

RECREATIONAL USE OF THE BLACK SEA COAST OF RUSSIA IN KRASNODAR KRAI: SIGNIFICANCE AND SENSITIVITY OF NATURAL COMPLEXES

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Abstract

The paper presents the results of a study of the current condition and prospects of development of sustainable tourism in the coastal zones of the Black Sea in Krasnodar Krai (Russia). The aim of the study is to give a basis for and develop a method for determining the level of recreational pressure on coastal zones. The research methods applied are the empirical and practical methods of comparison and systemic and comprehensive analysis. The analysis based on statistical techniques establishes the primary indicators for assessing the sustainability of tourism development in coastal areas. The conclusions confirm that the establishment of protected natural areas and the promotion of environmentally responsible practices among tourists and local residents are necessary to conserve the natural heritage of the region.

Keywords: Tourism; Sustainable development; Recreational infrastructure; Protected natural areas.

USO RECREATIVO DA COSTA DO MAR NEGRO DA RÚSSIA EM KRASNODAR KRAI: SIGNIFICADO E SENSIBILIDADE DOS COMPLEXOS NATURAIS

Resumo

O artigo apresenta os resultados de um estudo sobre a situação atual e as perspectivas de desenvolvimento do turismo sustentável nas zonas costeiras do Mar Negro em Krasnodar Krai (Rússia). O objetivo do estudo é fundamentar e desenvolver um método para determinar o nível de pressão recreativa nas zonas costeiras. Os métodos de pesquisa aplicados são os métodos empíricos e práticos de comparação e análise sistêmica e abrangente. A análise baseada em técnicas estatísticas estabelece os indicadores primários para avaliar a sustentabilidade do desenvolvimento do turismo nas áreas costeiras. As conclusões confirmam que a criação de áreas naturais protegidas e a promoção de práticas ambientalmente responsáveis junto dos turistas e residentes locais são necessárias para conservar o patrimônio natural da região.

Palavras-chave: Turismo; Desenvolvimento sustentável; Infraestrutura de lazer; Áreas naturais protegidas.

USO RECREATIVO DE LA COSTA DEL MAR NEGRO DE RUSIA EN KRASNODAR KRAI: IMPORTANCIA Y SENSIBILIDAD DE LOS COMPLEJOS NATURALES

Resumen

El artículo presenta los resultados de un estudio sobre la situación actual y las perspectivas de desarrollo del turismo sostenible en las zonas costeras del Mar Negro en Krasnodar Krai (Rusia). El objetivo del estudio es fundamentar y desarrollar un método para determinar el nivel de presión recreativa en las zonas costeras. Los métodos de investigación aplicados son los métodos empíricos y prácticos de comparación y análisis sistémico e integral. El análisis basado en técnicas estadísticas establece los principales indicadores para evaluar la sostenibilidad del desarrollo turístico en las zonas costeras. Las conclusiones confirman que el establecimiento de áreas naturales protegidas y la promoción de prácticas ambientalmente responsables entre los turistas y los residentes locales son necesarios para conservar el patrimonio natural de la región.

Palabras clave: Turismo; Desarrollo sostenible; Infraestructura recreativa; Áreas naturales protegidas.

1 INTRODUCTION

In 1992, the United Nations World Tourism Organization proposed a set of indicators of sustainable tourism represented by two interrelated systems of key indicators and specific indicators

(Indicators for Sustainable Management of Tourism, 1992). The load and intensity of use belong to the group of key indicators. However, the indicator of the intensity of use does not account for the specifics of various types of recreation and their impact on the natural environment (Meyer et al., 2021).



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Meanwhile, the organization of recreational activities within the coastal zone of the seas is characterized by a combination of different types of recreational activities amid the target beach bathing recreation (Pascoe, 2019). In this case, this refers to the provision of additional and associated recreational services and types of tourism alternative to the main recreational activity.

For this reason, it is quite an urgent task to solve the problems of clarification and detailization of the impact of various recreational activities on nature (Calogiuri & Chroni, 2014). However, it is first necessary to determine the natural and recreational value of natural landscapes of the Black Sea coast of Krasnodar Krai.

According to the official statistics Krasnodar Krai is one of the most popular tourist destinations in Russia. In 2022, despite the COVID-19 pandemic and closed skies regime, the region received more than 17 million tourists, which is 5% increase compared to 2019 before the pandemic period. The majority of tourists visiting Krasnodar Krai are domestic, with only about 5% coming from foreign countries.

The most popular types of tourism in the region are beach and coastal tourism, as well as ecotourism and adventure tourism. The Black Sea coast of Krasnodar Krai offers more than 300 km of sandy beaches and warm climate, attracting tourists from all over Russia and neighboring countries. The most popular resort towns in the region include Sochi, Anapa, Gelendzhik, and Tuapse (Gippius & Myslenkov, 2020). The combination of recreational resources, improving recreational infrastructure, and increasing accessibility contributes to the steady growth of the tourist flow received by the region.

According to official statistics (tourist flow to the Kuban in 2020 amounted to 11.5 million tourists, 2020), in 2020, due to the pandemic and restrictions, the number of tourists who visited Krasnodar Krai decreased by 45% compared to the previous year, with only about 11,5 million tourists. In 2021, with the easing of restrictions, the number of tourists increased to about 16,5 million, which is just a bit lower than the pre-pandemic levels. In 2022, almost 13 million tourists have visited the Krasnodar Territory. Besides these numbers of official and organized forms of tourism, the number of tourists who chose unorganized beach areas and natural areas for recreation increased significantly even during the pandemic.

According to official sources, in 2020, Krasnodar Krai implemented several measures to protect the Black Sea coast. These measures include a ban on the construction of new facilities and infrastructure on the coast (Law of The Krasnodar Region N 4348-KZ, 2020), limiting the use of motorboats and jet skis (Order

of the Ministry of Emergency Situations of Russia N 487, 2020), and regulating the use of beaches and coastal areas (Order of The Ministry of The Russian Federation N 732, 2020).

Additionally, Krasnodar Krai has launched several programs to increase environmental awareness among tourists and local residents, for example, the preschool institution of the Krasnodar Territory "Ecological and Biological Center" involves students in study of flora and fauna, monitoring of the ecological situation coastal regions of the Black Sea coast. There also the volunteer organization "Green Movement of Kuban" was created (Volunteer organization "Green movement of Kuban, n.d.).

However, despite the laws, a significant number of tourists continued to visit and use unorganized beach areas and natural areas for recreation. This has led to an increase in the load on the natural environment and a decrease in the quality of the tourist experience. Therefore, it is important to find a balance between the development of tourism and the protection of the natural environment in Krasnodar Krai.

Current research in the sphere of sustainable tourism development (Zekan et al., 2022; Gkoumas, 2019) focuses on analyzing economic and statistical indicators. Meanwhile, the statistical indicators that characterize the volume of tourist arrivals often fail to reflect the actual load on the natural environment (Blancas et al., 2023), they don't mention the specifics of the impact of different types of tourist and recreational activities.

A special feature of the development of tourist and recreational activities in the coastal zone of the Black Sea within Krasnodar Krai is a combination of different types of recreational activities within a limited area (Blancas, & Lozano-Oyola, 2022). Determining the impact of different types of recreational activities on the components of coastal landscapes is an important and necessary step to form a system of indicators for the sustainability of coastal tourism.

Along with the value of the natural-territorial complex as a reserve of rare and endangered species, a kind of storage of the gene pool providing biodiversity, the region in question has a high concentration of natural resources of great therapeutic and recreational value (Cui et al., 2022). These are, first and foremost, a favorable foothill climate, a clean sea, beautiful pebble beaches, spa resources (large stocks of medicinal mineral water), and clean air full of juniper phytoncides.

Considering the above-mentioned context, the aim of the study is to give a basis for and develop a method for determining the level of recreational pressure on coastal zones. To do so, the research methods applied are the empirical and practical methods of comparison and systemic and comprehensive analysis.

2 LITERATURE REVIEW

Tourism is a crucial aspect of the economic development of many countries worldwide. Sustainable tourism has become a priority for many countries and organizations, leading to a growing body of literature on the subject.

Recreational use of coastal areas is a popular activity worldwide, and the potential impacts of this activity on coastal environments have been widely studied in recent years. Numerous studies (Soto et al., 2021; Cooper et al., 2020) have highlighted the negative effects of recreational activities on coastal ecosystems, including erosion, habitat loss, and damage to marine fauna and flora. Therefore, it is important to develop sustainable management strategies to mitigate these impacts.

Degradation processes in the natural environment are a major concern for the recreational use of the seacoast around the world (Ferguson et al., 2021; Fagerholm et al., 2021). Human activities such as pollution, coastal development, and unsustainable tourism practices have been shown to cause significant damage to coastal ecosystems and reduce their attractiveness for recreational use. The degradation of coastal ecosystems can lead to the loss of biodiversity, degradation of water quality, and erosion of beaches, among other negative impacts (Lloret et al., 2022).

In recent years, researchers have emphasized the importance of sustainable coastal management practices to ensure the long-term viability of coastal ecosystems for recreational use (Jacob et al., 2021; Chakraborty et al., 2020). Sustainable coastal management practices involve balancing the needs of human activities with the conservation and protection of natural resources. This requires the development of policies and regulations to promote responsible tourism practices, as well as the implementation of strategies to reduce the negative impacts of human activities on coastal ecosystems.

One key aspect of sustainable coastal management is the use of marine spatial planning (MSP) to balance the competing demands of different stakeholders in the coastal zone. MSP involves the strategic allocation of space in the marine environment to different uses, such as tourism, fishing, and conservation. This approach helps to ensure that the different activities taking place in the coastal zone are compatible with each other and that the environmental impacts are minimized (Milashevskaja, 2022).

In addition to MSP, other strategies for sustainable coastal management include the use of marine protected areas (MPAs) and ecosystem-based management (EBM) approaches. MPAs are areas of the ocean that are protected from human activities to

promote the conservation of marine biodiversity (Almpanidou et al., 2021). EBM approaches involve the management of coastal ecosystems as a whole, rather than managing individual species or activities in isolation. Both of these approaches have been shown to be effective in promoting sustainable coastal management and protecting the natural environment for recreational use (Dominguez-Tejo et al., 2018; Cosquer et al., 2019).

Overall, sustainable coastal management is critical for ensuring the long-term viability of coastal ecosystems for recreational use. This involves a range of strategies and approaches, including the use of MSP, MPAs, and EBM, as well as the promotion of responsible tourism practices and the development of policies and regulations to minimize the negative impacts of human activities on the natural environment (Flandroy et al., 2019). By implementing these strategies, it is possible to protect the natural beauty and biodiversity of coastal ecosystems while still providing opportunities for recreational use.

3 METHODS

In the study authors conducted a description and assessment of the natural and recreational significance of the Black Sea coast in Krasnodar Krai was conducted, and recreational significance of the Black Sea coast based on several criteria, including landscape diversity, biodiversity, uniqueness, aesthetic appeal, and educational value. The assessment was carried out using a three-point scale, with high, medium, and low scores assigned to each criterion. This approach allowed for a comprehensive evaluation of the natural and recreational value of the coastal landscapes.

The sample consisted of 23 groups of natural complexes, authors have evaluated their significance for the development of recreational activities. Of high significance are such complexes as submediterranean xerophilus evergreen forest, seaside bluffs, lower montane evergreen hemixerophilous of Pitsundian pine, tomillyar shrubbery, cliff forest, subtropical lower montane mixed broad-leaved Colchic, subtropical evergreen Colchic yew boxwood, subtropical Colchic gorge, upper forest boundary ecotone, subalpine meadowland, and Alpine meadowland. No natural complexes of low or medium significance are found in the region.

The use of multiple criteria and a three-point scale is a commonly used method in assessing the natural and recreational value of landscapes (Brown & Brabyn, 2012; Olafsson et al., 2022). This approach provides a systematic way to evaluate different aspects of landscape value and to compare the value of different

landscapes. The criteria used in Atutova's assessment are also commonly used in similar studies (Simensen et al., 2018; Biedenweg et al., 2019).

The approach used by Atutova (2007) is a valid and reliable method for assessing the natural and recreational value of coastal landscapes. The use of multiple criteria and a three-point scale allows for a comprehensive evaluation of the value of different landscapes, and the criteria used are commonly accepted in similar studies. This methodological choice is supported by the literature and can be applied to other coastal areas to assess their natural and recreational value.

4 RESULTS AND DISCUSSION

4.1 Description of the Locus and Object of Study

According to the geomorphological zoning scheme (Chichinadze, 2022), the entire territory of the Western Caucasus belongs to the Crimean-Caucasian mountain range, to the Greater Caucasus province (high-mountain, mid-mountain, and low-mountain linear ridges with tectonic block and erosion-denudation relief), and to the Northwestern Caucasus region (mid-mountain ridges with erosion-denudation relief).

This area is located in an 8-point seismicity zone. The coastal zone, formed under the effect of abrasion during significant fluctuations in sea level, is very narrow, and only in some places does the coastal cliff step away from the water.

Within Krasnodar Krai on the Black Sea coast of the Caucasus stands out the mountain system of the western part of the Greater Caucasus. The greatest length of the mountains on the axis from the meridian of Anapa to the south-eastern boundary of the region is a bit over 300 km.

The width of the mountains increases from 40-45 km in the extreme northwest to 120-130 km in the southeast of the mountain structure. Starting from the northwest, the ranges are arranged in several parallel ridges extending to the northeast. Many ranges are divided into separate sections by transverse valleys, and parallel ranges are connected by cofferdams. As an exception to the pattern of the pan-Caucasian strike, some ranges are located in the meridional direction or close to it. These are predominantly the ridges of the eastern part of the region's mountains: Urushten, Alous, Kocherga, and others. Most of them extend from the Main Ridge to the Lateral Ridge.

The formation of seashores is primarily determined by the waves of the water surface (Feng et al., 2016; Ribas et al., 2011). At the same time, the abrasion-accumulative work of the sea proceeds

selectively in accordance with the geological conditions of the coast and its morphological features.

The anthropogenic factor is becoming increasingly important. Abrasion and accumulative landforms are forming in the coastal zone. The most common abrasion forms are cliffs and benches (Migoń, 2020). They stretch along many sections of the Black Sea coast. Abrasion shores protrude into the sea with Cape Iron Horn, Idokopas, Chugovkopas, Guavga, Kadosh, and others. Abrasion buttes are much rarer. These are the sandstone rock Parus near the seaside Dzhanhot village and a group of bryozoan rocks rising in the open sea to the west of Cape Panagia.

With the general lack of coastal indentation of the Black Sea, there are two large bays, which are the Tsemes Bay and the Gelendzhik Bay, as well as a multitude of smaller ones that barely reach into the land: the Fisherman's (Blue) Bay, the Betta Bay, the Inal Bay, the Mikhailovskaia Bay, the Olginskaia Bay, the Imereti Bay, and others.

The largest peninsulas are two land protrusions between the Anapa and Tsemes (the Abrau Peninsula) and the Tsemes and Gelendzhik bays (do not have a common name). Some broad promontories that are particularly well-defined and protruding into the sea (Cape Iron Horn, Cape Guavga) resemble small peninsulas. The coast has three marine terraces.

In the areas of development of high marine terraces, the prevailing height of the coastal scarp is 4-12 m, and the minimum height in the area of development of the Holocene terrace of the seashore (the Mzymta-Psou interfluvium) is 5-2.5 m. The coastal escarpment is composed of sands, sand and gravel deposits, and rocky ground. Beaches are present almost everywhere. The width of a beach varies from 2 to 100, most often 20-30 m.

In some places, the beach is composed of several storm shafts 0.5-2 m high, the number and shape of which depend on the strength of the storm and the direction of the waves. The seashore is dissected by riverbeds with a depth of 0.3-1.2 m, rarely 2 m, and a width of 20 to 340 m. The beach is composed of gravel- pebble-boulder, occasionally boulder and stone block, and rocky soils or sandy-gravel-pebble soils. Coarser clastic material is usually concentrated near the seashore. At the rear of the beach, the soil is more fine-grained (sandy-gravel or sandy).

The described natural-territorial complex is also distinguished by numerous picturesque landscapes, the unique appearance of which is shaped by a combination of complex foothill terrain, woodlands with rare coniferous and deciduous species, and the sea.

Given the high anthropogenic pressure on the Black Sea coast of Russia, measures aimed at the

protection of nature and recreation need to be developed.

One indicator of the transformation of a natural complex is its resilience or sensitivity to recreational impact (Table 1). All the assessed natural complexes

are characterized by high or very high sensitivity. Of high sensitivity are tomillyar shrubbery, lower montane deciduous hemixerophilous, mid-mountain beech, and high-mountain fir forest complexes. The rest are marked by very high sensitivity.

Table 1. Significance and sensitivity of natural complexes of the Black Sea coast

Natural complex	Significance score	Sensitivity
Moderate semihumid coastal steppe	20	Very high
Littoral psammophilic	18	Very high
Submediterranean xerophilus evergreen forest	21	Very high
Tomillyar shrubbery	21	High
Seaside bluffs	21	Very high
Lower montane evergreen hemixerophilous of Pitsundian pine	21	Very high
Lower montane evergreen hemixerophilous of Crimean pine	19	Very high
Lower montane deciduous hemixerophilous	18	High
Montane steppe	20	Very high
Subtropical lower montane mixed broad-leaved Colchic	21	Very high
Pterocarya floodplain	18	Very high
Subtropical evergreen Colchic yew boxwood	21	Very high
Subtropical Colchic gorge	21	Very high
Mid-mountain beech	18	High
High-mountain fir forest	18	High
Cliff forest	20	Very high
High-mountain maple forest of Trautwetter's maple	19	Very high
Upper forest boundary ecotone	21	Very high
Subalpine meadowland	21	Very high
Subalpine rock-gravelly	20	Very high
Alpine meadowland	21	Very high
Alpine rock-gravelly	20	Very high
Subnival	18	Very high

Source: own elaboration.

All natural complexes in the region have high aesthetic appeal and are full of endemic and relict species and rare landforms. Each natural complex has its own specific conditions for the development of a particular type of tourism.

Within the Black Sea coast of Krasnodar Krai, along with beach-bathing recreation, several other types of tourism and recreation services are developing: hiking (walks), animal or bird watching (photography), boating, camping (picnic), buying ("taking") souvenirs, diving/swimming, air sports (parasailing, paragliding), fishing, auto- and motorsports (riding quad bikes, cross bikes, jeeping).

The nature of their impact (the influence factor) includes the creation of paths or trails, physical presence, noise pollution, animal feeding, construction and reconstruction of campsites, spontaneous waste dumping, pollution of water bodies with detergents and cosmetics, purchases of feathers and souvenirs from animal body parts or living organisms, etc. These factors entail water pollution, the risk of forest fires, and the erosion and removal of nutrients. Furthermore,

such influence results in the trampling and destruction of vegetation (Yuejin et al., 2022).

Beach bathing recreation practiced in the region both in organized and spontaneous forms does not seem to greatly affect natural complexes at first glance (Tsujimoto et al., 2018). Yet given the development of mass tourism and the rising number of received recreationists, organized beach areas are filled to their maximum, almost to the limit of the area's recreational capacity.

Since organized beaches get overcrowded, even in the presence of all the necessary infrastructure, tourists seeking psychological comfort and relative privacy move to neighboring beach territories. These zones are not only not equipped for beach bathing, but sometimes are not quite suitable for people to swim in terms of geological and physical-geographical indicators and, moreover, are often dangerous due to their proximity to abrasion slopes.

Furthermore, these seashore zones are not cleaned, so the amount of garbage on them can reach significant volumes, and they may also be located near groundwater outlets. Recreants not only stay on the

beach during daylight hours, but also set up sites for overnight stays: they build tents out of waste material, set up campfires, and organize makeshift toilets within the nearby natural complexes, thereby actively disturbing the natural environment.

All the aforementioned consequences lead to digressive changes in the natural environment, which can become irreversible. At any stage, degradation processes in the natural environment reduce its attractiveness. Meanwhile, the attractiveness of the environment is a major component of coastal tourism and tourism in general.

Thus, one of the most essential conditions for sustainable coastal tourism will be the protection of natural heritage. The effective development of coastal tourism calls for the creation of protected natural areas, but some additional effort is needed to maintain the balance.

4.2 Development of Recreational Activities and Sustainable Practices

Based on the provided results of the study, it is clear that the Black Sea coast of Russia, particularly in the Krasnodar Krai, is an important natural and recreational area that requires protection from anthropogenic factors.

In terms of the significance of natural complexes for the development of recreational activities, the text identifies 23 groups and evaluates their resilience or sensitivity to recreational impact. The results show that all natural complexes in the region have high aesthetic appeal and are full of endemic and relict species and rare landforms. However, they are also characterized by high sensitivity to recreational impact, with some having higher sensitivity than others.

These findings are consistent with other studies that have investigated the impact of tourism on natural areas. For example, studies by Maldonado-Oré & Custodio (2020) and Lukashina et al. (1996) on the ecological consequences of tourism development on the Black Sea coast of Russia found that the increasing number of tourists in the region is leading to environmental degradation and loss of biodiversity.

The studies by Murashko (2022) and Goncharenko et al. (2021) also highlight the need for sustainable tourism practices and the establishment of protected areas to conserve the natural heritage of the region.

Another study by Avoyan et al. (2017) on the sustainable development of coastal areas in Russia emphasizes the importance of maintaining the balance between economic development and environmental protection. This study also recommends the development of eco-tourism and the promotion of

environmentally responsible practices among tourists and local residents (Baklanov, 2022).

Other studies (e.g. Afanasieva et al., 2022) have also highlighted the importance of sustainable coastal tourism and the need for the protection of natural resources. For example, a study by Achrekar (2021) on the sustainability of coastal tourism in India emphasized the need for conservation and sustainable management of natural resources, as well as the involvement of local communities in tourism development.

Similarly, a study by Mejjad et al. (2022) on sustainable tourism development in the Mediterranean region emphasized the importance of protecting natural and cultural heritage, as well as the need for sustainable tourism policies and practices that involve local communities and stakeholders (Amoako et al., 2022).

Overall, these studies support the importance of protecting natural resources for sustainable coastal tourism development. It is important to develop and implement sustainable tourism policies and practices that consider the environmental, social, and economic impacts of tourism activities and involve the participation of local communities and stakeholders.

5 CONCLUSIONS

In conclusion, the Black Sea coast of Russia, particularly in the Krasnodar Krai, is a significant natural and recreational area that requires protection from anthropogenic factors. The area is full of endemic and relict species and rare landforms, but it is also characterized by high sensitivity to recreational impact.

Therefore, it is essential to develop and implement sustainable tourism policies and practices that consider the environmental, social, and economic impacts of tourism activities and involve the participation of local communities and stakeholders.

Beach bathing recreation within organized beach zones surely does not produce much impact on the natural environment by itself. However, this recreation is realized either in a complex with additional recreational services, often provided illegally, or in combination with other recreational activities that recreationists practice on their own.

These associated recreational activities increase the negative impact on the natural environment manifold, especially in cases where recreational activities are carried out outside of organized beach areas.

This points to the fact that the recreational use of the natural complexes of Caucasian Rivas requires special and extreme care. These natural

complexes are distinguished by exceptionally high sensitivity to anthropogenic disturbances and great vulnerability.

Thus, the organization of recreational activities in this region needs to incorporate elements of the ecological framework, which are necessary to maintain the optimal functioning and dynamic stability of the natural environment in the area: ornithofauna, insects, biodiversity conservation.

Given the intensive development of the Black Sea coast at the time, it is vital not to lose the naturalness of landscapes and the specificity of natural complexes, not to destroy the vegetation cover and reduce its biodiversity, and not to intensify the degradative processes that already take place in some natural complexes.

Therefore, the establishment of protected natural areas and the promotion of environmentally responsible practices among tourists and local residents are necessary to conserve the natural heritage of the region.

While this paper has some limitations, such as the sample used and also the limited number of indicators, future studies could overcome these limitations by expanding the sample, the number of indicators and / or also testing using this theoretical and methodological framework to reproduce the study in other areas in order to check how it works in different contexts.

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Table 1. CRediT author statement

Term	Definition	Author 1	A.2	A.3	A.4	A.5	A.6
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims	+	+	+	+	+	+
Methodology	Development or design of methodology; creation of models	+	+	+	+	+	+
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components	+	+	+	+	+	+
Validation	Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/experiments and other research outputs	+	+	+	+	+	+
Formal analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data	+	+	+	+	+	+
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection	+	+	+	+	+	+
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools	+	+	+	+	+	+
Data Curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse	+	+	+	+	+	+
Writing - Original Draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)	+	+	+	+	+	+
Writing - Review & Editing	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre- or post-publication stages	+	+	+	+	+	+

Term	Definition	Author 1	A.2	A.3	A.4	A.5	A.6
Visualization	Preparation, creation and/or presentation of the published work, specifically visualization/ data presentation	+	+	+	+	+	+
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team	+	+	+	+	+	+
Project administration	Management and coordination responsibility for the research activity planning and execution	+	+	+	+	+	+
Funding acquisition	Acquisition of the financial support for the project leading to this publication	+	+	+	+	+	+

Source: adapted from Elsevier (2022, s/p), based upon Brand et al. (2015).

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