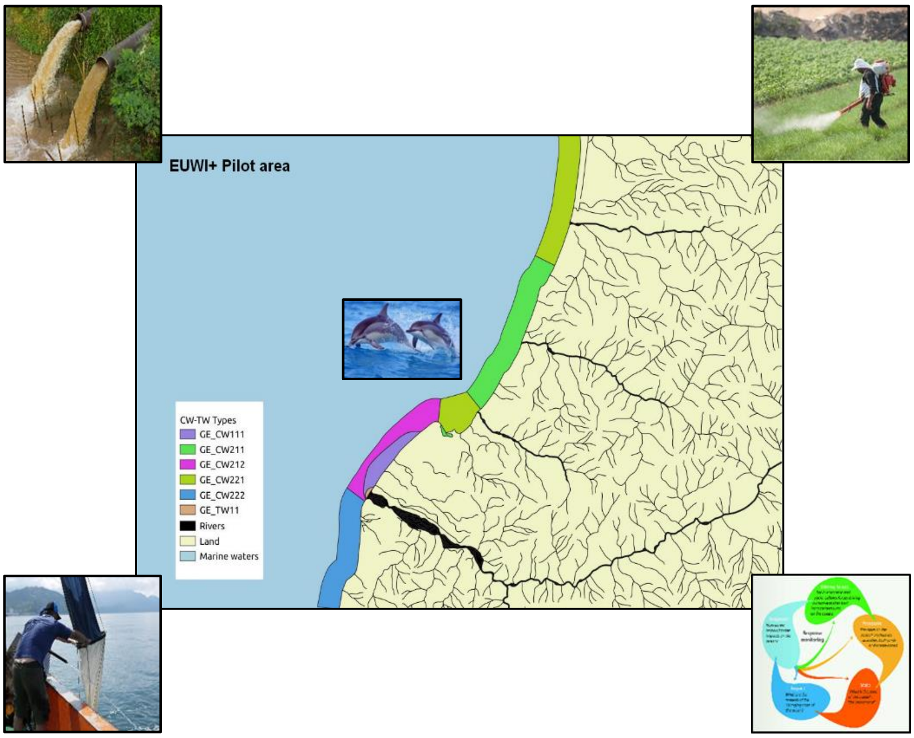
European Union Water Initiative Plus for
Eastern Partnership Countries (EUWI+): Results 2 and 3

ENI/2016/372-403

APPENDIX TO THE DRAFT RIVER BASIN MANAGEMENT PLAN OF THE CHOROKHI-AJARISTSKALI RIVER BASIN OF GEORGIA: COASTAL AND TRANSITIONAL WATERS



June 2021 Tbilisi

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Imprint
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Contents

EXECUTIVE SUMMARY

Chorokhi-Ajaristskali RBMP Coastal and Transitional Waters 1

BACKGROUND

Introduction 3

1 Importance of CTWs for RBMPs in the WFD... 3

2 River and marine basins and coastal strategies, plans and initiatives of relevance 4

3 Document outline 6

GENERAL CHARACTERISTICS OF COASTAL AND TRANSITIONAL WATERS

1 Baseline conditions 8

1.2 Natural characteristics of coastal and transitional waters 8

1.2.1 Morphological and geological characteristics 8

1.2.2 Climate 10

1.2.3 Hydrography 12

1.2.4 Physico-chemical characteristics of Georgian coastal waters 16

1.2.5 The Black Sea Coast and Biodiversity of Transitional Waters 21

1.2.5.1 Habitats and biodiversity of internal and transitional waters 21

1.2.5.2 Protected areas 23

1.2.5.3 Marine habitats and biodiversity 24

COASTAL AND TRANSITIONAL WATER BODIES

2 Chorokhi-Ajaristskali Basin Coastal & Transitional Waters 33

2.1 Methodology for delineation of coastal and transitional water bodies 33

2.1.1 Transitional waters 34

2.1.2 Coastal waters 35

2.2 Identified Coastal and Transitional Water bodies in the EUWI+ pilot area................ 36

SIGNIFICANT PRESSURE-IMPACT ISSUES AND WATER BODIES AT RISK

3 Risk analysis of significant pressure-impacts for coastal & transitional waters .. 38

3.1 Methodology.. 38

3.2 Drivers and types of pressures specific for the Black Sea 40

3.2.1 Screening of drivers and respective pressures 40

3.2.2 Significant pressures 45

3.2.2.1 Pollution and eutrophication of coastal & transitional waters from diffuse sources 45

3.2.2.2 Pollution and eutrophication of coastal & transitional waters from point sources .. 56

3.2.2.3 Hydromorphological pressures/drivers 72

3.2.2.4 Significant pressures/drivers on biological parameters 75

3.3 Significant impact on coastal and transitional waters 78

3.3.1 Impact on physico-chemical quality elements of coastal & transitional waters 78

3.3.2 Impact on hydro morphological quality elements... 116

3.3.3 Impact on biological characteristics 117
3.4 Water Bodies at risk 128
3.4.1 Coastal and transitional water bodies under the risk of pollution 128
3.4.2 Coastal & transitional water bodies under hydro morphological risk 131
3.4.3 Water bodies at risk due to biological impact 132
PROGRAMME OF MEASURES
4 Programme of Measures for coastal & transitional waters 133
MONITORING COASTAL AND TRANSITIONAL WATERS
5 Monitoring Programme for coastal and transitional waters 145
COMPETENT AUTHORITIES
6 Competent Authorities for Coastal and Transitional Waters 150
PUBLIC CONSULTATIONS
7 Stekeholder Consultation Report 151
References 170

Abbreviations

APA	Agency of Protected Areas of Georgia
AR	Autonomous Republic
AMBI	Azti Marine Biotic Index
BAS	Bulgarian Academy of Sciences
BENTIX	BENthic IndeX
BG	2-letter country code for Bulgaria
BOD	Biological Oxygen Demand
BWM	Ballast Water Management Convention
CEA	Cost-Effectiveness Analysis
CENN	Caucasus Environmental NGO Network
COD	Chemical Oxygen Demand
CWB	Coastal Water Bodies
DO	Dissolved Oxygen
DoE Ajara	Department of Environment and Natural Resources of Ajara AR
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ESA	European Space Agency
EIA	Environmental Impact Assessment
EMIS	European Seas Environmental Marine Information System
EMODnet	European Marine Observation and Data Network
EMP	Environmental Management Plan
EPIRB	Environmental Protection of International River Basins
Espoo	Environmental Impact Assessment in a Transboundary Context Convention
EU	European Union
EEI-c	Index
GE	2-letter country code for Georgia
GEL	Georgian Lari
GES	Good Ecological/Environmental Status
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HPP	Hydro Power Plant
ICZM	Integrated Coastal Zone Management
IMO	International Maritime Organisation
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature
LAWA	Länder-Arbeitsgemeinschaft Wasser (http://www.lawa.de)
m-AMBI	Multivariate Azti Marine Biotic Index
MARPOL	International Convention for the Prevention of Pollution from Ships
MDF	Municipal Development Fund
MEC	Microflagellates, Euglenaflagellates, Cyanophyta phytoplankton index (in %)
MODIS	Moderate Resolution Imaging Spectroradiometer
MEPA	Ministry of Environmental Protection and Agriculture of Georgia
MoEF Ajara	Ministry of Economy and Finance of Ajara AR
MoESD	Ministry of Economy and Sustainable Development of Georgia
MSFD	Marine Strategy Framework Directive
MW	Megawatt
NASA	National Aeronautics and Space Administration
NEA	National Environmental Agency
NMES&AP	National Marine Environment Strategy and Action Programme of Georgia
NTU	Nephelometric Turbidity Unit

OSHAS	Occupational Health and Safety Assessment Series
O&M	Operation & Maintenance
PA	Protected Areas
PAR	Photosynthetically Active Radiation
PoM	Programme of Measures
SMP	Shoreline Management Plan
RO	2-letter country code for Romania
RU	2-letter country code for Russian Federation
RBMP	River Basin Management Plan
SWMP	Solid Waste Management Plan
TR	2-letter country code for Turkey
TWB	Transitional Water Bodies
UA	2-letter country code for Ukraine
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WFD	Water Framework Directive
WWTP	Waste Water Treatment Plant

Executive Summary

Chorokhi-Ajaristskali RBMP Coastal and Transitional Waters

The Chorokhi-Ajaristskali River Basin Management Plan (RBMP) was first developed within the EU-funded project Environmental Protection of International River Basins (EPIRB, 2016). The document, following the provisions of European Water Framework Directive (WFD),[1] considered Chorokhi-Ajaristskali catchment, including its inland surface, transitional, coastal and ground waters as the River Basin District, within which ecological and chemical status of the water bodies was determined, environmental objectives set and Programme of Measures developed under EPIRB project.

A long-term goal set for in RBMP was to protect surface and ground waters of the Chorokhi-Ajaristskali River Basin District from risks that undermine their ecological status through attaining a number of environmental quality objectives. In addition to this, according to EU Water Framework Directive, water bodies include the categories of *coastal* and *transitional* waters, which are defined in WFD as follows:

> *"Transitional waters" are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows."*
>
> *"Coastal water' means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters."*

The follow-on initiative "European Union Water Initiative Plus for Eastern Partnership (EaP) Countries (EUWI+)" supported Georgia to move towards the approximation to EU in the field of water management and further support was granted to update and upgrade the essential elements of the Chorokhi-Ajaristskali RBMP, such as its Coastal and Transitional Waters.

Chorokhi-Ajaristskali RBMP therefore provides for the Coastal and Transitional Waters in the Georgian coastal zone included to the Chorokhi-Ajaristskali River Basin District. The coastal zone concerned stretches from Sarpi to Kobuleti and it was selected in EUWI+ project as the project's pilot area in order to update this particular part of the RBMP.

Water quality and water management provisions (including marine environment) in the EU-Georgia Association Agreement (AA) of 2014,[2] entail range of actions and approximations towards WFD as well as Marine Strategy Framework Directive (MSFD). These Directives are yet to be transposed in Georgian legislation, but progress was made by drafting national water legislation, as well as National Marine Environment Strategy and Action Programme of Georgia (NMES&AP, 2020). Other relevant provisions in the AA worth mentioning are Maritime Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM). EU-Georgia AA is supportive of Georgia's commitments under regional agreements such as the

[1] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000L0060-20141120&from=EN

[2] Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Georgia, of the other part. L 261/4 Official Journal of the European Union 30.8.2014. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2014:261:FULL&from=EN

Bucharest Convention (1992)[3] and its Protocols, which are serving to prevent, control and reduce the pollution of the Black Sea.

It is within this context in which Coastal and Transitional Waters part of Chorokhi-Ajaristskali RBMP is being developed and updated with the support of European EUWI+ project.

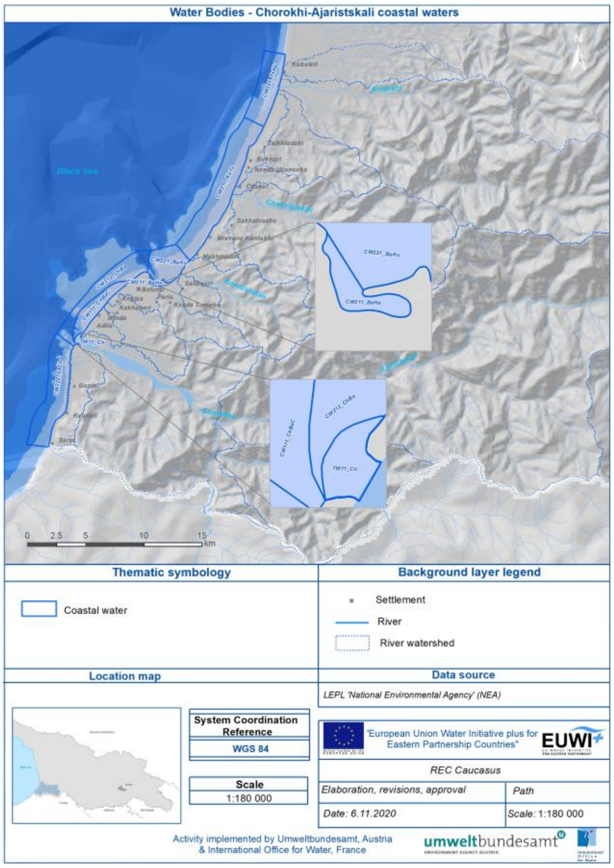

Fig. 1. Chorokhi-Ajaristskali River Basin Coastal and Transitional Waters

The first section is devoted to characterisation of baseline environmental conditions in coastal and transitional areas of basin, establishing environmental characteristics of coastal and transitional waters from hydrographical, physico-chemical and biological standpoints, marine and coastal biodiversity and habitats.

The second part maps coastal and transitional water bodies of Chorokhi-Ajaristskali Basin District and presents methodology applied to water body delineation process.

The third part is concerned with identification of the main drivers and significant pressure-impacts at defined coastal and transitional waters, such as such as eutrophication loads and pollution of coastal and transitional waters from diffuse sources, from point sources, significant pressures, drivers and impacts on hydromorphological systems and on biological quality elements.

The fourth part of the document is devoted to identifying Programme of Measures (PoM) for coastal and transitional water bodies of Chorokhi-Ajaristskali River Basin District. It provides for the methodological part, including ranking as applied to PoM, which is finally presented in the form of the two comprehensive tables addressing separately the measures proposed for *coastal* and for *transitional* water bodies. PoM priorities are finally defined through scoring and ranking combining the following factors: ecological effectiveness, time-span, investment needs, O&M costs, and indirect cost factors. Responsible lead stakeholders are named for each measure, as well as overall costs are estimated entailing implementation of the Coastal and Transitional Waters part of the Chorokhi-Ajaristskali RBMP.

The fifth part details programme for monitoring Georgian coastal waters, specified in PoM as one of the most important actions towards the long-term monitoring of ecological status in the coastal and transitional waters of Chorokhi-Ajaristskali River Basin District.

The sixth part of the report provides for institutional arrangements in harmonisation with WFD provisions, defining the Competent Authorities well as other coordinating authorities at all levels of governance from local to national and even international, where applicable.

The seventh final section reports on public consultation results as reflected in this document.

[3] Convention on the Protection of the Black Sea Against Pollution 1992 (Bucharest Convention) http://www.blacksea-commission.org/_convention-fulltext.asp.

Background

Introduction

The first RBMP in Georgia, Chorokhi-Ajaristskali River Basin Management Plan (hereinafter the River Basin Management Plan or RBMP), was developed within the EU-funded project Environmental Protection of International River Basins (EPIRB, 2012-2016). The document, to the extent feasible, was elaborated following the provisions of the Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (EU Water Framework Directive. Or WFD).[4]

For the purpose of effective basin management, Chorokhi-Ajaristskali River basin, including its inland surface, transitional, coastal and ground waters, was considered as River Basin District, a territorial unit within which ecological and chemical status of the water bodies has to be determined, respective environmental objectives set, and a Programme of Measures developed under EPIRB project for implementation, with further monitoring and evaluation.

The follow-on initiative "European Union Water Initiative Plus for Eastern Partnership (EaP) Countries (EUWI+)" involves six eastern neighbours of the EU including Georgia. The EUWI+ project addresses existing challenges in both development and implementation of efficient management of water resources. It specifically supports the EaP countries to move towards the approximation to EU acquis in the field of water management as identified by the EU Water Framework Directive (WFD). In Georgia, among other actions, support was granted to upgrade and update the essential elements of the Chorokhi-Ajaristskali RBMP.

1 Importance of CTWs for RBMPs in the WFD

The purpose of the WFD is defined in the Directive in the following manner:

> ***Article 1 Purpose***
> *The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:*
> *(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;*
> *(b) promotes sustainable water use based on a long-term protection of available water resources;*
> *(c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;*
> *(d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and*
> *(e) contributes to mitigating the effects of floods and droughts*
> *and thereby contributes to:*
> *- the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use,*
> *- a significant reduction in pollution of groundwater,*
> *- the protection of territorial and marine waters, and*
> *- achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community action under Article 16(3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.*

[4] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000L0060-20141120&from=EN

A long-term goal set for in RBMP was to protect surface and ground waters of the Chorokhi-Ajaristskali River Basin District from risks that undermine their ecological status through attaining a number of environmental quality objectives.

Further on, according to EU Water Framework Directive, water bodies include the categories of coastal and transitional waters, which are defined in the following way:

> ***Article 2 Definitions***
>
> *6. "Transitional waters" are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows."*
>
> *7). "Coastal water' means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters."*

Importantly, as prescribed by EU WFD, the Chorokhi-Ajaristskali RBMP contained provisions for the "Coastal and Transitional Waters" (CTW) related to the Georgian coastal zone of the Chorokhi-Ajaristskali River Basin District, which was appended to RBMP. The coastal zone part of Georgia concerned stretches from Sarpi to Kobuleti.

This area was again selected in EUWI+ project as the project's pilot area for coastal and transitional waters in Georgia. Among different performed actions within the EUWI+ project, foreseen was an update of the existing Appendix ("Coastal and Transitional waters") of the Chorokhi-Ajaristskali River Basin Management Plan.

This volume is also appended to Chorokhi-Ajaristskali River Basin Management Plan and is devoted to updated management arrangements for the downstream portions of river basin district – Coastal and Transitional Waters – referred to in Articles 2(6) and 2(7) of WFD. These water categories are at the load-receiving end of river basins, and their ecological status can thus be considered as an indicator of the health of ecosystems in the entire catchment.

2 River and marine basins and coastal strategies, plans and initiatives of relevance

There are range of other legal instruments, strategies and plans developed and/or are under development in Georgia, which complement and enhance the achievement of the objectives set forth in the Chorokhi-Ajaristskali RBMP and its annexed arrangements for CTW bodies.

Strong impetus towards improved environmental governance in Georgia was indeed provided by EU-Georgia Association Agreement of 2014,[5] namely, with regard to water quality and resource management including marine environment.

In particular, with respect to WFD the following provisions should be applied by Georgia:
- Adoption of national legislation and designation of competent authority/ies, in four years;
- Identification of river basin districts and establishment of administrative arrangements for international rivers, lakes and coastal waters (Article 3(1) to 3(7)), in four years;
- Analysis of the characteristics of river basin districts (Article 5), in five years;
- Establishment of programmes for monitoring water quality (Article 8), in eight years;
- Provisions related to surface water shall be implemented, in six years;
- Preparation of river basin management plans, consultations with the public and publication of these plans (Articles 13 and 14), in ten years.

[5] Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Georgia, of the other part. L 261/4 Official Journal of the European Union 30.8.2014. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2014:261:FULL&from=EN

The Water Framework Directive (WFD) has not been transposed yet, however, a new draft Law on Water Resources Management, based on its principles, has been drafted and it is currently in the process of adoption. It introduces the river basin management planning cycle and the objective of the prevention of any deterioration in the existing status of waters, in order to achieve good ecological and chemical status, in compliance with the WFD requirements. It is in this context that RBMP are being developed, such as the Chorokhi-Ajaristskali RBMP.

Further, EU-Georgia Association Agreement in its Article 309, in particular, requires the approximation of Georgian legislation with the Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy (or Marine Strategy Framework Directive), implementing the following:

- Adoption of national legislation and designation of competent authority/ies (in 3 years)
- Initial assessment of marine waters, determination of good environmental status and establishment of environmental targets and indicators (in 5 years)
- Development of a marine strategy (in 8 years).

This document entitled the Proposal for a National Marine Environment Strategy and Action Programme of Georgia (NMES&AP, Final Draft, July 2020) was already prepared as part of the EuropeAid project “Support to implementation of the environmental provisions of the EU-Georgia Association Agreement”. The strategy and action programme, proposed in this document, run until 31 December 2027. Its aim is to plan and implement further measures to ensure the achievement and maintenance of a good environmental status of Georgia’s part of the Black Sea, according to the requirements of the EU Marine Strategy Framework Directive. Provisions of this document are therefore harmonised with and actively utilised when developing CTW Appendix to the Chorokhi-Ajaristskali RBMP.

EU-Georgia Association Agreement in its Article 339 also refers to promoting Maritime Spatial Planning (MSP) as a tool contributing to improved decision-making for arbitrating between competing human activities, in line with the ecosystem approach, as well as to promoting Integrated Coastal Zone Management (ICZM), in line with the ecosystem approach, to ensure sustainable coastal development and to enhance the resilience of coastal regions to coastal risks including the impacts of climate change.

Worth underlining in this respect is the recent endorsement by Georgia and other Black Sea countries their commitment towards the development of the sustainable blue economy in the Black Sea, expressed in the Ministerial Declaration on Common Maritime Agenda for the Black Sea (May, 2019) and supported by the Strategic Research and Innovation Agenda for the Black Sea,[6] as these documents also establish clear framework for cooperation with EU.

Above agreements with the EU are indeed supportive of Georgia’s commitments under the regional framework such as the Bucharest Convention, to which Georgia is signatory since 1992.[7] The main purpose of the Convention and its Protocols is to prevent, reduce and control the pollution of the Black Sea to protect and preserve its marine environment and provide a legal framework for co-operation and concerted actions.

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6 https://ec.europa.eu/maritimeaffairs/press/black-sea-ministers-endorse-common-maritime-agenda_en.

7 Convention on the Protection of the Black Sea Against Pollution 1992 (Bucharest Convention) http://www.blacksea-commission.org/_convention-fulltext.asp.

The Black Sea Strategic Action Plan (BS SAP) 2009 is an agreement between the six Black Sea Coastal States (Bulgaria, Georgia, Romania, the Russian Federation, Turkey and Ukraine), prescribed by the Bucharest Convention, aiming at the protection and recovery of the Black Sea environment.[8] According to regional BS SAP Article 3.1, key ecosystem-based environmental management approaches promoted in the Black Sea Basin are the Integrated River Basin Management (IRBM) and Integrated Coastal Zone Management (ICZM).

Of particular relevance for the RBMP process notably is the Bucharest Convention's updated Protocol on the Protection of the Marine Environment of the Black Sea from Land-Based Sources and Activities (2009). The combined application of ICZM and IRBM is affirmed as an obligation in this Protocol, which is urging countries (Article 4f) 'to endeavour applying the integrated management of coastal zones and watersheds'.[9]

Important document in the ICZM field, produced at the regional level and entitled Guideline on Integrated Coastal Zone Management in the Black Sea[10], was approved on 12-13 October 2016 by the 32nd Meeting of Black Sea Commission - the regional intergovernmental body in charge of implementation of the Bucharest Convention, successfully fulfilling an action in the field of ICZM, specified in the regional strategic action plan BS-SAP 2009.

As for the national initiatives, draft Law of Georgia on Integrated Coastal Zone Management[11] prepared with support of the World Bank and GEF funded project merits mentioning, the draft law was submitted to the Ministry of Environment Protection and Natural Resources in 2005. Follow-up ICZM Strategy for Georgia[12] was developed in 2010 with EuropeAid project support and submitted in March 2010 to Ministry for governmental endorsement, though adoption of these two documents remain pending.

Worth mentioning in the context of this document is the legislation of Georgia on spatial planning and urban development (2005), now superseded by the Code of Georgia on Spatial Planning, Architectural and Construction Activities (adopted on 20 July 2018). This legislation provided and provides impetus to central and local authorities to prepare and approve several municipal spatial plans in coastal area concerned in this document. Despite incompatibility with certain integrated management principles stipulated by WFP (e.g. land-sea integration), preparation of such plans for Batumi (approved, under review), Kobuleti municipality, spatial scheme for Autonomous Republic of Adjara (approved) are all welcome initiatives.

Recently adopted Environmental Assessment Code and its Strategic Environmental Assessment (SEA) statutes in particular (in force since 01 July 2018), mandatorily subjects spatial and other strategic documents to SEA procedure, which is yet another requirement of the EU-Georgia Association Agreement implemented with success. Actually, RBMPs would have to be subjected to SEA as well, provided the WFD-compatible national water legislation mandates their preparation, once adopted.

3 Document outline

The document is presented in seven interconnected sections. The first section is devoted to characterisation of baseline environmental conditions in coastal and transitional areas of the basin. At the outset it starts by establishing the environmental characteristics of coastal and

[8] Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea (2009) http://www.blacksea-commission.org/_bssap2009.asp.

[9] Protocol on the Protection of the Marine Environment of the Black Sea from Land-Based Sources and Activities (2009) http://www.blacksea-commission.org/_convention-protocols.asp.

[10] http://www.blacksea-commission.org/Downloads/Black_Sea_ICZM_Guideline/Black_Sea_ICZM_Guideline.pdf.

[11] http://sites.google.com/site/iczmgeo/Home/20050412-e-draft-ICZM-Law-GEORGIA.pdf.

[12] https://sites.google.com/site/iczmgeo/Home/20100322_Draft_ICZM_Strategy_GEORGIA_ENG.pdf.

transitional waters from hydrographical, physico-chemical and biological standpoints. The baseline part further concludes with the presentation of the marine and coastal biodiversity, habitats and current conservation status descriptions.

The baseline characterisation culminates in the second section with concise and focused mapping of coastal and transitional water bodies of Chorokhi-Ajaristskali Basin District, including the detailed presentation of the methodology applied to water body delineation process.

The third part is concerned with the identification of main drivers and significant pressure-impacts at defined coastal and transitional waters, and related risk analysis following the DPSIR framework, in which the key pressures, drivers and impacts are addressed, such as eutrophication and pollution of coastal and transitional waters from diffuse sources, from point sources, significant pressures/drivers and impacts on hydromorphological subsystems and on biological quality elements. Applied DPSIR framework allowed the spatial characterisation and assessment of water bodies at risk against above-mentioned factors (diffused and point sources of pollution, hydromorphology and biology). This section is completed with the indicator map of coastal and transitional water bodies under risk from combined impacts.

Part four of this volume is devoted to identifying Programme of Measures (PoM) for coastal & transitional water bodies of Chorokhi-Ajaristskali River Basin District, applying the same methodology in defining PoM priorities as in the rest of the catchment. The section starts first with the methodological part, summarising the PoM method as well as providing master ranking threshold tables used for defining priorities in the Programme of Measures. PoM is presented further in the form of the two comprehensive tables addressing separately the measures proposed for coastal and for transitional water bodies. Indeed, issues identified in the baseline description and impact analysis parts are consulted to define coherent set of status/issues and objectives part of the PoM matrix/table, transparently linking to identified response actions in the form of the basic and supplementary measures. Priority setting is defined at the end through integral ranking of the expert scoring of the following five factors at identified measures: ecological effectiveness, time-span, investment needs, O&M costs, and indirect cost factors. Responsible lead stakeholders are named for each measure.

Part five of the report specifies the programme for monitoring Georgian coastal waters attempting to match WFD requirements (and to integrate with MSFD requirements, to the extent possible). This part indeed defines Monitoring Programme for coastal and transitional water bodies, which is indispensable for the future iterations of the planning effort against the sound measurement and long-term monitoring of chemical and ecological status in the coastal and transitional waters of Chorokhi-Ajaristskali River Basin District.

The next sixth part of the report provides for institutional setup for successful implementation of this document in harmonisation with WFD provisions, defining the Competent Authority as well as other coordinating authorities and organisations and the modalities for coordination and networking necessary for the implementation of this document all implementation levels, local, national and even international where applicable.

The final section reports on details of public consultations held and results as taken up and reflected in this document.

General Characteristics of Chorokhi-Ajaristskali River Basin Coastal and Transitional Waters

1 Baseline conditions

1.2 Natural characteristics of coastal and transitional waters

1.2.1 Morphological and geological characteristics

Geomorphology, morphodynamics. Coastal and transitional waters of Chorokhi-Ajaristskali River basin are part of the Black Sea coastline of Ajara Autonomous Republic. Ajara AR Black Sea coastline stretches from to Georgian-Turkish border to the mouth of the River Natanebi, which is a 50 km-long, slightly curved arc-shaped section. It is mainly represented with sand pebble beaches of various width and old, alongshore line of sand pebble levees. The latter consists of modern and old embankments and is a significant geomorphological element of the coastline. Small steep rocky (with precipices) coastal districts without beaches can be found occasionally. These are coastal areas of Tsikhisdziri, Mtsvane Kontskhi and Kalenderi headland located in the north of Georgian-Turkish border.

Accumulative coastline of Ajara is almost completely formed by alluvial sediments and belongs to Chorokhi morphodynamic system. According to morphodynamic-morphometric characteristics, coastline of the region can be divided into three, more or less independent sub-systems:

1. Kvariati-Batumi Cape,
2. Batumi-Tsikhisdziri Cape, and
3. Tsikhisdziri Cape - Natanebi River Mouth.

Sub-systems are distinguished with more or less variety of independent sections.

In the first sub-system, there are the following districts:

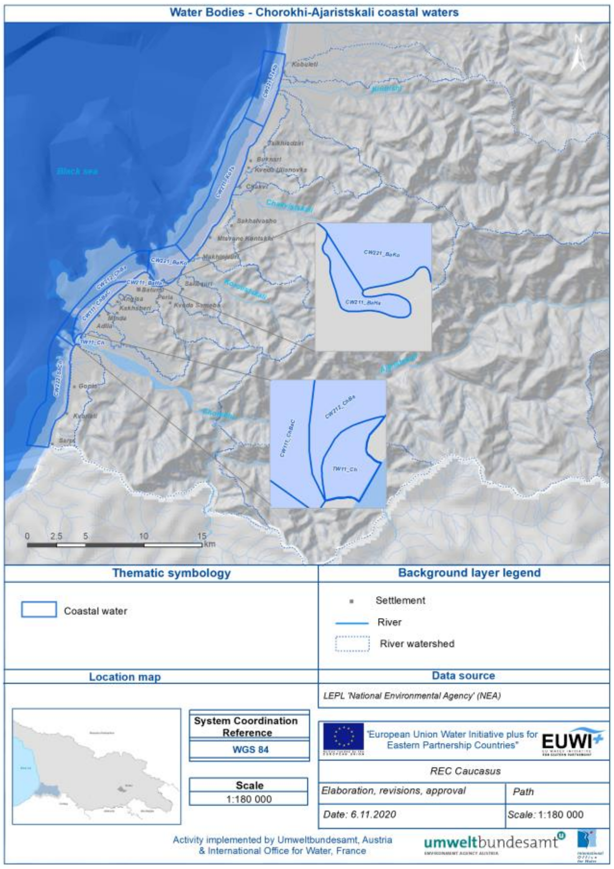

Fig. 1.1. Chorokhi-Ajaristskali River Basin Coastal and Transitional Waters

1.1) Sarpi coastline between Kalenderi (Georgia) and Semjum (Turkey) rocky capes created from their abrasive sediments;
1.2) Kvariati – created as a result of the Chorokhi River sediments and Kalenderi cape abrasive materials – coastline of Chorokhi River (5 km);
1.3) Adlia coastline, that is erosive and dynamically misbalanced as a result of reduced granulometry of the Chorokhi River (from Chorokhi River mouth up to the territory of Batumi shipbuilding plant).
1.4) Batumi shoreline (boulevard area). The natural stability of its beaches is due to sediments from Adlia;

1.5) Batumi accumulative cape is represented by a large mass brought from the Chorokhi River by waves and by up to 10-15% of sand serving as filler. It is very dynamic and sensitive to natural and anthropogenic impact (about 1 km).

More or less distinguished and independent zones of the second sub-system are:

2.1) Relatively stable section, with occasional gravel beaches up to mouth of r. Korolistskali.
2.2) Korolistskali River section up to Tsikhisdziri Cape, with very restricted gravel beaches or no beaches at all.

The districts that are dissimilar from each other belonging to the third sub-system are:

3.1) Tsikhisdziri Cape with practically no beach;
3.2) A 10 km section of Kobuleti to the south of which there is the damaged district of 4 km. The given coastline is supplied by beach forming sediments from the rivers Dekhva, Kintrishi and Achkva with total annual volume of 10-11 thousand m^3. Given that the loss of large mass per one running meter is 1000 m^3, it could be concluded that in a 10 km Kobuleti coastal zone, the volume of sediment brought by waves is just enough to compensate the losses for wearing.[13]

Since the Black Sea coast of Ajara is formed mainly from fluvial sediment, the shore and relief are in a dynamic balance, whereas the wave energy is spent on transporting the entire volume of the sediment along the shore. Excess sediment, if such, is accumulated causing the growth of the coastal land. Batumi or Buruntabia Cape at the Chorokhi River mouth is exactly of such origin. When there is a lack of sediment fluxes, the wave energy is spent on shoreline erosion. The exposition of Ajara coastline towards the dominant south-west waves has caused the change in the direction of the longshore transport from Chorokhi mouth to Kobuleti. In the region of the immediate impact of the Chorokhi River, the concentration of sediment in 27 spots of the sea surface reaches 1000-2000 g/m^3 and it can even move by 50-60 km to the north.[14]

The seabed is a typified relief for oceans and consists of three geomorphological elements: continental shelf, continental shoulder and deep cavern (abyssal plain, the same as seabed). The shelf, which occupies 24% of the sea space, starts from the modern coastline and ends at about 90-120 m of depth, where the underwater angle of slope sharply declines. It reaches the maximum width (200 km) in the north part of the sea, and minimum - at the coastline of Caucasus and North Turkey. Continental shelf on Georgian coastline is relatively narrow and is defined by 160 m depth isobath; however, Ajara coastline is 25 m isobath in places. Continental slope is between 100 and 2000 isobaths and makes up about 40% of the total area of the cavern. Strong fragmentation is characteristic for the shelf and continental slope: there is a system of canyons on the underwater slope, that is the continuation of Palaeolithic and modern river gorges. They are mostly developed within the territory of Turkey and Georgia. On the coastline of Ajara AR such canyons are the canyons of Batumi, Chorokhi and Kintrishi. The seabed – abyssal plain – is almost flat covering 36% of the total marine aquatic area and is within the boundaries of 2000 m isobath.[15]

With regard to the impact of longitudinal tectonic disturbances, Ajara coastline is divided into Sarpi-Kalenderi, Chorokhi-Batumi and Tsikhisdziri-Kobuleti structural blocks. Kobuleti

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[13] http://conference.sens-2014.tsu.ge/uploads/53bcd565097e3შავი_ზღვის_აჭარის_სანაპირო_ზოლის_მორფოდინამიკა.pdf

[14] Niko Pavliashvii. M.Sc. Thesis. Anthropogenic Transformation of Ajara Relief. Geomorphological Cartography and Landscape Planning. Ivane Javakhishvili Tbilisi State University. Tbilisi, 2013. http://conference.sens-2013.tsu.ge/uploads/51d2c6a6ad645აჭარის_რელიეფის_ანთროპოგენური_ტრანსფორმაცია.pdf

[15] Manual on Water resources, Vazha Trapaidze, TSU, 2012. https://www.tsu.ge/data/file_db/library/trapaidze_resursebi.pdf

structural block is located between the Natanebi River mouth and Tsikhisdziri Cape. The speed of its tectonic subsidence is 1-2 mm a year. Similarly, Chorokhi-Batumi coastline block (Kakhaberi lowland and Chorokhi delta) subside at a rate of 0.8-1.3 mm a year. As for Tsikhisdziri structural block, its sea coastline rises by 1-2 mm a year. Such trend is characteristic for Sarpi-Kalenderi structural block and its adjacent coastline. The latest tectonic dislocation regime significantly conditions the morphological nature of the coastline relief, namely the formation of accumulative plains and erosive shorelines.[16]

The terrestrial part of the coastline (sedimentary rocks along the coast) and underwater slope consists of middle, upper and modern quaternary deposits, featuring small and middle capacity marine, marine alluvial and marine continental sedimentation. They are represented by sand, carbonated and non-carbonated clay lenses, granulated sands. One can also come across several intrusive formations (for instance, in the area between Batumi and Sarpi).[17] Abyssal plain consists of strong sedimentary layers, whose capacity is 14 km.

1.2.2 Climate

Climate in Ajara is humid and semi subtropical with warm winters and hot summers. The sea area itself is distinguished by high humidity and sea winds during the whole year and abundant rains in autumn and winter. Along with other factors, circulation of air masses plays an important role in shaping the climate regime. Namely, maritime climate is conditioned by the interaction of humid air masses coming from the southern slopes of Caucasus and western range of Meskheti. The regime of air masses movement is also significantly affected by unevenly heated land and sea, creating local currents that are formed by monsoons and mountain winds characteristic for the Black Sea.[18] The average annual temperature in the coastal zone is 13-14.5^{0}C, the warmest place is Batumi with the average temperature of 14.5^{0}C. The average amount of multiyear precipitation equals to 2600-2700 mm.

Below is given the data of long-term observation according to a number of meteorological parameters.

Table 1.1 Atmospheric temperature (^{0}C)

Monthly average	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual average	Annual abs. min	Annual abs. max
Batumi airport	6.9	6.8	8.7	11.7	15.8	19.5	22.1	22.6	19.8	16.5	12.4	8.8	14.3	-9	40

Table 1.2 Relative humidity (%)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average	Average relative humidity at 13:00		Average 24-your amplitude of relative humidity	
Batumi airport	67	71	75	77	79	78	80	81	82	78	70	64	75	62	74	9	12

[16] http://conference.sens-2014.tsu.ge/uploads/53bcd565097e3შავი_ზღვის_აჭარის_სანაპირო_ზოლის_მორფოდინამიკა.pdf

[17] Analysis of Chorokhi-Ajaristskali Pilot River Basin. Environmental Protection of International River Basins. (EPIRB). Contract # 2011/279-666. Project financed by the European Union and implemented by the Consortium of Hulla & Co. Human Dynamics KG. Report was prepared by Information Engineering Centre, Tbilisi, 2013.

[18] Georgia's Second National Communication to the UN Framework Convention on Climate Change. Tbilisi, 2009. https://unfccc.int/sites/default/files/resource/Georgia's SNC.pdf.

Table 1.3 Amount of precipitation

Station	Annual average precipitation, mm	Maximum amount of precipitation in 24 hours mm
Batumi airport	2572	238

Table 1.4 Maximum wind speed

Station	Maximum possible wind speed 1, 5, 10, 15, 20 m/sec. once a year				
	1	5	10	15	20
Batumi airport	23	27	28	29	30

Table 1.5 Maximum and minimum wind speeds

Station	Speed m/sec	
	January	July
Batumi airport	9.0/3.6	5.6/2.2

Table 1.6 Wind –no-wind direction, and repeatability of no-wind conditions

Station	Repeatability of wind direction and no-wind conditions (%) a year.								
	N	NE	E	SE	S	SW	W	NW	No-wind
Batumi airport	4	1	3	54	2	20	11	5	19

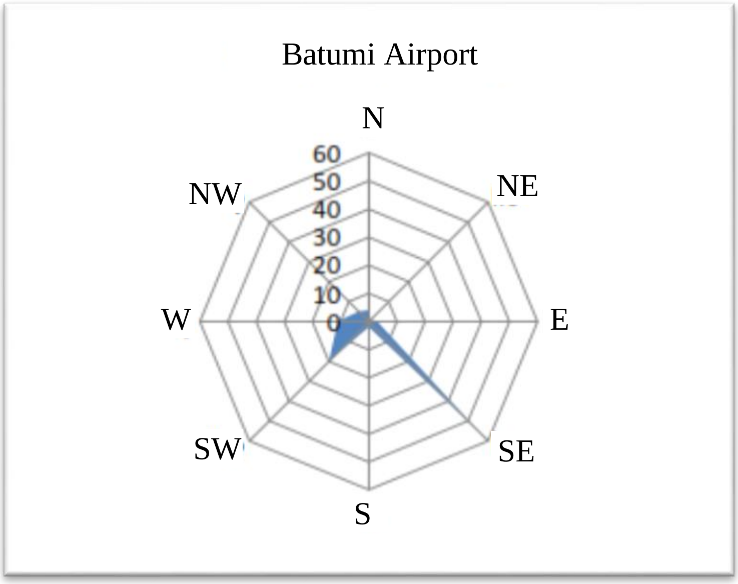

Fig. 1.2 Wind speed rose at Batumi airport

According to long-term observations, meteorological parameters in the coastal zone have changed considerably due to climate change impact. More precisely, the indicator of average annual temperature in Batumi in 1986-2010 increased by 0.2^{0}C, and in Kobuleti by 0.5^{0}C. Generally, until the 90s of the past century, the temperature in the coastline zone decreased by 0.2-0.3^{0}C, and in the last decade it rose by 0.2^{0}C. This change takes place against the backdrop of winter and spring cooling and summer-autumn warming. The amount of precipitation in 1990-2010 as compared to 1961-2010 has decreased in Batumi by 10 mm, in Kobuleti by 85 mm, whereas in Chakvi it increased by 121 mm. Maximum amount of precipitation during 24 hours in Batumi and Chakvi tends to decrease for average annual and winter seasons. Average indicator of annual humidity in Batumi and Kobuleti is reduced. Wind speed changes are of local character. In the adjacent area of Batumi it is decreased in all seasons, except summer, but the speed of change is not high (0.014 m/sec per year).[19]

1.2.3 Hydrography

Currents circulation, wave regime. The Black Sea surface current circulation system is of cyclonic character and is distinguished by annual repeated pattern, which is mainly due to wind movement. Maximum circulation is observed in winter and spring. Apart from seasonal wind regime, the sea current is also affected by vertical thermohaline (temperature and salinity of the sea surface) fluctuations and currents created due to regional peculiarities.

There major cyclonic currents distinguished, covering the whole sea along the continental shelf and relatively small, cyclonic currents, which can be observed within the main currents in eastern and western parts of the sea. The currents move anti-clockwise, which is due to cyclonic circulation of the atmosphere and continental runoff. The main current is determined by Coriolis parameter, which causes the deviation of body movements from the trajectory, due to the earth rotation around the axis. Since the sea surface area is small, winds have a strong impact and make it very unsteady. For the sea, the existence of anti-cyclonic eddies (reversed currents) is also typical, which are stable and clearly distinctive in the coastal waters of Georgia and Turkey.[20]

Observations and the results of modelling on a basin scale, indicate that main and internal cyclonic currents in winter are stable and intensive. In the beginning of spring, they weaken and gradually become more and more curved. Many strong mesoscale turbulences, meanders and filaments appear, forcing the zones of recirculation (anticyclone) of coastal waters or main currents to flow into deep waters. One of the most distinctive regional coastal currents is Batumi quasipermanent anticyclonic coastal current, which plays a great role in the transportation of nutrients from coastal waters into the open sea. Maximum speed of movement of water masses (20 cm/sec) is observed in the area of main cyclonic current which gradually lessens towards the central part.[21] Schematic illustration of the Black Sea circulation according to the regional model of the sea basin is given in the Figure 1.3 below, while Figure 1.4 depicts longshore transport of sediments along Ajara coast.

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[19] i) Ajara Climate Change Strategy UNDP. Tbilisi 2013. http://www.ge.undp.org/content/georgia/ka/home/library/environment_energy/climate-change-strategy-of-Ajara-.html;
ii) Georgia's Second National Communication to the UN Framework Convention on Climate Change. July, 2009. https://unfccc.int/sites/default/files/resource/Georgia's SNC.pdf.

[20] http://blacksea-education.ru/e2.shtml.

[21] i) Rim Current Variations in the Black Sea. 2012. COPERNICUS. MARINE ENVIRONMENT MONITORING SERVICE. http://marine.copernicus.eu/web/18-multimedia.php?item=757;
ii) State of Environment Report 2001 - 2006/7. http://www.blacksea-commission.org/_publ-SOE2009-CH12.asp;
iii) Black Sea Marine Forecasting Centre. Operational Oceanography Branch. Marine Hydrophysical Institute. http://bsmfc.net/Year_analysis.php.
iv) Preventive Methods for Georgian Sea Coast Erosion. Nodar Tsivtsivadze. http://collaborations.fz-juelich.de/ikp/cgswhp/cgswhp12/program/files_tbilisi/06.08/Parallel_Session_2/6_Nodar_Tsivtsivadze_Report.pptx

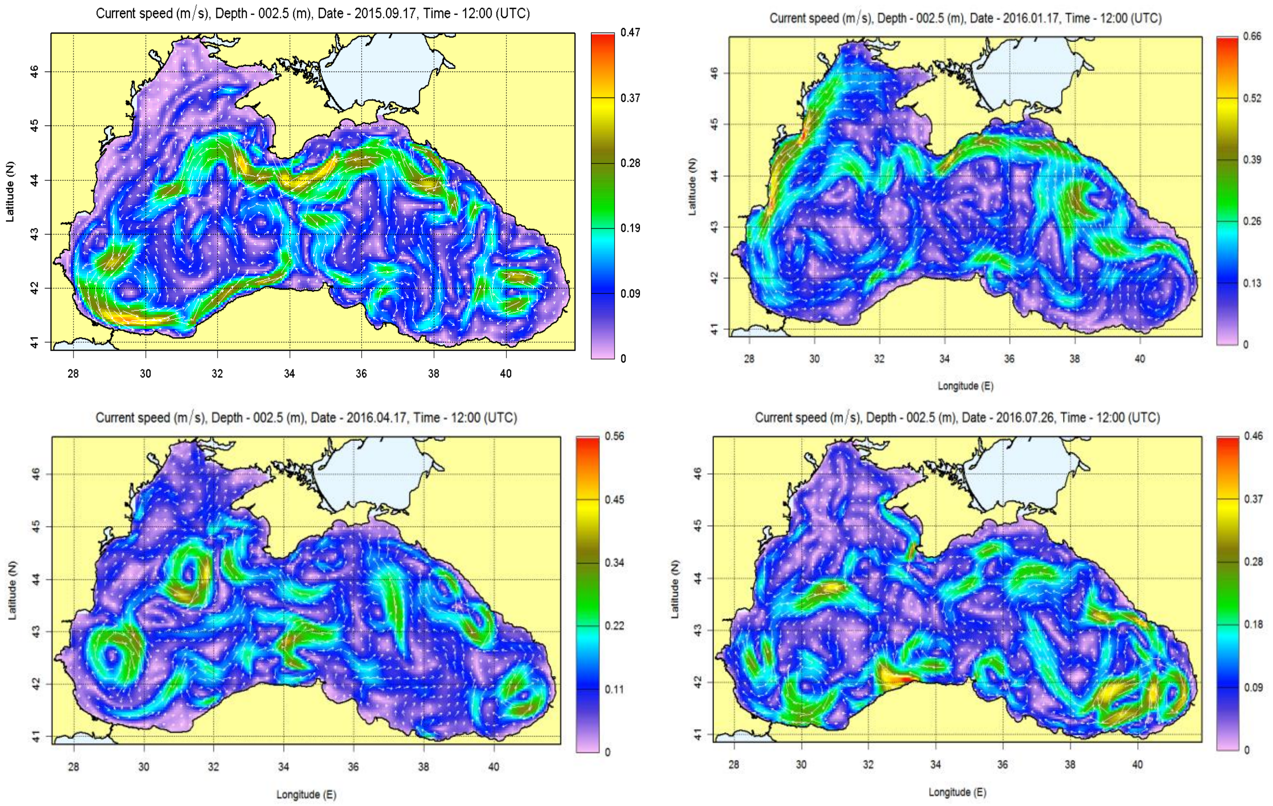

Fig. 1.3 Seasonal Black Sea circulation model for 2015-2016 [22]

Fig. 1.4 Sediment transport patterns along Ajara coast

[22] i) Black Sea Marine Forecasting Centre. Operational Oceanography Branch. http://bsmfc.net/Year_analysis.php.
ii) Higher 1 km resolution nested model for the Georgian section of the Black Sea http://www.ig-geophysics.ge/prognozi.html.

The average speed of the Black Sea current during the whole year is less than 0.4 m/sec. Low waves recur frequently. Namely, the recurrence of a wave of less than 1 m in the summer is 70%, while the waves higher than 3 m are very rare.

Table 1.7 Recurrence of the sea wave height %.[23]

Height (m)	Season			
	Winter	Spring	Summer	Autumn
<1	27	45	70	42
1-2	43	40	24	42
2-3	21	11	5	12
3-6	9	3	1	4
>6		1	0	0

Despite the fact that the likelihood of occurrence of strongest winds in the Black Sea area of Georgia is very low, hurricanes with the speed at 47 m/sec from the sea once in 20 years do recur, followed by storms and sea disturbance. During 50 years of the past century, based on observations over Batumi storms, we can see that since 1970s the frequency of these types of winds has increased considerably. Namely, from 70s to 2010, the number of storm of force 5 days had increased twice and the days of storm of force 6 - three times. A storm of force 7 has also been recorded. In the last decade, due to the climate warming impact, the distribution of proportion of storms has also changed. i.e., if in 1961-2000 the storms took place mainly in late autumn and winter, in 2001-2010, strong sea disturbances were observed in the summer as well.

Table 1.8 Changes in the number of stormy days of different force in Batumi in 1961-2011[24]

Years	Storm of force 4		Force 5		Force 6		Force 7	
	Number	%	Number	%	Number	%	Number	%
1961 - 1970	295	81.95	59	16.39	6	1.67		
1971 - 1980	499	80.75	117	18.94	2	0.33		
1981 - 1988	485	88.03	64	11.62	2	0.37		
1997 – 2000	69	60.53	42	36.85	2	1.76	1	0.86
2001 - 2011	413	73.89	125	22.37	21	3.76		

Bathymetry, sea level.[25] As mentioned above, the depth of the Black Sea is between 2000-2200 m, with the maximum depth of 2212 meters. The continental shelf along the Georgian coastline is narrow and is 110-160 m deep. In Ajara coastal waters (1 nautical mile) it is mainly within the limits of 5-50 isobaths, in Chorokhi-Adlia section it goes down to 20 isobath, and in Kobuleti section, it reaches 200 isobaths. The bathymetric maps below show the aquatorium of Black Sea coast along Ajara AR (data source: European Marine Observation and Data Network – EMODnet).

[23] Ajara Department of Environmental Protection.
[24] Ajara Climate Change Strategy 2013. http://www.undp.org/content/dam/georgia/docs/publications/UNDP_GE_EE_Ajara_CC_2013_geo.pdf.
[25] i) Water resources manual. Vazha Trapaidze, TSU, 2012. https://www.tsu.ge/data/file_db/library/trapaidze_resursebi.pdf.
ii) The European Marine Observation and Data Network – EMODNET. http://portal.emodnet-bathymetry.eu.

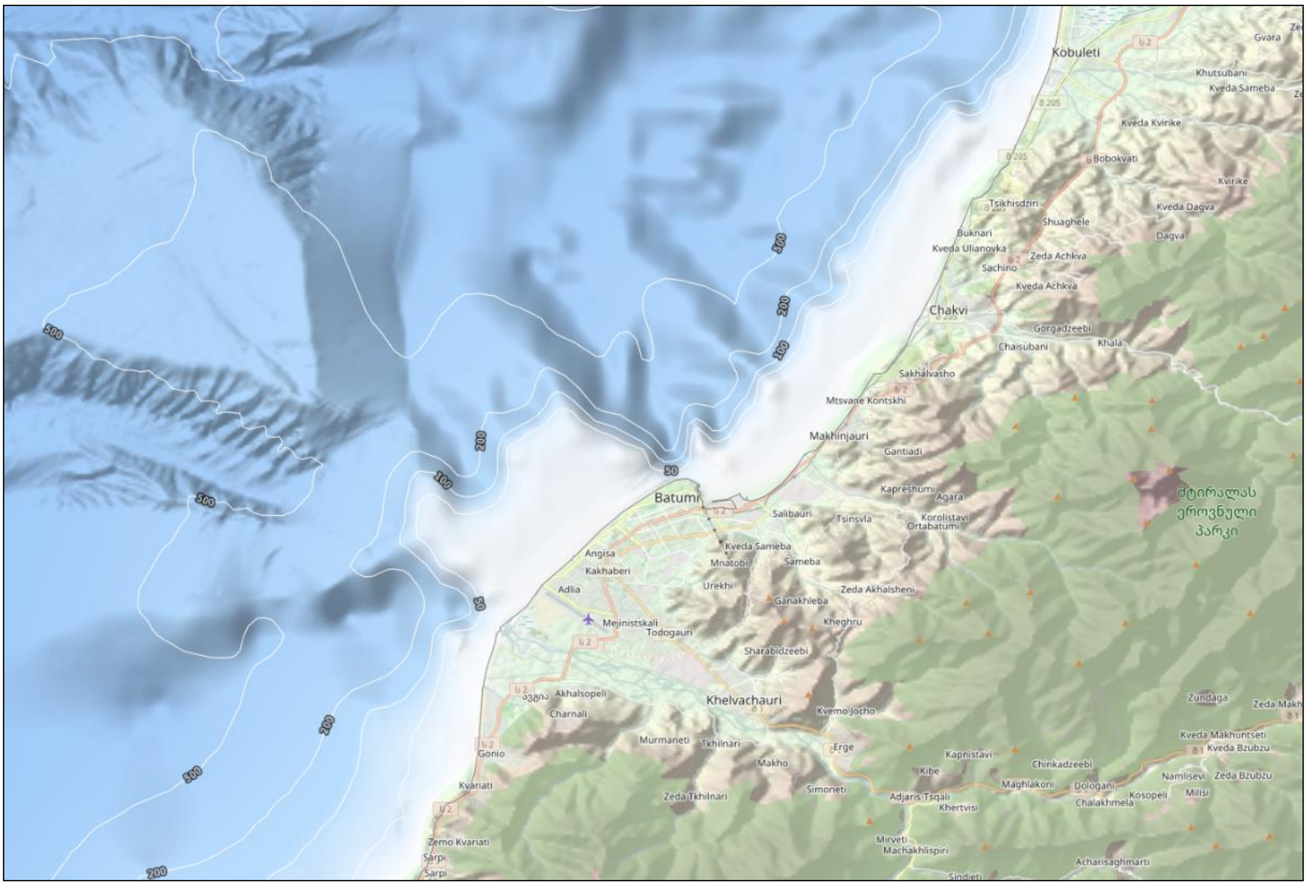

Fig. 1.5 Bathymetric Map of the Black Sea and Ajara coastal waters [26]

The range of flood and ebb does not exceed 10 cm, which correspondents to a microtidal category according to the WFD. The sea storm of western rhumb on the Georgian coastline can cause a 0.8 m rise in water level. In the case of damming of the river, the water level may rise twice or three times. As a result of spring flooding, the increased continental sediments may cause the rise of the sea level by 0.2-0.5 m compared to autumn, plus the storm flooding added to it, the increase in water level may exceed 1.0-1.2 m. Seiche current is also characteristic for the coastline, which is the oscillation of the sea surface caused by changes in atmospheric pressure (inverted barometric effect) during which the water level changes within the limits of 0.5-0.7 m in one or several hours. During seiche currents, the fluctuation of water levels reaches 60 cm. Apart from the factors given above, important are changes in the Black Sea level due to global rise of ocean level (see Figure 1.6).

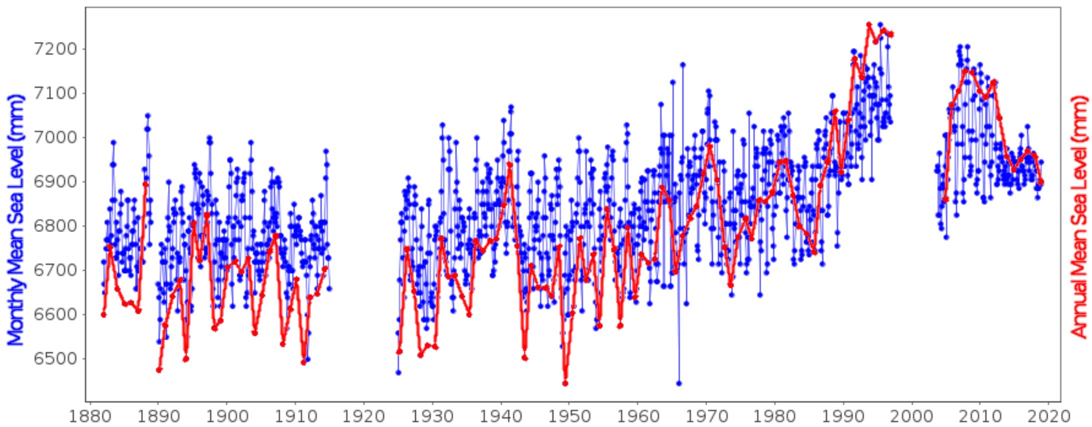

Fig. 1.6 Annual average mean sea level gauge data for Batumi 1882-2015
(http://www.psmsl.org/data/obtaining/stations/51.php)

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[26] The European Marine Observation and Data Network – EMODNET. http://portal.emodnet-bathymetry.eu.

Water balance. The Black Sea is one of the most meromictic saline water bodies (i.e. with very restricted ability of mixing upper and lower layers). Its total volume is about 55000 km^3 and has a positive freshwater balance, which means that it gains more water from continental runoff and rains, than it loses as a result of evaporation. Every year the sea is supplied with nutrients from about 350 km^3 of continental runoff and 230 km^3 of precipitation. 354 km^3 of water is lost during evaporation. Since the Black Sea level compared to the Marmara Sea level is higher by 0.43 m, the excess water flows out of the Black Sea via Bosphorus Straits. Thus, there are two currents formed in the Black Sea. Surface current, which is of relatively low salinity and cold, flows out of the Black Sea, and the lower, more saline and warm current, whose level of salinity is about 35‰, flows in form the Mediterranean (the Marmara Sea). Saline water is mixed with freshwater from continental flow and consequently, its salinity is reduced. The volume of lower currents makes up only half of the surface current.[27]

1.2.4 Physico-chemical characterisation of Georgian coastal waters

Transparency, turbidity.[28] Sea water transparency is very unsteady depending on places and seasons. It changes from 1 meter to 8 meters, on average it is 4.5 m. It reaches the highest point in Sarpi-Gonio aquatorium and the lowest – at the Chorokhi River mouth up to Buruntabia Cape. In winter, it is highest and in late spring and early summer – the lowest.

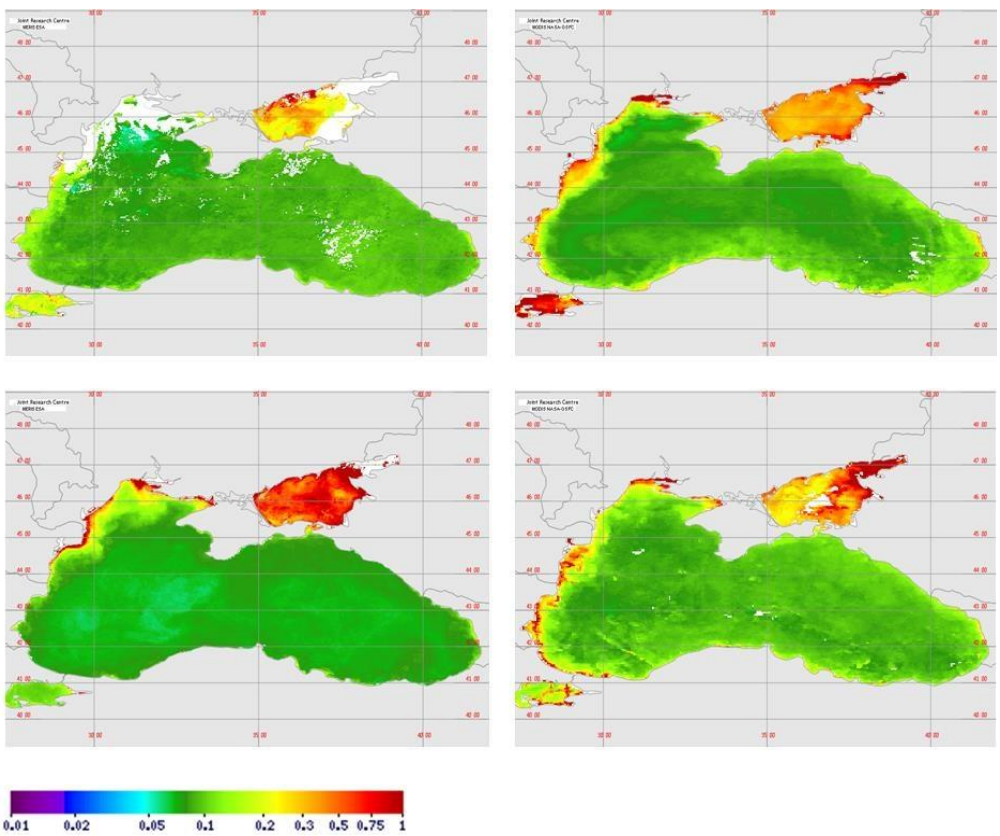

Fig. 1.7 Data from 2011 on monthly average sea bio-optical indicators (KD490), January, April, July and October [29]

The given parameter is an index of transparency of the water column and shows how the blue/green ray of light of the spectrum penetrates into the water column (in particular, at which

[27] The Black Sea Scene. http://www.blackseascene.net/content/content.asp?menu=0010000_000000.
[28] State of the Environment Report 2010-2013.
[29] EMIS - European Seas Environmental Marine Information System. https://mcc.jrc.ec.europa.eu/index.py; http://emis.jrc.ec.europa.eu/index_fullscreen.php?xml_selection=4km&variable_selection=32&time_selection=YY&month_selection=01&year_selection=2011&extent_selection=27.3 40.9 42.0 47.4

depth dissipates). Consequently, it indicates the existence of particles dispersed in the water. The index is represented logarithmically and its maximum penetration corresponds to its minimal index (0.01) on the colour grade. The figure indicates that the penetration of light fluctuates between 0.1-0.2 in the coastal zone of Georgia during different seasons, which corresponds to a transparency of 5-10 m.

Salinity.[30] Salinity in Ajara coastal zone fluctuates between 15-18‰ on average, which is due to the impact of continental runoff. It changes according to seasons and increases along with the increase of depth. On the seabed it reaches 22‰, due to the impact of inflow of the current from the Marmara Sea. High level of stratification is characteristic for the sea. Water exchange between upper and lower strata is very restricted due to salinity and uneven gradients of other relevant parameters (such as temperature, density). More specifically, vertical salinity starts changing abruptly from the depth of 50 m to 150 m and reaches 21‰. The given stratum is halocline, under which salinity increases at a slower pace.

Salinity is also reduced to 4-9‰ at the mouths of rivers (for instance, Chorokhi and much smaller Kintrishi deltas), where the estuaries are formed. The water in these places is characterized by high suspended matter content and low salinity. However, the level of salinity varies in different places of the estuary. Namely, it is the highest at the river mouth where the seawater flows in and the lowest in upper current, where the river water flows in. It also depends on tidal regime and the amount of river discharge. In general, salinity of an estuary decreases in spring due to melting snow and abundant atmospheric precipitation and increases in summer due to intensive evaporation.

Seawater temperature. Sea surface temperature in Ajara coastal zone warms in summer up to 24-25^{0}C near the shore and up to 21-23^{0}C in deep-water areas. Maximum temperature fluctuates between 28-29^{0}C in July and August. Minimal temperature is reported to be 7^{0}C in February. Water surface temperature fluctuates a lot throughout a year. Table 1.9 given below shows the data of the average annual temperature of the sea surface provided by Ajara Department of Environmental Protection based on long-term observation, while the Figure 1.8 below shows the remotely sensed sea surface temperature in different seasons.

Table 1.9 Average annual temperature of the sea surface [31]

Average monthly temperature °c	Month												Average annual temperature(°c)
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Sea surface	10.4	9.0	9.0	11.2	16.3	21.6	24.6	25.2	24.0	20.3	16.6	12.9	16.7
Air	5.3	7.1	11.5	12.2	15.5	21.4	21.7	25.7	20.7	17.6	11.8	6.3	14.7

[30] i) State of the Environment Report 2010-2013;
ii) http://blacksea-education.ru/e2.shtml.
[31] National Environmental Agency.

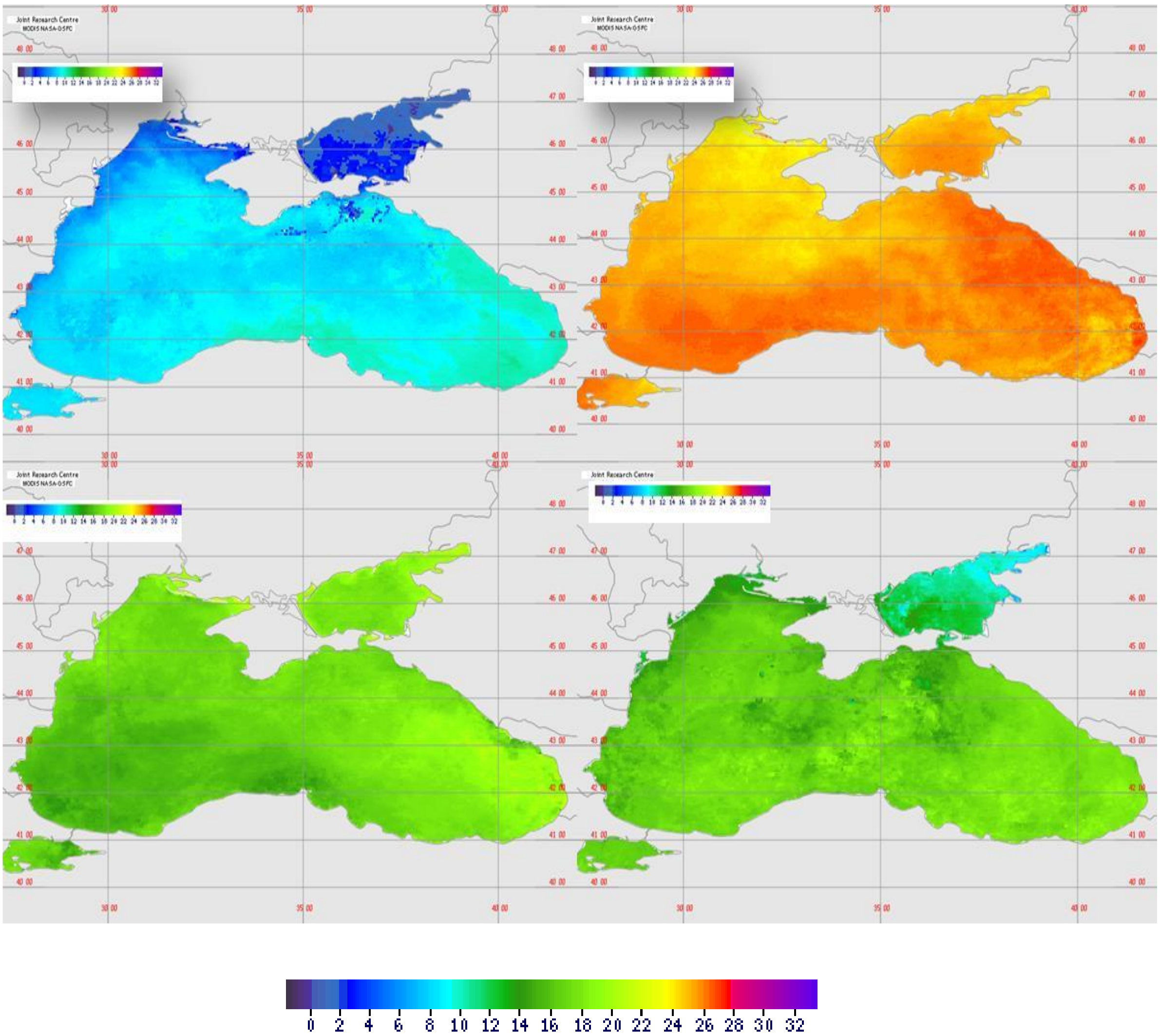

Fig. 1.8 Average monthly sea surface temperature for months of January, April, July and October of 2012[32]

The seawater temperature sharply decreases at the depths between 50-60 m and 80-90 m, where minimal indices are observed and the thermocline is formed, which is also called a cold interim stratum. In winter, water temperature goes drops in this place up to 5-6^{o}C and practically never warms in summer. Beneath the thermocline, water temperature gradually rose and on the seabed it reaches 8-9^{o}C, which is retained throughout a year. Similar to halocline, thermocline interim stratum prevents vertical movement of water.[33]

Along with other climate parameters, the sea temperature has also changed significantly since 1924: in 1924-1990, it dropped by 1^{0}C, and in1990-2006 it rose by 1.3^{0}C, due to which seawater cooled by 0.8^{0}C in 2006 compared to 1924. The main reason of a long-term cooling is the existence of a cold interim stratum in the sea and unless it is stabilized, the fall in the sea surface temperature will continue.[34]

Minimal and maximum indices having been identified in 2000-2009 in a predictable manner started to deviate from the norm. In the summers of 2010 and 2011, the sea surface

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[32] MODIS-TERRA Sea Surface Temperature 10 2012. European EMIS Marine Database (EMIS) Physical datasets http://emis.jrc.ec.europa.eu/index_fullscreen.php?xml_selection=4km&variable_selection=40&time_selection=YY&month_selection=01&year_selection=2012&extent_selection=27.3 40.9 42.0 47.4.

[33] http://blacksea-education.ru/e2.shtml

[34] Georgia's Second National Communication to the UN Framework Convention on Climate Change. Tbilisi, 2009. https://unfccc.int/sites/default/files/resource/Georgia's SNC.pdf.

temperatures reached 30⁰C and 33⁰C, respectively. Temperature anomaly in 2011 lasted longer than in the previous year. The Figure 1.9 below shows temperature fluctuation trends within the years of 2000, 2010 and 2011.

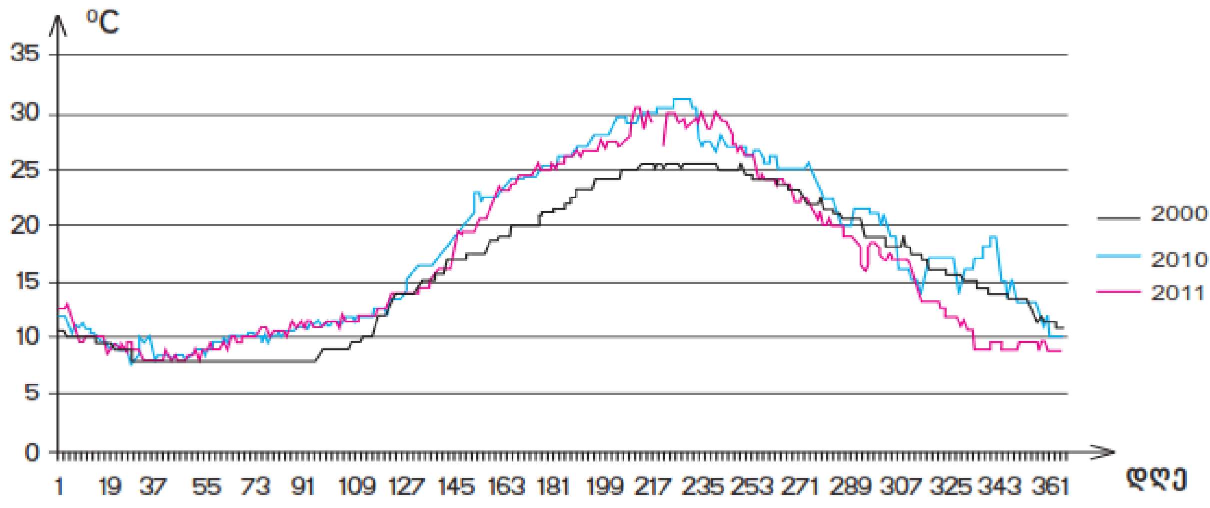

Fig. 1.9 The Sea surface water temperature trend within 2000, 2010 and 2011 in Batumi [35]

Water density.[36] Water density (expressed in units of σ = (ρ – 1) x 1000 kg/m^3, where ρ is density) in the upper 100 m stratum of the Black Sea is up to 5 kg/m^3. The zone of a drastic change of this parameter – pycnocline is formed between the depths of 100 m and 150 m in internal cyclonic currents and sometimes it even reaches 200 m in coastal anticyclones. Water density of pycnocline reaches up to 16.2 kg/m^3. The stratum beneath 200 m is almost fully homogeneous and the surface density here is 17-17.3 kg/m^3. The lowest stratum of the height of water below 1700 m is completely homogenous and has been formed for over the last several millenniums under the impact of geothermal flux of the seabed warmth.

pH.[37] pH in the Black Sea surface waters fluctuates between 8.1-8.5. The minimal amount is reported in winter and maximum – in summer. pH mainly depends on carbon dioxide that is dissolved in the water, while in depths below 150 m it depends on hydrogen sulphide (H_2S). That is why it is reduced to 7.6 below these depths.

Aerobic and anaerobic strata.[38] The presence of aerobic (with oxygen) and anaerobic (without oxygen, the same as anoxic) layers is characteristic for the Black Sea. The layer containing oxygen is located above the anoxic layer and goes down about 150 m in depth. It consists of 3 distinctive zones: euphotic, oxicline/nitracline and suboxic zones.

The extreme euphotic zone of the aerobic layer extends up to 50 m in depth and is characterized by active biological processes (formation of organic mass). The content of biogenic substances (nutrients) as well as organic masses, which occur in the sea from rivers and coastal zone and as a result of vertical mixing of upper and lower layers, is high here. Concentration of these substances varies from season to season and decreases in the

[35] i) Georgia's Second National Communication to the UN Framework Convention on Climate Change. Tbilisi, 2009. https://unfccc.int/sites/default/files/resource/Georgia's SNC.pdf;
ii) Ajara Climate Change Strategy
http://www.undp.org/content/dam/georgia/docs/publications/UNDP_GE_EE_Ajara_CC_2013_eng.pdf.

[36] State of Environment Report 2001-2006/7. http://www.blacksea-commission.org/_publ-SOE2009-CH1A.asp

[37] On EcoGeoChemistry of the Georgian Sector of the Black Sea. https://sangu.ge/images/nbenashvili.pdf.

[38] i) State of Environment Report 2001-2006/7. http://www.blacksea-commission.org/_publ-SOE2009-CH1A.asp.
ii) Hydrochemical Structure of Black Sea Hydrogen Sulfide. Galina Shtereva. Institute of Oceanology – BAS. http://www.chim.upt.ro/alina.dumitrel/HYSUFCEL_Presentation_Shtereva.pdf

middle of the sea. In the lower part of seasonal thermocline and euphotic zone, the content of biogenic substances rises again due to their recycling and constant supply of nutrients from the lower zone. Nitrates accumulated in the given layer favour the formation of phytoplankton. In winter the storage of nutrients is refilled from the lower zone and exhausts as a result of bioassimilation processes.

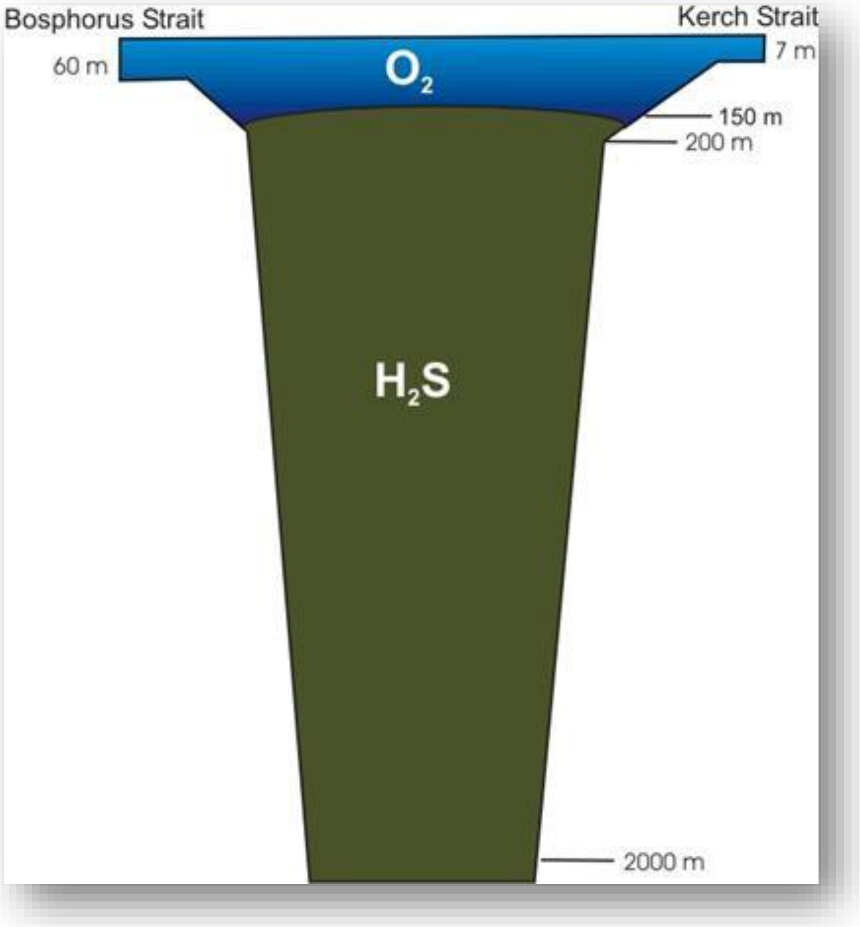

Fig. 1.10 Black Sea water column profile [39]

Euphotic zone is followed by the upper layer of oxicline or the same as nitracline, which spreads for about 75 m in depth. Oxygen concentration here increases sharply from three micromoles to 35-40 μmol/l in cyclonic areas and up to 70-100 micromole in coastal anticyclonic regions. Oxygen content at the lower limit of oxicline, in the layer with approximately 15.6 kg/m^3 of density, falls to 10 μmol/l.

Between oxicline and anoxic layers, there is a suboxic or the same as nitracline lower layer. It is about 30-40 m thick. It is very unstable and is characterized by fluctuations within the month. The zone experiences heterotrophic denitrification. Sulphur anoxic layer contains practically no nitrite, although it has a large storage of ammonium and dissolved organic nitrogen. Ammonium concentration sharply increases to concentrations of 10 μmol/l at the layer with the density of 16.0 kg/m^3 and reaches 10 μmol/l at the 150 m depth and 20 μmol/l at 200 m. Vertical content of phosphates is similar to that of nitrates in upper layers, but is more complex in suboxic and anoxic layers.

On the seabed, there are the depositions of manganese, ammonium and sulphides having been accumulated as a result of organic mass decay for 5000 years.

[39] State of Environment Report 2001-2006/7. http://www.blacksea-commission.org/_publ-SOE2009-CH1A.asp.

Table 1.10 Margins of concentrations of different substances in the sea layers[40]

Layer		S ‰	pH	O2 µM/l	NO3 µM/l	NH4 µM/l	PO4 µM/l
oxic	min	15.72	7.9	20	<LOD	0.1	0.0
	max	20.22	8.5	405	5.1	1.0	0.12
suboxic	min	20.67	7.8	<LOD	<LOD	0.9	0.02
	max	21.02	7.9~	20	0.02	5.0	0.04
anoxic	min	>21.0	7.6	<LOD	<LOD	4.4	0.5
	max	>21.0	7.8	<LOD	<LOD	18	6.9

1.2.5 The Black Sea Coast and Biodiversity of Transitional Waters

1.2.5.1 Habitats and biodiversity of internal and transitional waters[41]

In Ajara coastal zone and mainly around Chorokhi and Kintrishi river mouths, most commonly spread habitats are: ponds, salty and salinized lakes, streams, groves, marshes (sphagnum bogs, grass bogs) and estuaries (delta).

Generally, the plain in Ajara coastal zone is the extreme southern part of Kolkheti plain. Its width from Kobuleti is about 2-5 km narrowing towards the south and the front slopes of the mountain immediately go along Gonio and Sarpi territories. Ajara plain, due to abundant precipitation and high level of ground water column, has mostly turned into swamp. In the past, the large part of the plain in the coastal zone was covered by forest swamps, and sphagnum peat vegetation that were developed in swampy-meadow, peat-like and swampy podsolic soils. Currently, the large part of these territories has been dried out and exploited and only the remnants of excessively humid areas are retained on a small territory, for instance, Chorokhi delta and Kobuleti protected area.

In forest swamps most widely spread plants are *Alnus barbata*, *Pterocarya pterocarpa*, while in relatively dry areas - *Carpinus caucasica* and *Quercus imeretina*. Subforest is represented by *Frangula alnus*. In sparse areas the groves are covered thickly with blackberries and lianas - *Smilax excelsa*, *Periphloca graeca*, *Hedera colchica* and others. In wide groves of Chorokhi also widely spread plants are alder trees and buckthorn bushes mixed with typical vegetation – *Molina litoralis*, swamp iris, rushes and others. On relatively small areas we come across ferns, mixed grassy and mossy alder trees.

Small grasses freely float on or under the surface of water, such as, *Lemna minor* and *Spirodela polyrhiza*, also, *Salvinia natans*, *Myriophyllum spicatum*, *Potamogeton crispus*, *P.*

[40] Hydrochemical Structure of Black Sea Hydrogen Sulfide. Galina Shtereva. Institute of Oceanology – BAS. http://www.chim.upt.ro/alina.dumitrel/HYSUFCEL_Presentation_Shtereva.pdf.

[41] i) http://old.gobatumi.com/ge/feelit/protected-areas-natural-treasures/coastal-sand-dunes.
ii) Georgia's Fifth National Report to EU Convention on Biodiversity, Ministry of Environment and Natural Resources Protection of Georgia. 2015. https://www.cbd.int/doc/world/ge/ge-nr-05-en.pdf and http://www.eiec.gov.ge/თემები/Biodiversity/Data/Report/Fifth-National-Report-to-CBD-Georgia-ge-01-05-15-(.aspx.
iii) Black Sea Fish Check List. A Publication of the Commission on the Protection of the Black Sea Against Pollution. http://www.blacksea-commission.org/_publ-BSFishList.asp.
iv) Identifying Key Black Sea Coastal Habitats: Coastal Habitat Red Book for Georgia. PILOT STUDY FINAL REPORT. December 2005. Bucharest Convention on Protection of the Black Sea Against Pollution. Biodiversity and Landscape Conservation, Black Sea Environment Programme. http://oceandna.ge/files/27_116_604453_HabitatRedBookGeorgiaPilotStudy2005.pdf.
v) Regional Development Strategy of Ajara Autonomous Republic 11 March 2014. http://Ajara.gov.ge/branches/description.aspx?gtid=20506&gid=13#.V0IDAuTsHpc.
vi)http://old.gobatumi.com/ge/feelit/protected-areas-natural-treasures/coastal-sand-dunes.
vii) Habitats of Georgia. M. Akhalkatsi. Sustainable Management of Biodiversity, South Caucasus. GIZ. http://biodivers-southcaucasus.org/wp-content/uploads/2015/02/WP-26-Habitats-of-Georgia.eng_.pdf.
viii) Bolkvadze B., Vegetation of Central and Southern Kolkheti Coastal Lowland Dunes and Freshwater Ponds - Conservation and Wise Use, PhD Thesis, BSU, 2017, https://www.bsu.edu.ge/text_files/ge_file_9237_1.pdf.
ix) https://opac.iliauni.edu.ge/eg/opac/record/4873.

natans, P. perfoliatus, P. pusillus, Nymphaea candida, Nuphar luteum, Trapa colchica are found in estuaries.

Wetlands are distinguished by a diversity of migrating and resident species. Namely, here are *Philomachus pugnax, Haematepus ostralegus, Cygnus olor, Buteo rufinus, Buteo lagopus, Athene noctua, Tadorna ferruginea, Falco biarmicus, Falco cherrug, Falco vespertinus, Larus canus, Larus cachinnans, Larus armenicus, Columba palumbus, Cuculus canorus, Picus viridis, Dendrocopus minor, Apus apus, Hirunda rustica, Riparia riparia*, and so on. As for mammals, there are otter, badger, rabbit, field mouse. From amphibians and reptiles – Caucasian salamander, Turkish lizard, *Darevskia clarkorum, Darevskia rudis,* and red-bellied lizards – *Darevskia parvula, Anguis colchica, Platyceps najadum, Bufo viridis* and Caucasian toads *Bufo verrucozissimus, Rana ridibunda* and *Mertensiella caucasica*.

The species permanently found in the Chorokhi River basin have entered the Red Book for breeding. These are: trout and the Black Sea salmon, also Kolkhic and Anatolian Khramuli and Kolkhic barbell. The species of sturgeon that have been entered in the Red Book are: *Acipenser persicus colchicus Marti*, *Acipenser sturio Linnaeus*, *Acipenser stellatus Pallas*, *Huso*, *Acipenser gueldenstaedtii* forms are rarely found in Rv. Chorokhi. They enter the river only occasionally. In Ajara river deltas there are other species of fish, such as *Anguilla anguilla*, *Atherina boyeri pontica Eichwald*, *Syngnathus abaster Risso*, *Gambusia affinis*, *Mugil cephalus*, *Mugil soiuy*, *Liza aurata*, *Squalius cephalus orientalis*, *Petroleuciscus borysthenicus*, etc.

The following invertebrates are commonly found in transitional waters: Annelida, flat worms – Platyhelminthes, arthopods (*Arthropoda*), among them crustaceans, *Rotifera* and molluscs – snails.

In terms of conservation, out of land, internal waters and transitional waters habitats various types of marshes and estuaries are important. These are key habitats according to Emerald Network development program as well.

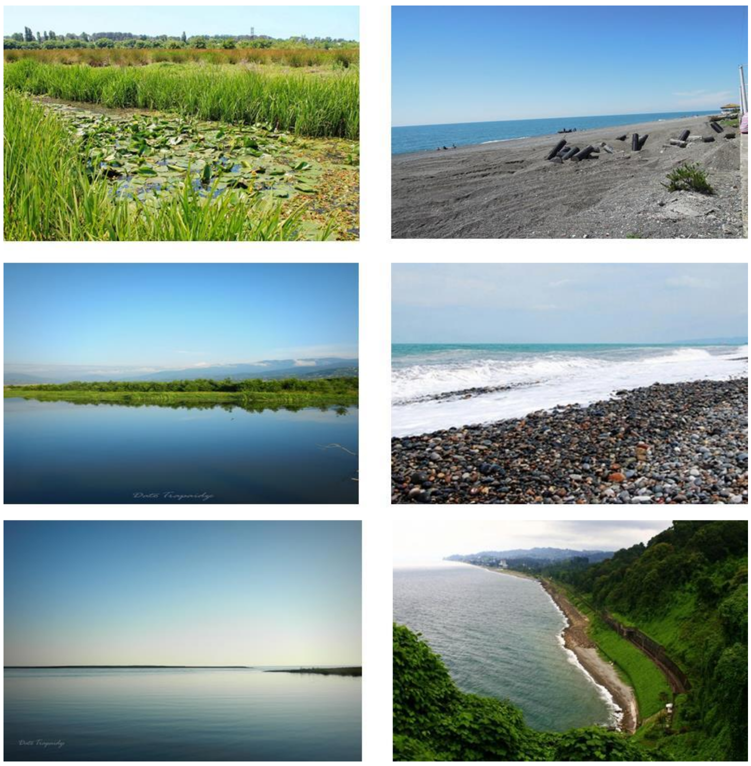

Fig. 1.11 Typical habitats of Ajara coastal zone

1.2.5.2 Protected areas[42]

Kobuleti protected area was established in 1999. It includes Kobuleti State Reserve – Ispani II (331 ha) and Kobuleti Managed Nature Reserve – Ispani I (439 ha). It is located to the north of Kobuleti, along the Black Sea in 300 meters from the pinery.

Ispani I consists of half degraded secondary plant complexes. Ispani II is a virgin sphagnum peat, which is fed only on rainwater. It is covered by 25-45 cm thick sphagnum – white moss. It is never covered by water. Together with water, sphagnum creates a completely smooth dome, without any hillocks that is located on the elevation of 4 or 5 meters from the vicinity. Sphagnum is like a sponge; it can absorb 25 times more water compared to its weight. During torrential rains, when the area is covered with water, Ispani II dome remains dry. Since 1996, Ispani II has become the wetland area of international importance recognized by Ramsar Convention, which is an important habitat for migrating and wintering bird species. Ispani I and II are recognised as unique *rainwater fed percolation bogs*, a peatlands type that cannot be found anywhere else globally.

Fig. 1.12 The map of Kobuleti protected areas

(source: https://sustainable-caucasus.unepgrid.ch)

In the peatland, sphagnum creates amazing "pillows", where together with quaternary ice age boreal plants one can come across endemic species of Colchis flora. Namely, the most commonly spread ones are the Imeretian sedge, white rhynchospora, the Caucasian rhynchospora, peat sedge, water clover, round-leaved drosera, azalea smilax, royal fern, orchis, lycopodiella.

In autumn and summer a great number of migrating and wintering birds get together on the

[42] i) Kobuleti municipality. Official portal http://www.kobuleti.org.ge/index.php?lang=ge;
ii) Agency of Protected Areas http://www.apa.gov.ge/ge/biomravalferovneba/qobuletis-daculi-teritoriebis-biomravalferovneba

territory of the peatland, such as: *Tringa erythropus, Buteo buteo, Aquila heliaca, Philomachus pugnax, Haematepus ostralegus, Cygnus olor*, etc.

The mammals inhabiting Kobuleti protected area are: *Lutra lutra, Meles meles minor, Lepus, Myocastor coypus, Microtus arvalis, Apodemus agrarius,* jackal, jungle cat. Amphibians inhabiting the area are: *Hyla arborea, Bufo, Rana esculenta, Triturus vulgaris, reptiles - Natrix natrix, Natrix tessellata, Anguis fragilis, Ophisaurus apodus, Eremias scripta, Mauremys caspica, Emys orbicularis*, from eels – *Perca fluviatilis, Carassius, Anguilla anguilla, Esox lucius*.

The "Red List" of Georgia includes the following rare and endangered species of animals and birds: otter - *Lutra lutra*, lesser kestrel, black stork, windhover, Eastern imperial eagle, sea eagle and Greater spotted eagle. Out of all European species, in Kobuleti protected area there are 28 endangered birds, among them are European bee-eater, Kingfisher, little pelecaniformes, Yellow-crowned night heron, Glossy ibis, black stork, etc. Out of birds facing the global threat there are 7 species of birds in Kobuleti protected area: Pallid harrier, lesser kestrel, field lawping, great snipe, corncrake and others.

1.2.5.3 Marine habitats and biodiversity[43]

Marine habitats. In Ajara AR Black Sea aquatorium there are the following types of marine (tidal zone and open sea) coastal habitats: lagoon, dune, littoral rocks and stony shorelands; shallow water area and bay; sublittoral sediments including deep sediments of continental shelf; deep sea bottom including canyons and former riverbeds on the continental slope; pelagic water column with various gradients of stratification.

Lagoons on the coastline of Ajara are rarely found. What has remained is a narrow band of hardened sand dunes with grass vegetation, plants like *Pancratium maritimum, Eringium maritimum, Cakile euxina, Glaucium flaum, Calystegia soldanella, Glycyrrhiza glabra* etc. These varieties of flora are protected within the frames of Emerald network. Kobuleti dunes have been awarded the status of nature monument and are the part of Kobuleti Protected Area which is in the east. With regard to conservation, most important coastal water habitats are lagoon coasts and hardened sand dunes, which according to Emerald Network development program are also considered a priority.

According to possible origin of species, the Black Sea inhabitants are conventionally divided into 5 groups:

- "Pontus Sea relicts" that originated in old geological periods in less salty waters;
- "North species" that were adapted to living in cold waters;

[43] i) Black Sea Fish Check List. A Publication of the Commission on the Protection of the Black Sea Against Pollution. http://www.blacksea-commission.org/_publ-BSFishList.asp;
ii) Identifying Key Black Sea Coastal Habitats: Coastal Habitat Red Book for Georgia. PILOT STUDY FINAL REPORT. December 2005. Bucharest Convention on Protection of the Black Sea Against Pollution. Biodiversity and Landscape Conservation, Black Sea Environment Programme. http://oceandna.ge/files/27_116_604453_HabitatRedBookGeorgiaPilotStudy2005.pdf;
iii) Habitats of Georgia, Maya Akhalkatsi, 2010, Sustainable Management of Biodiversity in South Caucasus GIZ. http://biodivers-southcaucasus.org/wp-content/uploads/2015/02/WP-26-Habitats-of-Georgia.eng_.pdf;
iv) Black Sea Inhabitants, part 2. Black Sea Black Sea Anthology, Teacher's handbook http://www.ge.undp.org/content/dam/georgia/docs/publications/GE_UNDP_EE_Black_Sea_Box_Geo.pdf;
v) Kobuleti Municipality Official Portal http://www.kobuleti.org.ge/index.php?lang=ge;
vi) Georgia's Fifth National Report to EU Convention on Biodiversity. Ministry of Environment and Natural Resources Protection of Georgia. 2015 http://www.eiec.gov.ge/თემები/Biodiversity/Data/Report/Fifth-National-Report-to-CBD-Georgia-ge-01-05-15-(.aspx and https://www.cbd.int/doc/world/ge/ge-nr-05-en.pdf;
vii) Ajara Fauna Registry Office. Institute of Zoology of Ilia State University Rustaveli National Scientific Fund http://faunageorgia.org/index.php?pageid=5&lang=Geo.

- “The species originated from the Mediterranean, 80% of the Black Sea species;
- “Fresh water species” that came from rivers;
- Alien species inhabiting in oceans and distant ecosystems, but have accidentally entered and established in the Black Sea.

Algal flora (seaweeds). The Black Sea is rich in seaweeds, namely phytoplankton, whose diversity depends on salinity and temperature regime of the sea, water column transparency, nutrient content and the number of organic substrata, on wind frequency and strength. Black Sea coastal and continental shelf waters are eutrophic (rich in nutrients). That is why it outstrips many seas around the world in terms of green biomass and productivity.

In Figure 1.13 the satellite image of the Black Sea is shown, in which the greenish-bluish spirals and rings apparently represent blossomed phytoplankton and sediment plumes.

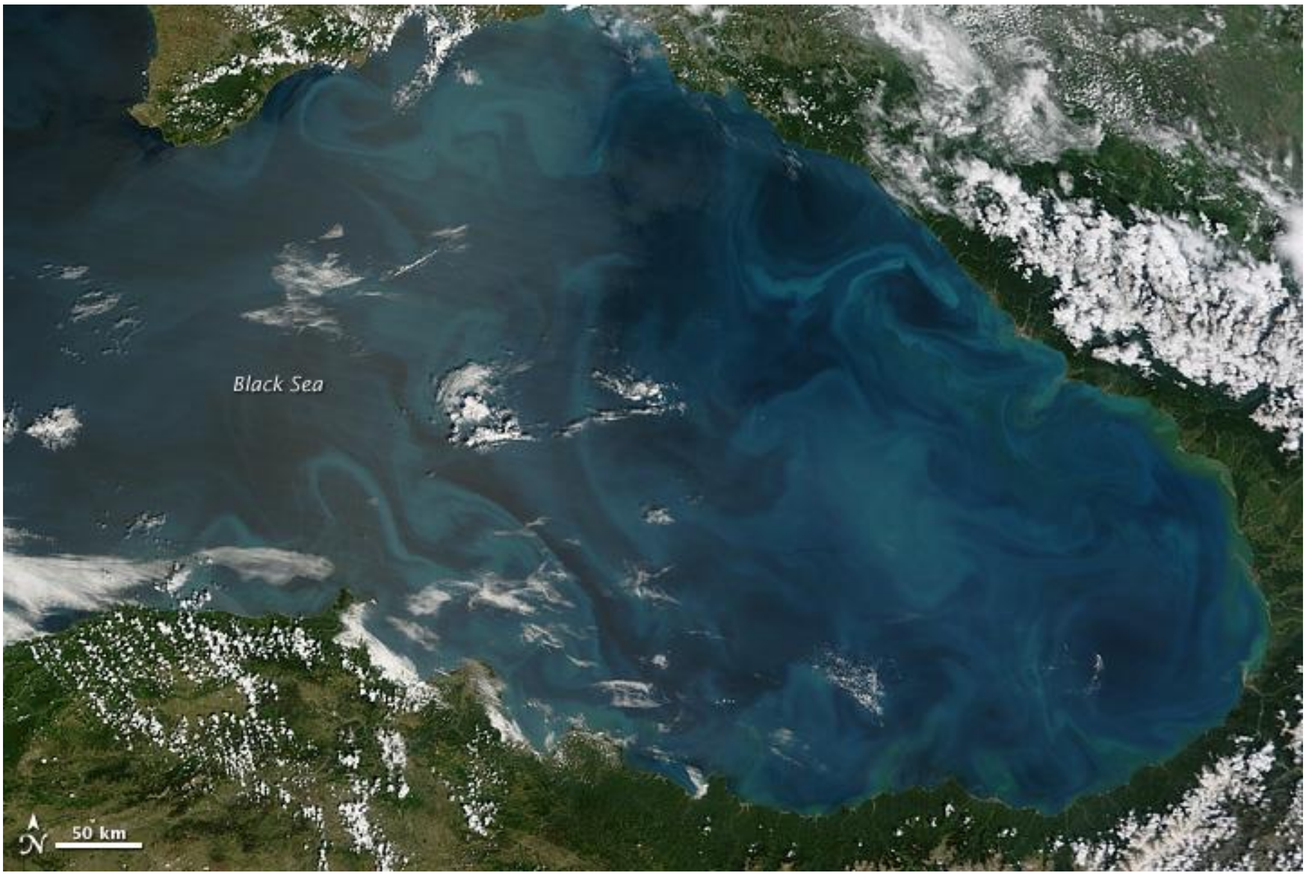

Fig. 1.13 Satellite photo of the Black Sea taken on 18 May 2012 and 30 May 2006 [44]

In winter, as a result of strong winds, relatively warm masses of water, together with their nutrients, move towards the water surface. But in summer, because of high temperatures, warm, shallow and mixed zones of a vertical stratification of the water are formed. The length of the day and the intensity of sunlight also affect the photic zone (sunlit zone of the sea) distribution. Nutrient availability is the limiting factor for the productivity of the sea plants below the photic zone, as lower layers of the water collect nitrate that are assimilated to ammonium and create depots. Sea benthic zone also plays an important role in the cycle of nutrients, as chemosynthetic bacteria and anoxic geochemical cycles provide nutrient recycling, which may reach the photic zone and increase the productivity of the algae.

[44] http://www.earthobservatory.nasa.gov/IOTD/view.php?id=77984&eocn=image&eoci=related_image

The study of the coastal phytoplankton in Georgian part of the Black Sea began in the 50s of the 20th century. The specific structure of Phytoplankton and the dominant species were recorded and 99 species were identified by the 1970s. In the 1980s, after the start of a large-scale study, it was revealed 116 species, while 155 species were identified in the 1990s. In the period of 1981-1991, The Black Sea Scientific-Research Institute of the Ecology and Fisheries carried out a study of the entire Black Sea coast of Georgia (from the River Chorokhi to the River Bzipi); phytoplankton material was collected at 8-12 sections, at various depths (0, 5, 10, 25, 50, 75, 100 m), at approximately 68-70 stations.

Algal flora of Ajara coastline is mainly represented by following groups - *Bacillariophyceae*, *Dinophyta, Chlorophyta, Cyanophyta, Chrizophyta, Xantophyta, Euglenophyta*, in which more than 250 varieties are united. Out of these, the main biomass of the Black Sea phytoplankton is created by diatoms (102 varieties) and dinophytes (96 varieties). 24 varieties of green seaweeds can be found in the Black Sea and as for cyanophyta – there are 22. Chrysophyte algae come in 22 varieties and 6 varieties of Xantophyta.

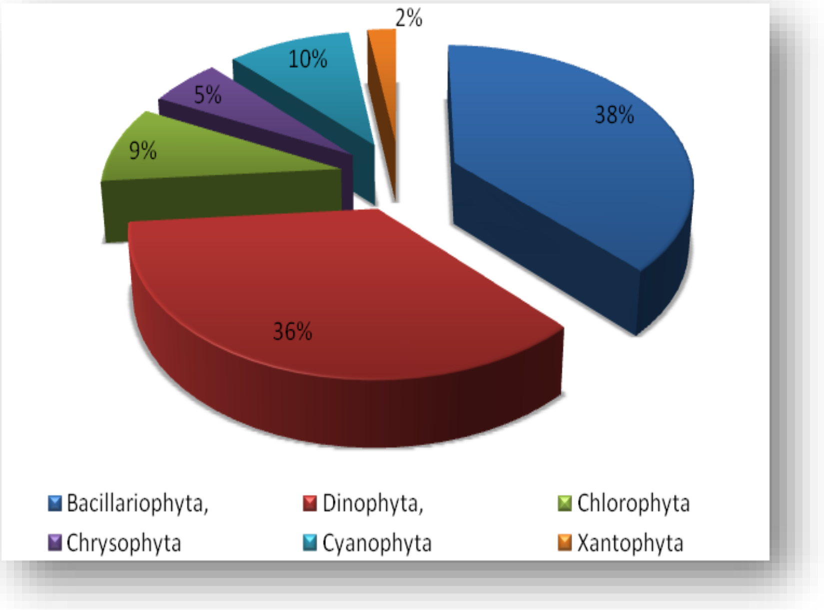

Fig. 1.14 Composition of Phytoplankton groups in Black Sea waters of Georgia [45]

The studies conducted in the 80s revealed the following dominant species among diatoms: *Thalassiosira parva, Nitzschia seriata, Nitzschia longissima, Rhizosolenia alata, Rhizosolenia calcaravis*. While 2010-2013 data showed that the following diatomic algae and dinophytes were prevalent: *Thalassionema nitzschioides, Sceletonema costatum, Chaetoceros curvisetus, Ch. lorensianus, Ceratium furca, C. fusus, Gymnodinium* and *Prorocentrum*. Dominant sub-species are: *Skeletonema costatum, Chaetoceros socialis, Ch. curvisetus Ch. affinis Cyclotella caspia*, whereas the dominant dinoflagellates were *Prorocentrum cordatum, Pr. micans, Prorocentrum compressum, Protoperidinium pellucidum, P. steinii, Hetercocapsa triguetra, P. bipes, Cetarium fusus, C. furca*. In some years, the abundance of *Microcystis acruginosa, Anabaena flos-aquae, Ankistrodesmus falcatus, Scenedesmus acuminatus, Trachaelomonas volvocina var. punctata* and *Euglena viridis* is marked. The abundance of algae is observed in estuaries and lagoons where salinity was less than 8-10 PSU as well as at ports and sewage discharge points.

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[45] Pilot monitoring of coastal waters of Georgia. Ministry of Environment and Natural Resources Protection. National Environmental Agency. Fishery and Black Sea Monitoring Service. Environmental Pollution and Monitoring Department. In accordance with European legislation on environmental protection (water framework directive and marine strategy framework directives). Batumi, 2016.

Annual cycle of the Black Sea phytoplankton development consists of the following phases:

a) Spring flowering season of diatom biomass dominated by *Dinoflagellata*;
b) Development of the relatively weak colonies of phytoplankton community below the seasonal discontinuity in the summer months;
c) Intensive formation of biomass on the sea surface in the autumn period.

Diatoms in the Black Sea are mainly represented in the form of the homogeneous colonies. The rapid growth of their populations is caused by silicate sediment discharge into the sea. When silicon is running low, the algae begin to emerge from the photic zone and they produce cysts (zygotes). Diatom annual cycle, zooplankton feeding, and ammonium-dependent regeneration also play an additional role.

Annual distribution of *Dinophytes* is defined in late spring and summer during the prolonged blow of algoid plants in subsurface zone of the sea. In November the formation of subsurface biomass is combined with superficial blow as a result of the vertical mixture of water masses with nutrients (specifically nitrites). The main type of forming biomasses is *Gymnodinium sp*. The variety of dinofits is not up to the Mediterranean indicator which is conditioned by a comparatively high freshwater, low transparency and the existence of anoxic water layers.

Macrophyte community of the Georgian Black Sea coast is not well investigated. First joint researches along rocky shores of Ajara coastline were carried out in 1999-2000 with the participation of Georgian and Ukrainian scientists. On the basis of obtained results Sarpi-Kvariati water area in terms of biodiversity was regarded as one of “hot points” of the Black Sea coast. Of particular note is the perennial water-plant *Cystoseira barbata* was recorded only in mentioned area. Cystoseira inhabiting surface marine waters has particular biological and environmental importance. This water-plant is a sensitive bio-indicator the existence or absence of which indicates the environmental state of the mentioned water area. *Cystoseira* could not adapt to eutrophicated water, therefore, it almost disappeared in north-western coast of Black Sea. *Cystoseira barbata* is an edificatory species of *Cystoseira* biocenosis which in turn covers many species growing on rock including dozens of epiphytic water-plants and invertebrates. In Sarpi water area also were recorded indicator species that define Good Ecological/Environmental Status (GES): *Zanardinia prototypes* and *Nemalion helminthoides*. At the time, in our coast were described 34 macrophyte species (Table 1.11).

Table 1.11 Macrophytes of Sarpi-Kvariati section of Georgia’s Black Sea shelf, 1999-2000[46]

Chlorophyta	*Scytosyphon lomentaria*
Enteromorpha intestinalis	*Striaria attenuate*
Ent. ahlneriana	*Cystoseira barbata*
Ent. flexuosa	
Cladophora dalmatica	**Rhodophyta**
Cl. vadorum	*Erythrotrichia carnea*
Cl. laetevirens	*Porphyra leucosticte*
Phaeophyta	*Kylinia virgatula*
Ectocarpus arabicus Fig.	*Nemalion helminthoides*
Ec. confervoides (Roth)	*Gymnogongrus griffithsiae*
Ec. siliculosus	*Antithamnion plumose*
Ascocyclus orbicularis	*Ceramium diaphanum*

[46] Pilot monitoring of coastal waters of Georgia. Ministry of Environment and Natural Resources Protection. National Environmental Agency. Fishery and Black Sea Monitoring Service. Environmental Pollution and Monitoring Department. In accordance with European legislation on environmental protection (water framework directive and marine strategy framework directives). Batumi, 2016.

Stilophora rhizodes	*C. arborescens*
Zanardinia prototypes	*C. rubrum*
Dictiota dichotoma	*Callithamnion corymbosa*
Dilophus fasciola	*Nitophullum punctatum*
Padina pavonica	*Heterosiphonia plumose*
Stipocaulon scoparium	*Polysiphonia sanguinea*

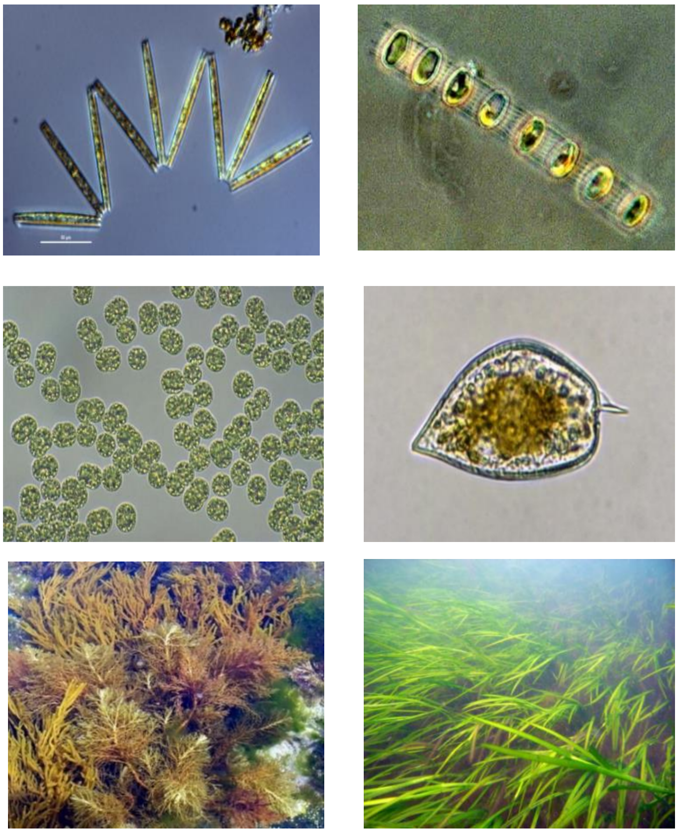

Fig. 1.15 Black Sea Seaweeds[47]

Invertebrates. Invertebrates make up the most numerous and diverse group among the Black Sea animals. They occupy an important place in food chain, since they provide food for many fish species.

Black Sea benthofauna is of Mediterranean origin still 4-5 times poorer than Mediterranean zone itself. The basic adverse factors for Mediterranean form settlement into the Black Sea area is the low-salinity of water on this eco-system and the existence of Hydrogen Sulfide zone which limits distribution of organisms (except hydrogen Sulfide bacteria) on this area.

The main determining factor of the bottom settlement is the ecological environment – bed, substrate. Benthic zone of the abovementioned exploratory regions is formed by the small and heavy fractions of sand, easily washable silt in different amount, detrite admixture and the fragments of mollusc shells. The facilitating factors for biodiversity in Neritic zone of Black Sea Georgia area are affluent rivers of West Georgia such as Bzipi, Kodori, Enguri, Rioni and Chorokhi. Natural conditions of this region are advantageous for its Hydrofauna.

There are numerous materials about Benthofauna of the Caucasian coastal region. Though the detail exploration of the bottom fauna of the coastal zone of Georgia started in the 70s of the XX century and is continuing now. The explorations were held on Sarpi-Gudauta section

[47] Black Sea Box http://www.ge.undp.org/content/dam/georgia/docs/publications/GE_UNDP_EE_Black_Sea_Box_Geo.pdf.

of the coastal zone of Georgia and included numerous depth transects. Nowadays samples are taken from Sarpi-Anaklia area of water on isobaths 0 m and 20 m. The annotated list of Black Sea bed coastal fauna has been compiled on the bases of 40 year-long findings of Benthofauna. The systematical structure of specific composition of Macrozoobenthos comprises 2 kingdoms, 12 phylum, 17 classes, 42 order, 93 families, 152 genus, 185 species.

The zooplankton of Georgian Black Sea coast is represented by widespread species of the Black Sea, crustaceans are the most diverse group - 43% of all zooplankton, of which 33% are copepods and 10% cladocerans, which make up the bulk of food zooplankton for pelagic fish species. Of other groups of planktonic invertebrates, only single species are found.

One of the most important species of The Black Sea zooplankton is *cnidaria*. Specifically, the species of this family, such as, *Scyphozoa, Hydrozoa, Anthozoa* are spread in this area. From Anthozoas we meet sea actants (such as *Actinia equina, Actinothoe clavata*); from hydrozoas – hydra (such as *Hydra viridis, Hydra vulgaris*) and from *Scyphozoa – Aurelia aurita* belonging to the dominant class of Black Sea Jellyfish. Besides, *Ctenophora* (class - *Tentaculata*) is the most spread species. In this family, transparent, free-swimming animals are included, which possess groups of shining combs arranged in rows. Two types of a scallop can be found in Georgian coastal waters: 1) *Cydippida* and 2) *Lobata*. From the first type the following species are the most common: *Pleurobrachia pileus* and *Pleurobrachia rhodopis*, and from the second – *Mnemiopsis leidyi*. This is a kind of invasive species, which is likely, to enter in this area in the 80s of the last century, along with the vessels arrived from North America and spread through ballast water. It decreased the anchovy population. However, in 1997, another type of invasive species, *Beroe Ovata*, also spread through ballast water, which started to hunt for *Mnemiopsis leidyi*.

Rotifera, one of the other invertebrate species of zooplankton, is widely spread in Ajara coastal waters.

Zoobenthos of the coastal waters (near-bottom fauna) is formed by three main types of invertebrate species: *Annelida*, *Mollusca* and *Arthropoda*, as well as its subtype – *Crustacea*.

Molluscs are the leading species characterized by a wide variety and have several classes. They are: 1) *Gastropoda* i.e. *Bela nebula, Brachystomia eulimoides, Parthenina interstincta, Tritia neritea, Trophonopsis breviata*; 2) Bivalvia i.e. *Brachystomia eulimoides, Anadara kagoshimensis, Arca tetragona, Donax trunculus, Chamelea gallina, Lentidium mediterraneum, Lucinella divaricata, Modiolula phaseolina, Pitar rudis* and *Fabulina fabula*; 3) *Polyplacophora* - *Lepidochitona cinerea*.

Molluscs can be found mainly in the 60-70 m-long sections of the water column in rocky substrates, covered with algae, and in the bottom sand with substrate of fine sand and shells. The maximum length of molluscs is 20 cm. One of the biggest shellfishes is veined rapa whelk or Asian rapa whelk (*Rapana venosa*). It is a kind of alien species, which appeared in the Black Sea in the 1950s. It is a predator foe bivalves and therefore, has a negative impact on the food chain. However, intensive hunting for bivalves has begun and, therefore, the number of Asian rapa whelk populations has plummeted.

Among chaetopod, *Polygordius lacteus, Polygordius neapolitanus, Arenicolides branchialis, Heteromastus filiformis, Heteromastus filiformis, Ophelia bicornis, Nainereis laevigata, Aricidea cerrutii, Aricidea pseudoarticulata, Cirrophorus harpagoneus, Prionospio cirrifera, Terebellides stroemii, Magelona rosea* and other species are widespread in Black Sea shelf detrites and in shelly gravels. More than 50 species are represented in Ajara coastal waters.

From the class of benthos crustacean, following species are spread: 1) *Malacostraca Latreille – Amphipoda, Decapoda, Isopoda, Mysida, Cumaceas, Tanaidaceas*; and 2) *Maxillopoda, Sessilia*; 3) *Ostracoda*. Benthos crustaceans lie motionless like anchors on the bottom and are basic feed for deep water fish (red mullet and Black Sea whiting).

The rest of Zoobenthos species are united under the types of *Coelenterata*, *Plathelminthes, Nematoda, Porifera, Nementini* and *Sarcomastigophora* and covers about 10 % of the whole Zoobenthos.

Fig. 1.16 Black Sea invertebrates - aurelia, conch shells, sponge, ctenophora, crab[48]

Ichthyofauna. Ichthyofauna in the Black Sea waters of Georgia is represented by anadromous (those that spend most of their lives in the sea but migrate to fresh water to spawn), catadromous (those that spend most of their lives in fresh water, then migrate to the sea to breed), pelagic (fish living in the open sea), demersal fish (the fish living on the bottom of the sea or nearby), coastal (neritic) and fishes with mixed habitats:

1) Anadromous and anadromous-demersal fishes such as sturgeons and salmons - *Huso huso, Acipenser persicus colchicus, Acipenser sturio, Acipenser gueldenstaedtii, Acipenser nudiventris, Acipenser stellatus, Salmo labrax*;

2) Pelagic-neritic and pelagic fishes - *Atherina pontica, Belone belone euxini, Trachurus mediterraneus ponticus, Alosa caspia, Sardina pilchardus, Sprattus sprattus, Sardinella aurita, E. encrasicolus ponticus, Aphia minuta, Chelon auratus, Planiliza haematocheila, Chelon saliens, Mugil cephalus, Pomatomus saltatrix, Sarda sarda, Scomber scombrus, Thunnus thynnus, Boops boops, Xiphias gladius;*

3) Demersal, demersal-benthic and demersal-pelagic-neritic fishes - *Aidablennius sphynx,*

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[48] i) Black Sea Box http://www.ge.undp.org/content/dam/georgia/docs/publications/GE_UNDP_EE_Black_Sea_Box_Geo.pdf.

Blennius ocellaris, Microlipophrys adriaticus, Salaria (Lipophrys) pavo, Arnoglossus kessleri, Callionymus pusillus, Callionymus risso, Callionymus lyra, Spicara smaris, Spicara maena, Conger conger, Dasyatis pastinaca, Merlangius merlangus, Lepadogaster candollii, Gobius niger, Knipowitschia caucasica, Knipowitschia longecaudata, Mesogobius batrachocephalus, Neogobius melanostomus, Neogobius ratan, Neogobius gymnotrachelus, Proterorhinus marmoratus, Symphodus tinca, Lophius piscatorius, Dicentrarchus labrax, Mullus barbatus, Mullus surmuletus, Ophidion rochei, Chromis chromis, Raja clavata, Sciaena umbra, Umbrina cirrosa, Psetta maxima maeotica, Scorpaena porcus, Serranus cabrilla, Serranus scriba, Pegusa nasuta, Diplodus annularis, Diplodus puntazzo, Sarpa salpa, Sparus aurata, Squalus acanthias, Hippocampus guttulatus, Nerophis ophidion, Syngnathus abaster, Syngnathus tenuirostris, Syngnathus typhle, Syngnathus variegatus, Trachinus draco, Chelidonichthys lucernus, Uranoscopus scaber;

4) Catadromous fishes - *Anguilla anguilla*.

According to IUCN classification all varieties of sturgeons are on the verge of extinction.

Out of teleosts in the Black Sea and transitional waters, the Red List of Georgia includes:

- *Salmo fario Linnaeus*
- *Rutilus frisii Nordmann*
- *Varicorhinus sieboldi Steindachner*
- *Neogobius fluviatilis Pallas.*

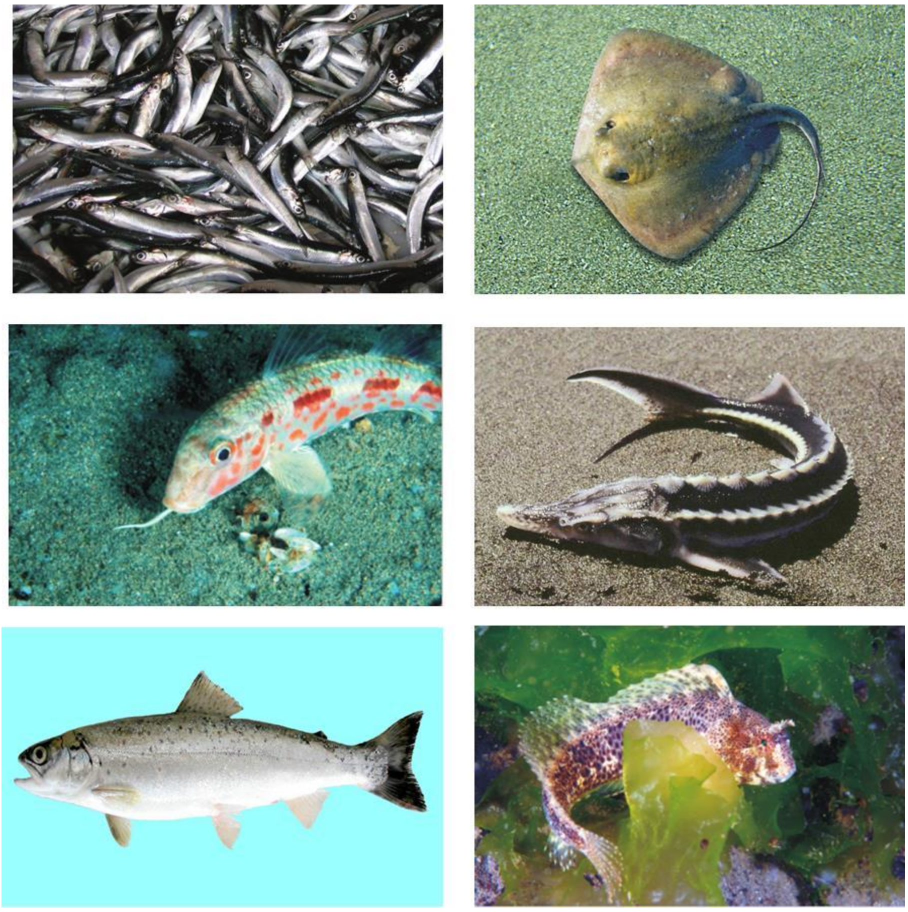

Fig. 1.17 The Black Sea fish. Anchovies, Sea bear, sultan, Kolkhic sturgeon, Black Sea salmon, tentacled blenny [49]

[49] Black Sea Box http://www.ge.undp.org/content/dam/georgia/docs/publications/GE_UNDP_EE_Black_Sea_Box_Geo.pdf.

Marine mammals. In the Black Sea territorial waters of Georgia (about 200 m depth and above) three species of dolphins can be found: bottle-nosed dolphins, porpoise and white-sided bottlenose. Dolphins inhabiting Black Sea are distinguished according to three sub-species: *Tursiops truncatus ponticus, Delphinus delphis ponticus, Phocoena phocoena relicta*. All three sub-species are entered into the IUCN Red List: *Delphinus delphis ponticus*, as being vulnerable (VU; A2cde); *Tursiops truncatus ponticus* as endangered (EN; A2cde); *Phocoena phocoena relicta* - as endangered. In accordance to surveys conducted in 2014, in winter season there are about 18000 porpoises and 16000 white-sided bottlenoses in territorial waters of Georgia in total, which points to the fact, that the Black Sea Aquatorium of Georgia is a wintering site for cetaceans and therefore it is a vitally important area.

The population of bottle-nosed dolphins is very small and it counts only 100-150 individuals. Most important threats for the Black Sea dolphins are bycatch in fishing gear (especially for porpoises), chemical pollution (oil products, heavy metals and solid waste), noise pollution and eutrophication.

Fig. 1.18 Sea mammals [50]

[50] Black Sea Box http://www.ge.undp.org/content/dam/georgia/docs/publications/GE_UNDP_EE_Black_Sea_Box_Geo.pdf.

2 Chorokhi-Ajaristskali Basin Coastal & Transitional Waters

2.1 Methodology for delineation of coastal and transitional water bodies

One of the first stages in the implementation of the WFD to a River Basin district is the characterisation of all occurring water bodies. This process can be referred to as typology. According to the provisions of the WFD the characterisation of water bodies within each surface water category (coastal and transitional) can be undertaken according to two typology systems: System A (fixed system with obligatory delineation factors) or System B (system with obligatory and optional delineation factors). For the delineation of the transitional and coastal waters appearing in Georgia the System B has been applied.

The coastline of Georgia from Sarpi (border to Turkey) in the south to the Psou river (border to Russia) in the north is 315 km long. The important freshwater inflows are provided by Chorokhi, Supsa, Rioni, Khobistskali, Enguri, Kodori and Bzipi rivers, forming transitional waters of different sizes between rivers and coastal waters. Both categories of coastal and transitional water bodies are exposed to a variety of pressures like inputs of nutrients and priority substances from municipal and industrial wastewater outfalls, agricultural activities, offshore installations, marine traffic, but also due to invasive species, hydromorphological alterations and fisheries.

Methodology used for the identification of water body categories (surface, transitional and coastal waters), definition of their types and then delineation was specifically based on the instructions on the division of water bodies set in the 2nd Appendix of Water Framework Directive, as well as methodology on typology of Coastal and Transitional Waters, reference conditions and classification systems as provided in the 5th guidance document of the general implementation strategy of Water Directive and recommendations developed within the project framework.[51]

Taking into consideration that no detailed average annual spatial data, such as the sea salinity, current's speed, wave exposure, average water temperature, turbidity are available, the coastal waters have been divided according to average depth, as well as the morphometry (type of substrate). Salinity and typology (delta/estuary) were also used as the criteria for the differentiation of transitional water bodies.

Considering various delineation options during the EUWI+ consultations, workshops and trainings, as well as based on the results of coastal surveys, the considerations following below are proposed for the delineation of coastal and transitional water types and water bodies in the pilot area from Sarpi to Kobuleti.

[51] i) Directive 2000/60/EC of the European Parliament and the Council. http://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF;
ii) Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance document no 5. Transitional and Coastal Waters Typology, Reference Conditions and Classification Systems. https://circabc.europa.eu/sd/a/85912f96-4dca-432e-84d6-a4dded785da5/Guidance No 5 - characterisation of coastal waters - COAST (WG 2.4).pdf;
iii) Notes on the development of water framework directive and transitional waterbody typologies and Guidance on monitoring of such waterbodies to conform with EC environmental legislation. Environmental Protection of International River Basins Project. Hulla & Co. Human Dynamics KG. http://blacksea-riverbasins.net/system/files_force/Annex 8_Salty WFD monitoring_final_v2_Eng.pdf.

Obligatory and optional typology factors (System B, EUWI+ proposal) for Coastal and Transitional Waters are given in Table 2.1.

Table 2.1 Proposed typology factors for Coastal and Transitional Waters in Georgia.

TYPOLOGY FACTORS FOR GEORGIAN COASTAL AND TRANSITIONAL WATERS		
Coastal waters	**Obligatory**	Latitude, Longitude
		Tidal range
		Average annual salinity range
	Optional	Mean depth
		Mean substratum composition
Transitional waters	**Obligatory**	Latitude, Longitude
		Tidal range
		Average annual salinity range
	Optional	Origin of transitional waters

Application of above factors, relevant justifications/argumentation and suggested type-coding supporting proposals for delineation are considered below.

2.1.1 Transitional waters

According to the obligatory factors, all Georgian Transitional Waters are:

- Located in the Ecoregion "Black Sea";
- Exposed to a microtidal range (< 1 m);
- Characterised with fluctuating salinities in the range 0.5-10 (oligo-mesohaline).

In addition to the obligatory factors the chosen optional factor differentiates the transitional waters originating from marine waters or lakes.

Taking these delineation factors in account, theoretically 2 transitional water types can appear in Georgia (Table 2.2).

Table 2.2 Possible transitional water types appearing in Georgia.

<table>
<tr><th colspan="2">Transitional water type</th><th rowspan="2">Ecoregion</th><th rowspan="2">Tidal range</th><th rowspan="2">Salinity range (PSU)</th><th rowspan="2">Origin</th></tr>
<tr><th>Description</th><th>Code</th></tr>
<tr><td>Oligo-mesohaline transitional water type with estuary origin</td><td>GE_TW11</td><td rowspan="2">Black Sea</td><td rowspan="2">Microtidal</td><td rowspan="2">0.5 < s < 10</td><td>Marine</td></tr>
<tr><td>Oligo-mesohaline transitional water type with lake origin</td><td>GE_TW12</td><td>Lake</td></tr>
</table>

2.1.2 Coastal waters

According to the obligatory factors, all Georgian coastal waters are:
- Located in the Ecoregion “Black Sea”;
- Exposed to a microtidal range (< 1 m);
- Characterized by a narrow average annual salinity range (15 < S < 18), except for areas in front of rivers with significant freshwater discharge, where the annual salinity fluctuations are stronger expressed (10 < S < 18).

In addition to the obligatory factors the chosen optional factors are:
- depth, which differentiates shallow (< 30 m) from deep (> 30 m) coastal areas;
- substratum size, which differentiates fine grained substrate (< 45 µm; clay and mud) from coarse grained substrate (> 45 µm; sand-pebble),

Taking these delineation factors in account, theoretically 8 coastal water types can appear in Georgia (Table 2.3).

Table 2.3. Possible coastal water types appearing in Georgia.

Coastal water type		**Ecoregion**	**Tidal range**	**Salinity range (PSU)**	**Mean depth (m)**	**Mean substratum size (µm)**
Description	**Code**					
Mesohaline, shallow coastal water type with fine grained substrate	GE_CW111	Black Sea	Microtidal	10-18	Shallow (< 30 m)	Fine grained (< 0.45 µm)
Mesohaline, deep coastal water type with fine grained substrate	GE_CW112			10-18	Shallow (< 30 m)	Coarse grained (> 0.45 µm)
Mesohaline, shallow coastal water type with coarse grained substrate	GE_CW121			10-18	Deep (> 30 m)	Fine grained (< 0.45 µm)
Mesohaline, deep coastal water type with coarse grained substrate	GE_CW122			10-18	Deep (>30 m)	Coarse grained (> 0.45 µm)
Narrow mesohaline, shallow coastal water type with fine grained substrate	GE_CW211			15-18	Shallow (< 30 m)	Fine grained (< 0.45 µm)
Narrow mesohaline, deep coastal water type with fine grained substrate	GE_CW212			15-18	Shallow (< 30 m)	Coarse grained (> 0.45 µm)
Narrow mesohaline, shallow coastal water type with coarse grained substrate	GE_CW221			15-18	Deep (> 30 m)	Fine grained (< 0.45 µm)
Narrow mesohaline, deep coastal water type with coarse grained substrate	GE_CW222			15-18	Deep (>30 m)	Coarse grained (> 0.45 µm)

Type coding principle for coastal and transitional water body types suggested for Georgia are shown in Table 2.4.

Table 2.4. Principle of coastal and transitional type coding.

Country	Surface water category	Typology factor				Type code
		Salinity	Origin	Depth	Substrate size	
	Coastal waters (CW)	Mesohaline	-	-	-	GE_CW1␣␣
		Narrow mesohaline		-	-	GE_CW2␣␣
Georgia (GE)		-	-	Shallow	-	GE_CW␣1␣
		-		Deep	-	GE_CW␣2␣
		-	-	-	Fine grained	GE_CW␣␣1
		-		-	Coarse grained	GE_CW␣␣2
	Transitional waters (TW)	Oligo-mesohaline	-	-		GE_TW1␣
		-	Marine			GE_TW␣1
		-	Lake			GE_TW␣2

2.2 Identified Coastal and Transitional Water bodies in the EUWI+ pilot area

In the coastal zone from Sarpi to Kobuleti (EUWI+ pilot area) 5 coastal water types and 7 coastal water bodies, as well as 1 transitional water type and 1 transitional water body was identified and all these Coastal and Transitional Water are shown in Table 2.5 and Fig. 2.1.

The proposed coastal and transitional water bodies are listed together in counter clockwise order and in landward-seaward direction with respect to the Black Sea coastline.

Table 2.5 Coastal & transitional water bodies from Sarpi to Kobuleti, Georgia.

Water category	Water type	Water body		Geographic position (**)	
		Site	Name (*)	Latitude	Longitude
Coastal	GE_CW222	From Sarpi to Chorokhi estuary	CW222_SaCh	41.51876 N 41.606517 N	41.528452 E 41.572925 E
Transitional	GE_TW11	Chorokhi estuary	TW11_Ch	41.598801 N 41.60808 N	41.573412 E 41.582099 E
Coastal	GE_CW111	From Chorokhi estuary to Batumi cape - near coast	CW111_ChBaC	41.5988 N 41.649227 N	41.571387 E 41.627758 E
Coastal	GE_CW212	From Chorokhi estuary to Batumi cape	CW212_ChBa	41.597429 N 41.673666 N	41.554294 E 41.647106 E
Coastal	GE_CW211	Batumi harbour	CW211_BaHa	41.646346 N 41.655154 N	41.647855 E 41.660823 E
Coastal	GE_CW221	From Batumi cape to Korolistskali river	CW221_BaKo	41.649063 N 41.679554 N	41.645445 E 41.688704 E
Coastal	GE_CW211	From Korolistskali river to Tsikhisdziri cape	CW211_KoTs	41.667299 N 41.779636 N	41.673601 E 41.759632 E
Coastal	GE_CW221	From Tsikhisdziri cape to Kobuleti	CW221_TsKb	41.773139 N 41.869945 N	41.739112 E 41.782162 E

(*) SsTt/Rr Abbreviation of settlement or town / estuary or lake. (**) Shapefile min/max extents.

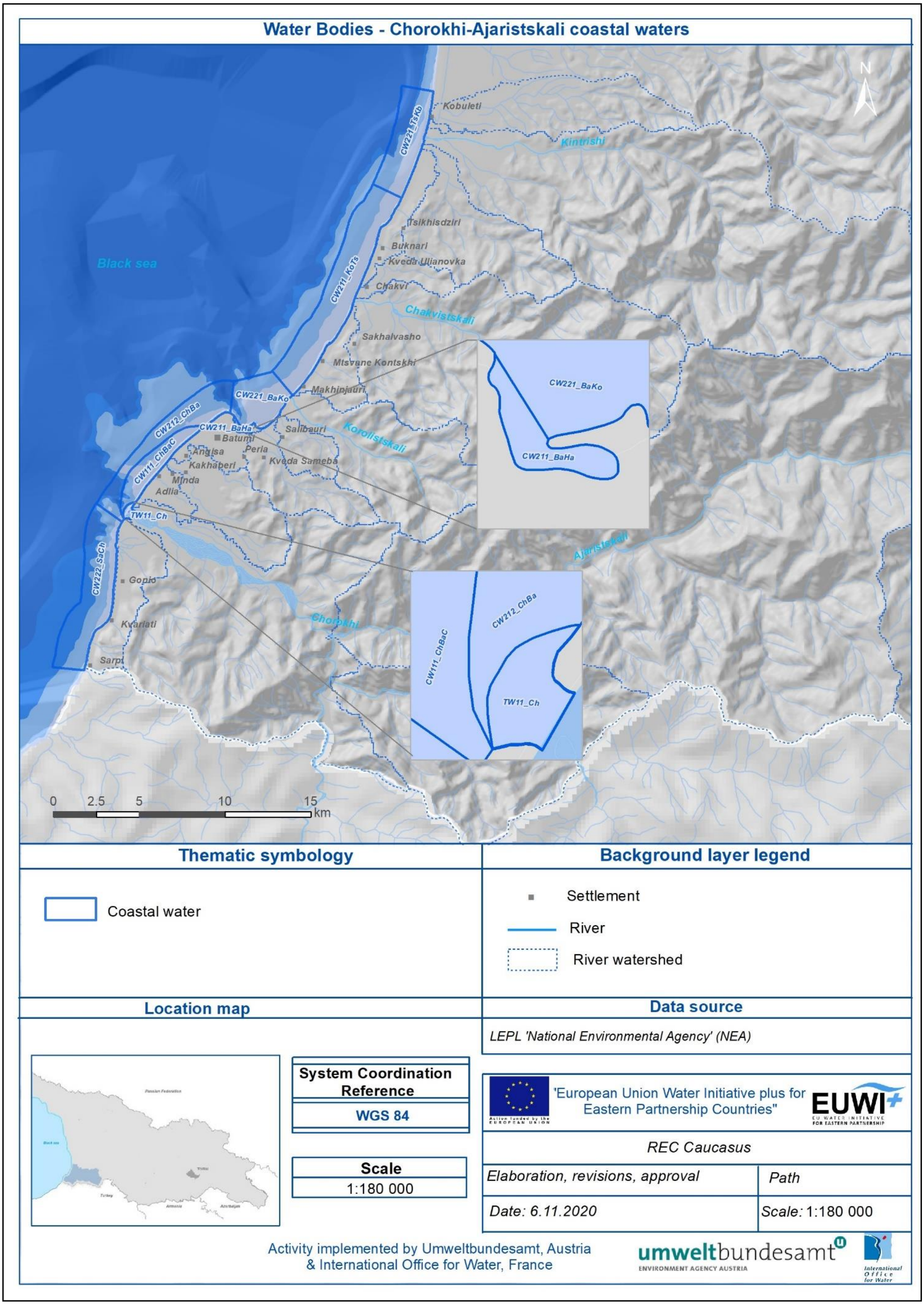

Fig 2.1 Coastal and transitional water bodies in Georgia from Sarpi to Kobuleti

Significant pressure-impact issues and water bodies at risk

3 Risk analysis of significant pressure-impacts for coastal and transitional waters

3.1 Methodology

There are no approved coastal and transitional water monitoring and water body classification systems corresponding to EU Water Framework Directive and its strategy implementation methodological documents in Georgia so far. Besides, the existing long-term monitoring data on biological, chemical, physico-chemical and hydrological quality elements of the water are rather limited in scope and sporadic in frequency. Consequently, it was impossible to identify the ecological status of the revealed water bodies and classify them. Instead, the assessment of pressure and possible/existing impact on water bodies (given the available corresponding information on impact indicators) has been based on the available literature, research or the data from incidental observations and feedback from various authorities in response for data requests. The aim of the study was to reveal water bodies "at risk" and the significant impact causing moderate to bad ecological status and the failure to achieve good ecological status.

The study has been divided into two stages. Initially, the main driving forces and respective significant pressure and impact specific for Ajara shoreline and coastal zone, were identified. At the second stage, the pressure-impact relation for individual water bodies were analysed and water bodies "at risk", with bad ecological status due to pressure-impact, were identified.

Concerning the methodology to reveal the main driving forces (or the drivers) and significant pressure-impact and risk assessment, the study used the method of the so called logical frame "DPSIR" – Driver-Pressure-State-Impact-Response analysis – which is provided in the 3rd guidance document of strategy implementation of EU Water Framework Directive.[52] Identification of water bodies at risk was based on significant pressure, negative impact proved by available empirical data (water quality and hydrological indicators, conservational status of biodiversity, etc.) and expert opinions. During risk assessment, the results of monitoring provided by the National Environmental Agency and other authorities, as well as the joint field research carried out in June 2016 (EPIRB) and 2019 (EUWI+), were taken into consideration.

The first stage of the study included the phases of screening and scoping of drivers and pressure-impact. The initial, screening phase considered all possible drivers and corresponding pressure-impact, typical for the Black Sea coast, whereas in the next phase, main driving forces and corresponding pressure, scope of activities and geographic scale, as well as respective environmental risks connected with them, were identified. In this process, we used the existing baseline information about the Black Sea, and in particular, the reports containing information about the driving forces and respective pressure-impact within the coastal zone, such as draft Integrated Coastal Zone Management Strategy for Georgia,[53] Chorokhi-Ajaristskali River Basin management plan project, the regional Strategic Action

[52] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance document no 3. Analysis of Pressures and Impacts. https://circabc.europa.eu/sd/a/7e01a7e0-9ccb-4f3d-8cec-aeef1335c2f7/Guidance No 3 - pressures and impacts - IMPRESS (WG 2.1).pdf.

[53] https://sites.google.com/site/iczmgeo/Home/20100322_Draft_ICZM_Strategy_GEORGIA_ENG.pdf https://sites.google.com/site/iczmgeo/Home/20100322_Draft_ICZM_Strategy_GEORGIA_GEO.pdf

Plan for the Environmental Protection and Rehabilitation of the Black Sea (2009) and, above all, the study based on the drivers and respective pressure-impact checklist (typical drivers and pressure-impact list) provided in the 3rd guidance document on strategy implementation of EU Water Framework Directive and pressure indicators (for instance, indicators and criteria elaborated by German Government), the list of pressure-impacts given in the 3rd Appendix of the 56th frame directive of 17 June, 2008 of the EU defining the Black Sea environmental policy and the criteria and methodological standards determining good environmental status of the sea water based on qualitative criteria, the so called "descriptors", provided in the EU resolution#477 dated 1 September 2010.[54]

At the second stage, risk analysis was carried out for each water body according to significant pressure and impact. As indicators, we used the parameters, which have impact and significantly influence on the common physico-chemical, biological and hydro-morphological quality elements determining ecological status of water bodies. As well as that, the focus was placed on the parameters determining chemical status (for instance, specific substances, among them, hazardous ones), given the availability of information about them.

Physico-chemical parameters determining ecological status are the following: the content of common ions / electrical conductivity, water temperature, salinity, transparency, content of nutrients, content of suspended particulate matter, oxygen saturation.

The following pressure indicators were used for physico-chemical elements: 1) the amount of effluents discharge in the sea per year and their correspondence with the maximum permissible discharge allowed by technical regulations; 2) capacity of discharge water treatment facility (checklist of German Federal Government (LAWA)); 3) the amount of pollutants with effluents discharge waters (nutrients, particulate matter, substances that have a negative impact on the oxygen balance) per year and their conformity with technical regulations (maximum permissible discharge); 4) the amount of pollutants with effluents discharged per year and their conformity with the technical regulations (maximum permissible discharge); 5) surface water discharge from over a 10^2 km urban settlement area; 6) urban area – over 15% (LAWA pressure checklist); 7) agricultural cultivable land area– 40% and above (LAWA pressure checklist); 8) non-perennial crops area – potatoes, corn, wheat – more than 20% of agricultural lands (LAWA pressure checklist); 9) perennial plants area – vineyards, orchards, citric groves – more than 5% of agricultural lands (LAWA pressure checklist).

Within the given context, pressure-impact indicators for physico-chemical quality elements were the state/quality of coastal and transitional waters in terms of common physico-chemical parameters, among them temperature, salinity, pH, ions, dissolved oxygen, total nitrogen, total phosphorus, ammonium, biological oxygen demand, chemical oxygen demand and their conformity with water quality national standards and/or maximum permissible norms determined by the EU Water Framework Directive and other relevant documents. Besides, microbial contamination and its correspondence with National and EU standards of bathing water quality were used.

[54] i) Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance document no 3. Analysis of Pressures and Impacts. https://circabc.europa.eu/sd/a/7e01a7e0-9ccb-4f3d-8cec-aeef1335c2f7/Guidance No 3 - pressures and impacts - IMPRESS (WG 2.1).pdf;
ii) Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance). http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN;
iii) 2010/477/EU: Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956). http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN.

Parameters determining biological quality of ecological status are following: 1) phytoplankton blooms, population structure / composition and biomass volume; 2) Population size of macro-invertebrates and species composition; 3) Size of benthic invertebrates and species composition; 4) Condition and distribution of habitats, for instance, the area of critical habitats under strong/modified impact (the areas of spawning, mating and feeding, migratory routes of animals and birds) and their functional state; 5) The numbers of alien/invasive species; 6) Age structures and numbers of fish and crustaceans.

Drivers and impact indicators used in the given context were: 1) Fishing; 2) Introduction of alien species; 3) Spread of diseases among fish; 4) Extraction of inert matter from the sea, etc. As for impact indicators, we used the available information on all kinds of biological quality elements.

Hydrological parameters are the following: 1) continuity of the shore/coastline; 2) seabed morphology – depth, shape, amount and structure of substrate; 3) Type of sediment/substrate of the beach/coastline; 4) Shape/morphology of the coast; 5) Sediment balance/budget; 6) Discharge and sediment transport regime/coastal morphodynamics; 7) Sea tidal regime; 8) Wave exposition.

The following indicators of drivers and pressure used in the given context were: 1) reclamation of piers, boating stations and adjacent lands of coastline, melioration (drainage) of wetlands; 2) development of the coastline and estuaries/deltas – building transport infrastructure, residential construction, development of the recreational zone (boulevard, park), construction of landfills; 3) seabed dredging; 4) creation of artificial beaches with inert matter/sediment from sea or riverbed; 5) intensive grazing in coastal wetlands; 6) regulation of freshwater effluents discharge regime as a result of building and operating hydropower stations, dams and reservoirs; 8) carrying out engineering works to protect stormy floods – reinforcement of coast with dams and protective embankments; 9) navigation – anchoring, towing, driftage; 10) fishing with commercial licensed net, angling and poaching.

Indicators used for hydromorphological impact were changes in all known morphological quality elements, where there existed relevant reports. These indicators are: sediment budget, multi-year/ annual river discharge, continuity of the coastline, etc.

According to risk, water bodies were divided into 3 categories: 1) Water bodies at risk; 2) Water bodies at possible risk, and 3) water bodies not at risk.

3.2 Drivers and types of pressures specific for the Black Sea

3.2.1 Screening of drivers and respective pressures

In order to single out the major drivers and pressures in the Black Sea coastal zone, the screening of drivers and pressure categories typical for coastal and transitional waters has been carried out, based on the checklist provided in the 3rd guidance document of the EU Water Framework Directive and the analysis of the local basic situation.

Typical drivers having impact on coastal and transitional surface water bodies and pressure categories are shown in Table 3.1.

Table 3.1 Typical drivers and pressures having impact on coastal and transitional waters [55]

#	Driver/pressure	Driver/pressure source category	Drivers/pressure typical for coastal and transitional waters
Pressure from diffuse sources			
1	Discharge water from industrial/commercial territories/zones	Industrial/commercial territories/zones	X
2	Discharge water from urban-type settlements	Urban-type settlements	X
3	Transport infrastructure	Airports	X
4		Arterial roads	X
5		Railway and facilities	X
6		Ports	X
7	Accidental spillage	Accidental oil spillage from land transport	X
8		Accidental oil spillage from oil terminals	X
9		Accidental oil spillage from ships	X
10	Recreation	Bathing in the sea	X
11		Development of the recreational zones	X
12	Navigation	Sailing of ships in the sea	X
13	Surface water discharge from agricultural cultivable lands	Non-perennial crops, pastures	X
14		Perennial plants	X
15		Overgrazing	X
16	Forestry	Peat digging	
17		Forest planting	
18		Pesticide application into the soil	
19		Manuring the soil with mineral fertilizers	
20	Other	Atmospheric deposition	
21		Applying the silt accumulated during sewage water treatment to the soil	X
Pollution pressure from point sources			
22	Domestic wastewater	Municipal discharge waters, mainly household wastewater discharge	X
23		Municipal waste water with a major industrial component	X
24		Storm waters	X
25		Water discharge from the bodies unconnected to central sewage systems	X
26	Industrial wastewater	Oil processing-storing-transportation	X
27		Chemical industry	
28		Paper and carton production	
29		Textile and wool production	X
30		Production of construction materials	X
31		Electric power production	
32		Leather production	
33		Shipbuilding	X

[55] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance document no 3. Analysis of Pressures and Impacts. https://circabc.europa.eu/sd/a/7e01a7e0-9ccb-4f3d-8cec-aeef1335c2f7/Guidance No 3 - pressures and impacts - IMPRESS (WG 2.1).pdf.

#	Driver/pressure	Driver/pressure source category	Drivers/pressure typical for coastal and transitional waters
34		Other industrial processes	X
35		Deep mining	
36		Opencast coal mining	
37		Oil and gas extraction	
38		Peat digging	
39	Waste handling	Abandoned pits and quarries	
40		Waste coal massif	
41		Tailings dam	
42		Old landfills	X
43		Industrial areas	X
44		Rural landfills	X
45		Military bases	X
46		Existing landfills	X
47		Existing transfer stations and/or scrap metal disposal points	X
48		Land melioration with non-organic waste	X
49	Agricultural facilities	Silt	X
50		Silage barns	X
51		Sheep parasite control measures	X
52		Manure storage facilities	X
53		Storage facilities for agricultural chemicals	X
54		Oil and fuel storage facilities for agricultural equipment	X
55		Agroindustry	X
56	Aquaculture farming/ fish farming	Fish ponds, Aquacultures	X
57		Open sea aquaculture farms	
58	River sources, nutrients, pesticides	Nutrients, pesticides	X
Hydromorphological pressure			
59	Water abstraction	Water abstraction by agricultural enterprises	
60		Abstraction for drinking and production purposes	X
61		Industrial water abstraction	
62		Water abstraction for fish farming	X
63		Water abstraction by hydro energy facilities	X
64		Water abstraction by quarries	X
66		Water abstraction by navigation (filling channels with water)	
67	Discharge regulation	Dams for hydroelectric power purposes	X
68		Water reservoirs	X
69		Protection dams, embankments	X
70		Dams	X
71		Physical alteration of riverbed	X
72	Engineering works	Agro-technical works	
73		Engineering works for fishing industry	X
74	Building & operating of transport infrastructure	Roads, bridges, airports	X

#	Driver/pressure	Driver/pressure source category	Drivers/pressure typical for coastal and transitional waters
75	Flood control	Creating artificial beaches	X
76	Seabed deepening	Extraction of seabed sediment, extraction of inert matter from estuaries and coastal waters	X
77	Land melioration	Land melioration at piers and in the coastline	X
78	Building/operation of marine hydrotechnical facilities, coast/riverbank protection works	Permanent constructions	X
79	Navigation	Navigation	X
80		Anchoring	X
81	Net fishing and angling	Net fishing and angling	X
82	Climate change		X
Biological pressure			
83	Fishing	Net fishing	X
84		Game fishing	X
85	Navigation	Shipping– underwater noise, pollution with fuel, ballast waters	X
86	Contamination of the sea with solid waste	Pollution of the sea with solid waste	X
87	Research	Use of submarine acoustic equipment	X
88	Recreation	Bathing in the sea, sunbathing on the beach	X
89	Manuring the soil with sewage silt	Manuring the soil with sewage silt	
90	Extraction of inert matter / earth from the seabed and dumping	extraction of earth from the seabed and dumping in the water	X
91	Development of the coastline	Modification of natural landscapes	X

Only 19 drivers and/or pressures out of the list given in Table 3.2 are characteristic for Ajara Black Sea coast.

Table 3.2 Drivers and respective types of pressure existing along Ajara coastline

#	**Driver/pressure source category**	**Driver/pressure source category**
Pressure from diffuse sources		
1	Surface water effluents discharge from industrial/commercial and urban areas into the sea	Industrial/commercial areas/zones; cities
2	Transport infrastructure construction and operation	Airports
		Arterial roads
		Railways and facilities
		Ports
3	Accidental spillages	Accidental oil spillage from land transport
		Accidental oil spillage from oil terminals
		Accidental oil spillage from ships
4	Recreation	Bathing in the sea

#	Driver/pressure source category	Driver/pressure source category
		Development of the recreational zone
5	Navigation	Sailing of ships, anchoring, drifting
6	Surface water discharge from agricultural cultivable lands	Non-perennial crops, pasturelands
		Perennial crops,
		Pastures- excess grazing/overgrazing
Pressure from point sources		
7	Effluents discharge from point sources into the sea	Municipal discharge waters, mainly household wastewater discharge
		Storm water
		Industrial wastewater
8	Waste handling	Old landfills
		Industrial areas
		Rural landfills
		Existing landfills
9	Water Discharge from fish farms into the sea	Fish ponds Aquacultures
10	River sources	Nutrients, pesticides
Hydromorphological pressure		
11	Discharge regulations	Dams for hydroelectric power
		Reservoirs
		dams, protective dams reservoirs, embankments
12	Protection of coasts against erosion	Creation of artificial beaches
13	Seabed deepening/ extraction of inert matter	Extraction of inert matter
14	Construction and operation of marine hydro technical facilities	Permanent constructions
Biological pressure		
15	Fishing	Net fishing and angling
16	Contamination of the sea with solid waste	Contamination of the sea with solid waste
17	Climate change	
18	Dumping the inert matter into surface waters	Dumping the inert matter into surface waters

3.2.2 Significant pressures

3.2.2.1 Pollution and eutrophication of coastal & transitional waters from diffuse sources

Effluents discharge into the sea from urban-type settlements and industrial areas – a 50 km coastline of Ajara is located between Khelvachauri and Kobuleti municipalities and within Batumi administrative boundaries. Batumi – the capital of Ajara Autonomous Republic is located here with the population of 154100 (as per 1 January 2015), Kobuleti – with the population of 29200 (as per 1 January 2015), town Chakvi – population 6720 (According to 2014 census data) and villages: Buknari, Tsikhisdziri, Bobokvati, Sarpi, Gonio, Kvariati, Makhinjauri, etc. Apart from that, in the perimeter of 5km of the coastal zone there are many communities. In total, the population in the coastal zone amounts to about 271000.

Table 3.3 Settlements and population in Ajara coastal zone (within perimeter of 5 km)[56]

Municipality	Administrative unit	Settlement	Type of settlement	Size of population[57]
Batumi	Self-governing city of Batumi	Batumi	city	154100[58]
Kobuleti	Kobuleti territorial body	Kobuleti	city	29200[59]
	Chakvi territorial body	Chakvi	town	6720
		Buknari	village	1166
		Sakhalvasho	village	688
	Tsikhisdziri territorial body	Tsikhisdziri	village	2472
		Stalinisubani	village	956
		Shuaghele	village	734
	Bobokvati territorial body	Bobokvati	village	2282
		Kveda Dagva	village	545
	Dagva territorial body	Dagva	village	2032
	Kvirike territorial body	Kvirike	village	1921
		Zeda Kvirike	village	490
		Kveda Kvirike	village	1699
	Gvara territorial body	Gvara	village	1089
		Kveda Konditi	village	320
	Mukhaestate territorial body	Mukhaestate	village	2045
	Khutsubani territorial body	Khutsubani	village	3483
		Kveda Sameba	village	929
		Nakaidzeebi	village	672
	Kobuleti territorial body	Kobuleti	village	2077
		Zeda Sameba	village	597
		Kokhi	village	599
	Sachino territorial body	Sachino	village	758
		Zeda Achkva	village	1037
		Kveda Achkva	village	1136
	Chaisubani territorial body	Chaisubani	village	2847
	Leghva territorial body	Leghva	village	2081
		Tskhrapona	village	698
		Skura	village	403
	Alambari territorial body	Alambari	village	1837
		Zeda Konditi	village	308
	Khala territorial body[60]	Khala	village	1503

[56] Source: Khelvachauri Municipality Assembly body. Resolution №08. 13 August, 2014, Batumi. On the approval of Khelvachauri municipality board provision and http://kobuleti.org.ge/text_files/ge_file_3_1.pdf.
[57] National census 2014 (http://www.geostat.ge): size of population according to administrative-territorial units and gender.
[58] 2015 statistical data.
[59] 2015 statistical data.
[60] Khali community includes v. Chakvistavi, which is situated outside the 5km radius of the coastal zone.

Municipality	Administrative unit	Settlement	Type of settlement	Size of population[57]
		Gorgadzeebi	village	1298
Khelvachauri	Sarpi territorial body	Sarpi	village	2826
		Gonio	village	
		Kvariati	village	
	Makhinjauri territorial body	Makhinjauri	village	735
	Shua Makhinjauri territorial body	Shua Makhinjauri	village	819
	Gantiadi territorial body	Gantiadi	village	1656
	Khelvachauri territorial body	Khelvachauri	village	1085
	Akhalsopeli territorial body	Akhalsopeli	village	2241
		Avgia	village	846
	Zeda Akhalsheni territorial body	Zeda Akhalsheni	village	1474
		Kheghru	village	557
	Tkhilnari territorial body	Tkhilnari	village	2239
		Ombolo	village	204
		Agara	village	318
		Zeda Tkhilnari	village	761
		Makho	village	2479
		Murvaneti	village	189
		Simoneti	village	258
	Charnali territorial body	Charnali	village	2330
	Zemo Charnali territorial body	Zemo Charnali	village	686
	Kapreshumi territorial body	Kapreshumi	village	1195
	Korolistavi territorial body	Korolistavi	village	1079
		Agara	village	672
	Peria territorial body	Peria	village	1830
	Tsinsvla territorial body	Tsinsvla	village	3115
	Salibauri territorial body	Salibauri	village	1214
	Ganakhleba territorial body	Ganakhleba	village	2009
	Akhalsheni territorial body	Akhalsheni	village	953
	Gantiadi territorial body	Gantiadi	village	1656
	Sameba territorial body	Sameba	village	1732
		Kveda Sameba	village	1160
	Mnatobi territorial body	Mnatobi	village	678
	Ortabatumi and Masauri territorial body	Ortabatumi	village	805
		Masauri	village	588

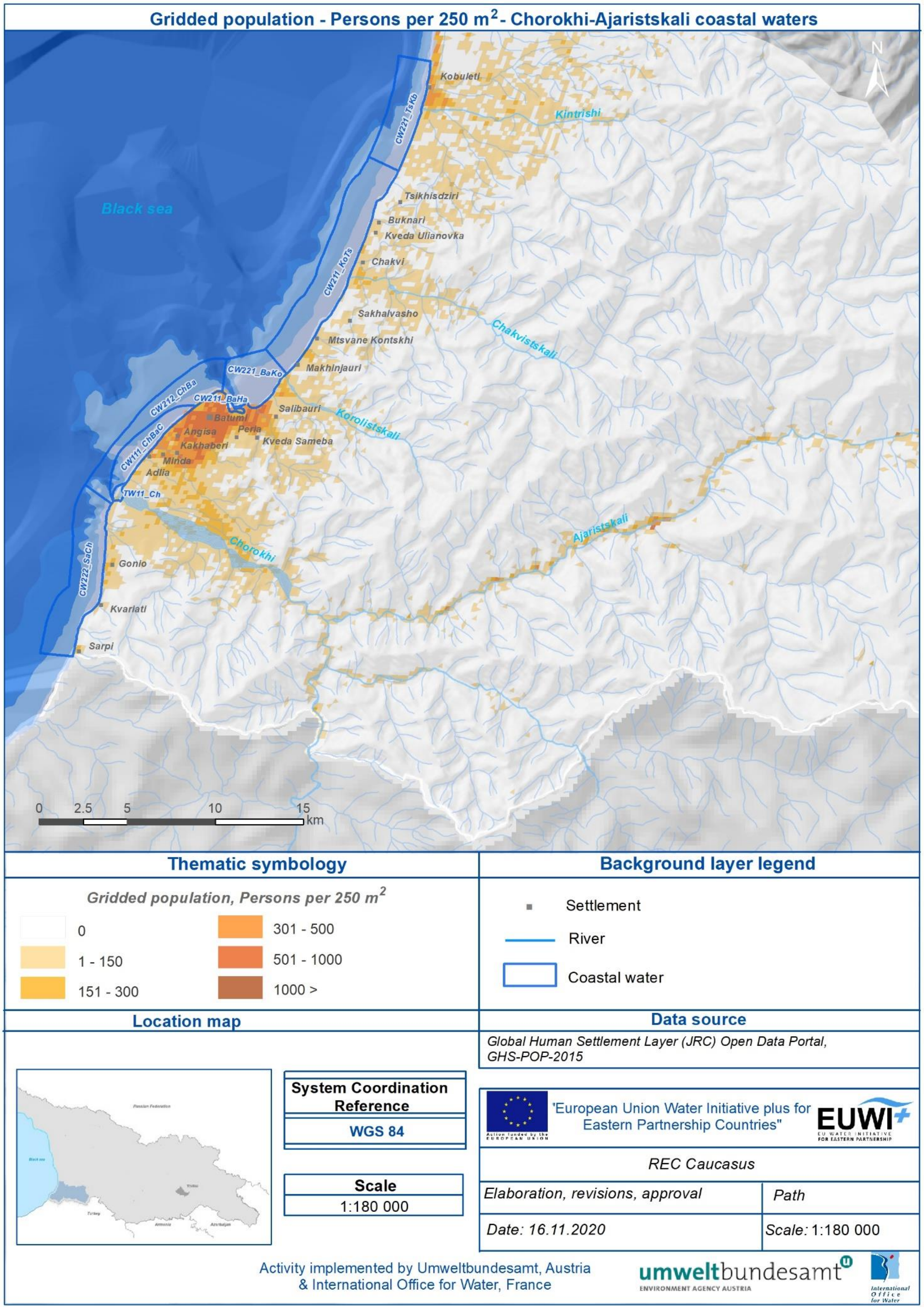

Fig. 3.1 Ajara coastal settlements[61]

[61] Global Human Settlement Layer https://ghsl.jrc.ec.europa.eu/index.php, https://ghsl.jrc.ec.europa.eu/ghs_pop2019.php.

Assessing pressures on Chorokhi-Ajaristskali coastal waters from diffuse sources. Anthropogenic pressure on land is one of a major pressure generating significant discharge of nutrients to the Sea. That leads to the eutrophication processes when the nutrients reach coastal water. Eutrophication is one of the major and oldest threats in coastal marine ecosystems that results undesirable changes in ecosystems (reference). It would be considered a significant problem in the Chorokhi-Ajaristskali coastal zone, where the nutrient load has strongly increased from its natural level, which stimulates phytoplankton growth, this leads to marked changes in the coastal ecosystem.

Eutrophication may result from changes in the physical characteristics of a system (e.g. hydrology), biological interactions (e.g. reduced grazing), or an increased organic and inorganic nutrient loading. Accordingly, it is likely to be aggravated where river discharge and fertilizer use increase.

Since one of the most important coastal process boosted by continental pressures is eutrophication, it is essential to evaluate the anthropogenic pressures on the Chorokhi-Ajaristskali coastal zone. For this reason, the indicator Land Uses Simplified Index (LUSI) has been used (Flo et al., 2019). LUSI is a simplified evaluation of anthropogenic pressures on coastal areas and therefore a useful tool for researchers implementing the European Water Framework Directive (WFD) or/and the Marine Strategy Framework Directive (MSFD).

As the urbanization, industry, and agriculture are the main pressures which are associated to the coastal zone, LUSI uses information on the anthropogenic land uses (urban, industrial, agricultural, and riverine) that influence coastal waters. Furthermore, it considers coastline morphology, which determines the degree of coastal water confinement and also the likelihood that continental freshwater inflows and the nutrients they contain will be diluted.

Land cover maps are most useful for the calculation of LUSI, as they provide information on the area occupied by various types of land use. Pressures taken into account by LUSI include agricultural (irrigated land only), industrial, and urban land uses as well as riverine effects.

Riverine pressure can be assessed by the mean coastal water salinity. Maximum salinity occurs in the complete absence of freshwater inflows, while a lower salinity is related to a higher pressure, since it implies the arrival of greater freshwater inflows from the continent and higher nutrient loads into coastal waters.

Coastline morphology which consists of concave areas, convex area, and straight coastlines, plays a significant role in LUSI calculation process. In concave areas water is confined, residence times are long and water circulation is reduced. Consequently, continental freshwater inflows are diluted at a low rate, potentially there are higher nutrient concentrations and high risk of eutrophication. In contrast, in convex areas, inflows are easily diluted, and the risk of eutrophication is decreased. Straight coastlines do not modify the influence of continental pressures reaching coastal waters.

Application of the Land Use Simplified Index (LUSI). In order to calculate LUSI for the Chorokhi-Ajaristskali coastal water area its quantitative information on pressure has been classified into categories and assigned a score. Afterwards, all the scores have been summed and multiplied by a correction factor that is related to coastline morphology. The steps to calculate the LUSI are as follows:

The continental area of study (from the coastline to 1.5 km inland) has been defined. For each water body, percentages of land use per category (urban, agricultural (irrigated land) and industrial) have been calculated within the study area. The percentage of land coverage has been calculated using GIS software and a land cover map. Then, urban and agricultural pressures have been divided into three categories, while industrial pressure into two, and each category has been scored according to Flo et al., 2019.

In order to describe riverine pressure, a pressure category, and its corresponding score have been assigned. It was suggested to use two ranges such as S=10-18 for the coastal waters which have a strong freshwater impact from the rivers and S= 15-18 for other coastal water of the Chorokhi-Ajaristskali coastal zone. Thus, riverine pressure has been divided into two categories and each one has been scored (see Table 3.4).

Table 3.4. Pressures categories and their scores used to calculate LUSI

Land use pressure			Riverine pressure	Pressure score
Urban (%LC)	Agricultural (irrigated) (%LC)	Industrial (%LC)	Salinity (S)	
	<5	<10		0
≤30	≥5	≥10	15-18	1
31-65			10-18	2
>70				3

To obtain the LUSI value a coastline correction factor has been used which varies depending on the morphology of the coastline of the study area. For a ***concave*** coastline, there is a high influence of continental pressures, the correction factor is ***1.25***. For ***convex*** coastline, where the influence is diminished by the high dilution rates of freshwater inflows, the correction factor is ***0.75***. For ***straight*** coastline, influence is unchanged and the correction factor is ***1***.

In order to calculate LUSI, for each water body, the individual scores are summed and the sum is multiplied by a coastline correction factor. Low LUSI value means that coastal waters are not or slightly influenced by the continental pressure, while a high LUSI value indicates that coastal water are strongly influence by the continental pressures.

Five-colour scale (High, Good, Moderate, Poor, Bad) of LUSI index (Lampou, Simboura, Drakopoulou, & Panayotidis, 2016) has been used in order to have enhanced imprinting of the results. Figure 3.2 presents a map of the Chorokhi-Ajaristskali coastal zone showing the continental pressure related to LUSI and the LUSI values of the different coastal water bodies.

Results of the LUSI calculation demonstrate the reliability and the usefulness of this method as an indicator of land based pressures on Chorokhi-Ajaristskali coastal waters. It shows that nearly the entire coast is influenced by continental pressures to some extent, with LUSI values ranging between 1.5 and 6.25. Coastal area that receives important fluvial inflows, such as a water body located around Chorokhi estuary (TW11_Ch, 3.0) has high LUSI value. Also, the water body (CW211_KoTs,3.0) with a high percentage of urban land coverage has a high LUSI value. Furthermore, the highest LUSI values were determined for water bodies (CW221_BaKo, 6.25), (CW211_BaHa, 6.25) which are located around the Batumi cape and Batumi harbour and consequently with the highest percentage of urban land coverage.

It would be concluded that the continental pressures are able to cause the eutrophication of the Chorokhi-Ajaristskali coastal waters. The nutrient loadings to coastal waters need to be reduced so that further water quality degradation is prevented.

It should also be noted, that for compatibility with risk assessment scorings applied to all other types of pressures, five-colour index is to be converted into tree risk levels with the following correspondence: high/good values – no risk; moderate – possibly at risk; poor/bad – at risk.

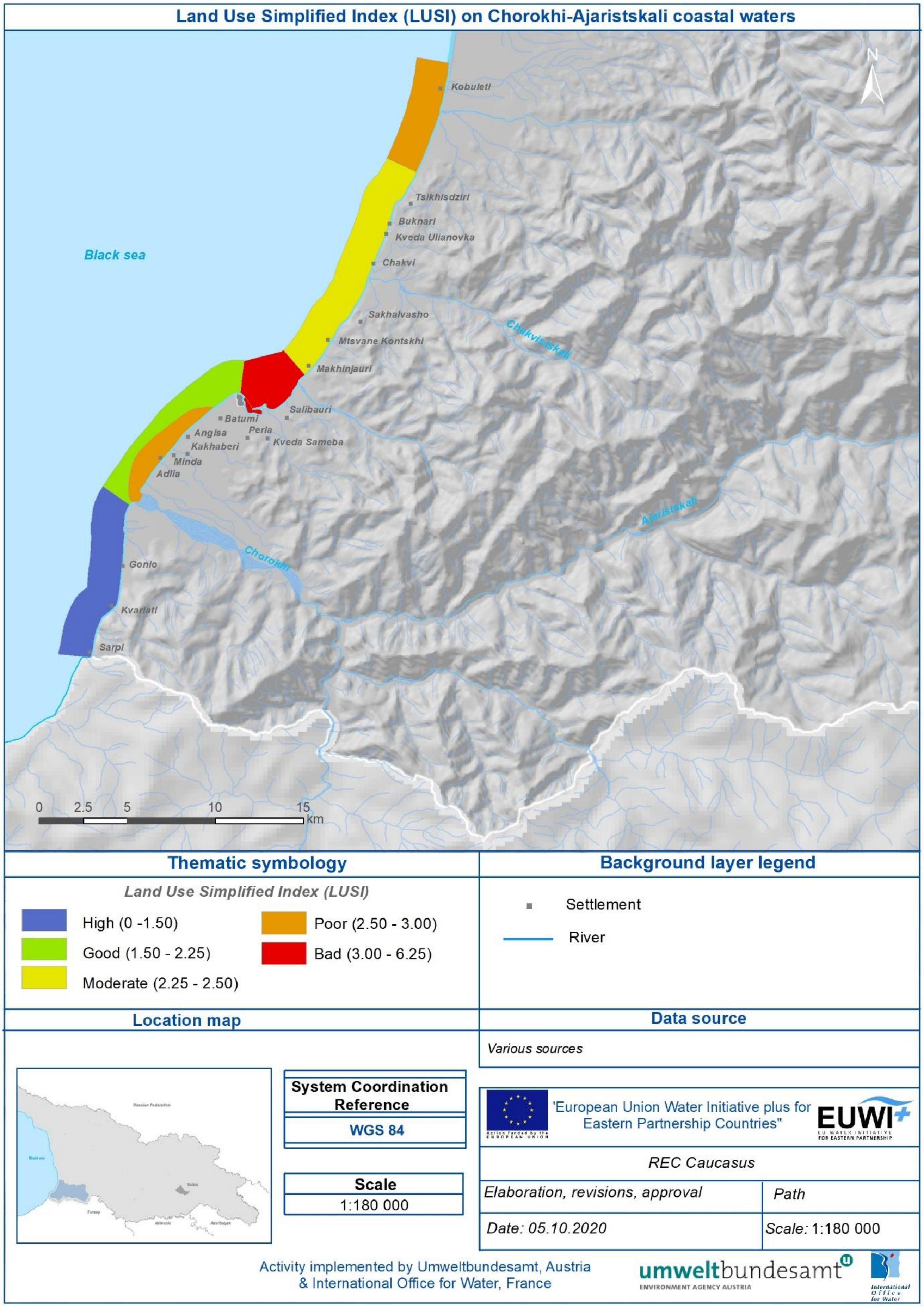

Fig. 3.2 Land Use Simplified Index (LUSI) for Chorokhi-Ajaristskali coastal and transitional waters

According to pressure screening methodology provided in the 3rd guidance document of the general implementation strategy of Water Framework Directive,[62] LAWA national working group (headed by the Federal Environment Ministry of Germany) considers the surface discharge significant if it flows from urban-type of settlement, whose area exceeds 15% of the total territory. Since the total area of Ajara coastline (the length – 50km and the width – 5km) is about 250 km^2, and Batumi area – 64.9km^2, which makes up about 26% of the total territory, the effluents discharge of surface waters must be considered a very significant pressure. In case of Kobuleti, whose area is about 20km^2, which is only 8% of Ajara coastal zone, effluents discharge pressure along the whole coastline on this territorial unit must be insignificant. However, taking into consideration that coastal waters in Kobuleti section is distinguished as a separate water body, then the impact of the city's storm waters must be significant. As for other settlements, there are only two cities and a town in Chorokhi-Ajaristskali Basin coastal zone. The rest are of small rural-type settlements.

The flow of surface discharge waters from agricultural cultivable lands into the sea – the total area of Kobuleti and Khelvachauri municipality agricultural lands, according to the data provided in Chorokhi-Ajaristskali River Basin Management Plan is 11450 ha, which is more than 45% of the total coastal zone area (about 25000ha). On 6164 ha there are perennial plants – citruses, tea plantations, orchards occupying approximately 25% of total coastal zone. Arable land area is 4598 ha, which makes up 18% of the total coastal zone area. According to LAWA criteria for pressures, agricultural surface discharge is considered significant, if agricultural land area is 40% of the total territory, arable land area – 20% and perennial plants area – 5%. By these criteria, Khelvachauri and Kobuleti municipality agricultural arable lands the pressure of surface water discharge flowing into the sea on coastal and transitional waters must be significant. Besides, diffuse pollution risk analysis provided in Chorokhi-Ajaristskali River Basin Management Plan, shows that most surface water bodies that merge with the sea, such as the whole River Achkva, the middle and lower part of the River Chakvistskali including estuary (Cha 004, Cha 006), middle and lower part of the Riv. Korolistskali, including estuary (Kor 002), whole River Bartskhana (Bar 001), whole river Mejinistskali (Med 001) and the lower part of the River Chorokhi, including estuary (Cho 008) are at risk due to pressure-impact of discharge waters from agricultural arable lands and animal farms/pastures. Based on the above, we can assume that surface discharge waters, created as a result of agricultural activities, must have a significant impact on Ajara coastal and transitional waters.

Building and operating transport infrastructure.[63] There is Batumi Port on the territory of Ajara and an airport (in Adlia). In the coastal zone, near the coastline, there is: 1) a 119 km (S2) international arterial road of Poti-Senaki-Sarpi; 2) a 159 km highway; 3) a railway of national importance.

In Batumi port, which occupies 22.2 ha, there is 1) an oil terminal; 2) a container and railway ferry terminal; 3) dry cargos terminal; 4) marine passenger terminal.

The capacity of the oil terminal is up to 15 million tons a year. It stores and processes raw oil and all types of fuel (diesel, petrol, fuel oil).

[62] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance document no 3. Analysis of Pressures and Impacts. https://circabc.europa.eu/sd/a/7e01a7e0-9ccb-4f3d-8cec-aeef1335c2f7/Guidance_No_3_-pressures_and_impacts_-_IMPRESS_(WG_2.1).pdf.

[63] i) http://batumiport.com; http://www.georoad.ge/uploads/files/407.pdf;
ii) Tengiz Gordeladze, Batumi Oil Terminal Ltd.

Table 3.5 Specification of oil terminal berths [64]

Berth	№ 1	№ 2	№ 3	No berth
Length (m)	200	140	165	
Depth (m)	11.0	8.7	9.4	14.5-37.0
Area (m2)	9 546	5 662	12 481	
Dead weight tonnage of ships (DWT) (DWT)	45 000	16 000	25 000	140 000

Throughput efficiency of the container terminal is 200 000 TEU a year. It has an open storage space and loading equipment serving loading and unloading of containers directly or the stored containers. The ferry runs between Varna, Ilichevsk, Poti and Batumi. The operation of the ferry is automated. The nominal throughput efficiency of the terminal is approximately 700 000 tones.

Table 3.6 Specifications of the ferry service of container terminal berth complex

Berth	№ 4.5	№ 6 ferry terminal
Length (m)	284.15	183.3
Depth (m)	11.0	7.6
Area (m^2)	36 000	
Ships' DWT	35 000	12 600

Maximum throughput of the dry cargo terminal is 2.0 million tons per year. It consists of 4 berths (#7-9). The Berth No.7 is equipped with 20-40t capacity hoisting cranes and serves the large-capacity. 60000 ton vessels and specializes in handling bulk cargo, fluid cargo, general and packing and piece load with the weight of one piece no more than 20 tones. Berth №8 serves the small-capacity vessels and specializes in bulk cargo, fluid cargo, general and packing-piece load with the weight of one piece no more than 10 tones. Berth №9 serves the small-capacity vessels and specializes in fluid cargo, general and packing and piece load with the weight of one piece no more than 6 tones.

Table 3.7 Dry Cargo Terminal

Berth	№ 7	№ 8	№ 9
Length (m)	263.3	180.0	204.0
Depth (m)	11.5	9.7	10.2
Area (m^2)	9450	3700	5600
Ships' DWT	60000	20000	25000

Marine passenger terminal is situated in the centre of Batumi, in the seaside boulevard. The throughput efficiency is about 180000 passengers annually. The berths No.10 and No.11 ensure handling passenger ships as well as small-capacity cargo and passenger ferries.

Table 3.8 Marine passenger terminal berths

Berth	№ 10	№ 11
Length (m)	225.7	188.5
Depth (m)	9.1	6.4
Area (m^2)	12.2	19.5
Ships' DWT	3080	2716

[64] http://batumiport.com; http://www.georoad.ge/uploads/files/407.pdf.

Fig. 3.3 Photo collage of Batumi Port Terminals and Berths

Batumi port has storm-water and utility discharge water collectors and treatment facilities as well as oil catchers. Due to the above, there is no threat of diffusive pollution except from terminals, technological pipes, pumping stations, railway carriages/transport and accidental oil leakage/spillage from ships. Furthermore, the oil terminals and sea ports were equipped with ISO 9001, ISO 14001, OSHAS 18001, ISO/TS 29001 operating, environmental protection operating, health and safety operating, integrated quality management systems certified with international standards, energy management and informational safety management systems ISO 50001, ISO 27001. Batumi oil terminal operates under ISO 17025 standard accredited ecological monitoring laboratory, which under the accreditation of the government does monthly laboratory control of the following water bodies: rivers Bartskhana, Kubistskali, Korolistskali, coastal waters – 25 points, ground water – 9 points and everyday flowing waters – 5 points.

The environmental activities of Ltd “Batumi Oil Terminal” on the basis of “Environmental Impact Permit” issued by the Ministry of Environment and Natural Resource Protection of Georgia and take into consideration the №12 ecological expertise account of January 30, 2009. The company accomplished more than 100 activities from 2009 to 2019 with the purpose of meeting the set aims of environmental protection:

- The ecological parameters of storing, transporting and general technologies of oil have improved;
- The leakage from the soil of the factory territory to the rivers has been stopped;
- The complete method of waste management is put in place;
- Water filtration is provided by modern technologies;

- Personnel have been trained to deal with any type of foreseeable emergency situations, all the necessary equipment has been provided;
- Air sanitation-hygienic norms have been put in place in the reserve dock sites to eliminate the problem of spreading smell;
- The environmental ecological monitoring system works effectively.

The company’s activities are constantly analysed to make sure that they are in accordance with the environmental legislation. There is a danger of oil spillage on stations, onto the surface water and into the sea, due to the technological difficulties, scale and power of the operation of the terminals as well as, the old and faulty machinery. In the interest of preventing these disasters, the operator of the terminal has to take additional preventative and control duties under his obligation. Specifically, at a given site, due to the specificity of production, there is an extra preventative system put in place. A ship-shore safety system is put in place, that is built on international standards, within the frame of which the person responsible for transfer of each tanker is obliged to draft the official papers on ecological safety control, the captains have to be informed on the official data on the port and the order of notifications and activities that have to be undertaken in an emergency situation. Inspection of underwater pipes and testing for hermetic locks are done periodically on the basis of international standards, for the prevention of oil leaks, same inspections are done for rivers by the coast. Periodic oil pollution laboratorial control measures are taken in accordance with the environmental Ministry of environmental Protection and Agriculture, on the basis of “Ecological Monitoring Plan” in the sea and rivers Bartskhana, Kubistskali and Korolistskali waters, daily qualitative and quantitative control is done in the sea and rivers.

Batumi Oil terminal and Batumi Port have an oil spill mitigation action plan. There is a response team ready 24/7, equipped with all the necessary tools to deal with the emergency. In case of need for additional resources, a contract has been made with NRC International Service, which are also based in Batumi port and will respond if necessary.

Despite the information given above, given the capacities of the site and the results of the risk assessment, there is still a contingency of oil spill. Therefore, we can judge the Batumi terminal to be a significant potential threat to the coastline waters.

One of the problems connected with oil terminals and storage ports is, old, faulty piping. There are a number of pipes to this day that had been installed in the 70s, that still have not been replaced. The problem with this is that the installation of the piping was not done up to any environmental or risk mitigation technology – there was an amount of oil left in there that is at a risk of spilling and harming the recreational area and the environment around it. In order to get rid of this risk, a study has to be done on these pipes and a safe system of dismantling has to be implemented. The main problem with this is the lack of financing, which could be allocated from government funds or donated by organizations. The legal issues are another problem as these pipes do not belong to Batumi Oil Terminal, nor to the Batumi Sea Port. However, both the Batumi Oil Terminal and the Batumi Sea Port are ready to assist in the dismantling of the pipes using their ships and personnel.

Near “Bartskhana” settlement there are around 20 underground oil pipes that have not been in use for a long time and are getting corroded. Because of this, the leftover oil gets leaked into the rivers flowing out of the town. The old unused pipes have to be dismantled.

Fig. 3.4 Old oil pipes in "Bartskhana" settlement and pollution[65]

Batumi airport is situated in Adlia coastline. It occupies the area of 4256 m^2. The airport has sewage and storm water collectors. That is why it should not be considered the source of diffusive pollution.

As for highways and railways, here the risk of accidental oil spillage is high, despite the fact that the arterial roads do meet international standards. However, taking into consideration the intensive movement of cargos and the outdated railway infrastructure – locomotives, carriages, cisterns/terminals, then the risk of accidents can be rather high. Besides, since oil spillage may cause a very negative environmental effect, the land transport infrastructure can be considered the important source of diffuse pollution.

Navigation.[66] Pollution from vessels by ballast waters and domestic wastewaters, along with accidental spillages, can be considered a significant diffusive pollution source for coastal waters given the intense movement of ships during the year. For instance, in total 2818 ships entered Batumi port in during 2017-2019 years. Out of them in 2017 955 ships entered Batumi port, 827 – in 2018 and 1036 – in 2019. Total 440 (in 2018 – 223 and in 2017 – 217) ships were checked by the Black Sea Protection Convention Service of the Department of Environmental Supervision in the period of 2017-2018. For pollution of sea waters, officials

[65] Tengiz Gordeladze, Batumi Oil Terminal Ltd.

[66] Ministry of Economy and Sustainable Development of Georgia, LEPL Marine Transport Agency, reports at https://mta.gov.ge/index.php?m=70&parent_id=38; Environmental Supervision Agency Reports at http://www.des.gov.ge/Ge/Reports.

responsible for 27 vessels were brought to administrative responsibility, and each responsible official were fined by 65000 GEL for the pollution of the sea. As well as that, control by responsible persons/administration was established for carrying out liquidation measures.

Recreation. Ajara coastline has high number of visitors during the summer holiday season, while level of bacterial pollution of coastal waters and the cases of intestinal infectious diseases grow significantly (see chapter 3.3 below).

According to official statistics[67], the number of holiday makers in Ajara hotels in June-September of 2017-2019 equalled 1584000 (including residents of Georgia and foreign tourists), while in 2017 visitor number was 496000, in 2018 – 518000, in 2019 – 570000.

3.2.2.2 Pollution and eutrophication of coastal & transitional waters from point sources

According to available studies and national statistical databases (MEPA, various institutions of Ajaria AR and Batumi, etc.) point source pollutions of coastal and transitional waters include urban/municipal wastewater, generated from cities and settlements, storm water drainage systems, various types of economic activities (mostly historical pollution emanating from industrial areas and in some cases untreated wastewater discharges form enterprises) and riverine sources. Apart from direct wastewater flow into the sea, storm-water, domestic and industrial wastewater flowing through rivers have a significant impact on Ajara coastal, transitional and surface waters, which is also addressed in the risk analysis of surface water bodies given in Chorokhi-Ajaristskali River Basin Management Plan.

Based on statistical annual yearbook on Actual Water Use produces by MEPA, in 2019 year in the Black Sea was discharged 24,265,977 m^3 wastewaters, from which 22,998,000 m^3 was discharged from Adlia municipal treatment plant of Batumi.

Pressure from municipal wastewater discharge into the sea.
For current time the most parts of Batumi, Sarpi-Kvariati-Gonio and Kobuleti are connected to the central sewage systems. In the rest of the districts of these settlements the network works are either under the way or are planned to be carried out in the near future. In the rest of the settlements no central sewage systems exist.

Within the delineated territory of the coastal and transitional waters of the Chorokhi-Ajaristskali river basin is operated three new municipal wastewater treatment plants, in Batumi, Kobuleti and Chakvi.

[67] http://GeoStat.ge.

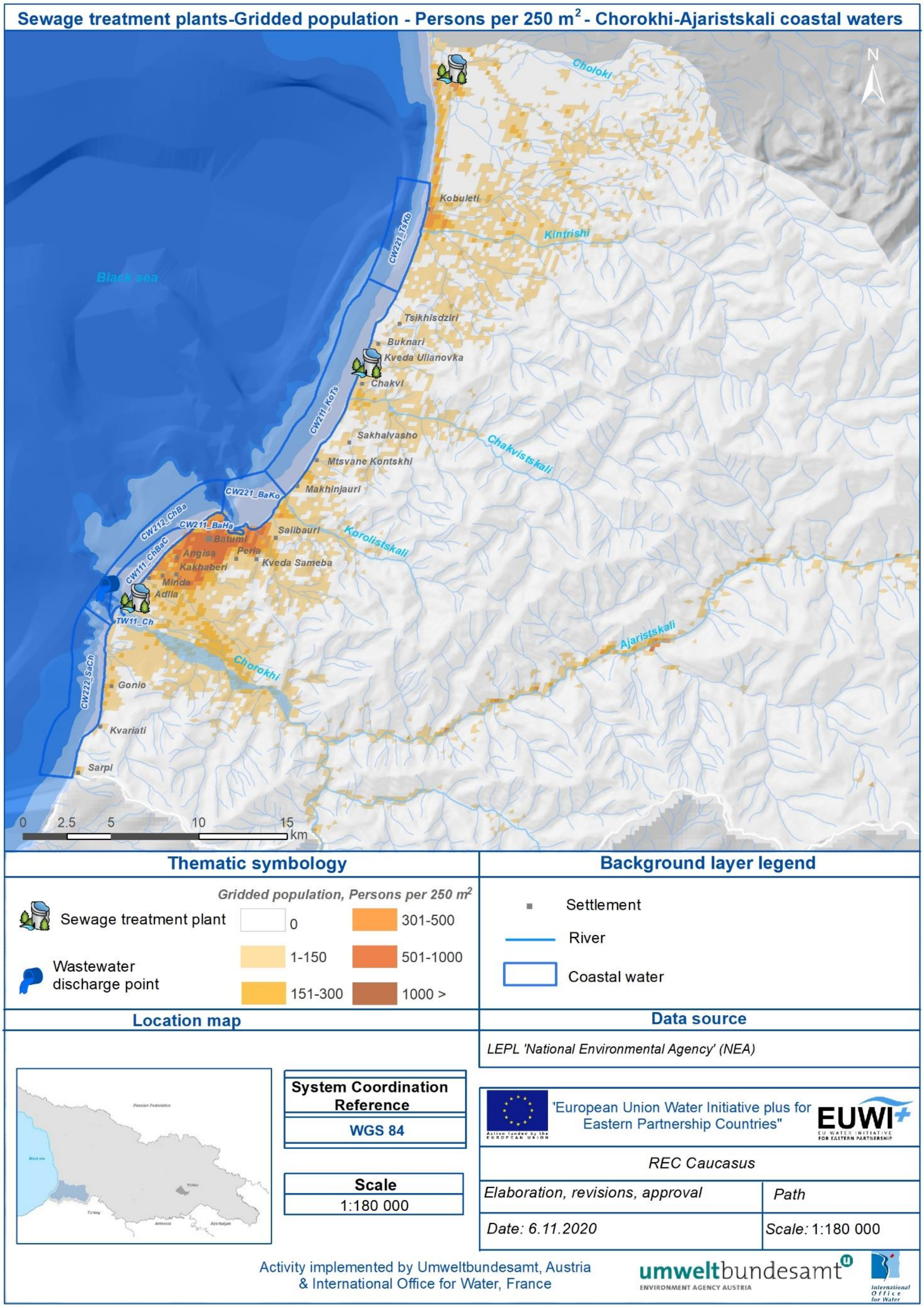

Fig. 3.5 Locations of discharge points from wastewater treatment plants

The wastewater treatment plant of Batumi, which is under responsibility of LLC Batumi Water, is located in Adlia, which discharges waters into the Black Sea via underwater sea outfall. The distance from sea shoreline to the discharge point is 940 m.

Fig. 3.6 Batumi WWTP and sea outfall discharge point locations

Construction of the Wastewater Treatment Plant (WWTP) began in 2010. The Austrian company Posch&Partner Hydro Ingenieure constructed the project, while the German Bank for Reconstruction (KfW) funded 17 million euros. The WWTP was completed in 2012. The WWTP is located near the coastline, between the airport runway and the mouth of the Chorokhi River. Currently, primary (mechanical) and secondary (biological) treatment of sewage wastewater is provided. By 2022 (envisaged by MAD normative document the approved by MEPA), upgrade of the treatment plant is planned, including arrangement an additional purification step to reduce the total nitrogen and total phosphorus contents, in order to fully comply with the requirements of the EU Directive on WWT by reduction of total nitrogen content to 10 mg/l and reduction of total phosphorus content to 1 mg/l.

Fig. 3.7 Biological treatment unit at Adlia wastewater treatment plant[68]

[68] http://bts.com.ge/ka/335.

According to issued Environment Impact Permit, wastewater discharge should be carried out in compliance with approved values of the Maximum Admissible Concentrations of Pollutants in Discharged Waters (MAD) (approved in 2018). Adlia Wastewater Treatment Plant Laboratory reportedly carries out daily self-monitoring of purified water. According to this document, limit of wastewater flow is 5832 m^3/hour, 51,088,320 m^3/year, physical-chemical discharge conditions and pollutants loads should not be exceeded the parameters indicated in Table 3.9.

Table 3.9. Approved MAD norms for pollutants, Adlia treatment plant.

NN	Ingredients	Allowable concentrations mg/l	Approved MADs	
			g/hour	t/year.
1.	Suspended solid	30	174960	1532.65
2.	BOD5	25	145800	1277.21
3.	COD	125	729000	6386.04
4	pH	6.5-8.5		
5	Total Nitrogen	20		1021.77
6	Total Phosphorus	3	116640	153.66
7	Dissolved Oxygen	>4	17496	
8	Temperature	<25^0 in summer, >5 ^{0} in winter		

The database of MEPA on actual water use in 2019 from the Adlia wastewater treatment plant was discharged 2180000 m^3 treated wastewater.

Adlia wastewater treatment plant is connected to sewerage system of Batumi. Batumi municipality, together with Batumi Water LLC, has started the process of rehabilitation and construction of a new sewage network in 2007, under a project funded by EU and the German Bank for Reconstruction KfW.

Batumi Water LLC operates twelve sewage pumping stations (the scheme of pumping stations of the treatment plant see in the Figure 3.8 below): A and B stations (located in Batumi), pump stations in Akhalisopeli, Kvariati, Sarpi and four pumping stations in Gonio, P/S on Gogebashvili street and two new stations in BNZ and Bartskhana settlements. Reconstruction of the A and B sewage pumps was carried out in 2009 as part of the project, while the rest of the pumps were started in 2011 and completed in 2012. The purpose of sewage pumps is to collect sewage and pump it into the Adlia Wastewater Treatment Plant.

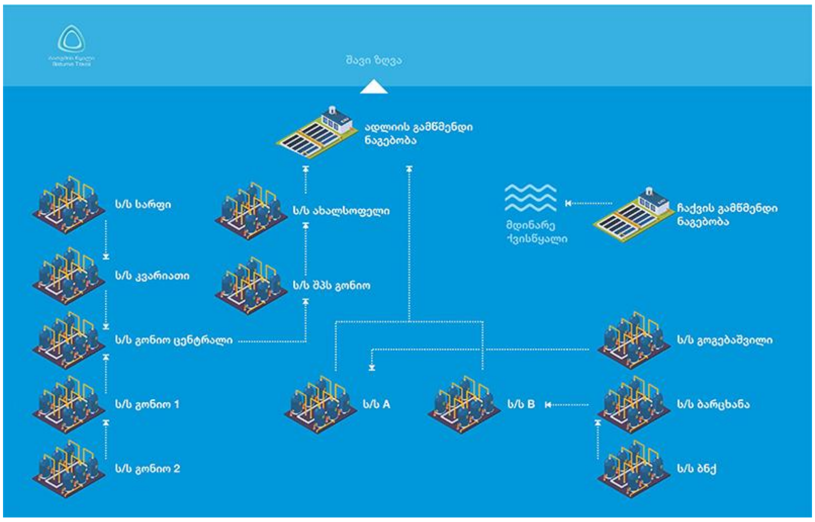

Fig. 3.8 Pumping stations connected to Adlia WWTP.

Rehabilitation and expansion of sewerage network of Batumi, including pumping stations, is carried out by the Batumi City Hall within the KfW supported project – Rehabilitation of Municipal Infrastructure in Batumi. The project is being implemented in several stages.

Within the frame of above-mentioned project, the territory of Batumi (including old Batumi as a whole) between the sea-port area to Griboedovi street has already been connected to new sewerage network. However, there are some sections of amortized and old sewerage networks and areas without sewerage network coverage. Within the framework of the 4th phase of this project covering period of 2016-2020, water supply and sewerage is being rehabilitated in semi-urban areas of Batumi. As of today, a new system is being set up in Angisa settlement; an arrangement of a new sewerage network and pumping stations in Tamari, Bartskhana and Boni-Gorodoki settlements has been completed and connected to Adlia treatment plant though pumping stations. The section from Javakhishvili Street to Mejinistskali is also partially connected to the new central network, however, the existing system (internal network) is outdated and is under rehabilitation. By 2020/21, rehabilitation and installation of the new network should be completed.[69]

The sewerage network of Gonio-Kvariati-Sarpi coastal area is also connected to the Adlia WWTP. As for Makhinjauri, Mtsvane Kontskhi and other newly added areas of Batumi, the sewerage network should be arranged in the next phase of the project. In the near future, it is envisaged to build a sewage collector and install an autonomous (modular type) treatment unit in village Makhinjauri. A feasibility study is currently underway. In preliminary negotiations with the German Bank for Reconstruction and Development, KfW will allocate an additional 60 million euros, which will be used mainly in the adjoined areas - Makhinjauri, Mtsvane Kontskhi, Khelvachauri, Adlia, Kakhaberi, Airport Settlement and Mejinistskali. The sewerage network will be completely arranged in these settlements. Within the framework of the same project, it is also planned to expand the Adlia treatment plant in order to comply with the EU WWT Directive (as mentioned above).[70]

The sewerage system of Chakvi is also connected to wastewater treatment plant. The treatment plant was constructed within the frame of above mentioned project, funded by EU and KFW. More than 400 thousand Euros were spent for the arrangement of the treatment plant. There have been 18 illegal sewage discharges into the sea in Chakvi over the years and this was considered to be one of the most polluting sections along the coast. The problem was resolved after Chakvi biological wastewater treatment plant was built. The treatment plants receives sewerage from the most densely populated area and it serves 1200 households.[71]

With the loan from EBRD and financial support of municipal fund, a biological treatment facility was constructed in Kobuleti. The treatment plant started operating in test mode in 2017, and in full operation from 2018. The total cost of the works is GEL 5867300. The project capacity of the facility is 5500 m^3/day in non-recreational season and 20550 m^3/day – in recreational season. It serves 22000 PE during the low season and 68500 PE during the high season. Treated wastewater from the plan is discharged to river Ochkhamuri (150 m from confluence to river Choloki). According to database of MEPA on actual water use, in 2019 from the Kobuleti treatment plant was discharged 3047000 m^3 treated wastewater to river Ochkhamuri. Total annual amount of pollutants discharged to river Ochkhamuri is given in the Table 3.10 below (source MEPA):

[69] http://maps.bats.ge.
[70] https://batumelebi.netgazeti.ge/news/207906.
[71] http://euneighbours.eu/ka/east/eu-in-action/stories/rogor-gadachra-batumma-ucqlobis-da-zghvis-dabindzurebis-problema.

Table 3.10 Approved norms for Kobuleti WWTP and pollution load for 2019 year

No	Ingredients	Actual amount of pollutants in 2019 t/year	Annual amount of pollutants (t/year) approved by MAD
1.	Suspended solids	120.3	132.5
2.	BOD_5	68.7	94.7
3.	COD	168.9	473.3
4	Total Nitrogen	53.8	56.8
6	Total Phosphorus	6.3	7.6

It should be mentioned, that some areas of Batumi, as well as other settlements without sewage systems or with sewerage systems not connected to treatment plans are illegally connected to nearby located stormwater drains and polluted water enters the surface waters and ends up in the Sea or rivers draining into the Sea.

In addition to sewerage systems and individual households, domestic wastewater is produced by various organizations. Based on official data of the Ministry of Environmental Protection and Agriculture, out of officially reported discharges in 2019, a total of 225920 m^3 domestic wastewater was discharged from various organizations directly into the Black Sea, out of which BOD5 – 517 t/year; COD – 2736 t/year, suspended solids – 594 t/year, total nitrogen – 428.48t/year, total phosphorus –56 t/year.

Absolute majority of organizations, which regularly submit annual reports to the Ministry of Environmental Protection and Agriculture, are located in Batumi. Only hotel Oasis is in Chakvi. It also should be mentioned, that enforcement regulation system of MEPA for collection of information from different water user enterprises and other organizations on annual water use (quantity and quality parameters of used water) is not effective to ensure collection of annual reports from all water users. Another problem for analysis of actual annual water use information is Access-based software of MEPA, which seems outdated and does not ensure processing of collected information by discharged pollutants and geographic locations of discharged points. Accordingly, in reality pollutant load into the Black Sea is likely much higher than the figures provided in the Table 3.11.

Table 3.11 Discharge of domestic wastewater into the Black Sea in 2019

Organization	Amount of discharged waters, 000 m^3/y	Method of treatment	Amount of discharged pollutants load, t/y				
			COD	BOD_5	Suspended solids	Total nitrogen	Total phosphorus
Ltd „Batumi Water"	2180	Biological	2725	514.48	588.6	427.28	56.68
Ltd „Batumi International Airport”	8. 34	Biological	1.04	0.2	0.64	0.096	0.012
Batumi Infectious Diseases, Aids and Tuberculosis Reg. Center	2	Mechanical	0.25	0.05	0.12	0.03	0.005
Chakvi Ltd „Dreamland Oasis” (Hotel)	65	Insufficiently treated	8.1	1.6	3.9	0.9	0.13
Ltd “Caspian Inspection Company”	0.26	Insufficiently treated	0.03	0.007	0.015	0.003	-
Ltd Urekhi (flour production)	0.3	mechanical	0.04	0.007	0.016	0.004	-

Ltd Lukoil	0.36	biological	0.045	0.009	0.021	0.005	-
Ltd Star G	0.4	mechanical	0.05	0.01	0.024	0.006	-
150537	11	Insufficiently treated	1.4	0.28	0.66	0.15	0.02
150602	0.6	mechanical	0.08	0.015	0.03	0.008	-
Sub-total	2259.9	**-**	2736	516.6	594.0	428.5	56.8

Pressure from storm water drainage systems. The source of pollution for Black Sea water is storm water drainage systems of Batumi and other small settlements. It must be noted, that the existing open and closed storm water channels obviously are not connected to sewage system and storm water flow into rivers and the sea untreated. Consequently, pollution from illegal sewage connections, if discharged into drainage system, flow into the Black Sea untreated. Within the bounds of Batumi about 15 such stormwater discharge points are located, see Figure 3.9 below.

As discussed above, despite completed and ongoing rehabilitation activities of sewerage networks of Batumi carried out within the KFW funded project, there are some parts of Batumi where sewerage pipes of households are not yet connected to main sewerage network and, consequently, to Adlia WWTP. Based on above mentioned information on sewerage system development of Batumi, the following areas of Batumi are not connected to Adlia treatment plant yet (i.e. are under rehabilitation, or future works are planned under the project of Batumi City Hall and KfW): Makhinjauri, Mtsvane Kontskhi, Adlia, Kakhaberi, Airport Settlement, Mejinistskali.[72] In addition, some upstream areas of Gonio and Kvariati are not covered by the sewerage network as well. It is most likely that untreated domestic wastewater from these territories are discharged to nearby located stormwater drainage network of Batumi. From the online cadastral database of Ltd Batumi Waters untreated wastewater most likely is discharged to the channels of Kobaladze str., Zhilini; Mejinistskali, Adlia, Adlia, Airport; Korolistavi; Gantiadi. Three drainage channels in Makhinjauri and Mtsvane Kontskhi can also be considered as polluted by domestic wastewater form the settlements of Makhinjauri and Mtsvane Kontskhi. See Figure 3.9 below for locations of these drainage channels with outlets into the Black Sea.

According to LAWA pressure screening criteria given in 3rd guidance document on common implementation strategy for the Water Framework Directive, a pressure is considered significant if the sewage PE exceeds 2000. Since in each of these districts within the Batumi, could be more than 2000 PE (about 8000 PE) this pressure must be considered as strong impact to the Black Sea waters. Pollutant loads can be calculated according to EU standards of following values of pollutants: 1 PE BOD5 = 60 g/day, 1 PE COD = 120 g/day, 1 PE Ntot = 11 g/day, 1 PE Ptot = 1.5-2 g/day and 200 l/day of used water. Accordingly, pollutant loads figure for 2000 PE is estimated as at 1600000 l/d of used water.

[72] http://maps.bats.ge; https://www.euneighbours.eu/en/east/eu-in-action/stories/how-batumi-solved-its-water-supply-and-sea-pollution-problems-eu-support).

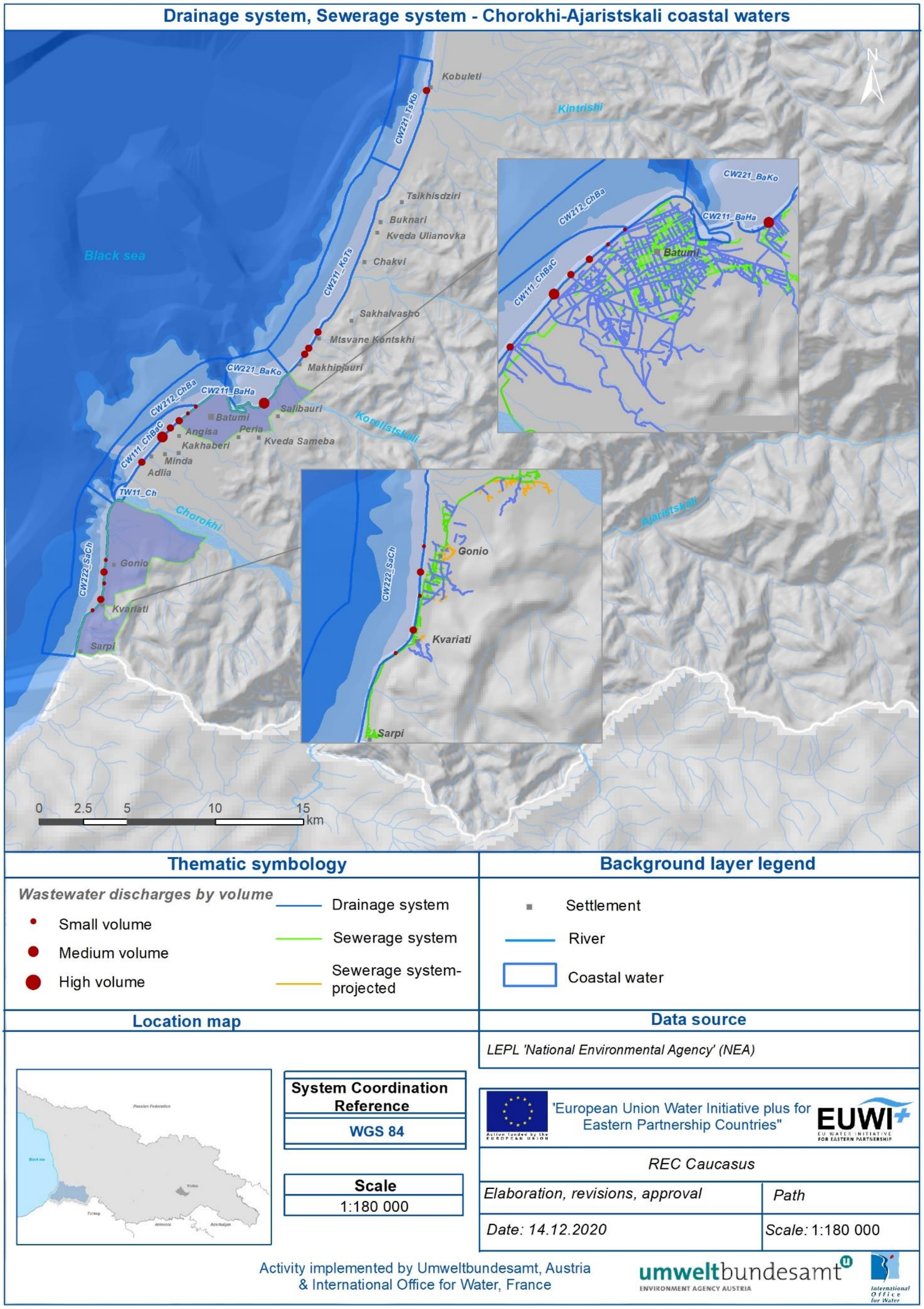

Fig. 3.9 Stormwater and sewage networks vs outlet channels draining into the Sea
Green/amber – existing/projected sewerage network; blue – stormwater drains (source: http://maps.bats.ge)

Below is given an approximate calculation of pollutants which likely can flow to sea though above described drainage channel outlets:

Table 3.12 Estimated pollutant load (portion of domestic wastewater) into the sea via stormwater network

Settlements and parts of Batumi without sewage network & Adlia plant connection	Population	Wastewater l/day	Wastewater m^3/year	Likely pollutant load, *t/year*
Makhinjauri	735	147000	*53655*	*BOD_5 = 3.2, COD = 6.4, Ntot = 0.5, Ptot=0.1*
Tsikhisdziri	2472	494400	*180456*	*BOD_5 = 10, COD=20, Ntot = 1.9 Ptot=0.3*
Mtsvane Kontskhi	2521	504200	*184033*	*BOD_5 = 11, COD=22, Ntot = 2, Ptot=0.4*
Adlia, Airport, Kakhaberi, Mejinistskali	About 36000[73]	7200 000	*2628000*	*BOD5 = 157, COD=315, Ntot = 28, Ptot=5*

Pressure from industrial discharge waters to the sea.[74] Per official statistical data, as of 1 January 2019, 68103 business entities were registered in Ajara. The pattern of business activities in 2017-2019 show that trade enterprises, small repair shops, workshops and car service centres have the largest share in the entire industrial turnover, followed by the construction sector, the third largest share has the processing industry, lastly followed by transport and communications. All the above points to the fact that the number of small and medium size enterprises that typically represent trade or service sectors, are a considerable part of the common composition of business enterprises. By production size, the leading is construction sector, followed by processing sector, transport, communications and trade.

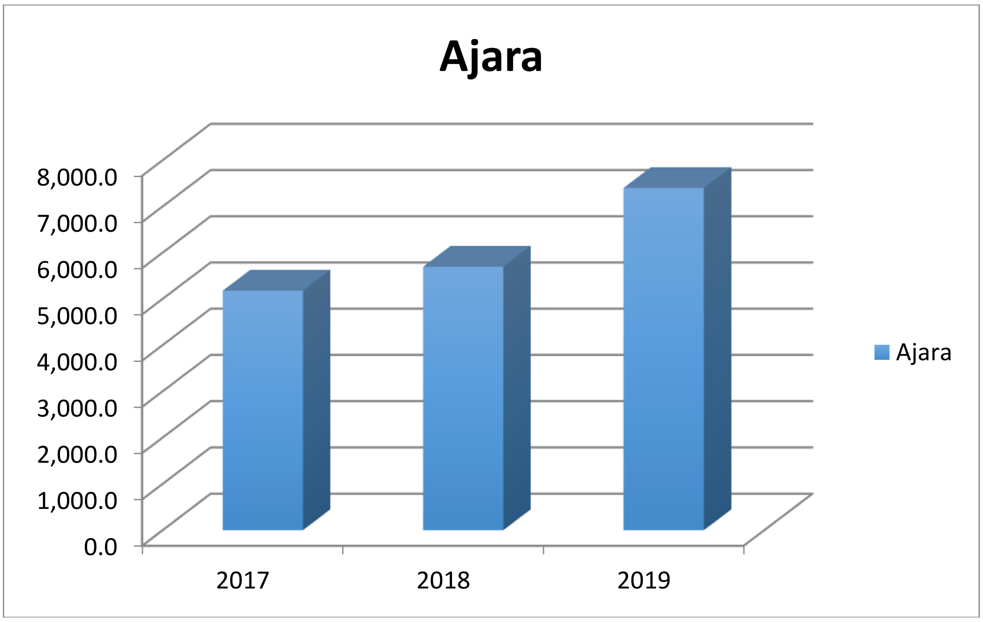

Fig. 3.10 Turnover according to economic activities, mln. GEL[75]

[73] Population estimated by JRC grid data.
[74] https://www.geostat.ge/regions/#.
[75] http://www.geostat.ge/?action=page&p_id=1192&lang=geo.

More specifically, as of 2019, the share of trade in the total turnover was 40%, the share of construction sector – 19%, that of processing sector – 9% and the share of transport and storage – 7%.

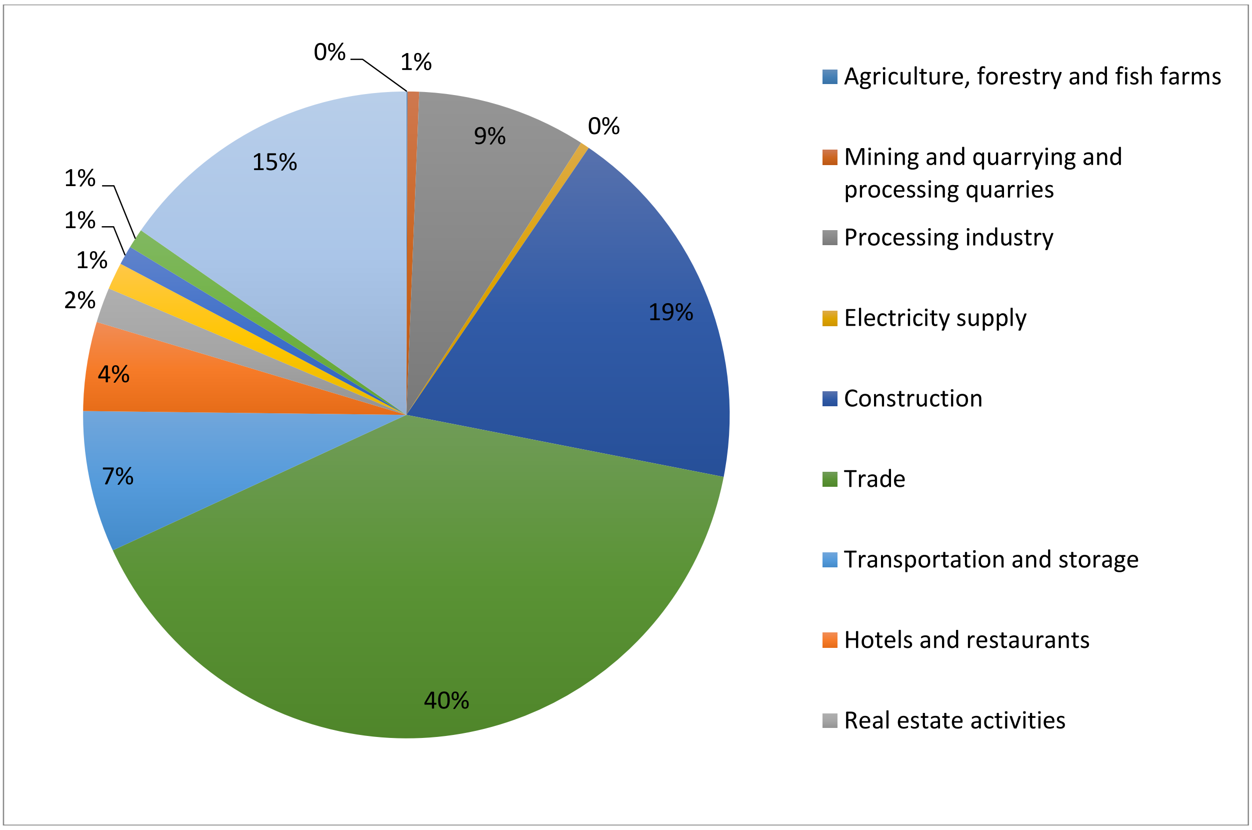

Fig. 3.11 Share of various economic sectors in total volume of turnover 2019, mln. GEL[76]

The largest enterprise in Ajara is Ltd Batumi Oil Terminal, whose total capacity of the tank farm is 580000 tons. It can accommodate 22 different types of petroleum products. The company also has liquid gas reservoir tank farm with the volume of 5000 m^3. In 2012-2013 the oil-slime utilization base and the railway Estacada was added to the enterprise, which together with the transport terminal are located next to Ltd “Batumi Oil-processing Plant” and “Batumi Petroleum”. The territory occupies 85 ha and includes main terminal between Mayakovski and Gogol Streets, also relatively small terminals “Kholodnaia Soboda”, “Kapreshumi” and “Bartskhana” as well as the reservoir tank farm of the company Vibro Diagnostik FZE. Near the main terminal, there are the cargo handling and sorting station and port. In 2011, 4 old reservoirs were installed on the territory of crude oil and petroleum pitch. In addition, in 2015, 3 new reservoirs were built with the capacity of 120,000 m^3.

The territories of each industrial area of Ltd "Batumi Oil Terminal" is organized industrial-storm water drainage collection systems and local treatment plants for industrial and local domestic wastewaters systems.

In the local industrial-storm sewerage systems is discharged waters used in industrial-technological process, wastewater produced during washing of industrial territory, storm waters from the territories of terminal areas, waters from reservoirs polluted by oil products. These local industrial-storm sewerage systems and treatment plants receive also wastewaters produced by domestic use by staff of company.

[76] http://GeoStat.ge.

Fig. 3.12 Industrial areas of Batumi Oil Terminal

Currently enterprise operates 6 main systems of industrial-drainage sewerage systems with treatment plants and, consequently, there are 6 water discharge points into surface water bodies. Technical specifications of these discharge points are carried out in compliance with approved norms of Maximum Admissible Discharge of Pollutants in Wastewater Discharged into Surface Water Bodies (MAD). Detailed information on MAD norms for each discharged point are provided below in the Table 3.13.

Table 3.13 Industrial wastewater discharges, 2019 (maximum admissible discharges)[77]

Organization	Type of wastewater	Water body for discharge	Amount of discharge water. 000 m^3 /y by MAD	Amount of admissible pollutant substances in discharge waters t/y / concentration mg/l		
				BOD	Suspended solids	Oil products TPH
Ltd Batumi Oil Terminal	Industrial storm waters	Black Sea	1336.8	33.402	33.402	13.24
				25	25	9.91
	Industrial storm waters	R. Korolistskali	1038.416	15.576	25.960	5.192
				15	25	5
	Industrial storm waters	R. Kubistskali	255.482	1.17	6.55	0.093
				15	25	5
	storm waters	R. Bartskhana	3.25	0.182	0.45	0.0091
				6	15	0.3
	storm waters	R. Bartskhana	25.698	0.154	0.386	0.0077
				6	15	0.3
	storm waters	R. Bartskhana	190.986	2.864	4.77	0.955
				15	25	5
Ltd San petroleum	Storm waters	Black Sea	16.944		0.051	0.001
					3	0.05
Ltd Batumi petroleum	Industrial storm waters	R. Kubistskali	164.867		4.122	0.658
					25	3.99
Ltd Batumi beer and drinks	Industrial water	Black Sea	49.641	1.2	2.9	
				25	60	5
Ltd Georgian Railway	Storm waters	Black Sea	221.65	5.5	13.2	1.3
				25	60	6
Batumi Airport	Storm waters	Black Sea	10.342	0.25	0.6	0.06
				25	60	6
Total			3314.085	60.298	92.391	21.515

[77] Ministry of Environmental Protection and Agriculture. MAD is calculated according to corresponding Georgian legislation (technical reglament #414 and technical reglament #17),

Based on currently valid approved MAD norms the total annual amount of water discharged into delineated coastal and transitional water bodies equals 3314085 m^3, out of which the BOD made up 60 tons, suspended solids – 92 tons and oil products – 21.5 tons.

As discussed above, due to problem with Access-based outdated software at MEPA, which does not ensure processing of information by discharged pollutants and geographic locations of discharge points, assessment of industrial discharges was carried out based on MAD reports. Consequently, information for other enterprises, not subjected respectively to Environmental Decision and MAD elaboration, is not available for analysis. Accordingly, in reality pollutant load is likely considerably higher than the figures provided in the Table 3.13.

Pressure from the river sources of Chorokhi-Ajaristskali river basin

Apart from direct water flow into the sea, stormwater and industrial wastewater flowing through rivers have a significant impact on Ajara coastline and waters, which is also well proved by the risk analysis of surface water bodies given in Chorokhi-Ajaristskali River Basin Management Plan.

The significant pressure on rivers flowing into the sea and the sea itself due to industrial and household wastewater is proved by regular observation data on certain rivers (Bartskhana, Kubistskali, Korolistskali, Chorokhi), 2012-2013 and 2017-2019 monitoring results for a number of points in the Black Sea (Batumi, Gonio, Kobuleti) and the results of the joint field research carried out. The latter is reflected in Chorokhi-Ajaristskali River Basin Management Plan, where rivers such as Bartskhana and Korolistskali fall under the category of water bodies at risk due to point source industrial pollution.

Apart from the pressure of effluents discharged in the sea, as was mentioned above, Ajara coastal and transitional waters are significantly affected by storm water, public and industrial wastewater flowing through rivers. Also, these rivers are affected by diffuse sources of pollution and flow into the sea being full of pollutants. According to pressure-impact analysis within the scope of Chorokhi-Ajaristskali River Basin Management Plan, the following rivers suffer from strong anthropological pressure and impact: Achkva, Kinkisha, lower part and estuary of Chakvistskali, lower part of Korolistskali delta and estuary, Bartskhana, Mejinistskali and the extreme lower part of Chorokhi, including the delta. The results of detailed studies are given in RBMP.

Fig. 3.13 The Bartskhana and Korolistskali River Banks

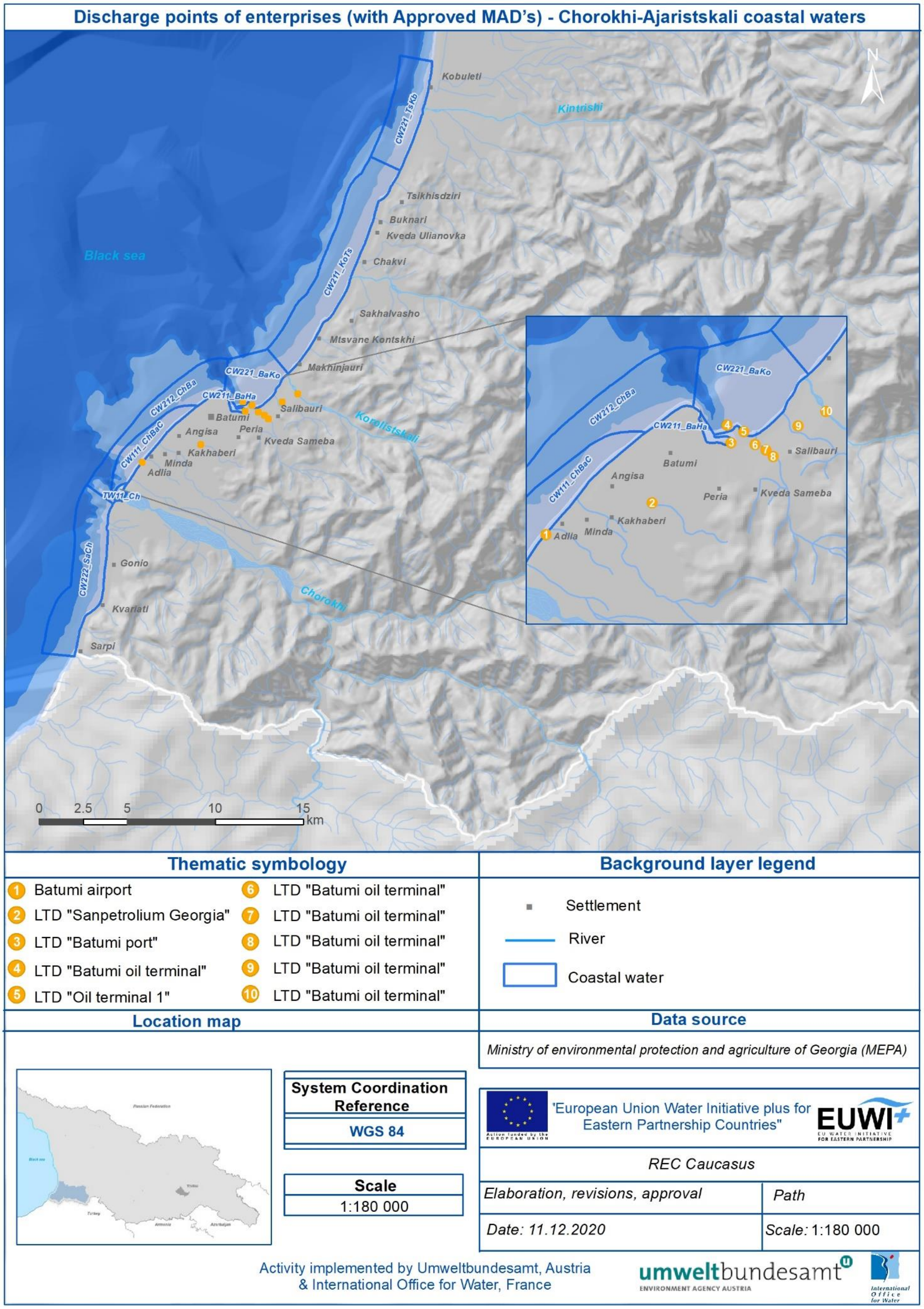

Fig. 3.14 Location of enterprises with approved Maximum Allowable Discharges (MAD)

Pressure from landfills. Current Ajara is served by two old landfills, one is in Batumi and the other one – in Kobuleti. Both sites of waste disposal in Ajara are non-sanitary landfills. The responsibility for municipal waste management (MWM) is under Ajara Solid Waste Management Company (formerly "Higiena 2009"). At the territory of Ajara MSW collection, transportation, disposal and street cleaning is under several companies, for more details refer to Table 3.14 below.

According to Adjara Solid Waste Management Company management, in 2019 total of 85,000 t of mixed MSW was landfilled, of which around 95% (~80,750 t) was accounted for Batumi city and the rest to other municipalities, except for Kobuleti municipality. Kobuleti disposes its MSW in Ozurgeti landfill operated by Solid Waste Company of Georgia (SWCG). Ozurgeti municipality belongs to Guria region, adjoining Kobuleti municipality. Ltd Khulo Sanitary Cleaning Service carries out MSW collection and street cleaning activities. Transportation is conducted jointly with Ltd Sandasuptaveba.

Table 3.14 Cleaning Services in Ajara

Municipality	Collection and cleaning/ sweeping the streets	Transportation to landfill	Waste disposal, maintenance of landfills
Batumi	Ltd Sandasuptaveba	Ltd Sandasuptaveba	Ltd Severi
Kobuleti	Ltd Kobuleti Cleaning Service	Ltd Kobuleti Cleaning Service	Sanitation
Keda	Ltd Keda Amenity Service	Ltd Keda Amenity Service	Ltd Severi
Khulo	Ltd Khulo Sanitary Cleaning Service	Ltd Sandasuptaveba	Ltd Severi
Khelvachauri	Ltd Khelvachauri Greening, Cleaning and Amenities Service	Ltd Khelvachauri Greening, Cleaning and Amenities Service	Ltd Severi
Shuakhevi	Ltd Sandasuptaveba	Ltd Sandasuptaveba	Ltd Severi

Batumi landfill is handled by Ltd "Severi". 19.2 ha controlled disposal site/polygon near Chorokhi mouth, on Kakhaberi accumulative plain in the water protection zone. The site is located in 10-15 km distance from the city centre. 7 ha, which is near the river month, is used for MSW disposal and remaining part – for Construction & Demolition Waste (C&DW).

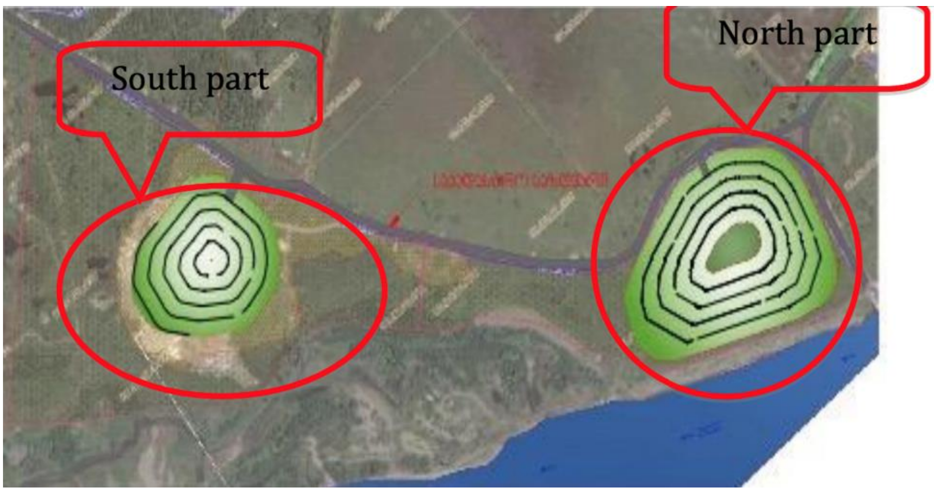

Fig. 3.15 Two parts of Batumi Landfill

Landfill is not fenced and is without drainage and leachate collection systems. There are animals and scavengers on-site. The area has stagnant water and groundwater level is high increasing the risk of leachates getting into ground water river, coastal and transitional waters of the Black Sea. Moreover, existing revetment wall is washed out in several places creating threat of bank collapse.

Fig. 3.16 Damaged protective wall in Batumi controlled waste disposal site

(source: SWECO EIA report, 2008)

As of 2018 there were around 120 illegal dumpsites with total area 2000 m^2 and about 3000 m^3 waste in the city. Exact location, quantity and composition of accumulated waste is unknown.

Since July 2019 building of new 33 ha regional landfill near Tsetskhlauri has been ongoing. It will be regional landfill serving all Ajara municipalities. Environmental decision was issued by November 2019 by Ordinance of the Minister of Environmental Protection and Agriculture. At this site 4 cells will be organised. As for hazardous wastes, if they enter the site, they will be stored separately on a temporary basis and handed over to hazardous waste handlers. Responsible for landfill management will be Adjara Waste Management Company under the Adjara AR Ministry of Finance and Economic Development. The project is financed by EBRD and SIDA. The project also envisages closure and remediation of Batumi waste disposal site mentioned above.

Batumi and Kobuleti landfills bear the risk for the river as well as the sea water bodies and are in need of further detailed investigation. It is also necessary that these sites are closed down in full compliance with the waste management and other environmental legislation.

Seabed dredging. Waste dumping takes place in many points of the Black Sea continental shelf. The mass extracted as a result of dredging is disposed in these places, which creates additional contaminative flux.

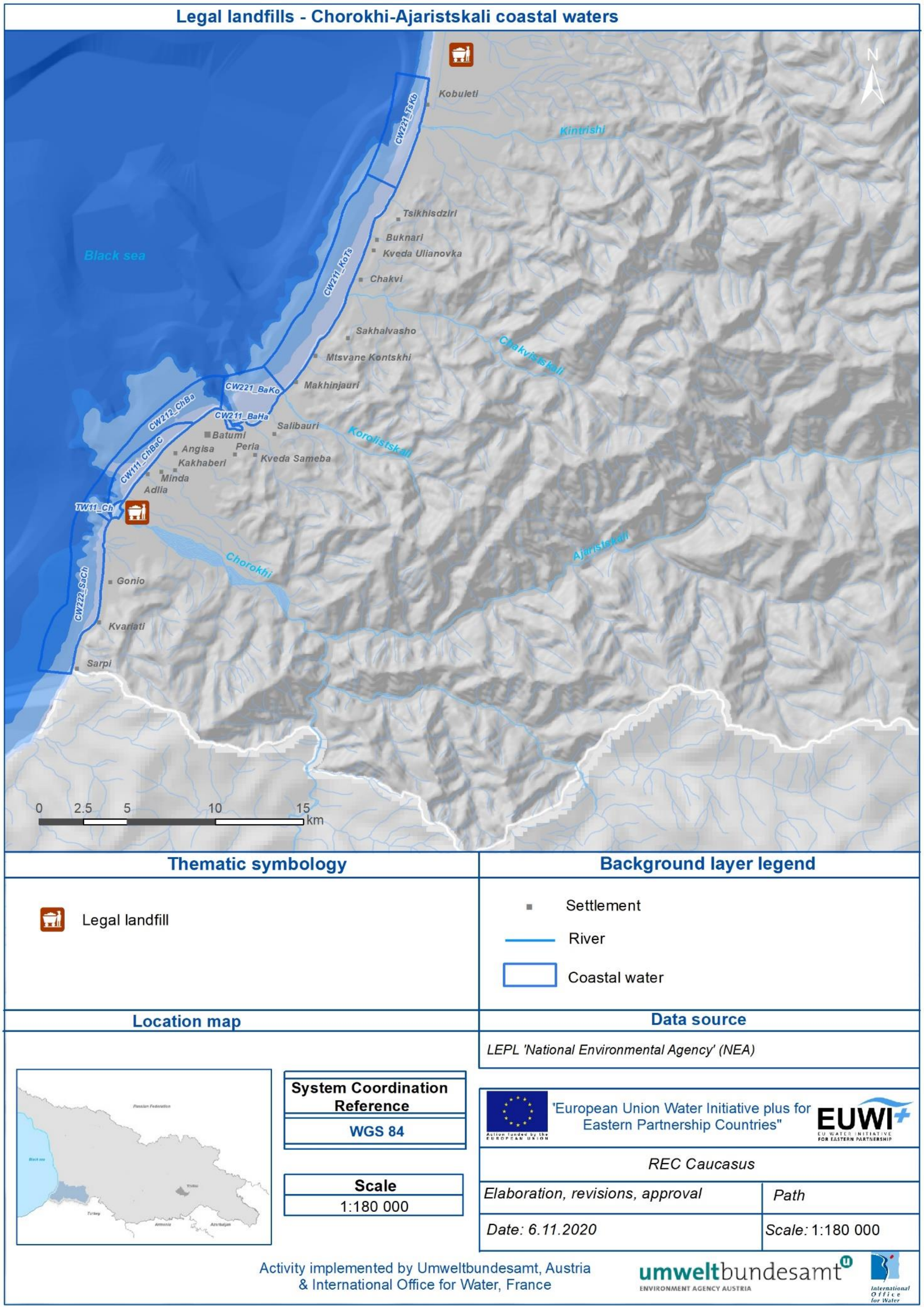

Fig. 3.17 Landfill locations near Batumi (existing) and Tsetskhlauri (new)

3.2.2.3 Hydromorphological pressures/drivers

River discharge regulation.[78] On the Chorokhi-Ajaristskali Rivers, the construction of several medium and large size hydroelectric power plants has been planned. Some stations will have dams. These projects are: Ajaristskali cascade – Shuakhevi (181 MW) and Koromkheti HPP (175 MW), Kirnati HPP (51.45 MW), Khelvachauri HPP (47.48 MW) and Machakhela cascade - Machakhela 1 (28 MW) and Machakhela 2 (27 MW). The detailed description of their technical parameters is given in Chorokhi-Ajaristskali River Basin Management Plan. New HPPs will have a negative impact due to reduction of beach-forming sediment flows. The impact of Ajaristskali Cascade must be especially significant, since the natural regime of sediment transport in the river has been more or less retained. In the case of Kirnati HPP, which is going to be built on the Chorokhi River, it is necessary to consider cumulative effect. In general, construction of Muratli, Borçka and Deriner dams from the Turkish side has presumably reduced the sediments by over 60%. Besides, construction of other additional dams is planned by the neighbouring country, which will most likely reduce river sediment by an additional 20%. Kirnati HPP construction and operation, including indirect impact of HPPs, will contribute to 10-12% reduction of the sediment flows. In total, the flow capacity of beach-forming sediments will be reduced by 95%. Construction of dams on Chorokhi River and its confluents will thus reduce the transit of beach forming material towards the sea coast.

Coast protection works, seabed dredging.[79] Beginning from the 20th century till present, coast protection works have been carried out on Ajara territory for the purpose to protect the coastline against erosion. Until the 80s of the past century, massive constructions were used, such as walls, embankments and spurs. After that the beaches and shores were reinforced with beach-forming sediments.

Geomorphological dynamics of the sea in general and that of Ajara Black Sea coastal zone in particular, is determined by many morphogenetic factors, the most important of which are the effect of sea waves and wave currents as well as the movement-accumulation of beach-forming matter (solid sediments) along the coastline. In this respect, the sediment balance, i.e. the balance of volumes of beach-forming solid sediment that has been formed in any district or brought in from neighbouring districts or else removed from this territory is of great importance. Sea level changes in the coastal zone determine the range of wave movement, which in its turn affects the movement of beach-forming sediments along the coastline. Thus, the sea morphodynamics and retention of dynamic balance depend on the pace of change in the sea level and the correlation of beach-forming sediment balance in the coastal zone.

Before the beginning of the 20th century, Ajara coastline was developing under the conditions of accumulation of fluvial sediments. Namely, the solid matter brought down by rivers was more than it was needed for the retention of the dynamic balance of the shore. As a result, 20-40 m wide full-profile beaches were developed almost along the entire coastline. The main source of nourishment for the coastline was the Chorokhi River, which until the second half of the 19th century joined the sea with two branches. The confluence of the northern branch was situated in about 3.5 km to the north from the present one, at the confluence of the Mejinistskali River (village Adlia), whereas the southern branch joined the sea in the south of

[78] Chorokhi-Ajaristskali River Basin Management Plan Project. Environmental impact assessment report on amendments and additions in the project of construction and exploitation of Kirnati HPP on the Chorokhi River. Ltd "Ajara Energy 2007" The report produced by "Gamma Consulting".

[79] The problem of shore cutting of Ajara coast. The report is prepared by "Ecomigration: dialogue and cooperation for the improvement of life standards in south Caucasus" with the financial support of the EU. CENN.2015. http://w3.cenn.org/wssl/uploads/Discussion Paper_Adjara_FINAL.pdf;
Municipal Development Fund of Georgia. Short description of Batumi coast protection project. The project title: Investment program of sustainable urban transport – tranche 4. Asian Development Bank. Prepared by Ltd "Technital" with sub-consultants: Stichting Deltares, Saunders Group Ltd. Batumi 2016.

present Chorokhi confluence, 2 kilometres away from it. Both branches formed wide deltas. In order to protect the adjacent areas of the river against floods, the protective dams were built along the sea coast (from village Makho till the sea) in the second half of the 19th century. With such construction Chorokhi River flew in a single riverbed and its confluence occurred in front of the head of a deep underwater canyon (Chorokhi Canyon). As a result of the above action, the most of the solid beach-forming sediment brought into the sea started to move in deep water and the volume of beach-forming solid sediment which was 2.5 mln m^3 (D>0.25 mm) brought into the delta annually was reduced to 0.5 mln m^3, where the volume of gravel and sand mixture amounted to 0.4-0.5 m^3 and the rest was coarse sand. Besides, until the same period, the Chorokhi River sediment could freely move along coastline as far as the confluence of the Natanebi River. After the construction of Batumi port, in order to retain navigation depths, as well as to avoid the shallowing of the aquatorium and protect it against tidal waves, a 200-250 m mole was built in the southern entrance of the port, which has entirely prevented Chorokhi sediment movement from the port in the northern direction. As a result, intensive accumulation of solid sediment began and the sea shore increased in width – Batumi accumulation cape was filled with the sediments from along the Chorokhi River bank and the matter formed as a result of shore cutting at the former confluence of the Mejinistskali River. The rate of growth of the cape was 4 m/y. In the given place a boulevard, a stadium and other public facilities were built. As a result of protrusion of the sea shore, the coastline, and namely, Batumi Cape approached Batumi underwater canyon heads, which resulted in the loss of solid sediment in deep water and consequently, its function of beach formation declined almost entirely. The volume of only coarse material having occurred in the canyon amounted to approximately 80-100 m^3 a year and taking into account the loss of fine-grained fraction, it doubled. The given figures are average multi-year indicators – the real volume of losses in the canyon fluctuates within the wide range and depends on annual storm activity, which has considerably increased recently. The movement of the sediment towards the north was also impeded by Tsikhisdziri Cape and Mtsvane Kontskhi, since due to shore cutting of their beaches, they played a natural role of moles. As a result, in the coastal zone to the north of Batumi Port, there arose a severe deficiency of solid sediments and the process of coastal erosion developed rapidly. Besides, in the 70s of the past century, an embankment was built along the left bank of Chorokhi delta to protect the pastures from flood, which finally fixed the confluence with the underwater canyon. As a result, 90% or more of solid sediment from rivers were lost in the depths of underwater canyon. From the same period, inert matter plant started to operate in the Chorokhi riverbed, whose capacity was about 0.5 mln m^3/y. In total, up to 15 mln cubic meters of solid sediment have been extracted from the sea coast and its adjacent territory. Consequently, the volume as well as thickness of materials that had occurred in the sea coastal zone sharply decreased. Namely, the average diameter of the sediment from 1979 to 2000 reduced from 53 mm to 18 mm.

The above activity, along with the growth of the sea level by about 15-20 cm as a result climate change, speeded up the process of the land loss on the sea coast. The total area of the caved land reached 140-150 ha, in most placed the sea shore along the coastline receded by 100-120 m, and near Adlia it receded by 200-400 m. The rate of shoreline erosion equalled on average to 5.2 m/y, and in 1926-1980 it reduced to 2.2 m/y.

In order to avoid intensive coastal erosion, in the end of the 20th century large size expensive engineering facilities were erected, such as breakwater walls, different size and shape armoured concrete massifs, tetrapods, piles, underwater wave cutters, etc. These measures stopped the shore cutting process of the sea coast temporarily, however, after these facilities became outdated, the coast was ruined again and got polluted by concrete constructions. In the 80s the approach to sea coast defence changed radically and in 1982-91, 6.2 m^3 coast-forming sediment was brought in at the depth of 3-3.5 m with the purpose of making artificial beaches and coast defence along the coastline. 1.9 mln inert matter was thrown in Chakvi, 1.4 mln m^3 – in Makhinjauri, 1.3 mln m^3 – in Adlia, 848 000 m^3 – in Kobuleti and 820 000 m^3 – in Bobokvati. Due to wave movement the sediment was distributed along the coastline and the old boulevard of Batumi, and the beaches in Chakvi, Buknari, Bobokvati and Kobuleti grew by 30-50 m and the area of the coastal zone by 54 ha.

From 1992 to 2007, the coast protection works stopped due to weak economic conditions. As a result, on the underwater slope near the port, on the edge of which the underwater canyons are wedged, 20-25 thousand excess solid matter is accumulated annually. These natural disasters increase the gravity load of the bottom and causes submarine landslides on canyon slopes, which acquires dangerous form on the sea surface and the coast. For instance, on January 14, 1999, the sea was absolutely calm when a big mass broke off the submarine slope and slipped into the canyon. As a result, a 250 m long and 150 m wide land on the coastal zone fell several meters into the depth. The accident did not entail any casualties, since this part of the coastline was then free from technogenic burden. At present, the above territory and the boulevard is being developed, which increases the risk of shore cutting by the sea and land fall.

Fig. 3.18 Condition along the coastline with damaged infrastructure built recently[80]

From 2007, nourishment of sediments has been renewed, however, process is irregular due to scarce financial resources. The works in the were planned to be carried out in 2016-2017 with the aim of protection of Batumi coastline, through sediment recirculation, reinforcement and lengthening the southern coast by 2 km. Materials extraction were meant by deepening the seabed. Besides, it was envisaged to collect the data on the possibilities of directing the flow of the river to the north (reorientation of the Chorokhi). During the seabed deepening

[80] The problem of shore cutting of Ajara coast. The report is prepared by “Ecomigration: dialogue and cooperation for the improvement of life standards in south Caucasus” with the financial support of the EU. CENN.2015. http://w3.cenn.org/wssl/uploads/Discussion Paper_Adjara_FINAL.pdf;
Municipal Development Fund of Georgia. Short description of Batumi coast protection project. The project title: Investment program of sustainable urban transport – tranche 4. Asian Development Bank. Prepared by Ltd “Technital” with sub-consultants: Stichting Deltares, Saunders Group Ltd. Batumi 2016.

operations, a considerable attention should be paid to water quality (increased turbidity) and protection of seabed living organisms. Proceeds of the Asian Development Bank credit to Georgia is used for coastal protection works.

Table 3.15 Coast-forming sediments introduced to Ajara coastline in 2007-2014 (in 1000 m³)[81]

Location	2007	2008	2009	2010	2011	2012	2013	2014	Total 2007-2014	Total 1982-2014
Kobuleti	140						5		145	993
Bobokvati							50		50	870
Chakvi							50		50	1912
Makhinjauri										1405
Adlia			100	100	100	50	18	82	450	1718
Total	140		100	100	100	50	123	82	695	6898

In the process of coast reclamation, possibility of the use of quarry in the Chorokhi riverbed is questionable. Currently, due to Turkish dams, the quarry is not refilled with solid sediments.

3.2.2.4 Significant pressures/drivers on biological parameters

Pollution, eutrophication.[82] As a result of the use of phosphorus containing detergents, untreated household wastewater and intensive agricultural activities over the past decades, the flow of nutrients in the Black Sea has grown significantly. The above is reflected in the growth of concentration of substances containing nitrogen and phosphorus. Between 1970s and 1990s, nitrate concentration grew two-three times. In the same period, phosphate concentration increased 7 times in the north-west shelf. Nutrients are revealed through bio-optical "colour" on the satellite image of the Black Sea surface, which is a substantial indicator of eutrophication. Data is insufficient on pollutants such as heavy metals, PAHs, pesticides.

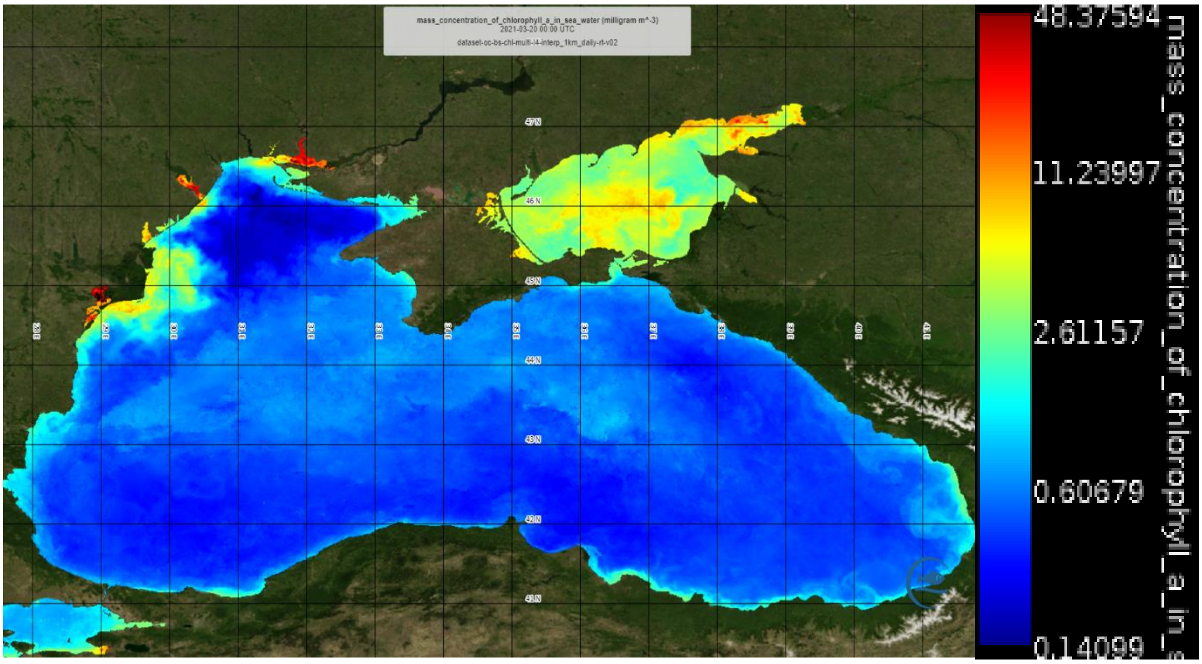

Fig. 3.19 Bio-optical image of Black Sea (surface concentrations of Chlorophyll-a in mg/m³)[83]

[81] The problem of shore cutting of Ajara coast. The report is prepared by "Ecomigration: dialogue and cooperation for the improvement of life standards in south Caucasus" with the financial support of the EU. CENN.2015. http://w3.cenn.org/wssl/uploads/Discussion Paper_Adjara_FINAL.pdf.

[82] State of the Environment Report 2010-2013. http://moe.gov.ge/res/images/file-manager/sajaro-informacia/2010-2013-wlis-garemos-mdgomareobis-shesaxeb-erovnuli-moxseneba.pdf.

[83] https://view-cmems.mercator-ocean.fr/OCEANCOLOUR_BS_CHL_L4_NRT_OBSERVATIONS_009_045

Fishing.[84] In 1970s and 1980s fishing was rather intensive in Georgia. About 800000-900000 tons of fish was produced in that period. The main commercial species were: *Engraulis encrasicolus, Trachurus mediterraneus, Trachurus trachurus*. Also, *Merlangius merlangus, Squalus acanthias, Mullus barbatus and Sprattus sprattus* and *Engraulis encrasicolus*, the same as anchovy were produced in especially big quantities. Despite a considerable degradation of the sector in the last three decades after the breakup of Soviet Union, from 90s fish industry increased, since there was a big commercial market for anchovies in Turkey. Fishing boats in Georgia are concentrated in Batumi and Poti ports. The annual quota for the production of anchovies is 60000 tons. Georgian companies hold 7 licenses but the absolute majority of them hire foreign vessels. For instance, in 2009 there were 20 Turkish seiners in the aquatic area of Georgia under the Georgian flag and the freighters paid them with fish. By law, the large license holders are obliged to process the caught fish in Georgia, and the rest can be exported. In Batumi port there are 17 small ships, but only 10 out of them are functioning. They mainly have bottom trawling. Information on adverse impact of trawlers on the state of the substrate (benthic invertebrates) is not available, but is speculated to be significant. It was reported from national sources, that 300-500 tons and sometimes 1000 tons of fish are caught daily by Batumi trawlers, whereas Turkish seiners catch 6000-10000 tons. Per FAO/GFCM report for 2016 "The State of Mediterranean and Black Sea Fisheries" the average annual landing (2000-2013) for the whole Georgian fishing fleet (47 fishing vessels) was estimated to be 12600 tons.[85] Fishing efforts remains significant, as illustrated by fishing patterns detected through Global Fishing Watch portal (Figure 3.20).

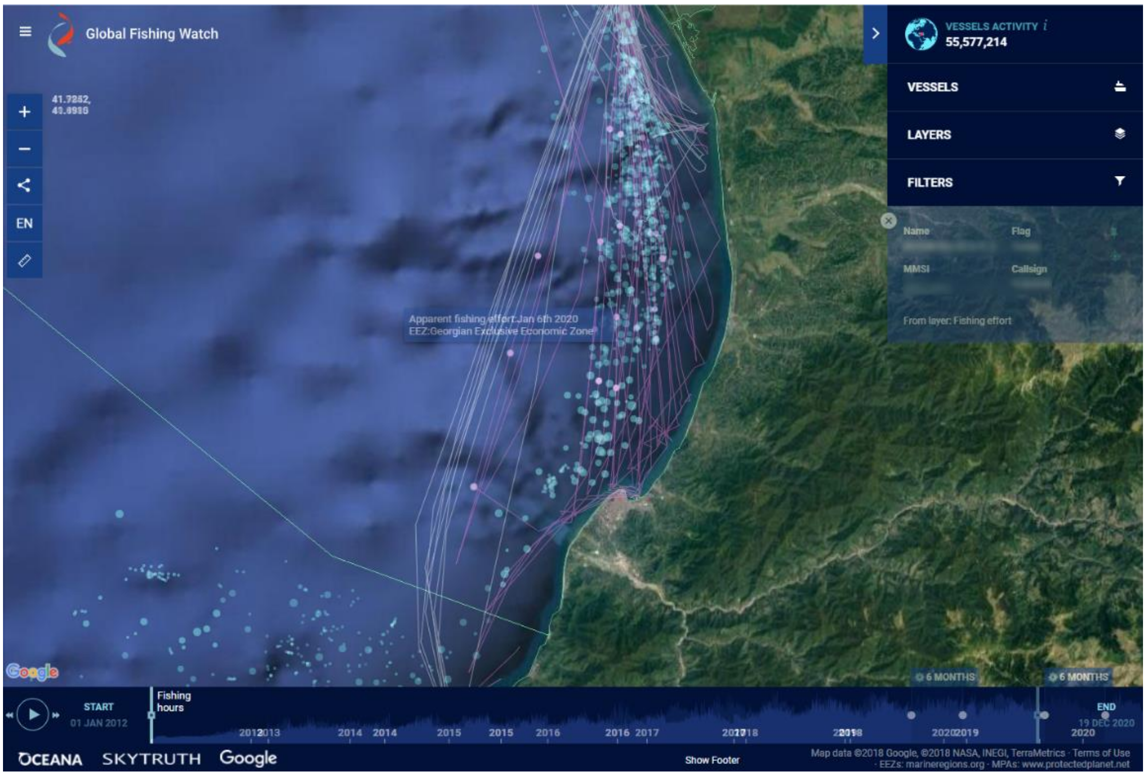

Fig. 3.20 Cumulative fishing vessel activity along Adjara coast in winter 2020 [86]

The endangered species of fish in Georgian territorial waters among the Black Sea and river fishes are all six varieties of sturgeons (*Acipenser sturio, A. stellatus, A. gueldenstaedti, A. nudiventris, A. persicus, Huso huso*). They are included in the Red List of Georgia, and

[84] Resolution of Georgian Government №343, 2014, 8 May, Tbilisi 'On the approval of the strategy and action plan of biodiversity of Georgia 2014-2020'.
[85] http://www.fao.org/3/i5496e/i5496e.pdf
[86] Source: https://globalfishingwatch.org/map/workspace/udw-v2-81d232f4-2644-4b6f-a2bd-efddc3b657e2.

Acipenser sturio is entered in the Red List of IUCN, as a critically endangered species. Illegal fishing takes place in spawning areas, particularly in Chorokhi River and its confluences. However anadromous fish rarely enter the Chorokhi River nowadays. The river, together with its confluences (Dgamishi, Korolistskali, Tkhilnaristskali, Jochostskali, Bolokho) is trout and salmon spawning areas as well and illegal fishing also takes place here. Especially important is the area at the confluence of the Bolokho and Chorokhi Rivers, where many Black Sea salmon nesting places have been discovered.

Tourism, recreation. The biggest flow of tourists in Ajara is observed in June-September. This is the main bathing season. Tourists have a negative impact on beaches and their adjacent habitats, causing their pollution by increased discharge of wastewater, solid waste.

Coastal development. The coast is being intensively developed presently causing fragmentation and degradation of the littoral and sub-littoral habitats (seaweeds, bushy beaches). There is a Chorokhi delta development plan in place, which may considerably damage the habitats and ecosystems of the estuary (delta). The works such as seabed deepening/dredging and throwing the inert matter into the sea with the purpose of coast protection, dredging of coast forming inert matter from seabed, extraction of the same type of sediment from Chorokhi estuary and the riverbed as well as the sea coast are being constantly carried out on Ajara coast. These works are carried out without considering the possible impact on marine and/or river habitats and species, such as direct destruction of benthos population colonies during dredging, substrate modification, water turbidity, etc., as it is not automatically subjected to environmental impact assessment procedure.

Navigation. Intense movement of ships, dumping ballast water discharges by ships, lying at anchor and accidental spillages, antifouling protections (e.g. tributyltin) have negative impact on living organisms and habitats (see Figure 3.21). Unfortunately, law enforcement with respect to observing ecological norms by ships is still poor, since the Environmental Supervision Department lacks financial and technical resources and qualified staff.

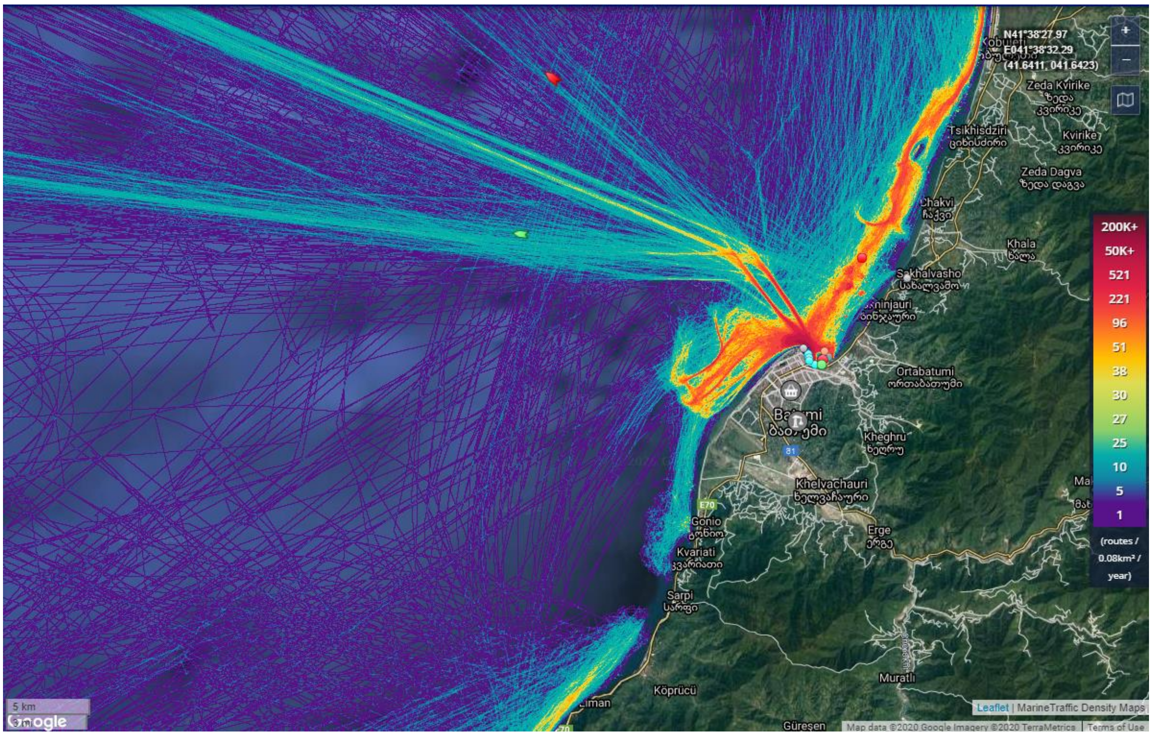

Fig. 3.21 Maritime traffic patterns along Adjara AR coast [87]

[87] Source: https://www.marinetraffic.com/en/ais/home/centerx:41.5/centery:41.7/zoom:11.

3.3 Significant impact on coastal and transitional waters

3.3.1 Impact on physico-chemical quality elements of coastal & transitional waters

Initiatives for the regular monitoring of the Black Sea coastal waters in Georgia.[88]
Within the framework of the on-going programs of the Bucharest Convention, the National Environmental Agency is carrying out observations on the Black Sea Georgian coastal waters and the conditions in Black Sea basin rivers. From 2008 on Georgia renewed investigation of the Black Sea Georgian coastal zone. National monitoring program has been conducted with quarterly investigation of coastal waters. Implementation of monitoring program till 2016 was conducted at five points, these were Gonio, Batumi, Kobuleti, Supsa and Poti. There are regular scientific studies on the marine pressures as well (from 2008 observations include Black Sea basin rivers as well) and these are briefly discussed in this document. Within the EPIRB project framework, measurements were conducted in July-August of 2016 and its summary results are also included in this document. Finally, in a frame of EUWI+ project southern parts of the Black Sea Georgian coastal zone were investigated in three surveys. investigated area was delineated in several water bodies, and their status was assessed.

Since 2006, National Environmental Agency of the Ministry of Environmental Protection and Agriculture has been conducting hydrochemical and hydrobiological monitoring to assess the ecological state of Georgian Black Sea coastal waters. From 2006 to 2015 there was seasonal monitoring and it included five hydrobiological stations: Gonio, Batumi, Kobuleti, Supsa and Poti. Samples were taken from the coast with the distance of 0,5-1 miles.

Since 2016, the frequency of hydrobiological observations increased and became monthly. Water samples were taken at four permanent stations on the coast - Sarpi, Batumi, Batumi Port, Green cape 10-20 m from the coast. There have been determined some parameters of sanitary, bacteriological and hydrobiological, planktonic and bottom communities, their numbers and seasonal dynamics have been studied. A study was also carried out on rocky biocenoses of Tsikhisdziri, Sarpi, Green cape and artificial substrates of the Batumi port.

Table 3.16 Black Sea biological monitoring stations in the pilot area from Sarpi to Kobuleti

Monitoring statins		Coordinates of monitoring statins		Status of monitoring statins
1.	Sarpi	41°54'32.61"N	41°55'78.07"E	Reference station
2.	Batumi	41°65'65.71"N	41°63'30.83"E	Station with Anthropogenic loading
3.	Batumi port	41°65'09.11"N	41°64'45.02"E	Station with High Anthropogenic loading
4.	Green cape	42° 69'17.92"N	41°70'35.10"E	Reference station

3.3.1.1. Results obtained in international projects EMBLAS-II, EPIRB, EUWI+, EMBLAS-Plus

In the frame of several international projects (EMBLAS-II, EPIRB, EUWI+ and EMBLAS-Plus) measurements and sampling have been conducted in the period from 2016 to 2020 at a large number of stations. The most important results obtained are presented below.

These projects used generally accepted methods of hydrobiological research, as well as guidelines prepared under the EMBLAS project (*Guidelines for Monitoring the Black Sea. Macrophytobenthos; Guidelines for Monitoring Mesozooplankton in the Black Sea; and Guidelines for Monitoring Phytoplankton of the Black Sea*).

[88] Source: National Environmental Agency.

Environmental Monitoring of the Black Sea - EMBLAS

In a frame of EMBLAS project scientific program of Georgia were conducted on board of the Romanian research vessel “Mare Nigrum” from 17 May until 4 June 2016 in Georgian waters, where sampling took place at 14 sampling stations along the Georgian polygons.

The sampling and observations programme of NPMS was implemented at the appointed sampling sites in Georgia presented in Fig. 3.22 and Table 3.17 below. Sampling, processing of samples and reporting were performed according to the methods and templates agreed among the EMBLAS project partners. Processing and analysis of the samples was carried out in the National Environmental Agency laboratories of Georgia.

The parameters covering a wide range of MSFD descriptors, WFD biological quality elements, priority substances and other chemicals were selected in a way allowing for their measurements and observations on all sites.

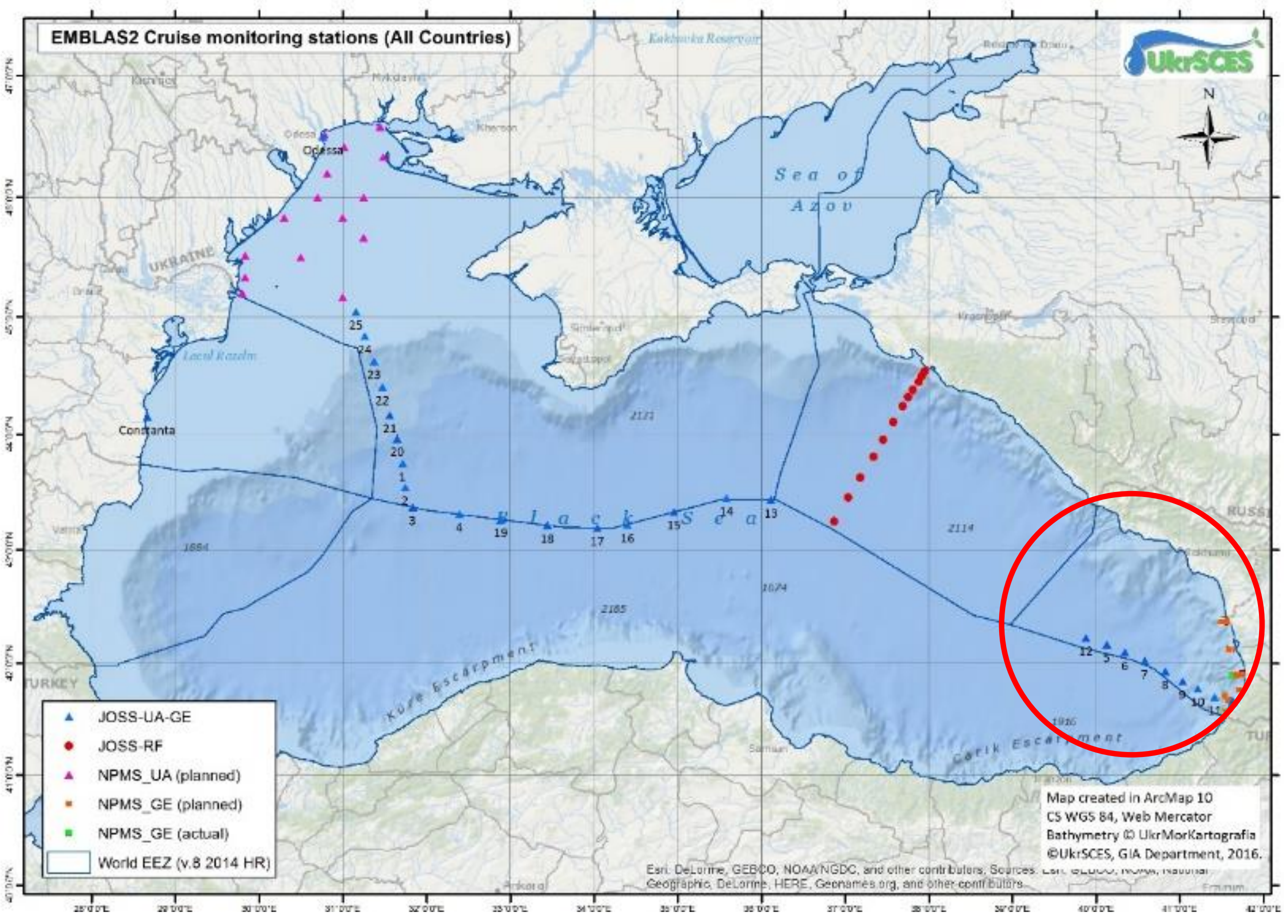

Figure 3.22 An overview map of sampling stations in NPMS UA, NPMS GE, JOSS UA-GE and JOSS RF.

The stations were located rather tightly in Georgian waters since the ecosystem hydrological structure (the quasi-stationary Batumi anticyclonic eddy) important for the Black Sea was planned to be investigated in more detail.

Estimation of water quality occurs based on supporting quality elements: temperature, salinity (‰), conductivity, ORP, pH, turbidity, suspended matter, dissolved oxygen, dissolved inorganic nitrogen (NO_3, NO_2, NH_4), orthophosphate (PO_4), silicates (SiO_3), TP, TN, Cu, Fe, Zn, Mn, Ni, Pb, Cd, As, Pesticides, PCBs, PAH. Sampling depths are shown on Table 3.17.

Table 3.17. The Georgia National Pilot Monitoring Studies (NPMS) information

Station N	Station description	Latitude, ºN	Longitude, ºE	H, m	Type	Sampling data	Sampling depth, m
Station 1	Gonio-1	41º33,477′	41º33,111′	46	coastal	28.05.16	0
							15
							40
Station 2	Gonio -2	41º34,354′	41º32,410′	76	coastal	28.05.16	0
							15
							30
							60
Station 3	Batumi-1	41º39,949′	41º35,612′	22	shelf	31.05.16	0
							18
Station 4	Batumi-2	41º40,353′	41º35,084′	32	shelf	31.05.16	0
							9
							20
							28
Station 5	Batumi-3	41º43,170′	41º32,158′	677	coastal	28.05.16	0
							15
							40
							70
							103,8
Station 6	Tsikhisdziri-1	41º45,768′	41º43,319′	23	shelf	31.05.16	0
							10
							18,4
Station 7	Tsikhisdziri-2	41º45,763′	41º42,883′	63	coastal	30.05.16	0
							5
							25
							55
Station 8	Kobuleti-1	41º54,259′	41º44,948′	42	coastal	30.05.16	0
							8
							18,4
							38
Station 9	Kobuleti-2	41º54,038′	41º40,277′	93	coastal	30.05.16	0
							9
							16,5
							38
							86
Station 10	Kobuleti-3	41º53,431′	41º37,253′	167	coastal	30.05.16	0
							10
							34
							101
							140
Station 11	Poti-1	42º07,359′	41º36,987′	38	coastal	29.05.16	0
							15
							26
Station 12	Poti-2	42º07,111′	41º35,613′	280	coastal	30.05.16	0
							8
							15
							35
							80
							116
							133
Station 13, 14	Anaklia-1-2	42º22,103′	41º32,311′	110	coastal	29.05.16	0

Station N	Station description	Latitude, ºN	Longitude, ºE	H, m	Type	Sampling data	Sampling depth, m
							5
							20
							40
							98
Station 15	Anaklia-3	42º22,237′	41º30,049′	440	coastal	29.05.16	0
							6
							20
							37
							70
							98,9
							119

Study of ecological condition of coastal zone has high importance for the evaluation of level and nature of anthropogenic impact on the sea ecosystem. Evaluation of water quality is the necessary component of any research and only through such evaluation it is possible to create comprehensive picture about the water eco-system.

In a frame of EMBLAS project for the estimation of ecological condition of the Adjara Black Sea coastal line the observations were conducted at 4 hydrological stations and started from 2016 and continues until the present time. The observation scheme is provided in Table 3.18.

Table 3.18. Monitoring Scheme for Georgian Coastal Line

Station №	Station	Station coordinates		Observation depths, m	Observation frequency
		Longitude	Latitude		
1	Sarpi	41.543261°	41.557807°	surface	monthly
2	Pier Batumi	41.656571°	41.633083°	surface	monthly
3	Batumi Port	41.650911°	41.644562°	surface	monthly
4	Green Cape	41.691792°	41.703510°	surface	monthly

Estimation of water quality occurs based on supporting quality elements: temperature, salinity (‰), conductivity, ORP, pH, turbidity, suspended matter, dissolved oxygen, dissolved inorganic nitrogen (NO_3, NO_2, NH_4), orthophosphate (PO_4), silicates (SiO_3).

Environmental Protection of International River Basins Project – EPIRB

Within the framework of the pilot monitoring in July-August 2016, National Environmental Agency's Environmental Pollution Monitoring Department and Fishery and Black Sea Monitoring Service (now the Department of Fisheries, Aquaculture and Water Biodiversity) conducted monitoring in Gonio-Kobuleti waters. In order to determine the ecological conditions in the Black Sea, phytoplankton, phytobenthos, zoobenthos and hydro-chemical samples were taken from 6 stations – Gonio, Chorokhi, Batumi, Batumi Port, Chakvi and Kobuleti (Figure 3.23). The samples were taken from a hired vessel, 0.5-1.5 miles from the coastline at two isobaths (0m, 20m). Samples of macrophytes were taken by divers off shore of Mtsvane Kontskhi.

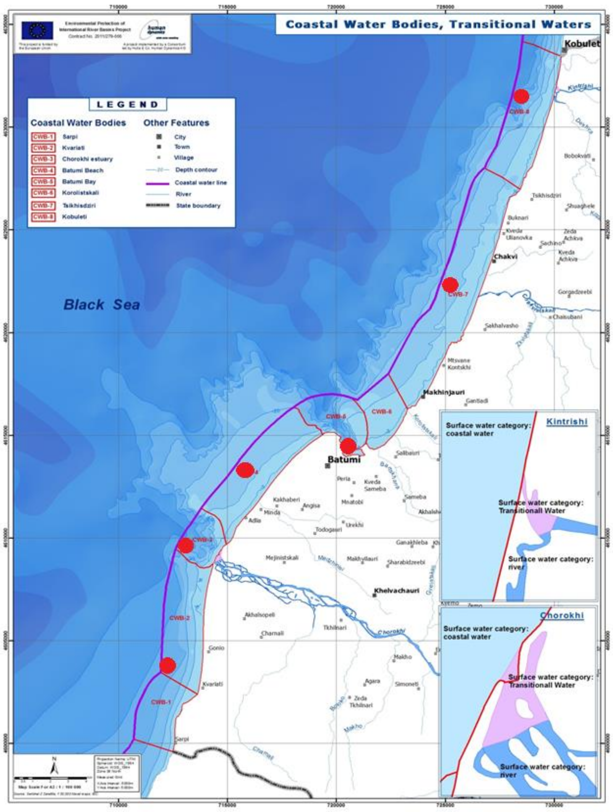

Fig. 3.23 Pilot Monitoring Points (2016)

Generally, at the mouth of the river or in shallow waters, the transparency in the water after rain might be very low. In the coastal waters, the water transparency in observation area during the investigation period were 2.0-8.0 m. Maximum transparency was detected at Gonio – 8.0 m. Minimum transparency was detected at Chorokhi and was 3.0 m, which can be explained by intensive development of algae in river waters that are rich with biogenic material and suspended matters.

During the study, the content of suspended matter in the surface level varied from 2.4 (Batumi) to 6.0 (Kobuleti) mg/l. At 20 m depth – from 2.2 (Gonio) to 1.6 (Batumi) mg/l.

The salinity in the coastal waters varied from 11.5% (Chorokhi) to 17.7% (Gonio). Low salinity at the surface was caused by the flow of freshwater from the rivers.

At the 20 m layer the salinity was at 17.0% (Kobuleti) – 18.2% (Chorokhi). The vertical distribution of salinity in the stations had a logical character – the salinity at the surface was the lowest due to the low density, while at a 20 m depth it slightly surpasses the surface salinity (Table 3.19).

Table 3.19 Water salinity, transparency, turbidity, SPM values (0, 15-20 m horizons)

#	Station	Depth, m	Transparency, m	Salinity, ‰	Turbidity, NTU	Suspended matter, mg/l
1	Gonio	surface	8.0	17.7	0.58	3.2
		20		17.7	1.43	2.2
2	Chorokhi	surface	3.0	11.5	0.53	4.0
		20		18.2	0.47	4.8
3	Batumi	surface	3.5	11.8	0.37	2.4
		20		17.9	0.49	6.0
4	Batumi (harbour)	surface	3.5	13.2	0.37	5.2
		20		17.8	0.43	4.0
5	Chakvi	surface	5.0	13.4	0.64	4.0
		20		17.5	0.52	2.8
6	Kobuleti	surface	5.0	14.4	0.48	6.0
		20		17.0	0.55	2.4

Identification of ammonium NH_4^+, nitrates NO_2^-, nitrates NO_3^-, phosphates PO_4^{3-} was an important part of this study. The results of the study are displayed in the Table 3.20.

Table 3.20 Ammonium NH_4^+, Nitrates NO_2^-, Nitrates NO_3^-, Phosphates PO_4^{3-} values at hydrological stations

№	Observation station	Sampling depths m	NH_4, μmol/l	NO_2, μmol/l	NO_3, μmol/l	PO_4, μmol/l
1	Gonio	surface	0.22	ND	0.34	0.25
		20	1.32	0.04	0.45	0.25
2	Chorokhi	surface	0.02	0.11	6.90	0.28
		20	0.10	ND	0.46	0.17
3	Batumi	surface	0.41	0.06	5.55	0.38
		20	5.92	ND	0.26	0.19
4	Batumi (harbour)	surface	0.16	0.05	3.41	0.37
		20	0.02	ND	0.23	0.21
5	Chakvi	surface	0.04	0.01	3.31	0.19
		20	0.06	ND	0.35	0.28
6	Kobuleti	surface	0.08	0.01	1.20	0.27
		20	ND	ND	0.32	0.31

During the study, range of nitrate in the surface layer was 0.34-6.90 μmol/l (river Chorokhi). This was the highest concentration range for nitrates.

The concentration of nitrates in the water was low compared to the surface, 0.3-0.5 μmol/l on average. There is a notable tendency when looking at the vertical structure of the nitrates – amount of nitrates decreases 6.4-0.9 μmol/l from the surface to 20 m depth (Figure 3.24).

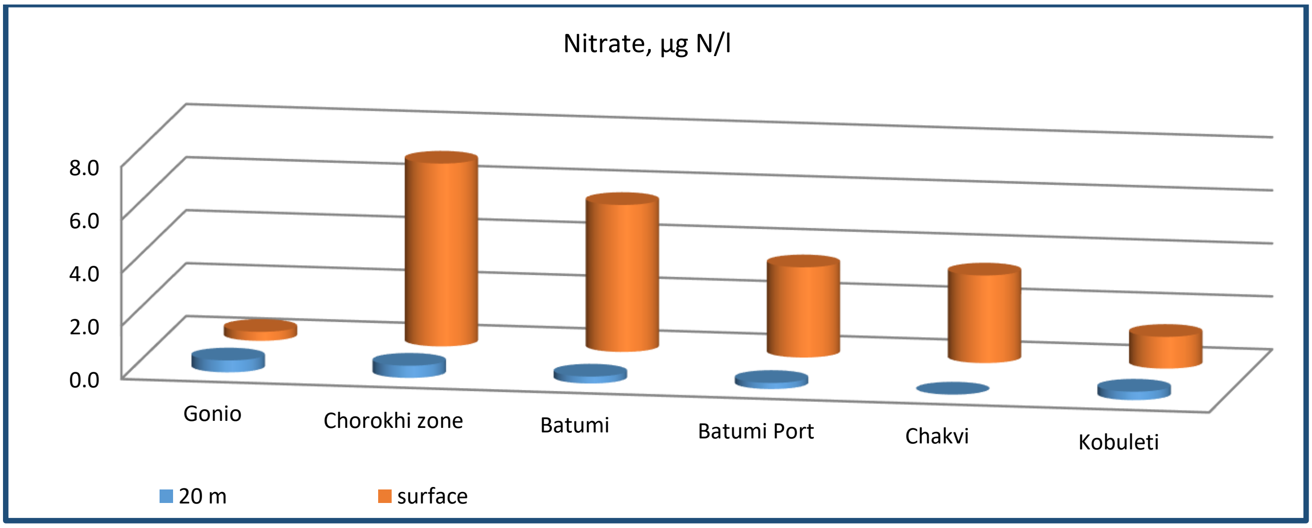

Fig. 3.24 Dynamics of changes in nitrate at hydrological stations 1-6

Low amounts of nitrates were found at the surface during the study. At a depth in the water, nitrates were practically at 0, whereas at surface 0.01-0.11 μmol/l.

Insignificant changes in phosphates were seen at different depths of the Black Sea: the concentration of phosphates at the surface level varied from 0.19-0.37 μmol/l at 15-20 m depth the figure was at 0.19-0.31 μmol/l. In zones that were considered at sea bed depth, the figures where more varied, which was expected and the figures were 0.04-0.09 micromole/l. This is caused by accumulation of metal-phosphates at the sea bed, which causes secondary pollution of the sea bed.

The dynamic of phosphate variations at the different stations is shown on the Figure 3.25.

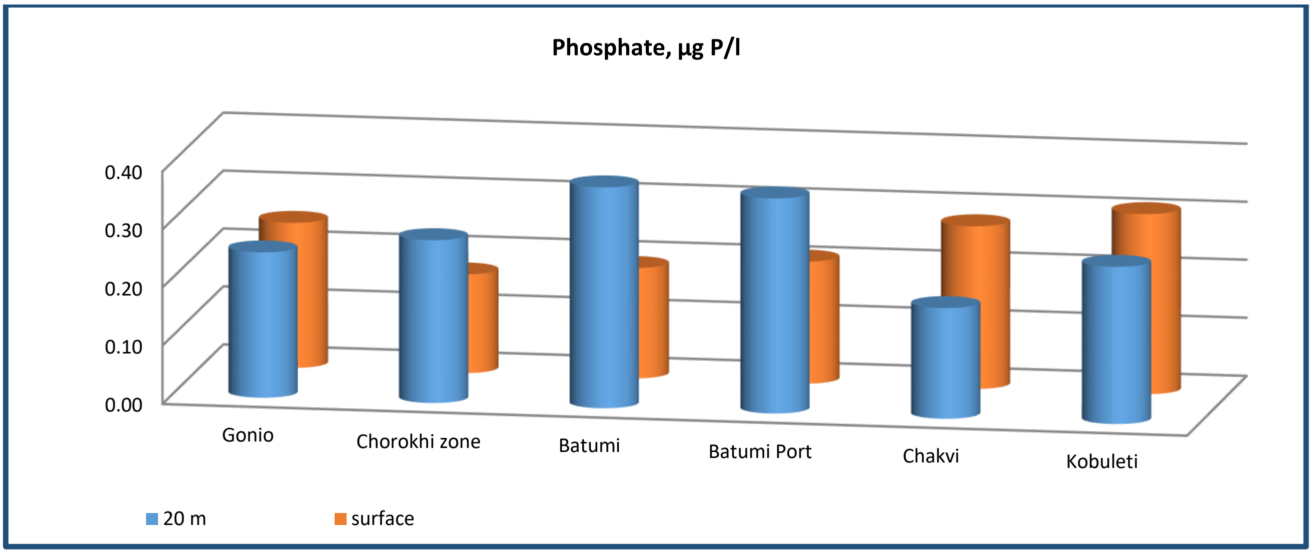

Fig. 3.25 Dynamics of changes in phosphates at hydrological stations [83]

European Union Water Initiative Plus for the Eastern Partnership (EUWI+ 4 EaP)

Within the framework of the EUWI+ project to determine the ecological status of the Georgian Black Sea coast and transitional water bodies studies were conducted with the first survey on September 8-13, 2019, the second survey on November 11-14, 2019 and third stage of study, from June 29 to July 3, 2020 (Tables 3.21-23).

According to the delineation of the Black Sea coast of Georgia, up to 11 coastal and up to 4 transitional water bodies have been allocated on the Sarpi-Kobuleti water area, each of them delineated in accordance with the requirements of the EU Water Framework Directive and the Marine Framework Directive.

During the expedition, were taken samples of phytoplankton up to 100, 24 zooplankton, 46 benthos, 10 microbiological, 9 macrophytes, which were processed in the laboratories of the Department of Fisheries, Aquaculture and Water Biodiversity.

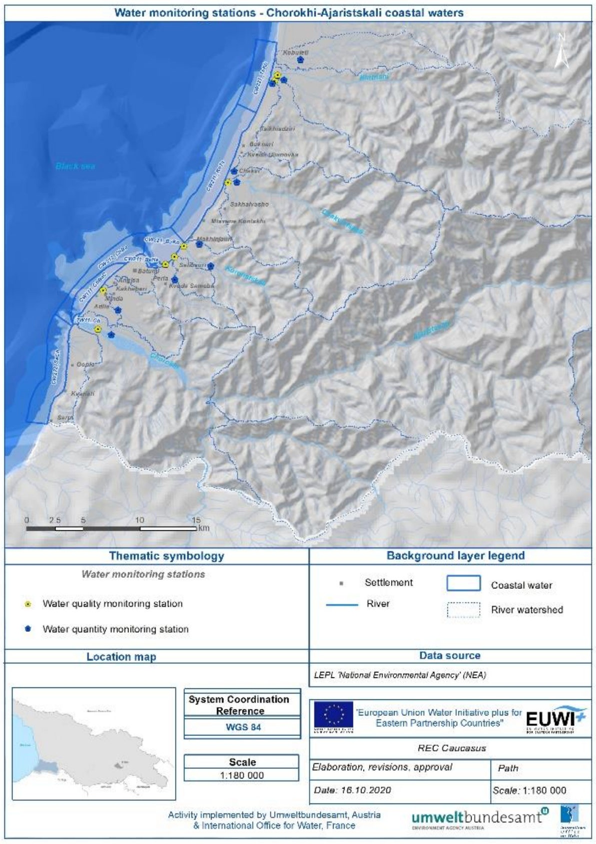

Fig. 3.26 Pilot Monitoring Points (2019)

Also in November of 2019 and 2020 on transition water stations, at the confluence of the rivers Chorokhi and Supsa, the specialists of the Department carried out fishing with the help of a hired fishermen's brigade, their own small boat (4.5 m long motor boat) and with all the necessary technical support. The species of fishing have been identified. The received data is processed and the results are sent in a special reporting format.

Table 3.21 Coastal and transitional water bodies identified at the I stage of the study in the Sarpi-Kobuleti area of the Black Sea coast of Georgia (09.2019).

WATER CATEGORY	WATER BODY	STATION	GEOGRAPHIC LOCATION (WGS 86)		STATION DEPTH (m)	ANALYSED PARAMETERS
			Longitude	Latitude		
TW	TW_CH	T1a-P	41° 36.315' N	41° 34.445' E	0.5	SQE, Phyto
TW	TW_CH	T1b-P	41° 36.465' N	41° 34.604' E	0.5	SQE, Phyto
TW	TW_CH	T1b-B	41° 36.301' N	41° 34.509' E	0.5	Benthos
TW	TW_REF (Kintrishi)	T2-PB	41° 48.225' N	41° 46.128' E	0.5	SQE, Phyto, Benthos
CW	CW3_CS	C1-PB	41° 32.288' N	41° 32.862' E	29	SQE, Phyto, Zoo, BI
CW	CW1_BCC	C2-PB	41° 37.674' N	41° 34.583' E	20	SQE, Phyto, Zoo, BI
CW	CW2_BC	C3-PB	41° 40.060' N	41° 35.568' E	22	SQE, Phyto, Zoo, BI
CW	CW4_BH	C4-PB	41° 39.223' N	41° 38.694' E	16	SQE, Phyto, Zoo, BI
CW	CW3_KB	C5-PB	41° 39.940' N	41° 39.360' E	11	SQE, Phyto, Zoo, BI
CW	CW2_TK	C6a-PB	41° 42.517' N	41° 41.979' E	24	SQE, Phyto, Zoo, BI
CW	CW3_KT	C6b-PB	41° 46.653' N	41° 44.293' E	25	SQE, Phyto, Zoo, BI
CW	CW3_KT	C7-PB	41° 48.005' N	41° 45.225' E	25	SQE, Phyto, Zoo, BI
CW	CW3_KT	C6b-SED	41° 46.171' N	41° 44.205' E	6	Sub
CW	CW3_KT	C7-SED	41° 47.838' N	41° 45.621' E	7	Sub

Table 3.22 Coastal and transitional water bodies identified at the II stage of the study in the Sarpi-Kobuleti region of the Black Sea coast of Georgia (11.2019).

WATER CATEGORY	WATER BODY	STATION	GEOGRAPHIC LOCATION (WGS 86)		STATION DEPTH (m)	ANALYSED PARAMETERS
			Longitude	Latitude		
TW	TW_CH	T1c-P	41° 36.506' N	41° 34.661' E	0.5	SQE, Phyto
TW	TW_CH	T1c-B	41° 36.359' N	41° 34.495' E	0.5	Benthos
TW	TW_REF (Supsa)	T3-PB	42° 01.220' N	41° 45.157' E	0.5	SQE, Phyto, Benthos
CW	CW3_CS	C1-P	41° 32.224' N	41° 33.199' E	28	SQE, Phyto, Zoo
CW	CW3_CS	C1a-B	41° 32.430' N	41° 32.538' E	54	BI
CW	CW1_BCC	C2a-PB	41° 37.425' N	41° 35.166' E	7	SQE, Phyto, Zoo, BI
CW	CW2_BC	C3a-PB	41° 39.313' N	41° 36.166' E	13	SQE, Phyto, Zoo, BI
CW	CW4_BH	C4-P	41° 39.187' N	41° 38.684' E	14	SQE, Phyto, Zoo
CW	CW3_KB	C5a-PB	41° 39.530' N	41° 39.248' E	5.4	SQE, Phyto, Zoo, BI
CW	CW2_TK	C6a-B	41° 42.332' N	41° 41.643' E	14	BI
CW	CW2_TK	C6c-P	41° 42.250' N	41° 42.117' E	10	SQE, Phyto, Zoo
CW	CW3_KT	C6d-PB	41° 46.156' N	41° 44.203' E	11	SQE, Phyto, Zoo, BI
CW	CW3_KT	C7a-B	41° 47.827' N	41° 45.637' E	5	BI
CW	CW3_KT	C7-P	41° 48.016' N	41° 45.232' E	25	SQE, Phyto, Zoo

Table 3.23 Coastal and transitional water bodies identified at the III stage of the study in the Sarpi-Kobuleti region of the Black Sea coast of Georgia (07.2020).

WATER CATEGORY	WATER BODY	STATION	GEOGRAPHIC LOCATION (WGS 86)		STATION DEPTH (m)	ANALYSED PARAMETERS
			Longitude	Latitude		
TW	TW_REF (Supsa)	T3-PB			0.5	SQE, HB, Phyto, BI
TW	TW_Ch	T1a-P			0.5	SQE, HB, Phyto, BI
CW	CW3_CS	C1b_P			25	SQE,HB, Phyto, Zoo, Benthos
CW	CW1_BCC	C2ab-P			5	SQE, HB, Phyto, Zoo
CW	CW2_BC	C3ab_P			5	SQE,HB, Phyto, Zoo, BI
CW	CW4_BH	C4_P			10	SQE, HB, Phyto, Zoo
CW	CW3_KB	C5ab_P			5	SQE, HB, Phyto, Zoo ,BI
CW	CW3_KT	C6d_P			10	SQE,HB, Phyto, Zoo,
CW	CW2_TK	C6c_P			8	SQE, HB, Phyto, Zoo, BI
CW	CW3_KT	C7_P			25	SQE, HB, Phyto, Zoo

The results of the three surveys will be present in a special EUWI+ report. The summary draft results are presented in Table 24.

Table 24. Draft summary results on the status of transitional and coastal water bodies for supporting physico-chemical and biological quality elements established during the EUWI+ project

Water category	Water body	Supporting physico-chemical QE						Biological QE				
		Temp.	Sal.	Transp.	O_2 Sat	DIN	PO4	Phyto	BI	MP	AGS	Fish
TW	TW11-Ch	NR	NR	ND	H	H	G	ND	ND	SND	SND	EP
CW	CW222_SaCh	NR	NR	G	G	H	H	ND	H	G	SND	QE_NR
	CW111_ChBaC	NR	NR	G	H	H	H		G	NP		
	CW212_ChBa	NR	NR	G	G	H	H		G	NP		
	CW211_BaHa	NR	NR	G	H	G	G		M	NP		
	CW221_BaKo	NR	NR	G	H	H	H		G	NP		
	CW211_KoTs	NR	NR	G	G	H	G		H	G		
	CW221_TsKb	NR	NR	G	G	H	H		G	NP		

TW-Transitional waters
CW-Coastal waters
QE-Quality elements
H-High
G-Good
M-Moderate
P-Poor
B-Bad

Temp–Temperature
Sal-Salinity
Transp-Transparency
O2 Sat-Dissolved oxygen saturation
DIN-Dissolved inorganic nitrogen
PO4-Orthophosphates

Phyto-Phytoplankton
BI-Benthic invertebrates
MP-Macrophytes
AGS-Angiosperms
Fish-Fish fauna

NR-In normal range
ND-Not determined
NP-Quality element not present
SND-Indicator species not defined
QE_NR-Quality element not relevant
EP-Evaluation in progress

Additionally, to the summary status table, below are presented some selected results for Macrozoobenthos and Macrophytes obtained within the framework of the EUWI+ project.

Macrozoobenthos

Studying of benthic fauna on the Black Sea Georgian coast was held in 2019 with support of EUWI+ project. Benthic samples were taken alongside the Sarpi-Kobuleti areas in different stations with the help of marine expedition arranged in September-November (Table 3.25).

Table 3.25 Macrozoobenthos samples station in the Black Sea Georgian coast 2019

Stations	Depth m	Substrate	Replicate
September, 2019			
C1 - PB-Sarpi	*29*	*Silt*	*2*
C2-PB -Adlia	*20*	*Mud*	*2*
C3-PB-Batumi 1	*22*	*Mud*	*2*
C4-PB-Batumi-2	*16*	*Mud*	*2*
C5-PB Batumi-3	*11*	*Mud-Silt*	*2*
C6a-PB Makhinjauri	*24*	*Silt*	*2*
C6b-PB Tsikhisdziri	*25*	*Silt*	*2*
C7-PB Bobokvati	*25*	*Silt*	*2*
November, 2019			
C1a-B -Sarpi	*54*	*Sand-Mud*	*2*
C2a-PB-Adlia	*7*	*Silt*	*2*
C3a-PB -Batumi	*12.6*	*Mud-Sand*	*2*
C5a-PB Batumi-3	*5.4*	*Sand*	*2*
C6a-B 0Makhinjauri	*13.7*	*Silt*	*2*
C6d-PB-Tsikhisdziri	*11*	*Mussel shells*	*2*
C7a-B- Bobokvati	*5*	*Silt*	*2*

Sample stations might be divided by nature of substrate and number of species into following groups: I – C2, C3, C4 and C 5 – clay substrate with 1-15 species; II – C1, C1a, C2a, C3a, C5a and C6a – silt substrate with 16-25 species and III – C7, C6a, C6b, C6d and C7a – silt shell substrate with 26-36 species.

In the study area 84 species were observed throughout the benthal area in 2019. Dominant species were Polychaeta (29 species/35%) and molluscs (25 species/30% – Gastropoda (13) and Lamellibranchiate (12)); Arthropoda was introduced by Crustacea (18 species/21%). Rest of 14% was composed of other bottom invertebrates such as: Coelenterata, Tentaculata, Nemertini, Chordata, Sarcodina, Spongia and Echinodermata (Figure 3.27).

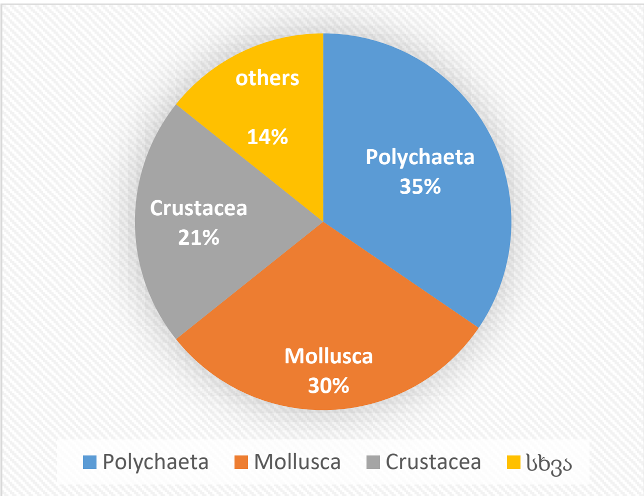

Fig. 3.27 Percentage correlation between the main groups of benthic fauna in the Black Sea Georgian coast, 2019

Number of benthic fauna was 2570 ind/m2, and biomass – 118.199 g/m2 dominating with molluscs with number of 2145 ind/m^2, and biomass – 108.695 g/m^2 relatively being 83-92% of the whole benthic composition. Out of molluscs the most prevailed species were Bivalvia with number of 2097 ind/m^2 (98%), and biomass 77.893 g/m^2. High indicators of quantity and biomass had *Donax semistriatus* with 1146 ind/m^2 and 63.885 g/m^2. By point of number of species, *Polychaeta* had the subsequent place like *Melinna palmata* (261 ind/m^2) and *A. diadema* (87 ind/m^2).

Benthos groups are mainly bottom species, for instance, in the depth of 11m of the study area, on the silt sandy substrate the dominant species were observed M. palmata (453 ind/m^2) consuming the smallest particles of silt as a food and construction of living pipes. Other species are presented negligibly or not at all. Massive population of Polychaeta has been set up in shell substrates. Out of 29 species, 22 are inhabited in shell substrates. As for molluscs, their habitat is the depth of 5-25m with clean sandy sediment. Out of 25 species, 12-13 have been grouped largely. Crustaceans mostly inhabit bottom waters therefor sandy habitat doesn't affect them. Sediment benthic fauna of the internal aquatorium of the station Batumi 2 is the lowest indicator of biodiversity (with 4 species).

Description of Benthic habitats

Based on vertical zonation of bottom fauna distribution, surveys held in 2019 showed that the Black Sea Georgian coast could be separated into two zones: infralittoral and circalittoral 5 benthic habitats have been established due to a type of bottom samples ground and dominant species composition (Table 3.26).

Table 3.26 Bottom habitats of the Black Sea Georgian coast, 2019

	Habitat	**Stations**	**depth**
1.	Infralittoral silt *Donax semistriatus, Chamelea gallina, Lucinella divaricata, Lentidium mediterraneum*	C7a; C2a; C6a; Bobokvati, Adlia. Makhinjauri.	5 -14 m
2.	Infralittoral mixed sediments, mud, silt with sand, sand, shells *Donax semistriatus* , *Chamelea gallina, Melinna palmata, Lucinella divaricata*	C5a; C5; C6d; C3a; Batumi „3“, Tsikhisdziri, Batumi „1“.	5-13 m
3.	Circalittoral clay *Heteromastus filiformis*	C 4; C 2; C 3; Batumi „2“, Adlia, Batumi „1“.	16-22 m
4.	Circalittoral silt *Lucinella divaricata , Chamelea gallina , Pitar rudis, Gouldia minima, Anadara inaequivalvis*	C6a; C6b; C7; C1; Makhinjauri, Tsikhisdziri, Kvariati (From Sarpi to Chorokhi).	24-30 m
5.	Circalittoral shells *Acanthocardia tuberculata, Lentidium mediterraneum*, *Cerithidium submammillatum.*	C 1a ; Sarpi.	50-54 m

Infralittoral silt with species: *Donax semistriatus, Chamelea gallina, Lucinella divaricata, Lentidium mediterraneum* habitats constituted by terrigans and air hydrants, were identified in the depth of 5-15 m in Bobokvati, Adlia and Makhinjauri stations. Dominant species of infralittoral silt were molluscs: *D. semistriatus, C. gallina, L. divaricata, L. Mediterraneum.* With average number and biomass *D. Semistriatus* was prevailed (2730 ind/m^2 and 135.8 g/ m^2) composing the 69-91% of samples. The key role in this habitat plays mollusc *A. Kagoshimensis* consequently with the whole number of macrozoobenthic fauna.

Dominants species	Average quantity (ind/m^2)	Average biomass (g/ m^2)
Donax semistriatus	2730	135.827
Chamelea gallina	837	12.098
Lucinella divaricata	302	0.533
Lentidium mediterraneum	111	0.189

Infralittoral mixed sediments: silt clay, silty sand, sand, shells with Donax semistriatus, Chamelea gallina, Melinna palmata, Lucinella divaricata have been identified in the depth of 24-29 m in Batumi, Batumi bay, Batumi 3 and Tsikhisdziri stations. Dominant species of infralittoral habitat are Bivalvias *D. semistriatus, C. gallina, L. Divaricata* and Polychaeta *M. Palmata*. Among them with average number 2730 ind/m^2 and biomass 135.8 g/m^2 the privileged species are *D. Semistriatus* (1907 ind/m^2 and 22.1 g/m^2). In this habitat with molluscs Polychaeta Melina takes an important place using small particles of silt sand and clay sediments for living processes.

Dominants species	Average quantity (ind/m^2)	Average biomass (g/ m^2)
Donax semistriatus	1907	22.100
Chamelea gallina	224	23.435
Melinna palmata	164	1.201
Lucinella divaricata	125	0.295

Circalittoral clay with Heteromastus filiformis

Dominants species	Average quantity (ind/m^2)	Average biomass (g/ m^2)
Heteromastus filiformis	50	0.117

Circalittoral clay habitats with air hydrates are inhabited only by Polychaeta *H. filiformis* being dominant and having 50 ind/m^2 and biomass 0.117 g/m^2. It was observed in depth of 16-22m at three locations: Adlia, Batumi Port internal area and benthal of Batumi coast. In line with Annelida in Batumi Port and clay benthal of Batumi shelf, minor number of Polychaeta was identified: *N. hombergii*, *P. cirifera* is inhabited in Adlia bottom clay sediment and in three stations of the same habitat *U. pusilla* was observed. This habitat has been characterized as a low biodiversity.

Circalittoral mud with Lucinella divaricata, Chamelea gallina, Pitar rudis, Gouldia minima, Anadara kagoshimensis

Dominants species	Average quantity (ind/m^2)	Average biomass (g/ m^2)
Lucinella divaricata	1459	8.038
Chamelea gallina	259	18.220
Pitar rudis	182	17.058
Gouldia minima,	180	10.174
Anadara kagoshimensis	107	13.370

Circalittoral mud habitat is presented in Chakvi, Tsikhisdziri, Kvariati (from Sarpi to Chorokhi river) stations in the depth of 24-30 m. 36 species with average number of 2187 ind/m^2 and biomass 66.86 g/m^2 were identified in this habitat. Dominant species are *L. divaricata, Ch. gallina, P. rudis. G. Minima* and *A. kagoshimensis*. Annelida (Polychaeta) S. tentaculata (68 ind/m^2) and Crustacean E. ischnus (53 ind/m^2) are typical for our region.

Circalittoral shells with *Acanthocardia tuberculata, Lentidium mediterraneum*, *Cerithidium submammillatum*

Dominants species	Average quantity (ind/m^2)	Average biomass (g/ m^2)
Acanthocardia tuberculata	106	0.071
Lentidium mediterraneum	79	0.098
Cerithidium submammillatum	75	0.276

Circalittoral shells with *A. tuberculata, L. mediterraneum*, *C. Submammillatum* are dominant at stations Sarpi C 1a in the depth of 50-54m. In this habitat average number of macrozoobenthos fauna was 260 ind/m^2 and biomass 0.445 g/m^2. Prevailed specie is *A. Tuberculata* having the quantity of 106 ind/m^2 being 41% of habitats species indicator.

Assessment of marine water ecological status in Georgian coast using several indices

Assessment of ecological status of the Black Sea shelf on Sarpi, Adlia, Batumi, Batumi Port, Makhinjauri, Tsikhisdziri, Bobokvati stations was applied by using benthic fauna indicators and Richness, Diversity, AMBI, M-AMBI indices identifying diversity level, sensitive pollution resistant species quantity etc. of bottom invertebrates in marine biocenoses (Table 3.27).

Table 3.27 Ecological status of the Black Sea Georgian coastal stations

Stations	AMBI	Diversity	Richness	M-AMBI	Ecological Status
September, 2019					
Sarpi- C1 - PB	0.589	3.03	22	0.71	Good
Adlia - C2-PB	3.648	1.41	7	0.29	Poor
Batumi 1 - C3-PB	2.316	2.44	8	0.45	Moderate
Batumi 2 - C4-PB	2.318	1.82	4	0.37	Poor
Batumi 3 - C5-PB	0.974	1.73	9	0.48	Moderate
Makhinjauri - C6a-PB	1.358	3.69	18	0.68	Good
Tsikhisdziri - C6b-PB	0.772	3.07	24	0.73	Good
Bobokvati - C7-PB	0.396	1.90	25	0.67	Good
November 2019					
Sarpi - C1a-B	1.336	3.73	21	0.71	Good
Adlia - C2a-PB	0.094	1.17	15	0.55	Good
Batumi 1 - C3a-PB	0.675	2.71	20	0.67	Good
Batumi 3 - C5a-PB	0.136	1.21	23	0.62	Good
Makhinjauri - C6a-B	0.183	2.06	25	0.70	Good
Tsikhisdziri - C6d-PB	1.894	4.60	38	0.90	High
Bobokvati - C7a-B	0.188	1.92	23	0.67	Good

Relied on surveys, it can be concluded that the majority of stations located in Sarpi-Kobuleti area have obtained the “good” ecological status. In September 2019 only Adlia and Batumi assessed as moderate ecological status (Moderate and Poor) being under anthropogenic impact due to Chorokhi river and Batumi Port. It must also be underlined that based on November’s data, Tsikhisdziri station has been considered as a high ecological status station (Table 3.27 above).

Improving Environmental Monitoring in Black Sea – Special Measures (EMBLAS-Plus)

The results are still in preparation for publishing.

3.3.1.2. Results obtained within national monitoring programmes

For the estimation of ecological condition of the Georgian Black Sea coastal zone the observations were conducted at 5 hydrological stations. Monitoring duration 2008-2016. Monitoring Frequency – quarterly. The observation scheme is provided in Table 3.28.

Table 3.28. Monitoring Scheme for Georgian Coastal Line (old)

Station №	Station	Station coordinates		Observation depths, m
		Longitude	Latitude	
1	Gonio	41°33'29.34"N	41°33'23.40"E	surface; 20
2	Batumi	41°39'23.09"N	41°39'43.13"E	surface; 20
3	Kobuleti	41°50'17.72"N	41°46'4.21"E	surface; 20
4	Supsa	42° 0'32.17"N	41°44'25.57"E	surface; 20
5	Poti	42° 8'39.65"N	41°38'23.16"E	surface; 20

In parallel with hydro-biological studies the hydrological and hydro-chemical indicators of sea water were determined. Hydrological parameters included temperature, pH, conductivity, salinity, TDS. Hydro-chemical parameters covered dissolved oxygen, BOD_5, nutrients: ammonia NH_4^+, nitrites NO_2^-, nitrates NO_3^-, phosphates PO_4^{3-}, silicates SiO_3^{2-} and presence of total suspended substance (TSS). Monitoring was not carried out regularly.

From 2020 Georgia started new monitoring program of coastal zone. Selection of station and research methodology were based on MSFD requirements and experience gained during EU projects. The observation scheme is provided in Table 3.29.

Estimation of water quality occurs based on supporting quality elements: temperature, salinity (‰), conductivity, ORP, pH, turbidity, total suspended substance (TSS), dissolved oxygen, dissolved inorganic nitrogen (NO_3, NO_2, NH_4), orthophosphate (PO_4), silicates (SiO_3), Cu, Fe, Zn, Mn, Ni, Cr, Mo, Cd, Co, Pb, TPH, Pesticides. Sampling depth are shown on Table 3.29.

Table 3.29. Monitoring Scheme for Georgian Coastal Line (new)

Site code	Station	Sampling depth, m
NPMS_GE_01_20.09	Gonio 1	<30
NPMS_GE_02_20.09	Gonio 2	30-50
NPMS_GE_03_20.09	Gonio 3	>50
NPMS_GE_04_20.09	Batumi 1	<30
NPMS_GE_05_20.09	Batumi 2	30-50
NPMS_GE_06_20.09	Batumi 3	>50
NPMS_GE_07_20.09	Kobuleti 1	<30
NPMS_GE_08_20.09	Kobuleti 2	30-50
NPMS_GE_09_20.09	Kobuleti 3	>50
NPMS_GE_10_20.09	Poti 1	<30
NPMS_GE_11_20.09	Poti 2	30-50
NPMS_GE_12_20.09	Poti 3	>50
NPMS_GE_13_20.09	Anaklia 1	<30
NPMS_GE_14-20.09	Anaklia 2	30-50
NPMS_GE_15_20.09	Anaklia 3	>50

Phytoplankton
Microalgae (phytoplankton) form the basis of the trophic chain of the planktonic biocenoses and largely determine the ecological state of the sea.

In recent years, the number of species in the qualitative composition of phytoplankton on Georgian Black Sea coast has increased (Figure 3.28). In 2014-2016 up to 100 species are registered, in 2017-2018 the species diversity of phytoplankton reached 236. In 2019, only 132 species and varieties were discovered, which belong to the following groups of algae: diatoms *(Diatoms)* - 49, dinophytes (*Dinophyta*) - 46, euglenophytes (*Euglenophyta*) - 7, cyanobacteria (*Cyanobacteria*) - 11, coccolithophores (*Coccolithineae*) - 1, golden (*Chrysophyta*) - 4, yellow-green (*Xanthophyta*) - 2, silicoflagellates (*Silicoflagellatae*) - 1, green (*Chlorophyta*) - 10 (Figure 3.28).

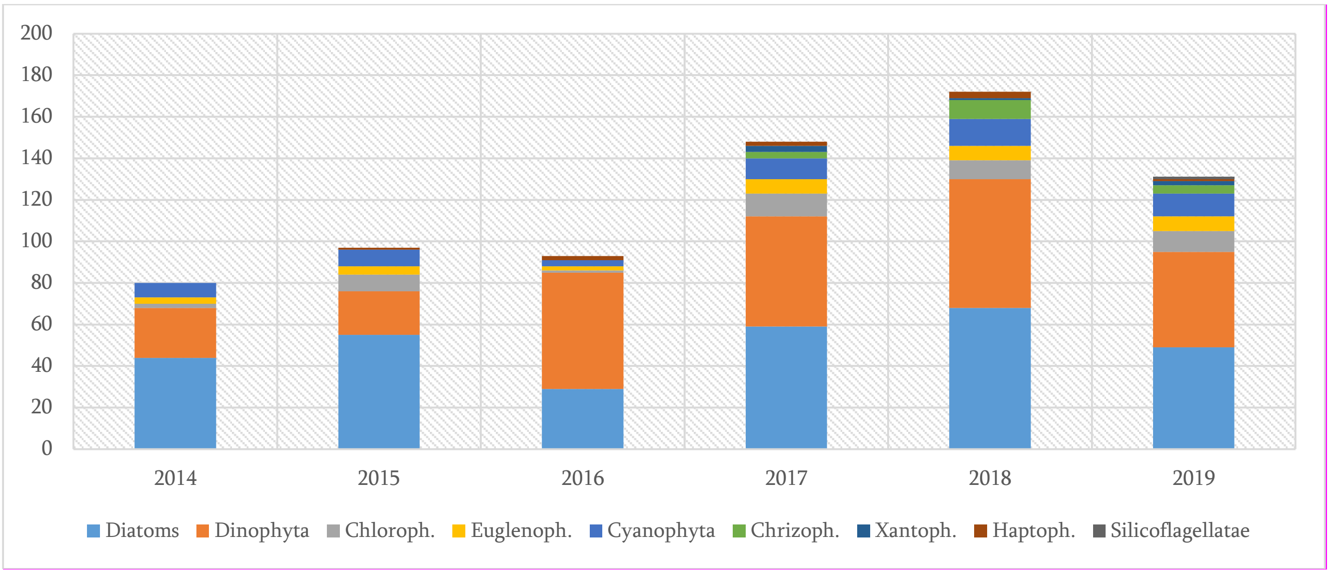

Fig. 3.28 Number of phytoplankton species of Georgian Black Sea region by years

Studies in 2019 again revealed the main role of diatom algae in the formation of phytoplankton biomass on Georgia Black Sea coast, which is one of the indicators of a weakening of the anthropogenic load on the marine ecosystem.

According to the data of the last three years, the quantitative indicators of phytoplankton have changed insignificantly, the maximum amount was recorded in 2017 and amounted to 184188.6 cells/l, the minimum - in 2019 - 111199.7 cells / l. As for biomass, in 2017 it was on average reach 1201.8 mg/m³, decreased by almost 2 times in 2018 and amounted to 545.2 mg/m³, and in 2019 increased again and reached an average of 954.2 mg/m³.

As in the previous year, in 2019, large diatoms *Pseudosolenia calcar avis* prevailed at all stations.

The picture changed depending on the month and season: in spring, the following species prevailed in the waters around the port of Batumi: *Nitzschia seriata, N. pungens*, *Skeletonema kostatum,* and several members of the *Chaetoceros* group.

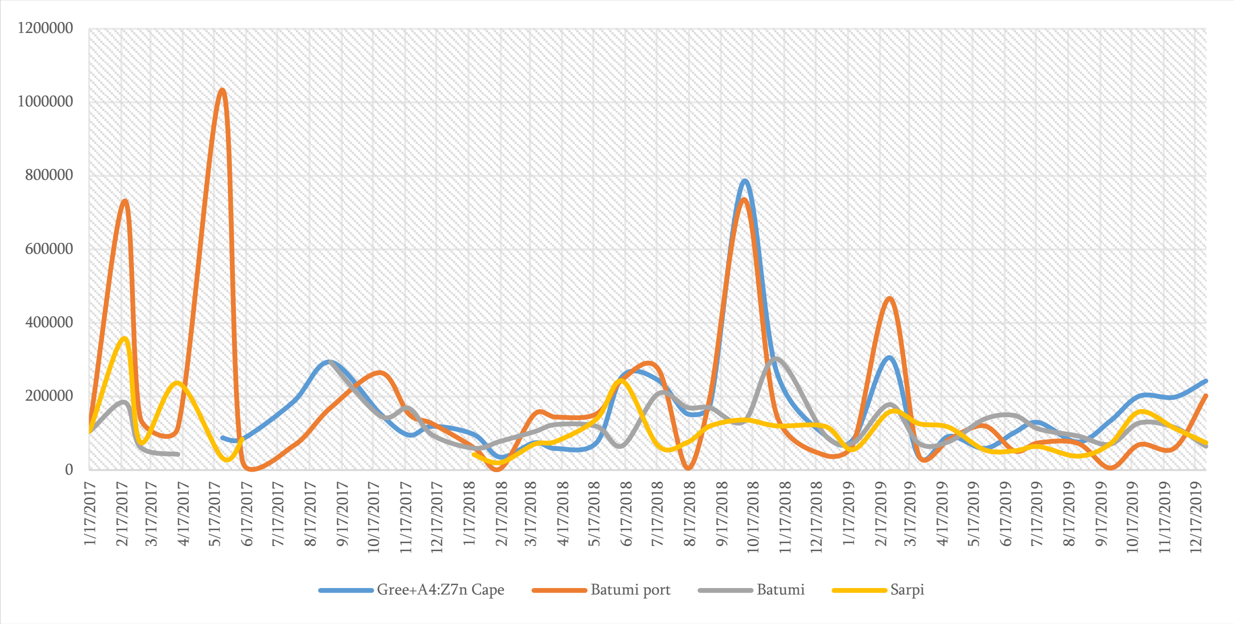

Fig. 3.29 Dynamics of the Georgian Black Sea coastal phytoplankton abundance by years (2017-2019)

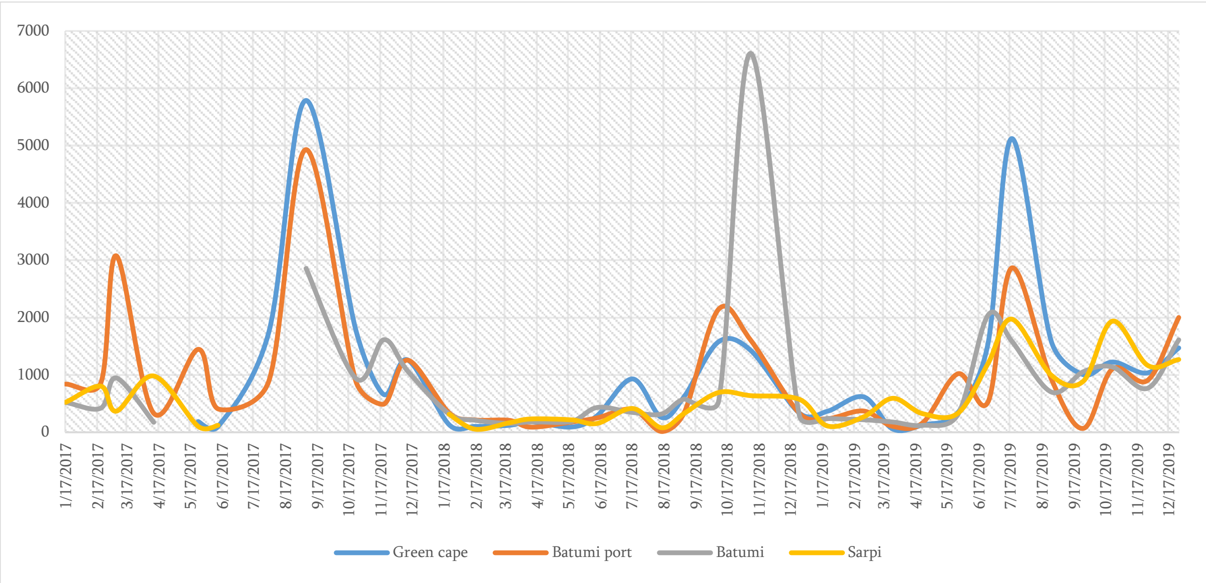

Fig. 3.30 Dynamics of the Georgian Black Sea coastal phytoplankton biomass by years (2017-2019)

During the summer season, samples of coastal waters near Batumi showed a relatively high abundance of phytoplankton - 121582.69 cells/l and biomass - 825.871 mg/m³, which is caused by the following dominant species: *Pseudosolenia calcar avis, Proboscia alata, Pseudonitzisschia*.

In autumn, there is an increase in the amount of phytoplankton and biomass in the waters around Sarpi and Green cape. The average amount in Sarpi - N = 114374.2 cells /l; Biomass 1330.6 mg/m³. The highest average is 176964 cells/l. It was observed on Green cape - where the biomass was 1086.686 mg/m³, respectively. A large number of algae on Green cape with a lower biomass in comparison with the corresponding data of Sarpi is explained by the predominance of small species in the waters of Green cape - *Skeletonema costatum, Chaetoceros socialis, Oxyrris marina.*

In winter, especially in February, the following species of diatoms "bloomed" in the waters of Batumi port and Green cape - *Skeletonema costatum, Nitzschia pungens, N. seriata* (as well as *cyanobacteria - Gloeocapsa sp., Microcystis aeruginosa, Phormidium sp*). That was reflected in the abundance and indicators of biomass.
Thus, the dynamics of phytoplankton development on Georgian Black Sea coast is characterized by seasonal fluctuations and periodic point bloom, which indicates a moderate anthropogenic load on our coast.

Zooplankton

About 40 species of the Mesozooplankton community of the Black Sea coastal waters of Georgia were represented in 2017-2019, most of which are widespread forms in the Black Sea. Among them, the most diverse group is crustaceans (17 species), which amounts to 45%-50% of total zooplankton species, 12 of which are Copepoda and other 5 species are Cladocera. The most prevalent crustaceans are the eurythermic species, important representative of edible zooplankton - *Acartia clausi* and two thermophilic species of Calanidae - *Acartia tonsa* and *Centropages ponticus.* Meroplankton (larval forms of benthic organisms), represented by 11 species (29%-32% of total zooplankton species), is also one of the most diverse groups. It shall be noted that only few species are discovered from other groups. The number of species of zooplankton fluctuated slightly during the current period, with a maximum of 38 species recorded in 2018 and a minimum species of 34 in 2019.

Species, which are indicators of an improvement in the state of the marine environment have been increased in coastal waters of Georgia over the past years, amongst other, *Penilia avirostris*, *Pseudoevadne tergestina*, *Evadne spinifera*, *Centropages ponticus*, Isopoda and Decapoda larvae. (Aleksandrov et al., 2015),

Furthermore, it shall be especially noted that in 2017-2019, for the first time in Georgia, an indicator species of copepoda *Monstrilla grandis* was observed at Sarpi and Green Cape stations, which indicates the current positive trends on our coast.

Significant changes have occurred in the quantitative indicators of zooplankton during this period. There was decrease in the abundance of zooplankton and biomass from 2017 to 2019. The average annual abundance of zooplankton reached 8878.74 ind*m^{-3}, while the biomass reached 245.76 mg*m^{-3} in 2017. These figures decreased almost 2 times in 2018, namely abundance of zooplankton became 3946.22 ind*m^{-3} and biomass - 116.78 mg*m^{-3}, while in 2019 it reduced again and amounted to 2073.97 ind*m^{-3} and 80.69 mg*m^{-3}.

In the spring of 2017, high quantities of zooplankton were caused by the abundant growth of *Noctiluca scintillans*, one of the phagotrophic species of dinoflagellates, especially in the Batumi aquatorium, where the *Noctiluca* biomass amounted to average 993.25 mg*m^{-3} and its' biomass share percentage fluctuated from 64% to 94% compared to the total biomass of zooplankton. This figure formed average 28% in 2017, while a significant decrease was detected the next years of 2018 and 2019, which made up 7.6% and 14.5% each respectively.

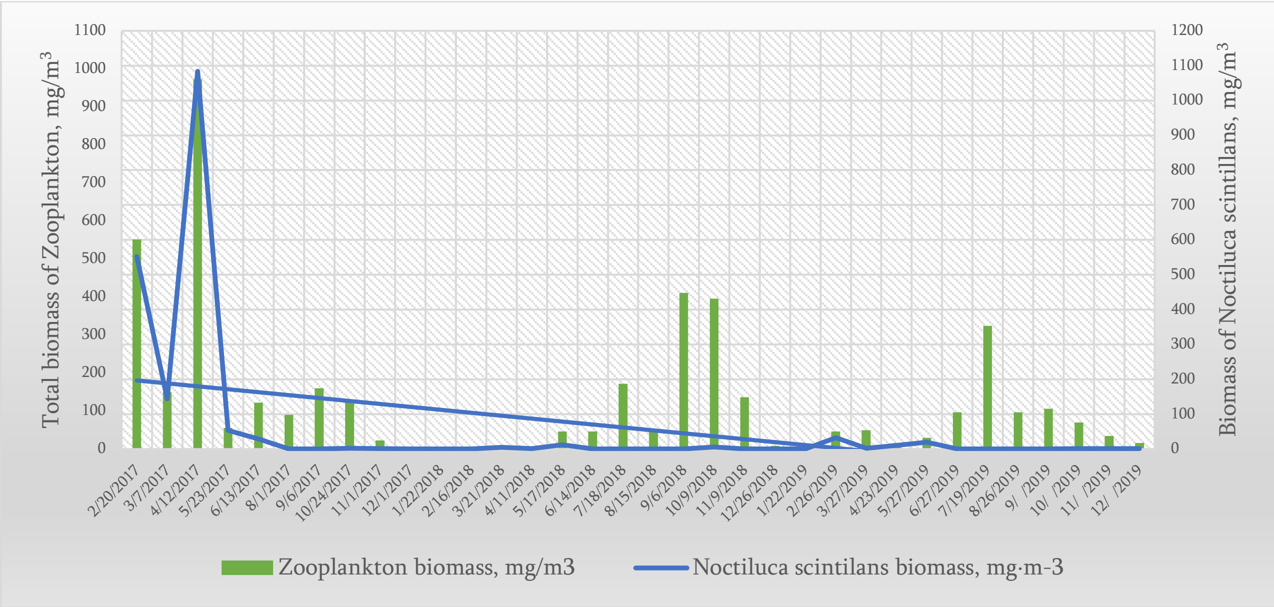

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Fig. 3.31 The seasonal dynamic of zooplankton total biomass and Noctiluca biomass in the Black Sea Georgian Coast 2017-2019.

The percentage of Copepoda in the total zooplankton biomass is a reliable indicator of the environmental status. The positive tendency is seen in connection with the increase of the percentage share (C, %) of Copepoda Biomass on coast of Georgia. GES is considered to be an average annual Copepoda biomass, which exceeds 45% of the total zooplankton biomass for Black Sea marine waters (Aleksandrov et al., 2015). In Georgian coastal waters mentioned index amounted to average 32.68%, 42.39% and 40.06% in 2017, 2018 and 2019 respectively. It fluctuated from 42.25% to 45.58% between 2017 and 2019 in the Green Cape Aquatorium.

Table 3.30 Assessment of the ecological status of sea water in the coastline of Georgia in accordance with the integral zooplankton index (IZI).

	Station	Subregion	2017	2018	2019	GES	Not GES
coastal	Pier Batumi	from Batumi cape to Chorokhi mouth (northern point)	0.617 ± 0.131	0.620 ±0.151	0.706 ± 0.08	>0,543	< 0,542
	Batumi port	from Korolistskali mouth to Batumi cape (Batumi bay)	0.598 ± 0.185	0.652 ±0.215	0.698 ± 0.114	>0,543	< 0,542
	Green cape	From Green Cape to Batumi	0.550 ±0.12	0.576 ±0.184	0.545 ±0.126	>0,543	< 0,54

The IZI (integral zooplankton index) indicator varies slightly over the years. The index corresponds to good GES quality at all stations.

Macrophytobenthos

Macrophytes are biological quality elements of coastal ecosystems for estimating Ecological Status Class (ESC) of coastal waters in accordance with the EU Water Framework Directive

(WFD). Macrophytes communities create a habitat for which there are relevant ecological features, with benthic communities and planktonic organisms. Morphofunctional parameters of macrophytes were used for assessment of Ecological Status Class (ESC) of coastal ecosystems.

Unfortunately, until 2016, systematic monitoring studies of macrophytes were not conduct on the Georgian coast. There is only single data on the morphofunctional parameters of the floristic composition of macrophytes, which were obtained in the framework of the international project “Recovery of the Black Sea Ecosystem” (BSEC) in 2004 on the Batumi coast. From 2016 Georgia started investigation of macrophytobenthos, their morphofunctional parameters with floristic composition, biomass, spatial and temporal dynamics. Expedition studies macrophyte community of the national monitoring Georgian coast made it possible to assess the current state of the ecological quality water in accordance with the requirements of Water Framework Directive and the Marine Strategy Framework Directive in the period 2016, 2017, 2018 and 2019.

From the period 2016 to 2019 macrophytobenthos samples were taken by diver with periphyton frame at four hydrobiological station at the same seasons at the same stations (Sarpi, Batumi Port, Green cape, Tsikhisdziri), where obtained total 93 samples.

There are three taxonomical groups of macrophytes: *Chlorophyta, Ochrophyta and Rhodophyta*. The most distributed taxonomic group is Chlorophyta. Nowadays, there are identified 27 species of Georgian coastal macrophytes. According to floristic composition Stations of Sarpi and green cape have most diversity. Area of Tsikhisdziri has less diversity. Macrophytes of Batumi Port is presented on artificial substrate where is the most anthropogenic loading.

As Ecological Evaluation Indexes (EEI), three morphofunctional indicators were used (Mincheva, 2013).

The key point for ESC assessment is present in floristic composition of macrophytobenthos communities the <u>sensitive</u> (S/W_p = 5-25 $m^2 \cdot kg^{-1}$, ESG I, *k*-species) and <u>tolerant</u> ($S/W_p \geq 25$ $m^2 \cdot kg^{-1}$, ESG II, *r*-species) macrophytes. Large, perennial species with low specific surface are indicators of the GES status of the marine environmental. Vice versa, a large number and biomasses of the small, finely branched species with high specific surface indicate a high intensity of production process, high level of eutrophication and low categories of ESC.

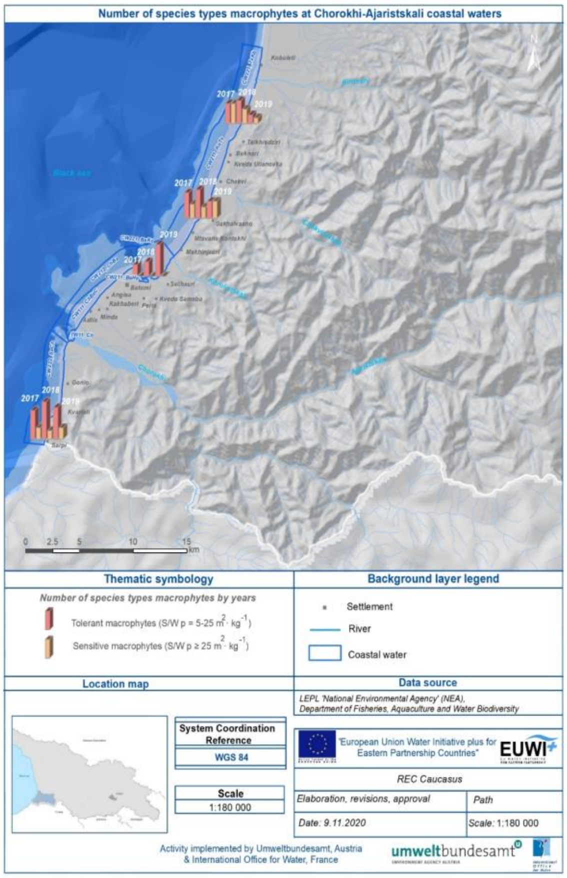


Fig. 3.32 Number of species types Macrophytes

In 2019 there were found 7 sensitive and 13 tolerant species at four hydrobiological stations on the Georgian national coast (Figure 3.32). Sensitive species, which are indicator species, such as *C. Barbata* (7.9 $m^2 \cdot kg^{-1}$), *D. dichotomus* (9.77 $m^2 \cdot kg^{-1}$) and *G. crinale* (19.38 $m^2 \cdot kg^{-1}$) were found all over the year. Tolerant species, which are epyphite dominants, such as *Cladophora albida (Nees) Kutzing* (74.97 $m^2 \cdot kg^{-1}$), *Ectocarpus siliculosus (Dillwyn) Lyngbye* (173.5 $m^2 \cdot kg^{-1}$) and *Acrochateum secundatum (Lyngbye) Nägeli in Nägeli & Cramer* (277.1 $m^2 \cdot kg^{-1}$) were found all over the year.

Georgian coastal monitoring showed that in 2019 are characterized by following ecological status: Sarpi, Green cape and Tsikhisdziri – ESC "Good", Batumi Port – ESC "Bad".

Macrozoobenthos

Benthic habitats play an important role in some of the key ecosystem processes (i.e., primary production, food webs, recycling, etc.), but they are subject to many human pressures which put in risk their functionality (Claudet & Fraschetti, 2010). The European Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC) requires European Member States to achieve a Good Environmental Status (GEnS) by 2020 (Borja (2006), Borja et al. (2011b) and Borja et al. (2013)). Achieving a GEnS requires knowing about the marine ecosystems, of which seabed habitats are an integral part (Cogan et al., 2009).

Within the pilot monitoring program in 2016, the study of benthic organisms in the Black Sea coast of Georgia were carried out on 12-22 m isobath in 6 biological station (Gonio, Chorokhi, Batumi, Batumi port, Chakvi, Kobuleti (Kintrishi)). During this monitoring program were collected 6 samples. Within the frame of monthly national monitoring in 2017, the study of benthic organisms and epifauna samples were carried out at four permanent biological stations for the purpose of studying the benthos community of the Black Sea coastline: Sarpi, Batumi port, Green Cape and Tsikhisdziri. In total, were collected 46 samples.

Benthic sampling was carried out in May of 2018 during sea expedition, from the Georgian Black Sea coast and shelf. Samples were carried out at 6 biological stations: Gonio, Batumi, Chakvi, Kobuleti, Poti, Anaklia. In total, were collected 40 samples.

Benthos samples were carried out in 10-60 m isobath, by commonly accepted methods by Van Veen grab in 2016 with surface of 0,127 m^2, in 2017 by Ekman grab 0,025m^2 and Van Veen grab with surface of 0,127 m^2, in 2018 by Van Veen grab with surface of 0.127m^2. For epifauna samples we used epifauna-frame (0,029m^2), on the 0.5-4 m depth with help of diver. Samples were washed by two-layered stainless metal (0.5-1, 5 mm mesh) benthos washing set. The material was fixed by 75^0 alcohol or 4% formalin, put into containers and labelled.

For systematic classification we used following guidelines**:** (Боруцкий, 1959; Определитель фауны Чёрного и Азовского морей, т. I, II, III 1968-72 г.г.; Скарлатоидр. 1972; Kurashvili 1996; Handbook of The Marine Fauna of North-West Europe 1999; Guido Arduino et all 2000; Киселёва 2004), Binocular and microscope Leica.

During research carried out in August 2016 hydrobionts of the benthic fauna are presented by 4 class (*Polychaeta, Bivalvia, Gastropoda* and *Crustacea)* composing of 32 species.92% of Benthofauna is presented by Mollusca (Bivalve-83%, Gastropoda -9%)

Research stations of Georgian Black Sea coast (Green cape and Batumi port) in 2017 is presented by 53 macrozoobenthic taxa; they are presented by following systematical structure: 7 Phylum (*Plathelminthes*, *Nemertini*, *Nemathelminthes, Annelides*, *Mollusca*, *Arthropoda*, *Tentaculata*), 10 class (*Turbellaria, Nemertini*, *Nematoda*, *Polychaeta, Oligochaeta*, *Gastropoda*, *Lamellibranchiata*, *Crustacea*, *Phoronidae*, *Bryozoa).* Mollusca composes 50% of the hole benthofauna *(Bivalve 37%, Gastropoda 13%),* 39% of the total benthofauna is presented by Polychaeta.

Research of benthic community of the Black Sea coast of Georgia carried out in May 2018 shows that there were fixed macrozoobenthic taxons up to 90 species, most of them being taxonomically determined at species level. The highest diversity was shown by the following groups – Mollusca (34 species) – 3 %, Polychaeta (29 species – 23%), Crustacean (16 species – 3%), other groups are presented by 11 species: Actinia equina, Nemertini sp., Hydrozoa sp., Nematoda sp., Membranipora sp., Quinqudoculina lavigata, Holothuroidea sp., Phoronis euxinicola, Ascidia sp., Olygochaeta sp., Amphiura stepanovi.

Macrozoobenthos taxa were presented by 3 main groups *(Polychaeta, Molluska, Crustacea*), with 32 species in research zones *(*Gonio, Chorokhi, Batumi, Batumi port, Chakvi, Kobuleti) *in 2016.* Dominant taxa are Mollusca, it composed 92% of the whole benthofauna. There were 53 macrobenthic taxa identified during research of benthofauna in 2017. Molluscs are 50% of the studied benthofauna (16 species) – Crustacea 5%, Polychaeta 39%. The benthofauna were presented by 90 species in 2018. During this research Polychaeta were presented by 29 species (23%), mollusca was 43% with 34 species, and crustacea is 3% – 16 species. In all three periods of the study (2016, 2017, 2018), molluscs prevail in benthofauna, which in turn, form the mollusc cenosis.

Average number of researched benthic fauna in 2016 is 2267 ind/m^2 and biomass is 157.225 g/m^2. Dominant are molluscs (2095 ind/m^2) and more privileged are Bivalvia *Ch. gallina* which average number in 6 research station is 1089 ind/m^2 composing 48% of the sample. Bottom benthic fauna is represented by low indicator of Crustacea (24 ind/m^2 and 0.591 g/m^2). This is probably caused by type of sediments.

Benthic quantity and biomass sharply varies in line with different stations of researched sites. High indicators were observed in Kobuleti station (6123 ind/m^2) caused by excessive number of Gastropoda and Bivalvia (96%). High number of *Ch. gallina* and *L. Divaricata* is obvious. High quantity of biomass is in Kobuleti station – 261.197 g/m^2, Low quantity of biomass is presented in Batumi station 1.036 g/m^2, where the species diversity is poor (4 species).

On the research stations Green cape (93.307 g/m^2) and Batumi port (99.959 g/m^2) in 2017 the biomass is almost equal. The dominant species from Bivalve mussels is L. Mediterraneum's. Biomass of this species is 73 g (78%) on a square meter. In the Batumi port station, Gastropoda-Rapana venosa – 99.959 g/m^2 (85%) is dominants species.

There were identified 43 species and 12 class (*Demospongiae, Turbellari, Nemertea, Nematoda*, *Polychaeta, Oligochaeta*, *Loricata*, *Gastropoda*, *Lamellibranchiata*, *Crustacea, Larvae of Insects, Bryozoa,)* of epifauna species in our research stations: Sarpi, Green cape, Tsikhisdziri in 2017.

Concerning to the data of research carried out in May 2018, there are following results. Minimal number of species were at Batumi station (10 m), The highest species richness (38) was reached in the circalittoral 49 m zone at Gonio and Poti. Mollusca is dominant group at Gonio (40 m) station. Mollusca is prevailed group almost in all stations except Poti (40 m) and Batumi (20 m) stations were Anelida is prevailed.

The average number of macrozobenthos in the study area during this period is 2229 ind/m^2 and biomass is 165.2 g/m^2. The maximum quantities were fixed in the infralittoral 20 m zone of Kobuleti, station, where the amount of benthos reaches 7143 ind/m^2 and the biomass is 752.4 g/m^2. Minimum quantity was indicated in the Batumi infralittoral 10 m zone and in circalittoral 60 m zone of Chakvi station. In research area low biomass are characterised for deep circalittoral zone. It is particularly low at the depth of 60 m in Kobuleti station, 1.52 g/m^2.

Mollusc quantity representing 70-95% of total zoobenthos in the infralittoral zone of the Black Sea Georgian coast. Except coast zone of Batumi where dominant groups are Anelidae and Crustacea. There is abundance of Anelidae in circalittoral and deep water circalittoral zones they represent in average 50-65 % of the macrozoobenthos, in Kobuleti deep circalittoral zone they rich even 93%.

The results of the study allowed us to make a graph of average abundance (ind/m^2) and biomass (g/m^2) of benthofauna (2016, 2017, 2018, see Figure 3.33).

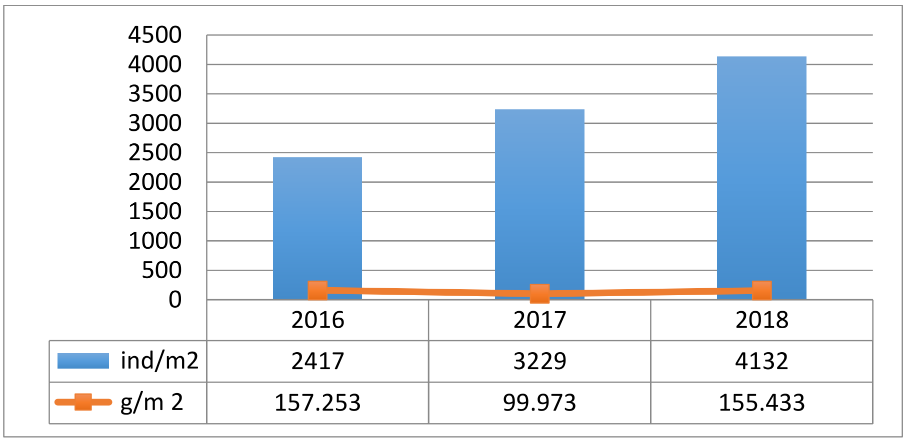


Fig. 3.33 Average indicators of abundance and biomass in 2016-2017-2018

Total abundance of benthofauna in 2016 is 2417 ind/m^2, in 2017 - 3229 ind/m^2 and in 2018 – 4132 ind/m^2. The average biomass of benthofauna in 2016 157.253 g/m^2, in 2017 99.973 g/m^2 and in 2018 155.433 g/m^2. For estimate ecosystem condition of research stations Gonio-Kobuleti in 2016 were calculated AMBI, M-AMBI. The diagram of the AMBI program shows (Table 3.31), that Gonio, Chorokhi and Batumi are as good ecological status stations, Chakvi and Kobuleti as high, and Batumi as moderate.

Table 3.31 AMBI, M-AMBI indexes of the Gonio-Kobuleti benthic fauna of the Georgian Black Sea coast 2016.

Stations	AMBI	Diversity	Richness	X	Y	Z	M-AMBI	Status
Bad	6	0	0	3.0456	3.0817	2.6642	-1.2E-16	Bad
High	0.07	2.75	20	-1.4713	-1.5478	-1.5287	1	High
Gonio	0.065262	2.0708	10	-0.60973	-0.36628	-0.21646	0.74983	Good
Chorokhi	3.217	2.5039	8	0.63959	-0.22168	0.46532	0.59548	Good
Batumi	2.7857	1.8424	4	0.93451	0.57268	1.0318	0.47118	Moderate
Batumi port	0.40418	1.1941	13	-0.39857	0.39965	-0.20459	0.67327	Good
Chakvi	0.37947	1.8668	16	-0.81303	-0.42306	-0.75143	0.80747	High
Kobuleti	0.43428	2.752	20	-1.3271	-1.4952	-1.4601	0.9801	High

In 2017 For determining ecological status of the Green Cape and Batumi port of the Black Sea coastal research stations has been used indexes of Richness, Diversity, AMBI, M-AMBI, which determine the level of diversity of sea bottom biocenoses, the number of sensitive and resistant to pollution species. Using the above classification systems, both of research station indicate as Good Ecological Status (GES) (Table 3.32).

Table 3.32. Ecological status classification system Black Sea Georgian part 2017

Station	AMBI	Diversity	Richness	M-AMBI	Ecological status
Green cape	1,4393	1,7582	34	0,80628	Good
Batumi port	2,2586	3,229	39	0,94052	Good

For estimate ecosystem condition of research stations Gonio-Batumi port-Chakvi-Kobuleti-Poti-Anaklia in 2018 were calculated AMBI, M-AMBI. The diagram of the AMBI program shows (Table 3.33) that Gonio, Chakvi, Chorokhi and Poti are as good ecological status stations, and Kobuleti as high, and Batumi port as moderate ecological status stations.

Table 3.33. AMBI, M-AMBI indexes of the Gonio-Batumi port-Chakvi-Kobuleti-Poti-Anaklia benthic fauna of the Georgian Black Sea coast 2018

Stations	AMBI	Diversity	Richness	X	Y	Z	M-AMBI	Status
BAD	6	0	0	3.93	-3.82	3.58	0.00	Bad
HIGH	0.23	4.14	36	-2.12	1.64	-2.25	1.00	High
1	1.026	2.84	20	-0.13	0.51	-0.08	0.69	Good
2	0.229	1.50	24	0.88	0.90	-0.05	0.65	Good
3	2.025	3.45	36	-1.28	0.30	-1.77	0.85	High
4	1.926	3.29	24	-0.63	0.07	-0.54	0.73	Good
5	2.936	2.75	9	0.62	-1.05	1.26	0.48	Moderate
6	3.856	1.93	17	1.16	-1.64	0.91	0.44	Moderate
7	3.310	2.24	18	0.77	-1.19	0.62	0.51	Moderate
8	2.215	3.60	18	-0.64	-0.21	-0.04	0.68	Good
9	0.378	3.17	21	-0.55	1.03	-0.39	0.76	Good
10	0.283	2.49	21	0.09	0.98	-0.13	0.71	Good
11	2.325	2.90	19	-0.00	-0.38	0.15	0.62	Good
12	2.256	3.67	22	-0.87	-0.13	-0.45	0.72	Good
13	0.397	3.51	28	-1.17	1.24	-1.20	0.86	High
14	0.316	3.07	26	-0.67	1.17	-0.84	0.81	High
15	2.289	2.97	30	-0.54	-0.10	-0.96	0.74	Good
16	0.451	1.08	9	1.94	0.34	1.61	0.46	Moderate
17	0.546	2.41	13	0.53	0.60	0.71	0.61	Good
18	2.241	4.14	36	-1.91	0.28	-2.01	0.90	High
19	2.253	3.25	17	-0.25	-0.32	0.20	0.64	Good
20	0.964	2.62	12	0.42	0.33	0.78	0.60	Good
21	2.296	2.76	12	0.42	-0.54	0.88	0.55	Good

Epifauna of the Georgian Black Sea coast in 2017, 2018
In 2017, the study of epifauna samples were carried out at 3 biological stations for the purpose of studying the benthos community of the Black Sea coastline: Sarpi, Green Cape and Tsikhisdziri. In total, were collected 18 samples on the rocky shores of Sarpi, Green cape and Tsikhisdziri.

Benthic sampling was carried out in May of 2018 there were collected 23 samples, from the rocky shores of Sarpi, Batumi port, Green cape and Tsikhisdziri (Table 3.34).

Table 3.34. Number of epifauna samples distributed by stations and depth on the Black Sea coast of Georgia and the shelf in May 2018

Stations	Batumi port	Green cape	Tsikhisdziri	Sarpi
depth	0,3-0,4 m	1-2 m	3-5 m	2,4,7-8 m
samples	3	6	7	7
	Total	Samples	23	

For systematic classification we used following guidelines**:** (Боруцкий, 1959; Определитель фауны Чёрного и Азовского морей, т. I, II, III 1968-72 г.г.; Скарлатоидр. 1972; Kurashvili 1996; Handbook of The Marine Fauna of North-West Europe 1999; Guido Arduino et all 2000; Киселёва 2004), binocular and microscope Leica.

Average abundance of *Polychaeta is 5636* ind/m^2, it's14 % of the total number of epifauna in 2017. The average number of crustacea is 2054 ind/m^2 (5%). Abundance of other species is 0.8 % (336 ind/m^2). Abundance of epifauna maximum is in Tsikhisdziri 102268egz/m^2, and minimum in Sarpi rocky fouling 10926 ind/m^2 (Figure 3.34).

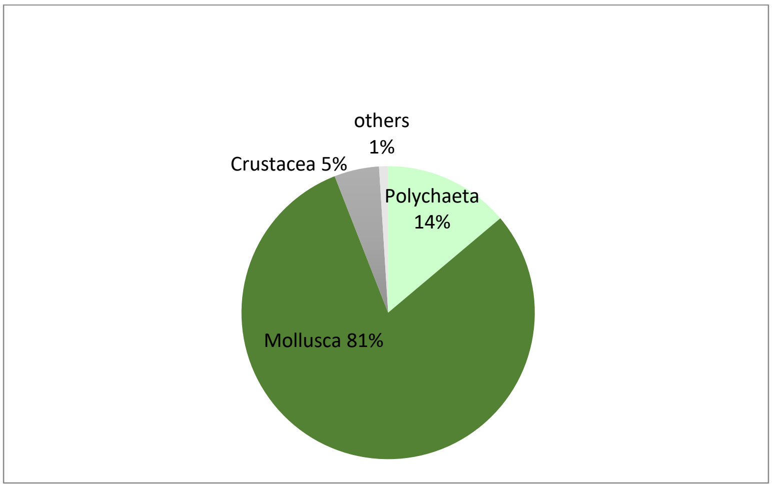


Fig. 3.34 Percentage composition of epifauna main groups in the Black Sea coast of Georgia (Sarpi, Green cape, Tsikhisdziri) 2017

The dominant group in epifauna samples in 2018 is Crustacea, it's 28% of the total epifauna species, Mollusca and Polychaeta composed – 22%, and other species (Stylochus pilidium, Haliclona ascidia, Cryptosula pallasiana, Ascidia, Olygochaeta sp. etc.) were composed 28% of the whole epifauna. There were fixed 61 species in all 3 research stations (Sarpi, Batumi port, Green cape, Tsikhisdziri). 38 species were identified in Sarpi and Green cape rocky substrate, 14 species in Batumi port research station and 33 species in Tsikhisdziri station (Figure 3.35).

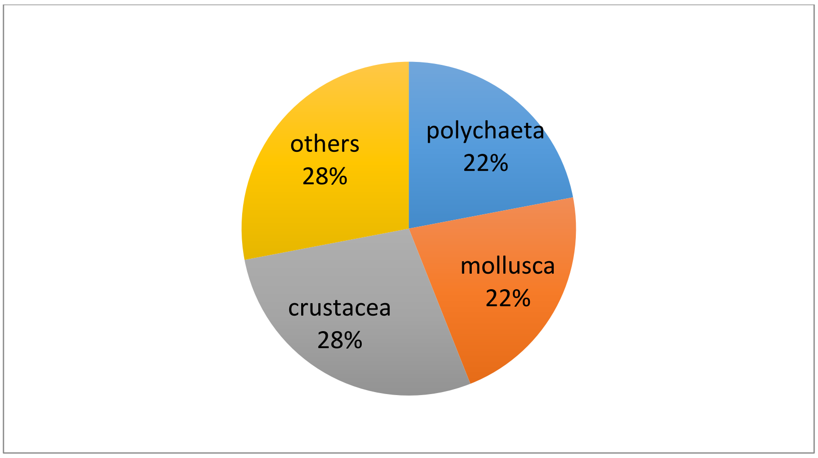


Fig. 3.35 Percentage composition of epifauna main groups in the Georgian Black Sea coast (Sarpi, Batumi port, Green cape, Tsikhisdziri) 2018

In 2017 and 2018, we studied the rocky bottom growths (epifauna). We had the following picture in the epifauna organisms in 2017, Mollusca is prevailed taxa it consists 81% (Gastropoda 2%, Bivalve 79%) (Figure 3.34). In 2018 dominant taxa was Crustacea 28%, presented by 16 species (Figure 3.35).

Average abundance of epifauna is maximum on Tsikhisdziri 102268 ind/m^2, biomass - 1702.253 g/m^2 and minimum on Sarpi rocky fouling abundance -10926 ind/m^2 and biomass 1300.501 g/m^2 (Figure 3.36).

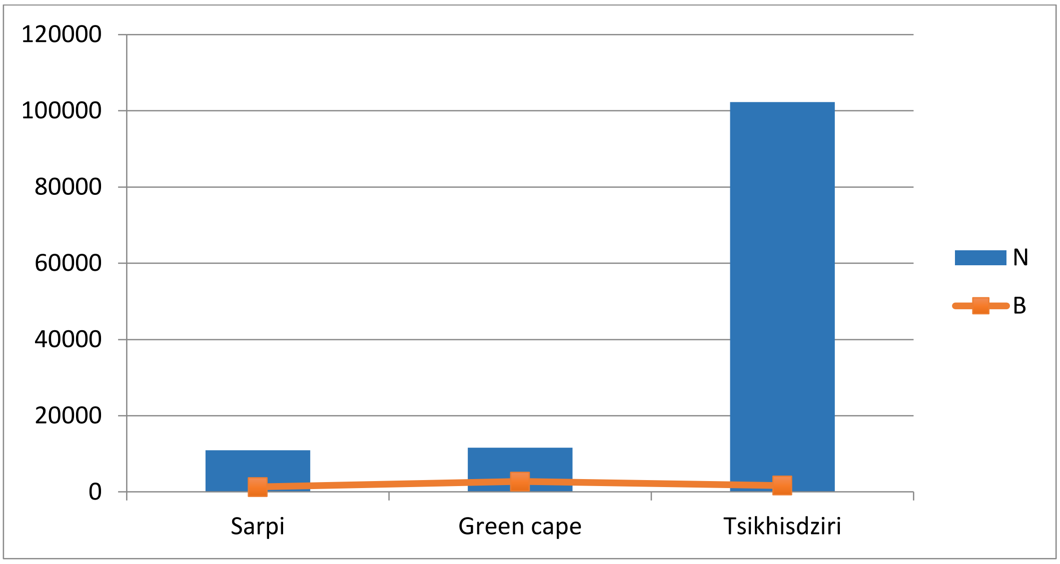


Fig. 3.36 Distribution of richness (N) ind/m2 and biomass (B) g/m 2on Rocky habitats of the Georgian Black Sea coast (Sarpi, Tsikhisdziri, Green Cape) 2017

The average number of bottom invertebrates in rocky area during 2018 is 12846 ind/m^2 and biomass is 1106.4 g/m^2. The maximum meaning of biomass were fixed in Green cape station 1813.048 g/m^2. Minimum biomass was indicated in the Tsikhisdziri zone 420 g/m^2. In our research area low quantity of epifauna were fixed in Batumi port research area 4518 ind/m^2, and high index of quantity was in Sarpi area. It's ordinarily, because Sarpi, Green Cape and Tsikhisdziri are natural regions and port is artificial (Figure 3.37).

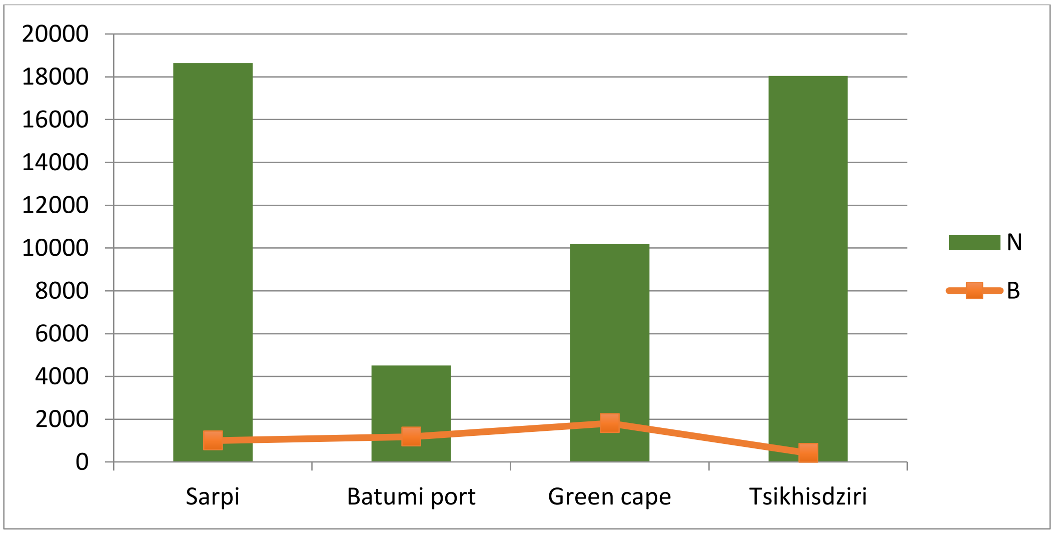


Fig. 3.37 Distribution of richness and biomass on Rocky habitats of the Georgian Black Sea coast (Sarpi, Batumi port, Tsikhisdziri, Green cape) 2018

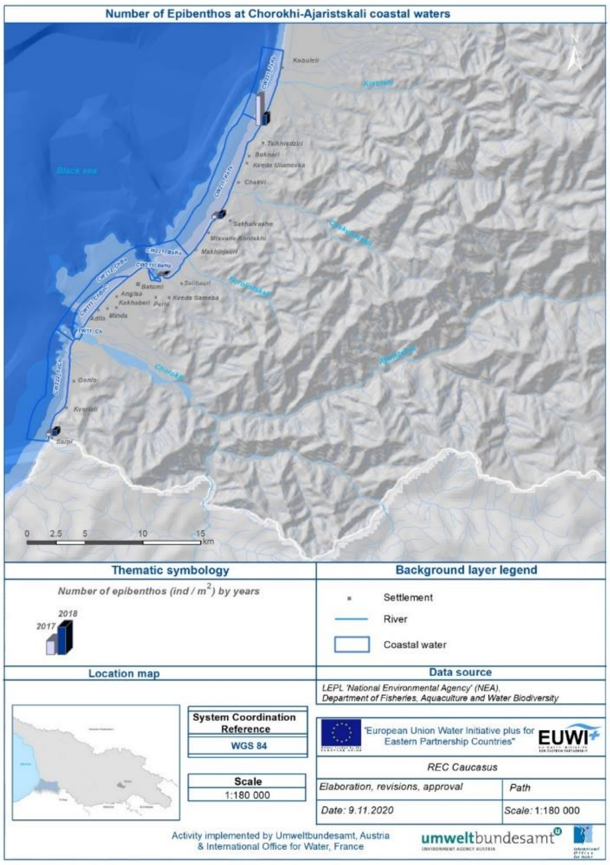


Fig. 3.38 Epibenthos in coastal waters

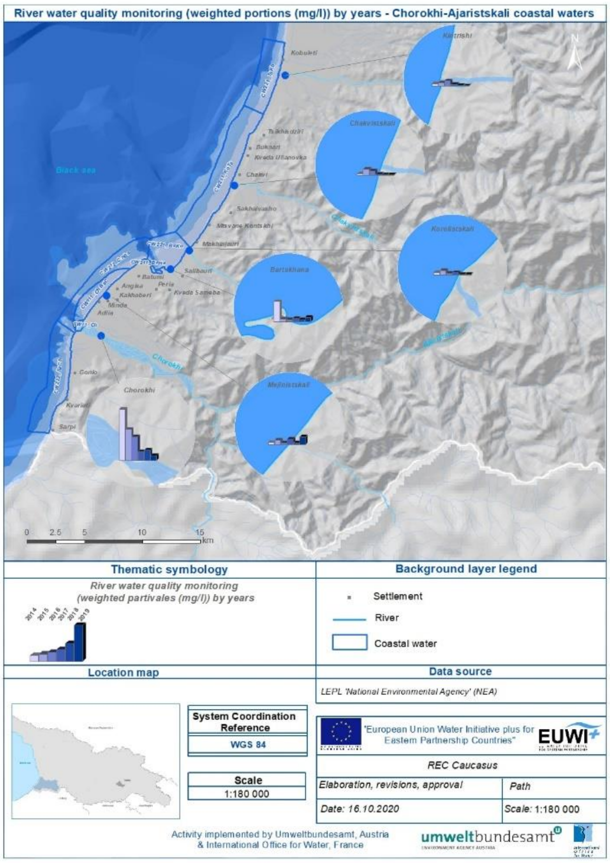


Fig. 3.39 River water quality time series

Microbiological pollution.[89]

The results of the Black Sea bacteriological pollution monitoring conducted in 2010-2011 (general and lactose positive coliforms, E.coli) indicate heavy sanitary hygienic conditions.[90] 6-8 locations in Sarpi, Kvariati, Batumi, Makhinjauri, Mtsvane Kontskhi, Chakvi, Tsikhisdziri, Bobokvati and Kobuleti beaches were observed. In 2010-2011 the observations were carried out in April-September, in 2010 the total number of samples were 96 and 90 – in 2011. The observation took place once a month, each month. In 2012-2013, monitoring was carried out in June-August. In 2012, 63 samples were taken and in 2013 -120, twice a month.

According to bacteriological analysis, in this period coliform indices on Batumi beaches fluctuated on average between 2400 and 9500. The peak was reported at the mouth of the Bartskhana River – over 24000. A better quality sea water was reported in Sarpi-Kvariati and Gonio beaches, where the index of general coliforms changed from 620 to 2800. Similar to Batumi, the indicator of general coliforms in Kobuleti central beach fluctuated between 1300 and 7000, and in Mtsvane Kontskhi and Tsikhisdziri it reached 9500 per 1 litre of water.

[89] Environment Protection Division of Ajara AR.

[90] Epidemiological Bulletin Disease Control and Public Health National Center 2015, August N8, volume 19. Intestinal infections. „On the approval of the norms of qualitative environmental conditions" Ministry of Labour, Healthcare and Social Protection of Georgia, Decree N297/m of 16 August 2001, https://www.matsne.gov.ge/ka/document/view/52384.

Figure 3.40 shows the general and lactose positive coliforms, as well as the amount of coli bacteria (shown in green, yellow and red colours, respectively) in Ajara coastline bathing season in 2013 (the period from June to August, frequency of monitoring – twice a month). The diagram also shows the maximum permissible means for the seawater set by national legislation indicated by the respective colour: 10,000 (general coli-index of intestinal bacterium) and 5,000 (lactose positive) units per 1 litre of the seawater.

The source of pollution is flow of discharge water and dumping household waste into the sea from households and commercial entities that are not connected to sewage network – many small seaside settlements, such as Makhinjauri, Bobokvati, Mtsvane Kontskhi, Tsikhisdziri, as well as rural settlements in river basin areas and most importantly districts of Batumi and Kobuleti that are not connected to sewage network. More specifically, large part of Batumi, such as Gorodoki-Bartskhana-Tamari area, is not yet connected to sewage network. Polluted waters flow into the Black Sea through Korolistskali and Bartskhana rivers without treatment. Sewage works are planned in these districts.

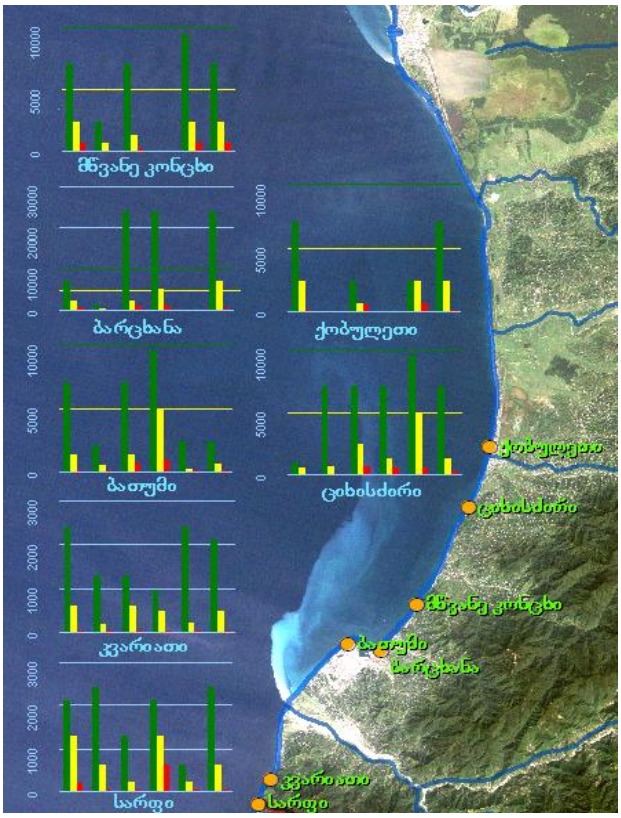


Fig. 3.40 Bacteriological pollution of Ajara coastal waters during the summer holiday season in 2013

Microbiological monitoring results for coastal waters in the period 2017-2020 with measured values acceding 5,000 cfu/l are provided on Table 3.35 and Figure 3.41 below.[91]

Table 3.35 Results of microbiological monitoring during bathing seasons of 2017-2020 years

Sampling point in the Sea (50 m distance from the shoreline)	2017 (16 samples)	2018 (14 samples)	2019 (14 samples)	2020 (15 samples)
Bartskhana	12	9	11	8
Aqua park	11	5	3	3
Central beach of Batumi	11	6	8	1
Mtsvane Kontskhi	4		4	2
Kvariati	5		4	
Sarpi	3		1	
Kobuleti city hall	3	1	6	
Kobuleti, Bobokvati	3		3	1
Central beach of Kobuleti	1		2	

[91] Environment Protection Division of Ajara AR.

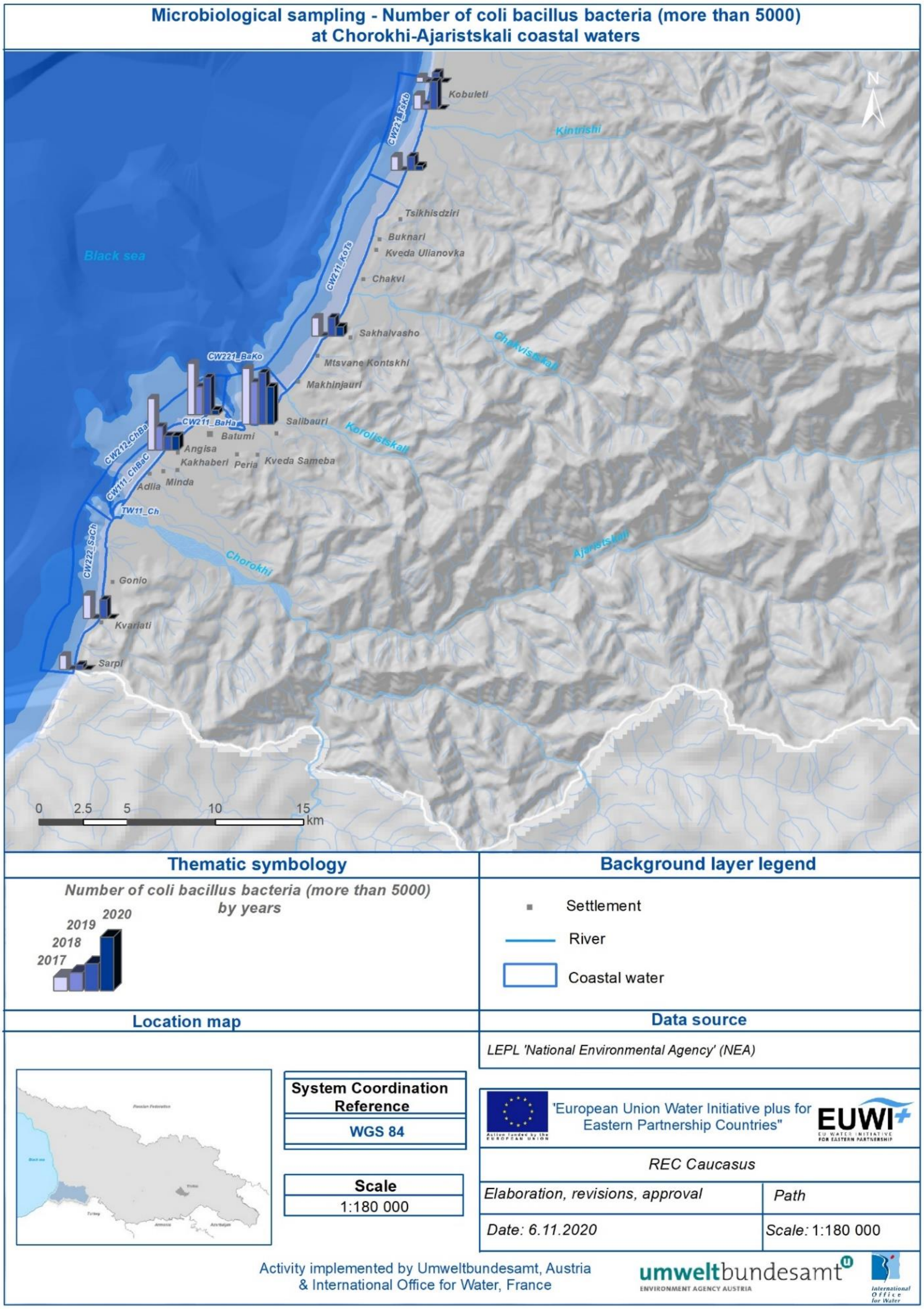


Fig. 3.41 Results of microbiological monitoring during bathing seasons of 2017-2020 years

National monitoring results for Rivers.

Total annual discharge volume of Georgian rivers is 65800 mln. m^3, including runoff originating on Georgian territory is - 56500 mill. m^3. There are 26060 rivers in Georgia, among them 99.4% are small streams (length less than 25 km). Hydrological studies conducted for 555 rivers in the Black Sea Basin and for 528 rivers in the Caspian Sea Basin.

River water composition is complicated and strongly variable. It depends on features of the water as soluble substance, on geochemical and soil conditions and biological process in the catchments, human activities in the river basins and climatic conditions in the area. All this contributes to high diversity of water characteristics and its variability intra-annually and inter-annually.

Inland waters of Ajara are also defined by complicated geology, relief and climate. Geology and relief define runoff rates and chemistry of groundwater, while climate affects runoff module (l/sec per km^2). Inland waters of Ajara are composed of rivers, lakes, wetlands and groundwater, while there are no reservoirs, permafrost and glaciers. Most important inland waters are rivers, which are of mountainous type.

Area of Adjara is not large and due to heavily undulated relief length of the rivers as well as catchment areas are small. Exception is Chorokhi River, which originates on Turkish territory and flows for long distance. None of Adjara rivers take source from permafrost and glaciers. Rivers are fed by rainwater, snow melt and groundwater, therefore they are characterised by spring and autumn rise. Elevation drops for most of the rivers are very steep, with high flowrates and on some sections rivers are flowing in narrow and deep gorges.

Table 3.36 Comparative characterisation of some rivers in South-Western Georgia

River Name	Catchment Area, km^2	Length, km	Discharge, m^3/sec			Annual discharge, km^3/year
			Max.	Min.	Ave.	
Kintrishi	291.0	45.0	386	2.41	17.3	0.55
Korolistskali	52.0	13.0	1240	0.95	3.3	0.10
Kubastskali	7.2	5.4	80	0.11	0.9	0.03
Bartskhana	16.9	8.6	115	0.32	1.3	0.04
Ajaristskali	1540.0	90.0	353	14.60	46.6	1.47
Chorokhi *	22100.0	438.0	3840	44.40	279.0	8.80

Chemical monitoring of our rivers is a vital tool in assessing the current state of these water bodies, as well as helping to identify pressures that may be impacting on the water quality of coastal waters and especially of transitional waters.

Surface waters quality elements fall into one of three classes:

1. Physico-Chemical conditions supporting biological elements - this group includes chemical properties such as pH (acidity/alkalinity), Dissolved Oxygen and Nutrients, the natural levels of which may be adversely impacted upon by human activities.

2. Specific Relevant Pollutants - this group of compounds are defined as substances that can have a harmful effect on biological quality which are identified as being discharged in significant quantities into Irish waters.

* River discharge estimations do not account for changes due to constructed dams in Turkey and in Georgia.

3. Priority Substances - these substances are identified by the Water Framework Directive as substances that present a significant general risk to, or via the aquatic environment, and include chemicals, certain metals, biocides, plant protection products and dioxins. Specific measures must be implemented for the progressive reduction of discharges, emissions and losses of these substances. This group of compounds includes a subset of Priority Hazardous Substances for which measures must be taken to stop or phase out discharges, emissions and losses.

At the current period monitoring of condition of the Georgian Black Sea rivers covers of physico-chemical parameters: temperature, pH, conductivity, dissolved oxygen, BOD_5, chlorides, sulfates, hydrocarbonates, hardness, Ca^{2+}, Mg^{2+}, Na^+, K^+, Nitrite, Nitrate, Ammonia, Phosphate, Silicate, Magnesium, Calcium.

Study area rivers belong to those with low mineralisation (less than 200 mg/l). Such rivers belong to calcium-hydrocarbonate type. Following ion series are characteristic for them: $HCO_3^- > SO_4^{2-} > Cl^-$, $Ca^{2+} > Mg^{2+} > Na^+ + K^+$.

Per data of National Environmental Agency it can be stated the ion series of these rivers are: $HCO_3^- > Cl^- > SO_4^{2-}$, $Na^+ + K^+ > Ca^{2+} > Mg^{2+}$. Only in rare cases, mostly for Chorokhi and Ajaristskali, cation series were observed: $Ca^{2+} > Na^+ + K^+ > Mg^{2+}$. Table 3.37 below contains physico-chemical characteristics of some rivers of the Black Sea catchment basin.

Table 3.37 Average annual value of some physico-chemical parameters of some Black Sea rivers during 2009-2019 (source: National Environmental Agency)

Year	Temperature, °C	pH	Conductivity Sm/cm	TSS, mg/l	Dissolved oxygen, mg/l	DO saturation %	BOD_5 mg/l
1	2	3	4	5	6	7	8
River Chorokhi							
2009	14.19	8.11	250.33	69.22	11.32	109	2.29
2010	15.52	8.26	335.58	78.68	10.55	103	1.49
2011	14.22	8.17	132.52	53.95	10.53	101	1.51
2012	14.12	8.14	118.20	64.76	10.93	104	1.29
2013	13.27	7.97	157.57	61.37	11.22	106	1.65
2014	14.12	7.99	130.35	221.78	10.83	103	1.74
2015	15.28	7.99	182.18	134.23	10.77	107	1.94
2016	13.03	7.74	191.62	102.20	10.81	101	1.85
2017	13.03	7.85	171.92	37.70	10.99	103	2.07
2018	15.65	7.40	216.32	45.64	10.35	102	2.81
2019	14.20	7.98	275.94	21.97	9.91	96	1.82
River Kintrishi							
2009	14.22	8.16	351.75	3.33	11.54	112	1.85
2010	15.12	8.36	313.67	9.71	10.60	104	1.49
2011	14.33	7.95	117.67	11.47	10.87	106	1.72
2012	13.85	7.98	113.50	4.77	11.49	109	1.55
2013	13.42	7.93	56.14	13.23	11.22	106	1.49
2014	15.40	8.01	171.65	9.76	10.71	106	1.65
2015	15.07	7.98	125.50	15.10	10.76	10	1.49
2016	14.63	7.78	162.70	23.33	10.61	103	1.53
2017	14.09	7.81	127.37	7.03	10.93	105	1.99
2018	16.12	8.07	202.28	3.02	10.22	103	1.96
2019	15.24	8.09	200.72	2.01	10.78	104	2.04
River Korolistskali							
2009	15.79	7.93	299.25	9.96	9.86	99	3.23
2010	16.61	7.80	223.25	7.66	9.08	92	3.23

2011	15.65	7.83	60.92	10.33	9.99	99	3.20
2012	15.55	8.01	59.67	5.70	10.36	103	2.07
2013	15.03	7.64	57.29	12.65	10.38	103	3.11
2014	16.50	7.86	91.00	9.45	9.96	92	4.21
2015	15.96	7.71	77.33	19.00	10.08	101	1.91
2016	15.97	7.54	83.62	7.40	9.85	99	2.71
2017	15.45	7.92	69.77	10.83	10.39	103	2.77
2018	17.25	7.84	108.39	2.95	9.54	98	2.66
2019	16.03	7.76	100.02	2.62	9.67	96	3.34
River Chakvistskali							
2014	13.87	7.91	74.15	5.60	10.55	100	1.72
2015	15.38	7.95	78.00	25.80	10.76	107	1.49
2016	14.56	7.74	72.33	19.03	10.52	103	1.84
2017	14.60	7.84	82.93	4.03	10.69	103	1.77
2018	16.71	8.14	96.55	3.42	10.26	104	1.87
2019	15.63	8.17	97.30	2.63	10.83	105	1.81
River Bartskhana							
2009	16.88	7.84	234.33	11.18	8.79	90	6.04
2010	17.63	7.66	317.33	17.66	8.51	88	4.85
2011	17.16	7.74	126.67	10.67	8.66	88	4.13
2012	16.50	7.58	122.42	9.13	9.12	93	4.35
2013	15.96	7.55	114.71	16.47	9.05	91	5.18
2014	17.51	7.55	157.60	86.51	8.68	89	6.30
2015	16.90	7.55	149.20	11.80	9.09	93	4.62
2016	17.32	7.42	171.28	10.03	9.14	92	4.29
2017	15.67	7.48	121.34	14.07	9.37	93	3.61
2018	18.34	7.69	168.75	9.64	8.50	88	4.72
2019	17.58	7.65	168.93	19.04	8.87	90	6.47
River Kubastskali							
2009	15.73	7.79	171.45	7.78	9.02	90	4.19
2010	17.08	7.55	344.50	13.85	8.50	87	6.03
2011	16.65	7.32	108.04	16.27	8.93	90	3.74
2012	15.77	7.50	102.84	7.42	9.29	92	4.01
2013	15.53	7.53	142.14	16.30	9.73	96	5.46
2014	17.09	7.56	136.30	19.27	9.27	94	6.19
2015	15.64	7.52	164.95	11.48	9.12	93	4.50
2016	15.41	7.33	181.27	207.95	9.48	93	4.85
2017	15.39	7.50	168.22	14.80	9.68	94	4.16
2018	17.68	7.58	185.03	3.11	8.59	88	4.42
2019	16.33	7.58	172.37	5.07	9.20	92	4.72
River Mejinistskali							
2014	15.07	7.59	407.50	8.67	9.61	94	3.90
2015	17.03	7.77	395.07	19.80	8.67	89	3.37
2016	16.65	7.56	392.35	7.30	9.38	95	2.97
2017	17.48	7.94	273.61	23.45	10.69	111	2.83
2018	17.65	7.57	361.10	8.47	8.39	88	5.46
2019	17.89	7.53	456.25	33.63	8.43	88	4.50

Essential and multiple importance is attributed to presence of soluble oxygen in natural water. First and foremost, oxygen is essential for most aquatic organisms. Due to strong oxygenation potential the oxygen plays important sanitary and hygienic function, contributing to fast mineralisation of organisms. Despite temperature factors, during the observations oxygen saturation levels reached 92-111 %.

Biological Oxygen Demand (BOD) is persistent, reliable, sensitive and important parameter characterising water pollution. In the rivers of the study area annual average values of this parameter was varying in the range of 1,29-6.30 mg O_2/l.

Nutrient enrichment
Inhomogeneity of chemical characteristics of the riverine water is strongly variable along the entire length of the river, less so variable across the river width and with some exceptions there is almost no variability in the water column/depth in the rivers. Reasons for inhomogeneity are river confluences, groundwater inflows and intermixing of waters with variable chemical compositions. Simultaneously there are factors, which are counteracting inhomogeneity: river flow, turbulence, regulated talweg. There are no rivers which have identical characteristics. These peculiarities are determined not only by natural processes, but also to a large degree by human interferences.

Ammonium concentration (MPL – 0.39 mg *N*/l) in unpolluted surface waters normally never exceeds 0.1 mg *N*/l and rarely exceeds 0.5 mg *N*/l.

Concertation of nitrites (MPL – 0.08 mg *N*/l) due to inherent instability is very law in natural waters. During most of the year nitrites cannot be observed or are at very low level in surface waters, at the level of hundredths of mg *N*/l. Values increase slightly buy the end of summer, when disintegration of organic matter is enhanced. High levels of nitrites in the water indicate active disintegration of organic matter and oxygenation of NO_2^- towards NO_3^- and retardation of oxygenation, which indicates towards the pollution of the water body and represents important sanitary indicator..

Ions transported by rivers are the most important source of most elements to the sea. The composition of river water is significantly different from seawater. To a first approximation, seawater is mainly a Na^+ and Cl^- solution while river water is a Ca^{2+} and HCO_3^- solution. It is pretty clear that we cannot make seawater simply by evaporation of river water. Other factors must be involved and significant chemical reactions and modifications must take place. Rivers transport chemicals to the sea. Among them most important are ions, which cause eutrophication process.

Nitrogen compounds together with phosphorus and silica belong to natural substances of biogenic origin in natural water. They are important substances for living matter in water bodies. Nitrogen and phosphorus are necessary elements for all living tissues. Without these elements development of plants and animals is impossible. In turn, concentration and dynamics of biogenic elements is entirely dependent on intensity of biochemical and biological processes taking place in water bodies. Obviously special treatment of these elements are somewhat arbitrary, as many other substances (such as Ca, Mg, K and others) contribute into processes essential for living matter in natural waters.

Table 3.38 Average value of some chemical parameters of river Chorokhi during 2009-2019 (source: National Environmental Agency)

Year	Nitrite, mgN/l	Nitrate, mgN/l	Ammonia, mgN/l	Phosphate, mgP/l	Silicate, mg/l	Sulphate, $mgSO_4$/l	Chloride, mg/l	Hydrocarbonates, mg/l	Calcium, mg/l	Magnesium, mg/l
River Chorokhi										
2009	0.0051	0.4649	0.0098	0.0170	15.64	11.96	23.27	106.58	20.98	19.34
2010	0.0098	0.3592	0.0189	0.1357	17.58	17.22	21.01	136.33	26.20	5.07
2011	0.0048	0.4407	0.0088	0.0161	18.91	16.80	20.03	124.12	22.01	4.82
2012	0.0053	0.3205	0.0060	0.0337	14.31	10.71	10.67	108.98	21.11	4.01
2013	0.0600	0.5309	0.0187	0.0099	11.24	7.57	3.84	92.73	22.41	5.02
2014	0.0053	0.3277	0.0308	0.0216	13.98	7.03	2.77	70.43	16.77	3.09

2015	0.0041	0.4282	0.0237	0.0121	13.01	13.70	3.11	94.25	21.85	4.86
2016	0.0119	0.3863	0.0865	0.0176	12.64	11.33	2.89	98.83	20.85	6.88
2017	0.0147	0.4717	0.0982	0.0276	10.25	9.94	3.84	95.88	21.27	5.72
2018	0.0178	0.4292	0.0536	0.2346	14.20	19.60	6.15	113.56	23.07	7.15
2019	0.0053	0.4121	0.0247	0.0422	7.80	24.68	6.82	129.12	24.48	8.50
River Kintrishi										
2009	0.0038	0.4395	0.0040	0.0181	18.10	3.88	19.84	72.18	9.15	2.13
2010	0.0042	0.4666	0.0143	0.1053	19.09	4.88	18.12	78.37	9.55	2.08
2011	0.0025	0.4667	0.0054	0.0175	19.80	2.60	14.70	88.04	9.09	2.17
2012	0.0029	0.4538	0.0020	0.0309	15.68	5.35	12.46	80.83	8.01	1.77
2013	0.0053	0.5337	0.0018	0.0354	13.16	3.08	3.15	50.85	8.27	2.12
2014	0.0033	0.2494	0.0048	0.0158	14.91	4.11	2.95	42.09	7.36	2.22
2015	0.0050	0.4937	0.0045	0.0143	15.08	5.91	2.37	51.65	8.32	2.22
2016	0.0032	0.4516	0.0910	0.0174	13.95	3.27	1.89	52.25	7.22	2.85
2017	0.0068	0.5045	0.0822	0.0578	13.66	3.42	2.40	56.24	7.26	3.78
2018	0.0075	0.5707	0.0087	0.0610	15.90	2.35	2.65	56.91	6.49	3.36
2019	0.0835	0.4193	0.1342	0.1016	11.8	5.29	3.35	61.32	7.77	3.00
River Korolistskali										
2009	0.0078	0.7289	0.1308	0.0650	20.04	4.24	18.65	64.66	8.68	2.24
2010	0.0127	0.8748	0.3298	0.1978	21.72	4.89	16.23	79.40	9.21	2.48
2011	0.0073	0.7680	0.2426	0.0602	21.47	1.96	17.92	71.99	8.13	1.88
2012	0.0062	0.6783	0.0762	0.0433	16.42	2.96	10.63	73.97	7.92	1.86
2013	0.0092	0.6755	0.3606	0.0521	13.83	2.72	3.90	47.27	8.29	2.03
2014	0.0152	0.4124	0.1947	0.0604	15.51	3.06	3.85	47.70	7.48	2.38
2015	0.0058	0.8106	0.0785	0.0399	16.12	4.60	3.14	44.52	7.27	2.37
2016	0.0049	0.8013	0.3055	0.0529	15.96	4.46	3.53	46.47	7.11	3.15
2017	0.0088	0.7307	0.1405	0.0371	11.79	4.03	3.46	49.40	5.54	3.03
2018	0.0104	0.8713	0.2297	0.1096	16.40	2.63	3.38	56.46	5.71	3.65
2019	0.0170	0.6583	0.1190	0.1373	15.80	3.90	3.86	58.66	6.93	3.58
River Chakvistskali										
2014	0.0027	0.2400	0.0115	0.0200	17.93	1.33	3.37	49.20	6.94	3.00
2015	0.0059	0.6130	0.0059	0.0181	16.77	6.76	2.42	49.22	7.40	2.57
2016	0.0043	0.5626	0.0776	0.0240	16.14	3.22	2.28	50.61	6.70	2.93
2017	0.0051	0.5505	0.0848	0.0352	15.73	2.40	2.67	55.20	6.90	3.00
2018	0.0126	0.6250	0.0255	0.0767	17.84	1.99	3.56	59.45	6.24	3.77
2019	0.0177	0.5208	0.0018	0.0645	12.10	3.25	3.11	58.57	6.55	3.65
River Bartskhana										
2009	0.0513	1.1851	0.3035	0.1397	24.76	4.93	21.72	87.63	15.86	4.09
2010	0.0881	1.1596	0.8641	0.3320	26.30	7.34	20.33	104.93	17.62	3.79
2011	0.0510	1.2139	0.4986	0.1751	27.22	4.93	18.72	104.40	16.27	3.88
2012	0.0424	1.3345	0.5373	0.2462	21.63	5.55	16.82	96.67	14.72	3.41
2013	0.1081	0.9846	0.5357	0.1166	18.77	4.92	5.42	73.20	13.83	4.19
2014	0.0665	0.8031	0.9388	0.1580	21.89	4.78	5.05	81.31	14.76	4.75
2015	0.0572	1.3509	0.5834	0.1290	20.71	7.69	4.12	72.97	14.05	4.40
2016	0.0965	1.3911	0.7403	0.1253	22.35	4.95	4.09	77.06	12.73	5.27
2017	0.0542	1.3193	0.5201	0.1017	14.62	4.25	5.28	76.48	11.62	5.33

2018	0.0596	1.3314	0.8528	0.4074	23.00	6.06	6.19	92.59	12.85	6.40
2019	0.0657	1.2330	0.4423	0.4348	20.35	8.38	5.28	93.23	13.92	5.90
River Kubastskali										
2009	0.0250	1.4455	0.2825	0.0949	25.07	5.92	22.68	77.42	15.27	3.95
2010	0.0178	1.2433	0.3063	0.3426	25.73	6.68	24.28	101.17	17.33	3.73
2011	0.0191	1.7157	0.4983	0.1522	26.13	5.72	21.47	97.10	16.82	3.73
2012	0.0208	1.5201	0.4887	0.1736	21.08	5.27	12.30	130.23	16.50	3.91
2013	0.0773	1.0585	0.9099	0.1911	18.11	4.59	9.91	80.31	15.34	4.42
2014	0.0259	0.7699	1.4140	0.2145	19.75	5.55	5.17	74.99	12.74	4.03
2015	0.0298	1.2735	1.1853	0.2158	20.79	9.23	5.11	82.24	15.49	4.72
2016	0.0416	1.2512	1.7236	0.2178	21.26	5.65	4.58	84.68	15.55	5.30
2017	0.0370	1.0730	1.3833	0.4174	18.09	5.92	7.44	96.47	14.50	5.06
2018	0.0326	1.2928	1.3433	0.4347	23.02	5.42	5.99	92.72	12.81	5.84
2019	0.0376	1.2248	0.6317	0.4058	12.97	7.53	5.73	92.72	13.26	5.75
River Mejinistskali										
2014	0.1807	0.9627	0.6763	0.1600	23.87	6.90	8.03	226.10	59.90	9.33
2015	0.1415	1.1951	0.7146	0.1679	22.47	13.59	10.30	196.82	53.96	7.71
2016	0.1449	1.0688	0.7884	0.1308	20.92	7.91	6.67	208.42	53.97	8.60
2017	0.1285	0.9873	0.5232	0.1378	15.96	6.65	6.58	189.40	41.22	7.09
2018	0.1376	0.8779	1.1090	0.5234	22.22	13.00	8.63	216.51	51.08	7.21
2019	0.1250	0.9998	0.9805	0.4783	16.71	19.09	11.54	216.83	46.12	9.56

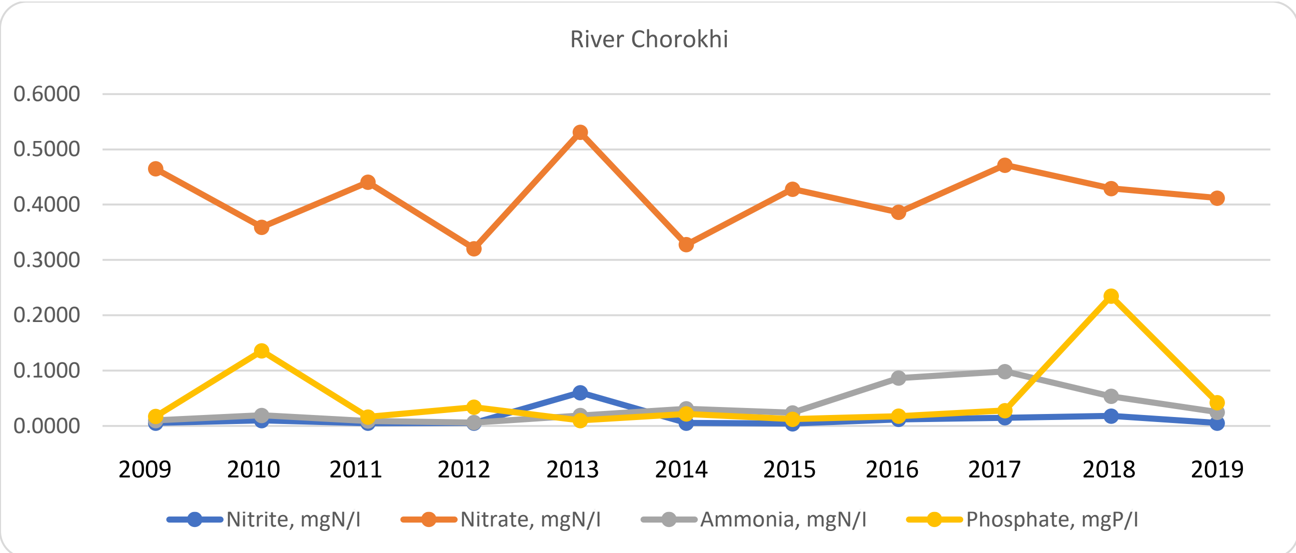


Fig. 3.42 Dynamics of average value of nutrients in river Chorokhi during 2009-2019 period

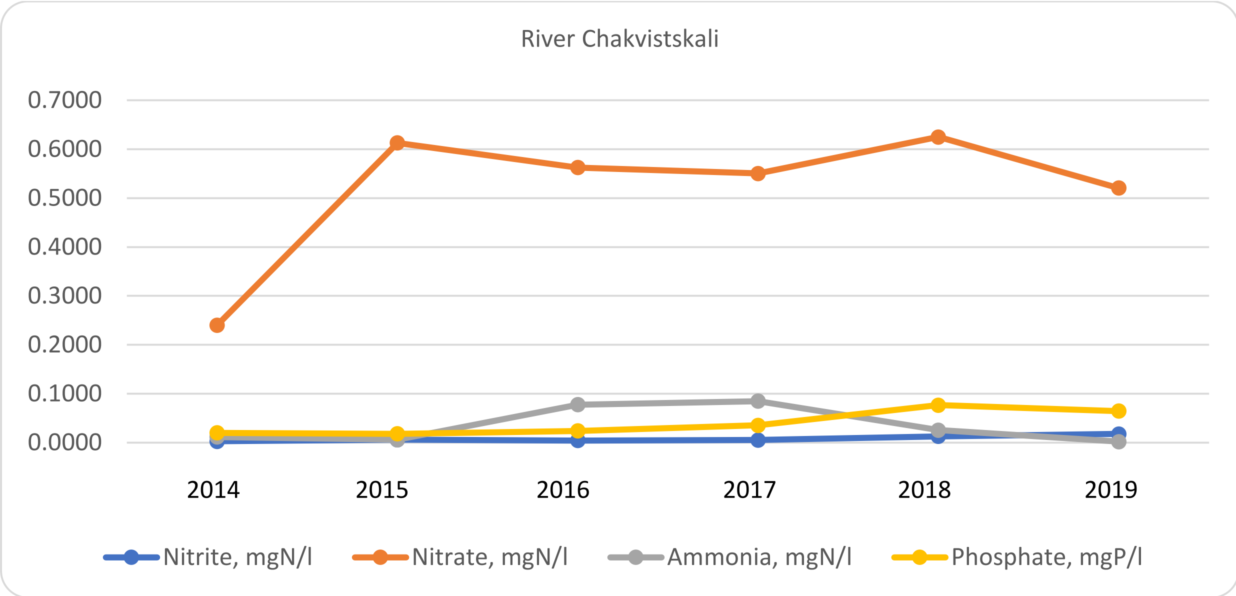


Fig. 3.43 Dynamics of average value of nutrients in river Chakvistskali during 2014-2019 period

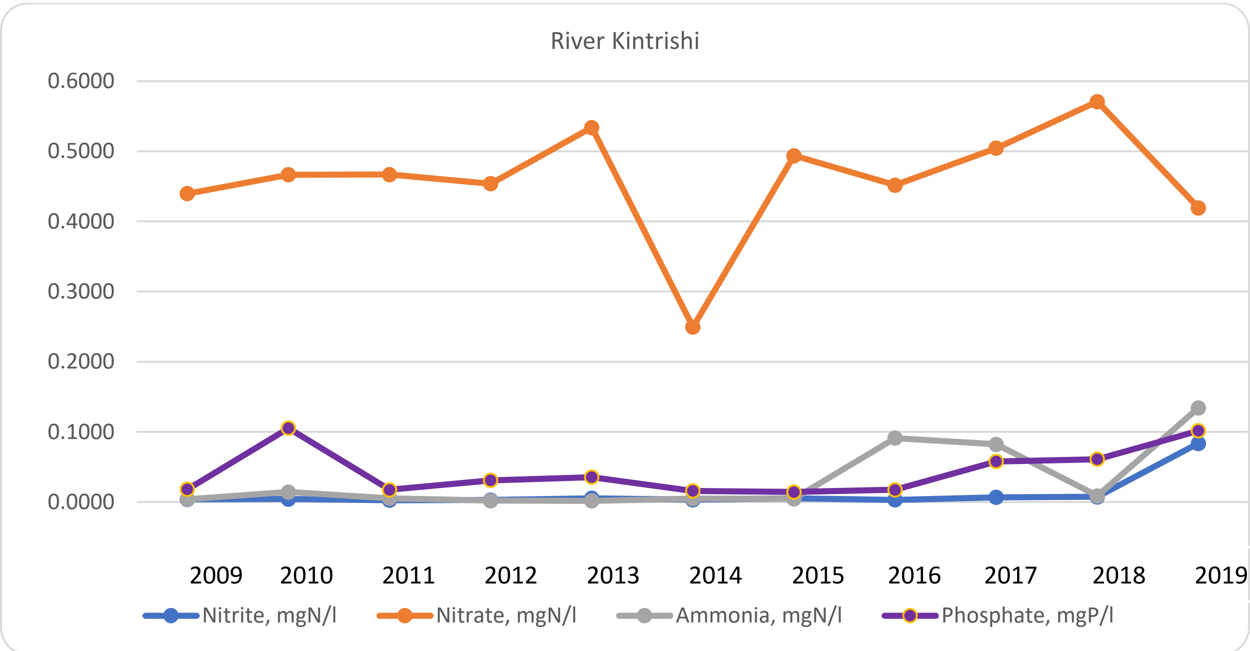


Fig. 3.44 Dynamics of average value of nutrients in river Kintrishi during 2009-2019 period

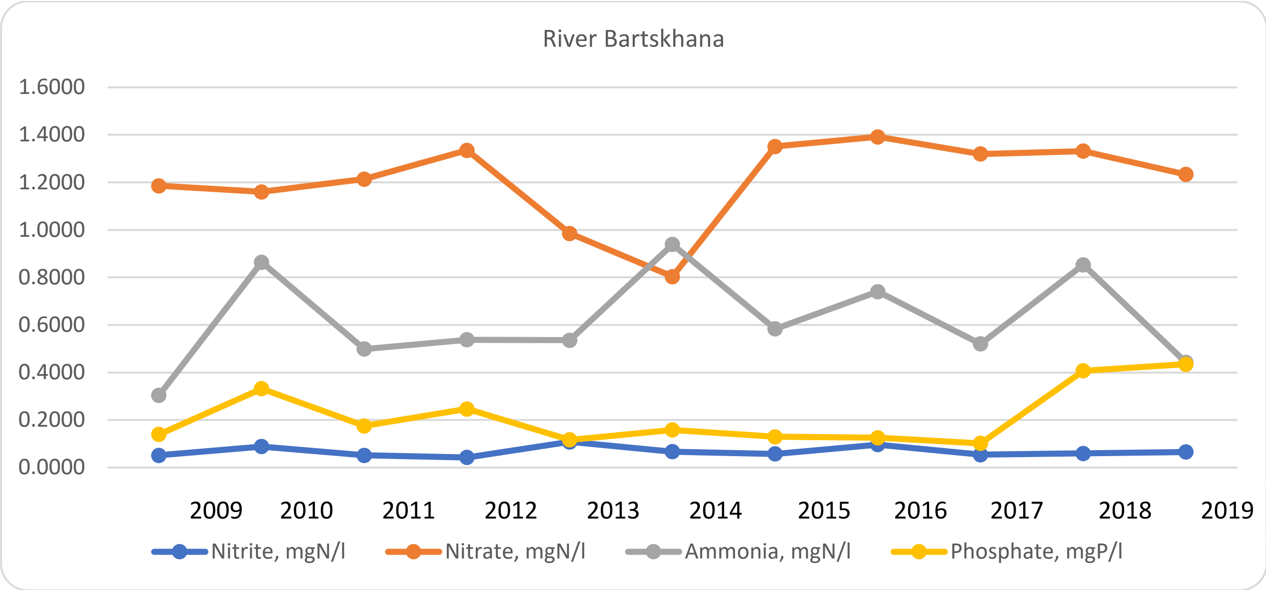


Fig. 3.45 Dynamics of average value of nutrients in river Bartskhana during 2009-2019 period

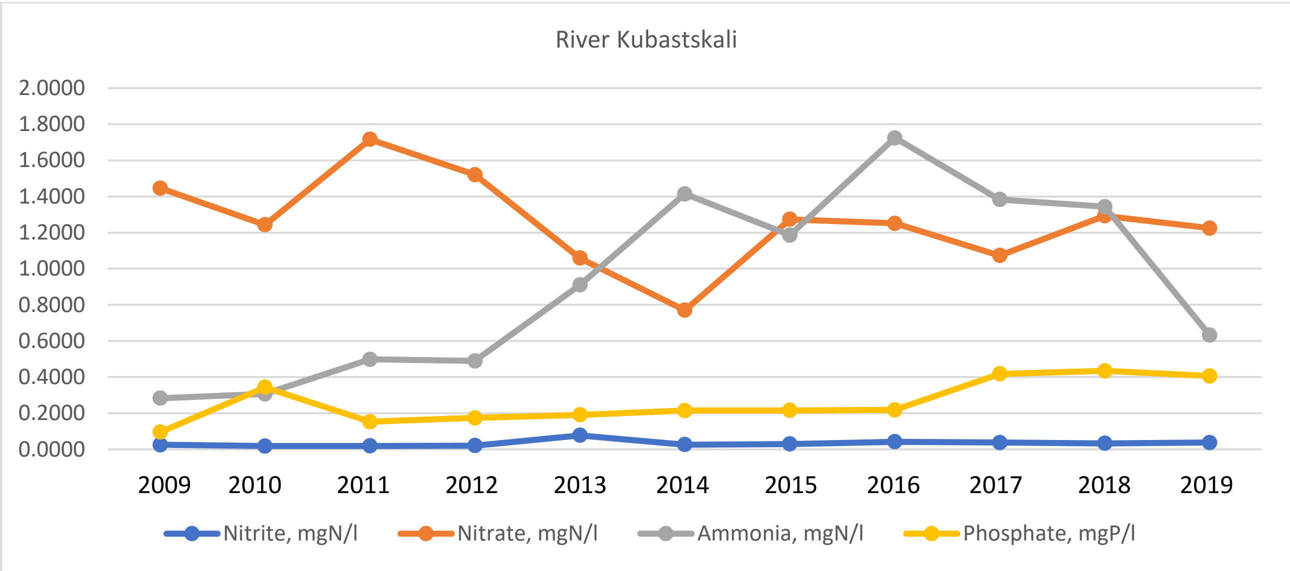


Fig. 3.46 Dynamics of average value of nutrients in river Kubastskali during 2009-2019 period

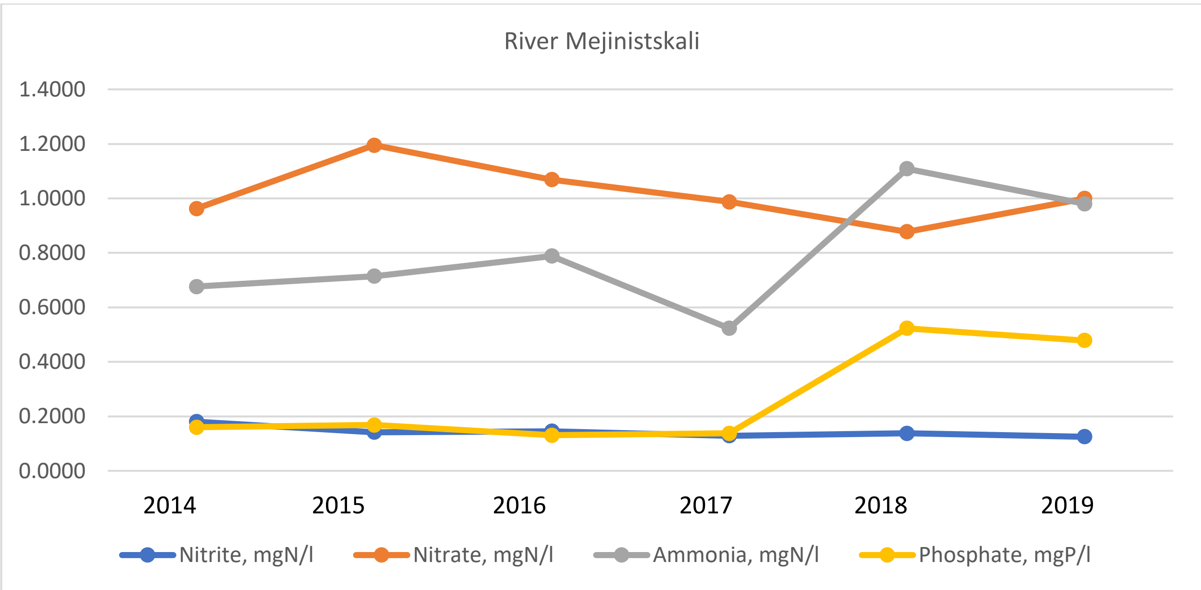


Fig. 3.47 Dynamics of average value of nutrients in river Mejinistskali during 2014-2019 period

Due to high content of nutrient in smaller rivers (discharge rates 0,03-0,04 km^3/year) Kubastskali, Bartskhana and Mejinistskali could be considered as hot spots. Anthropogenic activities on the catchment area and lack of a centralized water treatment system on the catchment area of that rivers are the main reasons of water quality in rivers. Average concentration of TPH during 2017 in surface waters are shown in Table 3.39.

Table 3.39 Average concentration of TPH in surface waters

River	Year	TPH, mg/L
Korolistskali	2017	0.0283
Chakvistskali	2017	0.0482
Kintrishi	2017	0.0273
Mejinistskali	2017	0,0278

Heavy metals are defined as metallic elements that have a relatively high density compared to water. Their multiple domestic, industrial, agricultural and technological applications have led to their wide distribution in the environment; Their toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals. Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority metals that are of public health significance.

Some heavy metals are naturally occurring elements that are found throughout the earth's crust, but most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds. Other group of heavy metals are considered as trace elements because of their presence in trace concentrations (ppb range to less than 10ppm) in various environmental matrices. In the table below, are shown average concentration of some heavy metals in Ajaran surface waters:

Table 3.40 Results of analyses of the trace metals in surface waters

River	**Year**	**Fe, mg/L**	**Zn, mg/L**	**Cu, mg/L**	**Pb, mg/L**	**Mn, mg/L**
Chorokhi	2010	0.1127	0.0022	0.0030	0.0004	0.0003
Kintrishi	2010	0.0283	0.0023	0.0015	0.0002	0.0008
Korolistskali	2010	0.0284	0.0036	0.0014	0.0001	0.0009
Korolistskali	2017	0.0207	0.0050	0.0051	0.0002	0.0080
Chakvistskali	2017	0.0280	0.0043	0.0058	0.0035	0.0045
Kintrishi	2017	0.0533	0.0103	0.0062	0.0029	0.0083

3.3.2 Impact on hydro morphological quality elements

Impact of dams. Historically, the biggest impact on solid sediment formation caused by existing HPPs came from hydroelectric power dams in Turkey (Murtali, Borçka, Deriner). They reduced the natural coast forming sediment which amounted to 400 000 m^3/y before the river regulation, by 60%. Anticipated construction of new dams on the river will reduce the coast nourishing sediment discharge by additional 20%. Sand-gravel that is necessary for construction and the erosion of the riverbed will have an indirect impact, which will reduce the amount of sediment by another 12%. Thus, as a result of Turkish HPP impact, Chorokhi natural sediment will be reduced by 95%. Added to that, sand-gravel extraction for industrial purposes and the indirect impact of HPPs, the sediment will be reduced by 2% and the sea will practically lose its source of nourishment by 2025.

Monitoring activities demonstrate, that the section of Kvariati-Gonio beach retained stability more or less in 2007-2011. However, granulometric analysis of the beach forming matter pointed to the reduction of the average diameter to 27 mm, as well as the lack of sand in the structure, which indicates the vulnerability of this section. In the case of Gonio, the diameter of gravel and coarse sand reduced to 32 mm, by 5 mm during 2007-2011. In the north part of the coast the shore is clearly caved, with the rate of 4 m/y, and construction of new HPPs upstream will speed up this process even more.

As for the volume of solid coast forming sediment of Ajaristskali and Machakhela, which in total amount to 58-60 thousand m^3 a year under reference conditions, it is too little for coast formation. Due to the river regulation, the sediments of Chorokhi confluences settle at the Chorokhi estuary; however, a small part still reaches the sea. But after the construction of Kirnati and Machakhela HPPs, even that small amount will not be able to reach the sea and the volume of flow into Chorokhi will be reduced as well.

Seabed dredging, dumping inert matter into the sea. As already mentioned above, intensive coast protection works have been carried out since the end of the 20th century and in the current decade consisting in the extraction of inert matter from seabed, shores and the Chorokhi riverbed. This, along with HPP construction in both Turkey and in Georgia has had a negative impact on hydromorphology of the Chorokhi River. Its hydrological and solid sediment regime is entirely disturbed, river banks are eroded in many areas and the delta, which together with groves contains small ponds and wetlands, is being affected, which implies an inevitable destruction of these ecosystems, besides, that loss of Chorokhi delta would have most significant negative impact on the formation of Gonio-Batumi coast. Material for coast protection were extracted from the coastline and seabed without specific hydro morphological (depth, seabed substrate structure, etc.) or physico-chemical studies of the littoral, as these operations were not subjected to environmental impact assessment.

3.3.3 Impact on biological characteristics

Eutrophication is one of the critical problems of the Black Sea causing following problems:

- Increased frequency of seaweeds, in particular, that of flagellate bloom;
- Gradual decrease of transparency in the whole basin (which has reduced from 50-60m in 1960s to 35 m, and in some areas of the coastal zone even to 10 m);
- Large-scale reduction in dissolved oxygen concentration;
- Occurrence of hydrogen sulphide with anaerobic conditions at benthos bottom layers (which bears different features from main anoxic layers of the sea);
- The loss of small depth microphytes (seaweeds);
- Changing in nutrient cycle;
- Drastic reduction in fish resources.

Biomonitoring data of the Black Sea in Georgia practically do not exist and we can only base our judgment about the impact on marine biodiversity on various international investigations, global satellite images or the results of modelling. The satellite image by NASA below shows that phytoplankton bloom and sediment discharge embraces the Black Sea coast in the form of light blue colour circulations.

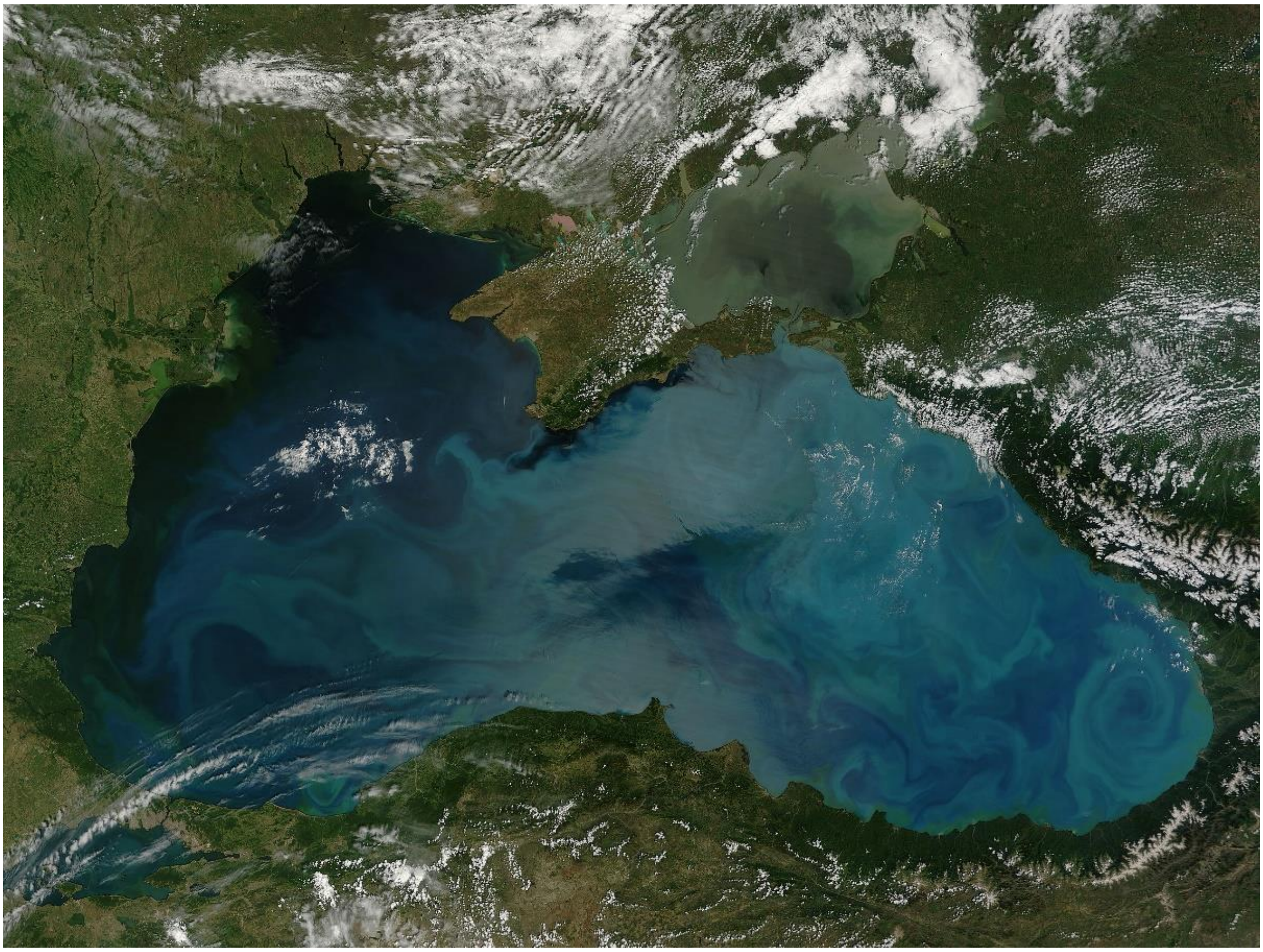


Fig. 3.48 Satellite image of the Black Sea indicating phytoplankton bloom[92]

Eutrophication has already caused the basic changes in the nutrient cycle of living organisms of the sea, which is expressed by the increased frequency of monospecific bloom of the plankton. There were changes in the nutrient cycle at higher levels as well, which were followed by the increase of biomass of *Aurelia aurita* and *Mnemiopsis leidyi* on the level of the entire sea basin. The massive decay of these two varieties resulted in hypoxia on a large scale and drastic reduction of macrobenthic marine species. These processes in the Black Sea ecosystem entailed tragic results for the fishing sector and diminished tourism potential as well.

Within frame of EPIRB pilot monitoring in 2016, the samples taken at Gonio-Kobuleti waters showed 6 taxonomic groups of phytoplankton: *Bacillariophyta, Dinophyta, Chlorophyta, Chrysophyta, Cyanophyta and very small amounts of Coccolithophoridophycidae* 2. As a result of the study, 68 species of algae, of which like in previous years *Bacillariophyta* was the dominating species (30 Species) and *Dinophyta* (26 Species). Relatively small amounts of green, blue-green and gold algae where also found, 5, 3 and 2 species (Figure 3.49).

[92] NASA MODIS Image of the Day: June 11, 2012 - Phytoplankton bloom in the Black Sea. http://www.spaceref.com/news/viewsr.html?pid=41066

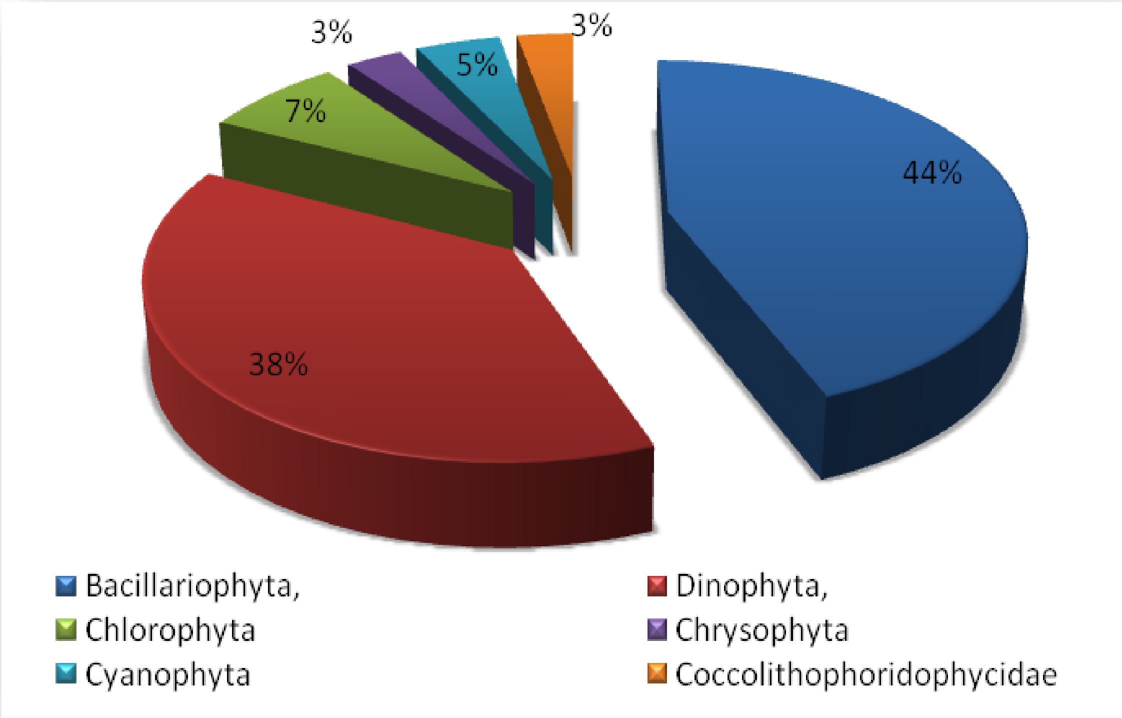


Fig. 3.49 Percentage ratio of phytoplankton groups in the waters of Gonio-Kobuleti, Black Sea, Georgia (2016) [93]

The diversity of phytoplankton species is evenly distributed through the stations and is represented by all 5 groups of algae, with the exception of the *Chrysophyta* species, which were only found in the samples taken at Batumi and Batumi port (Table 3.41).

Table 3.41 The species of Phytoplankton in the Georgian coastline of the Black Sea, in each station, August 2016

Species	Stations / Monitoring Points					
	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Bacillariophyta						
Achnanthes brevipes			+		+	+
Amphora hyaline		+				
Asteionellopsis gracialis		+	+			
Cerataulina pelagica	+	+				
Cilyndrotheca closterium	+	+	+	+		
Chaetoceros affinis	+	+	+	+	+	+
Chaet. Insignis	+	+	+	+	+	+
Chaet. curvisetus	+	+	+			
Cocconeos scutellum	+	+	+			+
Coscinodiscus janischii	+					
Cosc. Jonesianus		+				
Cyclotella caspis		+	+	+		+
Cymbella sp.				+		
Dactyliosolen fragilissima	+					+
Ditylum brightwellii						+

[93] Pilot monitoring of coastal waters of Georgia, National Environmental Agency, Fishery and Black Sea Monitoring Service, Environmental Pollution and Monitoring Department. In accordance with European legislation on environmental protection (water framework directive and marine strategy framework directives), Batumi, 2016.

Species	Stations / Monitoring Points					
	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Fragillaria crotoneis		+	+	+	+	+
Hemiaulus hauckii	+		+			
Hyalodiscus ambiguous			+			
Leptocylindrus danicus	+	+		+		
Licmophora ehrenbergii	+					
Navicula cancellata		+	+	+		
Paralia sulcate		+			+	
Pseudonitzschia delicatissima				+		
Pseudosolenia calcar avis	+					
Skeletonema costatum	+	+	+	+	+	+
Stephanodiscus dubius				+		
Steph. hantzschii			+	+		
Synedra tabulate				+		
Syn. pulchella				+		
Thalassionema nitzschioides	+	+	+	+	+	+
Dinophyta						
Ceratium furca	+		+			
Cochlodinium pirum			+	+	+	+
Cochlod. geminatum	+	+	+	+	+	+
Goniaulax cochlea	+	+	+	+		
Gon.polyedra			+	+	+	+
Gon. scrippsae	+	+	+	+	+	+
Glenodinium penardii					+	+
Glen pilula					+	+
Gymnodinium agile	+	+	+	+	+	+
Gymn.najadeum				+		+
Gyrodinium fissum					+	+
Heterocapsa triquetra	+	+	+	+	+	+
Phalacroma pulchellum				+	+	
Phal. rotundatum	+					
Proto-peridinium divergens	+		+		+	
Proto-peridinium breve	+	+		+		
Pr.-per. pellucidum	+			+		
Pr.-per. pallidum			+			
Pr.-prid. bipes	+					+
Pr.-per.subinerme			+	+	+	+
Pr.-per. steinii	+	+	+	+	+	+
Pr.-perid granii					+	+
Peridinium cinctum					+	+
Prorocentrum micans	+	+	+	+	+	+
Pror. cordatum	+			+		
Scrippsiella trochoidea	+					
Cyanophyta						
Gloeocapsa sp.	+	+	+	+	+	+
Microcystis aeruginosa		+				
Oscilatoria limnetica					+	
Chrysophyta						
Dinobryon elegans				+		
Mallomonas sp.			+	+		
Chlorophyta						
Trachaelomonas volvocina	+	+	+	+	+	+
Euglena viridis						+
Euglena sp.	+	+				
Protococcales						

Species	Stations / Monitoring Points					
	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Scenedesmus acuminatus			+			
Golenqinia sp.	+					
Coccolithophoridophycidae						
Coccolitineae sp.6-8 μm		+	+	+		
Pontosphaera sp.	+				+	+
Total species number	34	29	33	35	27	30

According to Shannon Diversity Index, it is possible to measure complexity of ecosystem structure. The more diverse the ecosystem, higher the index indicator (maximum of 5). According to the study, the Shannon Index varies very little across the stations, its minimum indicator (2.485) was measured on the Gonio sampling, the maximum (2.99) at Batumi port. The recorded readings indicate to a medium complexity in the structure of phytoplankton ecosystems in the Georgian Black Sea coastline (Figure 3.50).

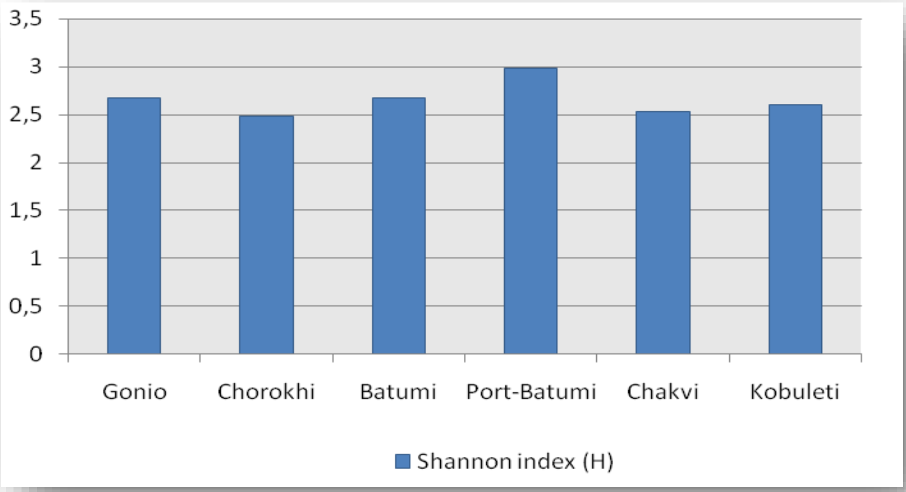


Fig. 3.50 Shannon's Index at each of the Stations [94]

The indicator of the amount of phytoplankton varies more or less, the maximum amount was recorded in Batumi samples (287265 cell/l), minimum was recorded at Kobuleti (78227 cell/l), in all cases, 70-80% of phytoplankton are diatom algae (Table 3.42). An important role in Phytoplankton biomass formation is played by diatoms as well as dinoflagellates, they comprise 50% of the mass, and even more in some cases, for example in samples taken from Batumi Port and Chakvi (70-75%). The maximum amount of biomass was found in Gonio samples (1437.2 mg/m^3), minimum at Kobuleti (408.4 mg/m^3) (Table 3.43).

Table 3.42 Amounts of Phytoplankton groups in Georgian Black Sea Coast cell/l, August 2016

Seaweed Group	Stations / Monitoring Points						
	Depth m	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Bacillariophyta	0	119856	186784	277236	177448	111636	32720
	15-20	191352	80422	167832	102752	41328	63784
Dinophyceae	0	46762	13470	25704	29772	30124	31084
	15-20	29512	20360	43512	47424	30504	15232

[94] Pilot monitoring of coastal waters of Georgia, National Environmental Agency, Fishery and Black Sea Monitoring Service, Environmental Pollution and Monitoring Department. In accordance with European legislation on environmental protection (water framework directive and marine strategy framework directives), Batumi, 2016.

Chlorophyta	0	8172	6286	11934	4328	2658	4908
	15-20		3054				3808
Cyanophyta	0	13620	16164	11016	8656	35432	4918
	15-20		6108	37296		21648	
Chrysophyta	0				6492		
	15-20						
Total amount	0	188410	222704	325890	226696	179850	73630
	15-20	220864	109944	248640	150176	93480	82824
Average amount		**204637**	**166324**	**287265**	**188436**	**136665**	**78227**

Table 3.43 Georgian Black Sea Gonio-Kobuleti coast Phytoplankton group mass mg/m^3, August 2016

Seaweed Group	Depth (m)	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Bacillariophyta	0	825,169	786,259	591.46	285,756	149,393	239,766
	15-20	805,666	245,101	329,282	180,608	57,257	97,611
Dinophyceae	0	743,605	154,487	461.09	725,208	481,665	291,66
	15-20	435.7	243,293	903,569	675,534	648,709	180,097
Chlorophyta	0	63,45	63,72	6.344	4,034	2,478	4,191
	15-20		2,847				3,55
Cyanophyta	0	0.785	0.965	0.658	0.499	0.672	
	15-20		0.365	2,228		0.201	
Chrysophyta	0				6,861		
	15-20						
Total biomass mg/m^3	0	1633,1	1005.4	1059.6	1022,4	634.2	535.6
	15-20	1241.4	491.6	1235.1	856.1	706.2	281.3
Overage biomass mg/m^3		**1437.2**	**748.5**	**1147.3**	**939.3**	**670.2**	**408.4**

One of the indicators of water ecosystem assessment was calculated within the frame of pilot monitoring – proportionate amount of microflagellates, euglena flagellates, cyanophyta in phytoplankton (MEC %). According to the indexes, the quality of the water in across the stations ranges from good to excellent ecological status (classification was done by using quality outlines used for Bulgarian coast waters) (Table 3.44). It is worth repeating, that determining ecological status classification for water bodies is impossible when using a single observation.

Table 3.44 Black Sea costal water quality evaluation scale and MEC % index

Taxonomic matrix	**High**	**Good**	**Moderate**	**Poor**	**Bad**
(MEC) %	2(5)-20	20-35	35-55	56-75	>75

Table 3.45 Classification of water bodies according to stations

Stations	**Gonio**	**Chorokhi**	**Batumi**	**Batumi Port**	**Chakvi**	**Kobuleti**
(MEC) %	5.3	9.5	10.5	3.4	21.9	8.7
Ecological status class	**High**	**High**	**High**	**High**	**Good**	**High**

In August 2016, within the frame of pilot monitoring, samples were taken at Sarpi and Mtsvane Kontskhi Cliffside shores, in which all three main groups of macrophytes were found: *Rhodophyta, Chlorophyta and Phaeophyta.* 9 species were identified in total, out of which, Chlorophyta species where found at both stations, two very important species-indicators of brown water algae (*Phaeophyta*) - *Cystoseira barbata* and *Padina pavonia* – were found in

Sarpi waters, and *Rhodophyta*'s good ecological status indicator species *Gratelupia dicotoma* and *Nemalion helmithoides at Mtsvane Kontskhi* (Table 3.46).

Table 3.46 Black Sea Georgian Coastline Macrophytes, 2016

Macrophytes	Sarpi	Mtsvane Kontskhi
Rhodophyta		
Ceramium arborescens	+	+
Gelidium crinale (Turn.) Lamour		+
Gratelupia dicotoma J. Ag		+
Nemalion helmithoides (Vell.) Batt		+
Chlorophyta		
Cladophora vagabunda (L.) Van Hoek	+	+
Ulva rigida	+	+
Ulva intestinalis (Linnaeus) Nees = *Enteromorpha intestinalis* (L.) Link.	+	+
Phaeophyta		
Cystoseira barbata	+	
Padina pavonia	+	

In providing qualitative evaluations of macrophytes, three indexes were used, the specific surface area (S/W), three dominants $(S/W)_{3Dp}$ and surface (SI_{ph}) indexes (Mincheva et al. 2003; http://www.eei.gr), an estimated ecological status was determined for coastal waters (Table 3.47).

Table 3.47 Black Sea coastal water (12-17 % salt) and the morphological indexes for Georgian coastline macrophytes

ESC	EEI range		
	$(S/W)_{3Dp}$, $m^2.kg^{-1}$	$(S/W)_x$, $m^2.kg^{-1}$	SI_{ph}, units
High	$(S/W)_{3Dp} < 15$	$(S/W)_x < 60$	$SI_{ph} < 25$
Good	$15 \le (S/W)_{3Dp} \le 30$	$60 \le (S/W)_x \le 80$	$25 \le SI_{ph} \le 40$
Moderate	$31 \le (S/W)_{3Dp} \le 45$	$81 \le (S/W)_x \le 120$	$41 \le SI_{ph} \le 55$
Poor	$46 \le (S/W)_{3Dp} \le 60$	$121 \le (S/W)_x \le 200$	$56 \le SI_{ph} \le 90$
Bad	$(S/W)_{3Dp} > 60$	$(S/W)_x > 200$	$SI_{ph} > 90$
	$(S/W)_{3Dp}$, $m^2.kg^{-1}$	$(S/W)_x$, $m^2.kg^{-1}$	SI_{ph}, units
Sarpi	32.32±0.76	31.11± 1.08	38.82
Mtsvane Kontskhi	32.5±0.6	26.6±0.8	36.21

The specific surface area (S/W) of the Sarpi macrophytes is 31.11± 1.08, at Mtsvane Kontskhi its 26.6±0.8. By these indicators, we can assign an excellent ecological status to both of the stations. The surface population index (SI_{ph}) is almost the same at both locations 38.82 and 36.21, respectively. These indicators correspond with waters that have a good status. However, the medium quality status of the three dominant index, can be overlooked in this case, as the $(S/W)_{3Dp}$ index is less sensitive in short term studies (Mincheva G. 2013). Thus, the aforementioned stations can be classified as having good ecological status. It is important to note that, at both sites, the dominant species are pollution sensitive indicator species with low specific surface area, In Sarpi - *Cystoseira barbata (S/W*=7.9±0.6) and *Padina pavonia (S/W*=19.4±0.8), at Mtsvane Kontskhi - *Gratelupia dicotoma (S/W*=8.6±0.3) and *Nemalion helmithoides (S/W*=4.6±0.2).

Within the frame of the Black Sea Georgian coastline pilot monitoring, 12-22 m of isobaths benthal is represented by fractions of sludge mixed fine sand, sand mixed sludge detritus and Ostracods, which is the main indicator of a diverse benthofauna.

Hydrobionts residing in benthals are represented by four types (*Nemertini, Annelides, Mollusca and Arthropoda)* and entail 32 species.

The anilides that inhabit detritus and Ostracods fractioned sand mixture sludge are represented by 9 types of *Polychaetes*: *Aricidea pseudoarticulata*, *Magelona rosea*, *Melinna palmata*, *Nephtys hombergii, Nephtys cirrosa longicornis, Sigambra tentaculata, Heteromastus filiformis*, *Prionospio cirrifera* and *Terebellides stroemii.*

Sludge, with fine sand sediment is represented by 2 classes and 15 species: *Archimacrostomum pusillum, Bela nebula, Odostomia pallida, Parthenina interstincta, Tritia neritea*, *Trophonopsis breviata, Anadara inaequivalvis*, *Arca tetragona Donax trunculus, Chamelea gallina, Lentidium mediterraneum, Lucinella divaricata*, *Modiolula phaseolina, Pitar rudis* and *Tellina fabula.*

Detritus, with small amounts of clay: *Ampelisca diadema*, *Amphibalanus improvises, Apherusa bispinosa*, *Brachynotus sexdentatus*, *Diogenes pugilator*, *Echinogammarus olivii* and *Callianassa subterranea*. Out of these, *A. diadema*, *A. improvises, A. bispinosa*, *B. Sexdentatus* were found in mature states and *D. pugilator*, *E. olivii* and *C. Subterranea* – at an early stage of development.

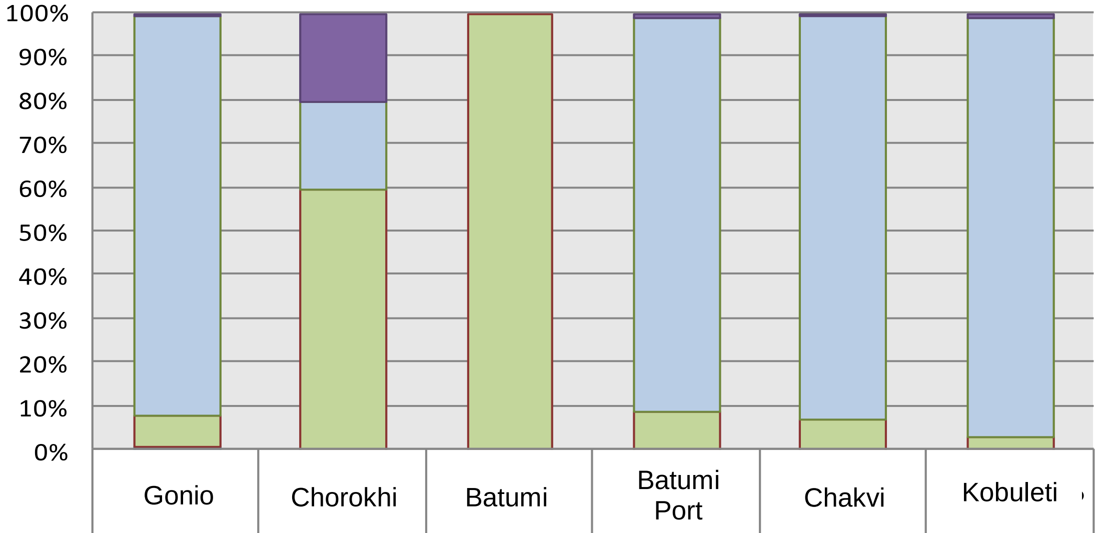
Table 3.48 Black Sea Georgian Coastline Gonio-Kobuleti 12-22 m Isobath) Benthofauna list, by each station [95]

Benthofauna	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Nemertea	1					
Nemertea sp.	+					
Annelides, Polychaeta	2	3	4	2	4	5
Aricidea (Aricidea) pseudoarticulata Hobson, 1972					+	
Heteromastus filiformis (Claparède, 1864)		+				+
Magelona rosea Moore, 1907	+		+		+	+
Melinna palmata Grube, 1870				+	+	+
Nephtys hombergii Savigny in Lamarck, 1818	+		+	+		+
Nephtys cirrosa longicornis Jakubova, 1930					+	+
Prionospio cirrifera Wiren,1883			+			
*Sigambra tentaculata (*Treadwell, 1941)		+	+			
Terebellides stroemii Sars, 1835		+				
Mollusca, Bivalvia	3	1		6	7	7
Anadara inaequivalvis (Bruguière, 1789)	+	+		+	+	+
Arca tetragona Poli, 1795				+	+	
Donax trunculus Linnaeus, 1758	+			+		+
Chamelea gallina (Linnaeus, 1758)	+			+	+	+
Lentidium mediterraneum (O. G. Costa, 1830*)*				+	+	+
Lucinella divaricata (Linnaeus, 1758*)*	+			+	+	+
Modiolula phaseolina (Philippi, 1844)					+	
Pitar rudis (Poli, 1795)					+	+
Tellina fabula Gmelin, 1791						+
Gastropoda	2	1		3	4	5
Archimacrostomum pusillum (Ax, 1951) Faubel & Warwick, 2005		+			+	
Bela nebula (Montagu, 1803)				+		+

[95] Pilot monitoring of coastal waters of Georgia. Ministry of Environment and Natural Resources Protection. National Environmental Agency. Fishery and Black Sea Monitoring Service. Environmental Pollution and Monitoring Department. In accordance with European legislation on environmental protection (water framework directive and marine strategy framework directives). Batumi, 2016.

Odostomia pallida (Montagu, 1803) *sensu* Jeffreys, 1867				+	+	+
Parthenina interstincta (J. Adams, 1797)					+	+
Tritia neritea (Linnaeus, 1758)	+			+	+	+
Trophonopsis breviata (Jeffreys, 1882)	+					+
Arthropoda, Crustacea	1	3		2	1	3
Ampelisca diadema (Costa, 1853)						+
Amphibalanus improvises (Darwin, 1854)				+		
Apherusa bispinosa (Bate, 1857)		+				
Brachynotus sexdentatus (Risso, 1827)		+				
Diogenes pugilator (Roux, 1829) (larv's nexst st.)		+		+	+	+
Echinogammarus olivii (Milne Edwards, 1830) (larv.)	+					
Callianassa subterranea (Montagu, 1808) (larv.)						+
Total	**10**	**8**	**4**	**13**	**16**	**20**

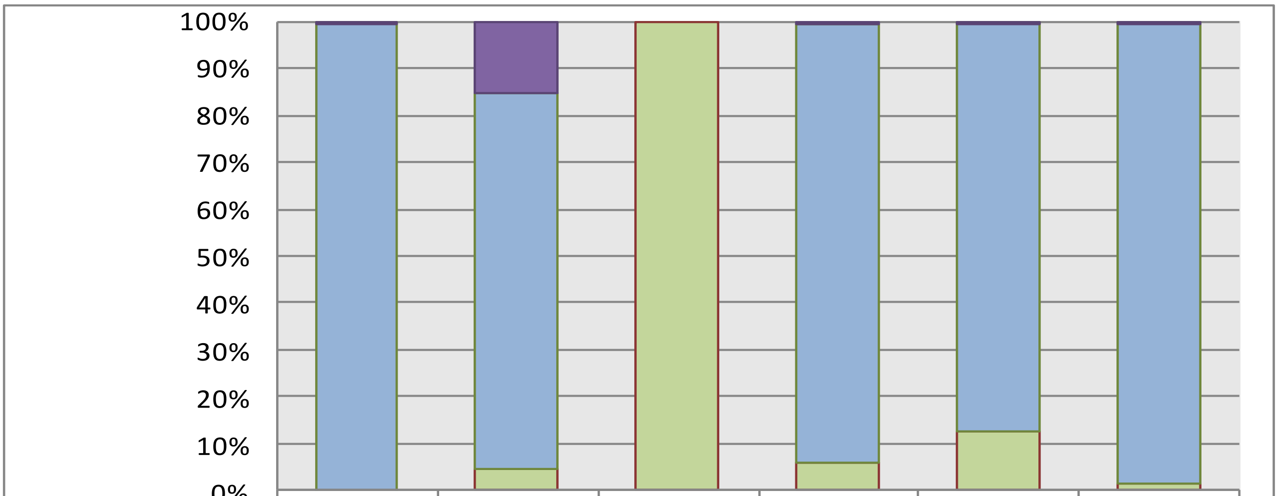
As a result of sampling treatment, general picture of distribution off benthic fauna and biomass of Black Sea coastline of Georgia in 2016 (Figure 3.51).



	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Crustacea	16	32	0	24	8	64
Mollusca	2738	32	0	1859	2040	5886
Polychaeta	220	95	56	181	158	173
Nemertea	16	0	0	0	0	0

Fig. 3.51 Number of benthic fauna of waters of Gonio-Kobuleti Black Sea shoreline of Georgia and correlation of the presented groups, August, 2016. [96]

[96] Pilot monitoring of coastal waters of Georgia, National Environmental Agency, Fishery and Black Sea Monitoring Service, Environmental Pollution and Monitoring Department. In accordance with European legislation on environmental protection (water framework directive and marine strategy framework directives), Batumi, 2016.



	Gonio	Chorokhi	Batumi	Batumi Port	Chakvi	Kobuleti
Crustacea	0,008	2,141	0	1,315	0,008	0,072
Mollusca	477,607	10,995	0	139,924	34,066	257,482
Polychaeta	0,244	0,626	1,036	9,075	4,923	3,643
Nemertea	0,173	0	0	0	0	0

Fig. 3.52 Benthic fauna biomass of Georgian Black Sea Coast waters and correlation of the presented groups, August 2016

Average amount of benthos fauna of the study region is 2267 units/m^2, while biomass is - 157.225 g/m^2. Molluscs are dominating (2092 units/m^2), bivalves consist 90% (1879 so/m^2) of whole benthos. Leading species among bivalves is *Chamelea gallina*, which amount is to 1089 units/m^2 and equals to 58%. Deep benthic fauna stands out by low number of crustaceans (25 individuals/m^2 and 0.592 g/m^2), which probably depend on sediment type.

On a number of various stations of the study area, amount of benthos and biomass are dramatically different. Very high index (6123 unit/m^2) was observed on Kobuleti station, which was caused by surplus of volutes and bivalves (96%). *Ch. gallina* and *L. divaricata* are also distinguished for their high amount. Low index was observed on Batumi station (56 unit/m^2), where diversity of the species is poor (4 species). It should be noted that among the observed species, each of the *polychaete* was physically damaged. Their number in samples was determined as 1-3 units.

For evaluation of Gonio-Kobuleti Sea area coastal ecosystems, AMBI, M-AMBI, BENTIX indexes were calculated, including respective software support.

Table 3.49 AMBI, M-AMBI benthic fauna indexes, Gonio-Kobuleti Black Sea coastal waters

Stations	AMBI	Diversity	Wealth	X	Y	Z	M-AMBI	Status
	6	0	0	3.0456	3.0817	2.6642	-1.2E-16	Bad
	0.07	2.75	20	-1.4713	-1.5478	-1.5287	1	High
Gonio	0.065262	2.0708	10	-0.60973	-0.36628	-0.21646	0.74983	Good
Chorokhi	3.217	2.5039	8	0.63959	-0.22168	0.46532	0.59548	Good
Batumi	2.7857	1.8424	4	0.93451	0.57268	1.0318	0.47118	Moderate
Batumi Port	0.40418	1.1941	13	-0.39857	0.39965	-0.20459	0.67327	Good
Chakvi	0.37947	1.8668	16	-0.81303	-0.42306	-0.75143	0.80747	High
Kobuleti	0.43428	2.752	20	-1.3271	-1.4952	-1.4601	0.9801	High

Table 3.50 AMBI, BENTIX benthic fauna indexes, Gonio-Kobuleti Black Sea coastal waters[88]

I (%)	II (%)	III (%)	IV (%)	V (%)	Overage AMBI	Overage BI from AMBI	Disturbance Classes
97.8	1.1	0	1.1	0	0.065	0	Intact
5.6	22.4	0	72	0	3,577	3	Moderate
28.6	14.3	0	57.1	0	2.786	2	Poor
87.2	3.1	8.1	1.6	0	0.36	1	Intact
80.7	13.5	5.4	0.4	0	0.382	1	Intact
74.3	23.9	0.5	1.3	0	0.434	1	Intact

According to the index, stations of Gonio, Chorokhi and Batumi Port can be characterized as good ecological status, Chakvi and Kobuleti – the best ecological status and Batumi waters as average status. However, it is impossible to identify ecological status of water according to only one study. At least 5-year monitoring is needed to identify ecological status of water objects according to water framework directive.

Changes in population size and species distribution area resulting from overfishing. Overfishing, the expansion of fishing industry in the entire sea, the use of bottom trawlers for fishing, together with other factors favoured the decrease and loss of predator (e.g. sarda, horse mackerel, bluefish, garfish), plankton-feeding (*Sprattus sprattus*) and anchovy (*Engraulis encrasicolus*) populations. The quantity of fishes having commercial value was reduced from 20 to 5 species in the whole Black Sea. Overfishing creates a threat not only for fish species, but it also favours the process of eutrophication, since many food fish feed on planktons and the decrease in their amount contributes to plankton growth and consequently strengthening the eutrophication process.

Invasion of alien species resulting from ballast water discharge – Invasion of alien, opportunistic species into the Black Sea aquatic area poses a serious threat to its ecosystems. Currently, there are 26 invasive species spread in the Black Sea. Of these, the following species had the strongest impact on the marine ecosystem: Mnemiopsis leidyi, *Rhithopanopeus harrisi*; out of molluscs: *Rapana thomasiana*, same as *Rapana venosa*), *Mya arenaria* and *Cunearca cornea* and out of fishes: *Mugil soiuy,* or *Liza haematocheilus*).

According to negative impact, we could mention in the first place *Mnemiopsis leidyi*, which entered the Black Sea in the beginning of the 1980s, presumably together with ballast water. Along with the spread of this species, ichthyoplankton and mesozooplankton, which also had an influence on plankton-feeding fish population.

Conch shells also had a serious impact on the Black Sea ecosystems, which resulted in the decrease of the population size among bivalva. Bivalvia filter the water and decrease in their size means the deterioration of water quality and reduction of feeding base for benthic fishes, among them of rare ones (for instance, salmon).

Coast development, tourism, recreation – intensive coast development and erection of public, and commercial facilities as well as various recreational or touristic activities cause the habitat fragmentation, degradation (damage, pollution) and loss.

Seabed dredging and dumping the inert matter into the sea – Seabed dredging with the purpose of coast protection causes the destruction of benthic organisms and seaweeds, modification and loss of substrate and pollution of the water by non-specific freed ions.

3.4 Water Bodies at risk

3.4.1 Coastal and transitional water bodies under the risk of pollution

Coastal and transitional water bodies that have been identified, the ones containing the rivers under diffuse and/or point source pollution impact risk, can be considered at risk of pollution sources. Besides, coastal and transitional waters at risk should be considered the ones, where significant impact has been identified or if there are empirically proven data on the impact on physico-chemical and/or chemical parameters.

Water bodies polluted by diffuse sources are:

1. The transitional section where Chorokhi flows in the sea, water body TW11_Ch, Chorokhi estuary/delta – pollution of the sea from agricultural discharge by discharges from agricultural lands and pastures;
2. The sections from the Chorokhi mouth to Adlia and until Batumi cape, water bodies CW111ChBaC, possibly CW212_ChBa at risk from pollution of the sea by agricultural surface discharge and small diffuse sources;
3. The part of the section from Batumi bay including Korolistskali estuary, water body CW221_BaKo at moderate risk from pollution of the sea by agricultural surface water discharge from plural small diffusive sources (households, small hotels, commercial and catering facilities) and by solid household waste;
4. The section from Korolistskali mouth to Makhinjauri and further to Tsikhisdziri Cape, water body CW211_KoTs, more precisely, the Chakvistskali estuary – agricultural runoffs, littering beaches with solid waste from dumping into rivers draining into the sea;
5. The section from Tsikhisdziri to Kobuleti, water body CW211_TsKb inclusive Bobokvati, Kinkisha estuary, Achkva estuary and Kintrishi delta – pollution by agricultural and animal farm discharges, littering and polluting the beaches and the sea with household waste mostly from riverine sources.

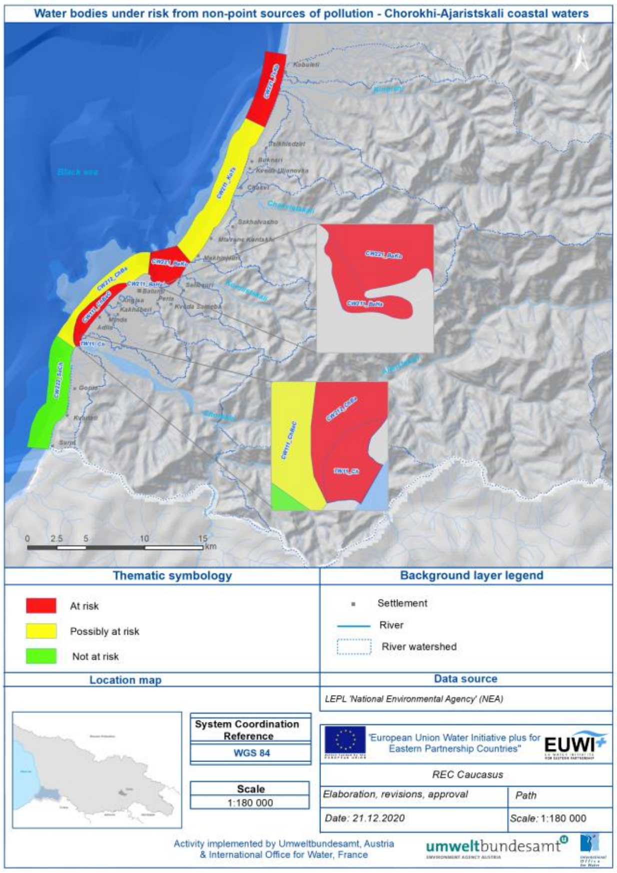


Fig. 3.53 Water bodies under risk from non-point sources of pollution

Based on both above qualitative analysis and results of the quantitative calculation of Land Uses Simplified Index (LUSI) and by converting five-colour index into tree levels of risks with following correspondence: high/good values – no risk; moderate – possibly at risk; poor/bad – at risk, continental pressures on eutrophication were assessed for coastal and transitional waters and reflected in the map of water bodies under risk from non-point sources of pollution.

Water bodies at risk polluted by point sources identified below and summarised in detail in Table 3.51 and depicted on Figure 3.54:

1. The section from Chorokhi estuary to Adlia, namely, Mejinistskali estuary is polluted by household discharge water, surface discharges of pollutants from the Batumi landfill on Kakhaberi plain.
2. Pollution of the sea and pollution risks by petroleum products from the port.
3. Bartskhana-Korolistskali section polluted by the untreated sewage and stormwater drains, as well as drainage from areas of historical pollution of oil terminal/refinery.
4. Makhinjauri-Tsikhisdziri area polluted by untreated household and stormwater outlets from Makhinjauri, Tsikhisdziri (population size here is over 2000, there are also touristic resorts).
5. Tsikhisdziri Cape-Kobuleti area also possibly at pollution risk by untreated household wastewater from Bobokvati, Kobuleti, and from Kobuleti landfill.

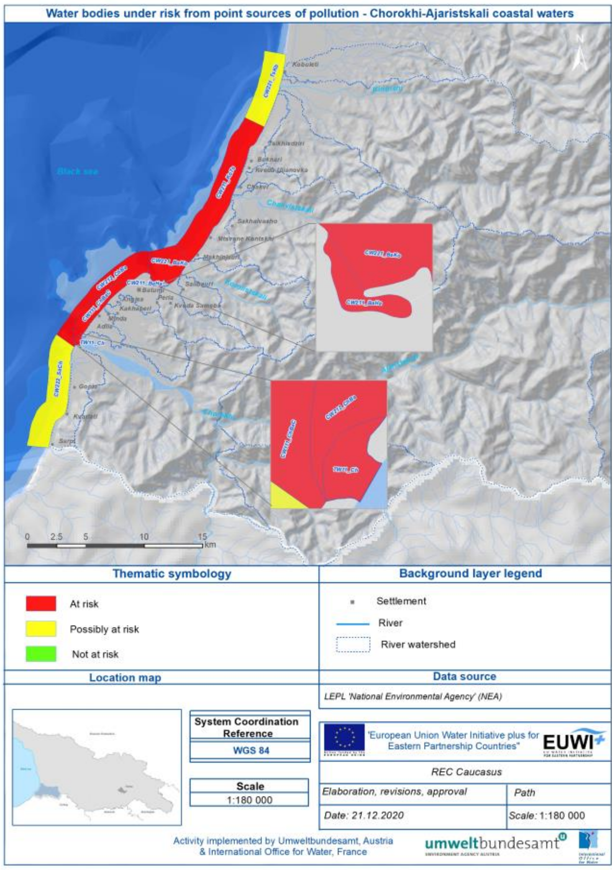


Fig. 3.54 Water bodies under risk from point sources of pollution

Table 3.51 Detailed characterisation of point source pressures/risks by water bodies.

Water body	Pressure	Evidence	Risk	Comment
Transitional Water Bodies				
TW11_Ch	1.Pollution from non-sanitary Batumi landfill via r. Chorokhi. 2. Pressures from Chorokhi and Ajaristskali river sources (uncontrolled solid waste dump sites and untreated domestic wastewater).	Field inspection.	At risk	Need more information on chemical monitoring of sea water
Coastal Water Bodies				
CW222-SaCh	1.Pollution of stormwater drainage channels by wastewater from upper area of Gonio, Kvariati and Sarpi. 2. Pressures from Chorokhi river sources (uncontrolled solid waste dump sites and untreated domestic wastewater).	Microbiological pollution (over 5000): 5 cases reported in 2019 of, no cases reported in 2020.	Possibly at risk	Need more information on chemical monitoring of sea water
CW111-ChBaC	1.Pollution from settlements of Batumi: Adlia, Angisa, Airport, Kakhaberi, through stormwater drainage outlets	Microbiological pollution reported on 6 cases in 2019-2020.	At risk	Need more information on chemical

	2. Pressures from Mejinistskali river sources (uncontrolled solid waste dump sites and untreated domestic wastewater) 3. Discharge point of Adlia wastewater treatment plant. Also affected by drainage outlets from Batumi area 4. 6 storm drainage outfall from Batumi settlements.	High concentration of suspended solid at the Chorokhi river water quality-monitoring site.		monitoring of sea water
CW212-ChBa	1.Discharge point of Adlia wastewater treatment plant. 2. Pressure from neighbouring water body CW111-ChBaC. 3. Also affected by drainage outlets from Batumi area.	8 cases of microbiological contamination in 2019 and 1 case in 2020.	At risk	Need more information on chemical monitoring of sea water
CW211-BaHa	1. Pollution load from Batumi port and Batumi oil terminal. 2. Contingency of accidents and operational spills.	Expert judgement.	At risk	Need sea monitoring database (self-monitoring, state monitoring as well as state supervision) on chemical parameters, including TPH.
CW221-BaKo	1.Pollution load from Batumi Oil Terminal. 2. Contingency of accidents and operational spills. 3. Pressures from Bartskhana, and Korolistskali river sources (uncontrolled solid waste dump sites and untreated domestic wastewater), including industrial pollution (historical pollution area of Batumi Oil Terminal) through river Bartskhana. 4. Storm water drainage channel outlets.	Microbiological pollution reported on 11 cases in 2019, on 8 cases in 2020. Need analysis results of the physico-chemical monitoring.	At risk	Sewage network in Batumi area: Bartskhana, Boni-Gorodoki and Tamari are newly connected to Adlia WWTP; Need sea monitoring database (self-monitoring, state monitoring and state supervision) on chemical parameters, including TPH.
CW211-KoTs	1. 3 outlets on storm-drainage channels (till r. Chakvistskali). 2. Pollution from settlements of Mtsvane Kontskhi and Makhinjauri. 2. Storm water drainage channel outfalls 3. Pressures from Chakvistskali river sources (uncontrolled solid waste dump sites and untreated domestic wastewater).	Microbiological pollution reported on 6 cases in 2019-2020.	At risk	Need more information on chemical monitoring of sea water
CW221-TsKb	1. Stormwater drainage channel outlets. 2. Kobuleti landfill (currently not operated). 3. Pressures from Kintrishi river sources (uncontrolled solid waste dump sites and untreated domestic wastewater)	One case on microbiological contamination near Bobokvati in 2020 and 3 in 2019.	Possibly at risk	Need more information on chemical monitoring of Sea water

3.4.2 Coastal & transitional water bodies under hydro morphological risk

Characterisation of water bodies at risk from hydro morphological impacts are as follows:

1. Sapri-Chorokhi section water body CW222_SaCh could be experiencing certain reduction of solid beach-forming sediment induced coastal erosion due to HPP construction and operations upstream of rivers Chorokhi and Ajaristskali;
2. Chorokhi estuary and delta transitional water body GE_TW11 with strong reduction of sediment flows would experience coastal erosion due to dams upstream and sand-gravel extraction;
3. Chorokhi estuary and Adlia section, water bodies CW111_ChBaC 4 at risk of coastal erosion due to sediment reduction and sand-gravel extraction, climate change (sea level rise), as well as and CW212_ChBa possibly at risk due to coastal works, developments and seabed modifications;
5. Batumi harbour CW211_BaHa water body and Batumi cape to Korolistskali water body CW221_BaKo at risk – coast and seabed modification due to coast development, port construction and maintenance works and climate change (see level rise);
6. Korolistskali-Tsikhisdziri section, water CW211_KoTs – coastal erosion affecting railway line;
7. Tsikhisdziri-Kobuleti section, water body CW221_TsKb – coastal protection works and modifications.

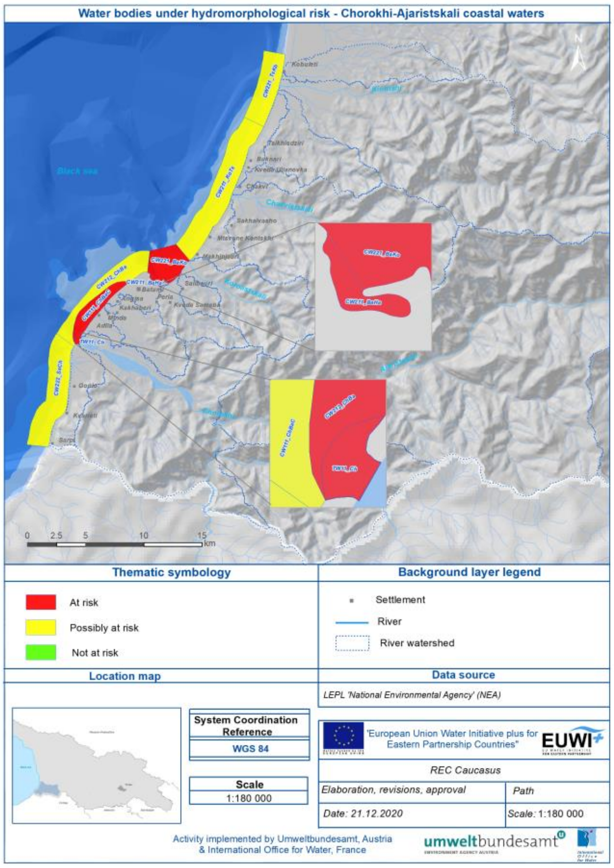


Fig. 3.55 Water bodies under hydromorphological risk

3.4.3 Water bodies at risk due to biological impact

It is implied that when water bodies are at risk due to pollution and hydro morphological factors, that their biological parameters are deteriorated and these factors taken together lead to the failure to achieve good or high ecological status. Physico-chemical and biological parameters are closely connected with each other, similar to biological and hydro morphological issues. Physico-chemical and hydro morphological parameters are also intertwined sometimes. But regardless these factors, there exist the types of impact which directly affect the biological quality elements. For instance: overfishing, poaching, introduction of invasive species. Water bodies under such pressure-impact risks are the following:

1. Chorokhi estuary transitional water body Sea TW11_Ch – the point near the Black Sea, where anadromous fish enter the river, affected by hydro morphological changes, as well as aggregate extraction from the riverbed;
2. Potentially at risk is Chorokhi delta, as part of the water body CW222_SaCh – spawning and feeding area for Black Sea salmon and other anadromous fish, rich coastal freshwater pond ecosystems. This site is affected by poaching and change in river regime, as well as from aggregate extraction in the delta. This is an ecologically sensitive and significant area.
3. All other coastal water bodies potentially are at risk from damaging fishing activities, such as bottom trawling, IUU fishing, overfishing, intense navigation and port operations.

As for some other types of pressures, such as introduction of invasive species, it is hard to make conclusions, as there are no proper maps for the distribution of invasion species and their impact on living organisms has not been studied either. Also, speaking of fishing, no research into the size of fish population, species distribution area, or composition exists. That is why, any water body can be considered "at possible risk", unless relevant monitoring and studies are carried out.

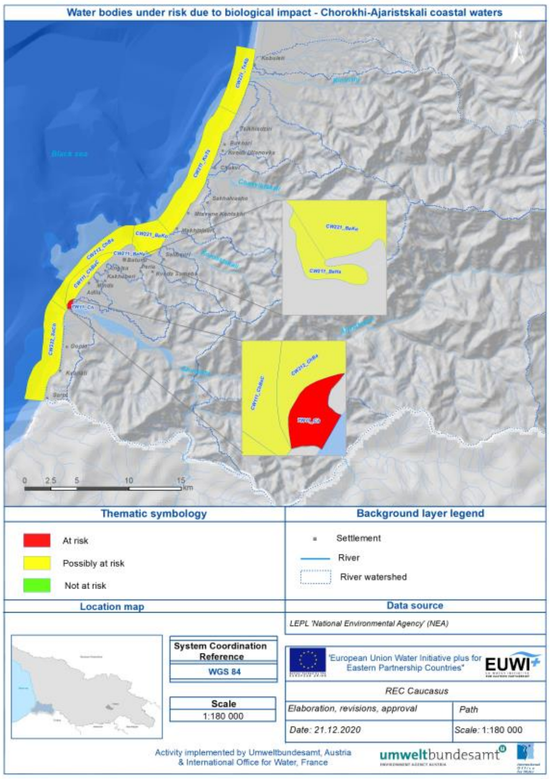


Fig. 3.56 Water bodies under risk due to biological impact

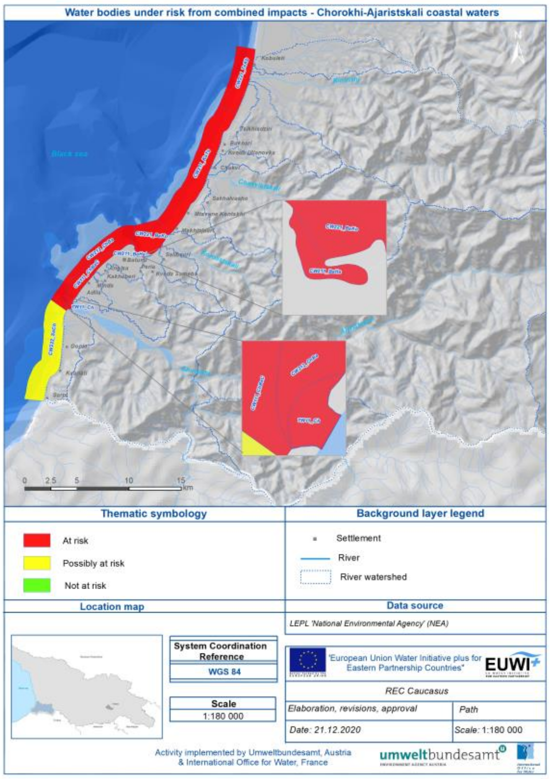


Fig. 3.57 Water bodies under risk from combined impacts

4 Programme of Measures for coastal & transitional waters

Programme of Measures. PoM developed for Chorokhi-Ajaristskali River Basin District is based on the requirements of Water Framework Directive (WFD) and follow Guidance Document on the Development of Programme of Measures (PoM) and the Achievement of Environmental Objectives According to the EU WFD.[97] Measures are divided into two types: i) Basic measures; and ii) Supplementary measures. Reference is hereby made to respective parts of the overall River Basin Management Plan, describing methodological aspects on elaborating PoM.

Similar methodology was therefore applied in a slightly simplified form to this coastal and transitional waters part in order to define PoM for those pressure-impacts, that are not being fully addressed in the river basin management framework. Those measures, which normally would have to comply with other requirements, such as the Marine Strategy Framework Directive (MSFD), are not considered in this volume of the plan, unless found necessary.

PoM is presented in two tables separately for coastal and transitional water bodies. The similar structure of the tables is followed as used for the basin-wide PoM: first two columns providing reference numbers and geographical names of water bodies under consideration, followed by characterisation of the status/issues in the water body and concise statement of the objectives to be achieved for the water bodies, while last two columns provide critical part of the PoM – basic and supplementary measures.

PoM list is referencing coastal and transitional waters names agreed for the EUWI+ pilot area: 'CW␣␣␣_SsTt/Rr' and 'TW␣␣_Rr', where CW is Coastal Water body, TW – Transitional Water body, '␣' – digit numbers 1/2 corresponding to water body typology components defined per salinity, origin, depth, substrate size, while SsTt/Rr – abbreviate names of respective settlement or town / estuary or lake, defining location of water body. Whenever possible, water bodies in PoM are listed in consecutive order counter-clockwise around the Black Sea coastline and/or in landward-seaward direction.

The matrix of the Programme of Measures (PoM) for Coastal Water Bodies (CWB) with basic and supplementary measures is given in the Table 4.1 below, entitled 'PoM for CWB'.

The matrix of PoM for Transitional Water Bodies (TWB) with basic and supplementary measures follows in Table 4.2 PoM for TWB.

In many cases, basic and supplementary measures refer to generic Monitoring Programme for Coastal and Transitional Water Bodies. This program is outlined in the next chapter 5 of this document. This program is of critical importance for monitoring the implementation of PoM in the short-, medium- and long-term time-span.

[97] Draft Guidance Document on the Development of Programme of Measures (PoM) and the Achievement of Environmental Objectives According to the EU WFD. EPIRB. Contract # 2011/279-666. Project financed by the European Union and implemented by the Consortium of Hulla & Co. Human Dynamics KG. September, 2014. http://blacksea-riverbasins.net/system/files_force/Guidance_Document_EPIRB_PoM_Environmental_Objectives.pdf.

Ranking and prioritising PoM. One of the important concepts of the EU Water Framework Directive, required to be implemented by the EU Member Countries while developing River Basin Management Plans (RBMPs), is to incorporate economic principles and Cost-Effectiveness Analysis (CEA) as mitigation measure of RBMP's Programme of Measures.

As noted in the volume dealing with PoM for the river basin waters, undertaking such economic analysis is a complicated multistep procedure, requiring complex analysis and a large volume of reliable and relevant environmental and economic data, which are in limited supply in Georgia. Therefore, simplified methodology proposed by the project and referenced above, is essentially focusing on the following:

- To estimate the intervention costs and budgets (both capital and O&M);
- To draw up realistic timetables for their implementation over relevant planning periods;
- To prioritize implementation of the measures.

The CEA in this study was undertaken through:

i) Ecological effectiveness analysis;
ii) Costing of the programme of measures;
iii) Prioritizing the measures based on ecological and economic effectiveness analysis.

A simplified ranking system was therefore applied to help identify the cost-effective measures, i.e. those with maximum potential ecological effect with the least costs in a relatively shorter period of time. More specifically, the following indicators and the ranking system has been used for prioritisation of measurers:

1. Ecological effectiveness. This is the indicator for assessing the ecological effectiveness of a measure, scoring them per expert judgment at the scale of 0, 1, 2 and 3.

2. Time for achieving the ecological effect. Score 2 is assigned to measures with shorter period of achieving the ecological effects, while score 1 is assigned to measures having positive ecological effect in medium or longer period.

3. Direct upfront investment cost. For this indicator scores 0 to 3 have been used: 3 for low (<50,000), 2 for medium (50,000-500,000), 1 for high cost (500,000-1,000,000 Euro) measures and 0 for measures with upfront investment cost more than 1,000,000 Euro.

4. Operation and maintenance/administrative cost. For this indicator scores 1 to 3 have been used: 1 for low (<50 000), 2 for medium (50 000-500,000), and 3 for high (>500,000 Euro) operation and maintenance or administration costs.

5. Indirect costs. Score 1 applies to measure if its implementation or adoption leads to indirect costs for economic players. Score 2 applies if there is no significant indirect cost incurred by economic players.

Finally, scores in each indicator are summed up to rank measures. Measures with ranking 1-8 are of lower priority, measures with ranking 9-10 are of a medium priority, and measures with ranking ≥ 11 are of higher priority.

Table 4.3 summarizes the results of ranking and prioritisation of measures for both coastal and transitional water bodies. Last but not least, the last column of this table lists the critical stakeholder responsible for taking the lead in respective PoM task implementation in cooperation with governmental/non-governmental actors and funding partners concerned.

Expert assessment ranges for indicators used in PoM ranking and prioritisation scores for combined indicators are summarised in two master tables provided below (see Table 4):

Table 4. PoM ranking master tables

Score / Indicator	0	1	2	3
Ecological effectiveness	-	low	medium	high
Time for achieving ecological effect	-	> 3 year	< 3 year	-
Investment costs	> € 1,000,000	> € 500,000 & < € 1,000,000	> € 50,000 & < € 500,000	< € 50,000
Operation	-	> € 500,000 & < € 1,000,000	> € 50,000 & < € 500,000	< € 50,000
Indirect costs (economic players)	-	increased	not increased	-

Combined score / Ranking	≥ 4 ≤ 8	≥ 9 ≤ 10	≥ 11 ≤ 13
Priority of proposed measure	**Low**	**Medium**	**High**

Combined value of investment as well as operation and maintenance costs of the Programme of Measures were derived by calculating minimal and maximal values of respective cost ranges per attribute scores for each measures scored. These straightforward calculations are not reproduced in this document, but results of the cost estimation are indicated further below:

Lowest values estimated for investment costs are ranging from 23.35 to 40.1 million Euros, while operation and maintenance costs are ranging from 1.9 to 13.0 million Euros. Combined overall lower end values for both cost types are not less than 25.25, but is expected to exceed 53.1 million Euros, as costs of several investment measures are considerably higher than scoring and ranking limits indicated in master tables, therefore overall implementation costs are expected to exceed quite substantively above indicated ranges for Table 4.3 measures.

Table 4.1 PoM for CWB

CWB	Location	Status	Objective	Basic measures	Supplementary measures
			Point Source Pollution		
CW222_SaCh	Sarpi-Kvariati	- Sarpi waste and wastewater	- Achieve good ecological and chemical status	- Connect fully to Batumi WWTP - Sarpi SWMP - Inventory of all point sources of pollution	- Ajara wastewater strategy - Ajara illegal waste dumps location study
CW222_SaCh	Kvariati-Gonio	- Kvariati waste and wastewater - Gonio waste and wastewater	- Achieve good ecological and chemical status	- Connect Kvariati and Gonio fully to Batumi WWTP - Kvariati SWMP - Gonio SWMP - Inventory of all point sources - Inventory of all illegal discharges to stormwater network - Bathing water monitoring	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Blue Flag award scheme - Monitoring programme for CWBs & TWBs (defined in Annex 1)
CW111_ChBaC **CW212_ChBa**	Chorokhi Outflow	- Batumi landfill leachate pollution	- Achieve good ecological and chemical status	- Chorokhi and sea water monitoring on hazardous chemicals - Batumi landfill remediation	- Batumi SWMP - Ajara illegal waste dumps location study - Batumi landfill remediation feasibility study
CW111_ChBaC **CW212_ChBa**	Adlia-Batumi	- Unconnected wastewater from urban areas	- Achieve good ecological and chemical status	- Connect entire Batumi to its WWTP - Batumi SWMP - Inventory of all point sources - Bathing water monitoring	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Blue Flag award scheme - Batumi landfill remediation feasibility study
CW211_BaHa **CW221_BaKo**	Batumi Bay	- Unconnected wastewater from urban areas - Port waste and wastewater including polluted by oil products - Operational spills - Dumping of dredge sediments	- Achieve good ecological and chemical status - Green port status	- Connect entire Batumi to its WWTP - Batumi SWMP - Upgrade of industrial and domestic wastewater facilities of ports and oil terminals, including for treatment of ballast water - Implement independent remote sensing monitoring of oil spills (e.g. ESA's Sentinels)	- Implement contingency plans - Implement provisions of MARPOL and Bucharest Conventions at ports - Ratify requirements of IMO Ballast Water Management Convention - Ajara wastewater strategy - Ajara illegal waste dumps location study - Assessment and options for dredge disposal in Georgia
CW221_BaKo	Batumi-Makhinjauri	- Wastewater from unconnected urban parts	- Achieve good ecological and chemical status	- Connect entire Batumi to its WWTP - Batumi SWMP	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Batumi new landfill
CW211_KoTs	Makhinjauri-Tsikhisdziri	- Makhinjauri waste and wastewater - Chakvi waste and wastewater	- Achieve good ecological and chemical status	- Connect Makhinjauri fully to Batumi WWTP - Makhinjauri SWMP - Chakvi SWMP - Inventory of all point sources - Bathing water monitoring	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Blue Flag award scheme
CW221_TsKb	Tsikhisdziri-Kobuleti	- Kobuleti waste and wastewater - Kintrishi Mouth pollution due to aggregate extraction	- Achieve good ecological and chemical status	- Kobuleti landfill remediation feasibility study - Commission fully into operation Kobuleti WWTP - Kobuleti SWMP - Bathing water monitoring - Ban aggregate extraction in Kintrishi mouth	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Blue Flag award scheme - Regulate material extraction - Monitoring programme for CWBs & TWBs

CWB #	Location	Status	Objective	Basic measures	Supplementary measures
Diffuse Source Pollution					
CW222_SaCh	Sarpi-Kvariati	- Waste and wastewater form diffuse sources	- Achieve good ecological and chemical status	- NMES&AP implementation - Latrines and septic systems scheme for rural households - Inventory of all non-point sources of pollution	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Rural latrines and septic systems guideline
CW222_SaCh	Kvariati-Gonio	- Waste and wastewater form diffuse sources - Beach litter	- Achieve good ecological and chemical status - Beach litter under control	- NMES&AP implementation - Latrines and septic systems scheme for rural households - Inventory of all non-point sources of pollution - Beach litter monitoring and clean-ups - Constructed wetlands behind dune system	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Blue Flag award scheme - Rural latrines and septic systems guideline
CW111_ChBaC **CW212_ChBa**	Chorokhi Outflow	- Agricultural runoff pollution - Waste and wastewater form riverine sources	- Achieve good ecological and chemical status	- NMES&AP implementation - Monitoring nutrient loads - Monitoring Chorokhi discharge - Modelling water quality and quantity in the Chorokhi catchment	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Rural latrines and septic systems guideline
CW111_ChBaC **CW212_ChBa**	Adlia-Batumi	- Beach litter	- Achieve good ecological and chemical status - Beach litter under control	- NMES&AP implementation - Latrines and septic systems scheme for not connected households - Inventory of all non-point sources of pollution - Beach litter monitoring and clean-ups	- NMES&AP approval - Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Rural latrines and septic systems guideline
CW211_BaHa **CW221_BaKo**	Batumi Bay	- Diffused oil pollution from contaminated soil and ground	- Groundwater protection and remediation	- NMES&AP implementation - Oil polluted groundwater and soil remediation feasibility study - Oil pipeline removal feasibility and EIA study (landward/seaward) - Oil pipeline sound deoiling, removal and remediation works - Monitoring oil in streams	- Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Implement independent remote sensing monitoring of oil spills (e.g. ESA's Sentinels)
CW221_BaKo	Batumi-Makhinjauri	- Diffused oil pollution from contaminated soil - Agricultural runoff pollution - Waste and wastewater form riverine sources - Beach litter	- Achieve good ecological and chemical status - Beach litter under control	- Latrines and septic systems scheme for not connected households - Inventory of all non-point sources of pollution - Beach litter monitoring and clean-ups - Monitoring nutrient loads - Monitoring oil in streams - Monitoring Korolistskali and other stream discharges - Modelling water quality & quantity in Korolistskali, other catchments	- NMES&AP approval - Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs
CW211_KoTs	Makhinjauri-Tsikhisdziri	- Waste and wastewater form diffused and riverine sources - Beach litter	- Achieve good ecological and chemical status - Beach litter under control	- Latrines and septic systems scheme for not connected or rural households - Inventory of all non-point sources of pollution - Monitoring nutrient loads - Monitoring Chakvistskali and other stream discharges - Modelling water quality and quantity in the Chakvistskali and other small catchments - Beach litter monitoring and clean-ups	- NMES&AP approval - Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Rural latrines and septic systems guideline
CW221_TsKb	Tsikhisdziri-Kobuleti	- Waste and wastewater form riverine sources - Beach litter	- Achieve good ecological and chemical status - Beach litter under control	- Latrines and septic systems scheme for not connected households - Inventory of all non-point sources of pollution - Beach litter monitoring and clean-ups - Monitoring nutrient loads - Monitoring Kintrishi and other stream discharges - Modelling water quality and quantity in the Kintrishi catchment - Modelling water quality and quantity in the Kintrishi and other small catchments	- NMES&AP approval - Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Rural latrines and septic systems guideline

CWB #	Location	Status	Objective	Basic measures	Supplementary measures
Hydromorphological and Biological Pressures					
CW222_SaCh	Sarpi-Kvariati	- Coastal works implemented without EIA - Loss of coastal resources/habitat	- Achieve good ecological and chemical status	- NMES&AP implementation - Implement mitigation measures to reduce residual impacts of coastal works - Shoreline management plan - Monitoring coastal dynamics	- NMES&AP approval - List coastal and marine works as mandatory in new EIA law - Establish coastal setback
CW222_SaCh	Kvariati-Gonio	- Major beach promenade implemented without EIA/EMP - Plans to continue with promenade, - Major tourism development plans in Chorokhi Delta	- Achieve good ecological and chemical status - Protect and restore coastal and wetland habitats and resources	- NMES&AP implementation - Implement mitigation measures to reduce residual impacts of beach promenade - Shoreline management plan - Restore water systems behind the dune/beach system combined with constructed wetlands and public education function - Establish protected area in Chorokhi Delta - Upgrade and approve management plan for Chorokhi Delta wetlands	- List coastal and marine works as mandatory in new EIA law - Establish coastal setback - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Adopt legislation on Chorokhi Delta PA - Feasibility of GE-TR joint tans-boundary MPA in East Black Sea to manage fisheries - Monitoring programme for CWBs & TWBs
CW111_ChBaC **CW212_ChBa**	Chorokhi Outflow	- Sediment load deficit due to HPPs - Aggregate extraction	- To be further determined through SMP - Achieve good ecological and chemical status - Restore ecosystem resilience in Chorokhi Delta (on both left and right shorelines)	- NMES&AP implementation - Shoreline management plan - Monitoring sediment loads - Monitoring Chorokhi discharge rates (daily) - Modelling sediment loads from Chorokhi catchment - Ecosystem based management study to restore and enhance coastal resilience in Chorokhi Delta - Monitoring coastal dynamics	- Revisit agreements with TR on HPP impacts/mitigations - Georgia to join ESPOO - Modify Batumi Master Plan taking account of ecosystem approaches for wider Chorokhi Delta (both banks) - Establish coastal setback - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Regulate aggregate extraction - Monitoring programme for CWBs & TWBs
CW111_ChBaC **CW212_ChBa**	Adlia-Batumi	- Sediment load deficit due to HPPs - Major road and promenade implemented without EIA/EMP - Coastal works implemented without EIA - Coastal development pressures - Regular floods in major urban areas	- To be further determined through SMP - Achieve good ecological and chemical status - Restore coastal resilience in Adlia-Batumi section of the coast - Prevent further encroachment of Batumi urban development - Reduce flood impacts combined with enhancement of green areas and urban biodiversity	- NMES&AP implementation - Shoreline management plan - Ecosystem based management study to restore and enhance coastal resilience in Chorokhi Delta and Adlia-Batumi section of the coast - Monitoring sediment loads - Monitoring Chorokhi discharge rates (daily) - Modelling sediment loads from Chorokhi catchment - Monitoring coastal dynamics - Design and piloting innovative green urban storm-water management scheme such as Sustainable Drainage Systems (SuDS) and other Nature Based Solutions (NBS)	- NMES&AP approval - Establish coastal setback - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Modify Batumi Master Plan taking account of ecosystem approaches for wider Chorokhi Delta (south Batumi shoreline in particular) and to limit urban encroachment - Regulate aggregate extraction - Monitoring programme for CWBs & TWBs - Feasibility of GE-TR joint tans-boundary MPA in East Black Sea to manage fisheries

CWB #	Location	Status	Objective	Basic measures	Supplementary measures
CW211_BaHa **CW221_BaKo**	Batumi Bay	- Impact of port facilities on coastal dynamics - See level rise	- To be determined through SMP - Achieve good ecological and chemical status	- NMES&AP implementation - Shoreline management plan - Monitoring coastal dynamics - Monitoring impacts of port maintenance and operations	- NMES&AP approval - Establish coastal setback - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Monitoring programme for CWBs & TWBs
CW221_BaKo	Batumi-Makhinjauri	- Impact of port facilities on coastal dynamics - See level rise - Fisheries port constructed without EIA	- To be determined through SMP - Achieve good ecological and chemical status	- NMES&AP implementation - Shoreline management plan - Monitoring coastal dynamics - Monitoring impacts of port maintenance and operations on coastline stability - Review mitigation measures of fisheries port and mitigate impacts to residual level	- NMES&AP approval - List coastal and marine works as mandatory in new EIA law - Establish coastal setback - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Monitoring programme for CWBs & TWBs
CW211_KoTs	Makhinjauri-Tsikhisdziri	- Poorly planned road and railroad infrastructure in need of coastal protection	- To be further determined through SMP - Achieve good ecological and chemical status	- NMES&AP implementation - Shoreline management plan - Monitoring impacts of coast protection maintenance and operation works - Monitoring coastal dynamics	- NMES&AP approval - Establish coastal setback - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Monitoring programme for CWBs & TWBs
CW221_TsKb	Tsikhisdziri-Kobuleti	- Impact of erosion on major settlement and its tourism facilities - Draining of wetland and rapid discharge of drained waters increasing flood risks and pollution - Regular floods in major urban areas - Waste and wastewater form riverine sources - Beach litter - Alteration of river Kintrishi mouth morphology	- To be further determined through SMP - Achieve good ecological and chemical status - Reduce flood impacts combined with enhancement of green areas and urban biodiversity - Beach litter under control	- NMES&AP implementation - Shoreline management plan - Monitoring impacts of coast protection maintenance and operation works - Monitoring coastal dynamics - Piloting wet agriculture and wet forestry schemes in drained areas in Kobuleti protected wetland buffer zone (e.g. peat supplements from sphagnum, palettes biomass and insulation from reed/sedge) - Replicate and implement green urban storm-water management scheme such as Sustainable Drainage Systems (SuDS) and other Nature Based Solutions (NBS) - Ecosystem based management study to restore and enhance coastal resilience in Kintrishi Mouth - Monitoring coastal dynamics	- NMES&AP approval - Establish coastal setback (including for the protection of remaining natural dunes) - Modify Kobuleti Land Use Plan taking account of coastal erosion, establish setback and plan for organised retreat of urban development along coastline - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Monitoring programme for CWBs & TWBs - Implement provisions of Kobuleti wetland protected areas management plan

Table 4.2 PoM for TWB

TWB #	Location	Status	Objective	Basic measures	Supplementary measures
			Point Source Pollution		
TW11_Ch	Chorokhi Mouth	- Batumi landfill leachate pollution	- Achieve good ecological and chemical status	- NMES&AP implementation - Chorokhi and sea water monitoring on hazardous chemicals - Batumi landfill remediation feasibility - Completion of new municipal landfill in Tsetskhlauri	- NMES&AP approval - Batumi SWMP - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs
			Diffuse source pollution		
TW11_Ch	Chorokhi Mouth	- Agricultural runoff pollution - Waste and wastewater form riverine sources	- Achieve good ecological and chemical status	- NMES&AP implementation - Shoreline management plan - Monitoring nutrient loads - Monitoring Chorokhi discharge rates (daily) - Modelling water quality and quantity in Chorokhi catchment	- NMES&AP approval - Ajara wastewater strategy - Ajara illegal waste dumps location study - Monitoring programme for CWBs & TWBs - Rural latrines and septic systems guideline
			Hydromorphological and Biological Pressures		
TW11_Ch	Chorokhi Mouth	- Alteration of river mouth morphology	- To be further determined through SMP - Restore ecosystem resilience in Chorokhi Mouth	- NMES&AP implementation - Shoreline management plan - Monitoring sediment loads - Monitoring Chorokhi discharge rates (daily) - Modelling sediment loads from Chorokhi catchment - Ecosystem based management study to restore and enhance coastal resilience in Chorokhi Delta - Monitoring coastal dynamics	- NMES&AP approval - Modify Batumi Master Plan taking account of ecosystem approaches for wider Chorokhi Delta (both bank-side shorelines) - ICZM strategy approval - ICZM law adoption - ICZM plan for Ajara coast - Monitoring programme for CWBs & TWBs

Table 4.3 Ranking, prioritization of measures and responsible parties for Coastal and Transitional Waters in Chorokhi-Ajaristskali Basin District

#	Measures	Ecological effectiveness	Time for achieving ecological effect	Direct investment costs (Euro)	Operation and maintenance/ administration costs (annual)	Indirect costs	Rank	Priority	Responsible Party
01	Georgia to join ESPOO Convention	3	2	3	3	1	12	High	MEPA
02	Streamline coastal and marine works mandatory EIA in the Environmental Assessment Code	3	2	3	3	1	12	High	MEPA
03	Revisit agreements with TR on HPP impacts/mitigations	2	1	2	3	1	9	Medium	MoFA
04	Establish coastal setback	3	2	3	3	1	12	High	MRDI
05	Approve draft National Marine Environment Strategy and Action Programme (NMES&AP) of Georgia	3	2	2	3	1	11	High	MEPA
06	Implement National Marine Environment Strategy and Action Programme of Georgia measures	3	2	0	2	1	8	Low	MEPA
07	ICZM strategy approval	3	2	3	3	1	12	High	MEPA
08	ICZM law adoption	3	2	3	3	1	12	High	MEPA
09	ICZM plan for Ajara coast	3	1	1	2	1	8	Low	MRDI
10	Reduce and strictly regulate aggregate extraction to achieve environmental sustainability	3	2	3	3	1	12	High	MoESD MEFAjara
11	Feasibility of GE-TR joint trans-boundary MPA in East Black Sea to manage fisheries	3	1	1	2	1	8	Low	MEPA
12	Develop Ajara wastewater strategy	3	1	1	3	1	9	Medium	DoE Ajara
13	Ajara illegal waste dump locations and landfills optimisation study	3	1	1	3	1	9	Medium	DoE Ajara
14	Batumi landfill remediation feasibility and construction	3		0	2	2	7	Low	MDF
15	Assessment and options for dredge material disposal along the Black Sea coast of Georgia	3	1	1	3	1	9	Medium	MEPA
16	Monitoring programme for CWBs & TWBs	3	2	1	3	2	11	High	NEA

#	Measures	Ecological effectiveness	Time for achieving ecological effect	Direct investment costs (Euro)	Operation and maintenance/ administration costs (annual)	Indirect costs	Rank	Priority	Responsible Party
17	Batumi and Kobuleti landfill remediation feasibility study	3	2	1	3	2	11	High	DoE Ajara
18	Blue Flag award scheme for Ajara	3	1	1	2	2	9	Medium	DoT Ajara
19	Rural latrines and septic systems guideline	3	2	2	3	2	12	High	Batumi Water
20	Connect entire Batumi to its WWTP	3	2	0	2	2	9	Medium	Batumi Water
21	Connect fully to Batumi WWTP (Sarpi, Kvariati, Gonio, Makhinjauri)	3	2	0	2	2	9	Medium	Batumi Water
22	Kobuleti sewage network	3	2	0	2	2	9	Medium	MDF
23	Kobuleti WWTP completion	3	2	0	2	2	9	Medium	MDF
24	SWMP (Sarpi, Kvariati, Gonio, Batumi, Makhinjauri, Chakvi, Tsikhisdziri, Kobuleti)	3	2	1	3	2	12	High	DoE Ajara
25	Inventory of all point sources (Sarpi-Kvariati, Kvariati-Gonio, Adlia-Batumi, Makhinjauri-Tsikhisdziri)	3	2	2	3	2	12	High	DoE Ajara
26	Inventory of all non-point sources of pollution (Sarpi-Kvariati, Kvariati-Gonio, Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri)	3	2	2	3	2	12	High	DoE Ajara
27	Latrines and septic systems scheme for rural households (Sarpi-Kvariati, Kvariati- Gonio, Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)	3	1	0	2	1	7	Low	MoEF Ajara
28	Bathing water monitoring (Kvariati-Gonio, Adlia-Batumi, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)	3	1	2	3	2	11	Medium	DoE Ajara
29	Beach litter monitoring and clean-ups (Kvariati-Gonio, Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)	3	2	3	3	2	13	High	DoE Ajara
30	Monitoring oil in streams (Batumi Bay, Batumi-Makhinjauri)	3	2	2	3	2	12	High	DoE Ajara
31	Monitoring nutrient loads (Chorokhi, Korolistskali, Chakvistskali, Kintrishi and other streams along Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)	3	2	3	3	2	13	High	NEA
32	Monitoring daily discharge rates (Chorokhi, Korolistskali, Chakvistskali, Kintrishi and other streams)	2	2	2	3	2	11	High	NEA
33	Modelling water quality and quantity (Chorokhi, Korolistskali, Chakvistskali, Kintrishi and other small catchments)	2	2	2	3	2	12	High	NEA

#	Measures	Ecological effectiveness	Time for achieving ecological effect	Direct investment costs (Euro)	Operation and maintenance/ administration costs (annual)	Indirect costs	Rank	Priority	Responsible Party
34	Modelling sediment loads (Chorokhi catchment)	2	2	2	3	2	12	High	NEA
35	Chorokhi Mouth monitoring water on hazardous chemicals	3	2	1	3	2	11	High	NEA
36	Provide ports with waste and wastewater control and oily water separation facilities	3	1	1	3	2	10	Medium	Ports
37	Batumi ports implement oil spill contingency plans	3	1	2	3	2	11	High	Ports
38	Implement independent remote sensing monitoring of oil spills (ESA's Sentinels)	3	2	3	3	2	13	High	NEA
39	Batumi ports implement provisions of MARPOL and Bucharest Conventions	3	1	0	1	2	7	Low	Ports
40	Batumi Bay oil polluted groundwater and soil remediation feasibility study	3	1	1	3	2	10	Medium	DoE Ajara
41	Shoreline management plan (Sarpi-Kvariati, Kvariati- Gonio, Chorokhi Mouth, Adlia-Batumi, Batumi Bay, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)	3	2	1	2	2	10	Medium	DoE Ajara
42	Monitoring coastal dynamics (Sarpi-Kvariati, Chorokhi Mouth, Adlia-Batumi, Batumi Bay, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)	3	2	1	2	2	10	Medium	DoE Ajara
43	Sarpi-Kvariati mitigation measures to reduce residual impacts of coastal works	3	2	2	3	2	12	High	MDF
44	Kvariati-Gonio mitigation measures to reduce residual impacts of beach promenade	3	2	1	3	2	11	High	MDF
45	Kvariati-Gonio restore water systems behind the dune/beach system combined with constructed wetlands and public education function	3	1	1	2	2	9	Medium	MDF
46	Sustainable fisheries management plan and legal ban on bottom trawling	3	2	2	3	1	11	High	MEPA
47	Chorokhi Delta PA upgrade and approve management plan	3	2	2	3	2	12	High	APA
48	Chorokhi Delta establish protected area	3	2	0	2	2	9	Medium	APA
49	Chorokhi Delta and Adlia-Batumi ecosystem based management study to restore and enhance coastal resilience in this section of the coast. Similar studies for Kintrishi, other streams along coast.	3	2	2	2	2	11	High	DoE Ajara
50	Batumi Master Plan modification taking account of ecosystem approaches for wider Chorokhi Delta (both banks)	3	2	3	3	1	12	High	Batumi & MoESD

#	Measures	Ecological effectiveness	Time for achieving ecological effect	Direct investment costs (Euro)	Operation and maintenance/ administration costs (annual)	Indirect costs	Rank	Priority	Responsible Party
51	Kobuleti Land Use Plan modification taking account of coastal erosion, establish setback and plan for organised retreat of urban development along the coastline	3	2	3	3	1	12	High	Kobuleti & MoESD
52	Batumi and Kobuleti, design and piloting innovative green urban storm-water management scheme such as Sustainable Drainage Systems (SuDS) and other Nature Based Solutions (NBS)	3	1	1	3	2	11	High	Batumi & DoE
53	Monitoring impacts of maintenance and operation works on coastline stability (Batumi Bay, Makhinjauri-Tsikhisdziri and Tsikhisdziri-Kobuleti sections)	3	2	2	3	2	12	High	NEA
54	Kobuleti piloting wet agriculture (reed/sedge, sphagnum) and wet forestry schemes in drained areas	3	1	0	2	2	10	Medium	Kolkheti Fund
55	Kobuleti wetland protected areas management plan (updated) provisions implementation	3	1	0	3	2	11	High	Kolkheti Fund
56	Oil pipeline removal feasibility and EIA study (both landwards Bartskhana area & seawards port area)	3	2	2	3	2	12	High	DoE Ajara & Oil Terminal
57	Oil pipeline sound deoiling, removal and remediation works	3	2	0	3	2	10	High	DoE Ajara & Oil Terminal
58	Batumi ports to implement provisions of IMO Ballast Water Management (BWM) Convention	3	1	0	1	2	7	Low	MoESD (i) Ports (ii)
59	Completion and sound operation of new regional landfill in Tsetskhlauri	3	2	0	2	1	8	Medium	MoEF Ajara
60	Georgia to join Euro-Argo (https://www.euro-argo.eu) and to contribute into Black Sea monitoring with deployment of Argo floats	1	2	2	3	2	10	High	NEA

5 Monitoring Programme for coastal and transitional waters

Pressures

Coastal and Transitional Water Bodies

The following guidance excludes monitoring of pressures, concentrating on status only. However, monitoring of pressures, as discussed in Section 3.2.2 also needs to be covered. This includes river flows, concentrations and loads, activities (land and marine-based), meteorological conditions and coastal currents (where possible). Atmospheric deposition of pollutants, such as nitrate, should be assessed and as further information is gathered in the future (both for WFD and MSFD purposes), habitat mapping of transitional, coastal and "open sea" waters should be undertaken.[98]

Phytoplankton

Coastal Water Bodies

Because phytoplankton are usually not distributed homogeneously throughout the water column, a composite sample should be collected from throughout the euphotic zone. This is the near-surface layer in which annually there is sufficient light for plants to grow, i.e. where net photosynthesis is greater than net respiration over the course of a year (see **Water Transparency**, below). This can be collected using a garden hose pipe, with a weight (*ca*. 1 kg attached to one end). This is lowered over the side of the boat until the bottom end is at the depth where 1% of surface light Photosynthetically Active Radiation (PAR) is recorded. The top end of the hose is then clamped and the pipe withdrawn vertically from the water, taking care to spill as little water as possible from the bottom end of the tube as it leaves the water. The collected sample should then be emptied into a sample jar and sealed. Once in the laboratory, it should be analysed for:[99]

- Chlorophyll-a content
- Phytoplankton biomass and enumeration of individual species to determine community composition.
- Diatom: dinoflagellate biomass ratio (only autotrophic and mixotrophic taxa to be included)
- The proportion of microflagellates, euglenophyceae and cyanophyceae (MEC %) in the total number of phytoplankton. (This is not in the RBMP monitoring programme, but is used by Georgia as an indicator of status. However, since the information will already be available in the raw data, it should take little extra effort to calculate this.)

[98] Minimum required monitoring frequencies should be met for each parameter provided for in the WFD.
[99] Composite depth sampling is a transitional arrangement and ultimately for the WFD purposes sampling from standard oceanographic depths would be required (0.5; 5; 10; 20; 30; 50 m; …).

Phytoplankton should ideally by sampled on a monthly basis, but as an absolute minimum on a 3-monthly, seasonal basis. Care should be taken over the setting of quantitative thresholds where 3-monthly sampling is undertaken because of the very high variability encountered. Chlorophyll-a is used as a surrogate for total autotrophic phytoplankton biomass, but under ideal conditions phytoplankton numbers may increase 4-fold in a week and blooms can crash literally within a day. Consequently, over the course of a year, peak levels are typically about 3 times greater than mean levels.

Transitional Water Bodies
As for coastal bodies - one sample every month should be collected if possible, but once every 3 months as an absolute minimum; and analysed for the same parameters. However, samples should be collected from 1 m depth, and not from throughout the euphotic zone.

Benthic Macroinvertebrates

Coastal Water Bodies
Surface sediment samples should be collected using a van Veen grab. Such samples should be brought to the surface as slowly as possible to reduce the risk of “fines” (small particles) being washed out of the sample as it travels through the water column. Samples should be allowed to settle and care should be taken to remove overlying water before placing them into storage containers. In the laboratory, for each sample (1 per sampling site), mean and median particle size should be analysed, and a histogram of particle size distribution provided. Total Organic Carbon content (% dry weight) should also be analysed and reported.

Macrozoobenthos samples should be collected from coastal water sites, using a van Veen grab – 3 replicates per sampling station as a minimum, but ideally 5 replicates per water body. Analysis of samples should follow the procedure laid down in the Regional Black Sea monitoring manual, using the following metrics:

- Taxonomic identification to species level
- Enumeration (reported as № of each taxon/m^2)
- Wet weight per taxon

Results should be provided individually for each replicated and as means for each sampling site. Mean results should be expressed according to the macroinvertebrate index m-AMBI.

Sampling should be undertaken at least once every two years in each coastal water body, allowing a minimum of three sampling events per 6-year WFD/MSFD management cycle.

Transitional Water Bodies
As for coastal water bodies – one sampling site per water body – same metrics, same number of replicates and same sampling frequency.

Macrophytes

Coastal Water Bodies

Macrophyte sampling and analysis should focus on use of the EEI-c index. Further information is available from: http://www.eei.gr. This should be assessed once every two years, in summer/autumn at one site in each water body.

However, this monitoring should be supported in the future by the development of a methodology in which the depth of colonisation of an indicator species is recorded. Insufficient information is currently available on the status of macroalgae/seagrasses in Georgian waters to recommend an indicator species, but current Bulgarian monitoring of *Cystoseira* colonisation depth may be able to provide a basis for Georgian monitoring in the future.

As with macroinvertebrates, macrophyte monitoring should be undertaken on a two-yearly basis, at one site per coastal water body.

Transitional Water Bodies

Transitional Water Bodies tend to be relatively turbid and dynamic environments, but this is largely due to tidal influences which are absent in Georgian waters. Thus, the same macrophyte monitoring guidance as given above for coastal water bodies should be applied to transitional water bodies, i.e. one site per water body, assessed on a two-yearly basis.

Fisheries

Coastal and Transitional Water Bodies

The WFD requires fisheries monitoring in transitional waters, but not coastal waters. However, fisheries monitoring is required in all marine waters (including transitional) under the MSFD. Nevertheless, in line with the general guidance on fisheries monitoring for rivers undertaken in EPIRB pilot studies and the difficulties of obtaining representative (high precision) fisheries monitoring data, it is recommended that for WFD purposes, no fisheries status data is currently collected. However, as MSFD fisheries monitoring requirements are elaborated; this guidance will need to be reviewed.

Water Transparency

Coastal Water Bodies

The underwater light climate is essential to understanding macrophyte and phytoplankton density/distribution.

Water transparency to be monitored at one site in each coastal/transitional water body by:

- Secchi depth
- Euphotic Depth of 1% surface light penetration (photosynthetically active radiation = 400-700 nm wavelength; see “Phytoplankton”, above).
- Turbidity (NTU – Nephelometric Turbidity Unit)
- Suspended solids (mg/l)

Sampling should be undertaken at least quarterly and preferably monthly, whenever phytoplankton (including chlorophyll-a) monitoring is undertaken.

Transitional Water Bodies
The transparency monitoring guidance for coastal water bodies presented above should also be used for transitional water bodies. However, this may be too shallow to record.

Supporting physico-chemical data

Coastal Water Bodies
At each of the phytoplankton/macrozoobenthos sampling sites, surface water samples should be collected and analysed for the following parameters:

- Nitrate, nitrite and ammonium[100] (results summed to produce an estimation of dissolved inorganic nitrogen)
- Phosphate and total phosphorus.
- Salinity/conductivity. Conductivity values should be converted to salinity (g/l = ‰).

Dissolved oxygen (DO) and temperature should also be monitored at the same sites, but in near-bottom waters (1 m above sediment). Dissolved oxygen may be monitored *in situ* using a probe (sonde), cable and meter, or samples may be collected using a Niskin bottle for Winkler analysis in the laboratory (titration). Results should be presented both as percentage saturation and mg/l. DO should be monitored 2 times per year in summer and autumn.

In addition, a depth profile of temperature, dissolved oxygen (mg/l) and conductivity/salinity should be recorded in the Batumi Bay (water body CW221_BaKo), with measurements every 10 m (closer together through the thermocline/pycnocline) to a maximum depth of 150 m. This may be undertaken during either the summer or autumn DO coastal monitoring exercise.

Nutrients should be sampled on a seasonal (four times per year) basis, from just below the water surface and at standard oceanographic depths. Moreover, the analysis of total phosphorus should be included. [101]

Transitional water bodies
The same guidance given for routine monitoring water of nutrients, dissolved oxygen and salinity in coastal bodies should be applied to transitional water bodies. Salinity monitoring should be undertaken to determine transitional water body boundaries, but will fluctuate within the water bodies themselves, depending on river discharges.

Hazardous/Priority Substances

Coastal and transitional water bodies

[100] Nutrient monitoring of both rivers and nutrients may be undertaken in terms of bioavailable and total nutrient fractions. Both may be monitored, for different purposes. In rivers, modelling of nutrients is usually undertaken in terms of total nutrient concentrations and loads, and nutrient loads to the marine environment are usually assessed in terms of total loads. However, total nutrient concentrations are more expensive to analyse than bioavailable nutrient fractions.

[101] It is recommended Georgia to join Euro-Argo (https://www.euro-argo.eu) and to contribute into Black Sea monitoring with deployment of Argo floats.

A survey of the 45 heavy metal and organic pollutants listed in the EU Environmental Quality Standards Directive (2013/39/EU) should be undertaken, based on 5 sediment samples from each water body. Sediment acts as the memory of water bodies, and thus is a much more reliable indicator of historical presence than the overlying water. Based on this analysis, as well as the costs and abilities of Georgian laboratories, a list of sites, matrixes and determinands for future monitoring should be developed.

Nevertheless, as some organic compounds do not concentrate in sediments, analysis of water samples is still necessary.

Substrates

Coastal and transitional water bodies

To further develop the typology presented in this report in terms of habitat/sediment type, it will be necessary to undertake a comprehensive survey of sediment particle size and habitat type in all transitional coastal waters. In an around transitional waters, a sampling resolution of 500 m is recommended, with coastal water bodies monitored every kilometre along three lines 500, 1000 and 1500 metres from the shoreline (coastal water bodies extend out to 1 nautical mile [1852 metres]) from the shoreline. This kind of intensive survey will only be required once to develop the typology.

In addition, the average size of shoreline clay/sand/gravel/pebble/cobble substrates and width of beaches should also be measured for coastal defence/beach nutrition purposes – in high risk areas on an annual basis, but in lower risk areas this can be reduced substantially. The size and shape of water bodies should be assessed using satellite-derived remote sensing information to support the shoreline substrate data.

Hydromorphological monitoring is needed for the evaluation of the ecological status of water bodies, therefore it is included in the monitoring programme as well.

6 Competent Authorities for Coastal and Transitional Waters

In harmonisation with European Water Framework Directive requirements, below is provided information about the Competent Authority and other Coordinating Authorities within this river basin and in charge of addressing potential issues concerned with international river basins and coastal water bodies.

(i) Ministry of Environmental Protection and Agriculture (MEPA), represented by the Deputy Minister of Georgia in charge of environmental affairs, including coordination of Black Sea marine environment affairs, will act as coordinating and reporting Competent Authority for the coordination of the implementation of the Management Plan of the Chorokhi-Ajaristskali River Basin and its Coastal and Transitional Waters (the Plan).

(ii) MEPA's National Environmental Agency (NEA) and its Department of Fisheries, Aquaculture and Aquatic Biodiversity (DoFAAB) will act as the implementing agency providing MEPA with the spatial data infrastructure underpinning the Management Plan of Chorokhi-Ajaristskali River Basin and its Coastal and Transitional Waters.

(iii) Governmental decree establishing the Chorokhi-Ajaristskali River Basin Commission (the Commission), will define coordinating and implementation powers of the Competent Authority and will describe the functions of the Coordinating Authorities and other Members represented in the Commission, chaired by the Deputy Minister of MEPA.

(iv) MEPA's Environment and Climate Department will act as the secretariat to support MEPA's coordination and implementation functions. MEPA's Environmental Education and Information Centre will provide functions for public access to data and information on the activities affecting and the state of the environment in the Chorokhi-Ajaristskali River Basin and its Coastal and Transitional Waters.

(v) The following are proposed, *inter alia*, as the Competent and Coordinating Members of the Commission: MEPA as Competent Authority (chaired by Deputy Minister), authorised representatives from its NEA, DoFAAB, Agency of Protected Areas (APA) and competent representatives from the Ministry of Economy and Sustainable Development of Georgia (MoESD, e.g. maritime affairs), Ministry of Regional Development and Infrastructure of Georgia (MRDI, e.g. spatial planning and MDF), Ministry of Economy and Finance of Ajara AR, Department of Environment of Ajara AR, Batumi and Kobuleti City Halls, Ltd. Batumi Water and Ltd. Kobuleti Water, Ajara AR Water Alliance, Port Authority, Oil Terminal, Batumi State University, Black Sea Commission Member and all National Focal Points from Georgia, competent representative(s) from private and non-governmental organisations and the public.

(vi) International relationships, whenever the territory of one or more neighbouring states are concerned for any issues related with the Management Plan of Chorokhi-Ajaristskali River Basin and its Coastal and Transitional Waters would be addressed by MEPA within its competence and mandate of environmental protection and in full coordination with the Government of Georgia and the Ministry of Foreign Affairs of Georgia in particular. MEPA will tap on the international network of the Black Sea Commission and its subsidiary bodies (Black Sea Commission Members, Regional Activity Centres and National Focal Points) of Georgia and from countries signatories to the Bucharest Convention. MEPA would also be liaising with the European Commission on issues concerned with the harmonization of implementation with the requirements of the European Water Framework Directive.

Public Consultations

7 Stakeholder Consultation Report

This chapter reports on the main conclusions of the online stakeholder consultation meeting for the Chorokhi-Ajaristskali River Basin Management Plan: Coastal and Transitional Waters, carried out with key national stakeholders and those of the basin district on May 5, 2021. Full recording is available at https://youtu.be/ZJFygzbI90o.

Due to the COVID-19, a particular attention was given to online consultation (online questionnaire and mailing campaign). Organization of physical meeting with regional authorities could not be managed, respecting the sanitary conditions set out by the Georgian Government at that time. Therefore, the stakeholder consultation meeting with Chorokhi-Ajaristskali River Coastal and Transitional Waters was organized online.

Overall, 12 responses and 4 suggestions have been provided by stakeholders through online questionnaire (all positive, see further below) and 8 persons intervened during online meeting. REC Caucasus Georgia, consultant for the EUWI+ project conducted the consultation process and analysed the feedback received. Results of the consultation are to be taken into account in the final Chorokhi-Ajaristskali River Basin Management Plan: Coastal and Transitional Waters and during its implementation phase from 2022 to 2027.

Feedbacks received from online meeting and questionnaire are given in this report.

7.1 Context and objectives of public participation

General context

According to EU WFD requirements, and particularly Article 14, all stakeholders, such as NGO's, local communities and water supply enterprises, has to be involved in discussions leading to the formulation of the river basin management plan (RBMP) during its 3 phases of development: time table and work program, main issues, draft RBMP and programme of measures. From public information to active public participation, the required actions and targeted public are different.

Georgia signed an Association Agreement with the EU in and entered into force in July 2016. Its roadmap foresees to get closer to the EU acquis, including in water management. Concerning more specifically public information and participation in planning process, Georgia is party to the Aarhus convention (that came into force in 2001), one of the main international legal instruments to promote and implement citizens' right to have access to environmental information.

Access to information

Legal basis for access to information in Georgia is a constitutionally guaranteed right and is further elaborated by the General Administrative Code of Georgia in its Article 10-1: "Everyone may have access to public information available at the administrative body, as well as receive copies unless the information contains state, professional, or commercial secrets or personal data".[102]

Major holders of environmental information and water information in Georgia are the MEPA and Ministry of Health, and relevant state bodies in the water sector such as the National Environmental Agency (NEA). NGOs collect and disseminate this information, providing access to more comprehensive information for public: Caucasus Environmental NGO Network (CENN), NGO Green Alternative and the Regional Environmental Centre (REC) Caucasus in Georgia, the latter with a focus on water management and last but not least MEPA's Environmental Information and Education Centre (EIEC).

Public participation
Legal basis for public participation in Georgia can be found in the Law on Environmental Impact Permit which guarantees the public's right to participate in environmental decision-making on project as well as strategic levels. the procedure of public hearings is used, in which comments are solicited one the final plan or strategy has been developed among ministries. More formal procedures and institutional mechanisms for conducting public participation processes at earlier stages are gradually developing in the country.

Concerning public participation in water management, as there is currently no approved RBMP in Georgia, there is not yet an experience of an official consultation and approval process. Since several years, a Draft New Water Law is being developed which provisions aim to approximate with the EU acquis, including Water Framework Directive. The still ongoing revision of Georgia's water law will have very significant impacts on how water management is organized, including on how RBMP are being developed, taking into account public participation.

Objectives of public consultation
Objectives of stakeholder consultation for the development of Chorokhi-Ajaristskali River Basin Management Plan: Coastal and Transitional Waters draft version are as follows:

1. to involve as many representatives of civil society and local stakeholders as possible in the process of discussion the RBMP;

2. to inform the public on the RBMP, and more generally on water management and water status in the coastal and transitional waters of the basin.

The final draft of the RBMP elaborated in the framework of the EUWI+ project will then pass the official adoption procedure, led by the MEPA and all concerned ministries.

7.2 Summary of the meeting

The stakeholder consultation meeting on Chorokhi-Ajaristskali RBMP: Coastal and Transitional Waters in Georgia has gathered 39 participants including the representatives of beneficiary institutions, regional and local authorities, NGOs, main contractors in Georgia for RBMP development and EUWI+East representatives (s. List of Participants).

[102] https://matsne.gov.ge/en/document/view/16270?publication=33

Infographics on point source pollution, diffuse pollution and hydro-morphological pressures in the coastal and transitional waters of Chorokhi-Ajaristskali River Basin have been prepared and disseminated for the meeting, see digital link further below.

After welcoming speeches of Mr. Giorgi Surmanidze, the Minister of the Agriculture of the Autonomous Republic of Adjara, Ms. Nino Tandilashvili, Deputy Minister of Environmental Protection and Agriculture of Georgia and Mr. Alexander Zinke, EUWI+ Project Team Leader, Mr. Zurab Jincharadze introduced the meeting agenda, that was followed by the presentation of Mr. Yannick Pochon, EUWI + for Eastern Partnership/International Office of Water on WFD River Basin Management Planning process in general. Mr. Jincharadze also gave a short presentation on the frame of the EUWI + East project as regards the RBMP development under the Component 2 and 3 of the project in Georgia and the participatory and consultation approaches applied by the project.

Presentation session

The first session has then allowed to present the Chorokhi-Ajaristskali draft RBMP: Coastal and Transitional Waters, delivered by Mr. Mamuka Gvilava, team leader for REC Caucasus, covering the following topics:

- River and marine basins and coastal strategies, plans and initiatives of relevance;
- Water body pressure types;
- Coastal and Transitional Water Bodies within Chorokhi-Ajaristskali River Basin;
- Coastal and Transitional Water Bodies under the risk of non-point source pollution;
- Coastal and Transitional Water Bodies under the risk of point source pollution;
- Coastal and Transitional Water Bodies under the risk of hydro-morphological changes;
- Coastal and Transitional Water Bodies under the biological risk;
- Point sources of pollution;
- Non-point sources of pollution;
- Hydro-morphology;
- Biology;
- Programme of Measures;

The next presentation was given by Mr. Grozdan Kušpilić, EUWI+ CTW International Consultant on delineation of Coastal and Transitional Waters in Georgia:

- Delineation process;
- Delineation proposals;
- Obligatory and proposed typology factors for transitional and coastal waters;
- Typology factors for Georgian coastal waters;
- Identified water bodies in the pilot area;
- Monitoring and status assessment of the water bodies in the pilot area.

The final presentation was delivered by Ms. Sophiko Akhobadze, REC Caucasus Director, briefly described the communication campaign for the Chorockhi-Ajaristskali RBMP: Coastal and Transitional Waters:

- Consultation process overviews: 5 different stages of the campaign;
- Stakeholder identification and analysis;
- Identification and application of efficient ways of stakeholder participation;
- Provision of information in an easily understandable, popular language;
- Organization of consultation meetings with different stakeholders;
- Organization of Stakeholder Consultation Meeting.

Q&A session
After presentations, stakeholders were invited for Question and Answer (Q&A) session.

Ms. Nino Tandilashvili thanked all the presenters for very interesting presentations and noted that monitoring programme for coastal and transitional waters could be particularly useful of the of Environmental Pollution Monitoring department for planning a monitoring programme of the coastal and transitional waters of Georgia. Ms. Tandilashvili also mentioned that according to AA with EU, the country has taken the obligation to implement river basin management approach of the water resources from 2024 and even though the new draft law on water hasn't been adopted by the Parliament of Georgia yet, development of RBMPs in advance will significantly contribute to the transition process of the management system. She had two questions, the first referred to the prioritization of the PoM, and the latter was about whether the PoM of the Chorokhi-Ajaristskali RBMP: Coastal and Transitional Waters comply with the National Marine Environment Strategy and Action Programme of Georgia actions or not.

Mr. Zurab Jincharadze clarified that the monitoring programme for coastal and transitional waters is developed for the water bodies only within the pilot area of the task - the Chorokhi-Ajaristskali river basin, however, some preliminary delineation works have been conducted for other areas as well and it can serve as a good basis for detailed planning of the monitoring program for the entire coast within the new project. Mr. Jincharadze explained that the measures are divided into three categories, considering environmental, chemical, economic and other measures: high priority, medium priority and low priority. Mr. Jincharadze also added that detailed economic calculations haven't been done for the PoM due to limited financial resources and timeframe. Mr. Jincharadze also mentioned that the RBMP covers coastal and transitional bodies within Chorokhi-Ajaristskali River Basin, while the National Marine Environment Strategy and Action Programme of Georgia focuses of marine waters. Moreover, Water Framework Directive and Marine Strategy Framework Directive are sister directives and documents drafted under those directives would not be controversial.

Mr. Mamuka Gvilava confirmed that National Marine Environment Strategy and Action Programme of Georgia has been carefully reviewed during RBMP development process and the actions and proposed measures don't duplicate but rather strengthen each other. The draft NMES&AP was referenced at many occasions in the PoM of the plan, as the mechanism and modality of implementation of respective measures.

Ms. Marina Makarova thanked project team and international experts for development of the very important document. Ms. Makarova noted that she had read the document and provided written comments, which were taken into account. Ms. Makarova added that there are a lot of very interested problem analysis and proposed measures in the document that are relevant for other water bodies outside the Chorockhi-Ajaristskali RB, therefore a lot of information will be used in the development of the National Marine Environment Strategy and Action Programme of Georgia, which is being elaborated by the Ministry of Environmental Protection and Agriculture. Ms. Makarova also added that she found very useful the economic analysis for Alazani-Iori and Khrami-Debeda River Basins and hoped that such analyses would be conducted for the Chorokhi-Ajaristskali RB at the later stage. Ms. Makarova mentioned she assumes that the RBMPs for Chorokhi-Ajaristskali and for Chorokhi-Ajaristskali Coastal and Transitional waters will be unified and corresponding economic analysis will be provided in the framework of the future project.

Ms. Salome Dvali asked a question using the Zoom Chat regarding the measure "List coastal and marine works as mandatory in new EIA law", which is proposed as a priority measure according to the plan. She mentioned that the coastal works are subject to screening, which is followed by the decision of MEPA whether a specific activity is subject to EIA or not. Moreover, she added that the coastal works is listed in Annex II of the WFD. She asked why isn't it enough and why is the measure proposed as priority one.

Mr. Mamuka Gvilava explained that some coastal developers either do not understand or try to avoid screening procedure, even though their development is concerned with coastal modifications and maritime works, therefore project team suggested this measure to make requirements clearer and leave less opportunity for escaping law's requirements.

Mr. Ramaz Mikeladze mentioned that the support of international agencies is of vital importance for Georgia. With the support of international community Georgia has been able to upgrade the equipment and therefore improve the coastal monitoring of the Black Sea and measure much more components compared to the past. Mr. Ramaz Mikeladze mentioned, that with the support of European Union, Georgia has significant progress towards integrated water management. He also noted that EUWI+ Initiative has carried out immense amount of work for Georgia. Mr. Mikeladze expresses hope that the support will continue in the future as well and Georgia will be a good acceptor of the deliverables and that RBMPs will be implemented. Mr. Mikeladze commented on the measure related to establishment of protected area in Chorokhi-Delta and feasibility study of Georgia and Turkish transboundary Marine Protected Area in East Black Sea to manage fisheries, which he deemed not possible due to hydro-morphological changes of the Chorokhi river, there are a lot of HPPs on the river, therefore the river conditions are very changeable and technogenic, also the left bank of the Chorokhi river is industrial and touristic area will is planned for development in the future. Considering the aforementioned, Mr. Mikeladze expressed an opinion that establishment if protected area in that location would not make sense and serve the purpose, while Mr. Mikeladze agreed that constructed wetlands behind dune systems is a good idea. Another remark Mr. Mikeladze had referred to the fishing issue, which he believed was not stressed out enough in the document, especially considering the fact that the river basin is full of HPPs which has direct impact on fish. He noted that due to the vulnerability of fish biodiversity, as well as decreasing quantities more studies of the topic would be useful.

Mr. Mamuka Gvilava agreed with Mr. Mikeladze regarding modified hydro-morphological systems of the rivers, also about the huge problem of decreasing quantities of fish in the Black Sea, and explained that under the protected area no strict regulations are envisaged, but the measure was proposed more for protecting fish and starting negotiations with Turkey in the fishing direction, as not only Georgia but Turkey as well is fishing in the Georgian section of the Black Sea and some restrictions for both countries would be very beneficial for the fish stock recovery. Mr. Gvilava also agreed that there was not too much attention paid to fishery due to the lack of data, but he mentioned that in the monitoring programme study of fish resources is foreseen as delegated to NMES&AP (per MSFD). As for the tourism development in the Chorokhi left bank area, Mr. Gvilava noted, that the project team was aware of this possibility while proposing the measure, in order to ensure sustainable tourism development and avoid over-exploitation of the area. Moreover, Mr. Gvilava added that areas on the left bank of the Chorokhi river are part of Emerald Network and no human impact should disturb or violate site's habitats. In addition, tourism development in these areas should clearly be aware of severe long-term impacts of rise of sea level and coastal floods due to climate change.

Mr. Temur Bedinadze thanked the presenters for very interesting presentations and noted that he understands the desire to maintain the natural conditions of the beach, but on the shore on the right side of the Chorokhi Delta, at least up to the River Mejinistskali, is washed out by the sea, also part of the Batumi airport has been washed out by the sea in the past and also the fence of the WWTP. Mr. Bedinadze asked what was the solution in this case to keep the beach unmodified and also have the coastline protected.

Mr. Mamuka Gvilava explained that coastal works have to be carried out wherever necessary, for protection of the WWTP, for example. Mr. Gvilava noted that general solution of the problem is development of shoreline management plans, where all the activities related to the coastal protection would be described and planned in advance.

Ms. Marine Gvianidze added that coastal works have been conducted after construction of the WWTP which protects the shore from being washed out and not the plant is safe, which wasn't the case when it was constructed. Ms. Gvianidze added that the coastal works have been carried out by the MDF alongside the New Boulevard, which doesn't look nice but it definitely serves the purpose and protects the area of Batumi airport and the new Boulevard.

Ms. Irine Baramidze thanked the project team, international experts and EU for all the support provided, including expertise, conducted studies, created database and purchased equipment. Ms Baramidze provided her opinion when responding to online questionnaire, see further below, where feedback is provided on raised issues as well.

Ms. Marina Mgeladze also thanked project for immense amount of work conduced and a very interesting experience. Ms. Mgeladze noted that the proposed PoM is quite realistic and feasible. She added that the monitoring programme was renewed in 2020 and new stations provided for by the programme are already included in monitoring network.

7.2 Public consultation through questionnaires

Preparation and dissemination

A consultation questionnaire has been developed for reflecting broader public opinions on programme of measures proposed by the RBMP CTW. Questionnaires were made available online at https://arcg.is/1fX0GL and results shared at https://arcg.is/1mWr5H.

Questionnaire link was distributed through official emails to all the participants. Moreover, link have been shared to all the participants of the Stakeholder Consultation Meeting for Chorokhi-Ajaristskali RBMP: Coastal and Transitional waters, held online on May 5, 2021 via Zoom chat.

7.3 Lessons learnt from public consultation process

This stakeholder consultation meeting for the draft Chorokhi-Ajaristskali RBMP: Coastal and Transitional Waters has been significantly marked by the COVID situation in Georgia, to a more extent than for the Alazani-Iori, since it was not possible to organize a physical consultation meeting and was held through online platform Zoom.

For future consultation process in Georgia, it is important to note that a special attention should be given to these consultation meetings, that allow at the same time to raise awareness, knowledge on water issues, answer to questions directly. They are a good way to share viewpoints, to make water experts meet with local and regional authorities who will be responsible for the implementation of the RBMP, and to break the barriers, misunderstanding and share their views.

If time, pandemic situation and resources allow, it would be a good idea to organize a physical consultation meeting and also more consultation meetings in smaller groups, it allows discussions to be more honest and relaxed, and thus to get feedbacks as close as what groups or people think about the water issues, the measures and RBMP in general.

It would be good also to emphasize more on awareness-raising actions with different publics that are not direct stakeholders or members of the water sector (schoolchildren, families, young people, etc.).

7.4 Public information campaign

Objectives, materials and dissemination channels
The objective of the communication campaign was to provide more comprehensive information material on the RBMP for the public and arouse interest in public consultation. The following materials have been prepared:

A detailed infographic, summarizing proposed PoM was developed for dissemination.

CWT_infographics.pdf

Dissemination channels were REC-Caucasus website, where draft documents were published in Georgian and English
https://rec-caucasus.org/wp-content/uploads/2021/04/121.pdf
https://rec-caucasus.org/wp-content/uploads/2021/04/122.pdf
and
EUWI+ FB.

Outcomes and lessons learnt
This first attempt at a larger communication campaign around RBMP CTW consultation and water issues faced some challenges such as the difficulty to elaborate clear and free of scientific details material for the wider public. The cooperation between water and communication experts was required to produce infographic for visual summary of PoM.

The timeline to prepare and disseminate the material was also a little bit short, this process could gain in efficiency if started earlier in the plan development process.

Concerning the dissemination channels: the involvement of local, regional and national authorities to relay the main messages is key for the success of such campaign and should be fostered.

7.5 Disposition of comments

Date of comment	Reception mode (meeting, letter, email, questionnaire, etc.)	Organisation/ institution	Sub-basin, province, district, etc.	Comments, observations, opinions	RBMP CTW chapter concerned	Treatment of the comment
05.05.2021	Stakeholder Consultation meeting	MEPA	Chorokhi-Ajaristskali Coastal and Transitional Waters	PoM of the Chorokhi-Ajaristskali RBMP: Coastal and Transitional Waters should comply with the National Marine Environment Strategy and Action Programme of Georgia actions	Programme of Measures (PoM)	The PoM is completely harmonized with the NMES&AP
05.05.2021	Stakeholder Consultation meeting	MEPA	Chorokhi-Ajaristskali Coastal and Transitional Waters	Chorokhi-Ajaristskali River Basin Management Plan should be renewed and unified with the RBMP of Chorokhi-Ajaristskali coastal and transitional waters	Entire document	Most probably the future project will try to do it in the future. Unfortunately, within the present project it was impossible due to the limited financial resources and time.
05.05.2021	Stakeholder Consultation meeting	MEPA	Chorokhi-Ajaristskali Coastal and Transitional Waters	Economic analysis for the proposed PoM in the Chorokhi-Ajaristskali RBMP: Coastal and Transitional Waters should be also developed in the future.	Economic analysis	Most probably the future project will try to do it in the future. Unfortunately, within the present project it was impossible due to the limited financial resources and time.
05.05.2021	Stakeholder Consultation meeting	MEPA	Chorokhi-Ajaristskali Coastal and Transitional Waters	Why was “List coastal and marine works as mandatory in new EIA law “proposed as priority measures the coastal works are subject to screening and final decision is upon MEPA whether a specific activity is subject to EIA or not, and also the coastal works is listed in Annex II of the WFD.	PoM	Some coastal developers either do not understand or try to avoid screening procedure, even though their development is concerned with coastal modifications and maritime works, therefore project team suggested this measure to make requirements clearer and leave less opportunity for escaping requirements of the law.

05.05.2021	Stakeholder Consultation meeting	Association Flora and Fauna	Chorokhi-Ajaristskali Coastal and Transitional Waters	Establishment of protected area in Chorokhi-Delta and feasibility study of Georgia and Turkish transboundary Marine Protected Area in East Black Sea to manage fisheries isn't quite reasonable as there are a lot of HPPs on the Chorokhi river, therefore the river conditions are very changeable and technogenic, also the left bank of the Chorokhi river is industrial and touristic area is to be developed in future.	PoM	Under the protected area no strict regulations are envisaged but the measure aims at protecting fish and starting negotiations with Turkey on fishing topic to support fish stock recovery. The project team was aware of the tourism development possibility while proposing the measure, in order to ensure sustainable tourism development and avoid over-exploitation of the area. Moreover, some areas on the left bank of the Chorokhi river are part of Emerald Network and no human impact should disturb or violate site's habitats. In addition, tourism development in these areas should clearly be aware of severe long-term impacts of rise of sea level and coastal floods due to climate change.
05.05.2021	Stakeholder Consultation meeting	Association Flora and Fauna	Chorokhi-Ajaristskali Coastal and Transitional Waters	Need for more data on fish species and fisheries was not stressed out enough in the document		There was not too much attention paid to fishery due to the lack of data and lack of time and financial resources to conduct appropriate studies, however, in the monitoring programme, the study of fish resources is foreseen. In the monitoring programme study of fish resources is foreseen as delegated to NMES&AP/MSFD.
30.04.2021	Stakeholder Consultation meeting	Association Mtabari	Chorokhi-Ajaristskali CTW	Suggestions on species and data sources. Riverbank protection suggested as pressure type.	Baseline studies, pressures	Suggestions and comments accepted

7.6 Agenda

Agenda of the Consultation Meeting with Stakeholders
Development of Draft River Basin Management Plan for the
Chorokhi-Ajaristskali River Basin of Georgia: Costal and Transitional Waters
Online Meeting via Zoom: https://us02web.zoom.us/j/85474680482

5 May 2021

TIME	AGENDA ITEM	SPEAKERS
11:00 - 11:15	**Opening Remarks** • Welcoming speeches	Ms. Nino Tandilashvili - Deputy Minister, MEPA Georgia Mr. Giorgi Surmanidze, Minister of Agriculture of Adjara AR Mr. Alexander Zinke - EUWI+ Project Team Leader
11:15 - 11:30	**Introduction of the meeting** • Introduction of the meeting objectives and agenda • WFD River Basin Management Planning process • Project preconditions and main results in Georgia	Mr. Zurab Jincharadze - EUWI+ representative in Georgia Mr. Yannick Pochon - Project Manager, IOW Mr. Zurab Jincharadze - EUWI+ representative in Georgia
11:30 -12:20	**Presentations** • Chorokhi-Ajaristskali RBMP: Coastal & Transitional Waters • Coastal and transitional water bodies and survey results • Communication campaign during development of RBMPs	Mr. Mamuka Gvilava -Team Leader, REC Caucasus Mr. Grozdan Kušpilić - EUWI+ CTW International Consultant Ms. Sophiko Akhobadze - Director of REC Caucasus
12:20 -12:50	**Feedback from key beneficiaries**	MEPA, NEA, Ajara DENR, etc.
12:50 - 13:10	**Discussion Session on Programme of Measures**	All participants
13:10 - 13:15	**Summary of the discussion and closure of the meeting**	Mr. Zurab Jincharadze - EUWI+ representative in Georgia Ms. Sophiko Akhobadze - Director of REC Caucasus

7.7 List of participants

Consultation Meeting with Stakeholders on River Basin Management Plan
for Chorokhi-Ajaristskali River Basin of Georgia:
Costal and Transitional Waters
Date: May 5, 2021

N	Name	Gender (M/F)	Organization, position	Contact Information
1.	Ms. Nino Tandilashvili	F	Deputy Minister of Environmental Protection and Agriculture of Georgia	info@mepa.gov.ge
2.	Ms. Marine Gvianidze	F	Head of Finance - Budgeting and Economic issues Committee, the Supreme Council of the Autonomous Republic of Adjara	+ 995 599 28 10 91 marika.gv@gmail.com
3.	Mr. Giorgi Surmanidze	M	Minister of the Agriculture of the Autonomous Republic of Adjara	+995 591 60 17 17 gsurmanidze@gmail.com
4.	Mr. Vakhtang Tsuladze	M	First Deputy Minister of the Agriculture of the Autonomous Republic of Adjara	+995 593 75 01 55 v.tsuladze@moa.ge
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11.	Ms. Ema Barkalaia	F	Senior Specialist at Integrated Environmental Control Service, Environmental Supervision Department, MEPA	+995 595 000 084 emmabarkalaia@gmail.com

12.	Ms. Marina Arabidze	F	Head of Environmental Pollution Monitoring Department, National Environmental Agency	+995 599 699 603 arabidzemarine0@gmail.com
13.	Mr. Ioseb Kinkladze	M	Deputy Head of Hydrometeorology Department, NEA	+995 599 525 178 ioseb.kinkladze@gmail.com
14.	Ms. Etuna Lomadze	F	Head of Municipal Policy Division, Batumi City Hall	+995 577 20 11 70 etu.lomadze@gmail.com
15.	Mr. Mirian Katamadze	M	Kobuleti Municipality Mayor	+995 577 30 24 40 mirokatamadze@gmail.com
16.	Mr. Jumber Vardmanidze	M	Khelvachauri Municipality Mayor	+995 599 26 64 41 j.vardmanidze@gmail.com
17.	Mr. Jambul Nakashidze	M	Head of Environmental Protection Division, Ministry of Agriculture of Autonomous Republic of Adjara	+995 591 19 81 11 jambuli.nakashidze@gmail.com
18.	Ms. Marika Mgeladze	F	Acting Head of Fishery Aquaculture and Water Biodiversity Department, National Environmental Agency	+995 591 40 40 24 mari.mgeladze@gmail.com
19.	Ms. Irine Baramidze	F	Chief Specialist at Ambient Air, Water and Soil Analysis Batumi Laboratory, National Environmental Agency	+995 557 56 40 40 irine.baramidze@gmail.com
20.	Mr. Irakli Chavchanidze	M	Convention on the Protection of the Black Sea against Pollution	+995 595 00 07 07 i.chavchanidze@gmail.com
21.	Mr. Zaza Varshalomidze	M	Operational Director Batumi Sea Port	+995 577 53 36 36 varshalomidzez@batumiport.com
22.	Mr. Tengiz Gordeladze	M	Environmental Manager at “Batumi Oil Terminal” Ltd	+995 577 20 26 54 gordeladzet@batumioilterminal.com
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24.	Mr. Davit Oragvelidze	M	Head of Sewerage Division, “Batumi Water” Ltd	+995 595 00 90 84 oragvelidze7474@mail.ru
25.	Mr. Temur Bedinadze	M	Director of “Adjara Water Alliance“ Ltd	+995 591 51 11 15 info@awa.ge
26.	Mr. Nodar Kontselidze	M	Director of “Adjara Waste Management Company” Ltd	+995 577 23 22 27 nkoncelidze@yahoo.com
27.	Ms. Tinatin Zoidze	F	Department of Tourism and Resorts of Ajara Autonomous Republic	+995 577 40 41 97 zoidze.tinatin@gmail.com

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29.	Mr. Archil Guchmanidze	M	Head, Association Flora and Fauna	guchmanidze@gmail.com
30.	Ms. Gulo Surmanidze	F	Project Manager, Black Sea Eco-Academy	+995 593 58 56 28 s_gulo@yahoo.com
31.	Mr. Nodar Tsintsadze	M	Regional Director in Adjara, Greens Movement of Georgia	+995 591 31 57 77 endemgroup@gmail.com
32.	Ms. Izolda Matchutadze	F	Professor, Batumi Shota Rustaveli State University	+995 593 303 957 izoldamatchutadze@bsu.edu.ge
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34.	Mr. Zurab Jincharadze	M	EUWI + for Eastern Partnership	+995 593 080 011 zurab.jincharadze@euwipluseast.eu
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36.	Ms. Sophiko Akhobadze	F	Director, REC Caucasus	+995 577 797 759 sophiko.akhobadze@rec-caucasus.org
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38.	Mr. Mikheil Kurdadze	M	Project Officer, REC Caucasus	+995 599 44 78 18 mikheil.kurdadze@rec-caucasus.org
39.	Ms. Keti Jibladze	F	Project Officer, REC Caucasus	+995 593 79 77 99 keti.jibladze@rec-caucasus.org
Total of women = 19 Total of men = 20 Total of participants = 39				

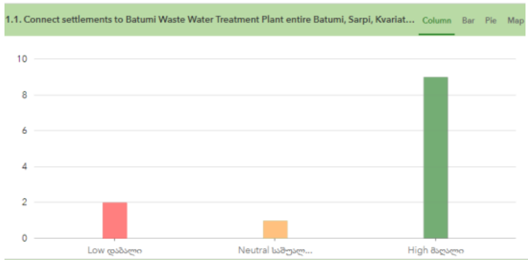
7.8 Responses to online questionnaire

Issue 1. Deterioration of water quality from point sources of pollution (discharge of untreated wastewaters, release solid wastes to river banks, etc.)

თემა 1. წყლის ხარისხის დეგრადაცია დაბინძურების წერტილოვანი წყაროებიდან (დაბინძურება საკანალიზაციო წყლებით, ნარჩენების მოხვედრა მდინარეებში და სხვა)

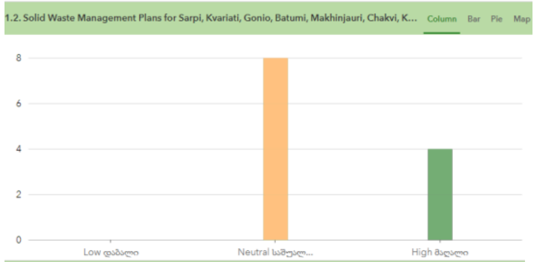
1.1. Connect settlements to Batumi Waste Water Treatment Plant entire Batumi, Sarpi, Kvariati, Gonio, Adlia, Makhinjauri

1.1. დასახლებების მიერთება ბათუმის გამწმენდ ნაგებობაზე: ბათუმი მთლიანად, სარფი, კვარიათი, გონიო, მახინჯაური



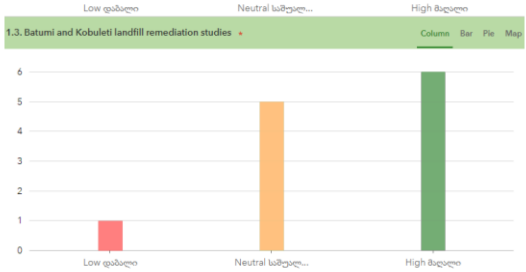
1.2. Solid Waste Management Plans for Sarpi, Kvariati, Gonio, Batumi, Makhinjauri, Chakvi, Kobuleti

1.2. ნარჩენების მართვის გეგმების მომზადება: სარფი, კვარიათი, გონიო, ბათუმი, მახინჯაური, ციხისძირი, ქობულეთი



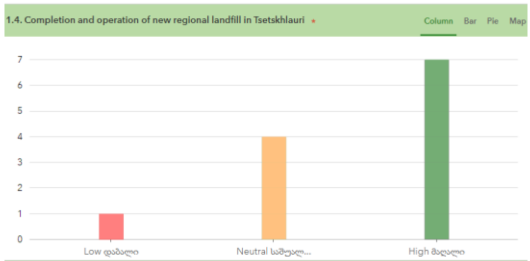
1.3. Batumi and Kobuleti landfill remediation studies

1.3. ბათუმისა და ქობულეთის ნაგავსაყრელების რემედიაციის კვლევა



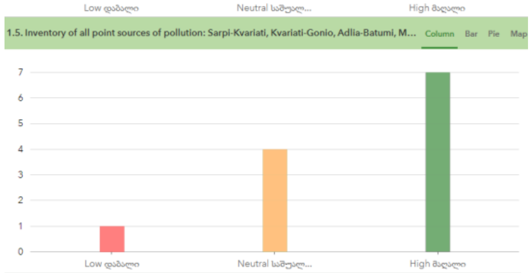
1.4. Completion and operation of new regional landfill in Tsetskhlauri

1.4. ცეცხლაურის ახალი რეგიონული ნაგავსაყრელის დასრულება და ოპერირება



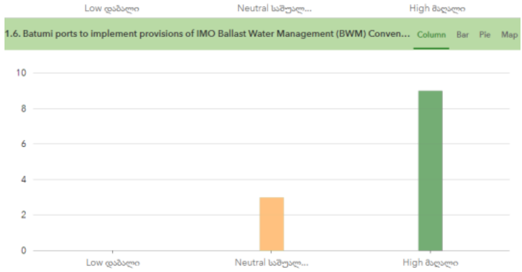
1.5. Inventory of all point sources of pollution: Sarpi-Kvariati, Kvariati-Gonio, Adlia-Batumi, Makhinjauri-Tsikhisdziri

1.5. დაბინძურების წერტილოვანი წყაროების სრული ინვენტარიზაცია: სარფი-კვარიათი, კვარიათი-გონიო, ადლია-ბათუმი, მახინჯაური-ციხისძირი



1.6. Batumi ports to implement provisions of IMO Ballast Water Management (BWM) Convention

1.6. ბათუმის პორტების მიერ საერთაშორისო საზღვაო ორგანიზაციის ბალასტური წყლების მართვის კონვენციის მოთხოვნების განხორციელება



Suggestions provided (Ms. Irina Baramidze)**:**

1) Raising public awareness (schools, media, eco-clubs) on the issue of environmental pollution with solid waste, including ways to reduce the amount of waste.
2) Increase the number of garbage containers in the river basin.
3) At the moment, the main emphasis (intellectual and financial) should be on small and medium rivers, the installation of floating litter traps on canals. Such traps would be the best solution for preventing marine pollution with solid waste. Their installation would radically changed the current situation.

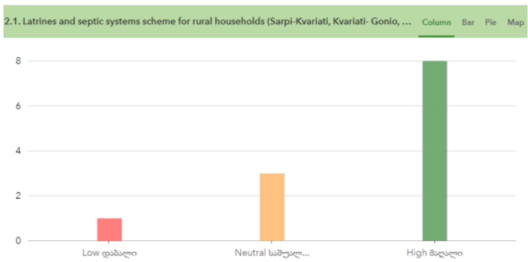
1) მოსახლეობის ცნობიერების ამაღლება (სკოლა, მედია, ეკოკლუბები) მყარი ნარჩენებით გარემოს დაბინძურების საკითხების თემატიკაზე მათ შორის ნარჩენების რაოდენობის შემცირების გზების თემაზე.
2) მდინარეთა წყალშემკრებ მაღალმთიან ზონაში ნაგვის კონტეინერების რიცხვის გაზრდა.
3) მოცემული მომენტისათვის მთავარი აქცენტები (ინტელექტუალური და ფინანსური) უნდა გაკეთდეს პატარა და საშუალო მდინარეებზე, არხებზე მექანიკური დამჭერების მონტაჟზე. ასეთი ცხაურები იქნებოდა საუკეთესო გადაწყვეტილება მყარი ნარჩენებით ზღვის დაბინძურების პრევენციისათვის. დამჭერების მონტაში კარდინალურად შეცვლიდა არსებულ სურათს.

Issue 2. Deterioration of water quality from diffuse source pollution (agriculture and other pressures such as illegal landfills)

თემა 2. ზედაპირული წყლების დაბინძურება დიფუზური წყაროებიდან (სოფლის მეურნეობა და სხვა ზეწოლები, როგორიცაა უკანონო ნაგავსაყრელები)

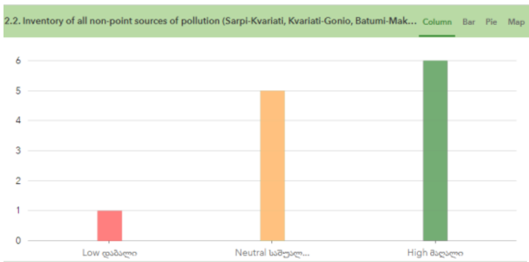
2.1. Latrines and septic systems scheme for rural households (Sarpi-Kvariati, Kvariati- Gonio, Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)

2.1. სეპტიკური სისტემების და საპირფარეშოების პროგრამა სოფლის დასახლებებისთვის (სარფი-კვარიათი, კვარიათი-გონიო, ბათუმი-მახინჯაური, მახინჯაური-ციხისძირი, ციხისძირი-ქობულეთი)



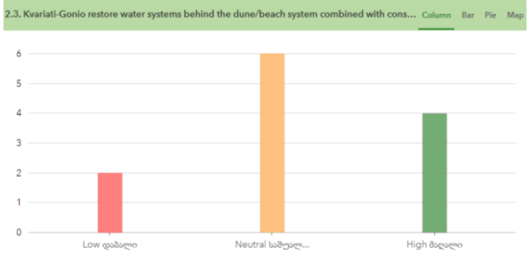
2.2. Inventory of all non-point sources of pollution (Sarpi-Kvariati, Kvariati-Gonio, Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri)

2.2. დაბინძურების არაწერტილოვანი წყაროების სრული ინვენტარიზაცია (სარფი-კვარიათი, კვარიათი-გონიო, ბათუმი-მახინჯაური, მახინჯაური-ციხისძირი)



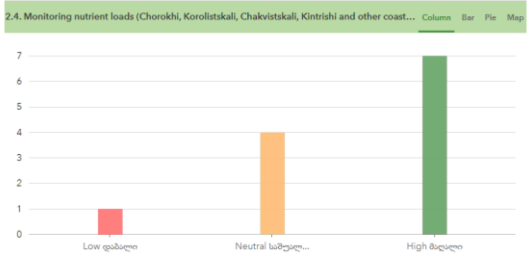
2.3. Kvariati-Gonio restore water systems behind the dune/beach system combined with constructed wetlands

2.3. კვარიათი-გონიოს მონაკვეთზე წყლის ეკოსისტემების აღდგენა დიუნის/პლიაჟის მხარეს, კომბინირებით ჭაობის ტიპის ბუნებრივ გამწმენდთან



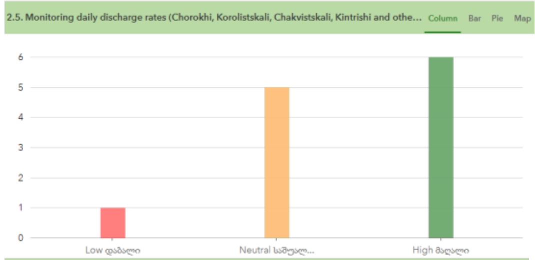
2.4. Monitoring nutrient loads (Chorokhi, Korolistskali, Chakvistskali, Kintrishi and other coastal streams)

2.4. ნუტრიენტების ნაკადის მონიტორინგი (ჭოროხი, ყოროლისწყალი, ჩაქვისწყალი, კინტრიში და ზღვის სხვა შენაკადები)



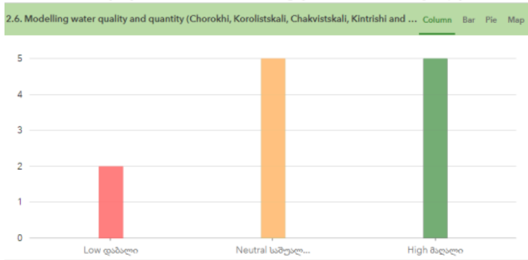
2.5. Monitoring daily discharge rates (Chorokhi, Korolistskali, Chakvistskali, Kintrishi and other streams)

2.5. დღიური ხარჯის მონიტორინგი (ჭოროხი, ყოროლისწყალი, ჩაქვისწყალი, კინტრიში, სხვა შენაკადები)



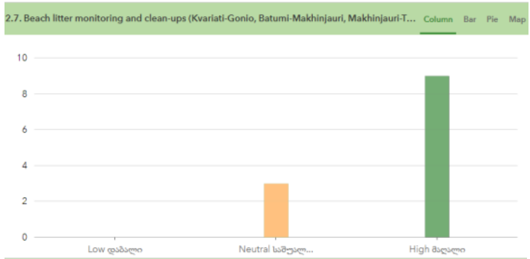
2.6. Modelling water quality and quantity (Chorokhi, Korolistskali, Chakvistskali, Kintrishi and other small catchments)

2.6. წყლის ხარჯის და ხარისხის მოდელირება (ჭოროხი, ყოროლისწყალი, ჩაქვისწყალი, კინტრიში და ზღვის სხვა შენაკადები)



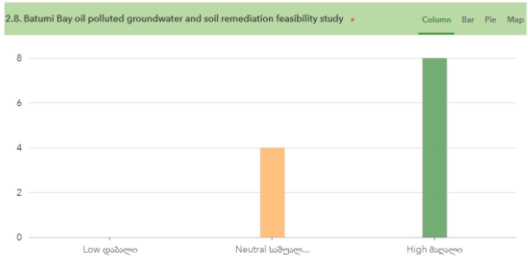
2.7. Beach litter monitoring and clean-ups (Kvariati-Gonio, Batumi-Makhinjauri, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)

2.7. პლიაჟის ნარჩენების მონიტორინგი და დასუფთავება (კვარიათი-გონიო, ბათუმი-მახინჯაური, მახინჯაური-ციხისძირი, ციხისძირი-ქობულეთი)



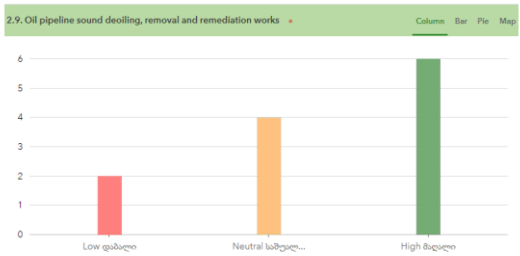
2.8. Batumi Bay oil polluted groundwater and soil remediation feasibility study

2.8. ბათუმის ყურის მონაკვეთზე ნავთობით დაბინძურებული გრუნტის წყლების და ნიადაგების რემედიაციის ტექნიკურ-ეკონომიკური დასაბუთება



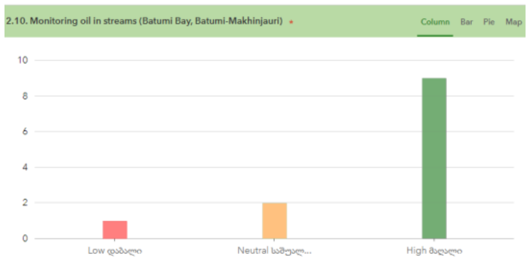
2.9. Oil pipeline sound deoiling, removal and remediation works

2.9. ნავთობის მილების ნავთობისგან გაწმენდა, ამოღება და აღდგენითი სამუშაოები



2.10. Monitoring oil in streams (Batumi Bay, Batumi-Makhinjauri)

2.10. ზღვის შენაკადების ნავთობით დაბინძურების მონიტორინგი (ბათუმის ყურე, ბათუმი-მახინჯაური)



Suggestions provided (Ms. Irina Baramidze)**:**

At the moment, unfortunately, the National Environment Agency is not capable to deal with oil sustances in the Black Sea rivers and sea water. As we have neither technical support for this at the Batumi laboratory (I represent this laboratory) nor enough staff. The purchase of a chromatograph, the provision of training and reagents, and the remuneration of one specialist would contribute into collection of this data during in the course of the project. I very much hope that such an important project will focus on these main problems.

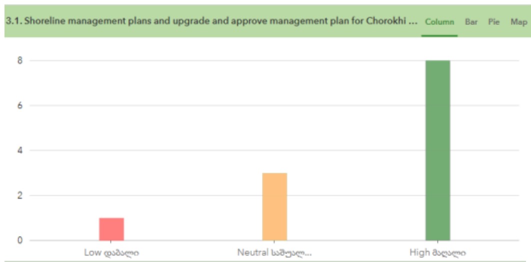
მოცემული მომენტისათვის სამწუხაროდ გარემოს ეროვნული სააგენტო ვერ ახორციელებს შავი ზღვის მდინარეებსა და ზღვის წყალში ნავთობპროდუქტების კონტროლს. ვინაიდან ამისათვის არც ტექნიკური მხარდაჭერა გვაქვს ბათუმის ლაბორატორიაში (თავად წარმოვადგენ ამ ლაბორატორიას) და არც საკმარისი პერსონალი. ერთი ქრომატოგრაფის შეძენა, ტრენინგითა და რეაქტივებით უზრუნველყოფა და ერთი სპეციალისტის შრომის ანაზღაურების უზრუნველყოფა პროექტის მიმდინარეობის პერიოდში საფუძველს ჩაუყრიდა მონაცემთა ბაზის გაუმჯობესებას. ძალიან დიდ იმედს ვიტოვებ, რომ ესოდენ მნიშვნელოვანი პროექტი გააკეთებს აქცენტებს მთავარ პრობლემებზე.

Issue 3. Addressing disturbance of hydro-morphological conditions

თემა 3. ჰიდრომორფოლოგიური ზემოქმედებების მართვა

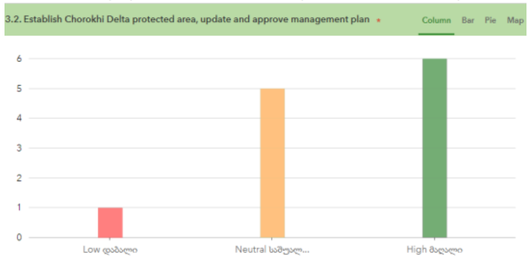
3.1. Shoreline management plans and upgrade and approve management plan for Chorokhi Delta wetlands

3.1. სანაპირო ზოლის მართვის გეგმა (სარფი-კვარიათი, კვარიათი-გონიო, ჭოროხის შესართავი, ადლია-ბათუმი, ბათუმის ყურე, მახინჯაური-ციხისძირი, ციხისძირი-ქობულეთი)



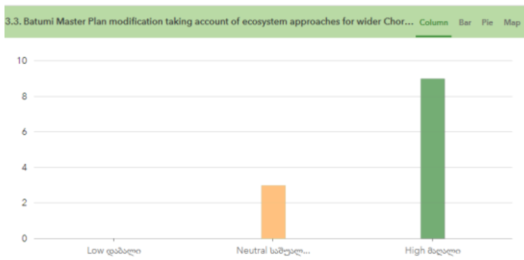
3.2. Establish Chorokhi Delta protected area, update and approve management plan

3.2. ჭოროხის დელტის დაცული ტერიტორიის დაარსება, მენეჯმენტის გეგმის განახლება და დამტკიცება



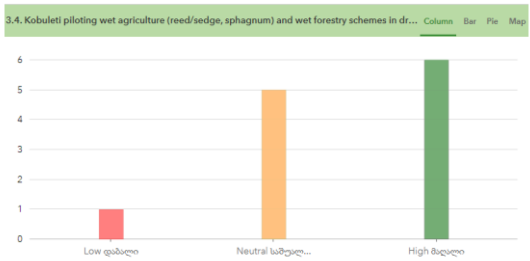
3.3. Batumi Master Plan modification taking account of ecosystem approaches for wider Chorokhi Delta (both banks)

3.3. ბათუმის გენგეგმის განახლება ჭოროხის დელტის მიმართ ეკოსისტემური მიდგომების ჩამოყალიბების უზრუნველსაყოფად (ორივე ნაპირი)



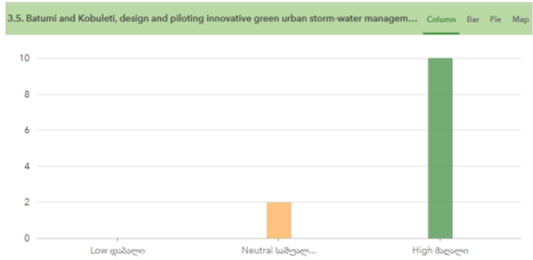
3.4. Kobuleti piloting wet agriculture (reed/sedge, sphagnum) and wet forestry schemes in drained areas

3.4. ჭარბტენიანი სოფლის მეურნეობის და ჭარბტენიანი მეტყევეობის სქემების დანერგვა დრენირებულ ტერიტორიებზე ქობულეთის დაცული ტერიტორიების ბუფერულ ზონაში



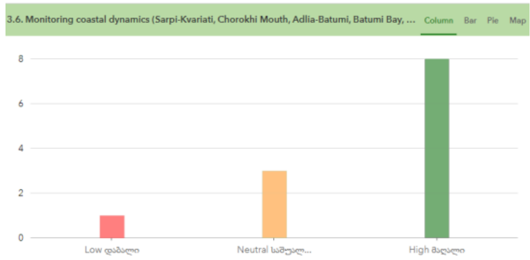
3.5. Batumi and Kobuleti, design and piloting innovative green urban storm-water management scheme such as Sustainable Drainage Systems (SuDS) and other Nature Based Solutions (NBS)

3.5. ბათუმის და ქობულეთის სანიაღვრე სისტემებისათვის მართვის ინოვაციური მწვანე სქემების დანერგვა (ე. წ. მდგრადი დრენაჟი, Sustainable Drainage Systems (SuDS) და ბუნებაზე დაფუძნებული სხვა მიდგომები)



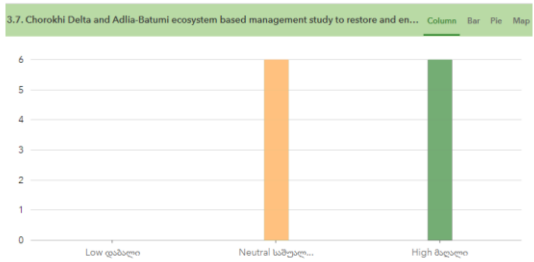
3.6. Monitoring coastal dynamics (Sarpi-Kvariati, Chorokhi Mouth, Adlia-Batumi, Batumi Bay, Makhinjauri-Tsikhisdziri, Tsikhisdziri-Kobuleti)

3.6. ნაპირების დინამიკის მონიტორინგი (სარფი-კვარიათი, ჭოროხის შესართავი, ადლია-ბათუმი, ბათუმის ყურე, მახინჯაური-ციხისძირი, ციხისძირი-ქობულეთი)



3.7. Chorokhi Delta and Adlia-Batumi ecosystem-based management study to restore and enhance coastal resilience in this section of the coast

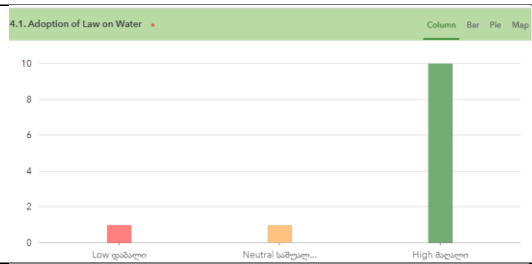
3.7. ეკოსისტემური მართვით ჭოროხის დელტის და ადლია-ბათუმის სანაპირო ზოლის მდგრადობისა და აღდგენის კვლევა



Issue 4. Water governance and integrated water resources management

თემა 4. წყლის მმართველობა და წყლის რესურსების ინტეგრირებული მართვა

<table>
<tr><td>4.1. Adoption of Law on Water

4.1. წყლის შესახებ კანონის მიღება</td><td>
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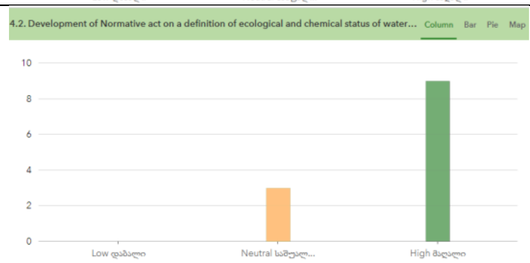
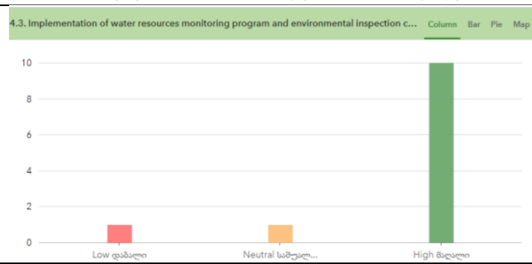
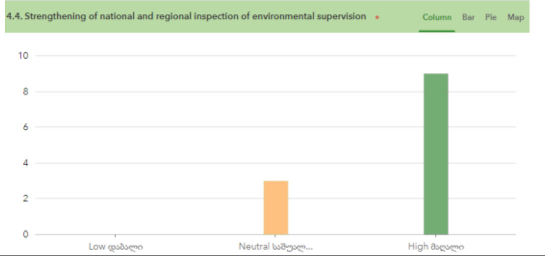
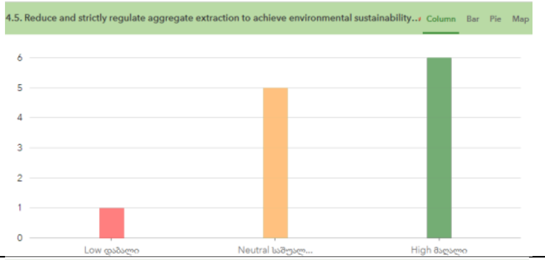
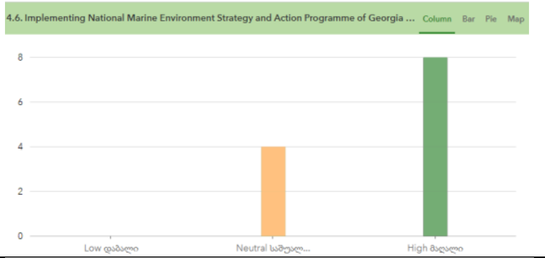
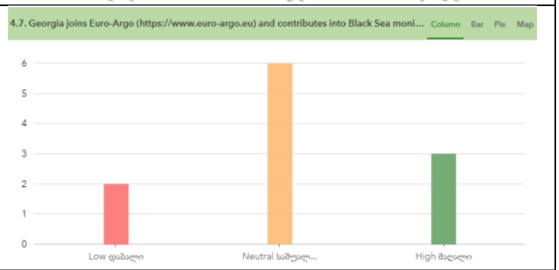
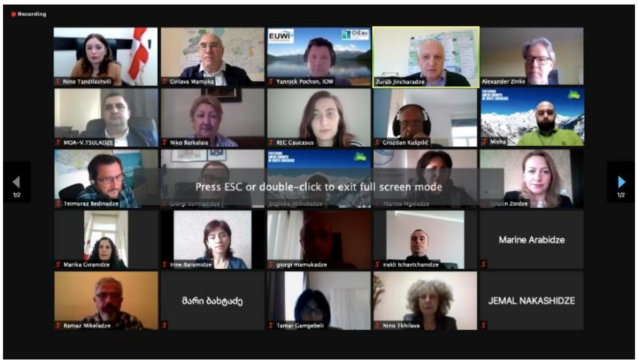
<tr><td>4.2. Development of Normative act on a definition of ecological and chemical status of water bodies

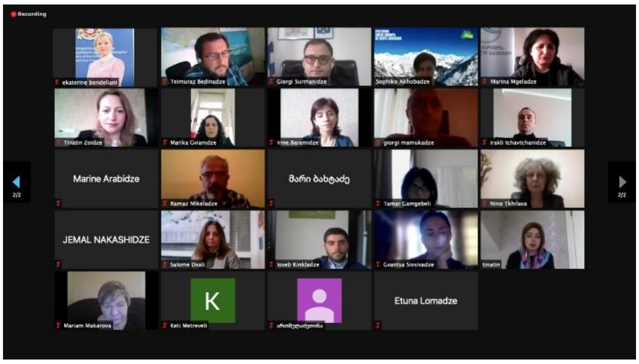
4.2. კანონქვემდებარე აქტის მიღება წყლის ობიექტების ეკოლოგიური და ქიმიური სტატუსის დასადგენად</td><td>
</td></tr>
<tr><td>4.3. Implementation of water resources monitoring program and environmental inspection controls

4.3. წყლის რესურსების მონიტორინგის და გარემოსდაცვითი ინსპექტირების პროგრამის დანერგვა</td><td>
</td></tr>
</table>

4.4. Strengthening of national and regional inspection of environmental supervision 4.4. გარემოსდაცვითი ზედამხედველობის ეროვნული და რეგიონული ინსპექციების შესაძლებლობების გაძლიერება	
4.5. Reduce and strictly regulate aggregate extraction to achieve environmental sustainability 4.5. ინერტული მასალების მოპოვების შემცირება და მკაცრად რეგულირება, გარემოსდაცვითი მდგრადობის მისაღწევად	
4.6. Implementing National Marine Environment Strategy and Action Programme of Georgia (NMES&AP) 4.6. საქართველოს საზღვაო გარემოსდაცვითი სტრატეგიის და სამოქმედო პროგრამის დამტკიცება	
4.7. Georgia joins Euro-Argo (https://www.euro-argo.eu) and contributes into Black Sea monitoring with deployment of Argo floats 4.7. საქართველო გაწევრიანდება "ევრო-არგო"-ში (https://www.euro-argo.eu) და წვლილს შეიტანს შავი ზღვის გარემოს მონიტორინგში "არგოს" ინსტრუმენტების გაშვებით	

7.9 Online stakeholder consultation meeting screenshots





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2. Clarification note in relation to the reporting of spatial data for Water Framework Directive (WFD) protected areas, in the context of the March 2016 reporting of the second River Basin Management Plans (RBMPs).
3. Common Implementation Strategy for the Water Framework Directive (2000/60/EC), 2003. Guidance document no. 2. Identification of Water Bodies. 23 p.
4. Common Implementation Strategy for the Water Framework Directive (2000/60/EC), 2003. Guidance document no. 3. Analysis of Pressures and Impacts. 148 p.
5. Common Implementation Strategy for the Water Framework Directive (2000/60/EC), 2003. Guidance document no. 4. Identification and Designation of Heavily Modified and Artificial Water Bodies. 108 p.
6. Common Implementation Strategy for the Water Framework Directive (2000/60/EC), 2003. Guidance document no. 5. Transitional and Coastal Waters. Typology, Reference Conditions and Classification Systems. 107 p.
7. EPIRB/MENR, 2016. Chorokhi-Ajaristskali River Basin Management Plan, Appendix Coastal and Transitional Waters (Draft).
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9. Lampou, A., Simboura, N., Drakopoulou, P., & Panayotidis, P. (2016). Application of the Land Use Simplified Index (LUSI) in the Hellenic coastal waters (Eastern Mediterranean) and cross-correlation with their Integrative Environmental Status.