A GRAPHIC REVIEW OF STUDIES ON COASTAL TOURISM AND BATHING WATER QUALITY

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Abstract
Coastal tourism is a significant part of the contemporary tourism, which is growing more and more due to the increasing world population with recreational needs. A part of the coastal tourism refers to using the coastal seawater for recreational activities, such as bathing. The bathing water quality is important for tourist fluxes and maintaining it at high standards is a challenge because of the today's accelerated changes of the natural environment. Using the bibliometric tools biblioshiny and VOSviewer, the main research themes and keywords of some specific research studies (from Web of Science Core Collection) are presented in a graphic form by using a tree map, a production and collaboration map, a three-field plot and a co-occurrence network map. Some of the common words in the selected scientific literature are: "economy", "management", "improvement", "recreational activities", "wastewater", "sewage", "contamination", "pollution", "Escherichia coli", "enterococci", "model". Frequently mentioned places are Brazil and Adriatic Sea. An upgraded management of the coastal areas is needed for a sustainable tourism in the near future.

Key words: *bacteria, beach, eutrophication, marine, occurence.*

JEL Classification: *Q25, Q53.*

I.INTRODUCTION

Coastal tourism is an activity that flourishes due to the facilities of mass tourism. The increasing number of world's population has as consequence the continuous augmentation of the population number that has mobilities depicted as tourism. Along the sea coastline, there are popular activities related directly to the seawater resource that are component of coastal tourism: bathing, swimming, boating and fishing.

The bathing water quality is of high interest for most beach goers because of its immediate impact on the recreational activity. If the seawater used for bathing and swimming has low transparency, unusual color or smell, tourists will avoid certain coasts, with consequences on the local economies.

The current climate change comes with numerous challenges for coastal tourism. Stronger and more frequent heavy rains or hurricanes (Carvalho, 2020) have an impact on the geomorphology of the beaches (Kinsela, Morris et al., 2017) - not only the configuration of the seaside infrastructure suffers unpredictable changes, but also the coastline vegetation, either submerged or emerged, because of the loses in biodiversity and ecosystem resilience. Infrastructure damages along the coastline, especially in urban areas, have high chances to create unwanted debris in the littoral zone (Ryan, 2020). Cumulated with the increasing plastic pollution in most rivers of the world (especially in the developing countries where measures to protect the environment lack or are poorly applied), the plastic debris from river watersheds will become more and more common in the shoreline landscape.

The rising sea temperature, caused by the global warming, is often measured as sea surface temperature, which also contributes to the sea level rise (besides the glacier melting) due to the thermal expansion of water (Murgulet, 2016). A higher bathing water temperature (and for a longer time interval) might be an advantage for tourists at a first glance, but it also comes with more advantages for bacterial activity and algal blooms (Jiang, Liu et al., 2021).

The consistent contamination of coastal waters with various organic and inorganic matters was a persistent problem in the developed countries for decades, especially due to the industrial activities. Nowadays, the water quality is increasing due to regulations in the mentioned parts of the world, but decreases in most of the other parts, where the demographic pressure is continuously augmented (as effect of the demographic boom), mostly due to the lack of wastewater treatment plants and to the transfer of some the most polluting industries from the developed countries (Hens and Boon, 1999).

The aim of the present study is to provide a graphic synthesis of the main research themes and keywords in the scientific literature indexed by Web of Science and related to the quality of the bathing water along the shores of the seas and oceans. The graphics, produced using bibliometric tools, are accompanied by brief comments of the most important topics in the form of a classic review.

II.DATA AND METHOD

Scientific papers regarding tourism and bathing water quality in coastal areas have been searched in Web of Science (WoS) using all available indices of the Core Collection (such as Science Citation Index Expanded).

The following combination of words was used to search for relevant papers in the topic field: ("beach*" OR "coast*" OR "shore*" OR "waterfront*" OR "oceanfront*" OR "sand*" OR "by the sea" OR "riviera" OR "seashore*" OR "seaboard*" OR "seafront*" OR "seaside*" OR "littoral*") AND ("water quality" OR "seawater quality") AND ("bathing" OR "swimming" OR "recreational") AND ("tourism" OR "tourist*"). Boolean operators were used, as well as the wildcard, used to allow any words derived from the selected root words (for example "coast*" allows searching for "coastal" or derived plural terms). The 142 papers retrieved by the mentioned search (as of November 13rd, 2023) are mostly of classic article type (125); secondary types are: proceedings papers (28), reviews (5) and book chapters (2). The sum of papers consists of yearly contributions that varied in the publishing intensity starting from 1992 (when the first available paper has been published). In the first half of the 1992-2023 time interval, 1-2 papers have been usually published per year, while in the second half the average numbers increased to 6-9 papers usually per year; the maximum annual production was reached in 2021, with 19 papers.

The metadata of the found/selected papers has been exported from Web of Science using the "full record and cited references" setting. The export file has been processed by using two softwares that are highly used in bibliometrics today (Chen, Wang et al., 2023): bibliometrix with biblioshiny web interface (Aria and Cuccurullo, 2017) and VOSviewer (acronym for Visualization of Similarities; van Eck and Waltman, 2010). The bibliometrics include techniques for quantitatively analyzing papers, authors, networking and the statistical relevance of keywords using dedicated softwares and methods (Herrera-Franco, Montalván-Burbano et al., 2021).

A tree map has been produced by using the authors' keywords of the selected papers; a list of items to remove was used to eliminate implicit terms of the search results such as "water quality". All items/words from the authors' keywords category and KeyWords Plus category were taken into account for generating the Sankey diagram of the three-field plots analysis (KeyWords Plus is a WoS exclusive that contains the most frequent terms in the cited titles of the analyzed papers which are not found in the titles of the citing paper).

A co-occurrence analysis of the words contained in the titles and abstracts of the selected papers has been conducted using the default settings of VOSviewer (binary counting of the occurrence, 10 occurrences as a minimum for a word in order to accept it into the analysis, which is then applied to the list of the 60% most relevant terms). Items that refer to words that are implicit to the process of research and publishing were removed from the co-occurrence network map (e.g.: paper, year).

III.RESULTS AND DISCUSSION

The most frequent keywords used by the authors of the selected studies (Fig. 1) show a significant focus on the biological quality of the coastal waters used for bathing (as proved by the name/type of various harmful bacteria). Fecal pollution of coastal waters still poses a risk to the tourists' health in some developed areas of the world because it brings microbes in the swimming water (Jang and Liang, 2018). Numerous studies on the bacteriological threat have been conducted in the developed countries, but fecal indicator bacteria and their ratios used in assessing the water quality of areas with temperate climate (and developed countries) are not appropriate for tropical regions (Lamparelli, Pogreba-Brown et al., 2015). The coastal waters with sewage problems have high concentrations of E. coli that is resistant to antibiotics, posing supplemental pressure on the tourists' health (Overbey, Hatcher et al., 2015). Moreover, because the climate change is associated with increased risk of floods, either coastal or fluvial, the increased runoff from city surfaces will lead to a higher contamination with E. coli and enterococci, thus decreasing bathing water quality even on distant beaches, a few km away (Schernewski, Schippmann et al., 2014).

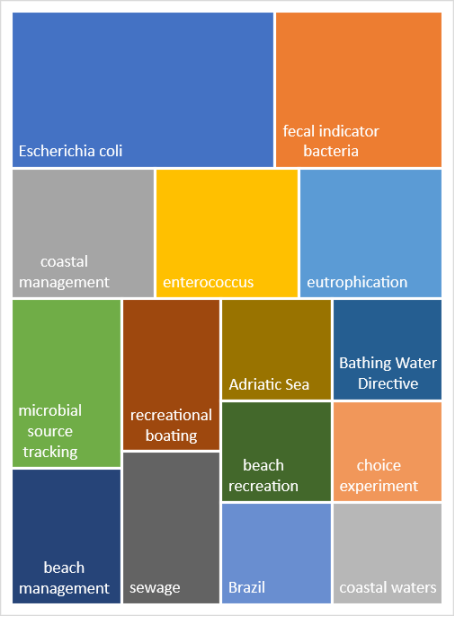

Figure 1 – Tree map of the top 15 most frequent authors' keywords

Bays and lagoons are prone to high concentrations of bacteria due to their enclosure, which limits the water exchanges. This is true mainly during periods with high water turbidity; rainfalls and winds data, along with marine currents data may be used in hydrodynamic models to assess the daily risk of contagion (Buer, Gyraite et al., 2018). Harmful bacteria have a higher concentration in the early morning due to the missing direct solar radiation during the night, when the input from various pollution sources cumulate (Lušić, Kranjčević et al., 2017). This information can be used in modelling seawater quality during a day, removing the seasonal scale forecast limit (there is a higher water contamination during periods of high density of tourists into the water).

The growth of tourist industry is correlated with increases of wastewaters that may affect the recreational areas along the shores; improved sewer networks, wastewater treatment and submarine outfalls may help in increasing coastal water quality (Legović, 2003). During the coronavirus pandemic, the bathing water quality of seawater along Morocco has increased compared to pre-pandemic years, especially during lockdown periods, due to the reduction in fecal coliform and streptococci levels of marine waters (Ben-Haddad, Charroud et al., 2023). Common sources of bacteria on beaches are the sewage from tourist accommodations and the outputs of the nearby wastewater treatment plants.

The eutrophication of coastal waters is the direct consequence of the abundance of anthropogenic nutrients in wastewaters, especially in estuaries and urban areas, and affects tourism activities though side effects such as the algal blooms (Oduor, Munga et al., 2023). The environmental problem generated by plastic pollution, especially microplastic, which generated a "plastisphere" (Zettler, Mincer et al., 2013), enhances the pathogens issue; the plastic debris may act as biotope for pathogens (bacteria) and harmful algal species (Keswani, Oliver et al., 2016).

Current E.U. states issued their first directive on bathing water quality in 1976 and modified it into the 2006 E.U. directive that regulates mandatory control and prevention of the proliferation of aquatic bacteria that can cause health issues (Merino and Prats, 2022). The Bathing Water Directive 2006/7/EC safeguards public health from microbial pollution by using fecal indicator organisms for classifying bathing waters with qualificatives ranging from "excellent" to "poor", mainly in order to avoid gastrointestinal diseases (Quilliam, Taylor et al., 2019).

Most studies on bathing water quality and coastal tourism were written by authors in institutions based in developed countries (Fig. 2): USA (70 papers), Spain (29), Croatia (27), Italy (24) or UK (20) – one can observe that countries with direct access to the seas have contributions to the studied scientific field (with the notable exception of Serbia, which was once part of Yugoslavia), meaning that a significant part of the studies with authors from a country will be related to the water quality of the same country. Countries with a long coastline in climates favorable to coastal tourism (e.g. Brazil – 30 papers) or with numerous population (e.g. China – 18 papers) also have important contributions.

Some Italian beaches of the Adriatic Sea record occasional critical situations because of the malfunctioning of the urban wastewater treatment plants (Liberatore, Murmura et al., 2015). The southern Baltic coast has issues related to eutrophication and algal blooms, low water transparency, which hampers touristic development and reduces the attractiveness of local beaches for tourists (Schernewski, Baltranaitė et al., 2019).

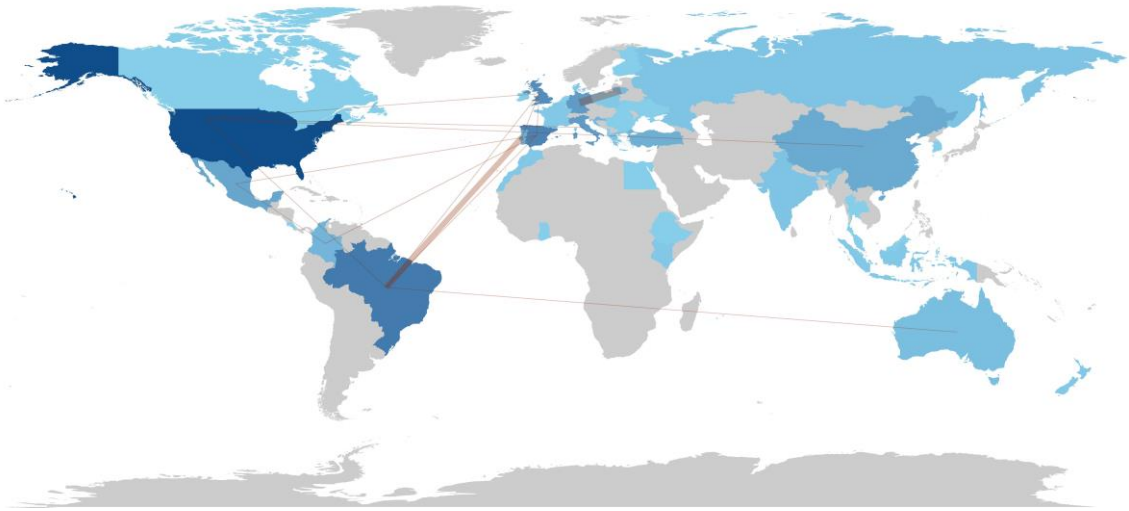

Figure 2 – Production and collaboration map based on the countries of the corresponding authors
(the darker the blue color, the higher the scientific production; the straight lines represent collaborations; using a generic map projection, with latitude on the vertical axis and longitude on the horizontal axis)

In India, the bathing water quality along the coastline is constantly worsened by the increasing environmental footprint of the coastal cities. Industrial discharges and maritime commerce activities add to the already contaminated urban runoff and endanger the health of beach goers; for example, Chennai metropolitan area has unsafe coastal waters with high toxicity because of domestic and industrial wastes (Panda, Pradhan et al., 2020).

The importance of some research topics for the top countries contributing (with both citing and cited papers) to the studied scientific theme is revealed by the Sankey diagram (Fig. 3).

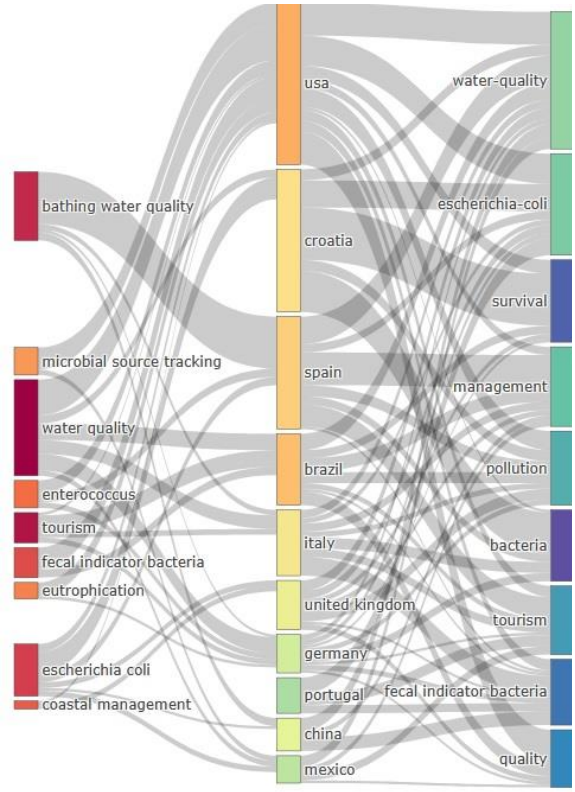

Figure 3 – Three-field plot (Sankey diagram) based on the authors' keywords (left field) and KeyWord Plus (right field) – top 10 related countries in the center

River outflows into the sea may act as source of contaminants and, when combined with wastewater from sewage pipes, they diminish the marine water quality because of their bacterial concentration, especially during the summer months, when it matters for coastal tourists (Cupul-Magaña, Mösso Aranda et al., 2006). For example, in Spain, marine currents driven by seasonal winds may contaminate beaches that usually have good water quality and the maximum permissible values of various bacterial concentrations are sometimes exceeded (Cupul-Magaña, Mösso Aranda et al., 2006).

Massive rainfall events cause river floods that carry numerous contaminants into seas partly enclosed by densely populated territories (e.g. Adriatic Sea); in this context, real-time alert systems can be implemented and can use autosamplers coupled with hydro-meteorological monitoring networks, placed either along the coast or along rivers that impact the coasts, in order to predict potential ecological risks (Penna, Baldrighi et al., 2021). Such measures are very useful for the proper assessment of the coastal risks and the adequate management of the beaches and their adjacent seas.

The co-occurrence network map reveals the grouping of some topics into research subthemes based on the interests of the researchers; in Fig. 4, the circles indicate the importance of various words, the colors are unique per cluster/group of strongly interconnected words, while the lines show the existing connections between the most relevant words. The clusters generated by the words of the studied papers are:

- Cluster #1 (15 items) - contains words such as "Brazil", "country", "economy", "management" and "improvement", suggesting struggles to increase efficiency;
- Cluster #2 (10 items) - contains, among other items, "river", "sediment", "sewage", "recreational activities", a memento of the importance of the rivers, that carry pollutants from watersheds into the seas;
- Cluster #3 (10 items) – contains "E. coli", "enterococci", "pollution", "wastewater", "contamination", indicating the studies focused on the biological quality;
- Cluster #4 (4 items) - "model" and "bathing water" indicate that the coastal bathing water is a common good of public interest and that water quality predictive models are needed and used for the prevention and warning of the tourists and authorities and the activation of proper services.

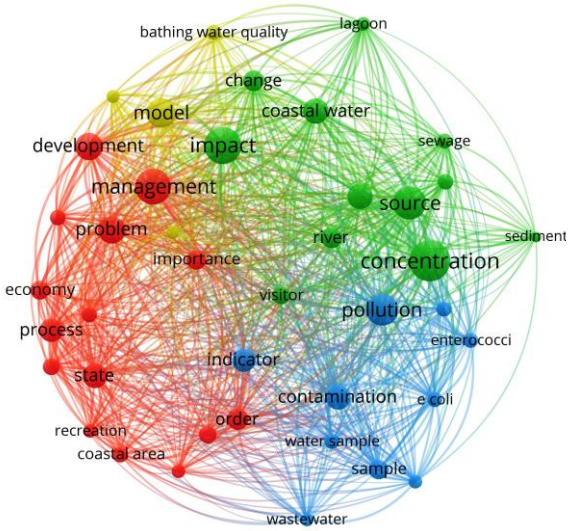

Figure 4 – Co-occurrence network map of the most relevant words in titles and abstracts

The coastal bathing waters of Europe have increased in quality over the last decades due to water sanitation plans; for example, in Spain, the wastewater treatment measures resulted in abrupt decrease in microbial concentration along shorelines (Pouso, Uyarra et al., 2018). The beaches with a Blue Flag (a program started in 1987) have cleaner water than those without this mark in Spain, France and Italy (Merino and Prats, 2022).

Stormwater management should be combined with upgraded wastewater management in order to obtain good seawater quality that safeguards jobs and profits in the seashore hospitality (Moncheva, Racheva et al., 2012). The harmful algal blooms, potential sources of cyanotoxins, have numerous negative effects on the economic side, such as declines in hotel and restaurant occupancy rates, job losses (for example, in Florida (Heil and Muni-Morgan, 2021)).

Tourists prefer beaches with pristine environment and low congestion levels (such as those of Oahu, Hawaii) and water quality and swimming safety are important in their choice - especially the water quality and the congestion have a great influence on the tourists' willingness to pay (Penn, Hu et al., 2016).

Forecasting models can be used to calculate the probable concentration of coliforms and are a must today to be used by beach managers and local authorities (Panda, Pradhan et al., 2020). Last but not least, environmental protection projects have the potential to diversify the recreational tourist activities along coasts (Font, 2000) and promote coastal tourism.

IV.CONCLUSION

The papers that were analyzed in the present study are variate in their research interests: some of them are studying directly the tourism phenomenon; some are interested in the impact of tourism on some territories and water bodies; others are more inclined to show the impact of tourism on some natural or anthropogenic contexts; a few studies analyze inland waters and discuss them in the broader context of the water quality, that includes the marine water.

Coliform bacteria contamination of coastal waters persists today as an issue with consequences on tourists. Algal blooms, favored by the nutrient discharges into the sea, especially from the urban areas, will degrade the coastal landscape. Plastic debris accumulations on beaches are on the rise.

Numerous threats gather at the line between the land and the sea, due to the increasing seawater level and temperature. Various predictive models try to assess future hazards in order to have a society (with growing population and standard of life) prepared for the consequences of changing a multitude of global and local natural parameters.

As result, an integrated management of the coastal waters, river watersheds and urban areas is necessary for a sustainable economy, a clean environment and healthy tourists.

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