Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 26(5): 1139 – 1163 (2022)
www.ejabf.journals.ekb.eg

Anthropic Impacts on Aquatic Mangrove Ecosystems Worldwide

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ARTICLE INFO

Article History:
Received: Aug. 28, 2022
Accepted: Sept. 19, 2022
Online: Oct, 25, 2022

Keywords:
Bibliographic review,
Anthropic activities,
Climate change,
Mangroves

ABSTRACT

Mangrove aquatic ecosystems are among the most threatened environments in the world due to the effects of climate change and anthropogenic activities. This study aimed to identify the anthropic impacts on mangrove ecosystems worldwide to determine a bibliographic review of scientific articles referring to the subject of the study of the MDPI; Taylor & Francis and Google Scholar bases were developed. It was found that aquaculture and agricultural activities, sea level rise, pollution by the oil spills, plastic waste and heavy metal concentration, deforestation, population development, wastewater discharges, coral extraction for construction material, cumulative impacts of dams, overfishing and meteorological phenomena are the impacts that stalk and directly degrade mangrove ecosystems around the world. From the results recorded, it was concluded that the American continent and Asia are the most affected with respect to their mangrove forests.

INTRODUCTION

Mangroves are tropical forests **(Caldo *et al.*, 2008)** considered one of the most productive ecosystems worldwide **(Turner *et al.*, 2003; Bouillon *et al.*, 2008)**, which generally occupy shallow waters near the coastal profile and adjacent lands **(Wolf, 2012; *Armono et al.*, 2022)** and in turn act as nurseries for many species **(Viet Dung *et al.*, 2021)**. Moreover, they maintain water quality and clarity **(Alongi *et al.*, 2004)**, and protect the coasts from floods **(Dahdouh-Guebas *et al.*, 2005; Chan-Keb *et al.*, 2021;; Waiyasusri & Chotpantarat, 2022; Zhang *et al.*, 2022)**, hurricanes and waves **(Barbier, 2016)**. Mangrove soils are highly effective carbon sinks **(Adame *et al.*, 2018)**, which store large amounts of carbon and prevent its entry into the atmosphere **(Agraz-Hernández *et al.*, 2019)**.

Globally, there are 152,000 km^2 of mangroves distributed in 123 countries **(Palacios *et al.*, 2021)**; they are rich in carbon **(Alongi, 2022; Pandisamy *et al.*, 2019)**. They cover approximately 13,776,000 hectares worldwide **(Giri *et al.*, 2011; Sanderman, 2017)**, estimated between 60% and 70% of the coasts in the tropics and subtropics **(Nathan *et al.*, 2020)**. These coasts are very dynamic due to the dense population of the canopy and the flooding of tides **(Mohamad *et al.*, 2022)**. Mangroves are critical breeding habitats for fish, birds and marine mammals **(Mumby *et al.*, 2004)**/ the area where they are found is characterized by highly variable environmental factors, such as temperature, sedimentation and tidal currents **(Nagelkerken *et al.*, 2008)**. Therefore, these tropical forests are purposed to mitigate the effects of climate change in coastal areas **(Al-Guwaiz *et al.*, 2021; Zhu *et al.*, 2021)**.

Estimates of the cumulative loss of mangroves over the past 50 to 100 years range from 25% to 50% of the global area of this ecosystem **(Mcleod *et al.*, 2011)**. Almost 100% of mangroves could be lost in the next 100 years **(Duke *et al.*, 2007)**. The deforestation of mangroves is an issue of great concern worldwide; it is estimated that more than 35% has been lost **(Hamilton & Casey, 2016; Huong Nguyen *et al.*, 2022)**. Despite the value they represent in the world, they are marginalized and degraded in numerous tropics **(Araño Tagulao *et al.*, 2022)**.

Anthropogenic activities **(Benson *et al.*, 2017)** highly contribute to the degradation of mangrove ecological systems **(Grellier *et al.*, 2017; Worthington & Spalding, 2018)**, in addition to the impact of agricultural activities **(Friess, 2017; Velde *et al.*, 2019)**, human settlements, coastal defense, tourism, and aquaculture activities **(Sousa & Small, 2021)**. These activities alter the natural dynamics of these ecosystems and inhibit their capacity to adapt to/ alleviate climate change **(Silva *et al.*, 2020)**; therefore, human actions are one of the most relevant pressures faced by mangroves **(Hinestroza-Mena *et al.*, 2021)**. It is estimated that the loss of mangrove forests worldwide represents 38% **(Awty-Carroll *et al.*, 2021)**. In Latin America, despite the environmental management that has considerably developed in the last years **(Silva *et al.*, 2014)**, it is still very common for problems associated with anthropic factors, such as pollution, destruction and the degradation of renewable natural resources and the environment **(Chacón Abarca *et al.*, 2021)**.

Due to the effects of climate change **(Escudero & Mendoza, 2021)**, the mangrove systems are among the most threatened ecosystems worldwide **(Nguyen *et al.*, 2021)**. The elimination of mangroves leads to a collapse of intertidal food webs and coastal fisheries **(Ellison *et al.*, 2005)** and a rapid accumulation of acidic sulphides in the soil, increased coastal erosion, and sedimentation on coral reefs offshore **(Canty *et al.*, 2018)**. In tropical and subtropical areas, mangroves are frequently used to stabilize the living coast **(Fatoyinbo *et al.*, 2008; Fillyaw *et al.*, 2021)**, provide shelter, food, nesting space for more than 1300 species of animals and provide a variety of goods and services important to humanity **(Li *et al.*, 2021)**.

The world's largest mangrove areas are located in low-latitude regions, such as Indonesia (22.6% of the world total), Australia (7.1%) and Brazil (7.0%) **(Arai *et al.*, 2021)**, the world's most developed mangrove forests can be found in the Sundarbans, the Mekong Delta, the Amazon, Madagascar, Southeast Asia **(Giri *et al.*, 2011)**. Indonesia has a great diversity of species of mangrove (48 especies) **(Murdiyarso *et al.*, 2015)**.

The scientific article was presented due to comprehend and determine the anthropogenic impacts of aquatic mangrove ecosystems on the five continents of planet earth; therefore, the study was based on identifying mangroves degraded by human activity and climate change all over the world.

MATERIALS AND METHODS

This scientific article corresponds to the review of the bibliography which is the documentary operation of recovering a set of documents **(Bernardo, 2010)**, or bibliographic references that are published in the world about a topic, an author, a publication or a specific work **(Silamani & Guirao, 2015)**. The work of bibliographic review is part of a fundamental stage of any research project **(Aleixandre *et al.*, 2011)** and must guarantee the obtaining of the most important information in the field of study **(Fernando-Navas *et al.*, 2014)**.

The bibliographic review of the research consists of reviewing the anthropic or anthropogenic impacts on aquatic mangrove ecosystems worldwid; to carry out the review, four stages are taken into account (Fig. 1).

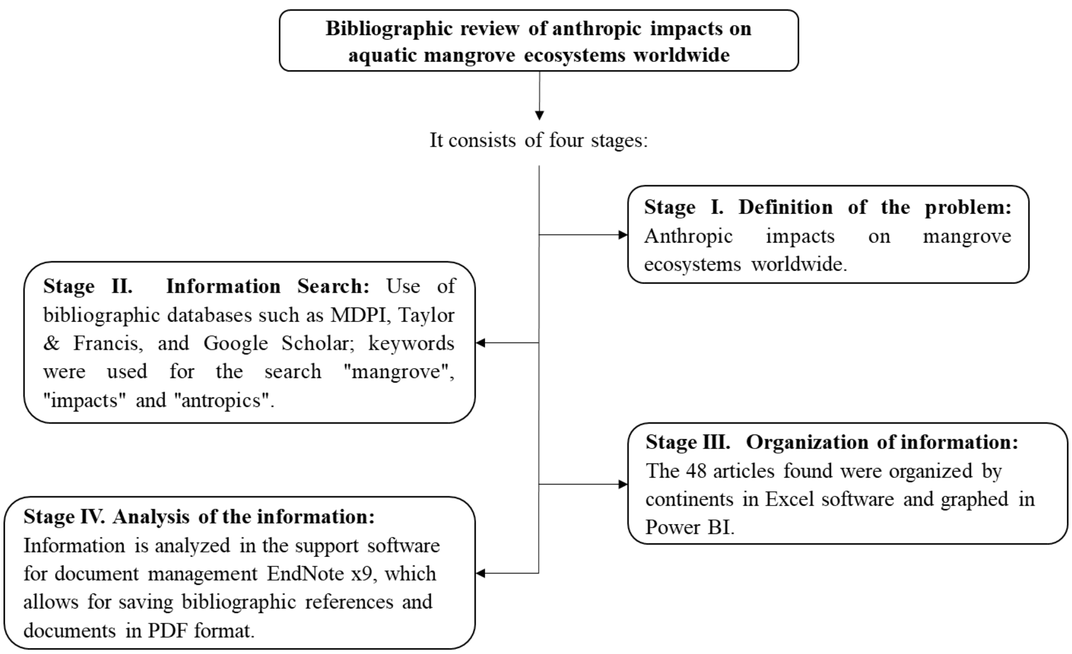

Fig. 1. Flowchart of the stages of the bibliographic review of the study

According to Fig. (1), the first stage of the research corresponds to the definition of the research problem; this must be clear enough to be able to carry out a bibliographic search that responds to the needs of the particular researcher, and that also allows the feedback of the researched **(Cué Brugueras *et al.*, 2008)**; therefore, the anthropic impacts on aquatic mangrove ecosystems worldwide are taken into account as a research problem.

The second stage refers to the search for information, which for the bibliographic research process must have informative material such as books, journals of scientific dissemination, sites web and other information necessary to start the search **(Cisneros & Olave, 2012)**; this is how the use of bibliographic bases of scientific articles such as MDPI is taken into account, besides Taylor & Francis and Google Scholar, using "mangrove", "impacts" and "antropics" as keywords for searching for information. At the stage of information organization (Stage III), it is relevant to systematically organize the documentation found that can be done both in a basic or detailed way **(Rivera & Garcia-Rojo, 2003)**; therefore, the 48 articles found were organized in detail in the Excel software and graphed in POWER BI.

Finally, at the last stage (Stage IV), the analysis of the information is taken into account, which is the task that takes more time in the bibliographic research since it is expected to identify the contribution to be made.In fact, once the main documents are identified, it is necessary to carry out an analysis of co-citation of authors and co-occurrences to identify the research fronts and the authors with the most citations. For this purpose, the endNote X9 document management support software was used, which allows to save and order the bibliographic references by authors, in addition to saving the copy of the scientific article in PDF format **(Fernández-Sora *et al.*, 2011)**.

A systematic review was carried out **(Moher *et al.*, 2009; Palacios *et al.*, 2021)**, in which they conducted individual searches in the MDPI, Taylor & Francis and Google Scholar databases of published articles. In this literature review, the focus was on the anthropic impacts on mangrove aquatic ecosystems worldwide, taking into account only research published from 2017 to 2022 due to the constant research carried out on the subject under study; Likewise, only research in the English language was considered.

A total of 368 articles were obtained from the three databases: 106 from MDPI, 197 from Taylor & Francis and 65 from Google Scholar. All the extracted articles were discarded (320) for not having sufficient relevance with the subject of study; thus, there were 48 investigations for the development of the scientific article (Fig. 2).

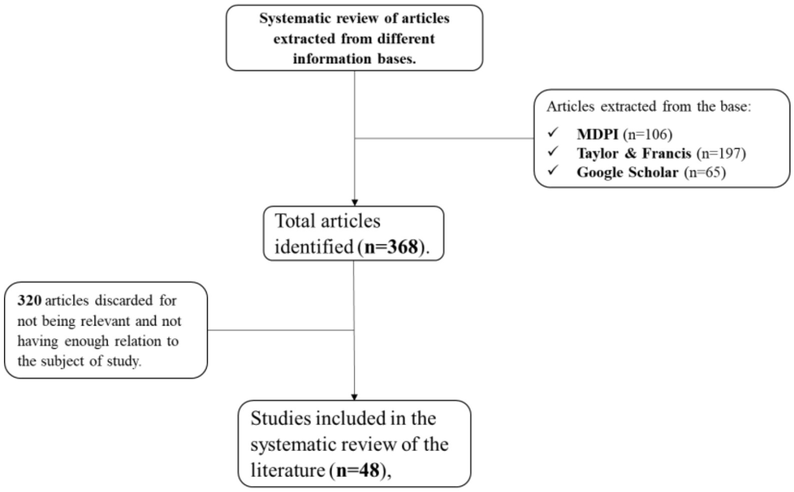

Fig. 2. Flowchart of the identification and selection process included in the bibliographic review

RESULTS

Reviewed the 48 scientific articles were found from the 31 studies of the MDPI base, 12 studies from the Taylor & Francis base and 5 studies from the Google Scholar base; these were duly ordered by continent as shown in Table (1).

Table 1. Results of the bibliographic review of the anthropic impacts of mangrove aquatic ecosystems worldwide

Continent	Country	Ubication	Anthropic impact	Article Base	Author
America	Brazil	Todos os Santos Bay mangroves, northwest coast	Weather Phenomena	Google Scholar	**Vasconcelos *et al.* (2022)**
	Brazil	Acaraú River Estuary, western coast of Ceará	Aquaculture activities, Plastic waste pollution and deforestation	Google Scholar	**Jorge *et al.* (2021)**
	Brazil	Peri-urban mangrove of the Itanhaém River, municipality of Itanhaém	Population development	Google Scholar	**Domingues *et al.* (2021)**
	Mexico	“Los Petenes” Biosphere Reserve, Campeche	Wastewater discharge and agricultural activities	MDPI	**Chan *et al.* (2021)**
	Puerto Rico	Piñones State Forest, coastal plain north of Loiza.	Wastewater discharge	MDPI	**Gao and Yu (2021)**
	Colombia	Alta Guajira mangrove, Guajira Peninsula	Overfishing and weather phenomena	MDPI	**Vasquez and Sullivan**

Continent	**Country**	**Ubication**	**Anthropic impact**	**Article Base**	**Author**
					(2021)
	Mexico	La Mancha lagoon, Gulf of Mexico	Deforestation	MDPI	**Chacon *et al.* (2021)**
	USA	Champagne Bay Mangroves, Port Fourchon, Louisiana	Weather phenomena and rising sea levels	MDPI	**Cohen *et al.* (2021)**
	Ecuador	Tropical forest of the Gulf of Guayaquil, province of Guayas and El Oro	Aquaculture activities	MDPI	**Mereci *et al.* (2021)**
	Panama	Parita Bay, central pacific coast	Aquaculture activities and agricultural activities	Taylor & Francis	**Castillo *et al.* (2021)**
	USA	Bookery Bay mangroves, Southwest Florida	Weather phenomena	MDPI	**McCarthy *et al.* (2020)**
	Colombia	The Majorcan swamps, the Pacific Ocean coast and the Caribbean Sea	Deforestation, population development and rising sea levels	MDPI	**Villate *et al.* (2020)**
	Brazil	Ceara river estuary	Weather phenomena and population development	MDPI	**Dos Reis-Neto *et al.* (2019)**
	Brazil	Guanabara Bay, Rio de Janeiro	Weather phenomena and population development	MDPI	**Granado *et al.* (2018)**
	Honduras	Large mangrove, Guanaja Island	Weather phenomena	MDPI	**Fickert (2018)**
	Ecuador	Inner estuary of the Guayaquil Gulf, Trinitaria Island and Chupador Chico, Guayas	Overfishing	Google Scholar	**Quevedo *et al.* (2018)**
	Mexico	Punta Banda Estuary, Baja California Peninsula	Rising sea levels and population development	MDPI	**Burke and Hinojosa (2018)**
Africa	Tanzania	Mangroves of the Rufiji delta	Weather phenomena and rising sea levels	Taylor & Francis	**Nyangoko *et al.* (2021)**
	Mozambique	Cabo Delgado mangrove forests	Overfishing and coral extraction for building material	Taylor & Francis	**Short *et al.* (2021)**
	Nigeria	Warri mangroves	Oil spill contamination	Taylor & Francis	**Adamu *et al.* (2018)**
	Benin	Adounko and Djègbadji mangrove forests	Agricultural activities	Google Scholar	**Akotossode *et al.* (2018)**

Continent	Country	Ubication	Anthropic impact	Article Base	Author
Asia	Vietnam	Xuan Thuy mangrove, Red River Basin	Deforestation and aquaculture activities	MDPI	**Huong *et al.* (2022)**
	Vietnam	Mangroves of the Red River Delta and Tien Yen Bay	Plastic waste pollution	MDPI	**Viet *et al.* (2021)**
	Sri Lanka	Muthurajawela Marsh mangrove and Negombo Lagoon, western coastal plain	Population development	MDPI	**Athukorala *et al.* (2021)**
	China	Beilun Estuary, shores of Fangchenggang City	Plastic waste pollution	MDPI	**Li *et al.* (2021)**
	Oman	Mangroves in the coastal area of the Gulf of Oman, Jask County	Rising sea levels	MDPI	**Davar *et al.* (2021)**
	Indonesia	Mangroves of eastern Surabaya, Java	Population development	MDPI	**Summarmi *et al.* (2021)**
	Vietnam	Mangroves in Thanh Hoa and Nghe An provinces	Aquaculture activities	MDPI	**Nguyen *et al.* (2021)**
	Malaysia	Johor National Parks, Peninsular Malaysia	Aquaculture activities and agricultural activities	MDPI	**Kanniah *et al.* (2021)**
	Mauritius	South Coast Mangroves, Pointe d'Esny	Oil spill contamination	MDPI	**Seveso *et al.* (2021)**
	India	Sundarbans mangrove swamp, West Bengal coast	Rising sea levels	Taylor & Francis	**Mohanty *et al.* (2021)**
	Indonesia	East Java Mangroves, Java	Deforestation	MDPI	**Rudianto *et al.* (2020)**
	Southeast Asian	Mangrove forests of Malaysia, Singapore, northern Kalimantan, western Thailand, western Papua, and southern Sumatra	Agricultural activities and overfishing	MDPI	**Sakti *et al.* (2020)**
	Vietnam	Can Gio mangrove forests	Aquaculture activities and population development	MDPI	**Le *et al.* (2020)**
	United Arab Emirates	Khor al Beidha mangrove, Arabian Gulf, Umm Al Quwain	Heavy metal concentration contamination	MDPI	**Samara *et al.* (2020)**
	Philippines	Dos Barangay Mangrove, Quezon Province	Aquaculture activities	MDPI	**Valenzuela *et al.* (2020)**

Continent	Country	Ubication	Anthropic impact	Article Base	Author
	China	Riparian mangroves, Danshui	Heavy metal concentration contamination	MDPI	**Yan *et al.* (2020)**
	Vietnam	Mekong river delta mangroves	Aquaculture activities	Taylor & Francis	**Bosma *et al.* (2019)**
	Cambodia	Koh Kong Estuary	Cumulative impacts of dans	Taylor & Francis	**Käkönen and Thuon (2019)**
	Bangladesh	Sundarbans mangrove forests	Rising sea levels	Taylor & Francis	**Ghosh *et al.* (2019)**
Europe	France	Guadalupe Beaches, Guadalupe Island	Plastic waste pollution	MDPI	**Lebordais *et al.* (2021)**
	France	Mangrove forests of Mayotte, the Mozambique Channel and part of the Comoros archipelago	Population development	MDPI	**Longépée *et al.* (2021)**
	Ireland	Mangrove area throughout the country	Aquaculture activities	MDPI	**Hastings *et al.* (2020)**
	France	Mayotte mangrove, Mayotte archipelago	Wastewater discharge	Taylor & Francis	**Trégarot *et al.* (2017)**
Oceania	Fiji	Mangroves that flow into the sea, Viti Levu Island and Vanua Levu	Rising sea levels	MDPI	**Zhu *et al.* (2021)**
	Fiji	Ba Delta and Rewa Delta mangroves, northwest of Viti Levu	Aquaculture activities and agricultural activities	Taylor & Francis	**Avtar *et al.* (2021)**
	Australia	Gladstone Harbour, Queensland mangroves	Overfishing	Taylor & Francis	**Flint *et al.* (2021)**
	Australia	Mangrove forests of Comerong Island, south of Sydney	Rising sea levels	Taylor & Francis	**Al-Nasrawi *et al.* (2018)**

Table (1) shows that, in the American continent, 12 articles were identified from the MDPI base, 1 article from Taylor & Francis and 4 articles from Google Scholar; for the African continent, from the MDPI base no article was identified, from Taylor & Francis 3 articles and from Google Scholar 1 article; from the Asian continent, 15 articles were identified from the MDPI base; from Taylor & Francis 4 articles, and from Google Scholar no article was identified. For the European continent, from the MDPI base 3 articles were identified, from Taylor & Francis 1 article, and from Google Scholar no articles was identified. Whereas, for the continent of Australia, from the MDPI base 1 article was identified, from Taylor & Francis 3 articles, and from Google Scholar no articles were identified.

The bibliographic review of the investigated topic resulted in different anthropic impacts on mangroves on the planet, which is why the different anthropic impacts on each continent are identified through map graphs with their respective legends (Figs. 3-7).

Fig. 3. Anthropic impacts on mangrove aquatic ecosystems in the American continent

Fig. 4. Anthropic impacts on mangrove aquatic ecosystems in the African continent

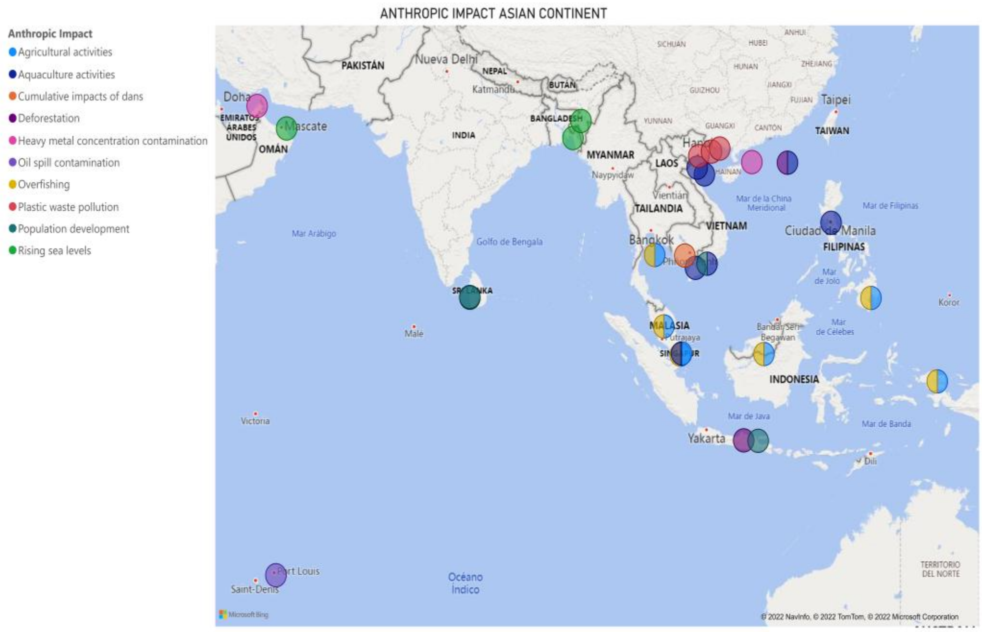

Fig. 5. Anthropic impacts on mangrove aquatic ecosystems in the Asian continent

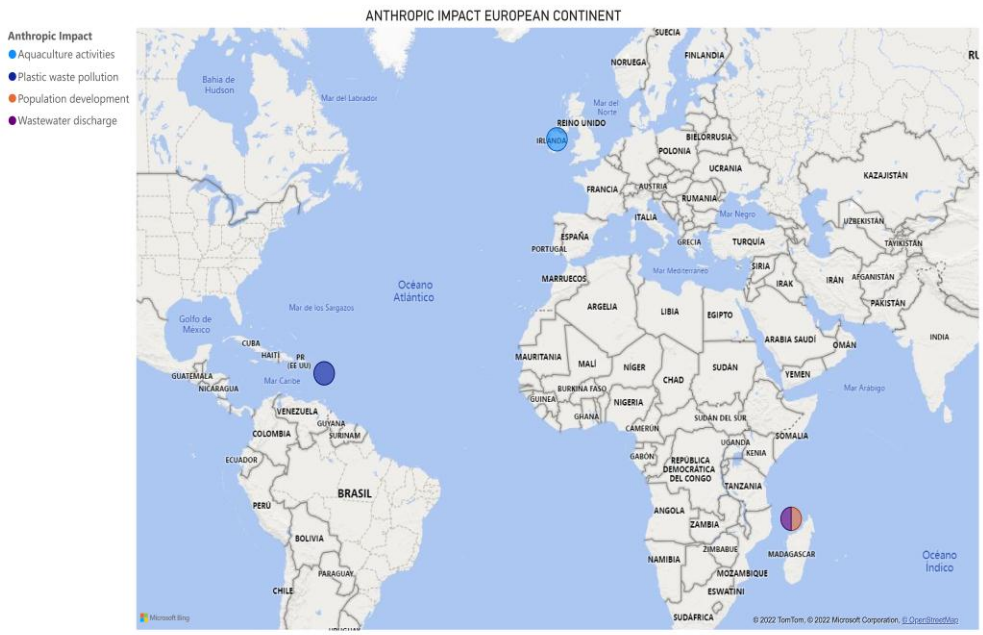

Fig. 6. Anthropic impacts on mangrove aquatic ecosystems in the European continent

Fig. 7. Anthropic impacts on mangrove aquatic ecosystems on the continent of Australia

DISCUSSION

Based on data in Figs. (3- 7), the following anthropic impacts affecting aquatic mangrove ecosystems globally were identified:

Aquaculture activities

Mangrove forests play an important role in mitigating climate change, but they are threatened by the expansion of aquaculture activities that represent a major impact on the decline of these forests **(Rodríguez Herrero & Bozada Robles, 2010)**. In the American continent, it was identified in the mangrove areas of the estuary of the Acaraú River on the western coast of Ceará in Brazil **(Jorge Benevides *et al.*, 2021)**, the tropical mangrove forests of the Gulf of Guayaquil in the provinces of Guayas and El Oro in Ecuador **(Mereci-Guamán *et al.*, 2021)**, and the mangroves of Parita Bay on the central Pacific coast of Panama **(Castillo *et al.*, 2021)**.

Likewise, in the Asian continent aquaculture activities represent a threat to mangrove ecosystems; this problem was evidenced in the Mekong River Delta **(Bosma *et al.*, 2020)**, in Can Gio **(Le *et al.*, 2020)**, in the mangroves of Dos Barangay of the province of Quezon in the Philippines **(Valenzuela *et al.*, 2020)** and in the Xuan Thuy mangrove of the Red River in Vietnam **(Huong Nguyen *et al.*, 2022)**. In addition, the mangroves of Thanh Hoa and Nghe province **(Nguyen *et al.*, 2021)**, the mangrove forests of the National Parks of Johor, Peninsular Malaysia in Malaysia **(Kanniah *et al.*, 2021)** are also under threat. On the other hand, in Europe and Australia, this threat was evidenced in the mangrove area of the whole country of Ireland **(Hastings *et al.*, 2020)** and in the mangroves of Ba Delta and Rewa Delta, the northwest of Viti Levu in Fiji **(Avtar *et al.*, 2021)**.

Agricultural activities

Pollution caused by the bad practice of agricultural activities is worrying since they affect the degree of health and permanence of mangroves **(Olguín *et al.*, 2007)**. In the American continent, this problem was identified in the mangrove area of Parita Bay on the central Pacific coast of Panama **(Castillo *et al.*, 2021)** and in the mangrove forests of the biosphere reserve "Los Petenes", Campeche in Mexico **(Chan-Keb *et al.*, 2021)**. While in the African continent, the problem is detected in the mangrove forests of Adounko and Djègbadji in Benin **(Akotossode *et al.*, 2018)**.

Simultaneously, this problem was evidenced in the mangrove area of Singapore, north of Kalimantan, west of Thailand, West Papua, south of Sumatra and Malaysia **(Sakti *et al.*, 2020)**, in Australia in the Mangroves of Ba Delta and Rewa Delta, northwest of Viti Levu in Fiji **(Avtar *et al.*, 2021)** and in the Asian continent in the mangrove forests of the national parks of Johor, Peninsular Malaysia in Malaysia **(Kanniah *et al.*, 2021)**.

Rising sea levels

It is common knowledge that sea level rise is a central part of the planet's response to human-induced global warming and is projected to continue to rise during the twenty-first century and beyond, various investigations denote that this is a high risk factor for mangrove ecosystems in the world **(Yáñez-Arancibia *et al.*, 1998)**; thus, inthe American continent this affectation occurs in the mangroves of the bay of Champagne, Port Fourchon, Louisiana in the United States **(Cohen *et al.*, 2021)**, in the mangrove forests of the Ciénagas de Mallorquín, coast of the Pacific Ocean and Caribbean Sea of Colombia **(Villate Daza *et al.*, 2020)**, in the Punta Banda estuary of the Baja California Peninsula in Mexico **(Burke Watson *et al.*, 2018)**.

Similarly, in Africa, sea level rise occurs in the mangroves of the Rufiji Delta in Tanzania **(Nyangoko *et al.*, 2022)**; likewise, this impact currently affects the Asian continent, in the mangroves of the coastal area of the Gulf of Oman, Jask County in Oman **(Davar *et al.*, 2021)**, in the mangrove forests of Sundarbans in India and Bangladesh **(Ghosh *et al.*, 2019; Mohanty *et al.*, 2021)**; and in Oceania this impact was evidenced in the mangroves that flow into the sea, Viti Levu Island and Vanua Levu in Fiji **(Zhu *et al.*, 2021)** and in the mangrove forests of Comerong Island, south of Sydney in Australia **(Al-Nasrawi *et al.*, 2018)**.

Oil Spill Contamination

This anthropogenic affectation was reported in the mangroves of the south coast, Pointe d'Esny in Mauritius, when the oil was released in coastal waters and washed towards the coast, and was deposited in the sediments that cover the fine highly sensitive feeding roots of mangrove trees in the area, preventing the respiration of the roots, stems, seedlings and surrounding sediments of these, as well as the fauna present in the burrows and hollows of the roots **(Seveso *et al.*, 2021)**; likewise, this type of contamination was evidenced in Africa, in the mangroves of Warri in Nigeria **(Adamu *et al.*, 2018)**.

Plastic waste pollution

Plastics are essential materials that play a fundamental role in the lives of people in the modern world, however, plastic pollution in the ocean has become a critical environmental problem, due to its durability and long service life directly affecting the life of mangrove aquatic ecosystems **(Jaén *et al.*, 2019)**. This problem was observed in the American continent in the estuary of the Acaraú River, western coast of Ceará in Brazil **(Jorge Benevides *et al.*, 2021)**.

Likewise, this impact was found in Asia, in the mangroves of the Red River Delta and Tien Yen Bay in Vietnam **(Viet Dung *et al.*, 2021)** and in the Beilun estuary, coasts of the city of Fangchenggang in China **(Li *et al.*, 2021)**.

Heavy metal concentration contamination

Metalpollution in mangrove ecosystems is really complex because the bioavailability of pollutants is influenced by a combination of multiple environmental factors including discharge from rivers, temperature, salinity, organic matter concentrations, nutrients and other pollutants **(Martínez-Alier, 2004)**. On the Asian continent, this affectation was observed in the Khor al Beidah mangrove, Arabian Gulf of um Al Quwain in the United Arab Emirates **(Samara *et al.*, 2020)**; also, in the riparian mangroves of Danshui in China **(Yam *et al.*, 2020)**.

Deforestation

Deforestation is considered one of the main anthropogenic causes of mangrove degradation, changes the phytogeographic landscape of mangroves and reduces their biological diversity **(Tovilla Hernández *et al.*, 2001)**. This impact not only decreases the number of mangrove specimens, but also produces ecological effects in the forest, such as stunted and shrubby growth, canopy opening, stem mortality, decreased regeneration of exploited species and changes in species composition, among others **(Walters, 2005)**. In America this anthropic impact is found in the estuary of the Acaraú River, western coast of Ceará in Brazil **(Jorge Benevides *et al.*, 2021)**, in the lagoon of La Mancha in the Gulf of Mexico **(Chacón Abarca *et al.*, 2021)**, in the Ciénagas de Mallorquín, coast of the Pacific Ocean and Caribbean Sea in Colombia **(Villate Daza *et al.*, 2020)**.

Similarly, this impact on mangrove ecosystems is found in the Xuan Thuy mangrove, Red River basin in Vietnam **(Huong Nguyen *et al.*, 2022)**, and in the east Java mangroves in Indonesia **(Rudianto *et al.*, 2020)**.

Population development

The loss of mangrove ecosystems is closely related to the growth and density of the human population, so the larger the population of the areas near the forests, the greater the destruction and exploitation of these ecosystems **(Mendoza Avilés *et al.*, 2019)**. In addition, population development constitutes a barrier to the inland expansion of mangrove ecosystems in the face of sea level rise **(Uribe Pérez & Urrego Giraldo, 2009)**. This problem in the American continent was identified in the peri-urban mangrove of the Itanhaém River in the municipality of Itanhaém **(Domingues Blotta *et al.*, 2021)**, in the estuary of the Ceará River **(Dos Reis-Neto *et al.*, 2019)**, and in Guanabara Bay in Rio de Janeiro in Brazil **(Granado *et al.*, 2018)**, in the Ciénagas de Mallorquín, pacific ocean coast and Caribbean Sea in Colombia **(Villate Daza *et al.*, 2020)**, and finally, in the Punta Banda estuary, Baja California Peninsula in Mexico **(Burke Watson & Hinojosa Corona, 2018)**.

Also, in the Asian continent, this problem was evidenced in the mangrove of Muthurajawela Marsh and Negombo Lagoon, western coastal plain of Sri Lanka **(Athukorala *et al.*, 2021)**, in the mangroves of eastern Surabaya, Java in Indonesia **(Sumarmi *et al.*, 2021)** and in the mangrove forests of Can Gio in Vietnam **(Le *et al.*, 2020)**. On the European continent, this impact was observed in the mangrove forests of Mayotte, Mozambique Channel and part of the Comoros archipelago belonging to France **(Longépée *et al.*, 2021)**.

Wastewater discharge

The discharge of wastewater or sewage is a serious problem because these are discharged into mangrove ecosystems directly, often without prior treatment, so they constitute not only an environmental aggression with a negative impact on these ecosystems, but also an imminent direct danger to human health **(Zhindón *et al.*, 2018)**. This problem in the American continent, was evidenced in the biosphere reserve "Los Petenes" of Campeche in Mexico **(Chan-Keb *et al.*, 2021)** and in the state forest of Piñones, coastal plain north of Loíza in Puerto Rico **(Gao & Yu, 2021)**; also in the European continent in the mangrove of Mayotte, archipelago of Mayotte belonging to France **(Trégarot *et al.*, 2017)**.

Coral extraction for building material

Over-harvesting of a species in a breeding habitat, such as seagrass beds, can have side effects for later stages of adult life in different ecosystems, such as coral reefs **(Unsworth *et al.*, 2008)**. It was evidenced that on the African continent, in the mangrove forests of Cabo Delgado in Mozambique, excessive extraction of coral reefs occurs for the creation of building materials **(Short *et al.*, 2020)**.

Weather phenomena

Meteorological phenomena are consequences of global climate change as a result of anthropogenic impact, this is how mangrove forests are often affected by storms, tropical cyclones, among others. On the continent of America, this affectation was identified in the mangroves of the bay of Todos os Santos **(Vasconcelos Nascimento *et al.*, 2022)**, the estuary of the Ceará River **(Dos Reis-Neto *et al.*, 2019)** and the bay of Guanabara, Rio de Janeiro **(Granado *et al.*, 2018)** in Brazil, in the manglar of the Alta Guajira in Colombia **(Vasquez-Carrillo & Sullivan Sealey, 2021)**, in the grande mangrove of the island of Guanaja in Honduras **(Fickert, 2018)**, in the mangroves of Champagne Bay, Port Fourchon, Louisiana **(Cohen *et al.*, 2021)** and in the manglares of Bookery Bay, southwest Florida **(McCarthy *et al.*, 2020)** in USA. Likewise, this affectation was observed in the mangroves of the Rufiji delta in Tanzania **(Nyangoko *et al.*, 2022)**.

Cumulative impacts of dans

The Koh Kong estuary contains the mangrove forests of Southeast Asia and some of Cambodia's best-known villages, where crabs and fishing are vital to maintaining the livelihoods of most people; however, these mangrove ecosystems in Cambodia have been totally affected by the cumulative impacts of dams **(Käkönen & Thuon, 2019)**.

Overfishing

Overfishing is one of the anthropic effects with the greatest impact on mangrove ecosystems due to overfishing that occurs when the mangrove's resource extraction capacity exceeds its renewal capacity **(Martínez Ballesteros *et al.*, 2014)**. In America, this impact was identified in the mangrove swamp of Alta Guajira in Colombia **(Vasquez-Carrillo & Sullivan Sealey, 2021)** and in the interior estuary of the Gulf of Guayaquil of Trinitaria Island and Chupador Chico in Ecuador **(Quevedo *et al.*, 2018)**. On the African continent this was evidenced in the mangrove forests of Cabo Delgado in Mozambique **(Short *et al.*, 2020)**.

Similarly, overfishing was observed in the mangrove forests of Malaysia, Singapore, Northern Kalimantan, Western Thailand, West Papua and South Sumatra **(Sakti *et al.*, 2020)**. In Oceania this affectation was found in the mangroves of the port of Glandstone, Queensland in Australia **(Flint *et al.*, 2021)**.

CONCLUSION

The bibliographic review resulted in 48 investigations being the most relevant to determine the object of study of the scientific article, identifying that much more information was found from the base of MDPI article base than from the Taylor & Francis and Google Scholar bases.

In the Asian and American continents, the greatest number of anthropic impacts on mangrove aquatic ecosystems were identified, among these are: aquaculture activities, sea level rise, population development, deforestation, meteorological phenomena and overfishing.

In the continents of Africa, Europe and Ausralia, fewer anthropic impacts were identified than in the continents of Asia and America, overfishing and sea level rise are the phenomena that most threaten the mangroves of these continents.

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