



**Technologies for Assessing the Ecological State of Marine and Coastal Ecosystems for the Rational Use of Natural Resources in Tropical Regions**



**Kovalevsky Institute of Biology of the Southern Seas of RAS (IBSS)** is located on the coast of the Black Sea in the southern part of the Crimean Peninsula in the city of Sevastopol, Russian Federation

**A.O. Kovalevsky Institute of Biology of the Southern Seas of RAS (IBSS)** is a leading research center in south of Russia in marine ecosystem studies, environmental monitoring & marine biotechnology



**IBSS** is the legal successor of the first marine station in the Russian Empire and third in the world – Sevastopol Biological Station (SBS), which was founded more than 150 years ago in 1871

## MISSION OF IBSS

Fundamental and applied research of the World Ocean for the sustainable development of human society in harmony with the environment



1871



# MAIN DIRECTIONS OF SCIENTIFIC RESEARCH



Structure and Productivity of the World Ocean

Biology, Physiology and Adaptations of Aquatic Organisms

Oceanography & Climate Change

Marine and Freshwater Biodiversity & Conservation

Sustainable Marine Resource Management

Pollution Monitoring & Mitigation

Integrated Coastal Zone Management

Marine Biotechnologies and Aquaculture

Marine Radiation Biology and Chemical Ecology

Environmental Monitoring Equipment Development

# State-Assigned Research Themes:

- Study of the functioning characteristics and dynamics of subtropical and tropical coastal ecosystems under conditions of climate change and anthropogenic pressure, using remote sensing methods, cloud-based information processing technologies, and machine learning to establish the scientific foundations for their rational utilization.
- Investigation of biogeochemical patterns in radioecological and chemoecological processes within the ecosystems of water bodies in the Azov-Black Sea basin, compared to other areas of the World Ocean and specific aquatic ecosystems in their drainage basins, to support sustainable development in Russia's southern seas.
- Biodiversity as the foundation for the sustainable functioning of marine ecosystems: criteria and scientific principles for its conservation.
- Comprehensive study of the mechanisms underlying the operation of marine biotechnological complexes, aimed at extracting biologically active substances from hydrobionts.

# Research in Vietnam – based at the Joint Russian-Vietnamese Tropical Scientific-Research and Technological Center

- **Ecolan E-1.3** "Study of the functioning and dynamics of landscapes in Central and Southern Vietnam under conditions of anthropogenic pressure and climate change, to establish the scientific foundations for their rational use"
- **Ecolan E-3.3** "Investigation and assessment of biodiversity in selected marine communities of the central and southern waters of Vietnam"
- **Ecolan E-3.6** "Current state of ecosystems and diversity of hydrobionts in the Dong Nai River basin"

# Relevance

Tropical marine and coastal ecosystems are characterized by high biological diversity and play a key role in the economy and food security of regions. They are significantly affected by climate change, increasing anthropogenic pressure, including pollution and overexploitation of resources.



There is a need to develop and apply modern methods and technologies for assessing the ecological state of marine and coastal ecosystems to ensure their preservation and rational utilization of natural resources.



# Comprehensive Assessment of Coastal and Marine Ecosystem State

- Remote and in-situ water quality monitoring
- Radiation and chemical risk assessment
- Plastic pollution assessment
- Microbiological indicators for ecological state assessment
- Biodiversity monitoring
- Geoecological assessment of coastal ecosystems and their vulnerability to climate change

*Based on years of research by IBSS in various regions of the World Ocean.*



# Research in the World Ocean

## Seas:

Azov  
Baltic  
Barents  
Bering  
East Siberian  
Greenland  
Kara  
Laptev  
Norwegian  
Okhotsk  
Pechora  
Japanese  
Weddell  
Philippine  
South China  
Black  
Aegean  
Marmara  
Mediterranean  
Scotia

## Bays:

Aden  
Tadjoura  
Taganrog  
Temryuk  
Taman  
Novaya Zemlya

## Straits:

Antarctic  
Bransfield  
Sannikov  
Vilkitsky  
Kara Gates  
Drake  
Kerch

4  
oceans

19  
seas

25  
expedition  
s

Тихий океан

Атлантический океан

Южный океан

## Research Vessels of the Russian Ministry of Science and Higher Education:

«Professor Vodyanitsky»  
«Akademik Boris Petrov»  
«Akademik Mstislav Keldysh»  
«Akademik Ioffe»  
«Akademik Oparin»  
«Akademik Sergey Vavilov»  
«Akademik Fedorov»  
«Ashamaba»  
RS «Iliya»

## Research Vessels of Roshydromet:

«Professor Multanovsky»

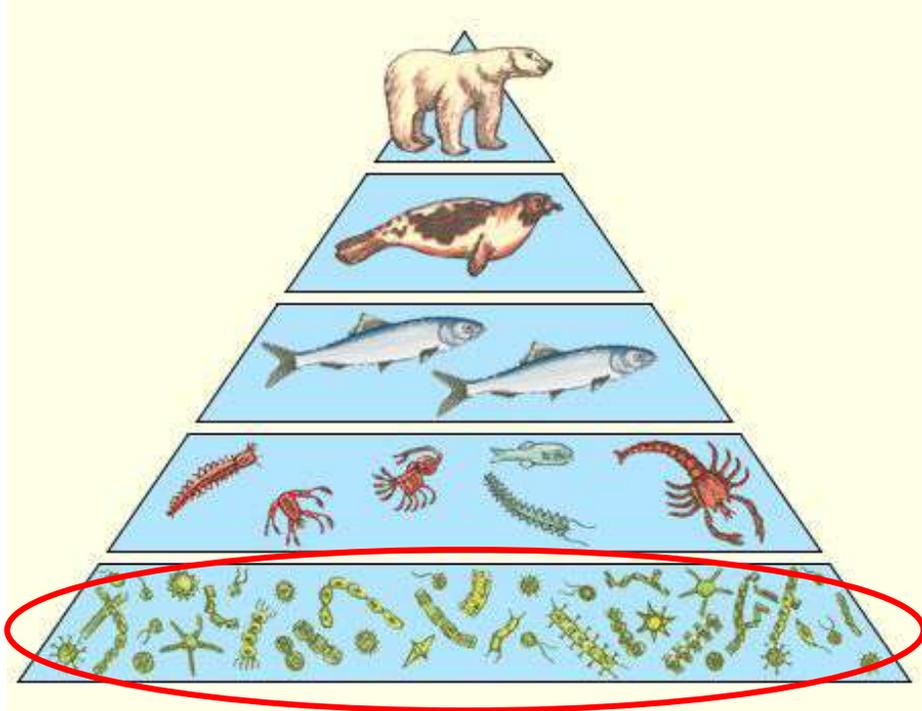
## Other Vessels:

Salvage  
Vessel «Epron» (Russian Black Sea Fleet)  
Yacht «Ugra»



# Control of Water Quality and Productivity Using Contact and Remote Methods

It is advisable to assess the productivity of water bodies based on the fundamental component of the ecosystem—photosynthetic organisms, specifically microalgae—since **photosynthesis forms the basis of water body productivity**, and **planktonic algae are the most sensitive** members of the ecosystem's biota to changes in the environment.



Based on Regional Algorithms Using Satellite Data, a Wide Range of Indicators Can Be Determined:



## Water Quality Indicators

*Water transparency (indicator of diffuse light attenuation)*  
*Depth of the photosynthesis zone*  
*Light in the upper mixed layer*  
*Light conditions in the bottom layer*  
*Content of suspended matter*  
*Content of colored dissolved organic matter*  
*Concentration of chlorophyll a*  
*Frequency and intensity of phytoplankton blooms (by Chl)*



## Water Productivity Indicators

- *Concentration of chlorophyll a*
- *Phytoplankton biomass*
- *Size and taxonomic structure of phytoplankton*
- *Rate of photosynthesis and growth of phytoplankton*
- *Primary production of the water body*

## Control of Water Quality and Productivity Using Contact and Remote Methods

Since 1997, the optical characteristics of scanners have been improving, and the standard decoding algorithms for scanner raw data (OC4, NN, GSM, OCI, GIOP) have been refined, but the problem of modeling accuracy remains. This is especially critical for inland water bodies and coastal sea areas. **It is necessary to create regional algorithms that take into account the features of the bio-optical indicators of the waters of a specific water body.**



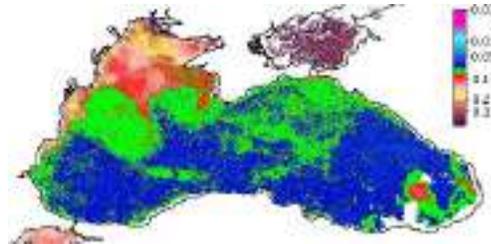
*The staff of the Institute of Biological Mechanics and Mechanics have successful experience in studying the spectral bio-optical parameters of water and in creating regional algorithms jointly with the staff of the Moscow Hydrometeorological Institute for the accurate assessment of water quality and productivity indicators using satellite data based on empirically established patterns of spatio-temporal variability of light absorption indicators by all optically active components of the environment.*

A complex of **spectral** bio-optical models has been created for the Black Sea to assess the state of the ecosystem based on **quality** and **productivity** indicators using satellite information.

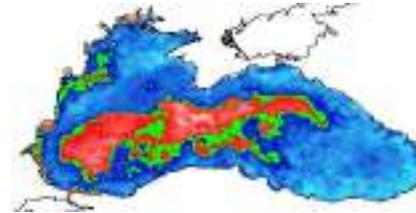
Colored Nonliving Matter (CDM)



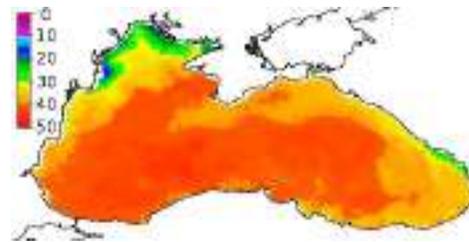
Water Transparency (Kd)



Concentration Chlorophyll



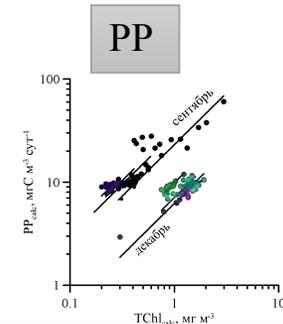
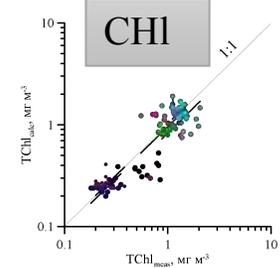
Photosynthetic Zone



Primary Production



Assessing  
the  
Accuracy of  
Models



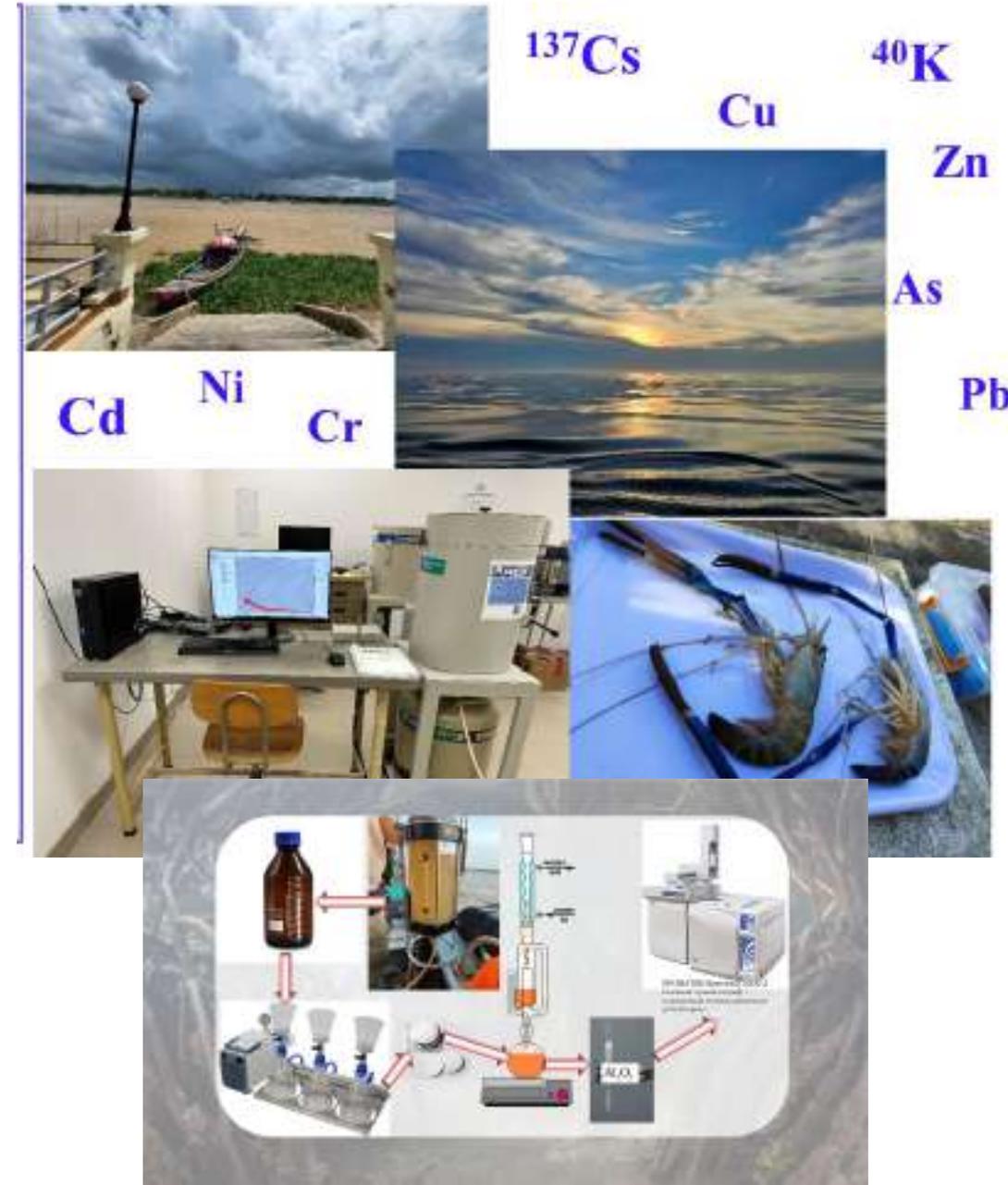
Accurate regional models are the basis for the development of operational monitoring of the state of aquatic ecosystems based on remote sensing data from space.

# Assessing Radiation and Chemical Risks in Coastal and Marine Ecosystems

Monitoring studies of key chemical and radioactive pollutants in coastal and marine ecosystems are necessary to assess anthropogenic impacts and climate change on the environment and human health.

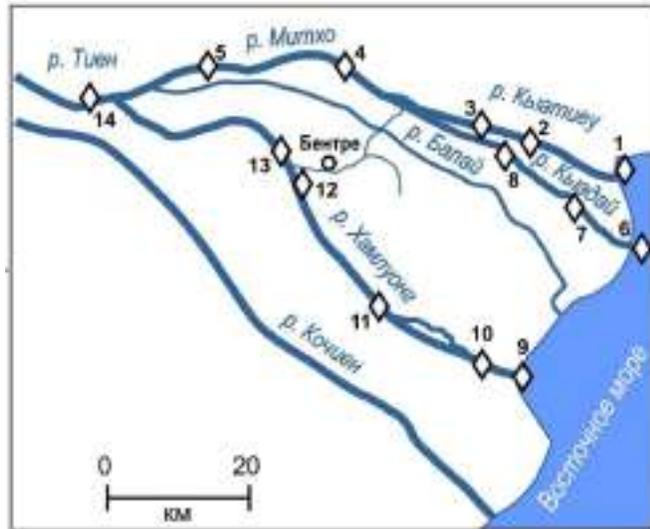
## OBJECTIVES:

1. Monitoring ecosystem pollution by inorganic and organic substances of various origins.
2. Conducting radio-chemo-ecological studies of water, suspended particulate matter, bottom sediments, and hydrobionts to determine the concentration of pollutants within them.
3. Identifying patterns of input, distribution, and dynamics of radioactive and chemical pollutants in the studied marine ecosystems using radiotracers.
4. Assessing the quality of the marine environment in the study area regarding pollutants of various types and their impact on the biodiversity of the studied waters.
5. Identifying areas with poor ecological status based on the intensity and nature of pollution.
6. Evaluating self-purification processes and/or redistribution, deposition (including bioaccumulation), and the ecological capacity of the water bodies.
7. Developing methods for biomonitoring (biomarking) the state of marine ecosystems.

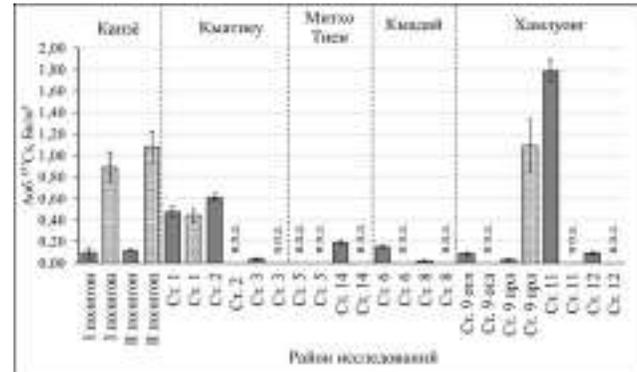


# Assessment of radiation and chemical risks in coastal and marine ecosystems

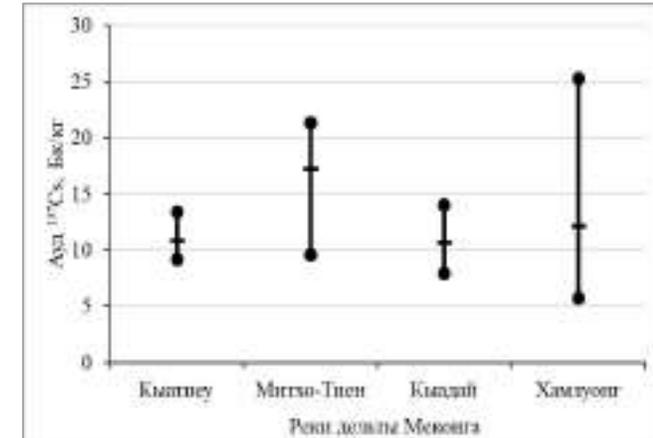
## $^{137}\text{Cs}$ in the Mekong Delta



Sampling stations in the Mekong Delta



Activity of  $^{137}\text{Cs}$ , Bq/m<sup>3</sup>, in dissolved (shaded) and suspended form (gray), n.p.d. — below the detection limit of suspended or dissolved form.



The activity range of  $^{137}\text{Cs}$  is 0-5 cm in the bottom sediment layer, the horizontal line is the average value for this region.

- A study on the levels and distribution patterns of anthropogenic  $^{137}\text{Cs}$  in various components of the river ecosystems in the eastern part of the lower Mekong Delta (in the Cua Tieu, My Tho, Cua Dai, Ham Luong, and Tien rivers) was conducted for the first time.
- Unlike the rivers of the Azov-Black Sea region, the source of dissolved  $^{137}\text{Cs}$  input into the Mekong Delta was the waters of the Eastern (South China) Sea, due to significant tidal activity.
- The content of  $^{137}\text{Cs}$  on suspended matter in the studied area of the Mekong Delta was comparable to, and even exceeded, that in the dissolved form. This indicates that suspended matter plays a leading role in the transport and redistribution of  $^{137}\text{Cs}$  in the delta during the wet season.
- The specific activity of  $^{137}\text{Cs}$  in the upper 0-5 cm layer of bottom sediments in the studied area of the Mekong Delta ranged from 5.72 to 25.26 Bq/kg. Compared to the Azov-Black Sea region, these values are low, indicating no significant recent inputs of this radionuclide.

# Assessment of radiation and chemical risks to coastal and marine ecosystems

## Studying Distribution and Assessing Ecological State of Can Gio Saline Watercourses regarding Heavy Metals (South China Sea Basin, Vietnam)

Table. Concentration (Cw) of Trace Metals (TM) and Major Leachable Deposits (MLD) in surface (SW) and bottom water (BW) of the rivers, and Maximum permissible concentrations (MPC):

element	Concentration, mkg/l					
	SW/BW		MPC <sub>FW</sub>	MPC <sub>HL</sub>	SOL <sub>HL</sub>	MPC(V) <sub>sw</sub> (A1)
	Cai Gian River	Long Tau River				
Pb	0,142 0,574	0,168 0,268	10	11	0,3	20
Cu	0,802 0,627	0,413 0,737	5	1,5	0,5	100
Zn	0,172 2,506	0,954 1,712	50	9,4	2,9	500
Ni	0,577 0,743	0,670 0,755	10	5,1	3,3	100
Co	0,025 0,011	0,020 0,004	5	2,8	0,2	n. d.
V	0,467 0,597	0,519 0,693	1	4,3	0,9	n. d.
As	0,004 0,001	0,027 0,021	10	25	1,0	10
Ag	0,033 0,059	0,027 0,021	n. d.	1,2	0,01	n. d.
Mo	1,62 2,13	1,212 1,093	1	290	4,3	n. d.
Cd	0,008 0,024	0,0094 0,0139	10	0,4	0,08	5
Se	0,123 0,199	0,073 0,010	2	5,3	0,09	n. d.

For the Cai Giao and Long Tau rivers, critical (> MPC) and potentially critical (>30% of MPC) elements in water were identified for priority monitoring.

Enrichment Factors (EF) for bottom sediments decreased in the order: Fe > Co > As > V > Pb > Ni > Zn > Cd > Sb > Tl > Ag > Mo (n×10<sup>3</sup> to n×10<sup>6</sup>).

EF for suspended matter decreased in the order: Fe > Co > As > Zn > Pb > V > Ni > Cu >> Tl > Sb > Mo > Se > Ag, ranging from n×10<sup>2</sup> to n×10<sup>6</sup>.

Trends in EF changes for bottom sediments and suspended matter were nearly identical.

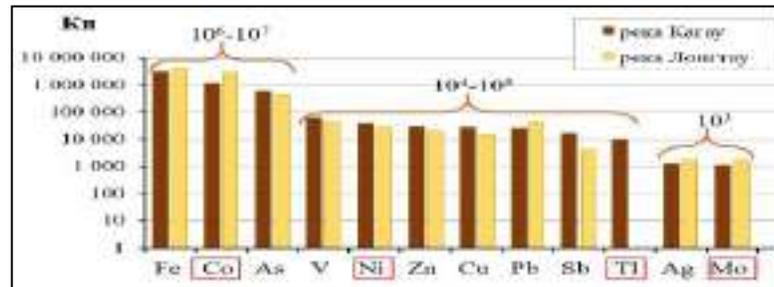


Fig. Accumulation of elements in bottom sediments: EF – Enrichment Factor, critical elements circled in red.



Fig. Study areas: sampling points (A) – Cai Giao River, (B) – Long Tau River, (C) – Mekong River Delta.

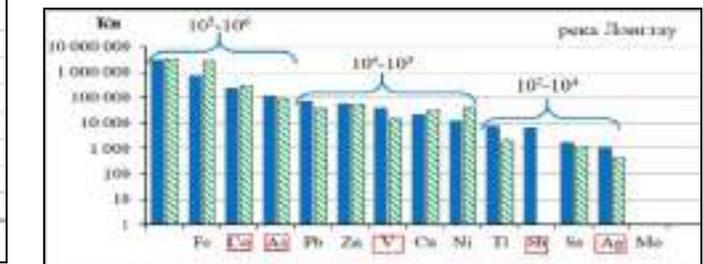
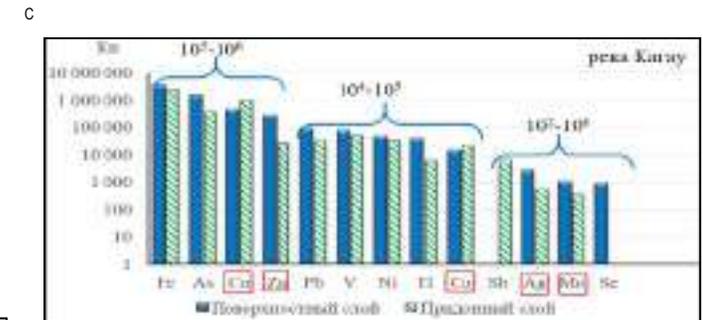
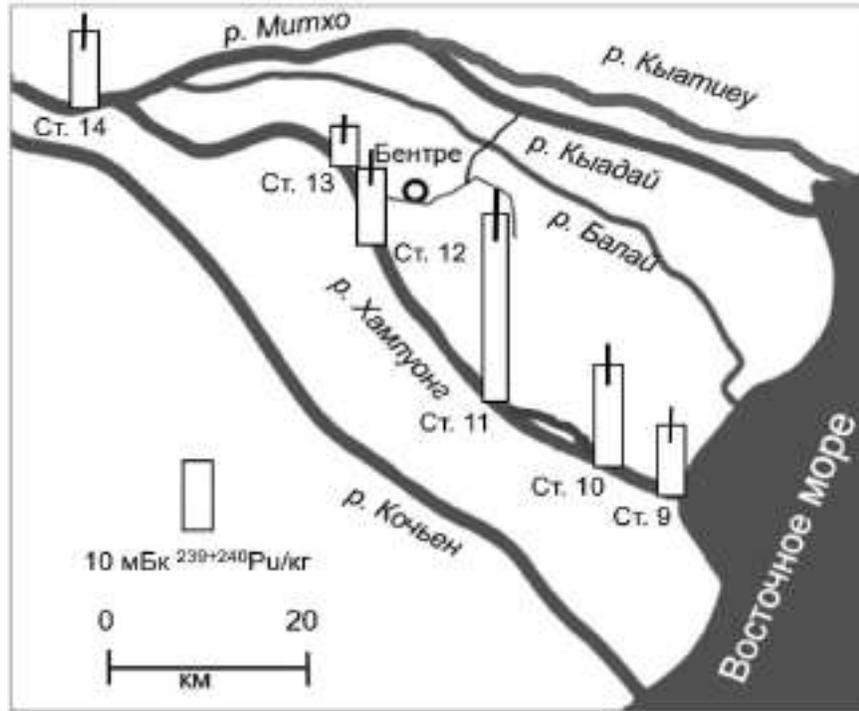


Fig. Accumulation of elements in suspended matter in the rivers: EF – Enrichment Factor, critical elements circled in red.

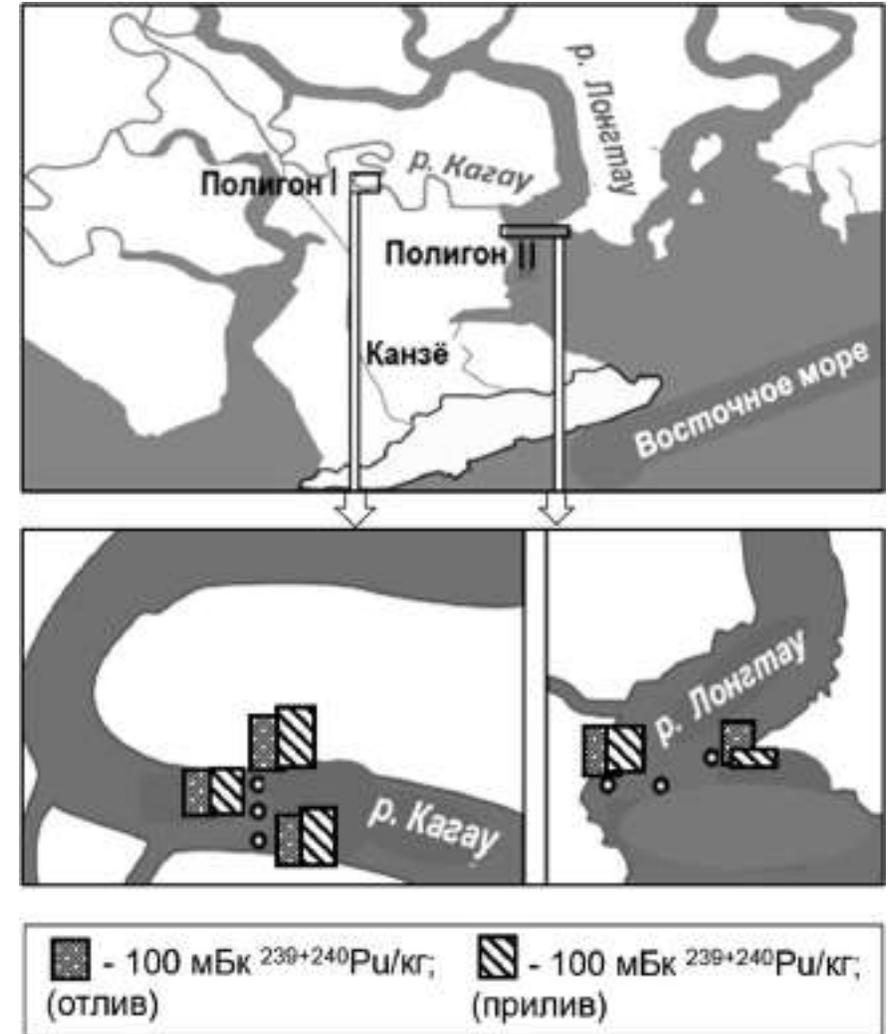
# Assessment of radiation and chemical risks to coastal and marine ecosystems

Specific activity of  $^{239+240}\text{Pu}$  (mBq/kg) in surface bottom sediments of the Hamluong River and the Tien River



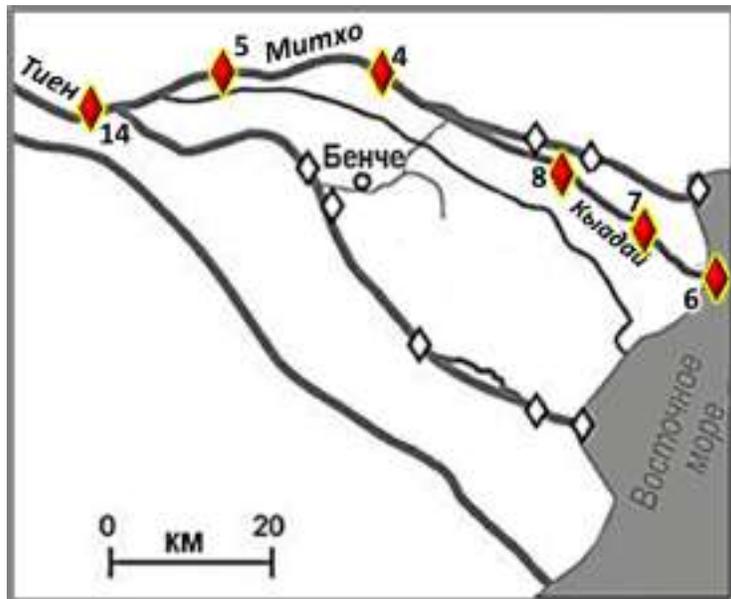
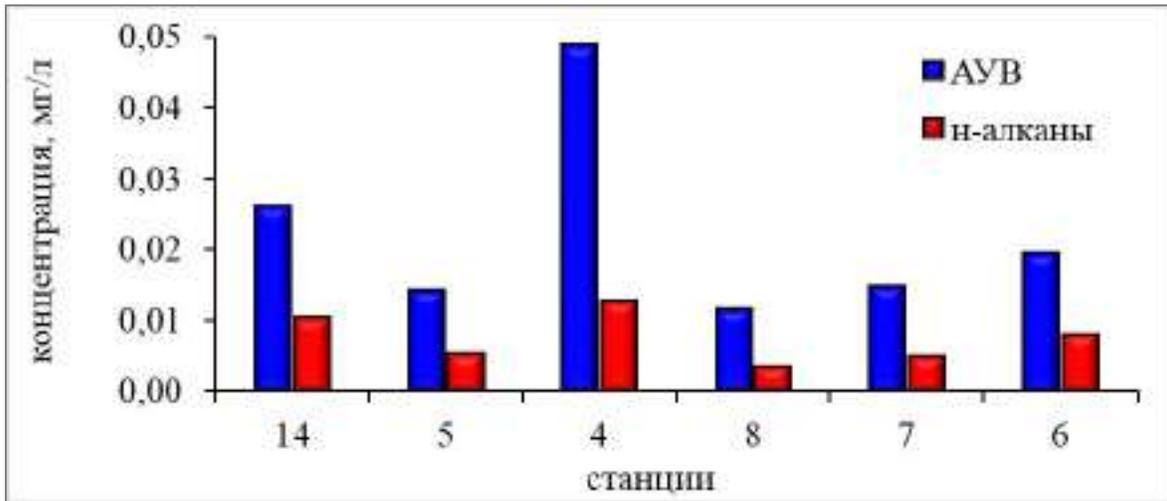
A decrease in  $^{239+240}\text{Pu}$  specific activity was noted in river mouth areas compared to previously observed values in adjacent marine waters. This trend over time is expected. Despite the long half-lives of  $^{239,240}\text{Pu}$ , the decrease occurs due to natural self-purification processes, mainly through dilution by hydrological processes and biogeochemical sedimentation with particulate matter into bottom sediments.

Specific activity of  $^{239+240}\text{Pu}$  (mBq/kg) of surface bottom sediments in the Kagau (Site I) and Longtau (Site II) rivers in the Kanzyo Nature Reserve

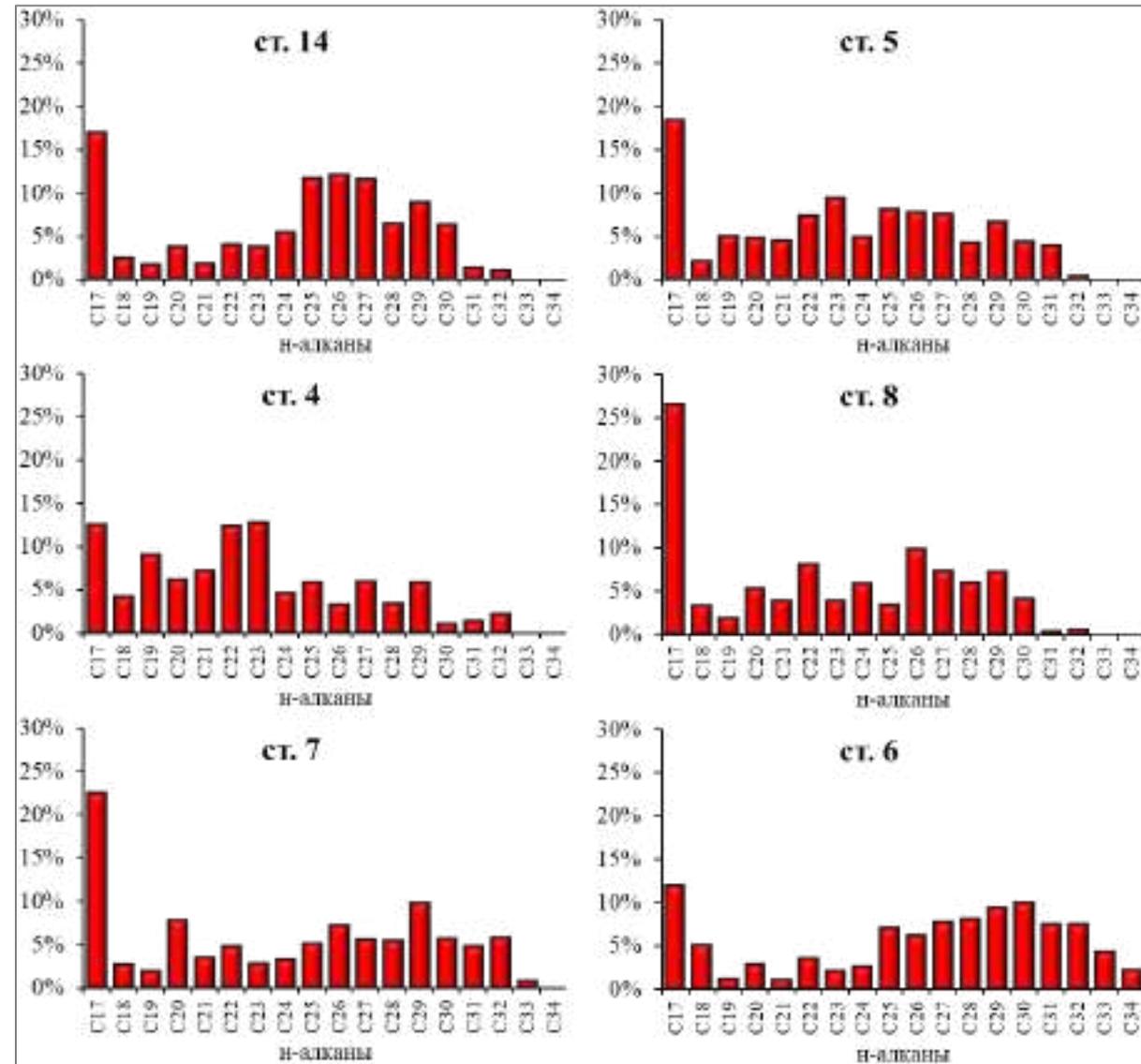


# Assessment of radiation and chemical risks to coastal and marine ecosystems

Concentrations of aliphatic hydrocarbons (AHC) and n-alkanes in suspended matter of one of the Mekong River branches, November–December 2022



Distribution of n-alkanes in suspended matter at sampling stations in the eastern Mekong Delta, Vietnam, 2022



# Assessment of the ecological state of marine waters based on microbiological indicators

**Bacteria** are the **first** link in the process of **biological self-purification of the marine environment** from various natural and anthropogenic pollutants.

Quantitative characteristics of indicator bacterial groups are used as indicators of pollution by various substances.

For example, **hydrocarbon-oxidizing bacteria indicate pollution by oil and its derivatives.**

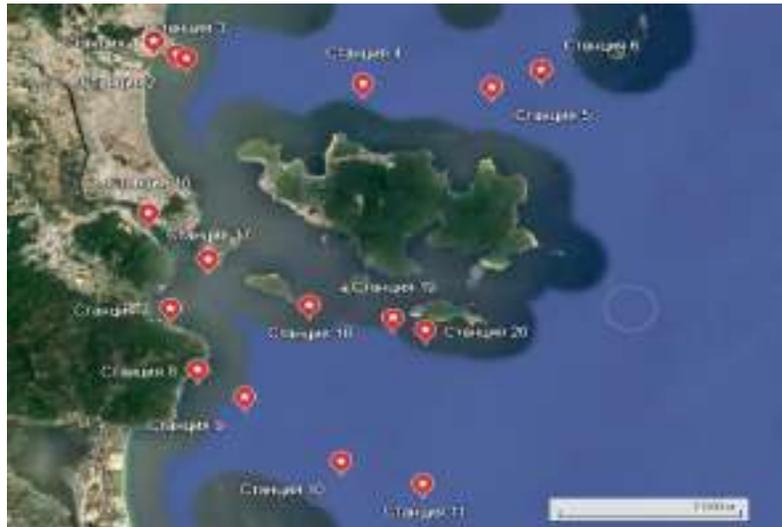
Quantitative characteristics of anaerobic bacterial groups indicate the transformation of organic matter under oxygen-deficient conditions.



# Assessing Marine Ecosystem State Using Microbiological Indicators

## Features of Distribution and Abundance Assessment of Bacteria Transforming Major Classes of Organic Compounds in various water areas of the Nha Trang region

Microbiological sampling scheme



Number (cells/ml) of studied bacterial groups in the surface water layer

No	No station	HB	UOB	LLB	ALB	h (m)
1	20	$10^2$	0	0	0	40
2	19	$10^4$	0	$10^3$	$10^3$	30
3	18	$10^3$	0	0	$10^2$	20
4	17	$10^3$	0	10	$10^2$	10
5	16	$10^5$	10	$10^2$	$10^5$	0.5

Number (cells/g) of studied bacterial groups in bottom sediments

No	No station	HB	UOB	LLB	ALB	h(m)
1	20	$10^4$	10	$10^2$	$10^2$	40
2	19	$10^5$	10	$10^3$	$10^3$	30
3	18	$10^4$	0	$10^2$	$10^3$	20
4	17	$10^3$	0	$10^2$	$10^3$	10
5	16	$10^6$	$10^4$	$10^5$	$10^4$	0.5

HB – Heterotrophic Bacteria  
ALB – Amylolytic Bacteria

LLB – Lipolytic Bacteria  
UOB – Hydrocarbon-Oxidizing Bacteria



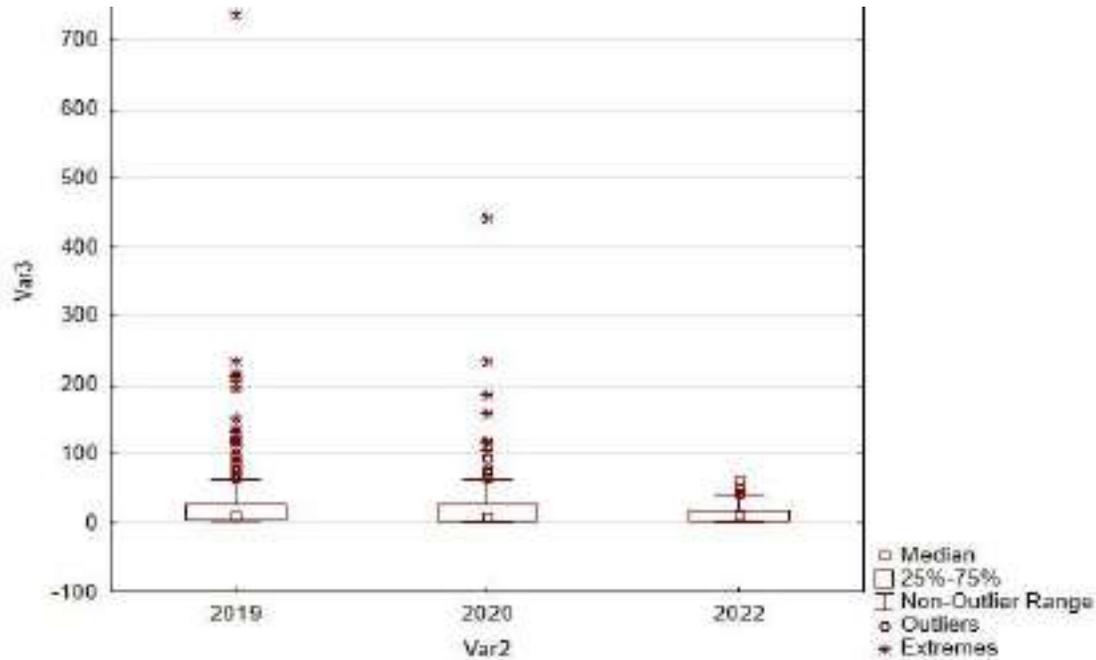
# Assessing Plastic Pollution in Coastal and Marine Ecosystems

1. Quantification of macroplastic pollution
2. Determination of concentration and assessment of spatial distribution of microplastics in surface waters
3. Assessment of the influence of river runoff and coastal sources on microplastic pollution
4. Study of the impact of microplastics on plankton communities
5. Study of microplastic accumulation in food chains of marine ecosystems



# QUANTITATIVE PLASTIC CONTENT

## Interannual variations in plastic content in trawl catches

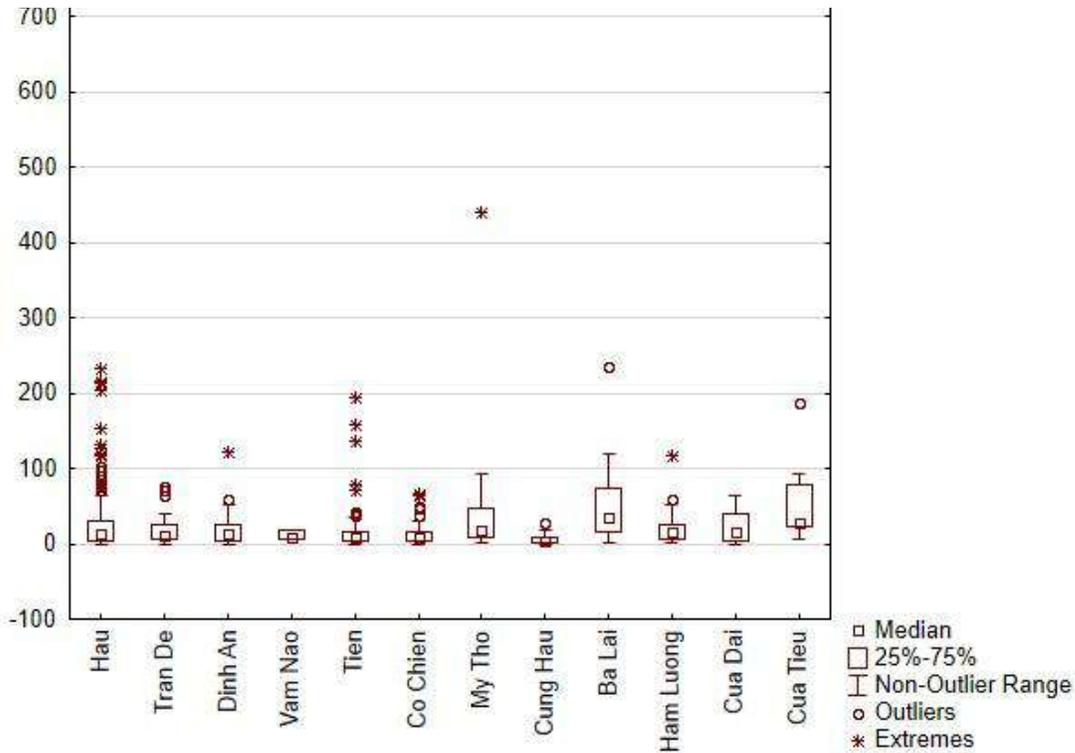


The study showed that the amount of macroplastic on the bottom of the Mekong is large, and a significant portion of incoming pollutants can be retained in the river's sediments for a short or long time. The plastic waste consisted mainly of packaging and containers for non-food goods (on average about 20% by dry residue mass), factory packaging for food products (about 25%), the rest (about 55%) was represented by household polyethylene bags, most of which, in accordance with the tradition of widespread use of street food, probably also served for storing food products and ready meals. Interannual variations were insignificant.



# QUANTITATIVE PLASTIC CONTENT

Statistical parameters of plastic content in delta rivers

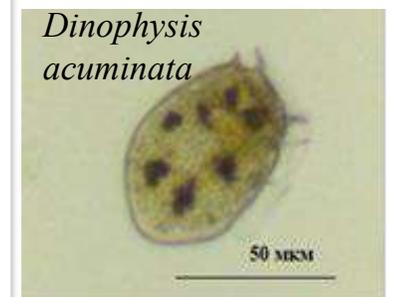
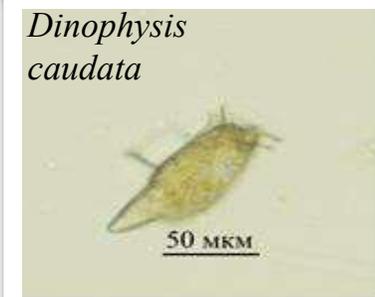
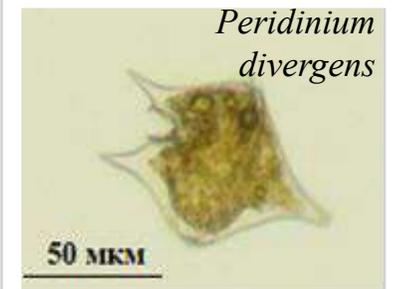
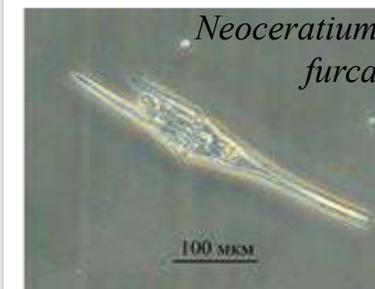


Region		Plastic weight, g/100 m <sup>2</sup>	
		Среднее	Макс
Mekong Delta		33.4	923.2
Tien, incl.	General	28.2	552.1
	Main Current	22.7	242.7
	Estuarine Zone	33.1	552.1
Hau, incl.	General	38	923.2
	Dry Season	55.3	923.2
	Wet Season	22.1	151.5
	Main Current, Including	43.3	923.2
	Dry Season	66.6	923.2
	Wet Season	21	100.8
	Estuarine Zone, Including	24.5	151.5
	Dry Season	24.6	94.8
	Wet Season	24.5	151.5

The highest average specific gravity of bottom macroplastics was recorded in the Khau River, particularly during the low-water period in the main river channel. Relatively high values were also observed in the estuarine zone of the Tien River—the Mytkho, Balai, Kyadai, and Kyatieu branches. The maximum pollution values were distributed similarly.

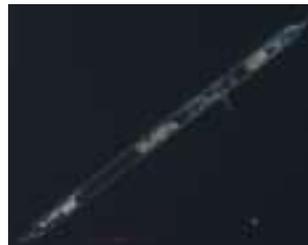
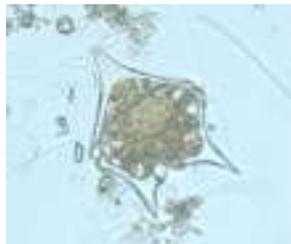
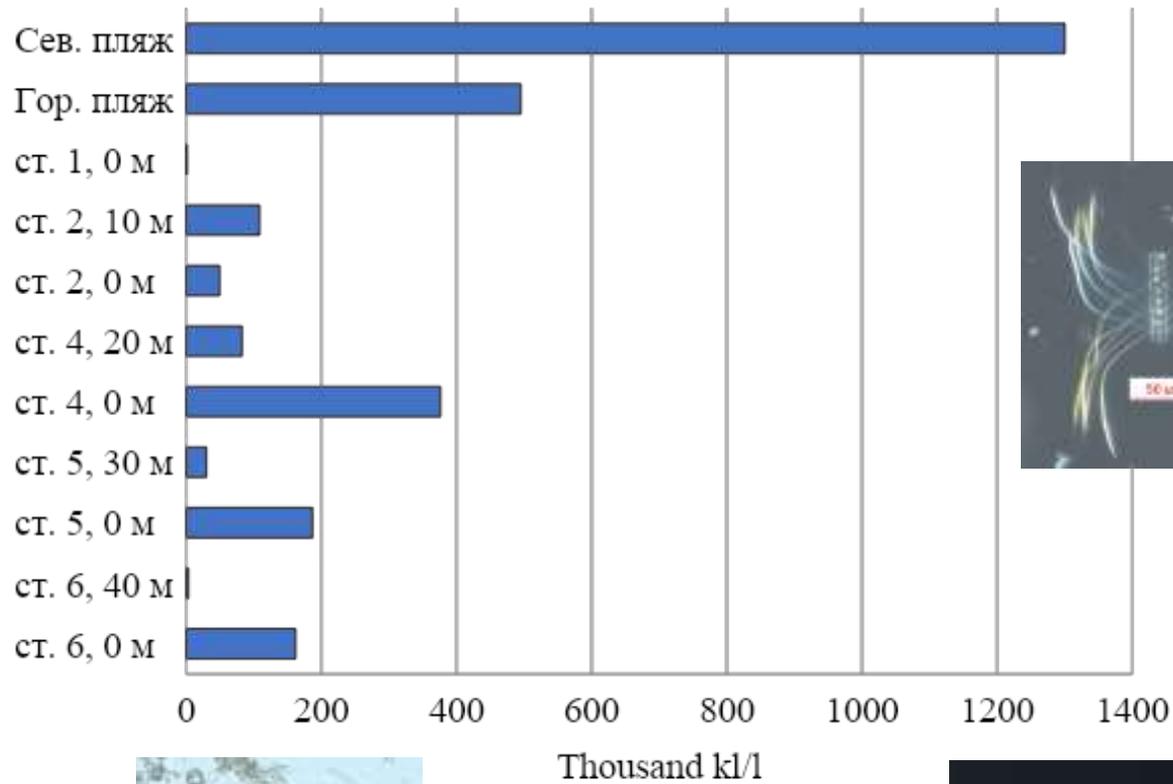
# Biodiversity Monitoring

- ❖ Phytoplankton is the foundation of marine food webs and a key indicator of water quality.
- ❖ Coastal water monitoring is providing alarming signals: the growth of toxic algae and harmful blooms threaten biodiversity, seafood safety, and ecosystem health.
- ❖ Amid climate change, intensive shipping, and economic activity, it is difficult to predict where and when the next outbreak will occur.
- ❖ Without systematic monitoring of phytoplankton status, it is impossible to assess the risks to the sustainable development of a region.
- ❖ Despite their importance, tropical coastal waters remain blind spots in the global monitoring of harmful algae.
- ❖ IMPORTANT is not just research, but an early warning tool:- forecasting dangerous blooms- water quality analysis- assessing threats to the environment and the economy.

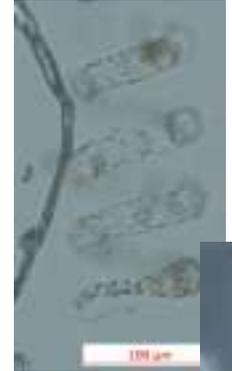
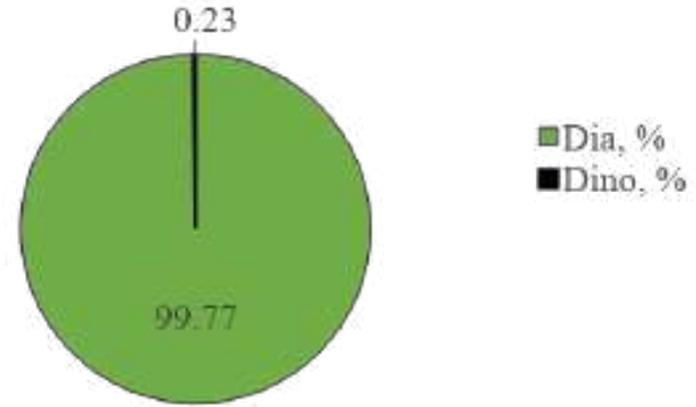


# Phytoplankton structure of Nha Trang Bay and adjacent water areas

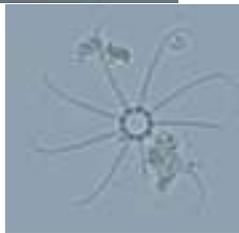
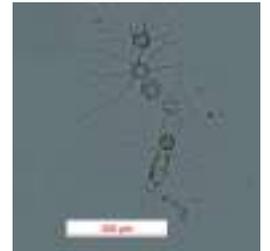
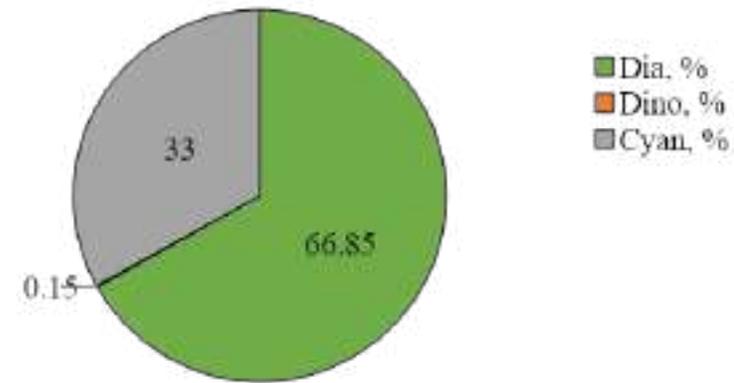
NUMBER, thousand cells/  
Section 1 and 2 coastal stations



RATIO OF THE MAIN PHYTOPLANKTON GROUPS  
(by abundance, %)  
Section 1



Coastal stations (1 and 2)



# Monitoring of the condition of benthic communities

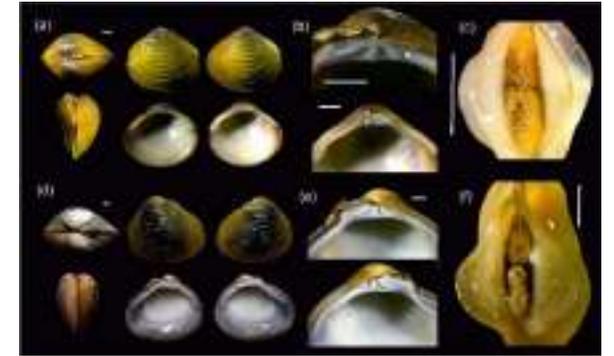
- ❑ - Bottom communities are one of the most significant biomass-producing and trophic links in marine ecosystems!
- ❑ - Many benthic organisms are the most important commercial species for humans and are also used as food by fish, birds, and mammals.
- ❑ - Benthic organisms serve as bioindicators of the ecological state of marine environments and act as powerful "filters" for water purification.

## Research on benthos is necessary for

- ✓ Identifying and preserving species diversity.
- ✓ Assessing the role of benthic animals in ecosystems to determine their economic and commercial potential.
- ✓ Analyzing the condition of aquatic ecosystems.
- ✓ Identifying threats to aquatic inhabitants and developing measures to eliminate them.

## Objectives:

- Determination of the taxonomic composition and structure of benthic communities
- Assessment of general quantitative indicators (population density, biomass)
- Analysis of spatial variability of the composition and structure of benthic communities in the studied water areas

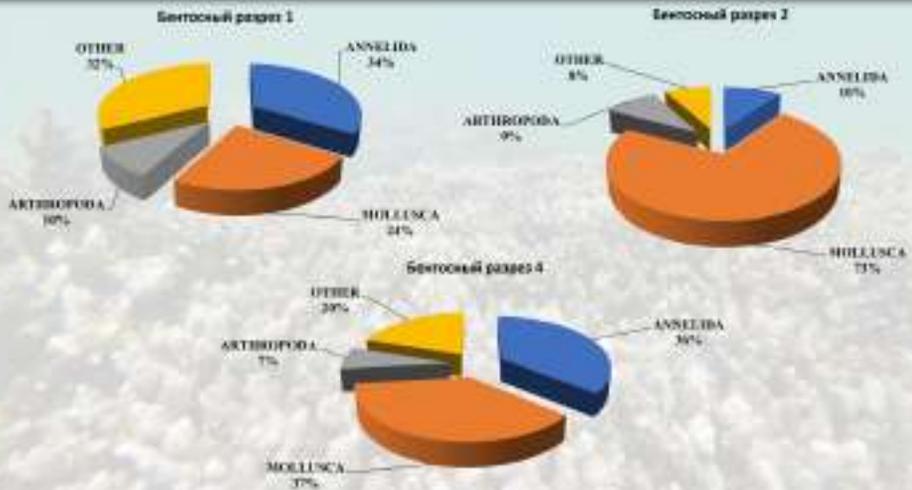


# Study of the composition and structure of benthic communities in various marine biocenoses along the coast of Central Vietnam

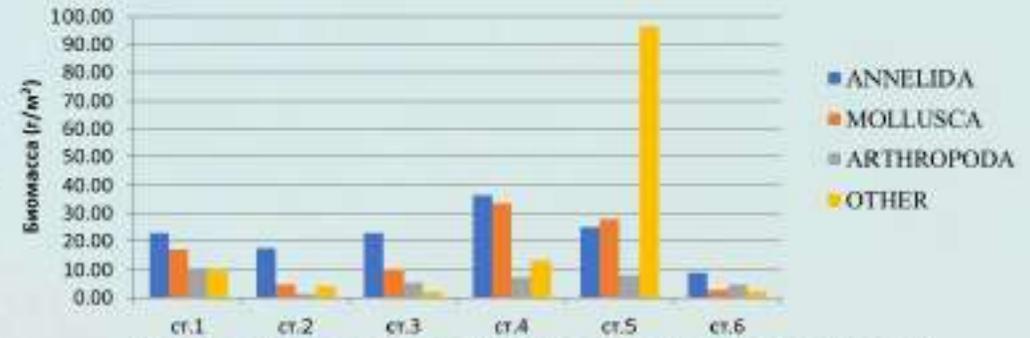
ОБЪЕКТЫ ИССЛЕДОВАНИЙ



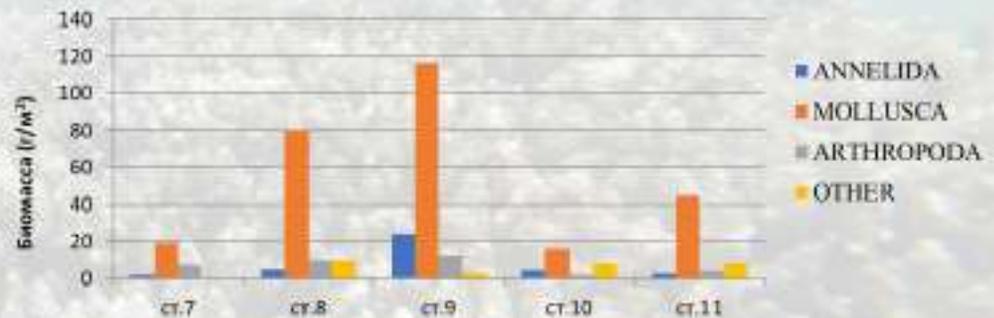
Contribution of the main groups of aquatic organisms to the total mass (%)



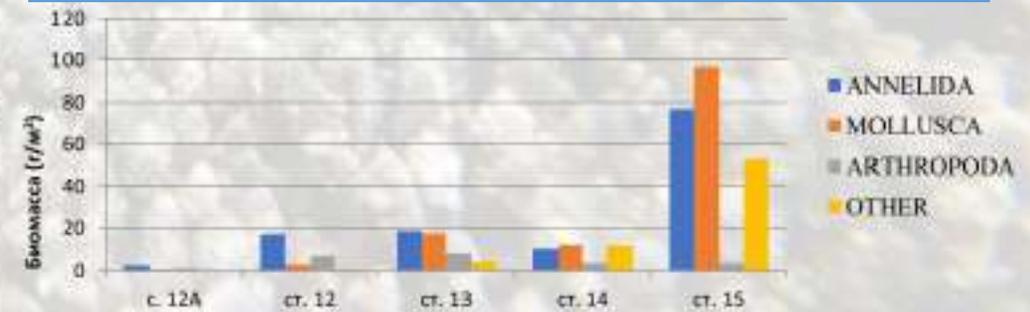
Average biomass of aquatic organisms in benthic section 1



Average biomass of aquatic organisms in benthic section 2



Average biomass of aquatic organisms in benthic section 4



# Assessment of the state of populations and life strategies of commercial fish species

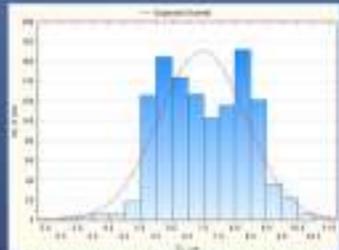
- The fishery sector in tropical regions is critically important but faces serious **threats** such as overfishing, climate change, and ecosystem degradation.
- There is an acute lack of data on key commercial species: growth parameters, demographics, reproduction, and survival remain poorly studied.
- It is essential to conduct **comprehensive assessments** of fish stocks, establish baseline biological parameters, and evaluate current risks to populations in both coastal and deep-water areas.
- The obtained data allow for **accurate stock status forecasts** and the development of **scientifically grounded recommendations** for fisheries management and marine ecosystem protection, **providing a scientific basis for resource conservation, sustainable industry development, and food security.**



## SOME BIOLOGICAL FEATURES OF ENCRASICHOLINA PUNCTIFER (ENGRAULIDAE)



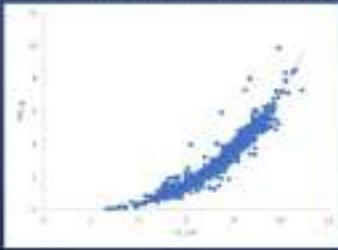
Особь *Encrasicholina punctifer*, выловленная в акватории г. Никанг.



Распределение по длине (TL) *Encrasicholina punctifer* из коммерческих уловов



An otolith of an *Encrasicholina punctifer* individual, TL = 61 cm. Arrows indicate zones showing concentric rings that may represent daily growth increments. The hypothetical age of the individual is from 60 to 90 days.



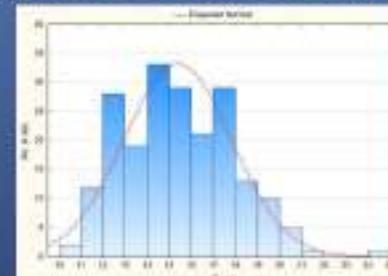
Зависимость массы от длины TL =  $0,0056TL^{2,10}$  при  $R^2 = 0,95$

The proportion of immature individuals was 45.6%, which may indicate excessive fishing pressure on the juveniles of this species.

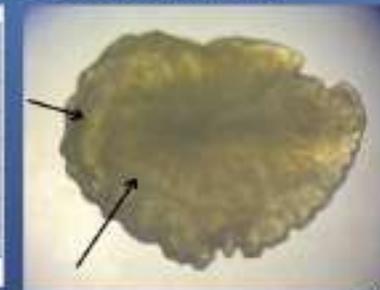
## SOME BIOLOGICAL FEATURES OF GERRES OYENA (GERREIDAE)



Особь *Gerres oyena*, выловленная в акватории г. Никанг.

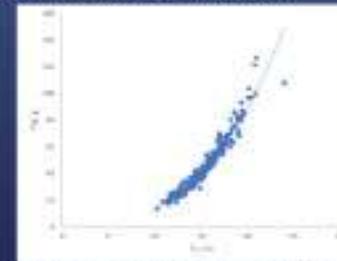


Распределение по длине (TL) *Gerres oyena* из коммерческих уловов



An otolith of an *OFGERRES OYENA* individual, TL = 14,9 cm. Arrows indicate zones showing concentric rings that may represent daily growth increments.

In the studied samples, the proportion of immature individuals was 13%, which is acceptable for sustainable fisheries, but requires strict monitoring.

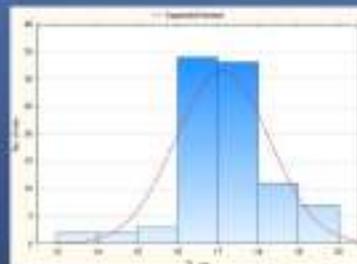


Зависимость массы от длины TL =  $0,0227TL^{2,77}$  при  $R^2 = 0,94$

## SOME BIOLOGICAL FEATURES OF POMADASYS MACULATUS (HAEMULIDAE)



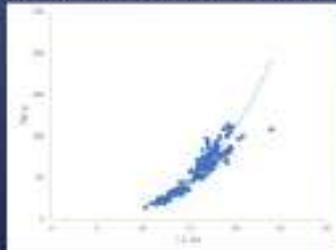
Особь *Pomadasys maculatus*, выловленная в акватории г. Дананг.



Распределение по длине (TL) *Pomadasys maculatus* из коммерческих уловов



An otolith of an *pomadasys maculatus* individual, TL = 19,8cm. Arrows indicate zones showing concentric rings that may represent daily growth increments.



Зависимость массы от длины TL =  $0,0104TL^{3,09}$  при  $R^2 = 0,83$

In the studied samples, the proportion of immature individuals was 8%, which is acceptable for sustainable fisheries, but requires strict monitoring.

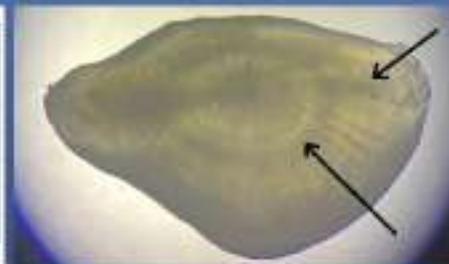
## SOME BIOLOGICAL FEATURES OF SILLAGO LUTEA (SILLAGINIDAE)



Особь *Sillago lutea*, выловленная в акватории г. Никанг.

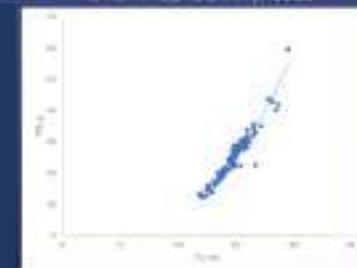


Распределение по длине (TL) *Sillago lutea* из коммерческих уловов



An otolith of an *Sillago lutea* individual, TL = 14,8 cm. Arrows indicate zones showing concentric rings that may represent daily growth increments.

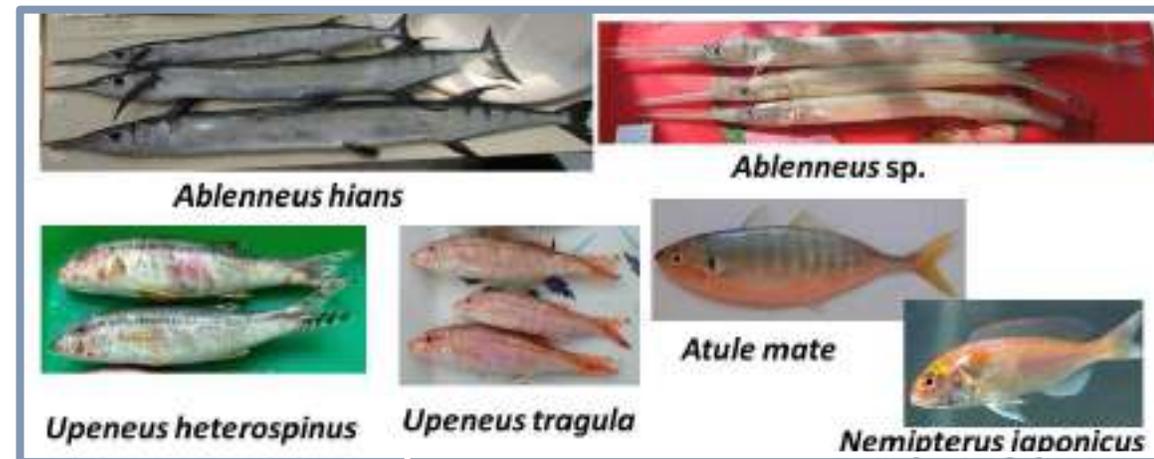
In the studied samples, the proportion of immature individuals was 28%, which may indicate excessive fishing pressure on the juveniles of this species and may indicate irrational commercial use.



Зависимость массы от длины TL =  $0,0097TL^{2,69}$  при  $R^2 = 0,92$

## Monitoring of parasite infestation of commercial and nutritionally valuable marine fish species

- ❖ Tropical regions are characterized by high biological diversity, which is also true of the diversity of PARASITES, including those that pose a threat to humans.



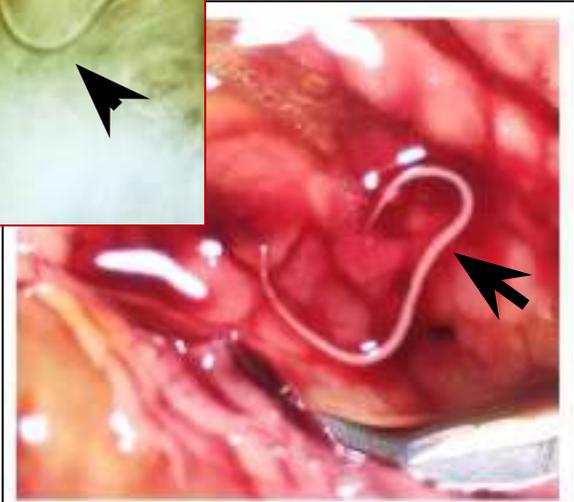
- ❖ The warming of coastal waters, the introduction of new species, the growth of marine aquaculture, and an increase in the proportion of seafood in the human diet are increasing the risks of the spread of parasitic invasions.



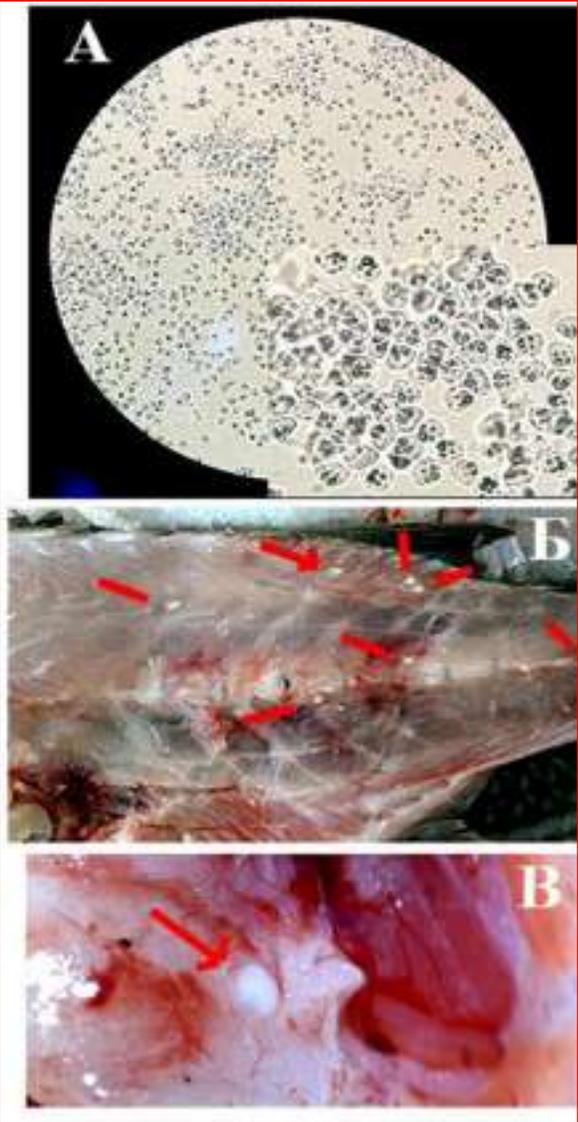
**Monitoring of the occurrence and abundance of parasites in fish of commercial importance is necessary to assess possible risks to aquaculture, fisheries and human health.**

**Studies of fish parasites in the coastal waters of Vietnam carried out in 2018-2024 revealed more than 50 species of parasites, which were first observed in this region, including:**

**Anisakid larvae are human pathogens found in commercial species: saberfish, tuna, snapper, horse mackerel, etc.**



✓ *They are dangerous when eating raw fish in traditional cuisines of Asian countries.*



**One of the most well-known types of microparasites that damage the fishery is found in horse mackerel.**

✓ *This species causes millions of losses to fishing and aquaculture, there is no treatment, early diagnosis is necessary to prevent the spread of the invasion.*

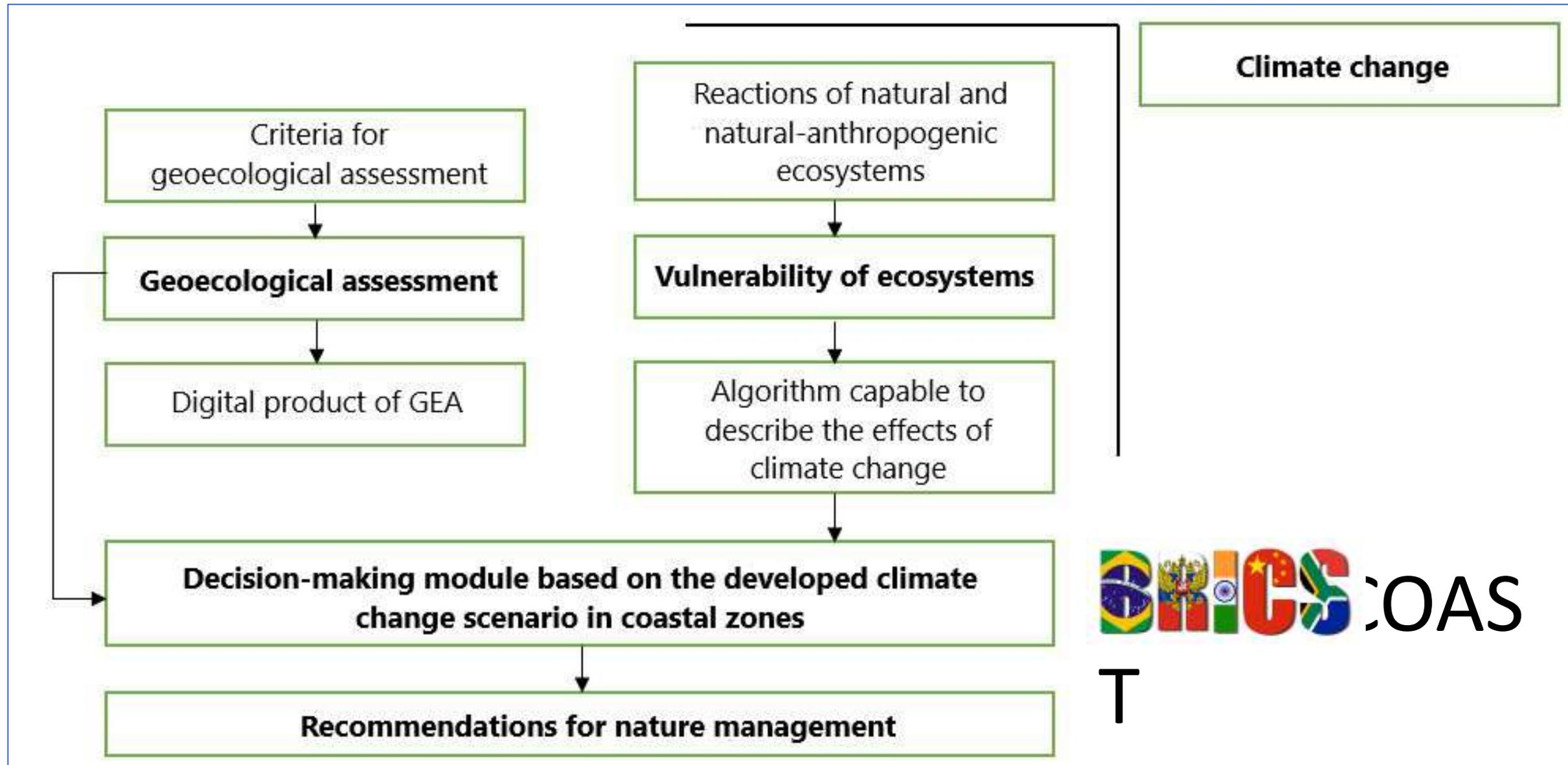
# Investigation of parasite infestation of commercial and nutritionally valuable fish species in marine coastal communities of Vietnam



- ❖ 15 species new to science have been identified in commercial fish species from the coast of Vietnam, and more than 50 have been observed in this region for the first time.
- ❖ 35 species of fish from the coast of Vietnam were examined, and half of them were studied for the first time for the presence of parasites in this region.



# Geoeological assessment of coastal ecosystems and assessment of their vulnerability to climate change

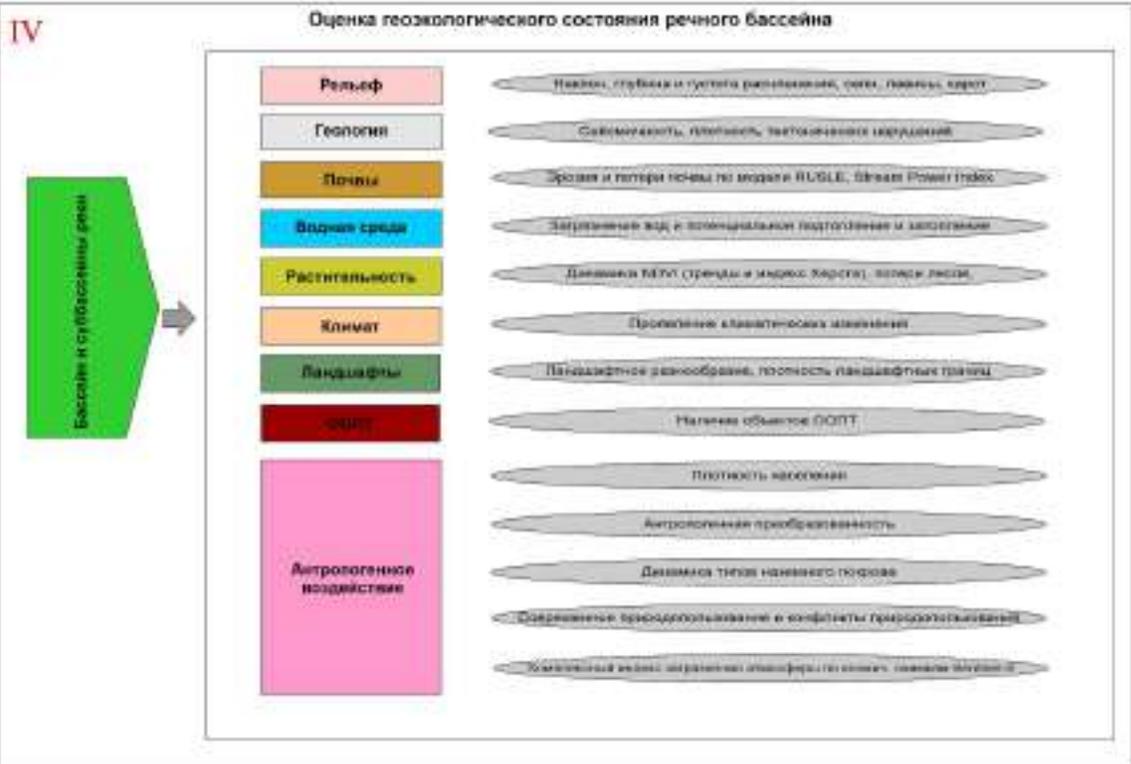


T

**I** Формирование теоретико-методологических основ исследования оценки геоэкологического состояния речного бассейна в пределах речного бассейна



**III** Анализ физико-географических и социально-экономических факторов формирования современного геоэкологического состояния в пределах бассейнов рек



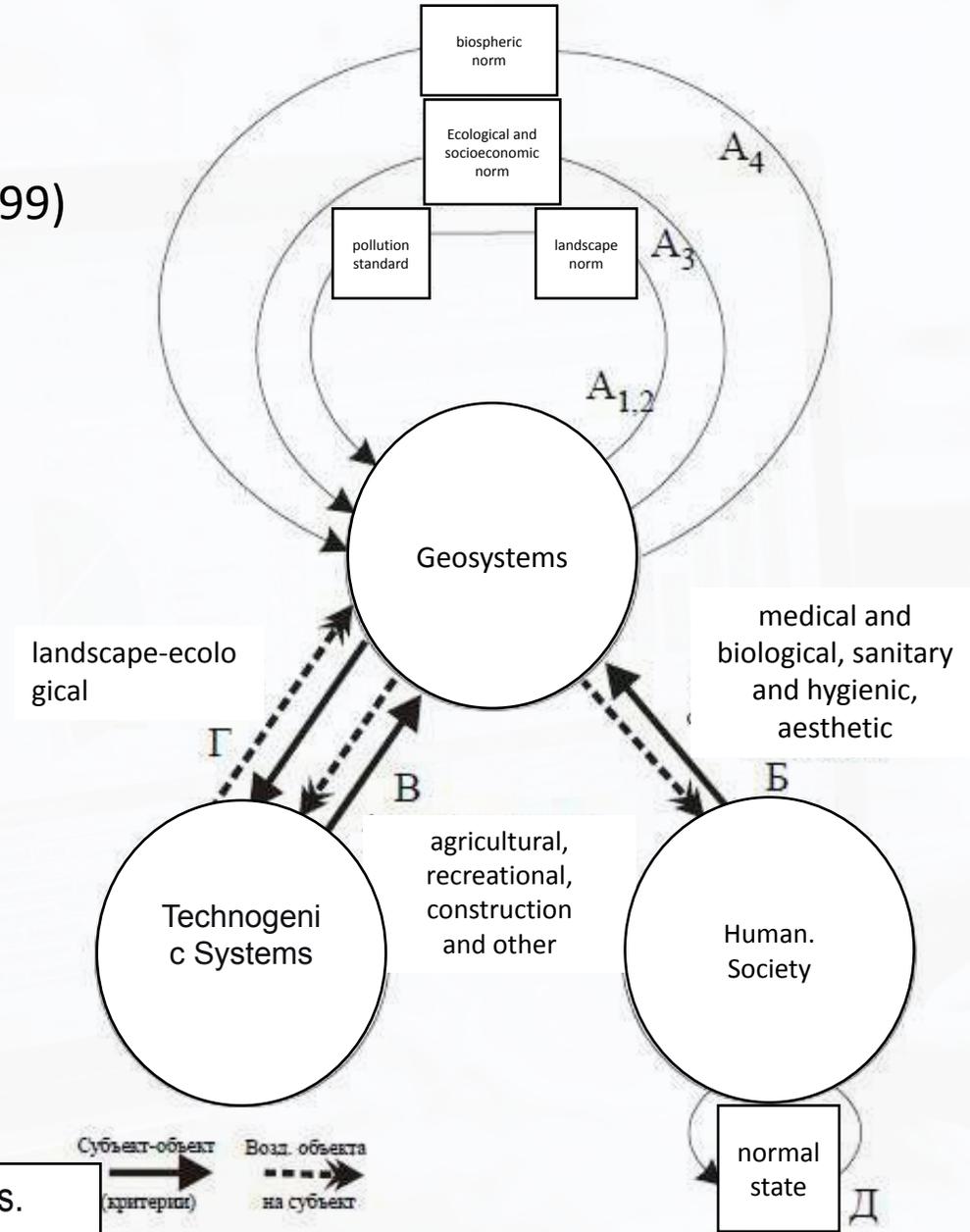
**V** Комплексная оценка геоэкологического состояния территории бассейнов рек. Рекомендации по устойчивому развитию территории бассейнов рек

A methodology has been developed for the geoecological assessment of coastal territories based on an assessment of the degree of deviation of landscapes from their natural norm, based on the idea of a matrix of criteria determined by regional specifics and the geographical position of landscapes.



Methodology testing areas

Graphic diagram of the relationship between assessment blocks – natural systems, humans and society (Lychak, 1999)



- A. Geosystem – Norm of Geosystems.
- B. Geosystem – Human.
- C. Geosystem – Technogenic Systems.
- D. Technogenic Systems – Geosystems.

# Environmental assessment

## Criteria:

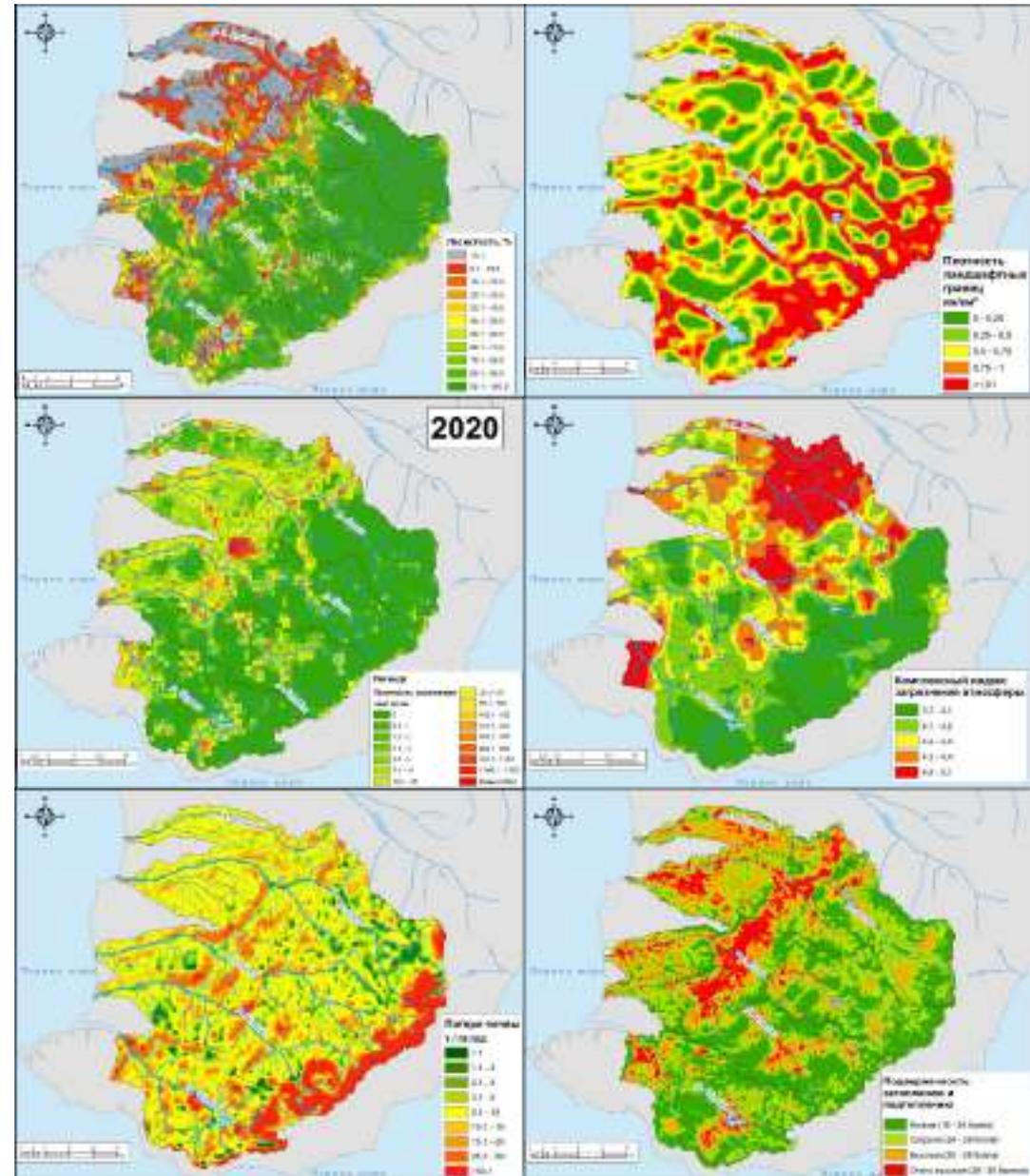
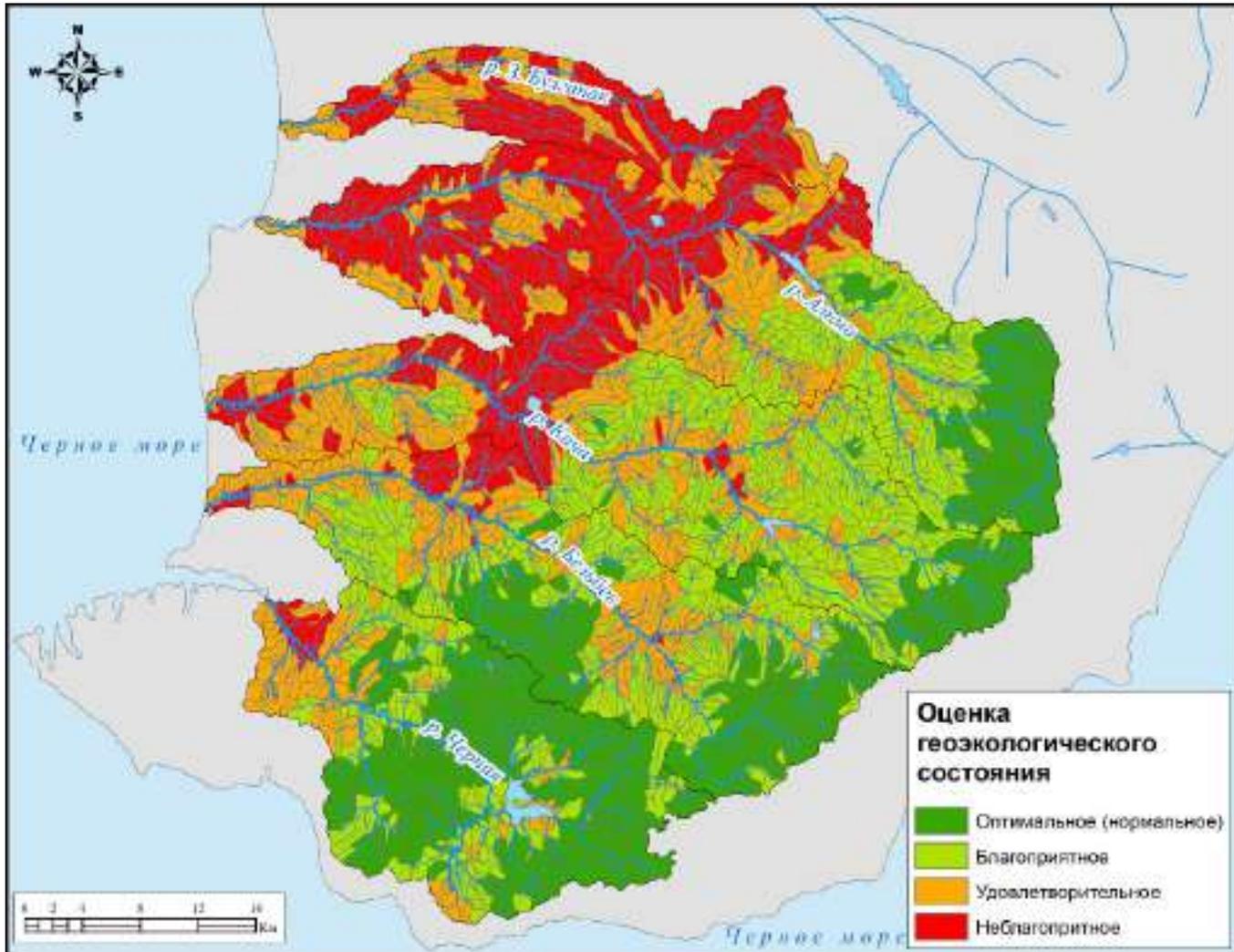
1. Karst
2. Landslides
3. Avalanches
4. Seismicity
5. Density of tectonic faults
6. Absolute height
7. The steepness of the slopes
8. The exposition of the slopes
9. The curvature of the relief
10. The depth of the relief
11. The density of the dismemberment of the relief
12. Temperature change
13. Precipitation change
14. Formation of climate anomalies
15. Drought/desertification indices
16. Change in snow cover area
17. Change in snow cover duration
18. Thermal pollution
19. Soil Erosion
20. Dynamics of NDVI index
21. Forest cover
22. Fragmentation
23. Landscape diversity
24. LU/LC dynamics
25. Anthropogenic transformation indices
26. Desertification
27. Air Pollution
28. Forest fire risks
29. Population Density Dynamics
30. Population Dynamics

# Vulnerability

## Criteria:

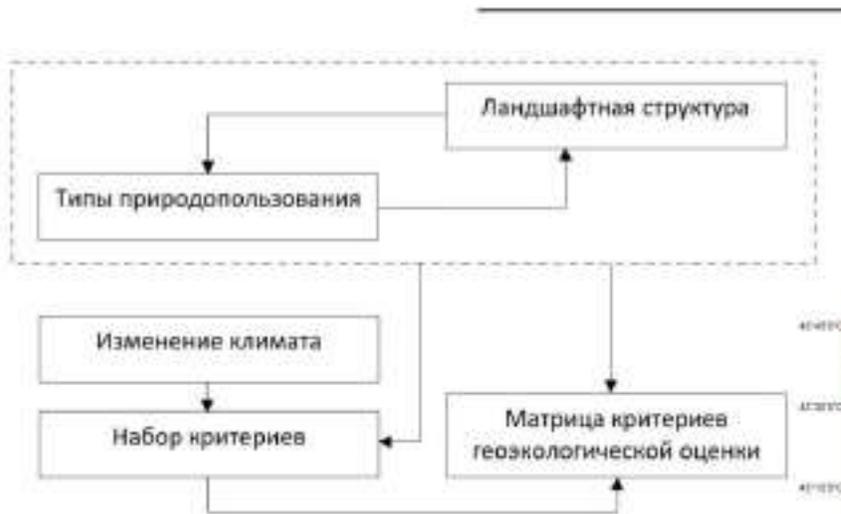
1. Flood risks
2. Landslide risks
3. Risks of increased soil erosion
4. Risks of growth and formation of new heat islands
5. Vegetation dynamics (degradation)
6. Risks of forest fires

# Map of the geocological condition of the river basins of the north-western slope of the Crimean Mountains



Some criteria for geocological assessment

Within the framework of the Large-scale scientific project "Dynamics of the geoecological state of mountain river basins of the Northeastern Caucasus, Azerbaijan and Iran in the context of climate change and growing anthropogenic pressure", an idea has been developed about the matrix of criteria for geoecological assessment, about socio-cultural gaps as environmental factors that serve as boundaries of operational and temporal units

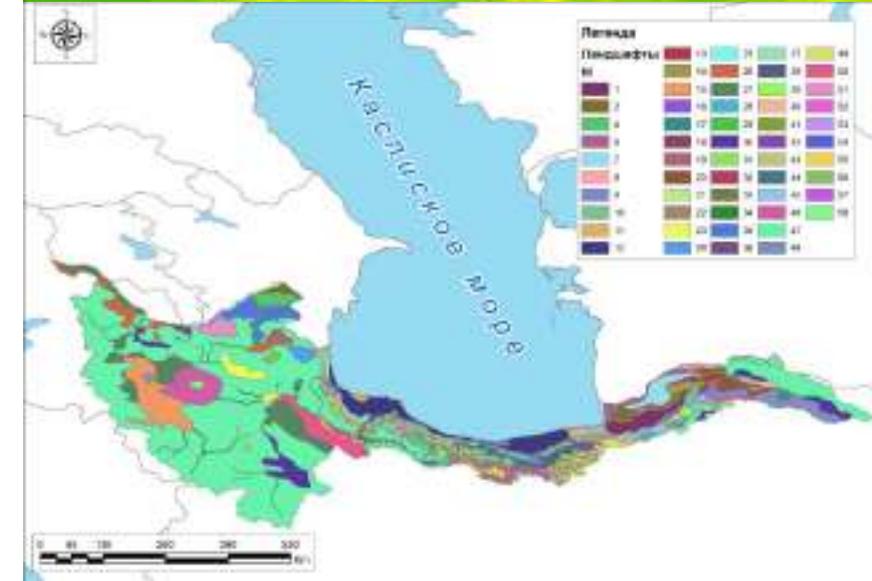


Logical scheme of geoecological assessment

All the criteria of the geoecological assessment selected in the framework of this study were differentiated by landscape contours based on information about the types of environmental management that exist within each contour.

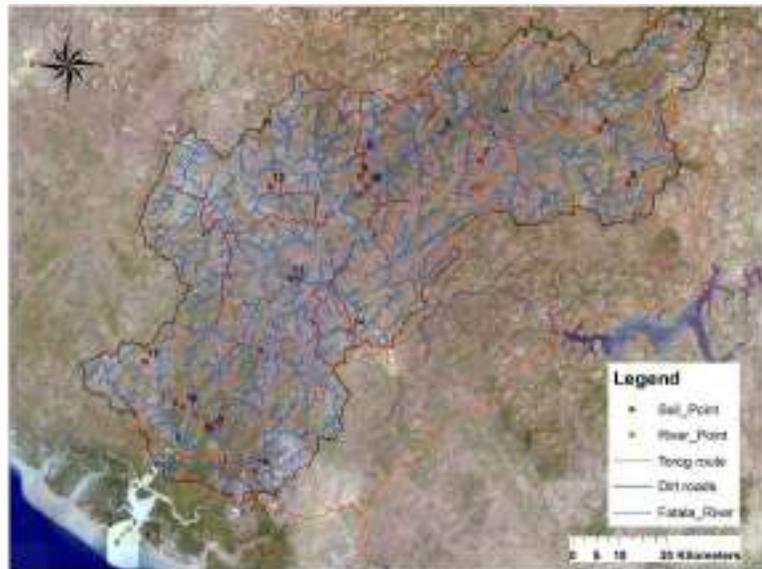
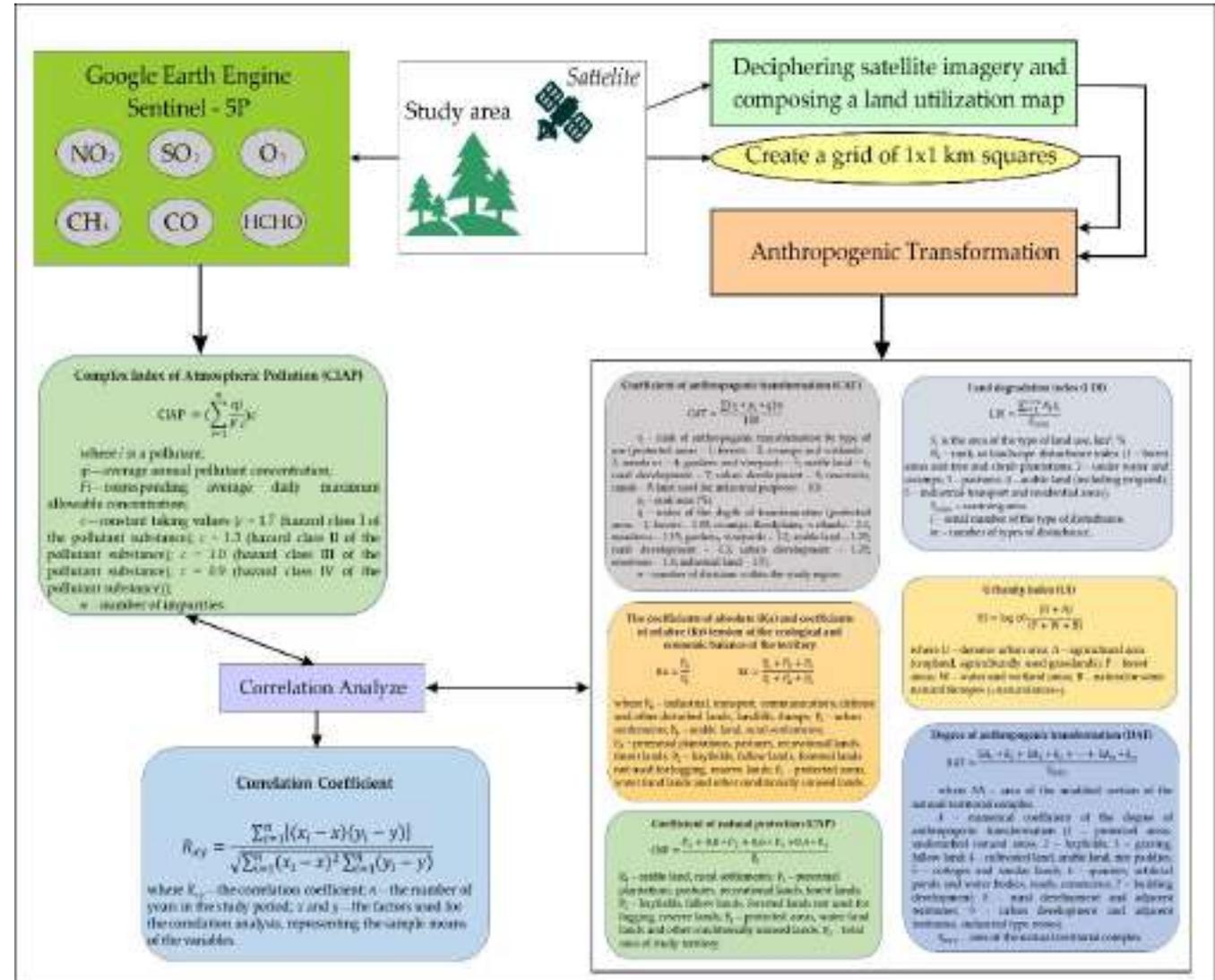
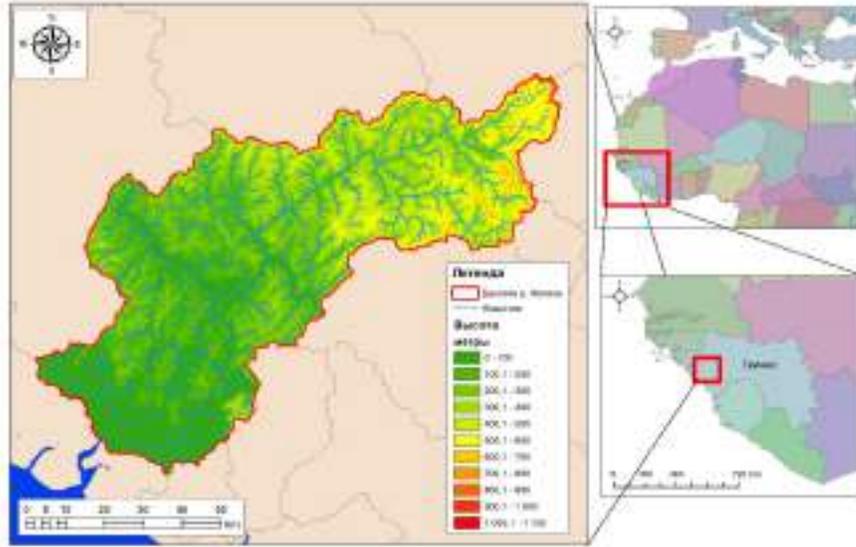


Environmental management in the Sunzha River basin (Chechen Republic)

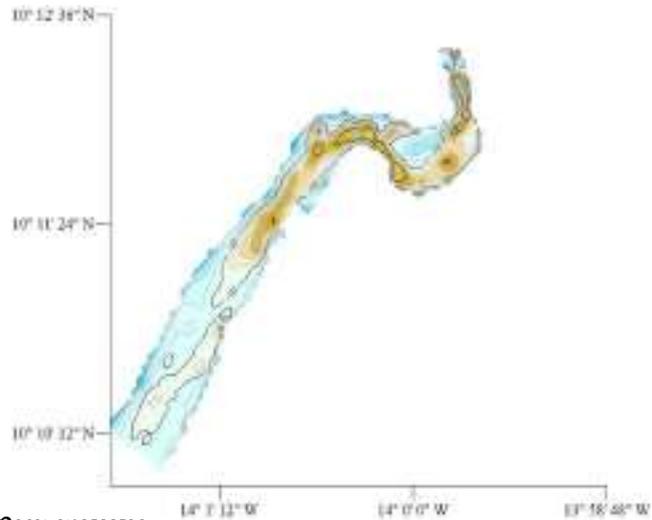
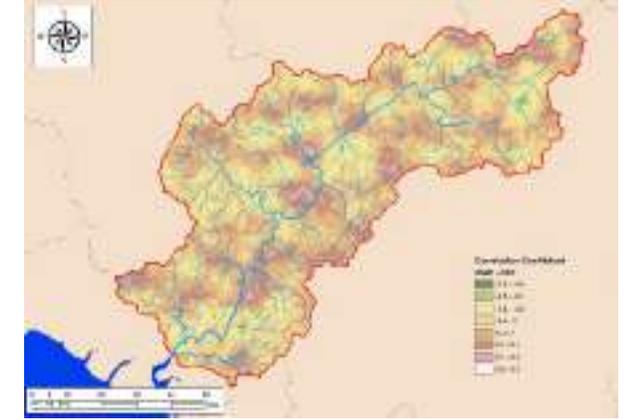
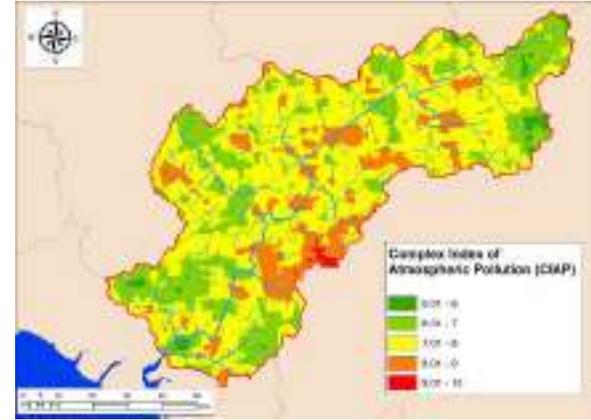
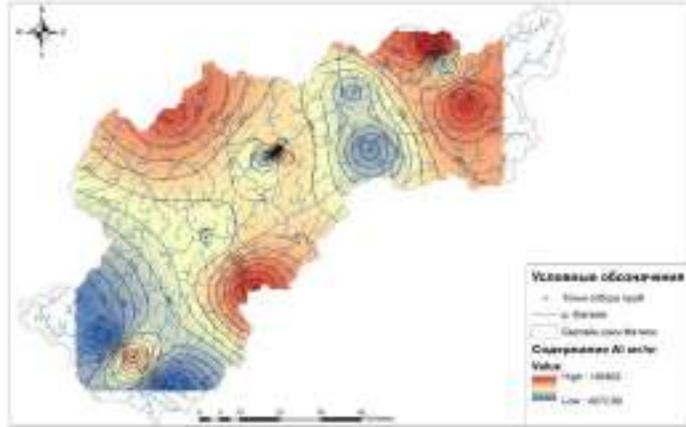


Landscape map of the territory of the Caspian Sea basin at the level of subtypes of landscapes within Iran

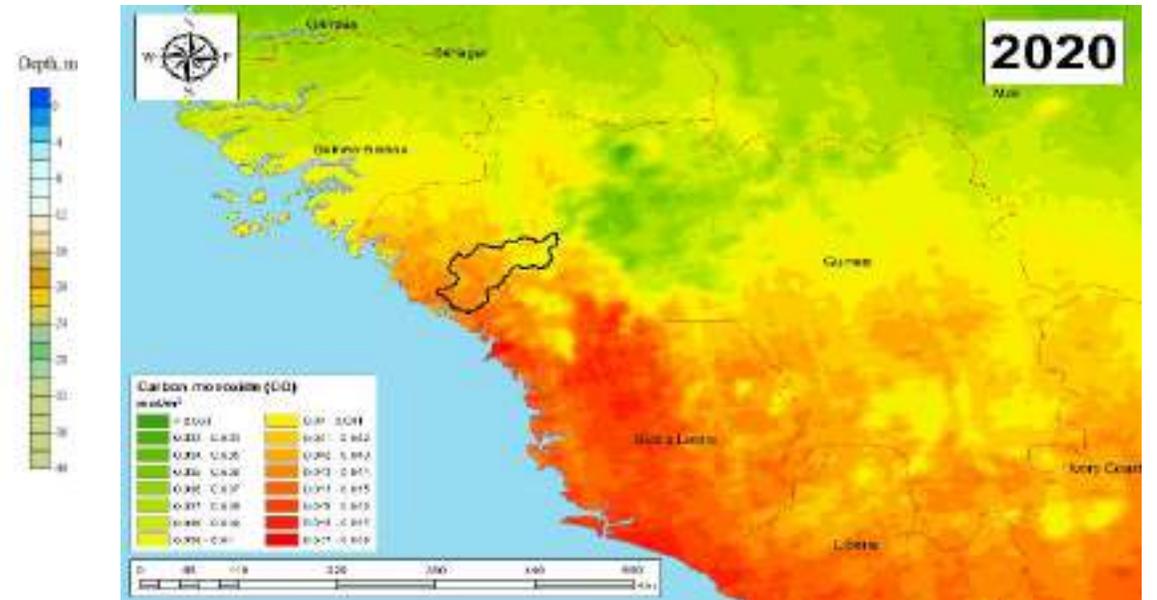
A technology for assessing anthropogenic impact on basin ecosystems of the tropical zone has been developed to provide recommendations for their protection and optimization of environmental management using the example of the Fatala River basin (Republic of Guinea)



A technology for assessing anthropogenic impact on basin ecosystems of the tropical zone has been developed to provide recommendations for their protection and optimization of environmental management using the example of the Fatala River basin (Republic of Guinea)

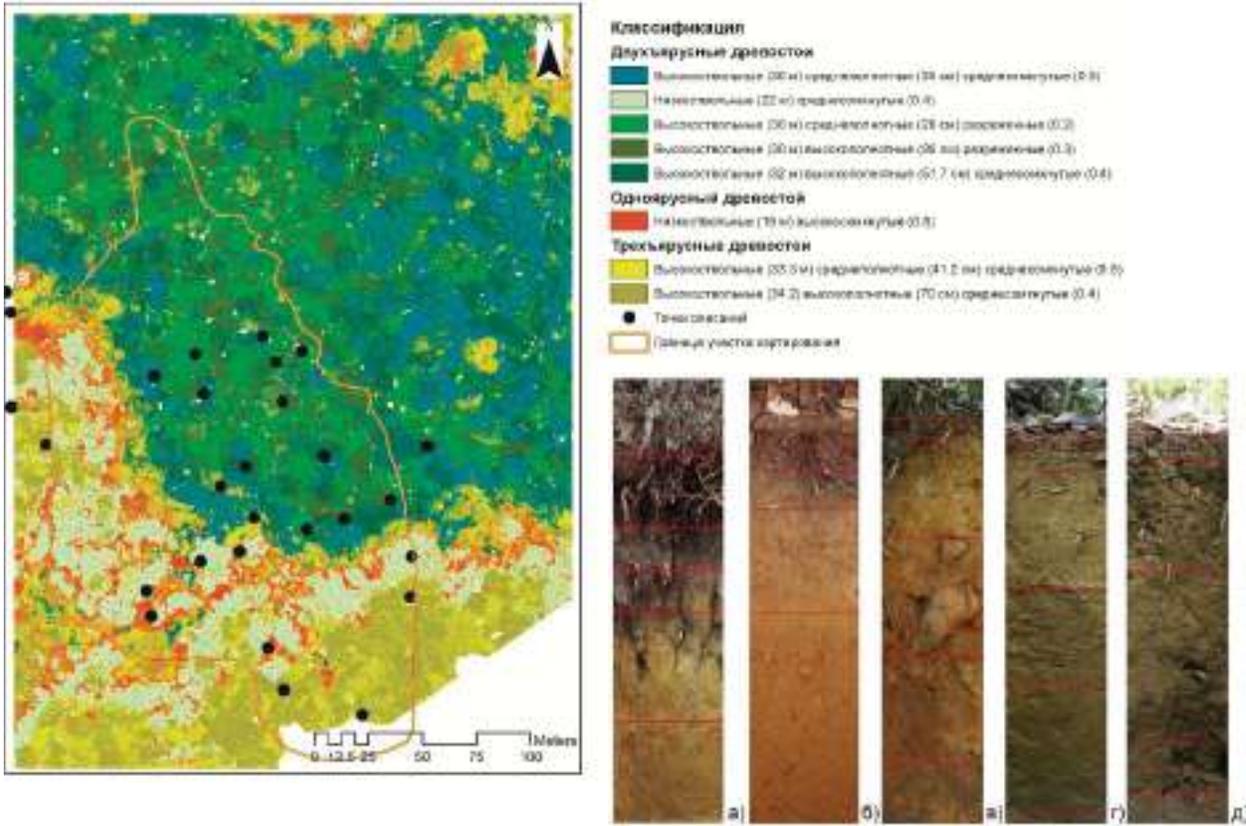


Bathymetric map of site 1 (Boffa-Pont de Fatala) of the Fatala River

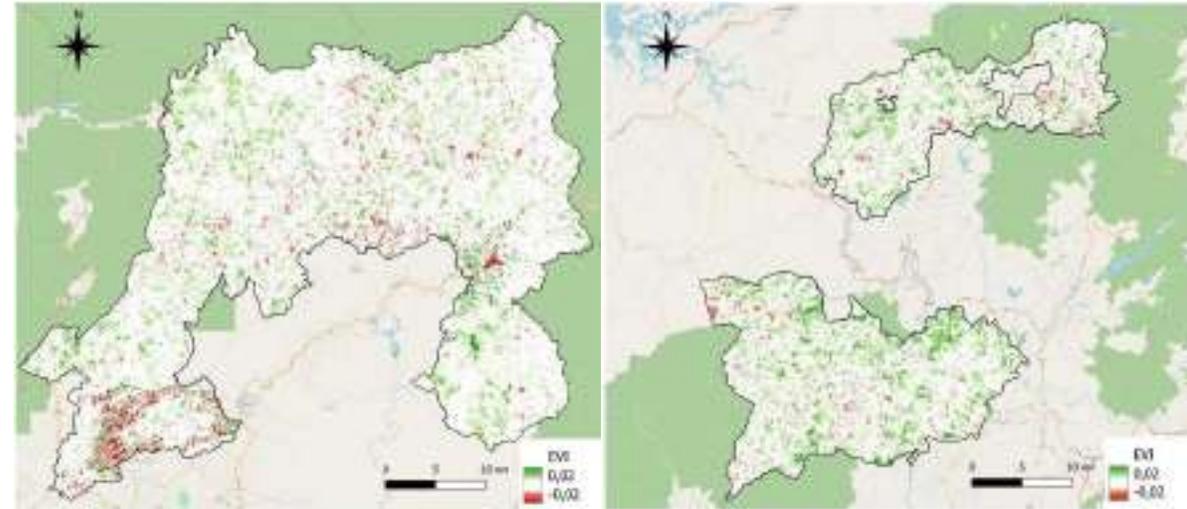


Fersialitic soils are powerful low-humus sandy loam, strongly skeletal on a stony-blocky deluvium of siltstone, fine-grained sandstones and mudstones

Within the framework of Vietnamese program approaches to the geocological assessment of tropical forest landscapes based on ideas about their functioning and dynamics has been developed .

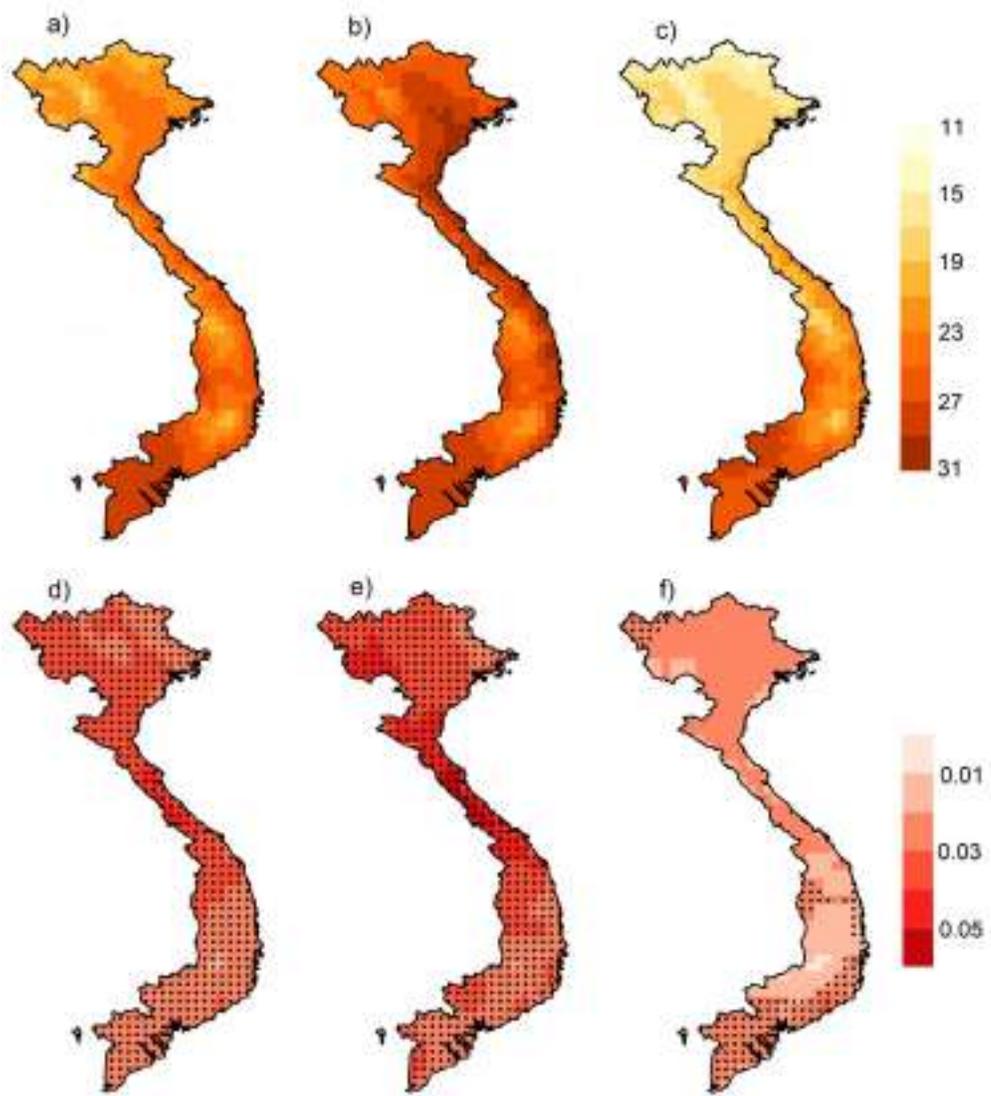


1. As a result of the use of unmanned aerial photography in combination with traditional methods, effective landscape mapping in mountainous rainforests has been achieved, and the limitations of existing cartographic materials have been overcome.
2. As a result of the expedition research in the Bidup-Nuiba National Park, new data on the structure and functioning of mountain tropical forest ecosystems at the topological level were obtained, and the Bidup Landscape and Ecological monitoring station was established.

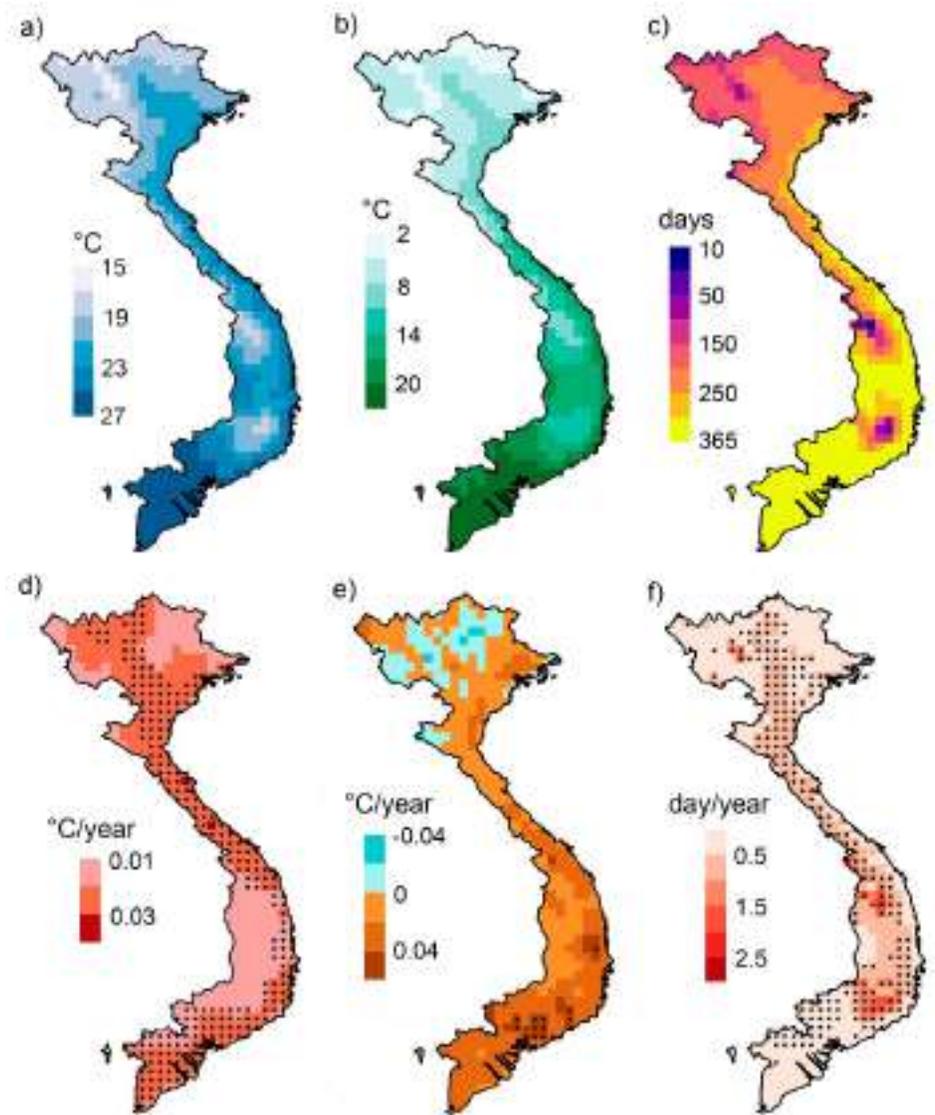


Vegetation changes in Bidup Nuiba and Cat Tien National Parks from 2015 to 2024

3. The key role of crown relief in the differentiation of solar radiation fluxes has been revealed; the subsurface space of forest ecosystems in both seasons demonstrates a negative radiation balance due to high values of effective radiation; seasonal changes and morphometry of crown relief have a significant impact on energy processes in tropical forests.



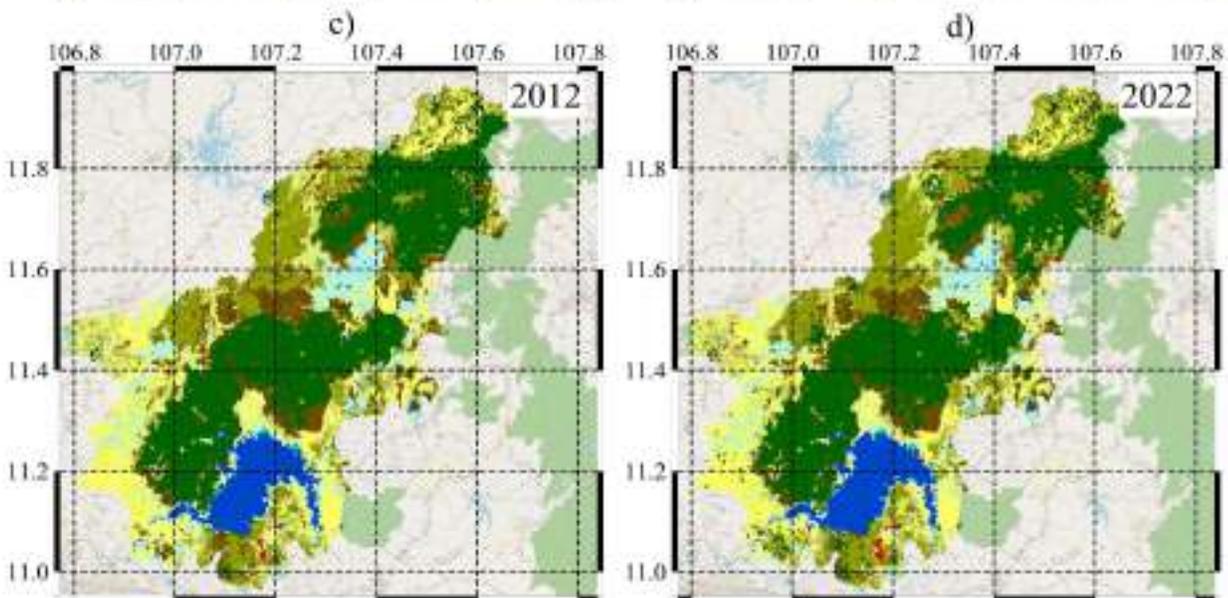
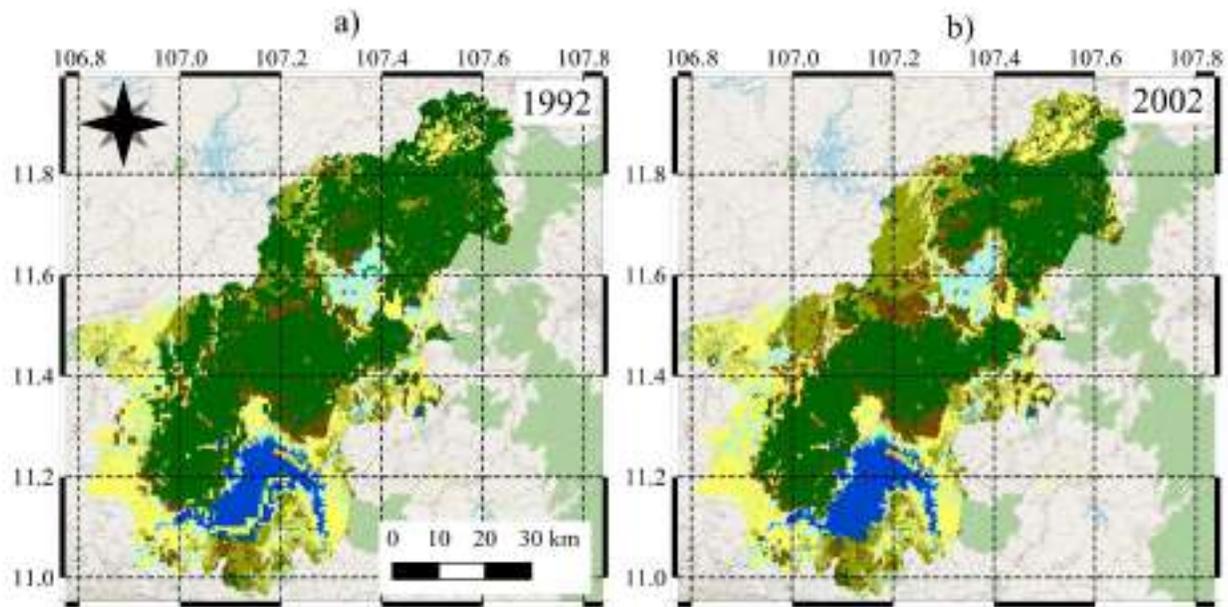
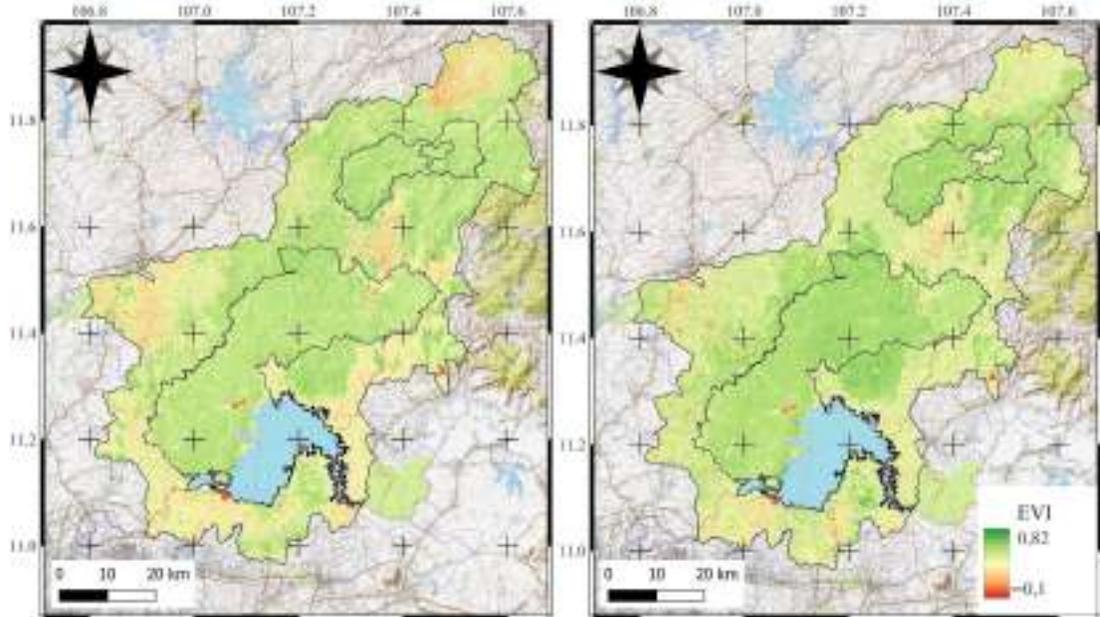
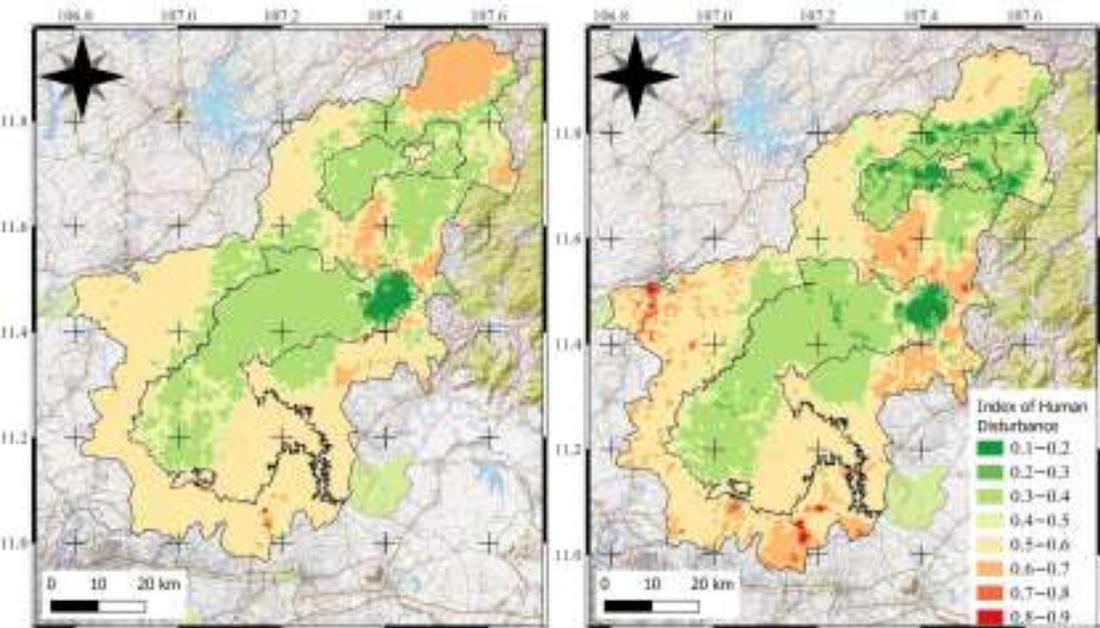
Average annual air temperature (a), average air temperature in summer (JJAS) (b) and winter seasons (DJBM) (c) and trends in °C/year (d-f, respectively). The black dots correspond to statistically significant trends ( $p < 0.05$ )



Spatial maps of minimum air temperature (a), TNn index (b) minimum minimum temperature, and TR index, tropical nights (c) and their trends (d-f, respectively) for the period 1991-2024

2000

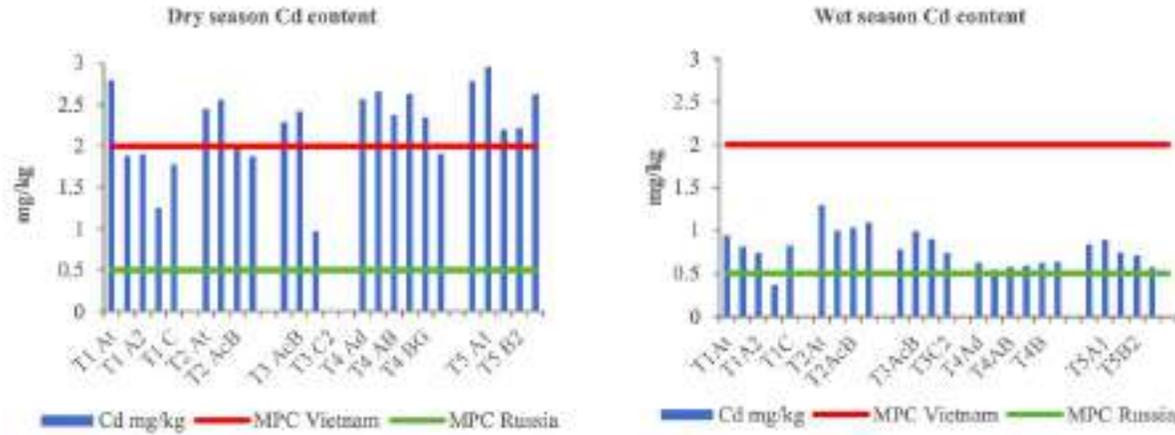
2024



Land cover CCI



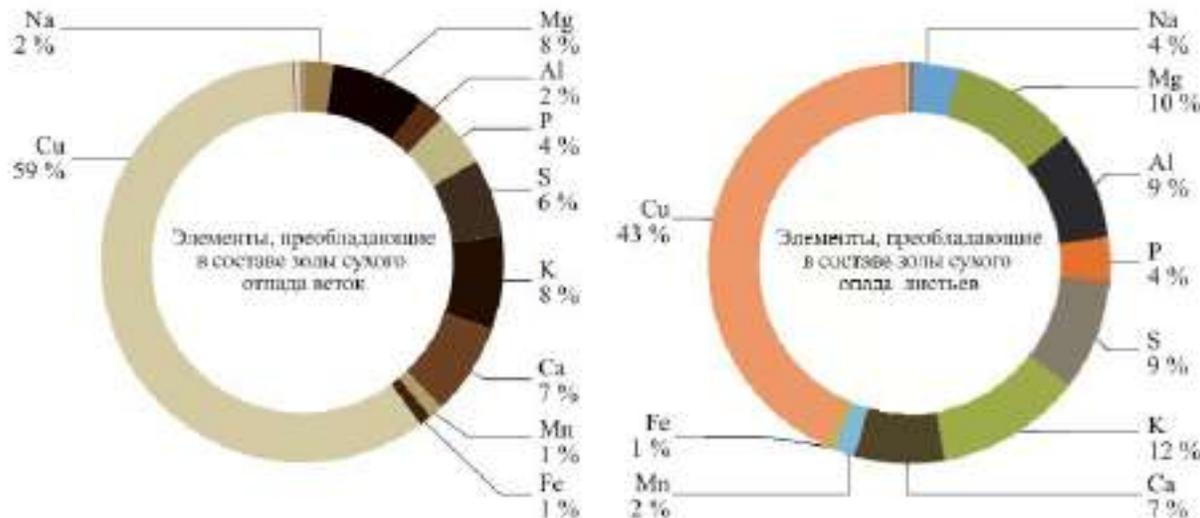
Studies of the content of heavy metals in the soils of the Bidup-Nuiba National Park have been carried out. Vertical and horizontal (catenary) migration of chemical elements in the soils of Bidup-Nuiba National Park has been studied



**Химические свойства желтозёма маломощного оподзоленного супесчано-суглинистого лессивированного на каолиновой коре выветривания (Т1)**

Горизонт	Элементы												
	pH H <sub>2</sub> O	K мг/кг	Mg мг/кг	Ca мг/кг	Si г/кг	Al г/кг	Fe г/кг	Ti мг/кг	Mn мг/кг	Cu мг/кг	Zn мг/кг	Sr мг/кг	Pb мг/кг
At	4,5	342,6	199,0	33,03	3,80	5,01	1,51	69,65	11,04	3,09	9,91	2,27	6,20
A1	5,1	404,0	2229,0	114,4	0,56	49,20	36,92	491,6	105,0	11,85	109,9	5,18	34,45
A2	4,9	179,5	170,0	23,49	0,24	14,22	2,64	20,46	12,30	1,39	12,01	2,36	18,91
B	5,8	628,2	354,0	3,20	1,69	32,35	30,85	17,57	15,14	5,38	12,81	3,49	50,91
C	6,7	893,2	262,0	0,86	8,16	25,87	27,77	4,90	38,32	11,41	19,91	4,43	62,61

The dynamics of the ash content of the mortmass and the migration of elements in the Bidup-Nuiba National Park have been studied.



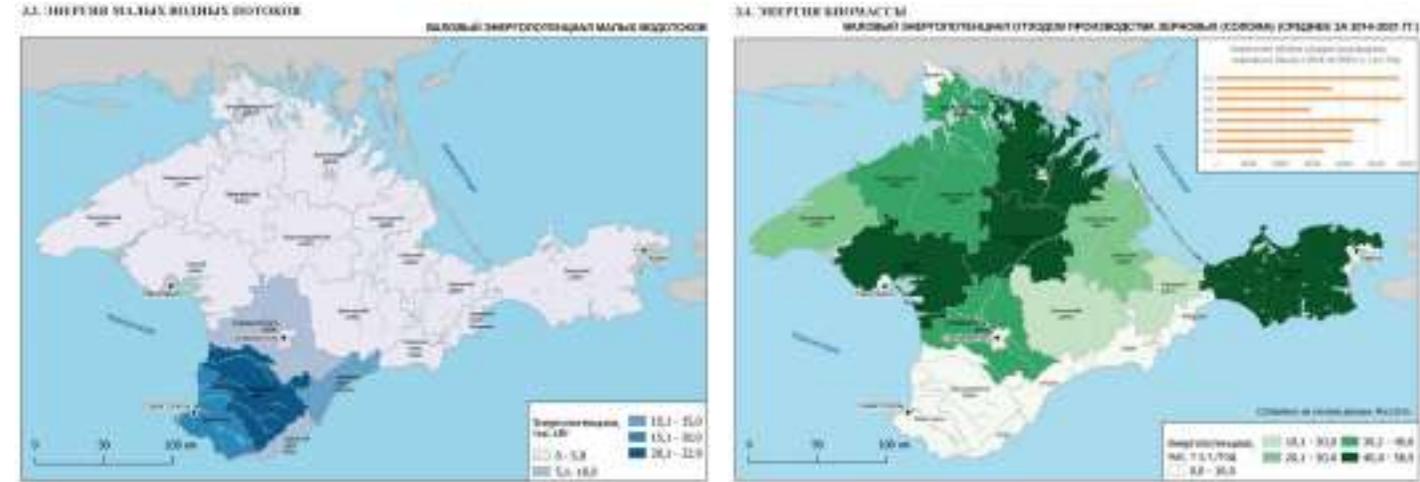
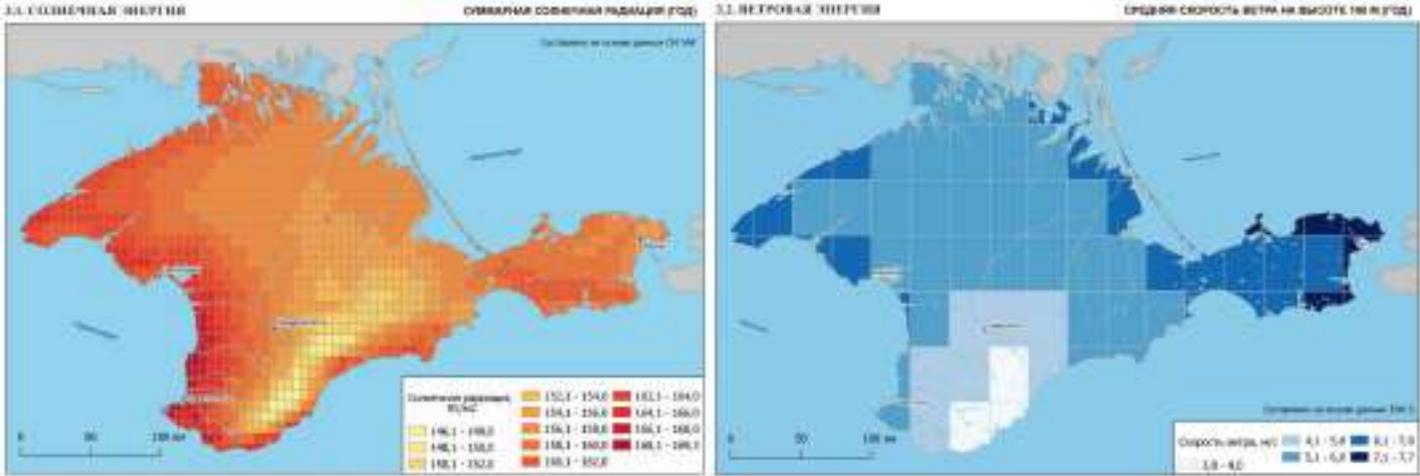
The seasonal biogeochemical migration of elements in the soil-plant system has been studied using the example of bamboo in Bidup-Nuiba National Park.



**Based on the landscape approach, a methodology for assessing the potential of coastal landscapes for various types of environmental management are formulated. An Atlas of the Renewable Energy potential of the Crimean Peninsula and an Atlas of promising areas for the development of aquaculture in the Republic of Djibouti have been created.**

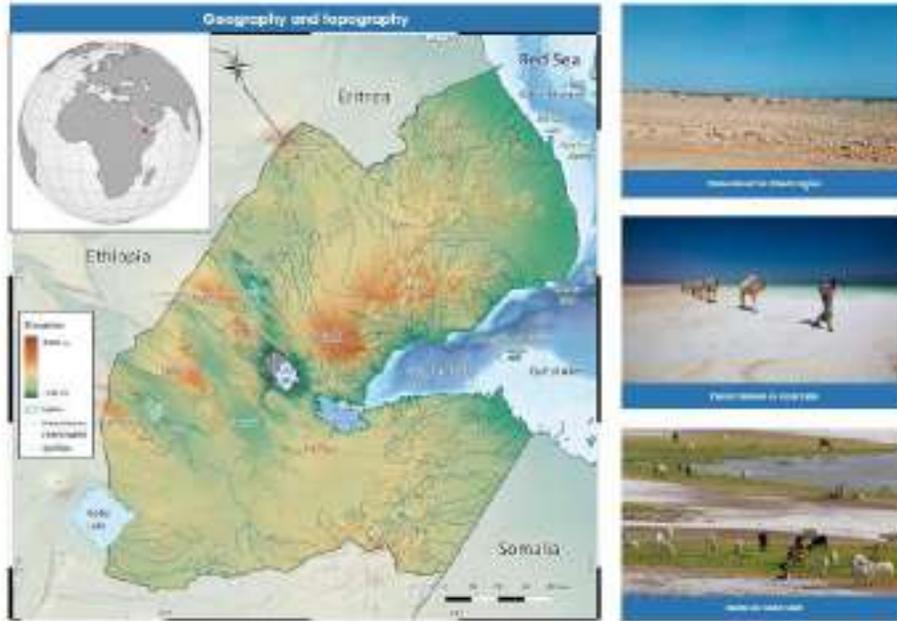


The concept of landscape potential for the use of renewable energy systems is formulated as an integral function of the natural, technical and geoecological potentials of the landscape. Landscape potential for the use of renewable energy systems is understood as the ability of the landscape to perform the function of energy supply, taking into account natural resources, the current level of technological development, as well as existing technical and geoecological restrictions on the use of the territory.



# An atlas of promising areas for the development of aquaculture in the Republic of Djibouti has been created

Atlas of Prospective Sites for Mammalian Development in the Republic of Djibouti



## ARTA REGION



### General Characteristics

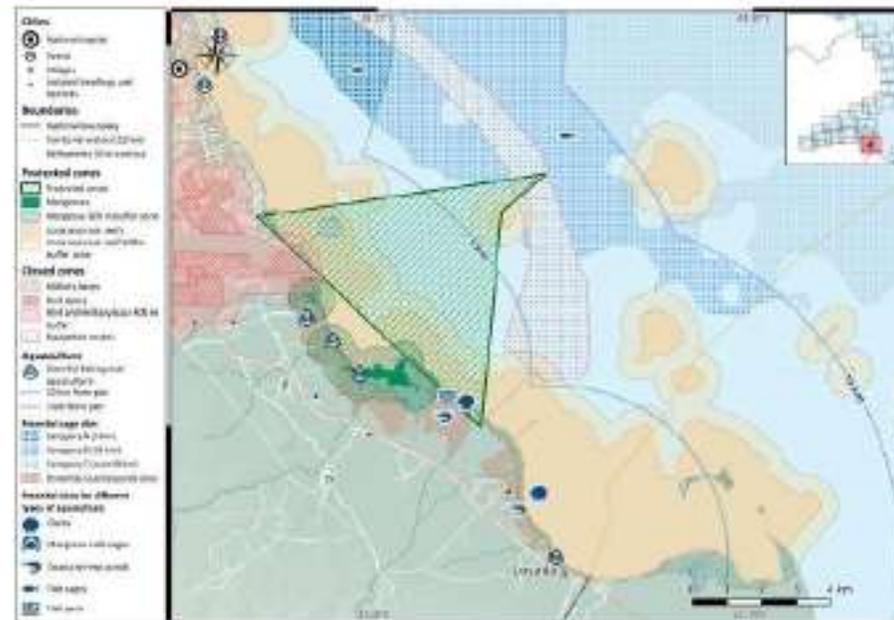
ARTA region is situated in the south-center of the country, bordering the Djibouti region to the north, the Obock region to the north-east, the Dikhil region and the Al Taleh region to the south, the country of Somalia to the east. The main town of the region is Arta which is located on a plateau in the ARTA Mountains, 200 m above sea level. The region has only one coastal town (Tadjourah). Other towns include Gheray, Chibkey and Maki. The highest mountain in the region is the mountain of ARTA, the elevation of ARTA town in 2003 accounts 1240 m (4068 ft), and overall, in the region live approximately 42,000 people.



### Climate types

The landscape of the ARTA region consists mountains, coastal and highlands, and coastal lowlands on the north and small mountainous areas on the east. The region has large areas of semi-desert, with sparse and short grasses and scrub vegetation. The main river in the region extends approximately in 50 km. The northern coastal part of the region has the border of different regions in Djibouti as it is relatively abundant area, with rocky steep slopes, and military large settlements and fishermen villages. Only isolated Arta towns with military camps.

Atlas of Prospective Sites for Aquaculture Development in the Republic of Djibouti





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