

Introduction

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Abstract This book presents a systematisation and description of the knowledge on environment in the Boka Kotorska Bay in Montenegro (South Adriatic Sea). The publication is based on scientific and research data collected in complex research activities conducted in the Boka Kotorska Bay over the past 50 years, scientific papers mainly published in ex-Yugoslav and Montenegrin editions and long-standing experience of authors of the chapters in the scientific research in Montenegro. Particular attention was paid to activities on the coast of the Bay that have an impact on the status of flora and fauna in the Bay as well as on physico-chemical parameters of water, sediments and biota. Over the past decades, population migration issue has been particularly notable as well as development of tourist

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ship (cruise) transport, shipbuilding, development of mariculture, yachting tourism, natural effects from the land and runoff and evident climatic changes. This book is addressed to specialists working in various fields of environmental problems and ecology, water resources and management, land reclamation and agriculture and regional climate change in Montenegro and this part of the Mediterranean. The main task of this book is to provide scientific information on the status of environment in the Boka Kotorska Bay and give recommendations for the preservation of the living resources and healthy environment through sustainable development of this part of Montenegro.

Keywords Adriatic Sea, Boka Kotorska Bay, Environment, Montenegrin coast, Water resources

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The idea of this book was born in the framework of collaboration between Montenegrin and Russian scientists. In June 2014, scientists from S.Yu. Witte Moscow University, Engineering Research Production Center for Water Management, Land Reclamation and Ecology ‘Soyuzvodproject’ and P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences (Moscow, Russia) visited Montenegro and signed agreements on collaboration with the Montenegrin Academy of Sciences, University of Montenegro (Podgorica), and Institute of Marine Biology (Kotor). In September of the same year, the consortium of these organisations organised the First International Scientific Conference ‘Integrated Coastal Zone Management in the Adriatic Sea’, which was attended by about 30 scientists from Montenegro, Croatia, Serbia, Italy, Albania and Russia. The conference started with the welcoming speech given by Academician Momir Djurović, President of the Academy of Sciences and Arts of Montenegro. There were also read-out greetings to participants of the conference from Prof. Radmila Vojvodić, Rector of the University of Montenegro, and Academician Vladimir Fortov, President of the Russian Academy of Sciences. On behalf of the Committee on Education of the Russian State Duma, Prof. Viktor Shudegov welcomed the Conference. Participants of the Conference have proposed to prepare and publish two books: *The Adriatic Sea Encyclopedia* and *The Boka Kotorska Bay Environment*. The first one is under preparation; the second one was published by Springer and is presented to the reader.

The Boka Kotorska Bay has a specific position in the Adriatic Sea. This is a single fjord in Adriatic. Its geographical position is determined with the end points: to the north $42^{\circ}31'00''$, to the south $42^{\circ}23'32''$, to the east $18^{\circ}46'32''$ and to the west $18^{\circ}30'29''$. It consists of four interconnected smaller bays (the Herceg Novi and

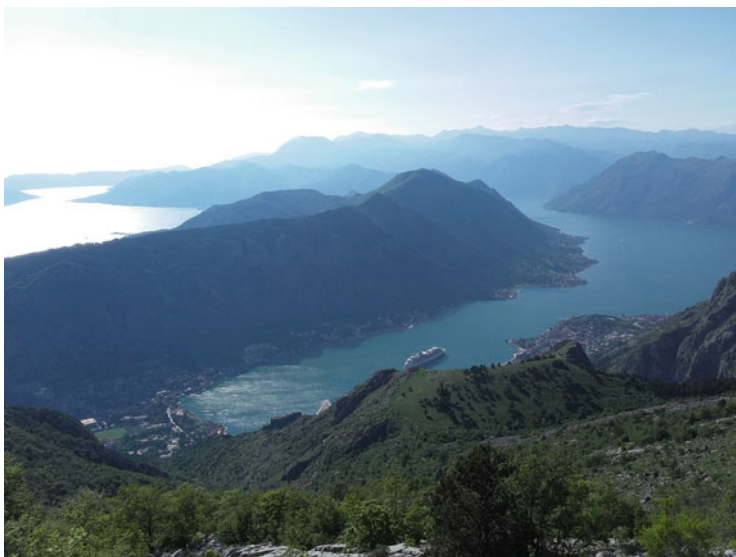


Fig. 1 Boka Kotorska Bay, a view from Lovcen Mountain (Photo by A. Joksimović)

Tivat bays that form the outer part and the Risan and Kotor bays that form the inner part) and two straits, one of which connects the open sea with the Herceg Novi Bay and the other (Verige) connects the Tivat with the Risan and Kotor bays (Fig. 1) [1].

The aquatorium area is 87.334 km² (0.06% of the Adriatic Sea) of which 22.158 km² is the area of the Kotor–Risan Bay and 65.176 km² of the Herceg Novi–Tivat Bay. The coastline length is 105.7 km, of which 37.6 km belongs to the Kotor–Risan Bay and 68.1 km to the Herceg Novi–Tivat Bay. The mean depth in the Kotor Bay is 27 m (maximum 58 m), in the Risan Bay 25.7 m (maximum 36 m), in Tivat Bay 25.5 m (maximum 47 m) and in Herceg Novi Bay 31 m (maximum 60 m) [1, 2].

Large quantities of precipitation (Crkvice above Risan 5,480 mm per annum) and enormous inflow of terrestrial waters through two rivers – Škurda and Ljuta – as well as a large number of submerged springs (*vrulja*), have a major influence on hydrographic properties of the seawater in the Bay, particularly the Kotor–Risan Bay. Consequently, a significant decrease in temperature and salinity as well as in transparency of seawater takes place in the period of November–April.

The geographical position of the Bay is such that the sea is for the most part calm but its life is extraordinarily diverse and specific as a result of a large number of springs, submerged springs, brooks and rivulets flowing into it. These factors result in an intensive water mass dynamic, but only in the surface layer of up to about 5 m in depth, which is particularly notable in periods of maximum freshwater inflows (winter and spring, heavy rainfall periods). Rainy season begins in November and lasts until the end of April. Southern winds dominate this period, but in the period from January to March, north wind – Bora – blows occasionally. As a result of its

enclosedness, and deep indentation into the land, large waves cannot be formed. Temperature, salinity and density of seawater are under significant influence of hydrometeorological parameters that are specific and susceptible to frequent local changes. Taking into account the structure and vertical stretch of the coastal area, it can be said that there is no coastal plain in the entire Kotor Bay (except for a small, narrow strip on its eastern side) and the Risan Bay, as steep rocky slopes descend to the very surface of the sea, and in these parts, the steep continental area spreads to the very bottom of the bays [3].

The specific geographical position and a combination of abiotic and biotic factors of the environment result in ecological conditions of the Boka Kotorska Bay significantly different from those in the open sea, making the Bay a specific biotope [3].

Fishing and activities related to the use of sea organisms in the diet of the local population in the Kotor–Risan Bay are traditional and date back to as early as the twelfth century. Protected and endangered species in the area of the Kotor–Risan Bay (aquatorium) are Magnoliophyta (*Posidonia oceanica*, *Zostera noltii*), Phaeophyta (*Cystoseira spinosa*), Porifera (*Geodia cydonium*) and Mollusca (*Lithophaga lithophaga*, *Luria lurida*, *Pinna nobilis*, *Tonna galea*). Due to the presence of rare and protected species of marine flora and fauna, particularly along the area from Dražin Vrt to Perast and around Perast Islands, this area should be placed under a special biodiversity protection regime. This implies prohibition of any intervention in the coastal zone, strict prohibition on building up beaches and anchoring of vessels at the depth of less than 30 m [4].

Taking into account the dominant influence of the Mediterranean climate in floristic and vegetation terms, the Boka Kotorska Bay is a diverse and specific area, not only in Montenegro, but far beyond in the eastern shore of the Adriatic Sea. The floristic specificities of this area are even more pronounced as a result of high mountains encircling the Boka Kotorska Bay. This causes vertical stratification of flora and vegetation elements from the sea level to the highest tops of the surrounding mountains.

The extraordinary universal value is a sublimate of cultural and natural values that goes beyond the national borders and is equally important for current and future generations of the entire humankind. The area of Kotor is located in impressive natural and cultural surroundings of the Boka Kotorska, which consists of four interconnected bays framed by high mountains and concentrated around the central visual axis that integrates these elements into an extraordinary landscape ensemble. According to the general principles of the Convention on the Protection of the World Heritage, the extraordinary universal value of the cultural and historical area of Kotor is represented by the quality of its architecture, successful blending of towns and settlements with the natural surroundings of the Bay and unique testimony of the role this area had in spreading of the Mediterranean culture on the Balkans. Quality of artisanal skills of the entire geo-cultural zone is also important, as a testimony of the unique expression created by a blend of eastern and western culture. The karst zone, distinct hydrography and extreme climatic changes from Mediterranean to Alpine in a very small area resulting from unique morphological



Fig. 2 Inner part from the Verige Strait: the Kotor–Risan Bay was included in the UNESCO’s list of cultural and natural heritage of the humankind (*orange line*) [4, 5]

and morphogenetic characteristics of the area enabled the creation of numerous rare and unique species of flora and marine fauna, thus contributing to the Boka Kotorska Bay’s inclusion in the group of the most beautiful bays of the world [4].

Due to all stated above, it is more than justified that the Boka Kotorska Bay (inner part from the Verige Strait: the Kotor–Risan Bay) was included in the UNESCO’s list of cultural and natural heritage of the humankind [5] (Fig. 2) by the World Heritage Committee at the conference held on 22–26 October 1979, in Cairo and Luxor (Egypt), for the purpose of preservation and valuation of authentic geological, geomorphological, biological and cultural heritage.

The main characteristic that gives specific character to the area of Kotor is the vertical landscape profile (Fig. 1). Naturally steep slopes with a specific vertical structure influenced the development of a characteristic ‘cross section’ composed of the following zones:

- Settlements in the coastal zone grouped in a sequence and developed coast, system of jetties and mole-enclosed berths
- Arable land, terraced gardens in higher elevations
- Older settlements or primeval settlements in the higher zone, most of which have been abandoned
- Terraced gardens in higher elevations
- Slopes with forests or rocky landscape
- All zones connected by a network of old roads/trails

The system of jetties and mole-enclosed berths in Dobrota, Perast, Muo, Prčanj, Stoliv and other towns is characterised by unique coastal development manner, which is an element of particular importance in terms of the cultural landscape and a testimony of the way of living and dwelling culture in the coastal part of the protected area.

The characteristic landscaping form in areas in front of buildings of traditional architecture is arbour (*odrina*) with grapevine or glycine. In a historical environment, these arbours are almost always accompanied by stone-paved gardens, terraces with benches, stone wellheads, multileveled plateaus, trails with pergolas on pillars and other elements from the broad range of cultural heritage in terms of landscaping [4].

Settlements built on the shores of the Boka Kotorska Bay consist of three larger towns (Herceg Novi, Tivat and Kotor) and a number of smaller towns (Njivice, Igalo, Bijela, Kumbor, Zelenika, Meljine, Kamenari, Krašići, Lepetane, Opatovo, Bjelila, Risan, Kostanjica, Morinj, Lipci, Strp, Risan, Perast, Dražin Vrt, Orahovac, Ljuta, Dobrota, Muo, Prčanj, Stoliv) (Figs. 3, 4, 5, and 6). According to results of the census of the population, households and dwellings of 2011, the Boka Kotorska had a population of 67,496. Majority of the population is registered in the Municipality of Herceg Novi, 30,864; followed by the Municipality of Kotor, 22,601; and the Municipality of Tivat, 14,031 [6]. During tourist season, this number multiplies several times.

Tourism and other human activities on the shores of the Bay affect also the quality of the environment, water quality and air quality. Excessive and uncontrolled urbanisation, already recognised as a risk by the UNESCO mission, poses particular risk to the area of Kotor and it could jeopardise its universal value. On the other hand, controlled development results in changes that can develop further the World Heritage Sites [4].

One of the main causes of pollution of the Bay's waters is a still not fully resolved issue of sewage discharge into the sea where, as a result of slow water circulation, bacterial growths occur as well as eutrophication. The continuance or completion of investment works on activation of the Kotor–Trašte sewer system, where all waste water outlets from the Kotor–Risan Bay would be connected to, will eliminate the risk of sea pollution by waste waters (Fig. 7).

The same applies to the Adriatic Sea with an increasing anthropogenic effect originating from the development of tourism, agriculture, industry, sea traffic and port activities (Fig. 8).

The issue of eutrophication and pollution of the Adriatic Sea, particularly in its northern part, began receiving particular attention in the 1960s. As a result of its structure (extreme shallowness) and major influx of nutrients through the Po River, this part of the Adriatic Sea is often exposed to eutrophication. Eutrophication signs are increasingly frequent along the shores of Montenegro's coast, particularly in the Boka Kotorska Bay, and this process of anthropogenic eutrophication (sea enrichment by nutritive salts by human activities on the land) is at present generally one of the most frequent factors of pollution of the coastal sea. Consequences of anthropogenic eutrophication are increase in organic production, changes in composition



Fig. 3 View on Herceg Novi (Photo by A. Joksimović)

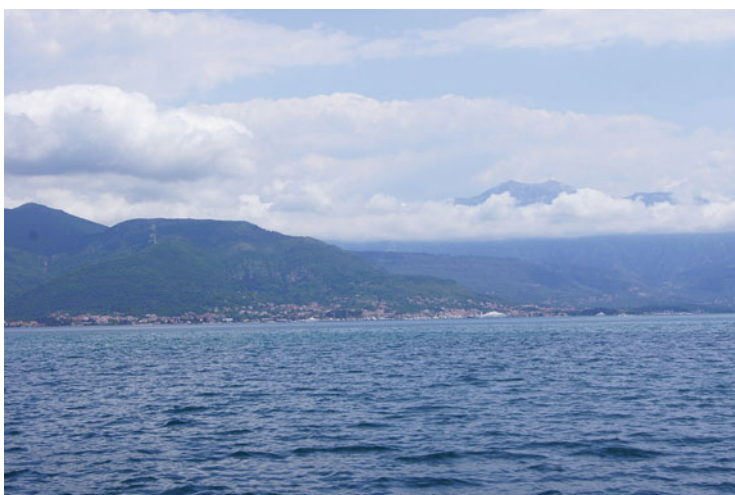


Fig. 4 View on Risan (Photo by A. Joksimović)

and relations among species in plankton and benthos, reduced transparency, change in sea colour, decreased oxygen levels in bottom layers along with increase in oxygen levels in depth as well as increasingly frequent phytoplankton blooming. The Boka Kotorska Bay is a very sensitive area from the aspect of anthropogenic eutrophication and its shallowest part – the Kotor Bay – is particularly endangered [7]. This issue needs to be properly addressed, and for those reasons, implementation of the sea monitoring programme began, which is implemented by the Institute of Marine Biology (Kotor, Montenegro) in cooperation with the Centre for



Fig. 5 View on Perast (Photo by A. Joksimović)



Fig. 6 View on Kotor (Photo by A. Joksimović)

Ecotoxicological Research for the Environmental Protection Agency (Podgorica, Montenegro) (Fig. 9). Furthermore, a project of drawing up the list of polluters in the Bay is underway, which would assist in systematic and lasting solution to the issues mentioned above.

The sea is one of the most important resources of the Earth, and it provides basis for the development of economic activities such as bathing and nautical tourism, shipping industry, shipbuilding, fishery and mariculture. Furthermore, it provides opportunities for economic activities that are currently not developed in



Fig. 7 Oil pollution in the Kotor Bay (Photo by A. Joksimović)



Fig. 8 Maritime transport – Kamenari–Lepetane ferry (Photo by A. Joksimovic)

Montenegro – biotechnology, exploitation of living and nonliving components of the marine environment for pharmaceutical purposes and exploitation of minerals, oil and gas, energy and others. Marine ecosystems provide a range of services (production, cultural and others) that are of great importance for economy and human welfare [4]. The total value of benefits from marine ecosystem services in the Mediterranean in 2005 was estimated to more than EUR 26 billion [4, 8].



Fig. 9 Monitoring of the seawater, researchers from the Institute of Marine Biology (Photo by A. Joksimović)

At the beginning of the last century, fishery was one of the important traditional economic branches in the Boka Kotorska Bay, evidence of which are records on small fish processing plants. Today, the Boka Kotorska Bay still disposes of some fish stocks; however, species of lower economic value make most of the catches, such as small pelagic fish (anchovy, pilchard, bogue, mackerel, Atlantic bonito). In addition to these species, fishing of economically profitable species, such as sea bass, dentex, sea bream and common pandora, is less represented (Fig. 10).

More intensive commercial fishing of the said species (trawling) is not done in the Bay as legislation in force prohibits it. However, securing a safe market for more abundant and less expensive fish species would create conditions for revival of the traditional small coastal fishery in the Bay. This would bring multiple benefits to various development fields in the Boka Kotorska Bay. It would enable employment of a larger number of people, develop further the tourist offer with traditional fish dishes and contribute to promotion of this region [4, 8].

Placing the posts on the shore of the Boka Kotorska Bay where seine nets are taken out – so-called fishermen’s posts – under protection would, in addition to preservation of this unique fishing method along with the traditional manner of fish preservation by salting, contribute to promotion and valorisation of centuries-old cultural and gastronomic values of the Boka Kotorska and its distinct style of living on the shores of the Bay [4, 8].

Mariculture, as a part of aquaculture, means artificial targeted farming of marine organisms under partly or completely controlled conditions (Fig. 11). In that context, farming of fish species and other marine organisms interesting for the market is a strategic issue for all states that aspire to protect their natural resources. Although farming of edible bivalve molluscs, particularly mussels and oysters, is



Fig. 10 Traditional fishery in Boka Kotorska Bay (Photo by A. Joksimović)

one of the oldest, well-mastered and safest maricultural activity, Montenegrin coast has so far been least used for that purpose in the entire Mediterranean Basin. There are several reasons for such a situation, but even without analysing them, it should be underlined that these do not include unfavourable environment for the development of this or other maricultural activities. The results of years-long experimental, scientific and technical researches conducted by the Institute of Marine Biology show that almost the entire coast of Montenegro is favourable for production of healthy food from the sea and that it satisfies all the preconditions necessary for market production (Fig. 11) [4, 8–12].

The Special Purpose Spatial Plan for the Coastal Zone and the Law on Marine Fishery and Mariculture of Montenegro [9, 10] identify areas favourable for mariculture within the Boka Kotorska Bay. Most of these are in sites where fresh waters flow into the Bay, either through rivers or submerged springs.

The site Orahovac, where river Ljuta flows into the Kotor Bay, is particularly important. Currently, in the Kotor–Risan Bay, there are around 15 farming sites for mussels *Mytilus galloprovincialis*, one and the first farming site for oysters *Ostrea edulis* as well as two fish farming sites for sea bream *Sparus aurata* and sea bass *Dicentrarchus labrax*. Since the capacity of the Boka Kotorska Bay enables production of around 600 t of bivalves, it is necessary to undertake systemic measures for its further development as soon as possible [13].

Mariculture, as a development resource, has undisputable advantages such as preservation of biological diversity and generation of positive economic effects through production of quality food in the sea.



Fig. 11 Fish and mussel farm in the Kotor Bay (Photo by A. Joksimović)

In the whole of Montenegro, the population, property and all resources are continuously exposed to effects of low- and medium-magnitude earthquakes and occasionally to catastrophic earthquakes of large magnitude. A seismically very active area of Montenegro is the Montenegrin coast which includes the seismogenic zone of the Boka Kotorska which is characterised by maximum earthquake intensity of IX degrees by (EMS981).

Following the disastrous earthquake in 1979, based on examination and analysis of all the damaged structures, the concept of integrated review and control of seismic risks was developed. However, in the absence of appropriate institutional system as well as noncompliance with the secondary spatial and urban plans adopted and seismic protection measures prescribed, the seismic risk level has increased compared to the early post-quake period. Illegal construction, illegal and inexpert conservation and restoration works on cultural heritage as well as uncontrolled and excessive urbanisation increase the risk of damages. In such circumstances it is questionable how safe the area of the Boka Kotorska Bay is, in seismic terms, with the exception of the old construction entity of Kotor. The area is exposed also to the risk of other accidents, such as fires, floods and accidents at sea. In Montenegrin coastal area, including the protected area, fires break out usually in summer period, not only as a result of heat or recklessness but also as a result of degraded or faulty electrical wiring, which is particularly dangerous for museums, archives or other facilities where movable cultural properties are kept. The area of Kotor or some of its parts or individual pieces of cultural property are exposed to risk of floods due to heavy rains or sea level rise. Since the entire aquatorium of the Kotor–Risan Bay falls under the protected area, the floristic–

faunistic values are exposed to the risk of various shipping accidents and ecological accidents [4].

With a view to providing a comprehensive and integrated protection of the area of the Boka Kotorska Bay, the Government of Montenegro – the Ministry of Sustainable Development and Tourism – adopted the Integrated Coastal Area Management Programme (CAMP) of Montenegro. The legal basis for implementation of the CAMP in the region of the Mediterranean was formalised with adoption of the Law on Ratification of the Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol) as the Seventh Protocol to the Barcelona Convention.

The Montenegrin National Strategy of Integrated Coastal Area Management (NS ICAM) will develop further the system of spatial development and encourage further strengthening of coordination mechanisms, development of result-oriented management practices and introduction of a systematic monitoring of coastal processes. The system thus strengthened will contribute to preservation of integrity of ecologically valuable habitats and ecosystem of the coastal area, landscape and cultural property, protection of the narrow coastal zone from linear urbanisation (Fig. 12) and development of rural areas, thus actually fulfilling the priority objectives of the ICZM Protocol. Additional value of the NS ICAM will also be strengthening the foundations for implementation of the sea use planning [9].

In order to preserve the development potential, it is necessary to establish an efficient integrated management system. It is a long, dynamic, multidisciplinary and iterative process of coastal resources management, aimed at achieving the sustainable development of the coastal area. It concerns the entire process of data collecting, planning, organisation, implementation and monitoring of implementation of the measures and activities planned.



Fig. 12 New urban tourism complex in the Herceg Novi Bay – Kumbor (Photo by A. Joksimović)

Evaluation of the situation in the coastal area under this document includes natural and cultural heritage, coastal resources, natural hazards, economy, social development and management. The evaluation of the situation points also to characteristics, positive trends and advantages of the coastal area as well as to vulnerability of specific environmental and spatial elements, occurrence of excessive pollution and unsustainable use of resources, economic inefficiency and weaknesses in the management system [9].

Marine resources are exposed to various pressures and pollution from untreated municipal waste waters, solid waste and shipbuilding/ship overhaul, from ports and marinas (which, as a rule, do not have adequate reception facilities for ship-generated waste and for minimising the environmental impact) and from vessels and industry. Vulnerability analysis (based on data from the Monitoring Programme of the Ecosystem Status of the Coastal Sea of Montenegro implemented in the period of 2008–2011, Environmental Protection Agency) revealed high vulnerability of the sea in the Boka Kotorska Bay and in certain locations along the Adriatic coast: in Budva, Petrovac, Sutomore, Bar and Ulcinj as well as in the open sea. The narrow part of the Boka Kotorska Bay; the part between the Shipyard Bijela and the Porto Montenegro (Fig. 13), Igalo Bay; and the narrow shallow strip from Valdanos to the mouth of Bojana are identified as extremely vulnerable. The narrow coastal strip of the open sea and the Boka Kotorska Bay is also quite vulnerable to pollution from possible ship accidents at sea.

A demonstration of limitations and possibilities for implementing an ecosystem approach in the context of the future planning of Montenegro's marine area was conducted in the Boka Kotorska Bay under the CAMP activities. Analyses show that the Boka Kotorska Bay is one of the most vulnerable parts of the marine area, under strong effect of anthropogenic factors caused by high population density in



Fig. 13 Shipyard Bijela in Tivat Bay (Photo by A. Joksimović)

the narrow coastal strip, development of tourism and accompanying urbanisation, limited effect of industry (shipbuilding), maritime activities and as of recently quite notable nautical tourism and inbound cruise arrivals. Extraordinary diversity of flora and fauna of the Boka Kotorska Bay is jeopardised by human activities located on the land as well as in the sea. Concentration of sites with high pollution level in a relatively small area shows that internal waters of the Bay are endangered most [8].

In this context, ecosystem approach in development of the plan for the use of marine area of the Boka Kotorska Bay is justified in order to enable the protection of particularly vulnerable marine areas and rational use of its economic resources. Although the optimal scope of the sea use plan is the entire marine area of Montenegro, complementary to the establishing of an integrated sea use planning system, it is pragmatic to begin working on a draft plan for the 'pilot' area. In that way, the data needed and their availability, obstacles in terms of introduction of the spatial plan for the sea and existing capacity for development of spatial plans of the sea can be reviewed in more detail. A demonstration example can significantly strengthen the planners' knowledge on the principles, methods and other technical knowledge for maritime spatial planning. Taking into account the relative availability of the data in the Boka Kotorska Bay, the first demonstration plan could be developed for the area of this Bay and the contiguous open sea [8].

This book will, for the first time, compile all the know-how built-in scientific research on ecosystem of the Boka Kotorska Bay conducted over several decades, for the most part implemented by the Institute of Marine Biology (Kotor, Montenegro) with its associates. In all the aspects of biodiversity of flora and fauna, sea and air pollution, chemistry, hydrography, oceanography, agriculture, tourism development, maritime industry, fishery and mariculture, we will try to summarise the knowledge on ecological status of the Boka Kotorska Bay. Along with all integrated management strategies needed for such a vulnerable area, we believe that the data and know-how presented in this book are invaluable for the future better behaviour towards the Boka Kotorska Bay, the pearl of the Adriatic and the Mediterranean.

A total of 70 scientists from 29 research institutes and faculties from Montenegro, Serbia, Croatia, Italy, Germany and Russia contributed to this book. The book is organised as follows. The first set of chapters is devoted to general physico-geographical characteristics of the Adriatic Sea and Boka Kotorska Bay. The next set of chapters deals with marine chemistry, general pollution and pollution from shipping activities in the Bay. Then we describe the bacterial, phytoplankton, phytobenthos, zooplankton, zoobenthos and ichthyoplankton diversity in the Bay. Going along the food chain, we continue with chapters on marine invertebrates, (Crustacea, Decapoda), aquaculture, fishery and its history and marine mammals in the Bay. On the land we describe a diversity of vascular flora and agriculture. Tourism and integrated coastal zone management have our special attention. Several chapters are focused on satellite monitoring of the Bay and general characteristics of the ongoing regional climate change. And we finish the book with conclusions.

We would like to thank the editors at Springer-Verlag for their timely interest in the Boka Kotorska Bay and the Adriatic Sea and their support of the present publication, because this is the first book on the Boka Kotorska Bay, and only two books on the Adriatic Sea were published in Springer:

- Gambolati G. (Ed.) (1998) CENAS: Coastline Evolution of the Upper Adriatic Sea due to Sea Level Rise and Natural and Anthropogenic Land Subsidence
- Cushman-Roisin B., Gacic M., Poulain P.-M., Artegiani A. (Eds.) (2001) Physical Oceanography of the Adriatic Sea

The editors of the book continue to work on the next planned publication, *The Adriatic Sea Encyclopedia*, which is based on the Russian version of the Encyclopedia published in 2014 [14]. We hope that this updated English version will be published in Springer in 2017.

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