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INVESTIGATION AND VISUALIZATION OF THE APPROACHES MOBILIZING THE CONCEPT OF HEALTH OF THE ENVIRONMENT

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Abstract

Precise terminology is essential for every field for developing problem-solving strategies. It also helps to establish effective legislation and management frameworks. The field of environmental sciences is not an exception. A fast and accurate reaction to environmental issues can lead to fruitful results and prevent catastrophes. In order to improve performance, various approaches are created and thoroughly studied which appear to be more efficient when used for specific situations and aims. Therefore, it is important to have a good understanding of synonymously appearing approaches.

The thesis's objective was to present and investigate the existing approaches addressing the concept of health of the environment. The study aims to achieve it via statistical analysis of scientific literature mentioning the terminology associated with the approaches.

Graphs on the historical development of terms were created to demonstrate the general trends occurring in the field and fluctuations in the popularity of each term. An analysis of the disciplines using the terms was performed to reveal possible similarities and overlaps in approaches known by different names. Finally, a keyword analysis was performed in VOSviewer aiming to demonstrate the environment's role in the approaches.

The study confirmed an existing increase in the popularity of the terms preferred in the scientific literature. It also revealed great convergence between the approaches of ecological health and ecosystem health. The results also indicated that the majority of the approaches show more anthropocentric than biocentric qualities. The study partially achieved its objectives since for a proper study of some approaches available literature was insufficient.

Keywords

health, environment, theoretical approach, visualization

IMPORTANT DEFINITIONS

Concept

> "A general idea or notion that corresponds to some class of entities and consists of the characteristic or essential features of the class." (Collins English Dictionary – Complete and Unabridged, 12th Edition 2014).

Concepts are essential for the research process and analysis of phenomena of interest. They are the basis of the ontology of the subject of study since a theory of ontology is a core attribute of a concept. The difference between a definition and a concept is that concepts, unlike definitions, contain crucial information about the entity data for the phenomena, and arguments, justifying why chosen attributes are especially important and indispensable for the ontological theory. (Podsakoff, MacKenzie and Podsakoff, 2016.)

The functions of theoretical concepts in the scientific field include the following:
1. To help organize the phenomena in the world around us into meaningful categories and describe their attributes
2. To prevent the usage of the same concept for different phenomena
3. To provide organizational and behavioural scientists with a common language to communicate their ideas to each other
4. To help distinguish the focal concept from other, seemingly similar concepts in the field
5. To serve as the essential building blocks of theory

Epistemology

The Oxford Dictionary defines epistemology as:

> "The theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion."

In general, epistemology concerns about people's assumptions about the nature of knowledge and its type or form and how it can be acquired and communicated to other individuals. Epistemological assumptions of a researcher about knowledge can influence the choice of approach and methods which will be used in the research. (Al-Saadi, 2014.)

Holism

According to the Oxford dictionary, holism is

> "The theory that parts of a whole are in intimate interconnection, such that they cannot exist independently of the whole, or cannot be understood without reference to the whole, which is thus regarded as greater than the sum of its parts. Holism is often applied to mental states, language, and ecology."

The main idea is that the whole is greater than the sum of its parts, for the reason that there are various interrelations and other aspects that will remain uncovered and unnoticed during the examination of qualities of parts separately. (Amini, 2001.)

Methodology

The methodology is a system of methods or ways to do something, e.g., studying, teaching, and achieving something. A research methodology is a strategy, design, and choice of methods, including logic and justification of this choice, which will lead to the successful solution of the research problem.

Nexus

According to the Collins English Dictionary (2014), nexus is

> "A means of connection between members of a group or things in a series; link; bond."

In this research, "nexus" represents interconnection, interlinkage between environment and health.

One Health

One of the most nationally and internationally recognized approaches to finding solutions to health-related issues. It considers interconnectivity between humans, animals, and the environment surrounding them, and proves a multidimensional approach to their challenges

to be more effective for each of the three sectors. (Conrad et al., 2013.) One Health approach served as a starting point for this research.

Ontology

The SAGE Dictionary of Social Research Methods provides the following definition of the ontology:

> "A concept concerned with the existence of, and relationship between different aspects of society, such as social actors, cultural norms and social structures."

Ontology concerns people's assumptions about the kind and nature of reality and whether the 'real' world is independent of social actors and individuals' personal experience or is socially constructed (Al-Saadi, 2014; Harrison et al., 2019).

Snowballing technique

A technique, commonly used in systematic literature research. It includes using the reference list of a paper or the citations to the paper to find additional papers for further analysis. Snowballing is a popular search approach. (Wohlin, 2014.)

CONTENTS

1 INTRODUCTION

The environment is an inseparable part of human life. It has a strong and direct influence on the life's quality. Consequently, it is for the benefit of humankind to investigate, understand, and learn how to live in harmony with the environment. The strong connection between our life and the ecosystems surrounding us is undeniable. Thus, successful development and future prosperity of humanity are impossible without paying attention to the changes in the environment, both natural and caused by human activity.

From ancient times, the human-nature relationship has been the object of interest. According to environmental history, for preindustrial societies, nature was a powerful agent. It was a source of health, beauty, and life as well as suffering and disasters. Traditions (Iwatsuki, 2008; Talukder, 2019) were placing the human in a wider cosmos of nature, where the two were coexisting in complete harmony. However, in industrial society, at the end of the 19th century, the role of nature was relegated to the background and remained there almost until the 1950s. With the growth of the human population and industrial progress, the adverse effects of human activity on ecosystems became stronger and more obvious. Environmental issues have rapidly advanced to the point where they can no longer be ignored; it became clear how disastrous the effects of human interventions in the environment can become. (Brüggemeier, 2001.) Nowadays, environmental problems cannot be avoided, and related environmental issues are always on the agenda (Warren, 2020).

The development of the modern world and industrialization increased the rate of environmental change, which led to the appearance of significant environmental problems, such as greatly increased precipitation in susceptible regions and more severe droughts in others (Zhao et al., 2018), increased runoff of chemicals (Zhang et al., 1997), erosion from severe storms and floods (Pollard et al., 2018), sea-level rise and more severe surges from cyclones and hurricanes in coastal zones (Maloney & Preston, 2014), as well as the inability of many species to adapt to rapid changes in climatic regimes (Shaw & Etterson, 2012), potentially having impacts on the population levels (Aguirre et al., 2016). In many areas, the

state of the environment has become more fragile and degraded, which has given cause for concerns.

However, a return to preindustrial society is not possible and, moreover, would be dangerous. Thus, the priority of the modern world is to maintain progress and, at the same time, change the activities providing it, so they could promote more ecological practices and, in general, move in a more environmentally friendly direction. (Katsoulakos et al., 2016.) Therefore, increasing attention is devoted to the study of the environment, its influence, and its role in the successful development of the human population.

1.1 Raising awareness of the importance of human-environment interconnection

The topic of importance of the environment has not only become a subject of discussion in scientific societies but also in socio-economic and management communities (Basiago, 1998). Special consideration is given to the challenges of environmental management and various qualities of the environment. Among them, the following can be highlighted: resilience, complexity, sustainability, and health.

Since the 1990s, both environmental epidemiological studies and the socio-economic development analyses relying on the multidimensionality of the human development approach have highlighted the existing link between population health and environment, assuming an integrated approach to health (Tong et al., 2002; Sinaga et al., 2015). Moreover, both the definition of human development provided by the United Nations and the definition of environmental health adopted by the WHO European Centre for Environment and Health rely on the integrated approach to health. (Marsili, 2009.)

The link between health and the environment has become more tangible. Consequently, this increases the necessity to structure and frame this interconnection in order to predict, observe, and control all possible changes occurring in this link and their consequences. This must be reflected in the

language. The appearance of specialized terminology allows the creation of efficient legislation, protocols, and effective management frameworks. Moreover, language can serve as a simple and logical litmus test, showing the latest trends in a given field. Fluctuations in the popularity and frequency in the use of various terms reflect the changes in the field, such as growing concerns about a particular problem or essential discovery.

The urgent call for finding an appropriate regulatory strategy for global health management has led to the development of various approaches to the achievement of the desired health objectives. One Health is one of those approaches. It recognizes the interconnectivity between human health and animal health within the context of the health of the environment and optimizes outcomes for each of these sectors by providing frameworks for developing solutions. (Sleeman et al., 2017.)

References to the different approaches related to various interconnection levels has become increasingly frequent in the scientific literature (Hill-Cawthorne, 2019). This is an indicator of their suitability and an existing demand for new, more specific approaches, better suited for particular types of issues.

One Health is not a new concept (Mackenzie & Jeggo, 2019). A great amount of literature is dedicated to its analysis, critique, and comparison with other approaches. It contributes and gives rise to various terms and concepts aimed at simplifying the process of describing, defining, and eventually managing problems occurring in the interference of human health, animal health, and the health of the environment. One Health is one of the most influential approaches, and it shares numerous common features with various other approaches (Beasley, 2009; Lerner & Berg, 2017; Harrison et al., 2019), which makes it a suitable starting point for this thesis.

This study’s aim is to present and investigate different approaches which address the concept of the health of the environment. By analyzing the terminology associated with them. The study includes a collection of terms related to the

approaches, review of those terms, mass analysis of the papers found during the database research, and a related key-word analysis. The analysis will illustrate the historic evolution of the terms and which disciplines mobilize them. Moreover, it will reveal possible convergences in the approaches known by different names and show how important the environment is for the choice of an appropriate strategy and action plan.

1.2 Structure of the thesis

The idea for the thesis was obtained during practical training which was organized remotely for the German Centre for Integrative Biodiversity Research (iDiv) in the spring and summer of 2020. IDiv is a DFG research centre with an emphasis on the ongoing biodiversity crisis. The two main missions of the centre are to provide a scientific basis for the sustainable use of our planet's biodiversity and develop a new field of research: 'Integrative Biodiversity Research'. (*iDiv.de*, 2015.)

IDiv has thirteen core research groups, working in Leipzig. During the practical training, the work was performed in the group, which is called Ecosystem Services. This research group's main focus is on the field of ecosystem services and biodiversity conservation in a changing world. Inter- and transdisciplinary approaches, which are commonly used in the studies connected to the ecosystem services, include facilitating participatory methods and knowledge exchange at the science-policy interface. (*iDiv.de*, 2015.)

The research, which served as a basis for this thesis, was performed as a part of a larger internship project, dedicated to performing an integrative and narrative qualitative review of the literature addressing the issue of the health of the environment. It was aimed at questioning the underlying managerial assumptions of the various approaches, comparing the usage of terms associated with them among different disciplines, and finding the way to define and make visible the health of the environment. That research project paid particular attention to thorough reading and in-depth detailed analyses with a particular focus on the ontological, epistemological, and methodological underpinnings of the concept of

health and the environment within the scientific communities. It sought to answer the question of how people interpret the concepts of the environment and health of the environment, and how human organizations can arrange actions to manage environmental issues, particularly in the agricultural industry.

This thesis presents the part of the research project. Here, the main focus is also on the analysis of scientific literature. However, in this study, the analysis was mainly performed with the help of various tools and did not include a thorough reading of all the collected papers. The main aim was to present the trends in the academic literature regarding the approaches where environment and health are interrelated.

In order to achieve that aim, the following smaller aims were formulated:

- Identify the terms used to describe approaches in the health – environment nexus
- Identify the historical trends the terms underwent
- Define disciplines that mobilize these terms
- Find convergence or divergence in the use of these terms.

It is important to highlight that unlike the main internship project, this study is not concentrated on the analysis of the philosophical concepts behind the approaches and will not provide definitions of the terms associated with them.

2 THEORETICAL BACKGROUND: PRESENTING THE LINKS BETWEEN THE ENVIRONMENT AND HUMAN HEALTH

The environment affects human life in various ways and it is difficult to deny interconnection and the significant effect of the state of the environment on human health (Prüss-Üstün et al., 2016), both directly, for example, by exposure to hazardous agents, and indirectly, by a decrease of biological diversity (Ramlogan, 1997), as well as the adverse effects of anthropogenic activity on the environment (Prospero & Arimoto, 2008).

It is important to study the health of the environment and also to investigate how exactly interaction with nature will affect humans and animals. One of the oldest

concepts that employs such an interdisciplinary approach is the One Health movement.

2.1 One Health

For the investigation of the concept of the health of nature, it is important to include background information about the One Health concept. Due to its good coverage in the literature and the fact that this concept is widely and internationally acknowledged, it served as a good starting point for this study. In addition, it has many interconnections with other concepts, the analysis of which was the priority for this thesis.

2.1.1 Historical overview

One Health is one of the most internationally best-known approaches broadly aimed at understanding the links and interactions between human, animal, and environmental health. One Health promotes the collaborative effort of multiple disciplines working together to obtain an optimal state for the health of each of the three segments. (Alonso Aguirre et al., 2019.)

This concept originates from the 19th century when the idea of linkage between human and animal medicine started to gain popularity. In the first half of the 20th century, the importance of animals' role in the epidemiology of zoonotic diseases became clear and spread worldwide. Calvin Schwabe made a great contribution to the popularization of this approach. Through his position as chair of a new Department of Epidemiology and Preventive Medicine at the University of California, Davis School of Veterinary Medicine, and his writing, Schwabe strongly advocated for collaboration between professionals in human and veterinary public health to address zoonotic disease concerns. He also introduced the term "One Medicine", which later evolved into "One Health", placing emphasis on health promotion rather than treating diseases. (Gyles, 2016.)

The One Health concept of the 21st century has been seriously modified and has seen some significant changes. The most important is switching its focus more towards ecological processes and environmental factors as key determinants of human and animal health (Evans and Leighton, 2014). After that, One Health was evolving and has grown into a broad, encompassing concept containing several scientific fields. Currently, the One Health concept is still a subject of ongoing discussion. Below, Figure 1 presents the visualization of One Health as an umbrella for various scientific fields (Lerner & Berg, 2015).

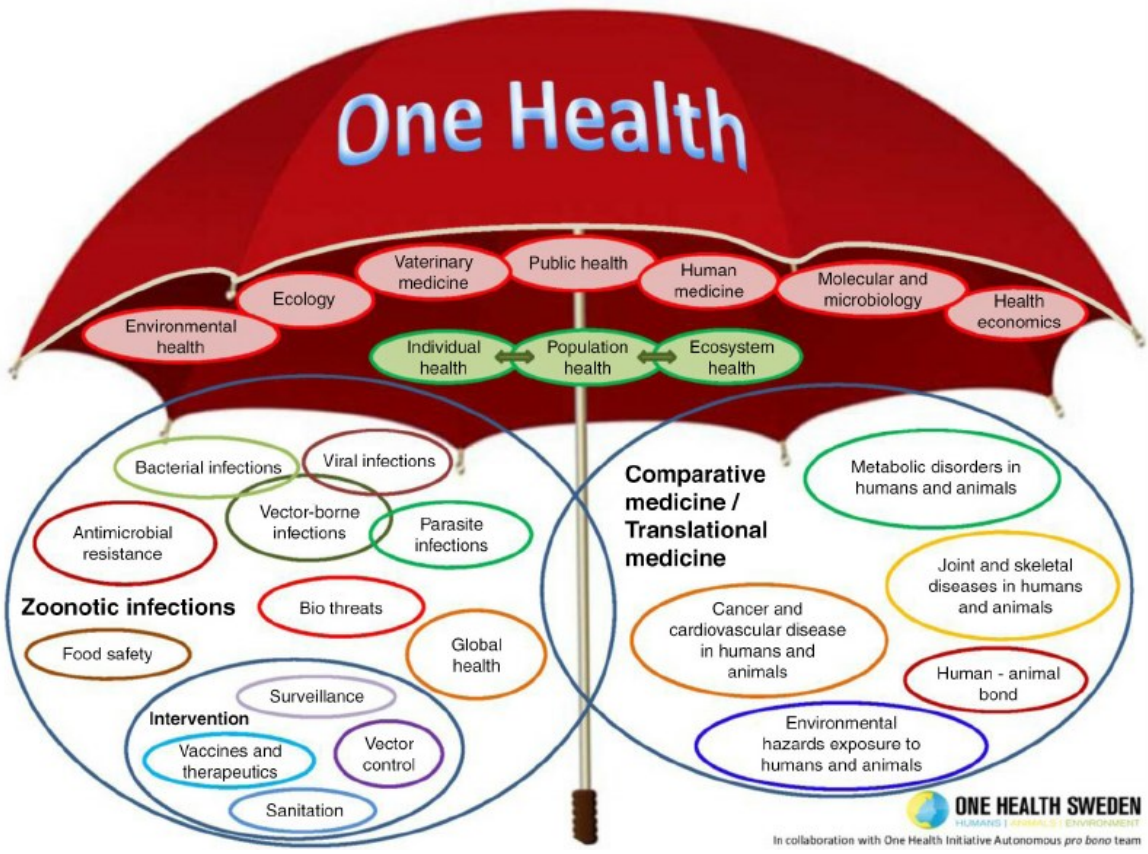


Figure 1. The 'One Health Umbrella' (developed by 'One Health Sweden' in collaboration with 'One Health Initiative'. Available at https://onehealthinitiative.com/).

As can be seen, the following major scientific fields are presented under the «umbrella» of One Health: environmental health, ecology, veterinary medicine, public health, human medicine, molecular and microbiology, and health economics.

2.1.2 One Health implementation

The One Health Initiative defines One Health as *"a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals, and the environment"*. This concept is a milestone coalition and movement built upon older concepts of zoonotic disease and the connection between public health and the environment. This approach promises to renovate and improve the entire procedure of treating the problems related to health by promoting a system which will be based on preventive measures and a more careful attitude towards the environment. (Mwangi et al., 2016.)

The practicality and efficiency of the concept can be demonstrated in a couple of historical examples presented below. In both cases, lack of appropriate attention to environmental problems and neglect of warning signs led to ecological catastrophes, which later resulted in devastating epidemics of vicious diseases.

Minamata Disease

Minamata disease discovery, which was made in the Japanese city of Minamata in 1965, is an illustrative example. The first symptoms occurred in 1956 in local children. The discovery of an epidemic of an unknown disease of the central nervous system was then reported to the local public health officials. Subsequently, an investigation of the epidemic was organized. During this investigation, the unusual behaviour of local fauna was reported. It was found that already in 1949, fishermen had started to complain about reduced catches. Moreover, dead fish was found floating in the water. By 1953, seabirds and crows had begun to spiral into the sea, and cats that consumed seafood from the Bay demonstrated severe incoordination and seizures which were described as 'dance in circles' and 'cat suicides' since cats were falling into the water and drowning. Later, the same syndrome was experimentally reproduced by feeding seafood to cats. The diagnosis was made in 1959: the children were experiencing methyl mercury poisoning. The point source producer was identified in 1961 to be a chloralkali production facility which had polluted the bay with mercury.

However, these actions were not stopped, and pollution continued until 1968. (Beasley, 2009; Aguirre et al., 2016.)

Industrial wastes, which were contaminating the bay, resulted in the accumulation of mercury in fish and further consumption of these mercury-contaminated fish by local people and animals, many of whom developed mercury poisoning that was most severe in infants and young children. Animals tend to be more sensitive towards changes in the environment. Unfortunately, health professionals failed to connect animal health problems with the symptoms in children. Therefore, they lost the opportunity to prevent the spread of the disease and a real chance to avoid the tragic end. Also, insufficient attention was paid to the warning signs and the state of the bay. The environmental connection was uncovered only after the tragic cases of harmful effects on human health. (Rabinowitz et al., 2009.)

Ebola

Another vivid example of demonstrating the advantage of the One Health approach implementation is the Ebola outbreak of 2013-2015. The human-to-human route of Ebola infection became common knowledge during the global alarm of the recent outbreak. Less appreciated was the zoonotic origin of the virus: final data pointed to several species of fruit bats as the natural reservoirs of the pathogen (Smith & Wang, 2013).

Deforestation, an extension of the length of the drought periods, and global warming influence the territory bats must occupy to access fruit and mates. Bat migration is a potential source for virus spread among bat populations as well as a source of greater interactions with humans, and the very activity of flight has been implicated in selecting for viral symbionts of bats that are adapted to high metabolism and febrile daily cycles. The greatest attention was paid to the human-human contacts, and much less to the human-bat contacts and even less to the environmental factors which influenced the interaction in the first place. Minamata disease stayed in history as one of the four big pollution diseases of Japan. (Mwangi et al., 2016.)

Both of the aforementioned crises revealed gaps which could be addressed by the One Health approach. These gaps included the following:

1. Insufficient monitoring and ecological modelling of zoonotic infection and transmission
2. Insufficient systems for rapid dissemination of and community education about the ecological aspects of disease outbreaks and management
3. Insufficient resources committed to enhancing food security to limit environmental encroachment and exposure to zoonotic disease in the wild.

To sum up, the One Health concept encourages interdisciplinary collaboration among veterinarians, physicians, and ecologists (Buttke, 2011). It promotes a multidisciplinary approach to health-related problem solving, explains the interconnection between the health of humans, animals, and the environment.

2.1.3 The health of the environment

The One Health concept initially evolved from the collaboration of human medicine and veterinary fields. Therefore, the environmental aspect has remained secondary, and the focus is mostly on human-animal disease transmission (Harrison et al., 2019). In addition, the One Health concept is very wide, which makes it slightly challenging to apply, particularly since it lacks specificity. Because One Health cannot be entirely universal for all situations, other concepts are still acutely needed. This has led to the appearance of multiple other concepts related to the health of nature.

For this thesis, the approaches which highlight the importance of the health of the environment were a matter of specific interest. It was essential to look at the environment through the lens of health. Since it is not fully obvious how the health of something so vague and abstract could be assessed and what the criteria should be. (Döring et al., 2011), the concepts chosen for this study were very biocentric.

2.2 Definition of environment in this study

It is necessary to clarify what kind of environment was of interest for this study and define what is understood in this study by ‘environment’, because the notion of the environment may vary greatly, similar to that of health.

However, this study is focused on a certain kind of environment which can be specified as a combination of various factors: physical, chemical and biotic. The combined effect of these factors on an individual organism or a community heavily determined their chance of survival and quality of life (Frumkin, 2016). Because that description applies to numerous types of environments, it should be stated that the scope of this thesis was focused on the natural environment which has not been artificially created. Thus, literature dedicated to the topics of occupational health, and hence the indoor environment, was not included in this thesis.

2.3 The role of terminology for the field

An analysis of the specific terminology of the field is essential for the full understanding of the subject. Professional and scientific jargon and the terminology reflect changes and progress in parallel with developments occurring in different fields of study. In the field connected with the environment, language can for example, show growing concerns about a specific issue or the latest technical developments. The evolution of languages is a natural process; a language is a tool, and an instrument of communication. It helps to achieve objectives that are valued and make the required process more efficient (Schutter & Robichaud, 2012). The sphere of environmental sciences is not an exception.

Evolution and changes in professional and scientific jargon can reflect the current situation and objectives of the movement at a given time. Undeniably, the changes in a language are closely linked to the changes in the language since appropriate terminology is the basis of professional communication (Martyanov et al., 2017). The terminology used in environmental sciences and policies evolves over time (Kelley, 2013).

The primary purpose of any language is to create and ensure effective communication. In order to achieve that, it is essential to ensure that parties involved in the communicational process are able to understand the language used, at the appropriate level. For scientific and professional jargon, it is crucial to have clear and explicit definitions for all specialised terminology. The objective should be to provide means for effective communication and fruitful cooperation on different levels, from interpersonal to mass level communication, and in different areas, for example, within scientific communities or between citizens and legal authorities. Distinct conceptual definitions are essential for scientific progress. Without establishing useful, precise concept definitions, it is impossible to conduct work or conceptualize a topic. (Podsakoff et al., 2016.)

The particular importance of terminology in scientific and professional jargon can also be explained by the fact that it is often involved with complicated and abstract phenomena. Moreover, words used to describe phenomena often shape the phenomena themselves. In these cases, words can be seen as an act in which reality is produced, i.e. communication is considered performative. (Heilmann, 2020.)

2.4 State of the art

Concerns about the environmental state are growing exponentially, and, consequently, so is the demand for reliable information on the topic. Therefore, it is not surprising that a considerable amount of literature is dedicated specifically to the theoretical aspects of concepts, approaches, and movements behind the health of the environment. With a proper understanding of the theoretical basis, the chances to choose the best strategy and implement it in the most effective way will significantly increase. Papers and review articles on similar topics exist, and their numbers are rising (Figure 4a,b). Many of them are aimed at comparising and revealing similarities, intersections, and differences in approaches. As the first step in this thesis, these papers were examined in order to create a general understanding of the field and validate the relevance of the

current study. In this chapter, several papers are briefly reviewed, and similarities and differences are discussed.

Since the concept of the health of the environment implies an interdisciplinary approach, papers from various fields relate to the subject. Many of them contain in-depth analysis of theoretical discussion aiming to compare different approaches and related terminology to discover convergence, differences, and overlaps.

One of the key sources in this study is Lerner and Berg's article *A Comparison of Three Holistic Approaches to Health: One Health, EcoHealth, and Planetary Health* (2017). As the title implies the paper compares three important concepts aimed at safeguarding health of which One Health was already discussed earlier in this study. EcoHealth and Planetary Health were added to the list of the approaches for further analysis. As it often happens with articles on similar topics, the literature selection is subjective, which is also relevant for this study. And therefore, the difficulties were the same.

It is hard to repeat the exact procedure described in the Lerner and Berg's article. Besides, the described situation has a chance to change in the future with the publication of more material on this topic. The focus of the article is on the theoretical aspects of the selected approaches, their core values and potential scientific areas. The authors conduct a detailed, in-depth analysis of literature and thoroughly describe the terms that are used. In conclusion, they emphasize the difference between Planetary Health and the two other approaches and discuss the possibility of closer convergence of On7e Health and EcoHealth.

The question about investigating an opportunity to merge these two concepts is also discussed by Harrison (2019) and Roger (2016). Both concentrate on the theoretical aspects behind the approaches, with a particular emphasis on the in-depth analysis of the ontological, epistemological, and methodological aspects. The idea of investing the possible convergences between approaches by different names was based on the aforementioned papers, but the method was

different. In this thesis, the presence of similarities was verified with the help of several statistical tools without delving further into the philosophical concept behind the approaches.

Many papers are dedicated to the analysis of One Health specifically. Angela Cassidy (2016) explores this approach, she demonstrates how One Health emerged as a separate field and how its popularity and frequency of references has changed over the years. Cassidy's study also gave the inspiration for this thesis to create a similar evolution graph for all the presented approaches. Also, was performed a disciplinary analysis of One Health and related terms. Cassidy introduces One Health as an example of the fact that interdisciplinarity is gaining popularity in the twenty-first century. (Cassidy, 2016.)

Lerner and Berg's study (2017) was also highly beneficial for this thesis. It provides valuable information about all three approaches. Especially, the authors highlight that the focus of the Planetary Health approach is mainly on humans, and the approach in general is anthropocentric. That conclusion raised interest, and the Planetary Health approach was analysed in this thesis as well, but with statistical tools. Even though Lerner and Berg's study has a similar methodology than the first part of this thesis, it does not use a great amount of statistical methods and does not provide a key-word analysis or the historical evolution of the terms.

It is also important to mention Alonso Aguirre's article '*Transdisciplinary and social-ecological health frameworks—Novel approaches to emerging parasitic and vector-borne diseases*' (2019), where a bibliometric analysis was extended to the analysis of multiple terms, the percentage of publications by subject areas and changes over the years. The methods of literature selection for this thesis were adapted from Harrison (2019). Also, similarly to her studies, this thesis aims to collect different points of view and present a basis for future research; it does not seek to give one defined answer.

2.5 Problem of the study

Based on a literature review in the field, the number of approaches aimed at finding solutions to the problems related to the health of the environment is increasing. However, the majority of these approaches do not have well-established universal definitions. A considerable amount of literature is dedicated to the in-depth philosophical analysis and comparison of the approaches, but at the same time, there is no organized compilation of all the names of these approaches. Therefore, it was considered necessary to attempt to present all the existing terms and observe with the help of several tools what role environment plays in the approaches, and if there is a noticeable convergence between them which could indicate that different names are used for the description of the same approach.

The current study presents the existing approaches found in the nexus between health and the environment, their historical evolution, disciplines, and keywords associated with them. It also aims to reveal convergences between the approaches and examine if there are approaches with high similarities. That would indicate that even though the approaches have different names, they might have similar strategies and concepts. As was mentioned before, this study presents only a part of a larger project aimed at the review of scientific literature related to the concept of the health of the environment. It is important to highlight that finding the correct definition of the health of nature or related concepts is not an objective of this thesis. Instead, its purpose is the collection of data and representation of the situation related to the topic in the scientific community at the moment. This study aims to answer the question “What are the trends in the approaches aimed at the health of the environment?”.

The One Health approach was the starting point for the internship project described earlier since the majority of concepts related to the health of nature has evolved from it. However, it was not included in the final compilation of the approaches. This study is more concentrated on expanding and understanding the role of the approaches which are less concentrated on human and animal health and are aimed more at the health of the environment itself, which is crucial

for effective interaction with the environment as well as its protection and management.

3 MATERIALS AND METHODS

The process of this thesis consisted of three parts:

1. For search and scanning of the scientific literature

The first part involved the investigation of the terms in the scientific literature and personal acquisition of the nexus between health and the environment. This was achieved by two steps. The first one was a thorough reading of the key source materials discovered by means of reverse snowballing. The second was a database research on Web of Science , where a large mass of literature was scanned.

The aim of this part was the discovery and collection of the names of approaches aimed at studying the health of the environment.

2. Description of the historical evolution of terms and their representation in various disciplines

The second part was aimed at the analysis of the main disciplines that apply the identified approaches and the creation of historical graphs showing the frequency how often the collected terms were mentioned in the titles of scientific and academic papers

The information obtained in this way relates to the changes in the popularity of different terms. In addition, a frequent use of the terms can help identify the areas where the approaches are most in demand, which possibly indicates the importance of the role of the environment in these approaches. Distribution of the approaches among the disciplines also shows the similarities between the approaches that go by different names, which helps to highlight their possible overlaps.

3. Keyword analysis of the scientific literature utilizing the approaches

The objective of the third part was to present a visual representation of the keyword analysis of the papers utilizing the approaches and to show the changes in the use of keywords over time for each approach in particular the evolution of priorities. The keyword analysis was performed by VOSviewer software. In addition, it shows the possible convergences between approaches.

3.1 Introduction to the concept of the health of the environment

Before starting to collect existing approaches for analysis, it was necessary to examine the topic of the health of the environment in general. In order to achieve this aim, a thorough literature review was performed. The literature included several key papers provided by the supervisor at the beginning of the study. The following papers were chosen as a starting point:

- Lerner and Berg, *'A Comparison of Three Holistic Approaches to Health*' (2017)
- Harrison et al., *'EcoHealth and One Health'* (2019)
- Roger et al., *'One Health and EcoHealth'* (2016)
- Döring et al., *'Concepts of Plant Health - Reviewing and Challenging the Foundations of Plant Protection'* (2011)
- Cassidy, *'Advocating (Inter)Disciplinarity at the Interfaces of Animal Health, Human Health, and the Environment'* (2016)

These papers served as a basis for the study and guided in selecting other papers of interest and in general served as an introduction to the existing approaches. Then the snowballing technique was implemented to find more papers relevant for thorough reviewing. All source materials were managed with Zotero software and Excel tables.

During the second step (see Chapter 3), database research was performed. All searches were performed in the Web of Science database. For this purpose, selective reading of key literature was performed. After that, other relevant sources were discovered via the usage of the reverse snowballing procedure

which involves using the reference list to identify other related papers (Wohlin, 2014).

3.2 The challenge of defining health when applied to the environment

As was already mentioned, currently there is no agreed universal definition of the health of the environment. Completely different views are presented in the literature. Frequently, the starting point for the assessment of health is the concept of human health (Döring et al., 2011). Furthermore, there are various approaches suggesting strategies for achieving the desired “healthy” environment, and defining the criteria that should be used when considering a particularly environment “healthy”.

However, the evaluation of the health of the environment can be challenging. There are significant differences between the organisms and the environment, such as the absence of biological indicators, which make the assessment of the health of the environment very difficult. In addition, even though people are able to feel empathy towards the objects of nature, there is still a tendency to place a smaller value on them. (Berenguer, 2008.)

Moreover, because of the complexity of assessment, there is an opinion that the ecosystem or the environment should not be characterized as “sick” or “healthy”, and the existing strategies and approaches for the monitoring of the health of the environment should be re-evaluated (Lancaster, 2000).

3.3 Investigating the different approaches in the health – environment nexus: defining the area of study

The majority of the source literature chosen for the preliminary reading has been related, to some extent, to the topic of One Health. Also a great amount of literature has been dedicated to the analysis of various aspects and attributes of its philosophical components and the history of its emerging. In this study, One Health served mainly as a gateway to other approaches, and it was not included in the final list of terms because this approach is already well covered and

analysed in many papers. In addition, One Health does not relate to the objective of this thesis since, as was mentioned before, it does not place primary focus on the aspect of the health of the environment.

Based on a careful study of the chosen source materials applying a holistic approach helped to create the first list of terms as presented in Figure 2.

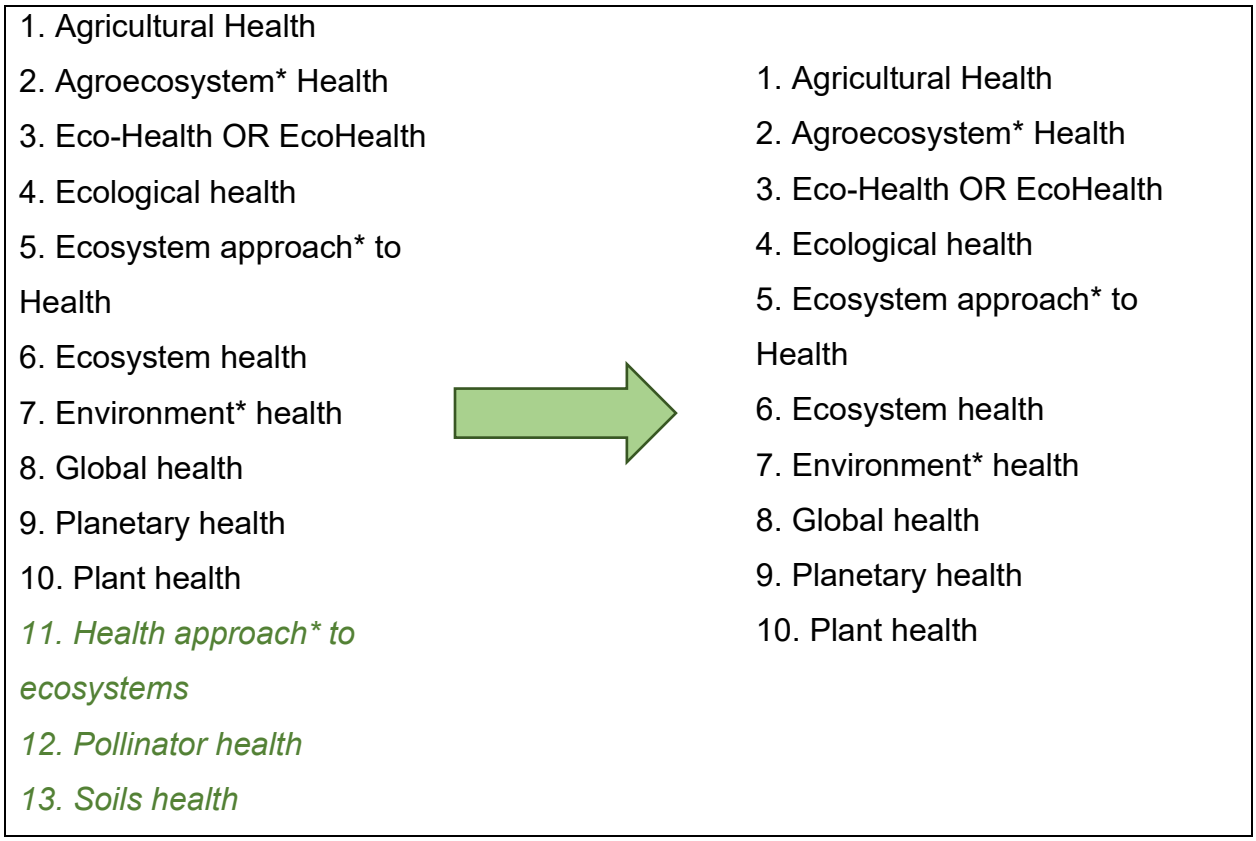


Figure 2. The first list of the terms and the final list after applying the criteria.

After the first list was made, the criteria for adding a term to the list were:

- the use of the term in a scientific paper
- the use of the term in the context of an approach generally described as holistic
- the approach in the context of which the term was used related both to health and the environment
- the term was mentioned in a sufficient number of different sources

Consequently, the terms “Soils health” and the “Pollinator health” were excluded from the list because they referred to excessively specific and limited aspects of the environment and were not considered holistic. The term “Health approach* to

ecosystems” was excluded as well. Initially, it was added as by analogy with “Ecosystem approach* to health”. However, an insufficient number of references was found on this topic.

3.4 A systematic review of definitions and epistemological foundations

A systematic literature review is one of the most commonly used means for the aggregation and analysis of the information gained from various sources and different studies in order to answer the specific research question (Budgen & Brereton, 2006).

Literature review is used for identifying, evaluating, and interpreting a great amount of available source material related to a particular research question, topic area, or phenomenon. All individual studies contributing to a systematic review are acknowledged as primary studies, and the systematic review is a form of a secondary study. (Kitchenham, 2004.)

3.5 Literature review

The aforementioned literature review on the topic of health-related approaches helped to identify the definitions, theoretical backgrounds and current representations of the selected terms as well as the connotations which the scientific community places on the terms. The different trends in the use of the terms, and the historical background and controversies were also the object of the study.

The next step was to perform a systematic and more thorough analysis of the scientific literature accumulated in the Web of Science database. Web of Science provides access to multiple databases that provide comprehensive citation data for many different academic disciplines. It also provides sufficient options for filtering content, convenient search tools, and content extraction functions. Another benefit was the possibility of directly uploading the extracted Web of Science data in VOSviewer for further analysis. (Gusenbauer & Haddaway, 2020).

For a successful completion of the analysis, it was necessary to process a vast mass of papers, and, therefore, additional criteria were implemented. In order to qualify, the papers had to contain one of the selected terms in its title, discuss the theoretical aspects of the approaches, and provide an epistemological analysis of the term. In order to increase the probability of a suitable match a mandatory requirement of having one of the words “epistemological”, “ontological”, “methodological”, “philosophical”, “field-building” or “framework” in the paper’s topic was added. More technical criteria were implemented as well: English was chosen as the language, time frame was set to cover all years of publication, types of documents were limited to articles, books, and book chapters. In addition, various ways of spelling the names of approaches were attempted when entering search words (e.g., “Eco Health” OR Ecohealth; “Agricultur* Health”). The final search strings were formed according to the following pattern:

Title: “<name of the approach>” AND Topic: epistemol* OR ontolog* OR field+building OR methodol* OR philosop* OR framework

After the search, the selected papers were additionally manually filtered by a more thorough process of reading their abstracts or, in some cases, longer passages of text. After that, the papers meeting the set criteria were bookmarked in a separate Excel file for a further study of the definitions these papers might provide. This procedure is not included in this research and was a part of the internship project.

However, that whole process served as a filter for the terms, which were further analysed in the following parts. As a result, several terms were excluded from the final list (Figure 2), and the general understanding of the approaches was gained, which was crucial for meaningful work.

3.6 Historical evolution of the terms and their representation in the various disciplines

In order to demonstrate the changes in the popularity of the terms related to the health of the environment, historical graphs on the frequency of occurrence of the approaches in scientific papers were created. As source material, all the databases of the Web of Knowledge were used. All years were included in the time frame search except for 2020. The criteria for the inclusion of a paper in a graph were the presence of the name of the approach in the title, abstract or author keywords. All types of publications were included in this analysis.

In order to determine the correlation between the approaches and the disciplines, where these approaches are in use, another analysis was performed. The same search results were separated by the Web of Science categories and then were visualized in the form of treemaps. In the final illustration, the ten research areas with the largest number of papers were represented. The results were later represented in the form of pie charts for illustrative purposes (Figure 6).

3.7 Exploring the nexus through visualization tools

For gathering information about the analysis methods and visualization, the following literature was used:

- Hines et al., ‘Mapping Change in Biodiversity and Ecosystem Function Research’ (2019)
- Lisitza and Wolbring, ‘Sustainability within the Academic EcoHealth Literature’ (2016)
- Harrison et al., ‘EcoHealth and One Health: A theory-focused review in response to calls for convergence’ (2019)
- Cassidy, ‘Advocating (Inter)Disciplinarity at the Interfaces of Animal Health, Human Health, and the Environment’ (2016)

These papers did not only directly relate to the objective of this study but they also contained methods for data analysis. A thorough reading of these papers

helped to create an appropriate search strategy, perform proper analysis of the data, and provide an illustration of the results.

3.7.1 VOSviewer

In parallel with definitions mapping, a visual analysis of the keywords used in the scientific papers related to health and the environment was performed in VOSviewer. VOSviewer is a software tool for constructing and visualizing bibliographic maps based on a co-occurrence matrix. Its functionality also provides multiple possibilities for further detailed exploration of these maps (van Eck & Waltman, 2009).

The software is flexible, allowing the use of various types of data for the analysis best-suited for the user's aim. It supports network data, text data, or bibliographic data for map creation. The latter includes co-authorship, citation, bibliographic coupling, and keyword co-occurrence. Therefore, it was an optimal choice for the analysis in this thesis.

Figure 3. Screenshot of the main window of VOSviewer.

The main window of VOSviewer is shown in Figure 3. Each item is represented by a label and a circle. And their size reflects the item's weight or its importance. In order to avoid overlapping, some labels are not shown, but they will appear

when the scale is made larger. Colours indicate the cluster to which the item belongs. Lines represent the links between the items, while the distance between them shows their relativeness in terms of the co-occurrence of the keywords. This relativeness is expressed in numerical value and is called link strength. The tabs on the bottom of the image contain information about the chosen link. In this example, the terms *ecosystem health* and *integrity* occur together as keywords in three publication. Therefore, their link strength is equal to three. (van Eck, 2020.)

VOS stands for visualization of similarities and it is a mapping technique. The map construction process consists of three stages: calculation of similarity matrix, applying VOS mapping technique to it, and transformation of the solution via translation, rotation, and reflection. (van Eck & Waltman, 2009.)

Similarity matrix can be obtained through a normalization of the co-occurrence matrix. VOSviewer provides several options for normalization. For this study, the association strength method was chosen. Using this method, the similarity between two items can be defined with Equation 1.

$$S_{ij} = \frac{c_{ij}}{w_i w_j} \qquad (1)$$

where	i and j	items
	S_{ij}	similarity between and j
	c_{ij}	number of co-occurrences of i and j
	w_i and w_j	the total number of occurrences of items i and j or the total number of co-occurrences of these items

In the next stage, a two-dimensional map is constructed where all the items are placed in such a way that the distance between items i and j reflects their similarity, obtained in the previous stage. In other words, items with higher similarity are placed closer to each other than items whose similarity is lower. Meanwhile, a higher similarity means higher weight. VOS seeks to minimize a weighted sum of the squared Euclidean distances between all pairs of items. In

addition, to prevent the construction of a map where all items would have the same location, the following constraint is imposed: the average distance between two
items must be equal to 1. The optimization problem of minimizing is solved using a majorization algorithm which is run several times using different randomly generated initial solutions. (van Eck & Waltman, 2009.)

Since the optimization problem does not have a unique globally optimal solution, additional steps are necessary to produce a consistent result. Therefore, a third stage is performed where the obtained solution goes through three transformations (translation, rotation, and reflection), which allows VOSviewer to present a coherent result. (van Eck & Waltman, 2009.)

3.7.2 Keyword analysis

The objective of the keyword analysis was to visualize the evolution of keywords related to the selected terms, to show their potential similarities and present the term's connection to various academic spheres which could possibly focus on the health of the environment.

For the analysis of literature in VOSviewer, the full records and cited references extraction of the papers from the WoS database was performed. The extraction was completed in the period of 17 June 2020 — 02 July 2020. The exported records were downloaded from the core web of science data collection. The language of searched literature was restricted to English. The types of documents and publication years were not specified. Apart from language, the only requirement for a suitable paper was the presence of any of the selected terms (either in the title, abstract, author keywords, or Keywords Plus).

For each term, several extractions were downloaded. In order to observe temporal trends, each term extraction was divided into 5-year segments, starting from the year of the first mention of the term .

In order to increase the reliability of the final maps and exclude possible repetition, a Thesaurus file was created manually and applied to the list of key terms. The Thesaurus file included abbreviations (i.e., *bmi* was replaced by *body-mass index*), different spelling variations of one word, or with or without a hyphen (i.e., *colour* was replaced by *color*, *surface-water* was replaced by *surface water*), and plural forms of words (i.e., *aids* was replaced by *aid*).

For each of the maps, a 50-word limit was established to increase the clarity of the final image. The exception was made for the first time-segments since often there were not enough keywords in the beginning. Three main colours were used for the clusters' colour code: red, blue, and green. In addition, for the better demonstration of consistent development of the keywords through the years, the additional rotation of the map was used as a final adjustment.

In conclusion, results were presented on several images. They illustrate the changes in the most often occurring keywords. The final image presents a summarization of the 50 most used keywords during the latest 5-year time period of existence of the term in the analysed literature (2016-2020).

4 RESULTS: PRESENTING THE VISUAL INFORMATION

4.1 Historic evolution of the terms

As a result of the automatic analysis of the search results, Web of Knowledge provides the citation report. It reflects citations to source items indexed within All Databases. Bellow, in Figures 4a,b, the compilation of all of the analysed approaches is presented. Figure 4a shows all the terms, while in Figure 4b Environmental Health and Global Health are removed. This was done for illustrative purposes.

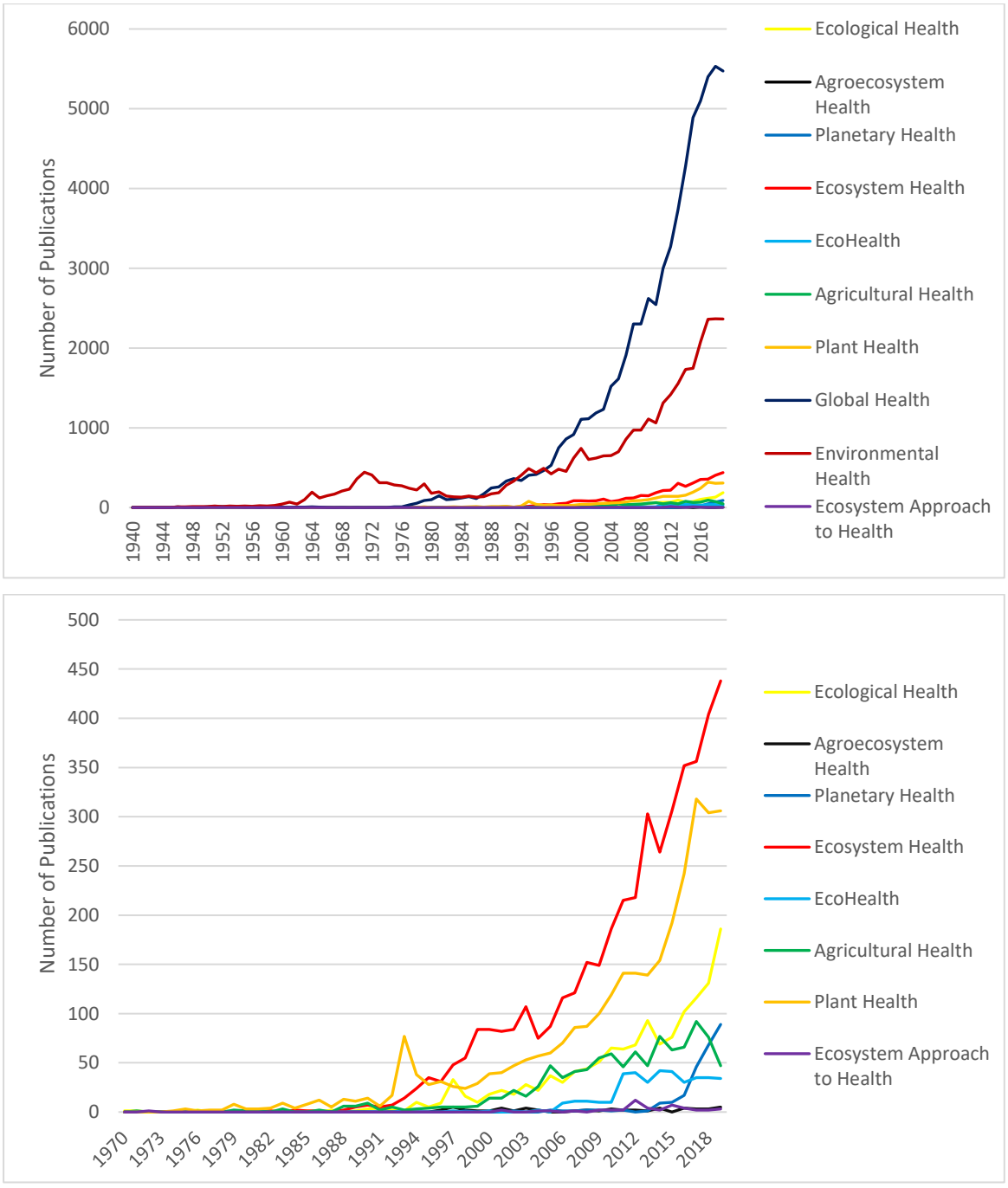
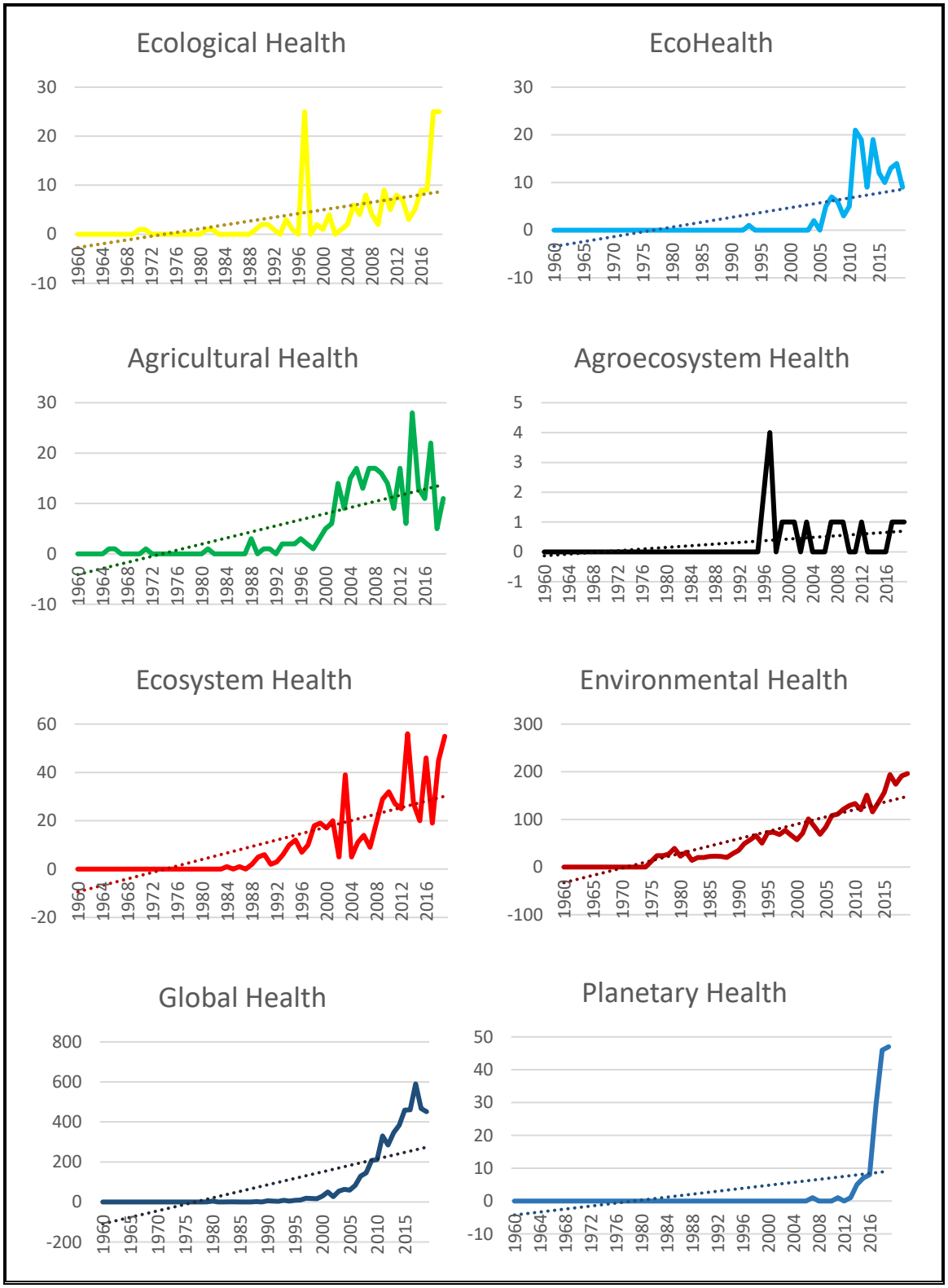


Figure 4a, b. The occurrence of the terms in publications topics (Source: Web of Science Core Collection).

In Figure 5, each term's occurrence fluctuations are presented separately. The X-axis represents the time range, and the Y-axis – the number of publications.


Ecological Health
30
20
10
0
-10
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012 2016
EcoHealth
30
20
10
0
-10
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Agricultural Health
30
20
10
0
-10
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012 2016
Agroecosystem Health
5
4
3
2
1
0
-1
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012 2016
Ecosystem Health
60
40
20
0
-20
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012 2016
Environmental Health
300
200
100
0
-100
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Global Health
800
600
400
200
0
-200
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Planetary Health
50
40
30
20
10
0
-10
1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004 2008 2012 2016

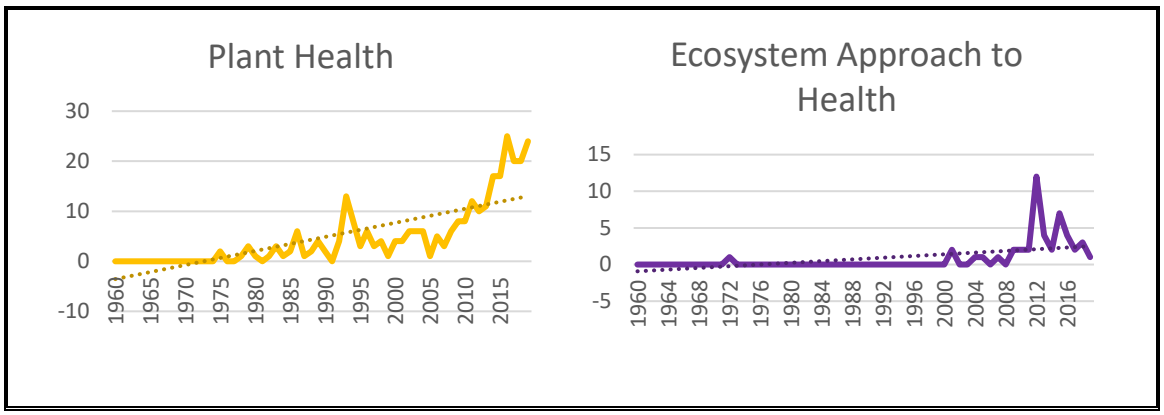


Figure 5. Changes in the occurrences of different terms in the topics of scientific papers (Source: Web of Science Core Collection).

Information presented above (Figure 4a, b; Figure 5) provides an understanding of the differences in the popularity of various terms and shows how this popularity was changing. The character of changes becomes more obvious and the common trend of increasing attention towards approaches.

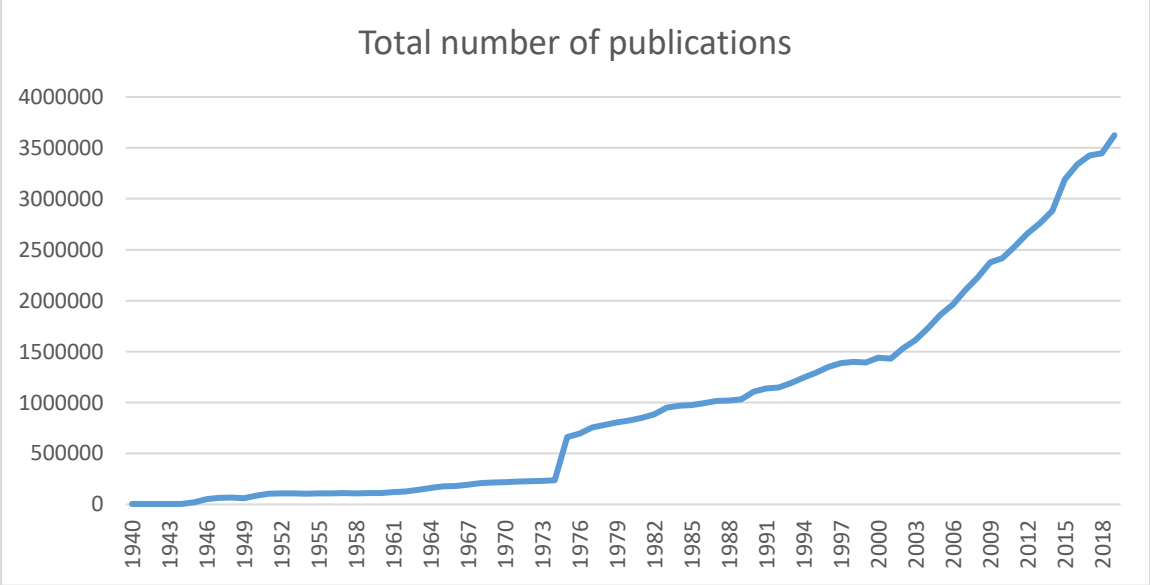
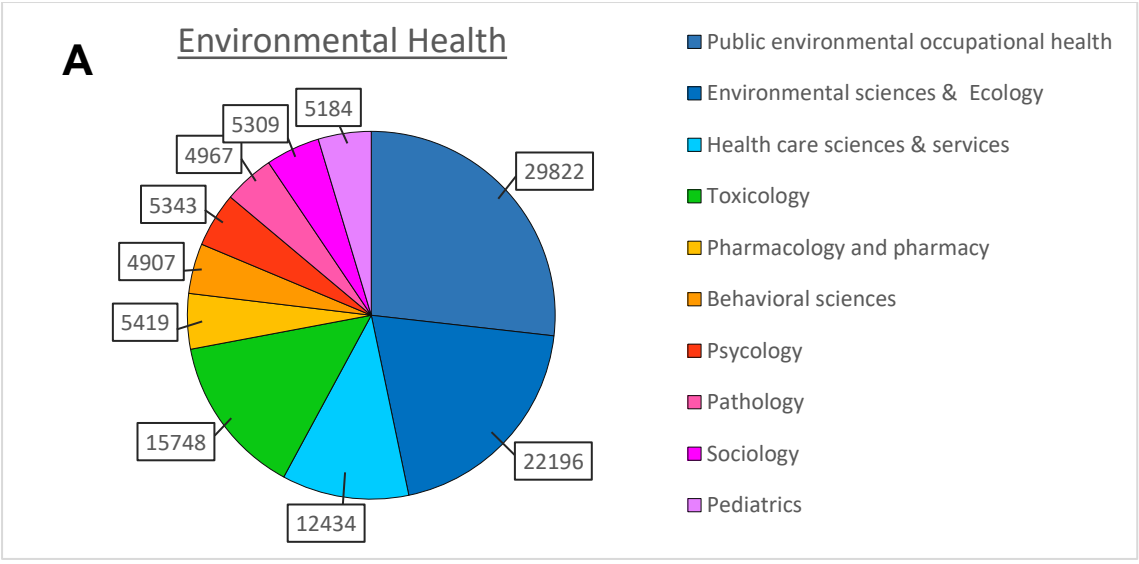


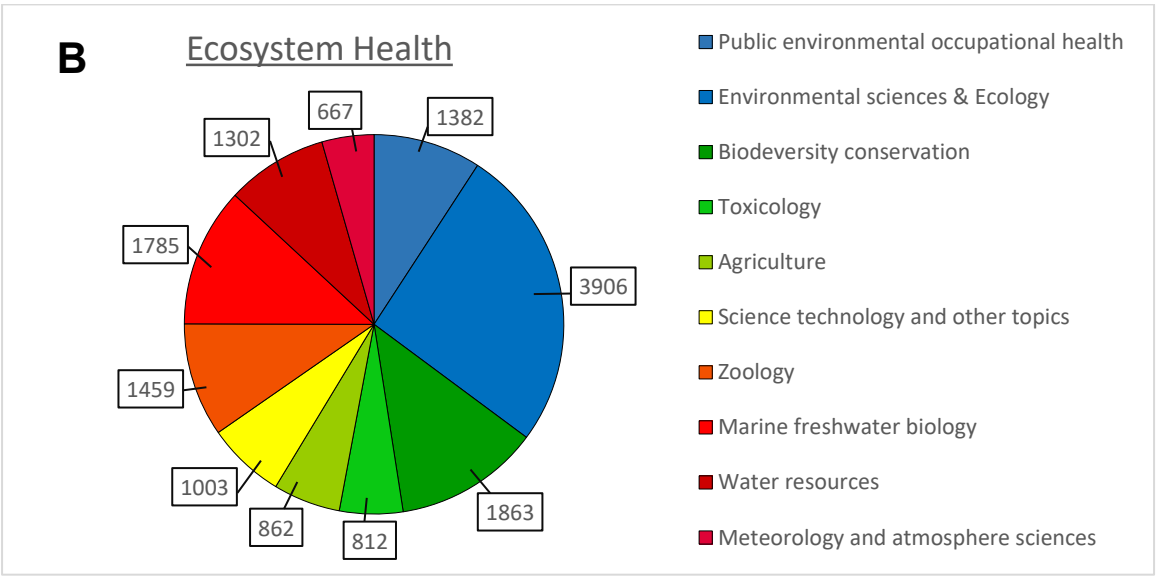
Figure 6. Changes in the total number of scientific publications (Source: Web of Science Core Collection).

Changes in the total number of publications are illustrated in Figure 6. It was important to present them as well, since that number also was increasing during the studied timeframe.

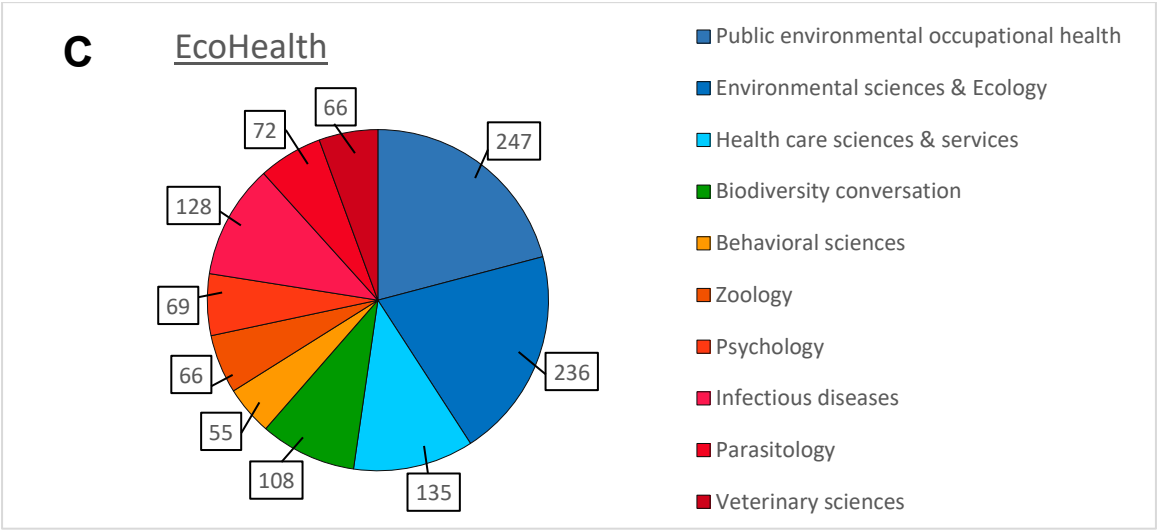
4.2 Distribution of terms among various fields of study

In this segment, all the pie charts with ten disciplines, which mobilize the approaches the most, are presented. The colour code was used to make more noticeable common disciplines, mobilizing several concepts. Labels with numbers on the graphs indicate the number of papers containing the terms in the title, abstract, or keywords.

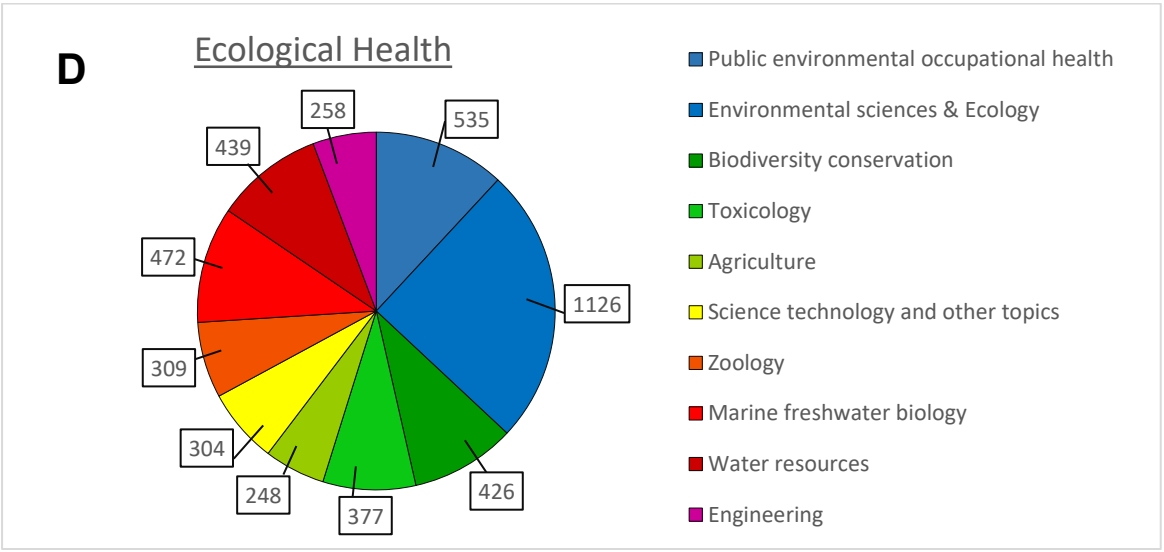




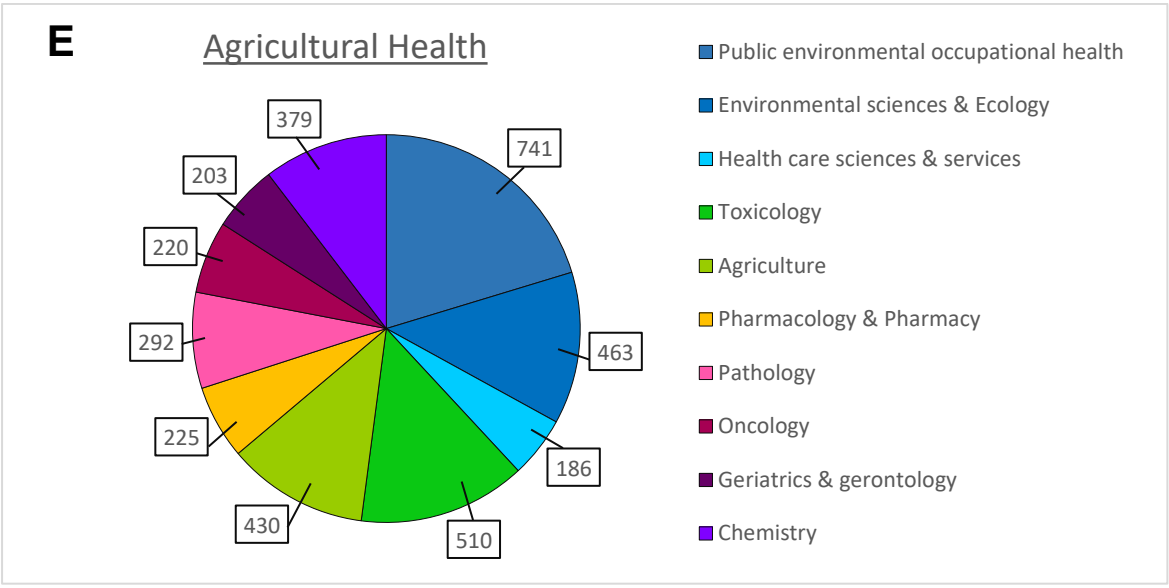
C


EcoHealth
247
236
135
108
55
66
69
128
72
66
Public environmental occupational health
Environmental sciences & Ecology
Health care sciences & services
Biodiversity conversation
Behavioral sciences
Zoology
Psychology
Infectious diseases
Parasitology
Veterinary sciences

D


Ecological Health
535
1126
426
377
248
304
309
472
439
258
Public environmental occupational health
Environmental sciences & Ecology
Biodiversity conservation
Toxicology
Agriculture
Science technology and other topics
Zoology
Marine freshwater biology
Water resources
Engineering

E


Agricultural Health
741
463
186
510
430
225
292
220
203
379
Public environmental occupational health
Environmental sciences & Ecology
Health care sciences & services
Toxicology
Agriculture
Pharmacology & Pharmacy
Pathology
Oncology
Geriatrics & gerontology
Chemistry

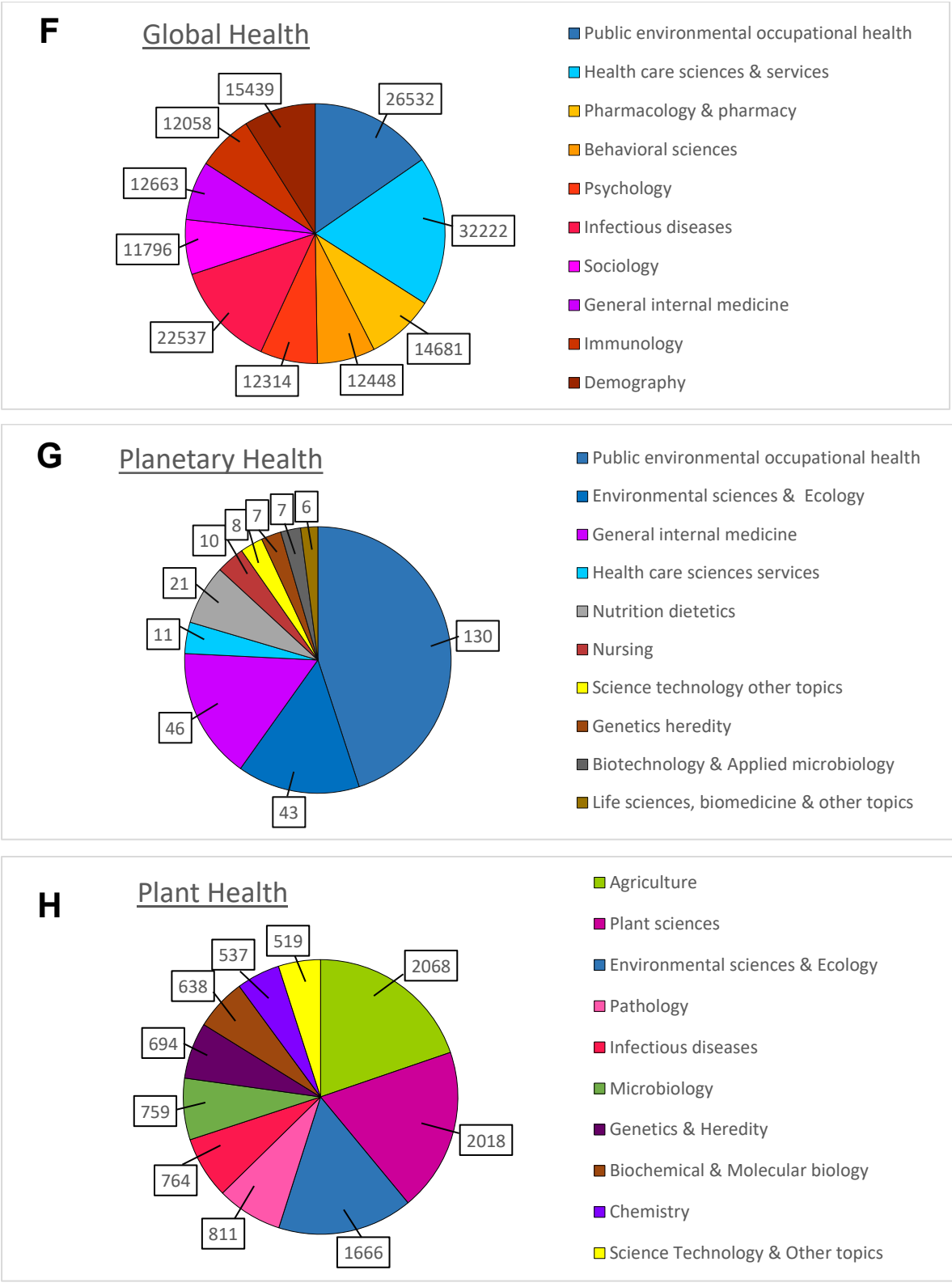


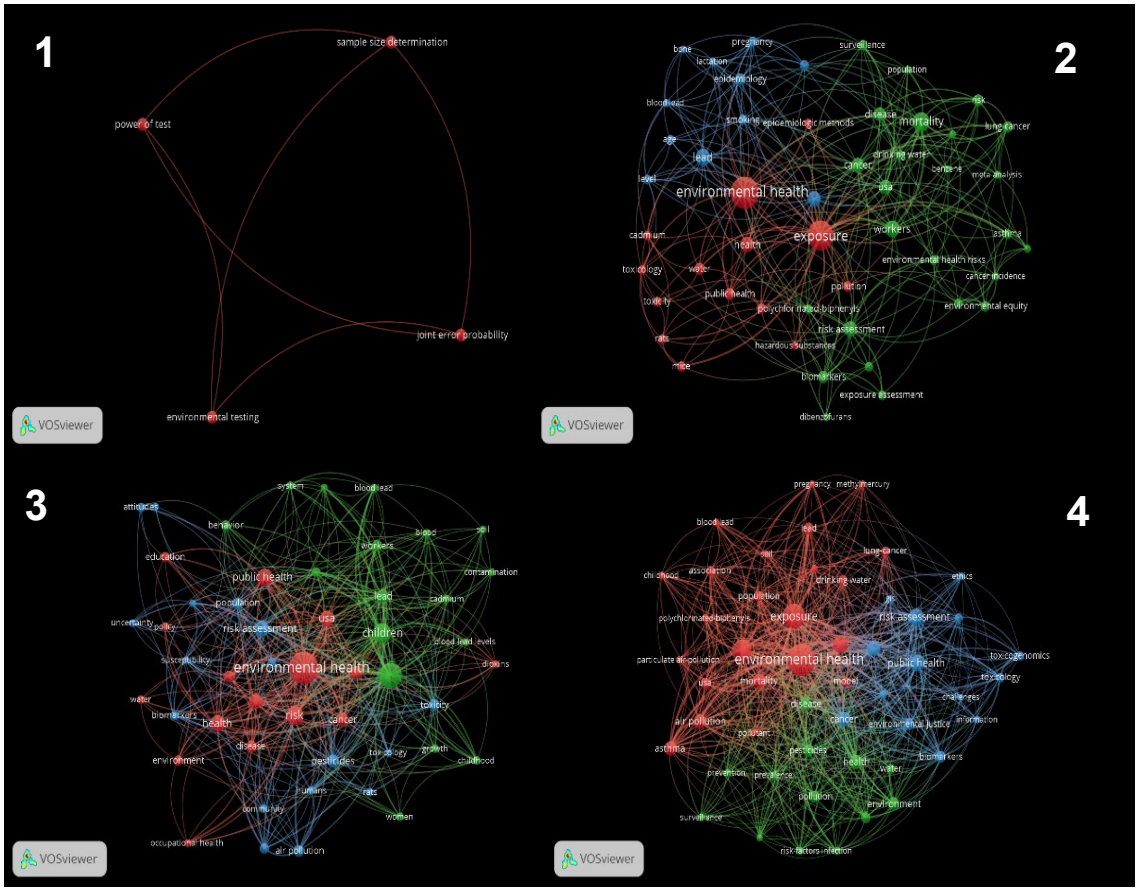
Figure 7. Ten research areas where the following terms are used the most: a. Environmental Health, b. Ecosystem Health, c. EcoHealth, d. Ecological Health, e. Agricultural Health, f. Global Health, g. Planetary Health, h. Plant Health.

Information presented in Figure 7 gives the impression of the disciplines actively using the approaches in their studies. It also demonstrates the general demand and popularity of the approaches. As was mentioned before, study areas can reveal similarities between approaches and show how much attention is dedicated to the environment.

4.3 Visualization of the keyword analysis via VOSviewer

Environmental Health

In Figure 8, the visualization of the changes in the keywords of chosen articles is presented. Similar maps were created for each term and can be found in Appendix 1. This one is made for the articles related to Environmental Health.



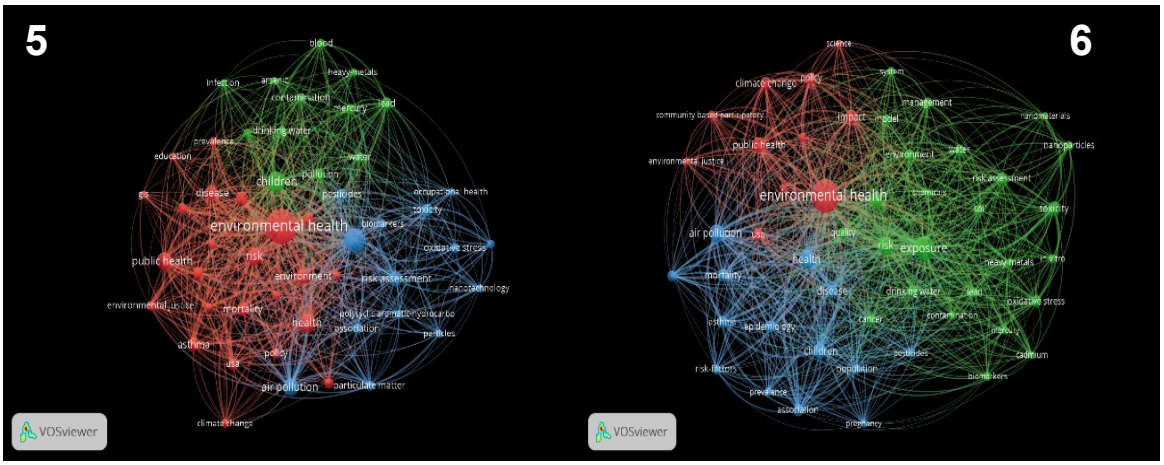


Figure 8. Evolution of the keywords of articles related to the term *Environmental Health*. Time periods are: (1)1975-1990, (2) 1991-1995, (3) 1996-2000, (4) 2001-2005, (5) 2006-2010, (6) 2011-2015.

The following figures (Figure 9 – Figure 16) show maps of keywords from the last five years period:

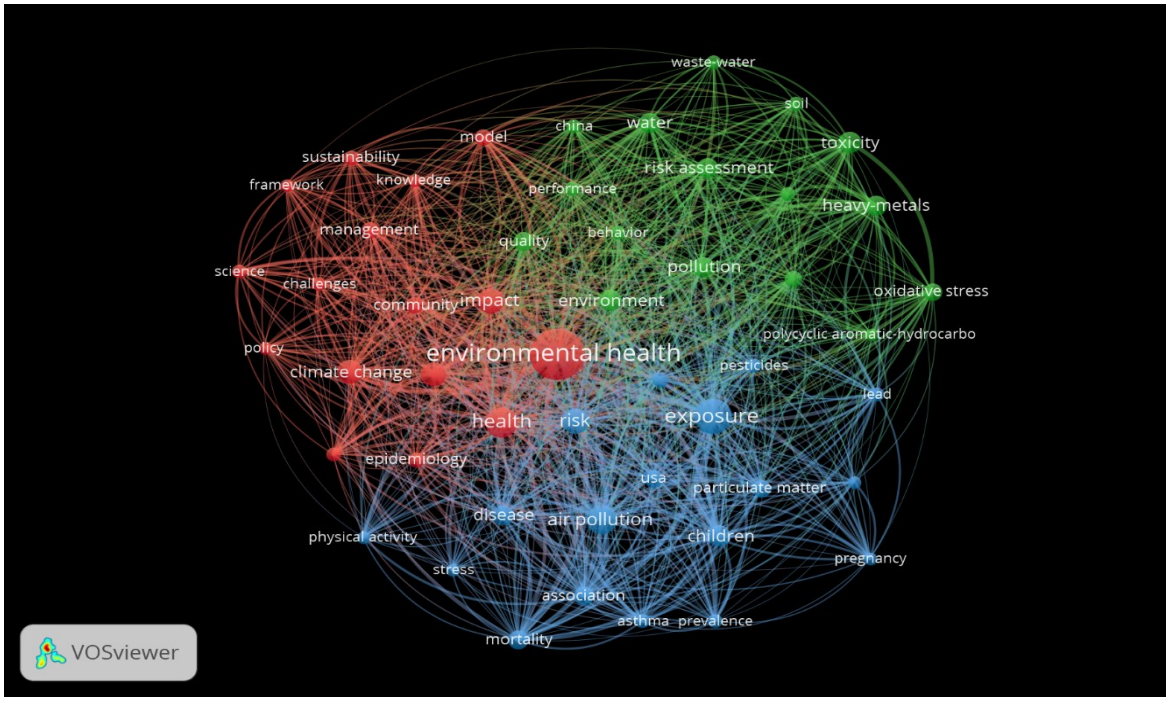


Figure 9. Map of the keywords of articles related to the term *Environmental Health* published in 2016-2020 time period.

Agricultural Health

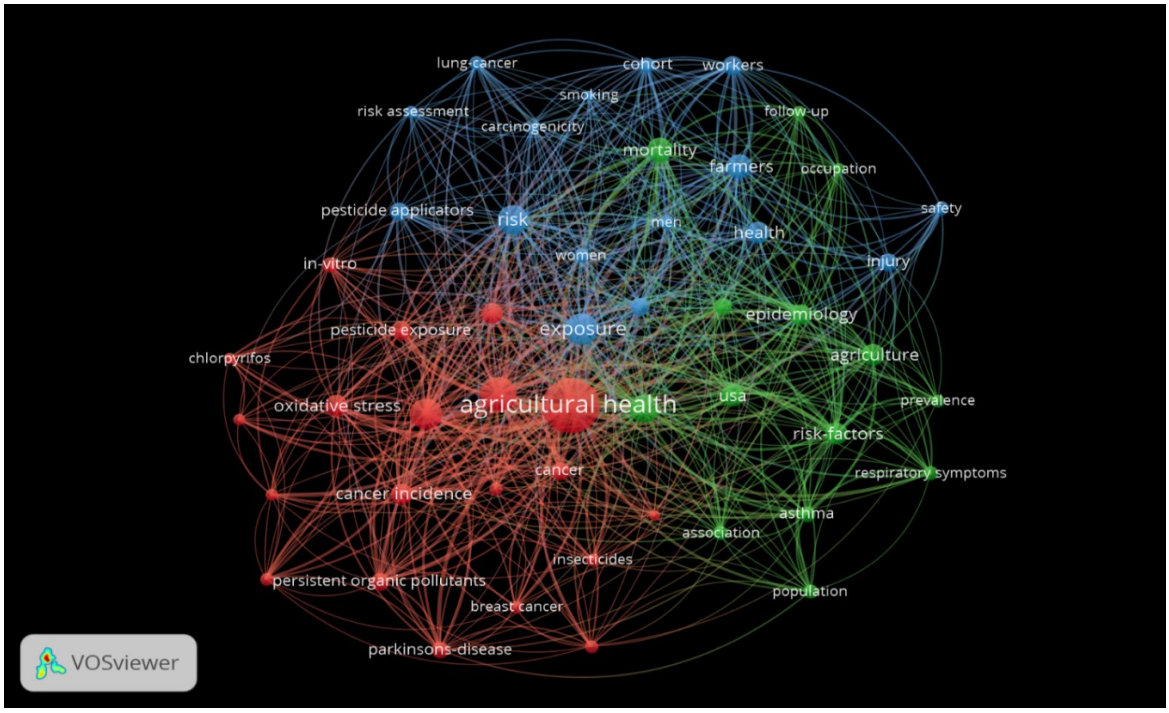


Figure 10. Map of the keywords of articles related to the term *Agricultural Health* published in 2016-2020 time period.

EcoHealth

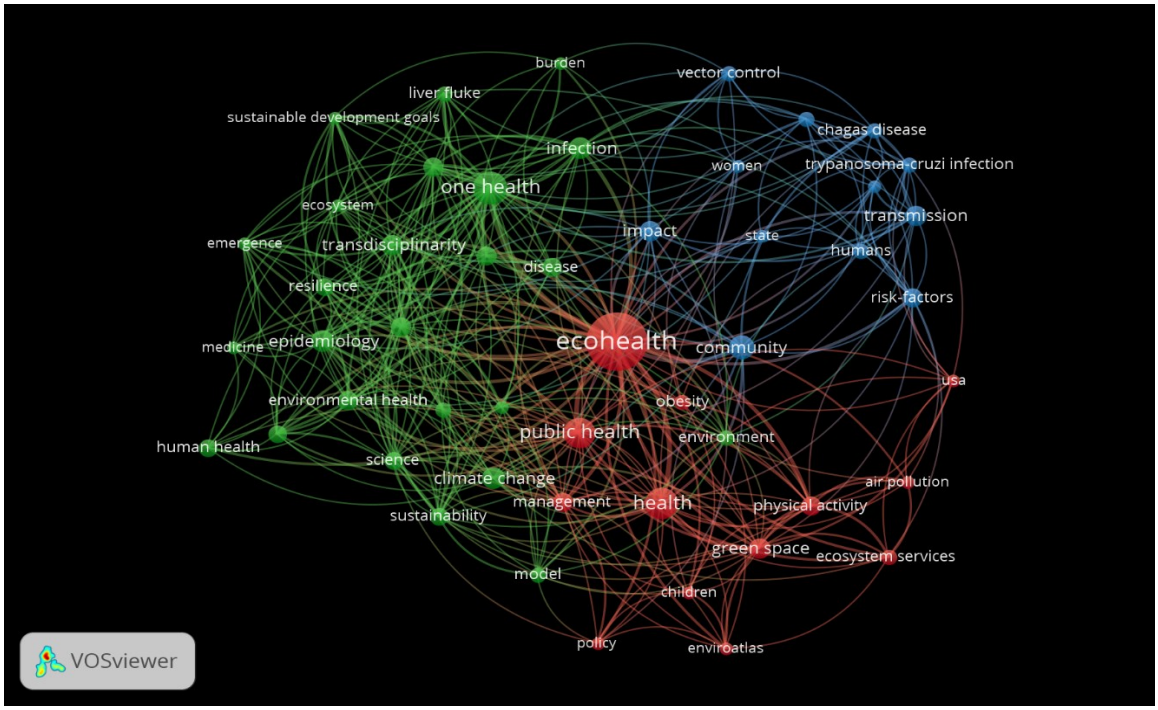


Figure 11. Map of the keywords of articles related to the term *EcoHealth* published in 2016-2020 time period.

Ecological health

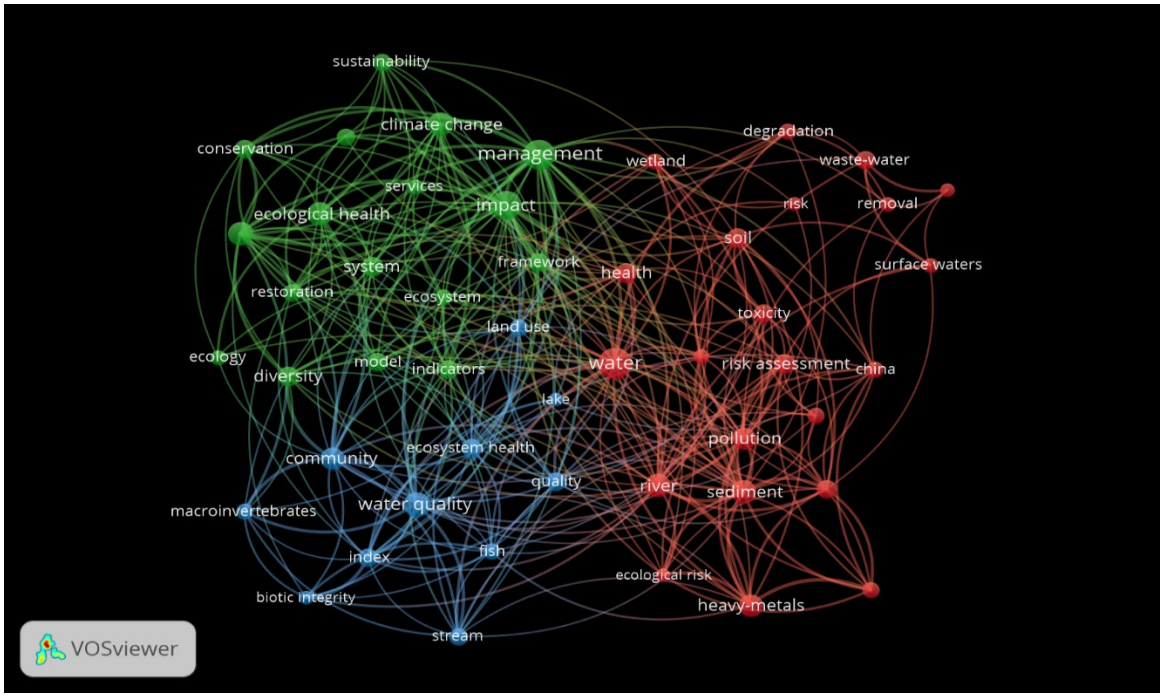


Figure 12. Map of the keywords of articles related to the term *Ecological Health* published in 2015-2020 time period.

Ecosystem health

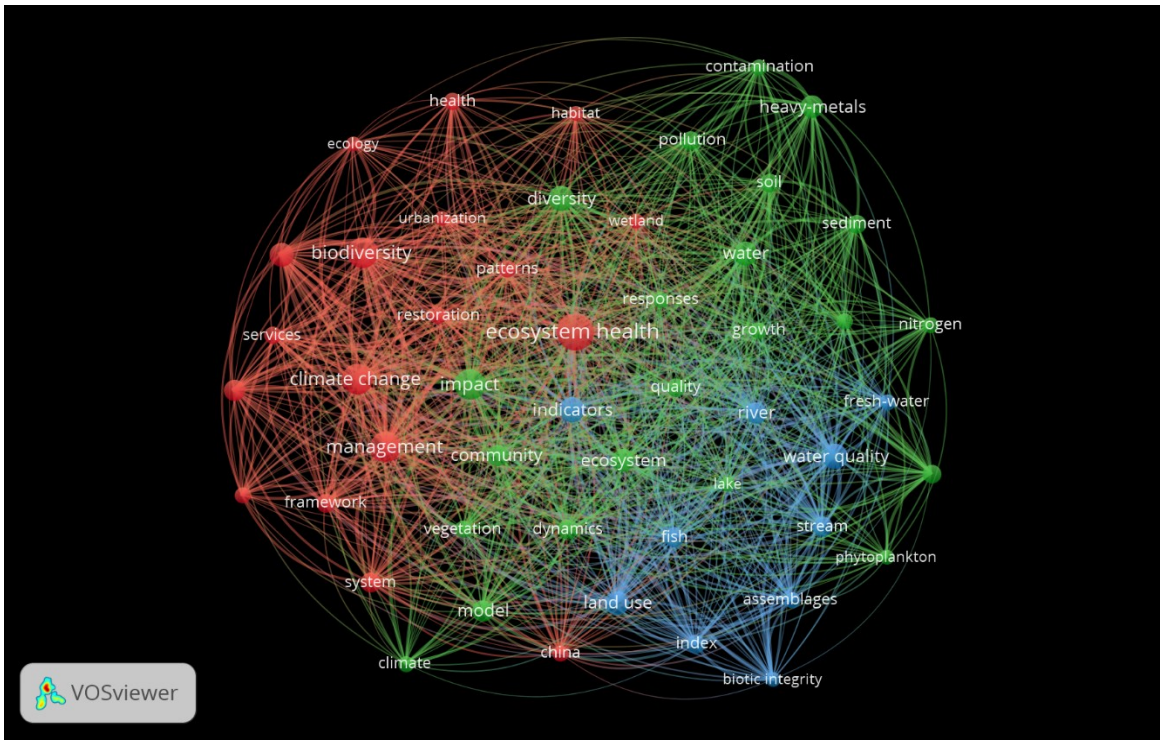


Figure 13. Map of the keywords of articles related to the term *Ecosystem Health* published in 2016-2020 time period.

Global health

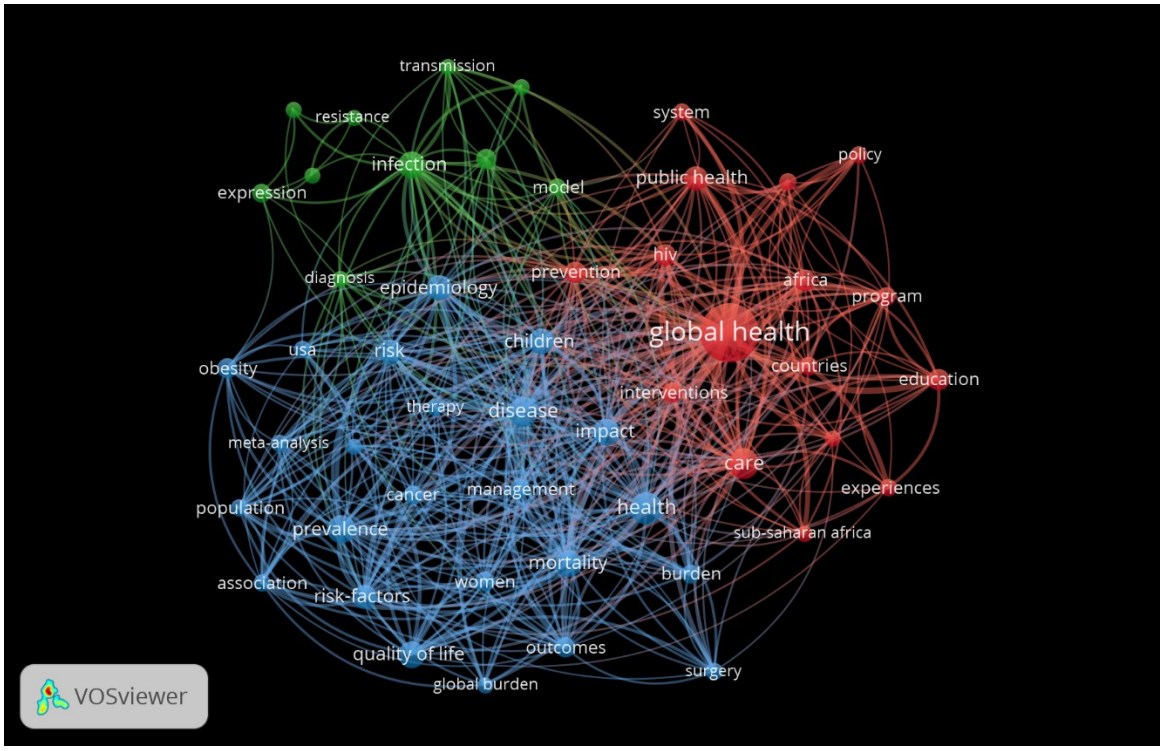


Figure 14. Map of the keywords of articles related to the term *Global Health* published in 2016-2020 time period.

Planetary health

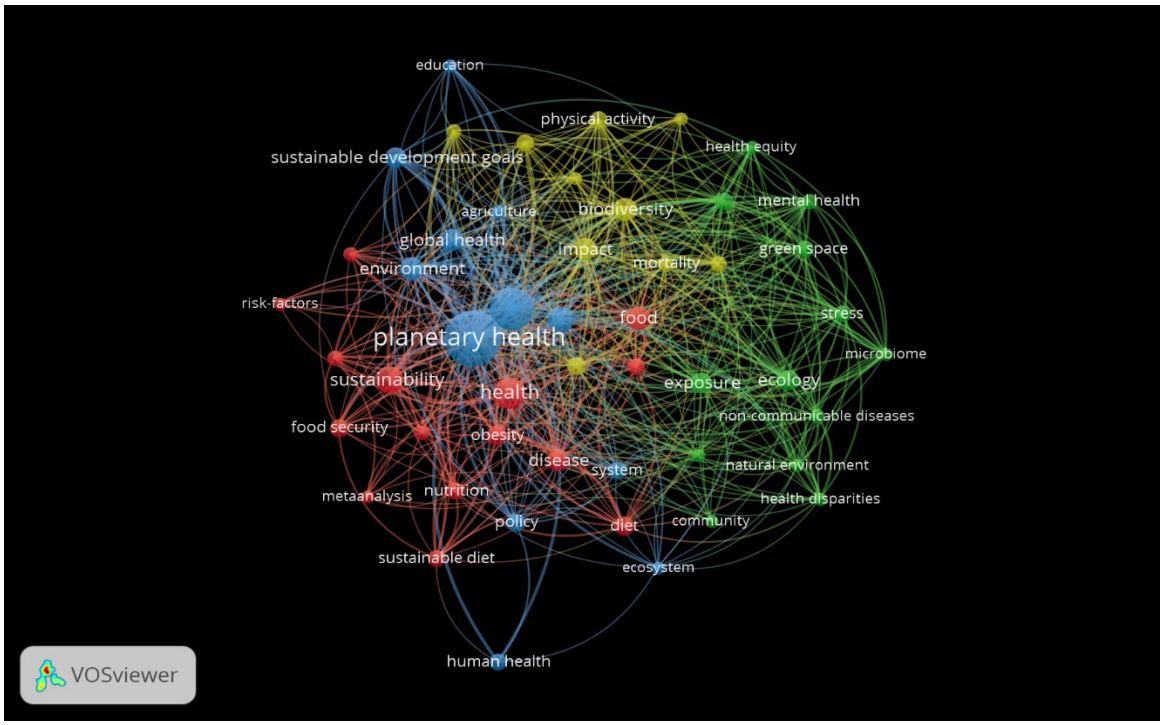


Figure 15. Map of the keywords of articles related to the term *Planetary Health* published in 1995-2020 time period.

Plant health

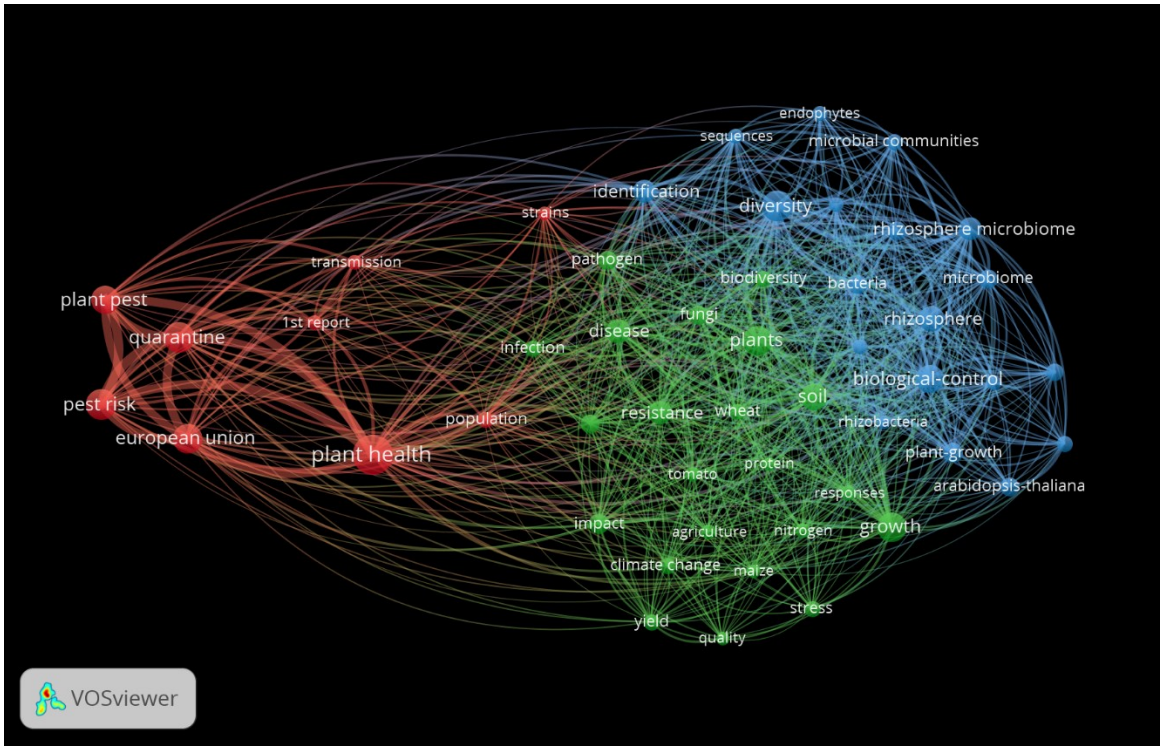


Figure 16. Map of the keywords of articles related to the term *Plant Health* published in 2016-2020 time period.

Colour code symbolizes the clusters of keywords close to each other. Planetary Health is the only exception, where, because of the equal amount of the keywords in clusters, four colours were used.

Agroecosystem Health and Ecosystem Approach to Health are not presented in this chapter because of the insufficient number of articles and consequently keywords available for the analysis. However, an attempt to create a similar map for Agroecosystem Health was made, the results can be observed in Appendix 1.

5 DISCUSSION AND CHALLENGES OF THE STUDY

5.1 Discussion

Historical trends

After observing the historical evolution trends, it gets clear that the demand for finding the best fitting approach is growing. Despite the existing opinions that the

environment should not be categorized as “healthy” or “sick” (Lancaster, 2000), Figure 2a, b shows that the usage of the term “health” together with different inanimate broad notions is increasing every year. Especially noticeable this trend becomes in the first decade of 2000. Several new approaches start to be mentioned around this time. Moreover, mentioning a lot of long-time existing approaches noticeably increases in the same period.

This trend is particularly well observed in EcoHealth, which almost was not mentioned before 2004. Agricultural Health, according to the graph (Figure 5.), was known for a long time but started to gain popularity only around the 2000s. A similar situation can be observed in Ecosystem Health and Global Health, the popularity of which began to increase remarkably fast at the beginning of the 2000s, and only recently its growth began to slow down. As a result, Global Health quickly became the most frequently mentioned approach.

Historic trend graphs also showed that Planetary Health is the youngest approach; it was mentioned in 2007 for the first time. However, around 2012 its popularity started to grow very actively. By 2019, in a short time, it left behind several other approaches, including the oldest – Agricultural Health. Such growth might indicate the convenience of this approach and its possible high-effectiveness.

Environmental Health is shown as an old and stably growing approach. It is the second popular term, and the difference between it and the third one (Ecosystem Health) is incredibly big. Its popularity growth also shows the increase in the speed, which allows assuming, that in the near future, the usage of the term will only become bigger.

Ecological Health and Agroecosystem Health have similar fluctuations patterns, specifically in 1997, both of them have a sudden increase in mentioning. However, they do not reach the level of Planetary Health. Agroecosystem Health and Ecosystem Approach to Health stay relatively unpopular. Both of them had a

sudden increase, but by 2019, the amount of publications mentioning these terms is incredibly low. That fact will bring difficulties in the further analysis.

Disciplines mobilizing the terms

Among disciplines, Public, Environmental & Occupational Health, and Environmental Sciences & Ecology are mobilizing almost all of the terms. Rare exceptions are Plant Health (Figure 6h), which is not mobilized in the first study area, and Global Health (Figure 6f), which appears not to be strongly related to the Environmental sciences & Ecology. Moreover, when looking at the disciplines using this concept the most, almost all of them are related to human medicine and human behaviour. This might indicate that the main focus in this approach is on humans. In contrast, Plant Health is mobilized mainly by the disciplines, which are concentrated on the environment. Even though most papers mentioning Plant Health are related to agriculture, the difference is not large, and papers are spread between the areas relatively evenly.

The majority of the disciplines mobilizing Environmental Health (Figure 6a) are anthropocentric. Several study areas are the branches of human medicine as well. Ecosystem Health (Figure 6b), by comparison, is more popular in research areas, which study specific aspects of the environment, like water, atmospheric sciences, and biodiversity. It is also important to highlight, that not many disciplines are common for both terms. Also the public environmental occupational health, which demands Environmental Health the most, is only in the 5th place for Ecosystem Health. The one field, which is indeed using both terms actively is Environmental sciences & Ecology.

However, there is an approach that has a lot of common disciplines with Ecosystem Health. Ecological Health (Figure 6d) is mobilized by all the same disciplines in approximately the same percentage. The only difference is the last study area: for Ecosystem Health, it is Meteorology and Atmosphere Sciences, while for Ecological Health – Engineering. That might indicate a possible serious convergence in the approaches behind these terms.

Many papers were describing Planetary Health as an anthropocentric approach, and the disciplines, mobilizing it, confirmed it. Figure 6g illustrates that majority of the study areas are related to humans and their wellbeing.

EcoHealth is also used by human medicine, but unlike Global Health or Environmental Health, Figure 6c shows that a lot of disciplines related to animal health and biodiversity conversation are using this term.
There are similarities between disciplines related to Agricultural Health (Figure 6e) and Plant Health. However, the Agricultural Health is associated with more disciplines related to chemistry and human health.

The disciplines mobilizing Agroecosystem Health and Ecosystem Approach to Health are shown in Appendix 2. They are not presented here because of the low number of papers. Analysis of which may lead to unreliable results.

Keyword analysis

From the example of Environmental Health evolution (Figure 7), it becomes very clear how the approach was framing over time and how its aspects were becoming more interconnected. Besides, the keywords map (Figure 8) supports the idea of this approach to be more focused on human health. Three clusters can represent sources of possible risk (i.e., pollution, wastewater), factors that can increase the negative effects (i.e., pregnancy, asthma), and measures for prevention or treatment (i.e., science, management).

The connection between Agricultural health and human medicine is observed through keyword analysis as well. In Figure 9, several big items are describing the potentially vulnerable groups of people (i.e., farmers, workers), keywords connected to health (i.e., epidemiology, mortality, respiratory symptoms), and harmful agents and diseases (cancer, insecticides).

It is interesting to point out that in Figure 10, aside from the health-related cluster (i.e., obesity, physical activity) and disease-related cluster (i.e., transmission, Chagas infection), one cluster of EcoHealth is dedicated to other theoretical approaches and their qualities (i.e., One Health, Ecosystem Health, interdisciplinarity).

In Ecological Health keyword map (Figure 11), the name of the approach itself is not in the center. Items associated with Ecological Health are just a part of one of the clusters related to the aspects of environmental management. Also, Ecological Health-related articles are not concentrated on human health or medicine but focus mainly on various environmental characteristics. Besides, relatively big on the map is the Ecosystem Health. From Figure 12, it becomes clear that in Ecosystem Health a similar situation is observed. This once again highlights the similarities between the approaches.

Global Health (Figure 13) and Planetary Health (Figure 14) also show common traits; they contain keywords mainly aimed at human health and wellbeing. However, Global Health does not touch on the subject of the environment at all, while Planetary Health map contains a cluster of keywords dedicated to ecology.

Plant Health (Figure 15) related keywords are similar to Ecological and Ecosystem Health. This approach does not target human health or medicine and is purely concentrated on the biological and environmental components. Three clusters represent the papers dedicated to particular types of plants, qualities typical for all plant communities, and various aspects associated with plans..

5.2 Challenges of the study

The thesis was entirely theoretical, and the majority of work involved subjectivity to some degree. This leads to the issue of possible variations of the selection of the optimal procedures and choice of literature. However, it is important to highlight again that this thesis does not aim at concluding the work with the provision of specific explicitly “right” answers. Instead, the goal was to present the

existing multitude of views and meanings, which authors of the scientific literature have about the approaches.

In addition, the area of study is relatively young: a lot of approaches, presented here started to gain popularity only at the beginning of the 21st century. Therefore, more and more publications will appear in the field, which will touch on the subject of these approaches and probably their analysis. That means that the situation can change significantly in a relatively short time.

During the analysis, another difficulty was revealed: since the topic of the thesis was aimed at the relatively new, young approaches, not much literature was dedicated to them yet. While for the statistical analysis a sufficient amount of data is crucial, it increases the preciseness of the results and ensures their reliability. In this case, several approaches were not suitable for the keyword analysis because the study material was unrepresentative.

Another aspect of work, which can be criticized is that collected literature material selected for the analysis reflects on the ground concept and theory, however, not all the papers were collected by the usage of the procedure described. At the beginning set of key papers was already created. Then their reference lists served as a source of new papers. That makes it hard to repeat the exact same procedures.

6 CONCLUSION

The importance of clear, explicit terminology is essential for every field. Especially this is important for the creation of problem-solving strategies. Since that involves the interaction of professionals and scientists from a huge number of various organizations. For environment-related issues, cooperation often has to be international. That requires the maximum possible understanding to achieve the best possible level of efficiency. That creates the fastest reply to emergencies and gives a base for the foundation of the legislation. Besides, the environmental issues often demand the involvement of huge masses of people who are not involved in the topic that much, for example, change of routine behavioural habits

of citizens. A proper education with the usage of well-established terminology will increase the value of such studies.

An increasing number of approaches related to the health of the environment indicate the growing demand and efficiency of their implementation. However, to avoid mistakes or miscommunication, the proper definitions should be well known by all the interested parties. Therefore, information about existing approaches should be clear and easily accessible. Currently, because the area is still developing, a comprehensive compilation of the data is hard to find.

This thesis was an attempt to present the existing trends in the field and accumulate information. Moreover, to investigate the approaches with the help of statistical analysis of the related scientific and professional literature.

The study confirmed that the demand for and popularity of the approaches are increasing, especially starting from the 2020s. The investigation of the terms separately showed the existing similarities between Ecological Health and Ecosystem Health approach, which might indicate that they are closely connected. That might reveal the presence of overlap in them. It also showed that these two approaches and Plant Health focus more on the issues connected to the environment. On the other hand, the majority of other approaches tend to be more anthropocentric (Environmental Health, Global Health, Planetary Health, EcoHealth). However, the degree of anthropocentrism differs between them. For example, Global Health focuses much less on the environment than Planetary Health, even though the last one is known to be human-focused.

An insufficient amount of data on the Agroecosystem Health and Ecosystem Approach to Health made their statistical analysis unreliable. Hence, they had to be excluded from the final results. That fact makes the objectives of the research to be achieved only partially.

However, with the increase of the material available for the investigations, it will become more effective to perform similar analyses. Especially fruitful can be a

combination of the in-depth analysis of the philosophical concepts behind the approaches and the statistical analysis similar to the one, performed in this research. The results of a study like that will provide good comprehensive results, which could change and incredibly improve the strategies for facing the environmental challenges of various types.

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LIST OF FIGURES AND TABLES

VOSVIEWER KEYWORDS ANALYSIS OF THE TERMS

Agricultural Health

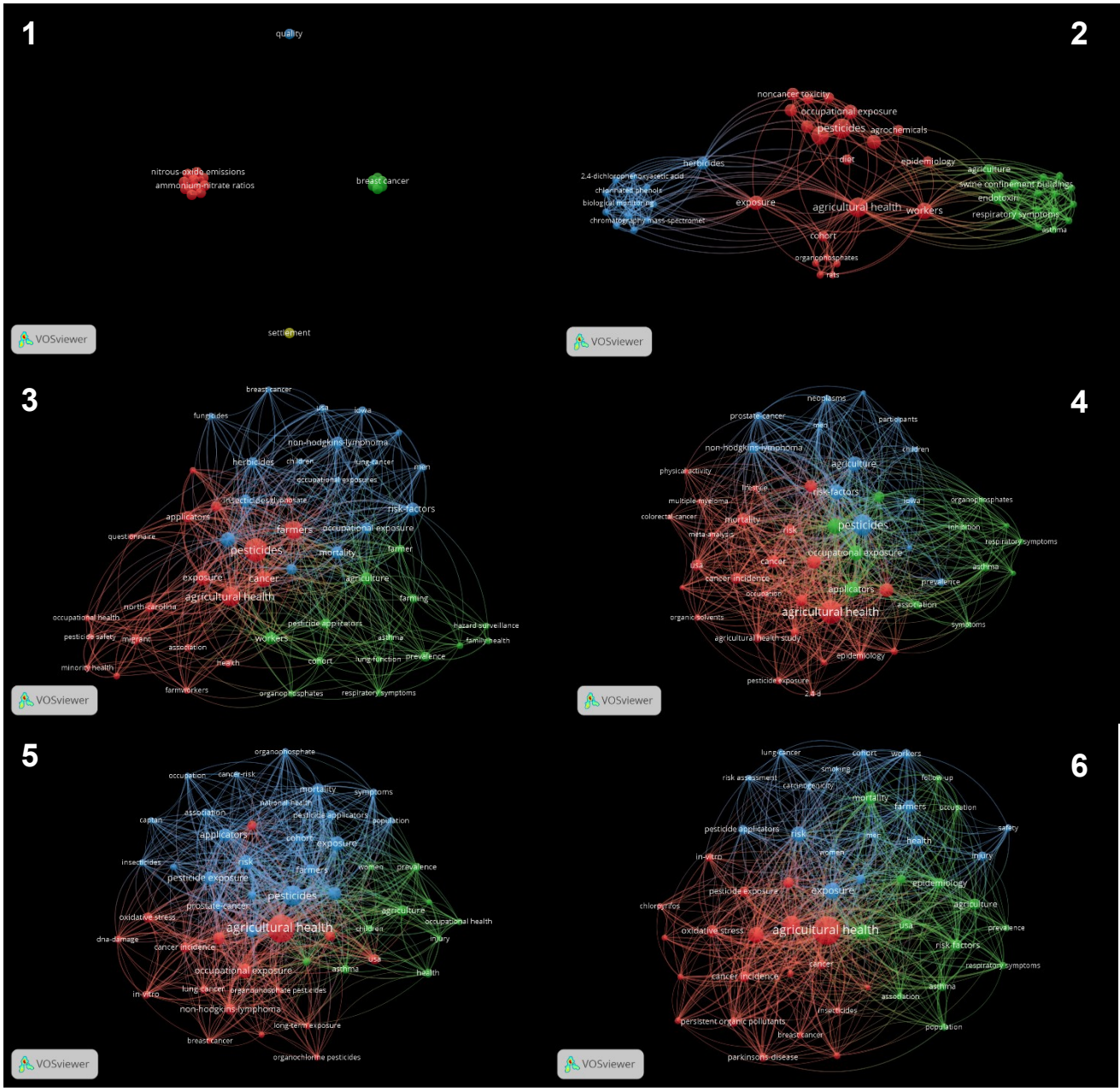


Figure 17. Evolution of the keywords of articles related to the term Agricultural Health. Time periods are: (1) 1980-1995, (2) 1996-2000, (3) 2001-2005, (4) 2006-2010, (5) 2011-2015, (6) 2016-2020.

Agroecosystem Health

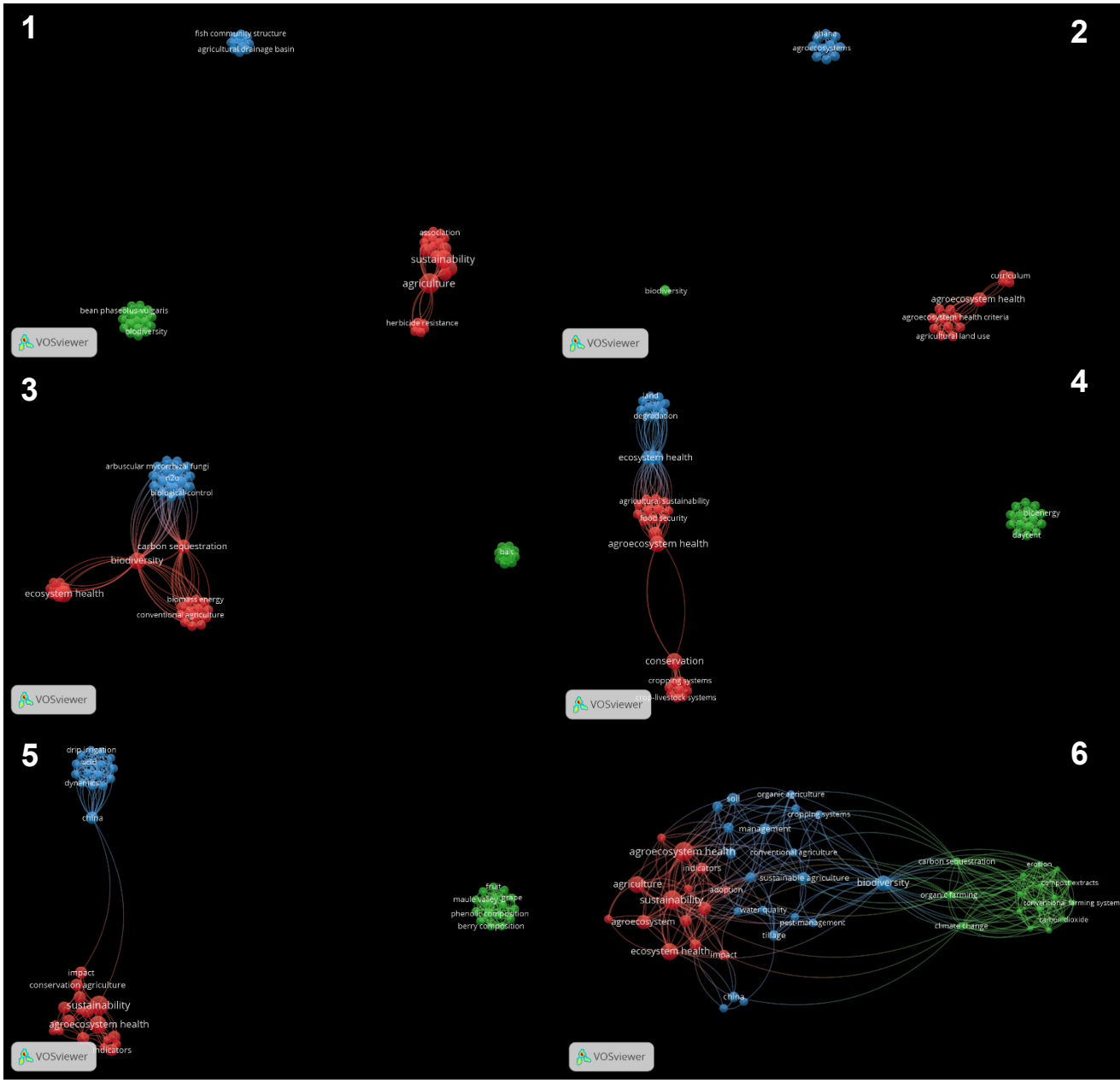


Figure 18. Evolution of the keywords of articles related to the term Agroecosystem Health. Time periods are: (1) 1995-2000, (2) 2001-2005, (3) 2006-2010, (4) 2011-2015, (5) 2016-2020, (6) 1995-2020.

EcoHealth

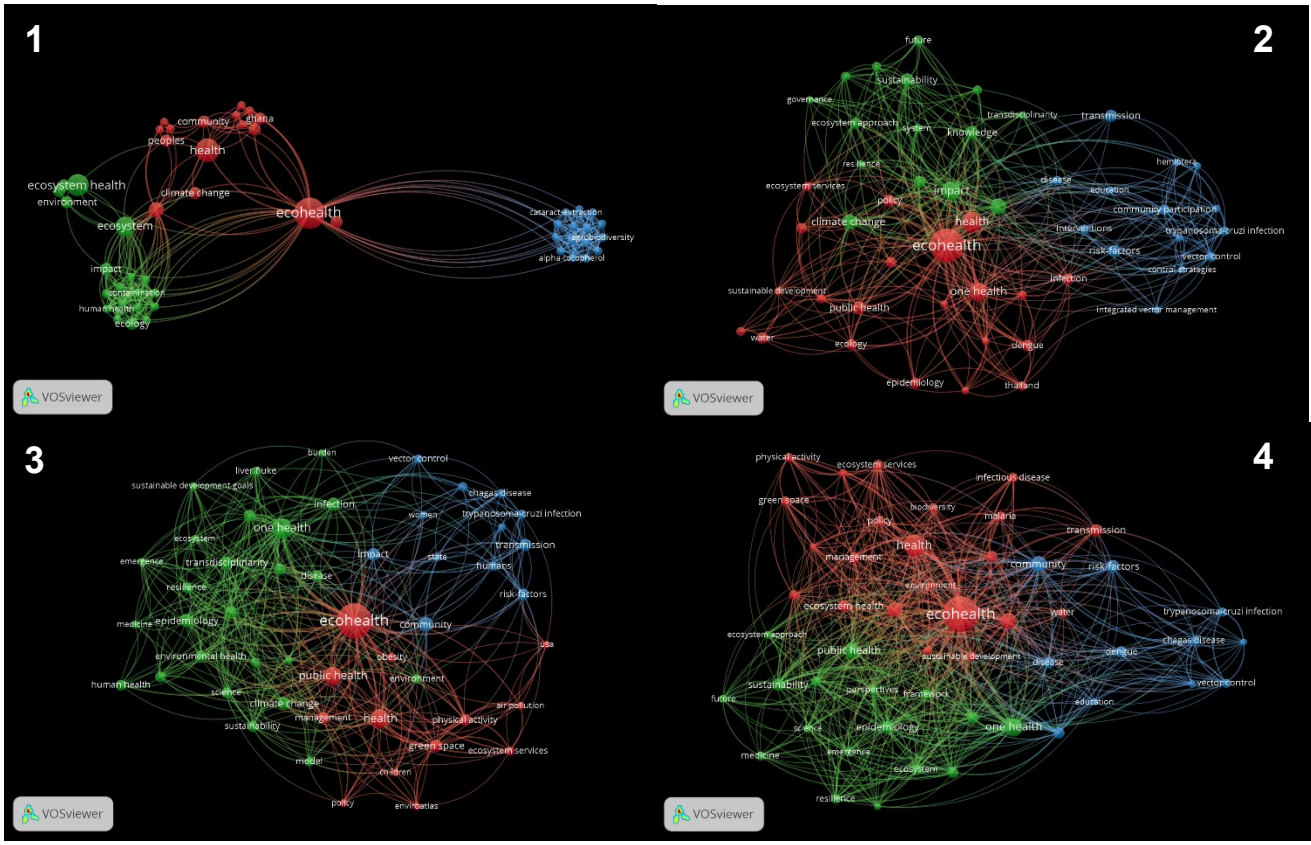
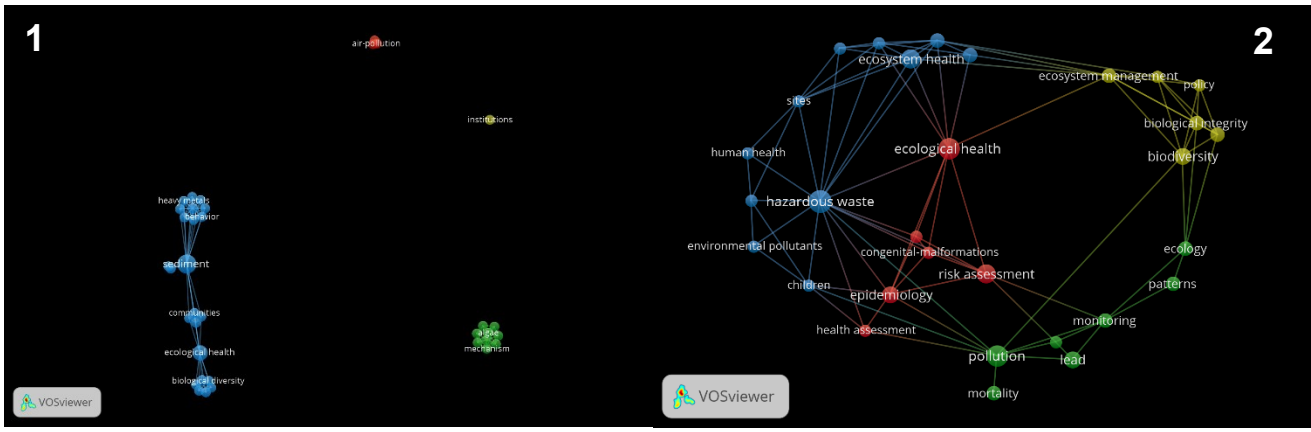


Figure 19. Evolution of the keywords of articles related to the term *EcoHealth*. Time periods are: (1) 2004-2010, (2) 2011-2015, (3) 2016-2020, (4) 2004-2020.

Ecological health



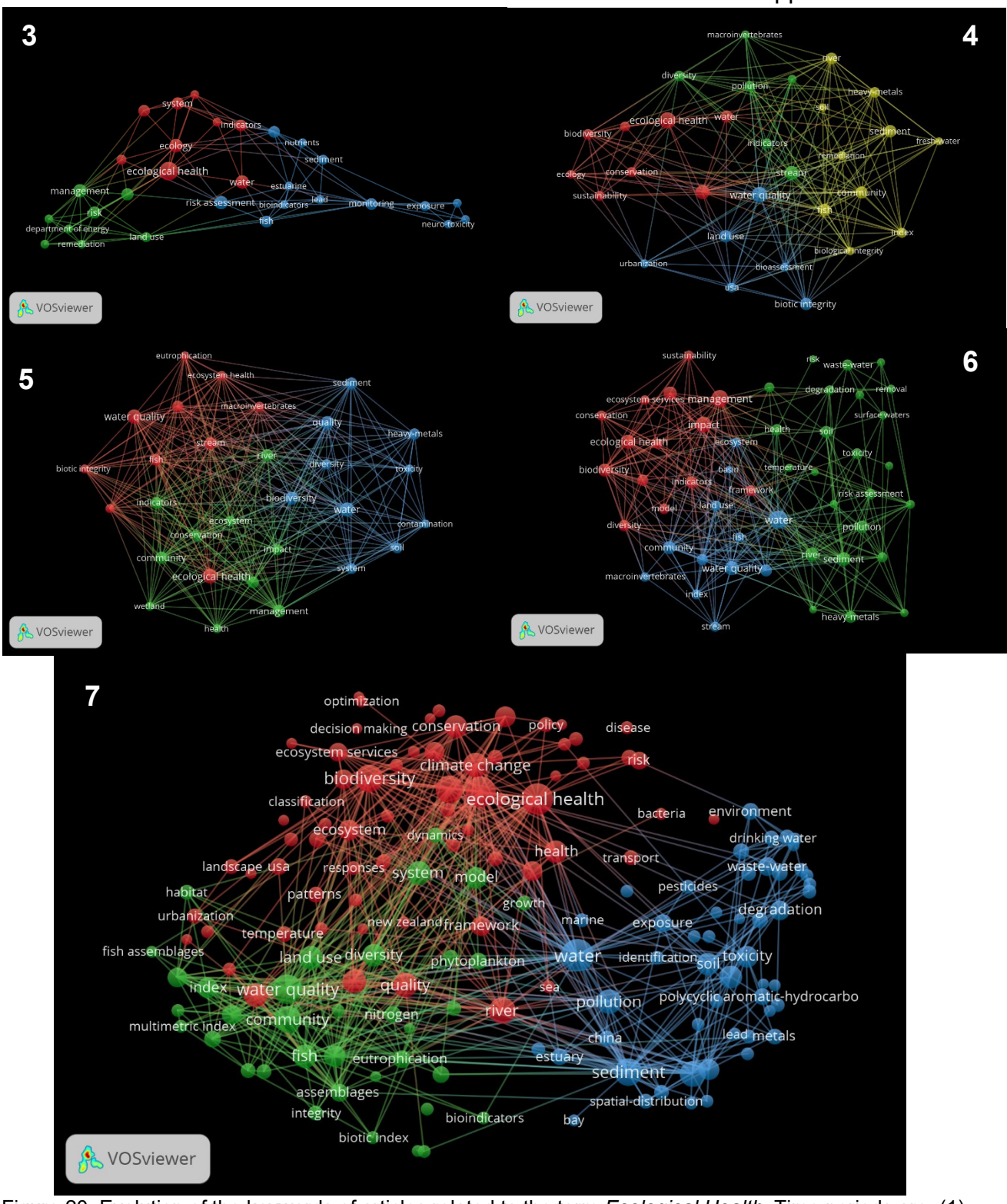


Figure 20. Evolution of the keywords of articles related to the term *Ecological Health*. Time periods are: (1) 1985-1995, (2) 1995-2000, (3) 2000-2005, (4) 2005-2010, (5) 2010-2015, (6) 2015-2020, (7) 1985-2020.

Ecosystem health

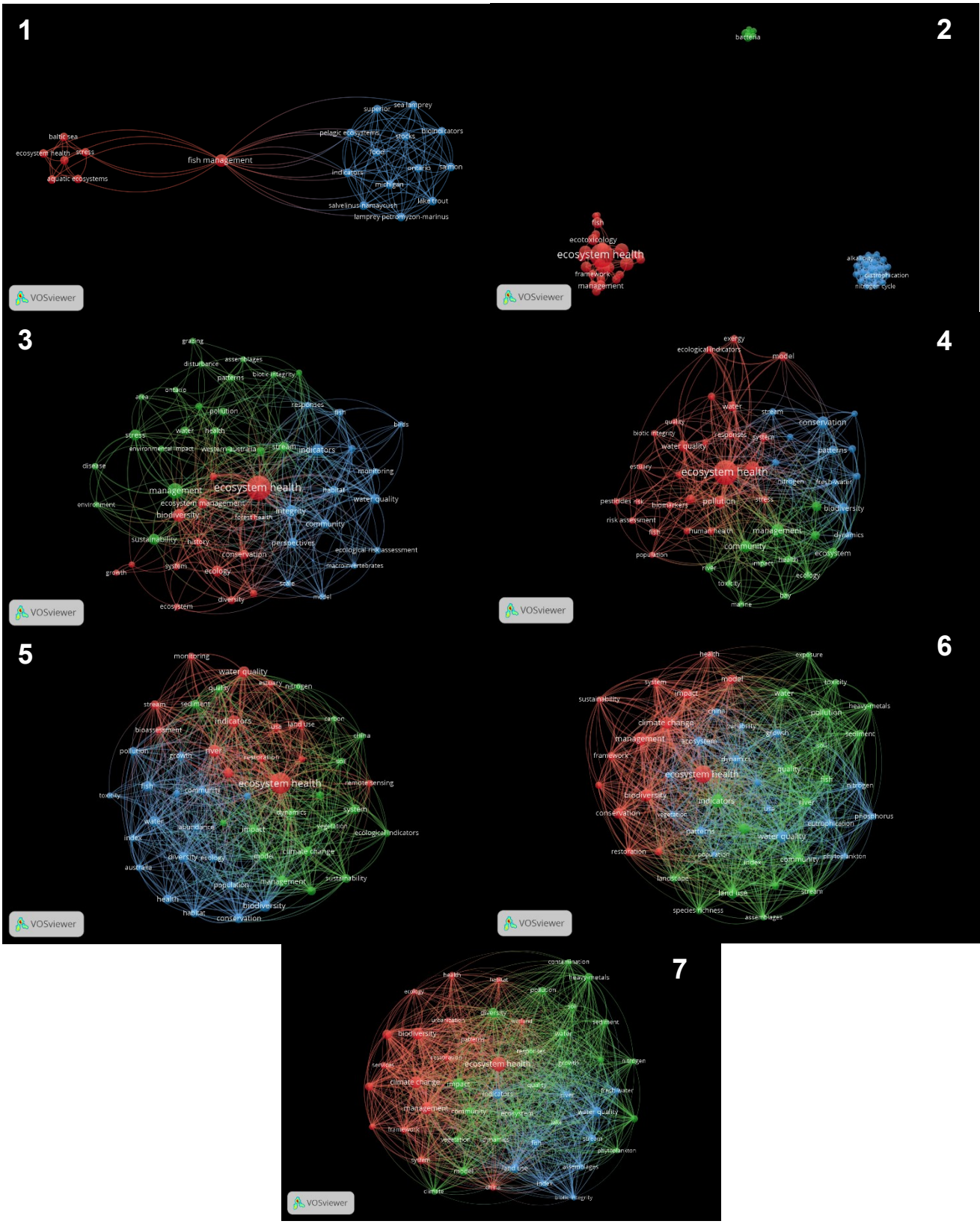
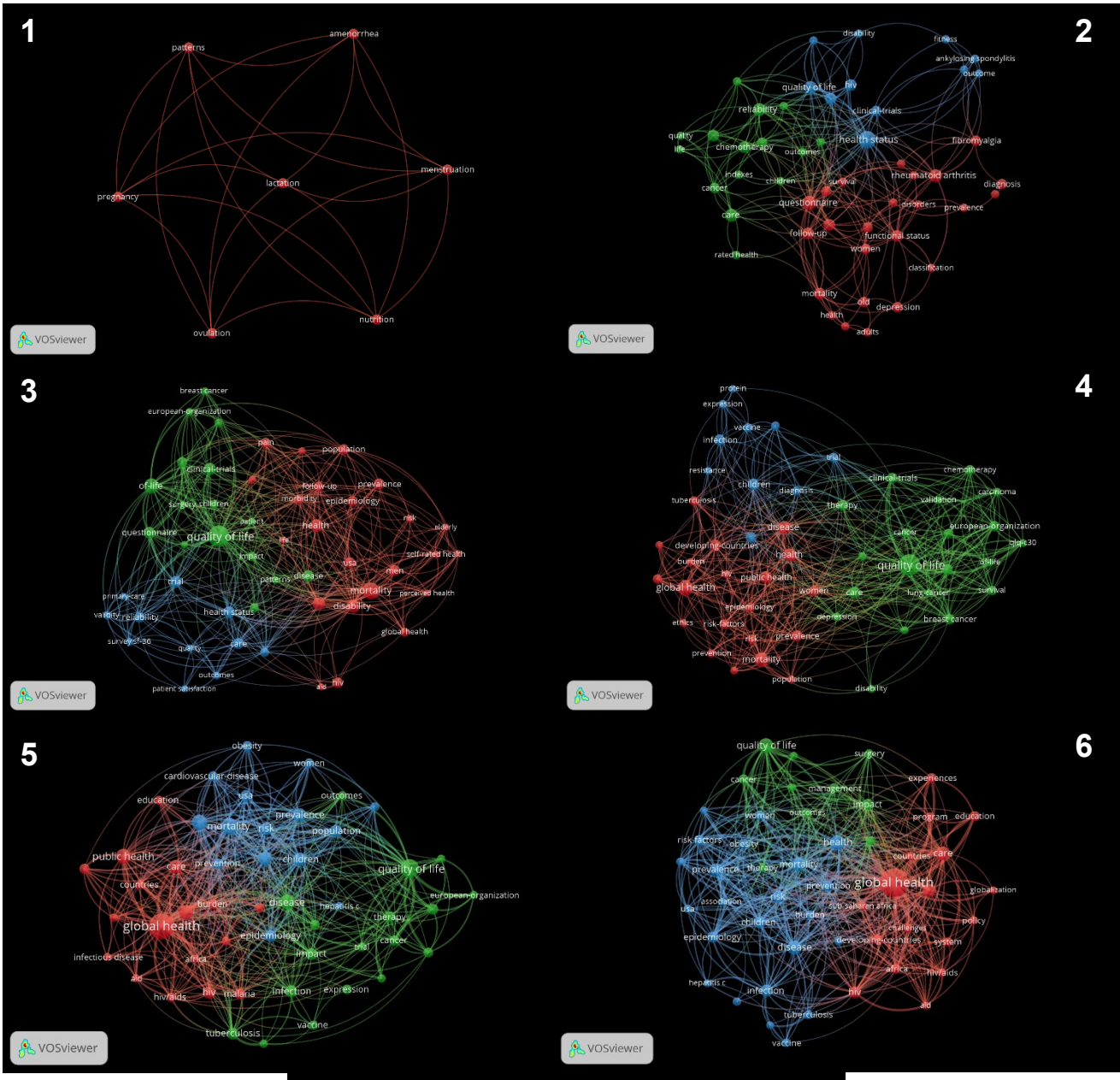


Figure 21. Evolution of the keywords of articles related to the term *Ecological Health*. Time periods are: (1) 1980-1990, (2) 1991-1995, (3) 1996-2000, (4) 2001-2005, (5) 2006-2010, (6) 2011-2015, (7) 2016-2020.

Global health



Appendix

Figure 22. Evolution of the keywords of articles related to the term *Global Health*. Time periods are: (1) 1975-1990, (2) 1991-1995, (3) 1996-2000, (4) 2001-2005, (5) 2006-2010, (6) 2011-2015, (7) 2016-2020.

Plant health

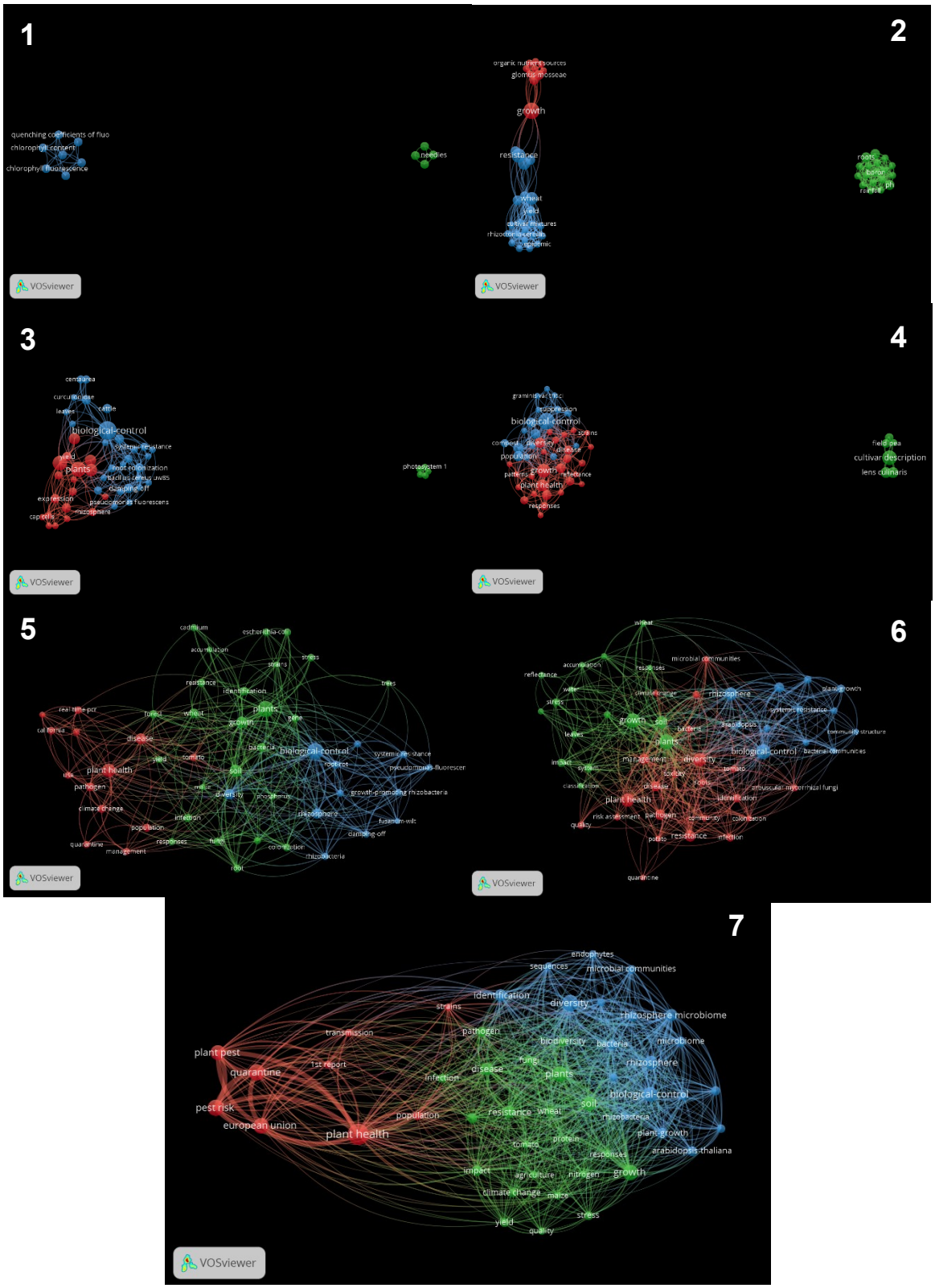


Figure 23. Evolution of the keywords of articles related to the term *Plant Health*. Time periods are: (1) 1975-1990, (2) 1991-1995, (3) 1996-2000, (4) 2001-2005, (5) 2006-2010, (6) 2011-2015, (7) 2016-2020.

Planetary Health

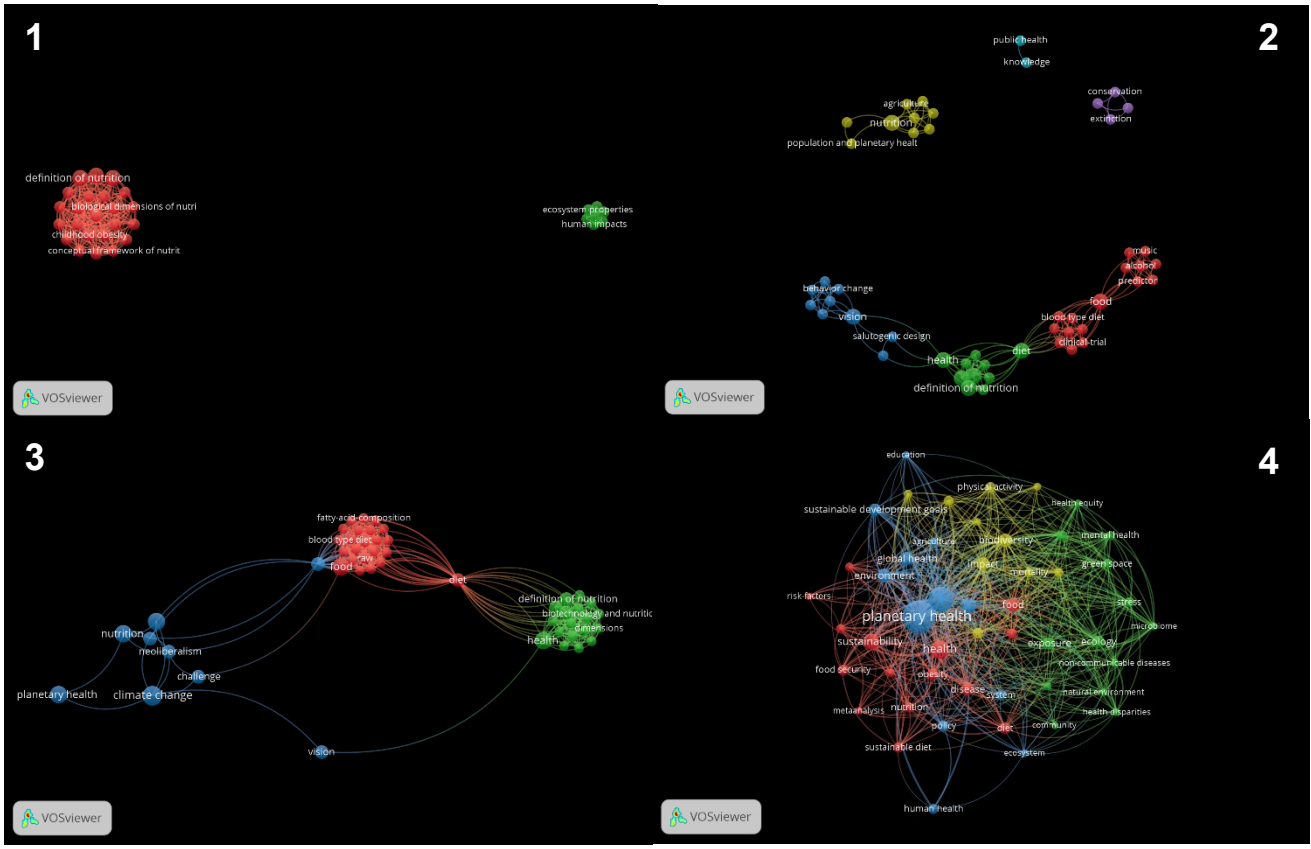


Figure 24. Evolution of the keywords of articles related to the term *Planetary Health*. Time periods are: (1) 1995-2005, (2) 1995-2010, (3) 1995-2015, (4) 1995-2020.

FIELDS OF STUDY MOBILIZING AGROECOSYSTEM HEALTH AND ECOSYSTEM APPROACH TO HEALTH

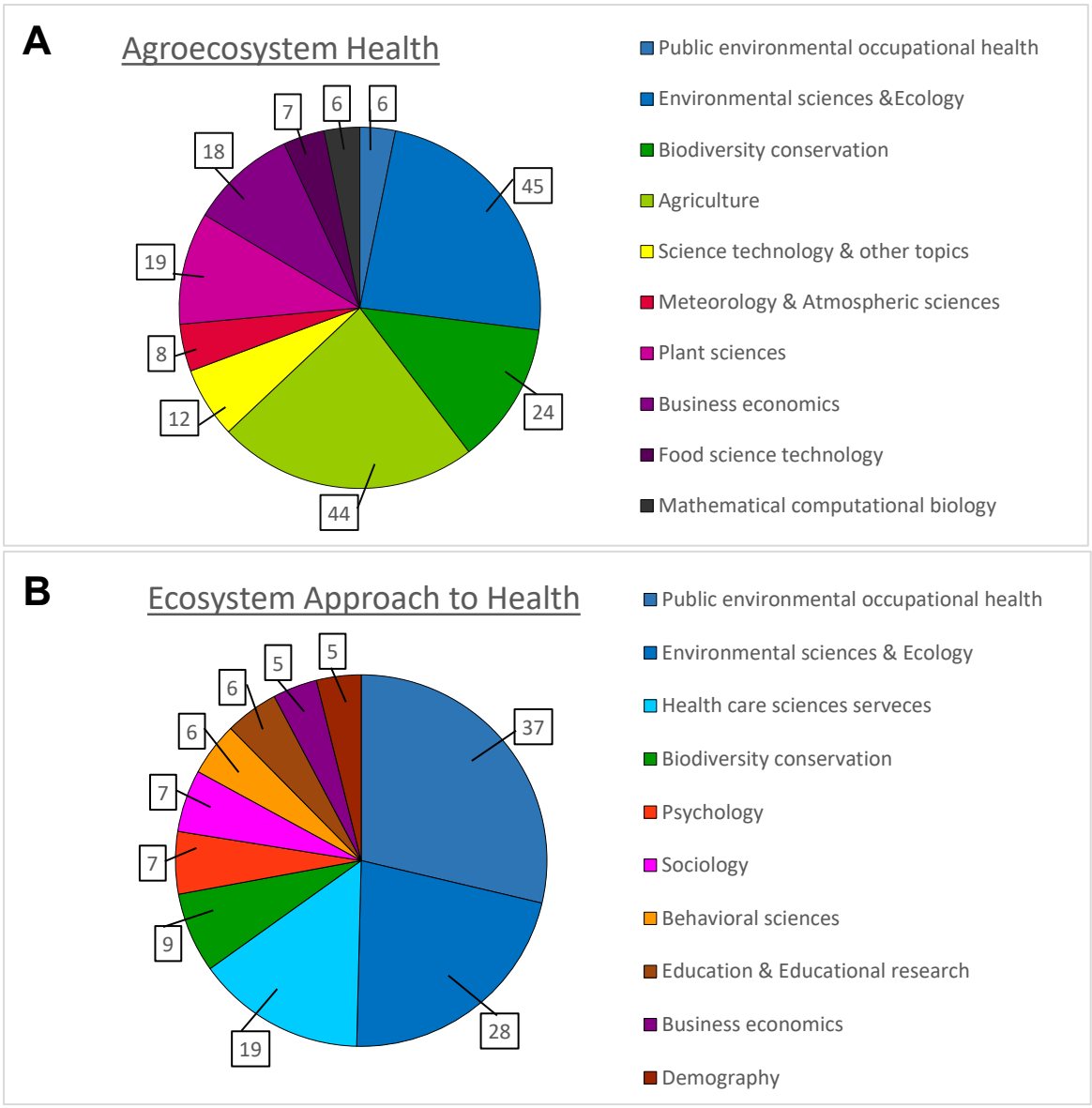


Figure 25. Ten research areas where the following terms are used the most: a. Agroecosystem Health, b. Ecosystem Approach to Health.