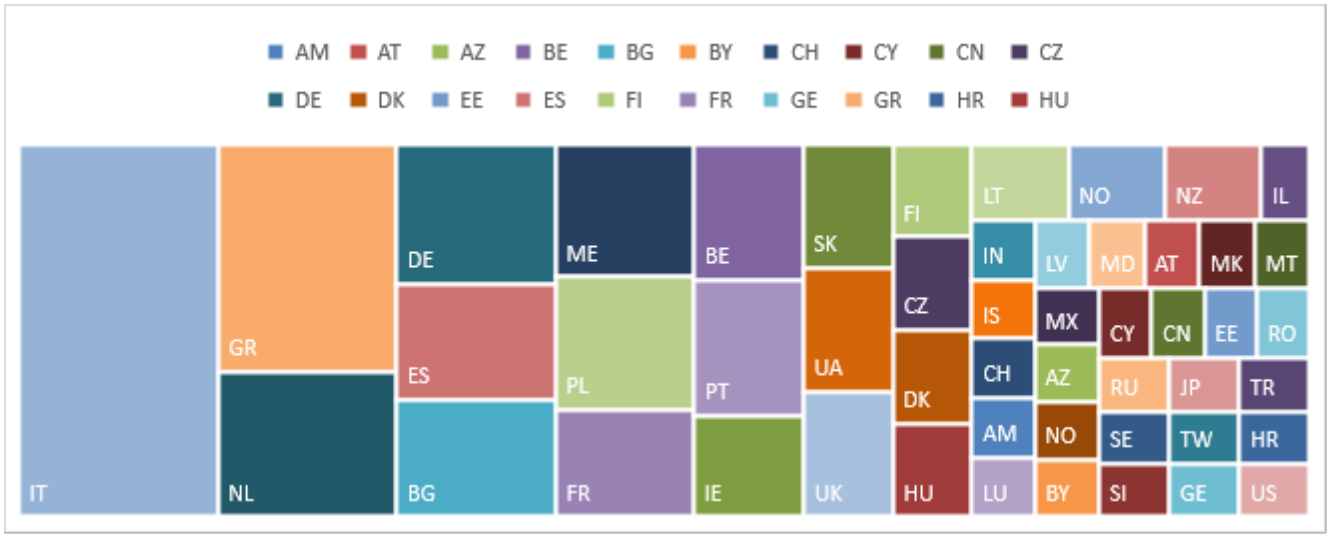
154-156]; with the assessment of the biological characteristics of the waters of Lake Shkodra and the Drin and Buna rivers [100, 110]; with the study of algae and macrophytes flora of Lake Shkodra Basin and Buna River [102, 114, 157-158], and also with the study of the aquatic fauna, mainly of the protists of Shkodra Lake [101, 159-160], as well as molluscs, fish and aquatic birds [161-162], etc. An important contribution to the recognition of the main characteristics of Shkodra Lake were the publications of the summation character of the limnological, hydrological, ecological, biodiversity and management of Lake Shkodra [161, 163-164]. Special attention has been given to the study of the flora of vascular plants of Albania [99, 106, 112, 114-119] and fauna of Albania [111-112, 161, 165-166], etc.

4. Cooperation with research institutions

FNS authors have collaborated with a considerable number of international institutions in the preparation of papers and scientific projects. 72 publications were conducted in co-authorship with international institutions. This accounts for 58% of all FNS authors' publications indexed by Scopus.



a) Collaborations with international research institutions, based on the no. of the papers co-authored by FSN's staff



b) Presentation of the collaborations with international research institutions, based on the no. of papers led by FSN's staff

Figure 1: Countries[1] which have influenced and those which have been influenced by the authors of FSN. The numbers in these graphs refer to the number of papers published in cooperation between the staff of FSN and external authors. a) Show no. of papers with external first author and b) show no. of papers by FSN's staff as first author.

[1] Country codes (ISO 3166) are defined by the International Organization for Standardization (ISO).

Almost half of the publications have been co-authored with external authors. As can be seen from Figure 1, the majority of the collaborations have happened with European institutions. Collaborations in terms of publications have also been realized with universities outside Europe, such as USA, Australia, Israel, etc. However, the major collaborations arise from Italian institutions (13.7%). Also, substantial collaborations have been made also with Greece, Germany, Netherland, Bulgaria, Hungary, Belgium and France.

As far as collaboration with authors in the country, co-authorships in publications within the University of Shkodra cover the major part of the publications. While the University of Tirana remains the leading partner within the country with over 2/3 of the joint publications, the rest of the publications within the country (about 1/3 of the total number of publications) have been conducted in cooperation with other institutions in the country, such as the Academy of Sciences of Albania, the Agricultural University of Tirana, the Polytechnic University of Tirana, the Institute of Public Health, etc.

5. Research projects and staff trainings

In addition to the papers, in collaboration with other authors, the research projects attended by the FSN's staff has participated are an indicator of their scientific contribution. Thanks to the FNS projects, there have been several individual and institutional collaborations.

5.1. Projects and international mobility in the field of Physics

As a member of the Department of Physics, Mandija, F. within the SIGMA project has had some post-doctoral mobilities. In the frame of SIGMA project, he has been hosted by Dept. of Physics of the University of Milan. After that, the implementation of the JOIN-EU-SEE project, was achieved with collaborations with the Universities of Granada (Interuniversity Research Centre of the Environment IISTA-CEAMA) and the Polytechnic of Catalonia in Barcelona, Remote Sensing Laboratory (RSLab), Dept. of Signal Theory and Communications (TSC). The AGILE project was carried out in the Dept. of Physics at the Geophysical Institute of the University of Warsaw (Atmospheric Physics Group). Meanwhile, the Green-Tech-WB project was implemented in the EPhys Laboratory, Faculty of Science of the University of Vigo, which was implemented through the Green-Tech-WB project. Other collaborations in the framework of the preparation of the project proposals, Mandija, F. were also with other foreign universities such as the University of Sherbrooke (Quebec, Canada), Univ. Sheffield (UK), University of Leipzig (Germany) and Ludwig-Maximilians University of Munich (Germany), Potenza Observatory (Italy), and University of Murcia, University Complutense of Madrid, University of A Coruna (Spain), Institute for Tropospheric Research (Germany), etc. In addition, some national projects, especially in the field of environmental monitoring, have been carried out by the Department of Physics in cooperation with the University of Tirana (Department of Physics and Chemistry), the Nuclear Physics Centre and the Albanian Academy of Sciences, among which the most important mention can be made of the national project " Monitoring and assessment of air quality in some areas of Albania".

The Department of Physics since 2009 operates the sensors for atmospheric lightning activity monitoring. These sensors are part of the Lightning Location Network LINET (https://www.nowcast.de) and have been in continuous operation early in 2006 and covers large parts of Europe, developed by the University of Munich, Germany [167].

5.2. Projects and international mobility in the field of Informatics

Collaborations with Western Universities have been of particular importance in the development of research in Informatics. Since the opening of this unit, the qualification of the academic staff has been made in the framework of these collaborations. From the co-operation with HAN University of Applied Sciences, Arnhem, Netherlands, two masters were granted during 2001-2005. The cooperation with the "Alpen Adria" University of Klagenfurt, Austria, started in 2004 and continues, emphasizing the qualifications of academic staff and students of the unit of Informatics. This collaboration has led the granting of doctoral studies and master studies in the field of informatics.

A very important cooperation is between our University and the University of Montenegro. Within this cooperation, the completion of doctoral studies has been completed in the area of Informatics. Also, lecturers from the University of Montenegro have developed Operation Systems, Web Applications during 2005-2007.

In the framework of the Erasmus+ project, some mobility of lecturers and students of Informatics with foreign Universities has happened. During the academic year 2018-2019, in the field of Informatics, three western universities have been successful, namely: with the University of Applied Sciences, Villach, Austria, with the University of Zagreb, Croatia, and with the University of Vidzeme, Latvia. These projects are of great importance for improving curricula as well as for cooperation opportunities in the framework of scientific publications and participation in international conferences.

5.3. Projects and international mobility in the field of Chemistry

A lot of mobility of researchers from the field of Chemistry have been conducted: lecturer Neziri, A. during the years 2002-2004 has participated as a scientific researcher in the EULIMNIOS PROJECT financed from HRK, Germany and has conducted training activities in cooperation with important foreign research centres, e.g, Research work at the Hygiene Institute, University of Heidelberg ,Germany) for application of SPMD-s in Shkodra Lake for analyzing organic pollutants (PAH)s and testing a range of toxicity tests to the SPMDs samples. (Financed from HRK Germany) from 2002-2004.

Moreover, Neziri, A. (year 2002) has been trained at "La Sapienza" University of Rome, Italy, regarding instrumental techniques of chemical analysis with GC-ECD, GC-FID, GC-MS, and has conducted scientific activity at the Institute for Chemistry, University of Graz, Austria for heavy metals analysis by ICP-MS, Center for Ecotoxicological Research (CETI), Podgorica, Montenegro, etc.

Neziri, A., completed her PhD studies by conducting research work in the (Centre for Environmental Research – UFZ, Leipzig, Germany), for application of the passive sampling membrane enclosed silicone collector (MESCO), silicone rod(SR), bare SR, in Shkodra Lake for analyzing organic pollutants. (Financed from UFZ Germany), (2004-2007).

Neziri, A. has been an expert in the following projects; Institutional Support to the Albanian Ministry of Environment, Forests and Water Administration for the Conservation and Sustainable Use of Biodiversity in Protected Areas: (Italian Ministry of Foreign Affairs and the Ministry of Environment of Albania; Promotion of a Common Implementation of the Water Framework Directive within the cross-border river basin of Aoos-Vjosa, IPA Cross-Border Albania-Greece program 2007-2013; Traditional Indigenous Plants for the value added value of new products with different applications, SEE-ERA.NET PLUS, German Aerospace Center (DLR). Neziri, A., Bushati, N., Rakaj, M, Smajlaj, RR., etc. participated as experts in the projects: EULIMNIOS Integrated monitoring of Shkodra Lake) financed from HRK Germany (2002-2007) and (FP6) Joint research project "An integrated strategy to assess and evaluate water quality of Lake Shkodra" for the years 2008-2010.

5.4. Projects and international mobility in the field of Biology

Rakaj, M. and other members of the Water Research Center of the Shkodra Region have conducted a series of individual and institutional co-operations in the implementation of various national, cross-border and international research projects on the study and monitoring of chemical, microbiological and biological parameters of the Lake Shkodra, Drin and Buna rivers. Among the most important, is the cooperation with the University of Graz, with the Conference of Rectors of Germany in the project EULIMNIOS (HOLLERT et al., 2004); with the World Bank in the project "Shkoder/Skadar Lake Eutrophication level"; with the GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) in the project “Initial characterization of Lake Shkodra, Lake Ohrid and Lake Prespa in Albania”; with the Hungarian Museum of Natural History, Budapest in the project "Towards a checklist of Flora of Albania", in the project "On the status of habitats and species of Lake Shkodra", supported by IPA Albania-Montenegro etc.

Rakaj, M. has been co-ordinator and participant in several projects, such as: "Evaluation of physico-chemical and biological qualities of Shkodra Lake resources, USH project (2005-2006); SEE-ERA NET and MASH (2007-2008) project; Evaluation of the saprobic level and endemic plants of the Drini River, USH project (2007-2008), Investigation of Shkodra / Skadar Lake Eutrophication level, the World Bank project (2012).

He has also participated as a member or consultant in the following projects: Performing the Integrated Environmental Management Plan at the local level in the Shkodra Lake Ecosystem - EMA PLAN, Cross-Border

Cooperation Program, IPA Albania-Montenegro (2012-2013); Conservation and Sustainable Use of Biodiversity at Lakes Prespa, Ohrid and Shkodra: Study on: Initial characterization of Lake Shkodra, Lake Ohrid and Lake Prespa in Albania (2012-2014); Towards a checklist of Flora of Albania, Hungarian Academy of Sciences (2012-2017); Enabling Transboundary Cooperation and Integrated Water Resource Management in the Extended Drin River Basin, GEF (2017); Regional Project in Albania, Macedonia and Montenegro to the EU Water Framework Directive (WFD), supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in favour of the Federal Ministry for Economic Cooperation and Development (FMECD).

Rakaj, M. has completed a 4-month qualification in phytoplankton study methods during 1995-1996 at the Carinthian Institute for Lake Studies, Klagenfurt, Austria. He has also developed lectures on "Biogeography and Land Use" during second Term with postgraduate students in the Geoscience branch at Corvallis State University, Oregon, USA (2005).

There have also been publications in cooperation with the Albanian Academy of Sciences, in the field of biology [168], etc. One of the authors with the most dynamic scientific activity in this regard is Dhora, Dh. For many years he has been a member of the Pan-European Species Directories Infrastructure - Amsterdam (Netherlands), a part of the PESI Fauna Europaea Focal Point Network, also the focal point of Fauna Europaea online (Museum fur Naturkunde Berlin). Co-worker of AnimalBase - Göttingen (Germany), SeaLifeBase and FishBase - Los Banos (Philippines), etc., as well as in the network with many other prestigious databases in the global, regional or local plan like World Register Marine Species - WoRMS and European Register Marine Species - ERMS (Belgium), Eu-nomen or PESI (Belgium), Canadian Register Marine Species - CaRMS (Canada), Web Museum of the European Fauna - Ictiofauna (Italy), Wikipedia - Encyclopedia of Life (USA) Catalog of Life (Netherlands), University of Chent UK, Yumpu (Switzerland), Mars Network (Belgium), Scribd (San Francisco), Marbef (Netherlands), Invasive Species Compendium (UK), IUCN.

Regarding the Hygiene Institute and Institute of Zoology Heidelberg, also Bushati, N. during the period 2002-2006 has participated as a scientific researcher in the EULIMNIOS PROJECT financed from HRK, Germany and has conducted training on the application of the bacterial contact test, the micronucleus method in blood samples obtained from different fishes, the first application of the semi-permeable SPM sediment membrane method and the extract was used to implement the EROD bio-tester with samples from sediments and water samples from Shkodra Lake. During this period, the toxicity of sediment samples taken from both sides in Albania and Montenegro was determined.

Bushati, N. during the years 2001, 2002 and 2003 has completed post-graduate studies at the Karl-Franzens University Graz, Institute of Hygiene Graz, Austria, focusing on microbiological analysis of waters, virology and serology fields, “identification of Anaplasma infection in the North of Albania” etc.

Bushati, N. has been a local coordinator of the working group for the University of Shkodra "Luigj Gurakuqi" in the project EULIMNIOS "Integrated monitoring and ecological surveys of Shkodra Lake " from 2002-2007 with the subject study "Microbiological Investigation of Shkodra Lake", “Applying of different methods of bioassays” and "Test of micronucleus in erythrocytes of Cyprinos carpio (Teleostei Pisces) in Lake Shkodra".

5.5. Projects and international mobility in the field of Nursing

Shabani, Z. and other staff members of the Department of Nursing are involved in several socially impacted projects in the city of Shkodra. Among the most important projects is the project "Reducing Women's Poverty, a Necessity for Comprehensive Equality" within the Regional Program on Local Democracy in the Western Balkans (ReLOaD), Organization: Albanian Red Cross Branch Shkodra, financed by the European Union and implemented by the United Nations Development Program (UNDP). Other projects involving the nursing staff are; "Free and Voluntary Blood Donation" funded by ARC and Albania's Ministry of Health, "Fight against HIV," "Knowledge of First Aid", "Community and Personal Hygiene", "Club 25" MKS Shkodra Branch, "Improvement of Primary Health Care in Albania" USAID, "Training of Primary Health Care Personnel under the Basic Medical Check Package for Citizens Aged 40-65", provided by the Community Centre for Health and Welfare for the period: 2015, for the Region of Shkodra, etc. Along with national projects, important work has also been done on cross-border research projects (Albania-Montenegro) by the Institute for Scientific Research and Development.

6. Scientific degrees acquired abroad

The scientific degrees obtained at Western Universities are an important indicator of the scientific level of the new staff of this faculty. They show the coordination of the activity of the new faculty staff with the international research priorities. Masters and PhDs have been granted in several fields, such as Mathematics, Physics, Informatics, Biology, etc.

In the field of Mathematics there have been experiences in Western Universities that are worth mentioning, a Master's degree from Kadija, B. at the University of Agder, Department of Mathematical Sciences in 2010, on "Albanian Upper Secondary Students ‟ ways of working with equations".

In the field of Applied Physics, doctoral protection by Gavoçi, E. at the University of Bologna, Italy [50] should be mentioned.

In the field of Informatics, two lecturers of Informatics, Paloka, B. and Berati, G. have completed their Master studies and have given a scientific contribution to the implementation of new tools at HAN University of Applied Sciences, Arnhem, Netherlands. Berati, G. and Berberi, L. have attended doctoral studies at the Alpen Adria University Klagenfurt, Austria, in the field of applied sciences. Also, two students of Reci, E. and Xhura, D. graduated with a Bachelor of Informatics in Shkodra, have completed master studies at "Alpen Adria" University and are completing PhD studies at this University. Moreover, E. Reci is part of the academic staff of "Alpen Adria" University. Also, Duli, S. has completed her doctoral studies in the field of Parallel Programming at the University of Montenegro.

In the field of the Environmental Chemistry Neziri, A., completed her PhD studies by conducting research work in the (Centre for Environmental Research – UFZ, Leipzig, Germany), for application of the passive sampling membrane enclosed silicone collector (MESCO), silicone rod (SR), bare SR, in Lake Shkodra for analyzing organic pollutants. (Financed from UFZ Germany), (2004-2007).

In the field of Biology, Bushati, N. in the year 2000 has prepared the diploma thesis at the Institute of Hygiene, Karl-Franzens University, Graz in Austria with scientific leader Prof. Dr. Wolfdieter Sixl. "The Spread of Ehrlichiosis in Northern Albania, Shkodra and Malësia e Madhe". In 2003, Bushati, N. completed her master thesis at the Institute of Hygiene, Karl-Franzens University, Graz, Austria, on "Identification of infection of Anaplasma spp in North of Albania in domestic animals by the PCR method".

7. Bibliometric indicators

Scopus provides quantitative and qualitative information on the scientific productivity of an author or an institution. Quantitative productivity estimates are based on the number of publications, while qualitative addresses the number of citations received. Below are the analyse search results obtained by Scopus.

The total number of publications is 62, with 315 citations received since 2005, based on Scopus. The number of citations received from these papers derive a h-index of 10. Figure 2 presents time-series of publications from 2000 to 2019.

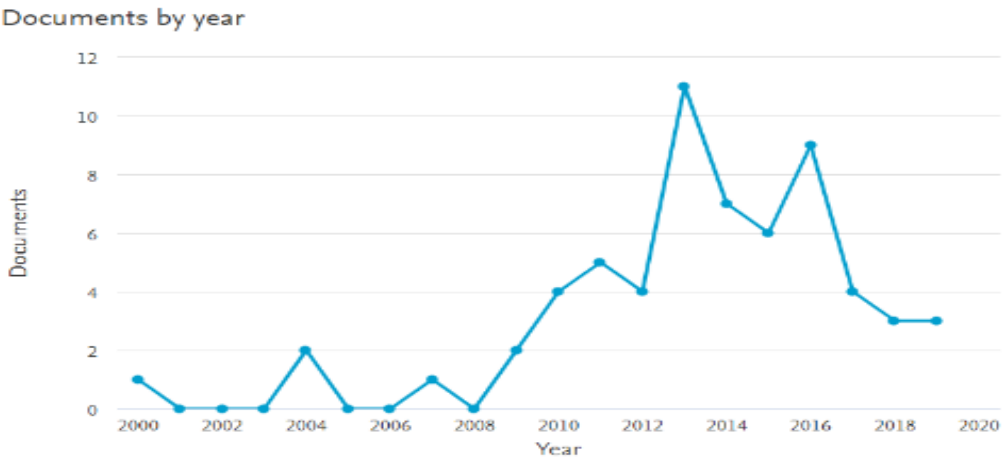


Figure 2: Documents by year of the FNS's staff (2000-2019).

The number of publications reaches an irregular maximum during the period 2013-2016, a period associated with the acquisition of scientific degrees and academic titles.

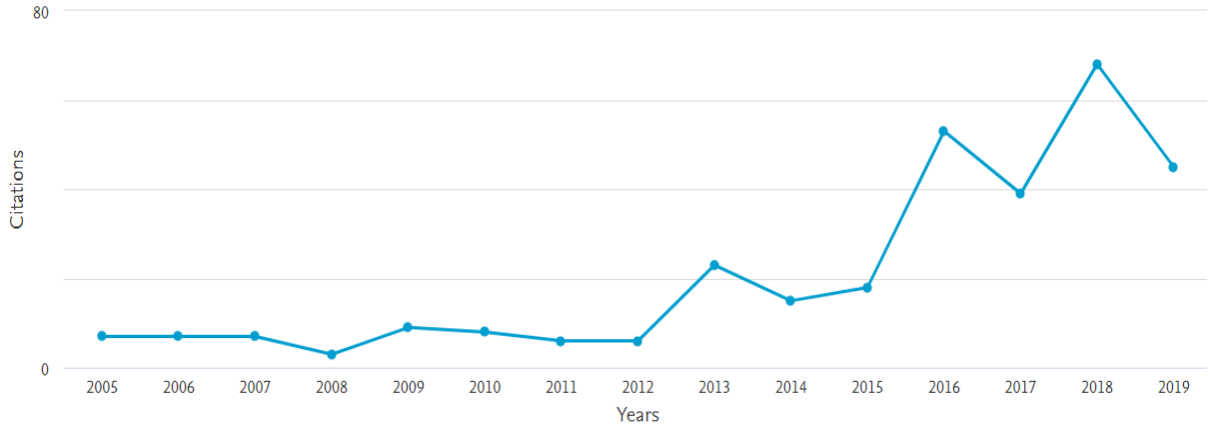


Figure 3: Time-series of citations received by the FNS's publications (last 15 years).

As it can be clearly seen from the Fig. 3, the trend of citations advances markedly after 2015, which also depends on the young age of these publications. The citation trend is significantly upward, with exponential approximation (R2 = 0.74).

Most of the publications (53) in Scopus are articles in peer-review journals. Another part (6 were published proceeding reports, while another part (3) had different forms of publication (Fig. 4).

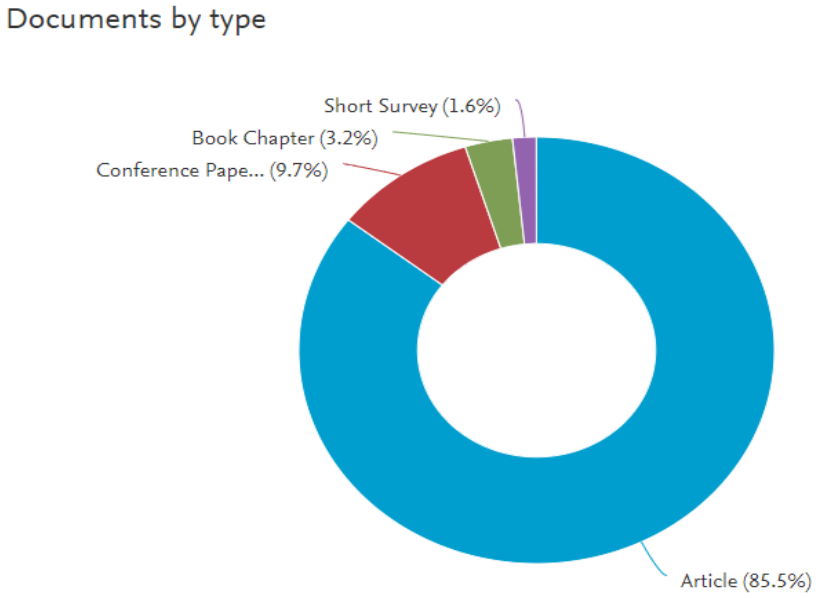


Figure 4: Documents by type (2000-2019, Scopus).

One of the most important points of this analysis is also the definition of the main subject-areas and subject-categories research, based on publications in major journals. Based on Scopus, Figure 5 shows the main research-lines elaborated by the FSN's staff.

Figure 5 shows that Environmental Sciences occupy the major part of the publications (36). Significant publications have also been in Earth and Planetary Sciences (13) and in Agricultural and Biological Sciences (12). The rarest are publications in other directions (28).

In addition to the data from Scopus, data from other platforms are also used to assess the publication rate made by FNS staff. For example. Data obtained from Google Scholar and Microsoft Academic present these time-series of publications by the departments of Biology, Chemistry, Physics, Nursing, Informatics and Mathematics.

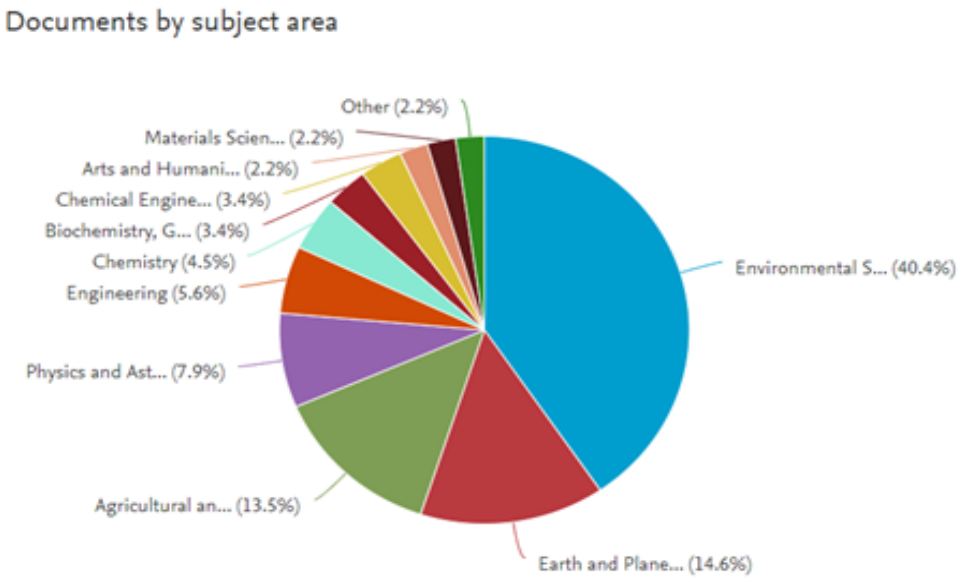


Figure 5: Documents by subject area (2000-2019, Scopus).

The highest publications rate in Google Scholar and Microsoft Academic, in traditional units such as Biology, Physics and Chemistry were recorded during 2012-2014 (Figure 6). While in the newer units, such as Informatics and Nursing, this maximum was observed later in 2018, even though Nursing also had a second maximum in 2013. On the other hand, the maximum in the Mathematics unit was during 2016- 2017.

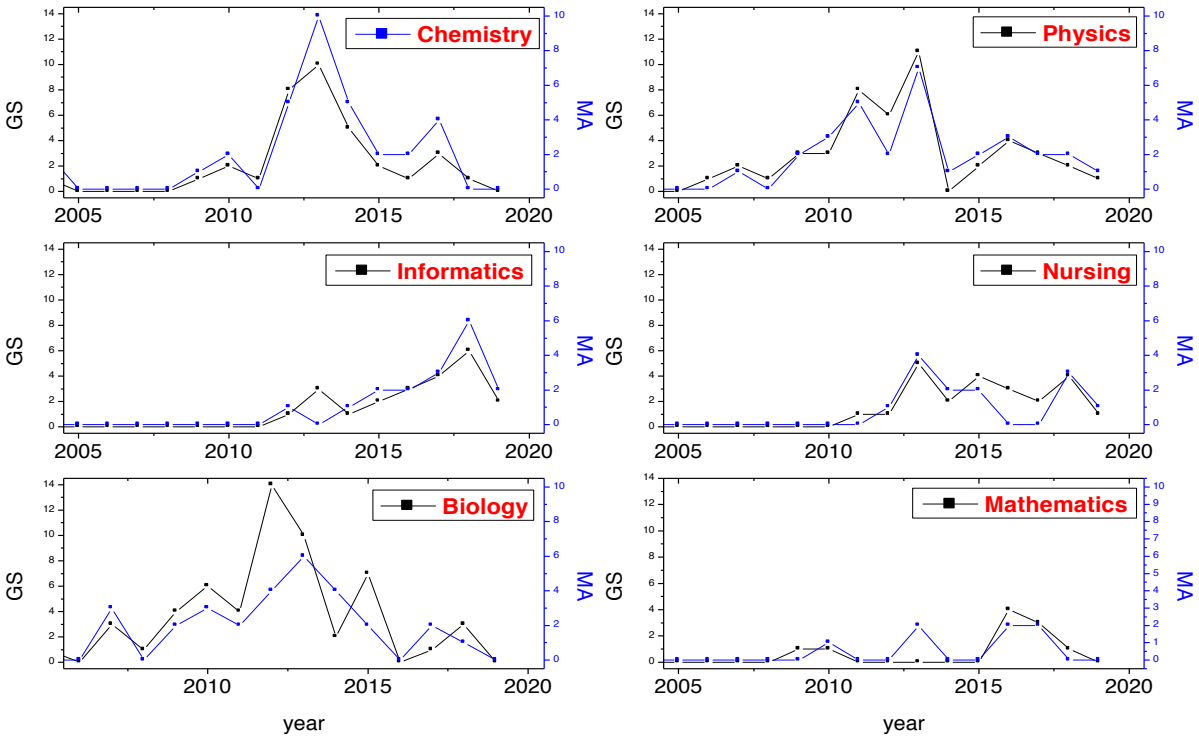


Figure 6: Time-series of the number of publications for each department/section of the FSN (period 2000-2019), based on; a) Google Scholar and b) Microsoft Academic.

Despite the different number of publications presented by the three platforms, time series are strongly correlated. Pearson's coefficients of correlation between the number of publications in Google Scholar, Microsoft Academic and Scopus are very high; respectively 0.94, 0.85 and 0.96.

The combination of publications and citations provides clearer information, not only on the scientific productivity of the institution, but also on its qualitative level. The number of citations received from scientific papers shows the degree of their impact on the scientific community. Table 1 shows the percentages of the number of publications and citations for each department. The data were obtained by Google Scholar, Microsoft Academic and Scopus platforms.

Table1: Reports on no. of papers and their citations by departments (sectors), based on Google Scholar. Moreover, citations per paper, citations per author and h-index, for each department/sector, are presented.

Dept./Sec.	papers	citations	cit./year	cit./paper	cit./auth.	paper/auth.	h-index
Biology	30	49	14.26	3.61	124.27	34.10	9
Chemistry	18	26	5.68	3.09	41.72	20.98	5
Physics	32	24	9.69	1.59	44.35	32.21	6
Informatics	10	5	4.29	1.15	13.25	15.67	3
Nursing	10	1	0.63	0.19	1.67	8.53	1
Mathematics	4	0	0.00	0.00	0.00	5.70	0

Table2: Same as Table 1 but based on Microsoft Academic database.

Dept./Sec.	papers	citations	cit./year	cit./paper	cit./auth.	paper/auth.	h-index
Biology	23	23	3.50	1.81	25.68	13.87	5
Chemistry	25	44	5.58	3.12	16.92	14.71	2
Physics	24	26	5.25	2.03	16.58	11.16	6
Informatics	13	7	2.29	0.94	6.25	9.00	3
Nursing	12	1	0.29	0.15	0.67	4.45	1
Mathematics	5	0	0.00	0.00	0.00	4.75	0

Table3: Same as Table 1 but based on Scopus database.

Dept./Sec.	papers	citations	cit./year	cit./paper	cit./auth.	paper/auth.	h-index
Biology	21	31	3.00	3.56	57.00	16.00	4
Chemistry	25	31	5.60	2.95	56.00	19.00	5
Physics	32	32	4.83	2.64	58.00	22.00	5
Informatics	13	3	0.83	0.38	5.00	13.00	1
Nursing	9	3	0.57	0.67	1.00	1.00	1
Mathematics	0	0	0.00	0.00	0.00	0.00	0

Values of Table 1 show that Physics and Biology are the major contributors to Google Scholar, with approximately 62% of all publications in this database in the Faculty-level database. Biology has received nearly half of the citations in the platform. The situation changes slightly when it comes to the Microsoft Academic review, in which

Chemistry, Physics and Biology have the highest percentage of publications (72%), where Chemistry has already received the highest percentage of citations (44%). On the Scopus platform, Physics has the highest percentage of publications (32%), while Physics, Biology and Chemistry have almost the same percentage of citations with 94% in total. In all three of these platforms, Informatics and Nursing come after three main units, both in terms of the percentage of publications and their quotes. The combination of the number of publications with citations received, gives insights about the research-science dynamics [169]. Based on the h-index values, Biology has the highest index in Google Scholar (9), due to the high number of citations accepted in this database. Physics and Biology have the highest h-index in Microsoft Academic, respectively 6 and 5. While in Scopus Physics, Chemistry and Biology have the highest h-indices, respectively 5, 5 and 4. An indicator of the quality of articles is the total number of citations they have received and their number per year. The most highly-cited papers in the three platforms are ranked according to the citation/year in Table 4.

The papers with the highest citation rates are as follows; more than 3 citations per year simultaneously in Google Scholar and Microsoft Academic [29-30, 70, 93, 170] and more than 3 citations per year in Scopus [29-30, 94, 70, 119, 170]. Table 4 shows that also many papers with first author by FNS are among the most quoted [29-30, 70, 170]. Some of the most significant publications are those published in impact-factor journals. Among them, we can mention those published over last two decades [23-30, 44, 46-49, 57, 74-78, 81-82, 84, 89, 92, 96, 99-100, 103, 107-108, 110, 114-120, 122, 124-125, 139, 143, 146-147, 153-155, 170]. Another quality indicator of publications is the rank of journals where there are published. Based on the Scimago Journal & Country Rank (SJR) journals are classified into four quartiles; Q1, Q2, Q3 and Q4 (Fig. 6). The prestigious journals are grouped in the 1st quartile category Q1. In this category, the authors of the FNS have been published in several sub-categories. Thus, in the atmospheric sciences there have been published papers in journals with impact factor higher than 4.0, such as Atmospheric Research [29-30] and Atmospheric Environment [27], but also in the atmospheric research have been published in journals with a higher impact factor than 4, in the Chemistry Engineering Society's Royal Society Chemistry Advances [24] with impact factor 3.0. In the field of medicine, publications in the European Journal of Internal Medicine [153], impact factor journal 3.6, was realized. There were also publications in the environmental sciences, such as in the journal Environmental Science and Pollution Research (Hollert et al., 2004; Rastall et al., 2004), with an impact factor of 2.9. There have been published even in top 10% (T10) journals of the field, such as Atmospheric Environment [27].

Table4: Most cited papers (Source; Google Scholar, Microsoft Academic and Scopus).

Paper	cit./year	citations	cit./year	citations	cit./year	citations
	Google Scholar		Microsoft Acad.		Scopus	
Rastall et al., 2004	5.67	85	6.00	90	3.87	58
Mandija et al., 2017	4.50	9	4.00	8	3.50	7
Çoba et al., 2017	5.00	10	2.00	4	2.00	4
Mandija et al., 2018	5.00	5	3.00	3	4.00	4
Barina et al., 2018	5.00	5	1.00	1	2.00	2
Çoba et al., 2019b	4.00	4	2.00	2	3.00	3
Jong et al,. 2015	3.00	12	2.50	10	2.75	11
Çoba & Zanker, 2017	3.50	7	1.67	5	1.00	2

Alongside publications in scientific journals, a very important contribution of the authors of FNS are also publications of scientific monographs. Although most of these monographs have been published in Albanian, they have great value not only nationally but also regionally and beyond that [112, 138, 160-163, 165-166, 173-174]. There are also monographs/polygraphs or chapter-contributing publicized abroad [117-118, 175].

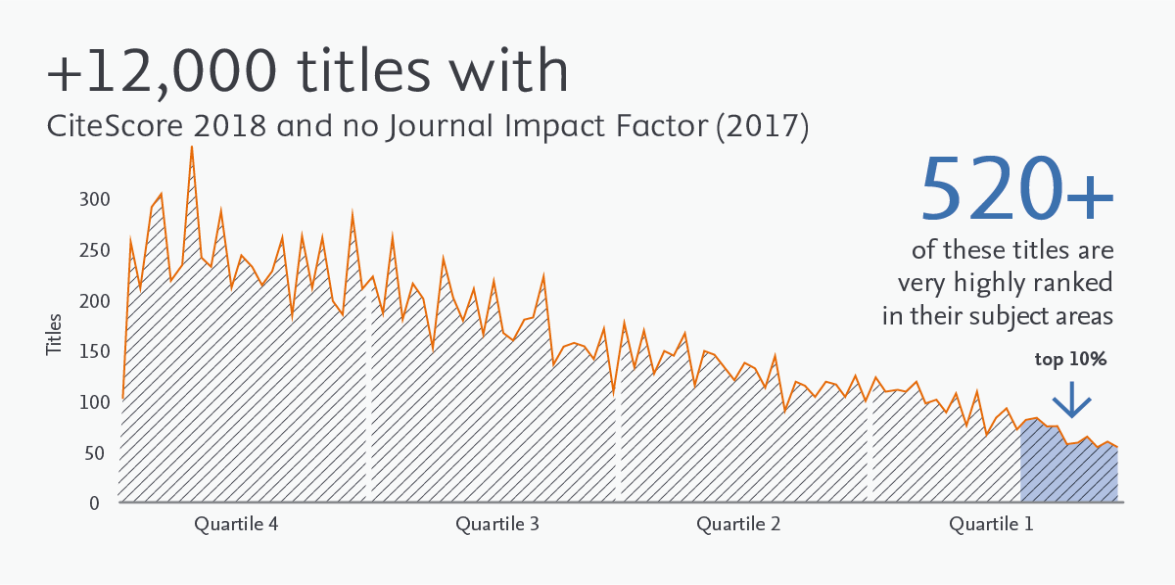


Figure 7: Comprehensive coverage: Available for more than 23,830 titles on Scopus, CiteScore covers twice as many journals as the Impact Factor, including over 500 top-ranked titles (ELSEVIER, Cire Score) [172].

Conclusion

This is the first time that a review of the scientific activity of the Faculty of Natural Sciences has been compiled. Although one of the main tasks of the University of Shkodra "Luigj Gurakuqi" is teaching, the conditions under which universities to-date determines the goal toward the scientific research. Research projects, as well as the promotion of the creation and expansion of national and international networks and consolidating the skills of the academic staff through scientific research are steps towards the integration of this new institution in the international scientific community.

The Faculty of Natural Sciences has the most intensive research activity at the University of Shkodra, expressed in terms of publications and citations in peer review journals, participation in international conferences, cooperation in research projects, international mobilities, etc. at university level, FNS has about 2/3 of the publications in Scopus.

The main subject areas elaborated in this faculty are; Natural & Environmental Sciences (Departments of Biology and Chemistry, Physics and WRCSHR), Earth and Planetary Sciences (Department of Physics) and Agricultural and Biological Sciences (Department of Biology and Chemistry, WRCSHR). The most dynamic period of research productivity based on Scopus published papers is 2013-2016. After this period, 2016-2019 the citation count reaches its maximum. Almost all the platforms used in this study yield the same publication trends. Time-series of the number of publications counted by Google Scholar, Microsoft Academic and Scopus, have very strong relationships. It is noteworthy that especially during the last decade, the environmental research is the main research stream where the publications and the projects are processed. The departments of Biology and Chemistry and that of Physics have the highest calculated h-index. They have the best performance in terms of number of publications, respective citations, citations per year, citations per author, etc.

An interesting pattern in the type of publication is evidenced by Scopus. Almost all publications here are done as papers in peer-review journals, and only 15% are published as conference proceedings reports.

The Faculty of Natural Sciences has many collaborative research institutions and faculties in Albania and abroad, especially in the EU area. Those in are in Italy, Spain, Hungary, etc. However, the main output of research comes from the collaboration with the University of Tirana, which is the principal national university.

There are many high-cited papers published by the staff of this faculty, prepared in collaboration with abroad institutions, where they often act as first author in these papers. Many of these papers are published in high impact factor journals as well in the 1st quarter (Q1) and even in the T10 journals. An essential part of the research productivity in this faculty is the publication of monographs. Although most of them are written in the native language, their impact in science is extraordinary.

It should be noted that a very important part of the activity of this faculty has been and has to do with didactics and teaching methodology, which has not been the focus of this study. A further study, which encompasses the entire range of the faculty's activities, may provide more comprehensive information.

The results of this review highlight the need for further scientific productivity at the faculty level. Today's challenges require that universities and their constituent faculties to be more efficient in terms of scientific research, collaborative projects and their impact both in the scientific community, economy and society.

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