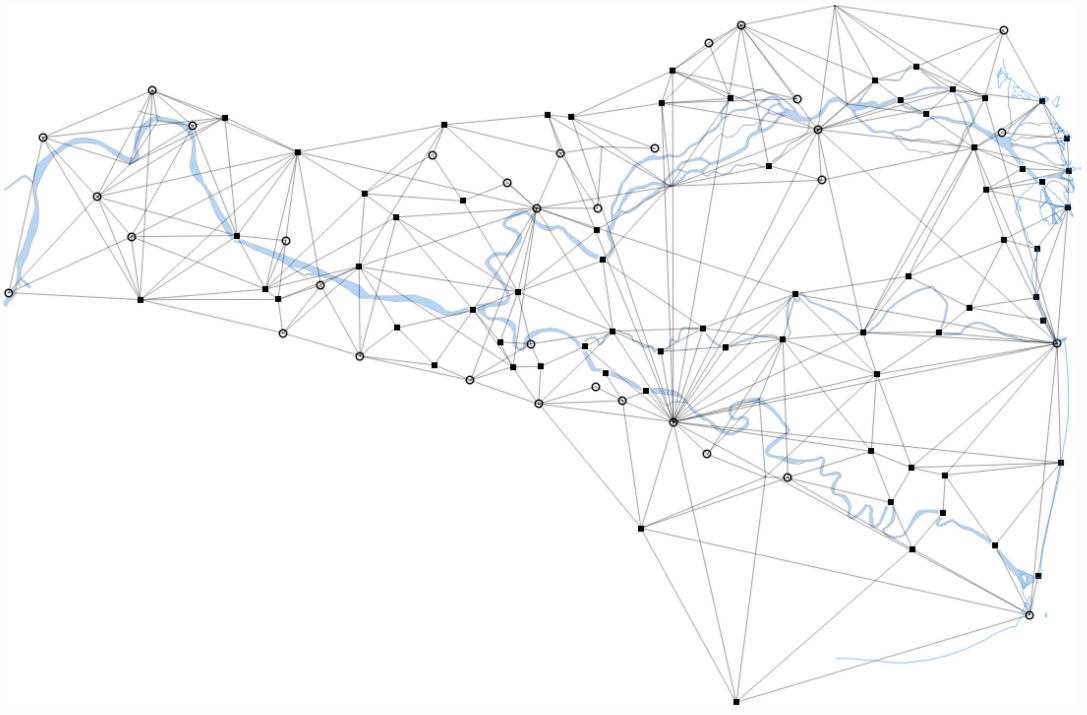
Ştefan Constantinescu

Danube Delta Atlas



București

2026

Danube Delta Atlas

Ştefan Constantinescu

University of Bucharest

Faculty of Geography

Marine and Fluvial Research Station Sf. Gheorghe

ISBN 978-973-0-43541-2

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Danube Delta Atlas

We cannot forget the Danube, and we cannot live far from it.

Jean Bart (1933), *Cartea Dunării*




Sentinel-2 (2025-08-29)
Copernicus/ESA

Introduction

The Danube Delta Atlas was born from the wish to provide, within the Marine and Fluvial Research Station from Sf. Gheorghe, a series of maps useful both to researchers and to students carrying out fieldwork in this unique space. At the beginning, we made our own navigation maps to load onto Garmin GPS devices. Later, our results were offered to the Digital Romania Project, with vector data made freely available through geo-spatial.org.

Over time we came back to revise the most important cartographic layer, the extent of water surfaces. At first, we relied on Landsat images of 30 m resolution, then on Sentinel-2 products with 10 m resolution, and in parallel on orthophoto images. Yet behind every dataset there were constant uncertainties, especially toponymic. By comparing cartographic information with the reality on the ground we found many inconsistencies, the official toponymy often differing from the local one.

For years access to data was difficult. *Public* institutions produced new datasets with *public* money, but often kept them locked away, a practice reminiscent of pre-1990 attitudes. Only with Romania's accession to the European Union and the implementation of the INSPIRE directive did change become possible. The open-source philosophy, once disturbing, has gradually become an obligation: data produced from *public* funds must be *public*.

This Atlas is therefore both a testimony and an invitation. We did not wish to write lengthy interpretations for each map, leaving the reader the freedom of a personal approach. Like any atlas, this one is open to improvement, which, we are convinced, will come with new editions. We hope these maps will encourage you to dream, to bring the waters of the Danube closer to you. And if the results fall short, we take full responsibility,

Stefan Constantinescu

13/08/2025 Sf. Gheorghe

Acknowledgements

This atlas could not have been completed without the support of my colleagues Priscila Lopes and Natasa Vaidianu, who helped us throughout its preparation. The work was published within the Just4MPA project under Romania's National Recovery and Resilience Plan (PNRR-III-C9-2023 - I8).

Together with Mihnea Tănăsescu I explored the liquid territories of the Delta, combining the cartographic perspective with that of human ecology. Many of the maps were conceived jointly, Mihnea playing an important role in the way I began to see this space.

I am sincerely grateful to my colleagues at the Marine and Fluvial Research Station in Sf. Gheorghe, whose advice and discussions have been invaluable: Alfred Vespremeanu-Stroe, Florin Tătui, Marius Budileanu, Sorin Constantin, Ioan Şerban, Florin Zăinescu, Luminița Preoteasa and Florin Filip. Fieldwork and many of our conversations were sustained by Daniel Ivanov, Răzvan Crimschi and Viorel Ivanov, to whom I owe my full gratitude.

I wish to thank Liviu Giosan, who has always supported us unconditionally, and whose advice has been of great help. My warm thanks also go to Vasile Crăciunescu, the only one who has seen all the stages of this work, in our long weekly discussions. I am equally thankful to my friends from the geo-spatial.org association, who have supported us with advice and many datasets: Florin Iosub, Codrina Maria Ilie, Ionuț Ovejanu, Cornel Tudose and Ion Nedelcu.

Since my student days, my colleagues Adrian Stănică and Viorel Ungureanu have supported me in all our research, whether on cliffed coasts or in the delta. I remain deeply grateful to them.

Finally, this atlas would not have been possible without the support received from Professors Emil Vespremeanu and Mihai Ielenicz, to whom I express my sincere appreciation. The University of Bucharest and my colleagues at the Faculty of Geography have always been by our side and supported us during the long periods spent in the Delta.

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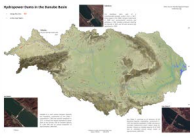
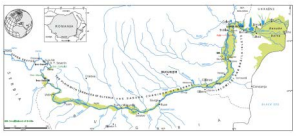
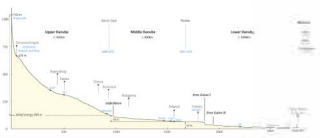

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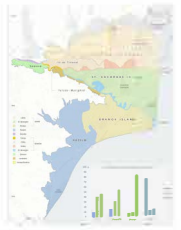

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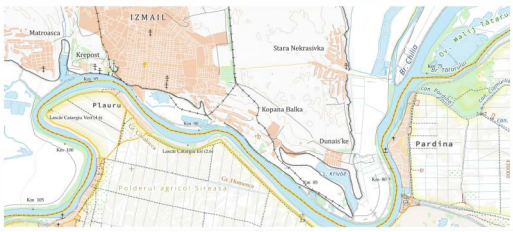



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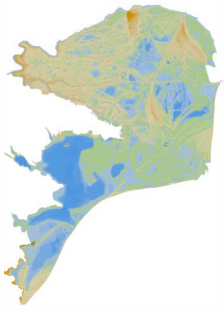

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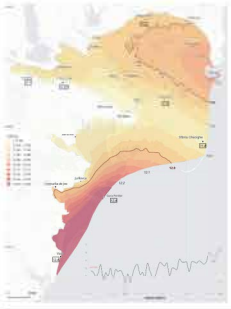

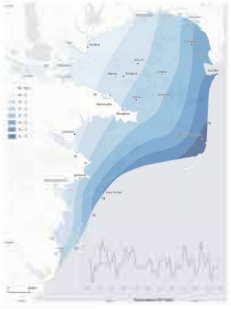
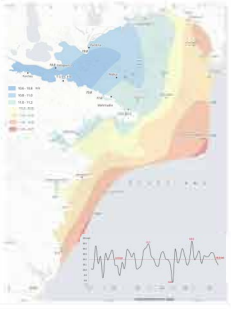

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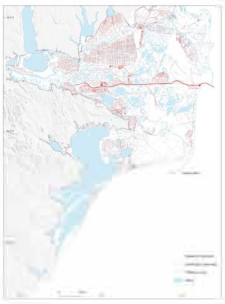





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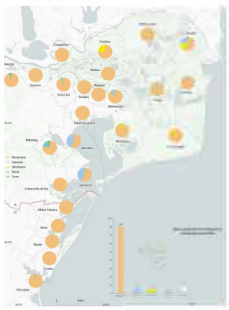

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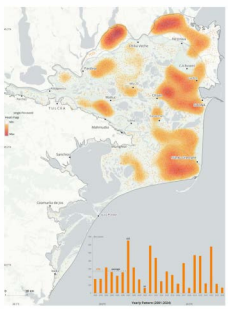
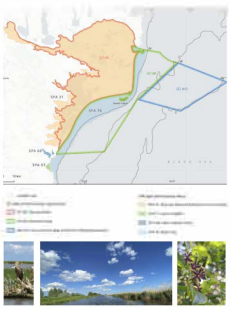

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RGB composite (432) created from Sentinel-2 data, Copernicus/ESA (2025-08-29)
processed by the author.

Towards a definition of deltas

As simple as it might sound, there is no single, universally accepted definition of deltas within the scientific community. Can any river form a delta? Certainly not, we have all seen rivers emptying into the sea through estuaries instead. What we do know for sure is this: in order to form a delta, a river must deliver a significant amount of sediment. A second condition is that the continental shelf of the receiving sea or ocean should be shallow and broad enough to allow sediment to accumulate. Some geography textbooks put it rather simplistically: the sea must be tideless! But then how do we explain the existence of some of the world's largest deltas on coasts with a macrotidal regime (4–6 m), such as the Ganges-Brahmaputra? These are just a few of the many contested aspects among researchers – not to mention the debate over where, exactly, a delta begins upstream.

What we do know for certain about deltas is this: they are environments of outstanding biodiversity, they occur across all climate zones, and they are full of hazards (venomous snakes, mosquitoes, swarms of insects and in some tropical deltas, even freshwater or saltwater crocodiles). Yet despite all this, the world's deltas are among the most densely inhabited places on Earth, often passing unnoticed. How many of you, for instance, realised that Barcelona sits on an old deltaic plain, shaped by the Llobregat and the Besòs?

Danube Delta: an overview

The Danube is not only the largest river basin of the European Union (817,000 km^2 in area and 2,870 km in length), but also one of the most densely populated river systems (some 83 million people live here). Its transboundary character is unique worldwide: no other river basin stretches across as many as 19 countries (for comparison: the Congo spans 13, the Nile 11, the Amazon 9, and so on).

The Danube has an average discharge of 6,470 m^3/s and provides more than 60% of the freshwater input to the Black Sea, exerting a major influence on both marine and terrestrial ecosystems. At this transition zone, which covers 4,152 km^2, Romania accounts for 82% and Ukraine 18%, making it the second-largest delta in Europe. To the south lies the Razelm-Sinoe lagoon system, extending over 1,015 km^2. Renowned for its exceptional biodiversity, the delta is structured around three main branches (Chilia, Sulina, and Sfântu Gheorghe) and a dense network of lakes, channels, and wetlands. Its defining

geomorphological trait is its low elevation: more than two-thirds of the area lies below one metre.

The space between the arms has always been seen as one with *island* attributes. The first maps of the ECD used the next nomenclature: *Ile de Leti* (Letea Island, between Chilia and Sulina Arms), *Ile de St. George* (Sf. Gheorghe Island, between Sulina and Sf. Gheorghe Arms), *Ile de Dranova* (Dranov Island, between Sf. Gheorghe and the eastern shore of Razelm Lake). Another island was demarked by Chilia, Sulina, Tulcea Arms and Şontea channel: *Ile de Tchatal* (in turkish *tchatal* means *fork* and represent a point where the river course is divided into two separate branches). Other authors used Caraorman Island instead of Sf. Gheorghe (Driga, 2004; Gâștescu and Știucă, 2008).

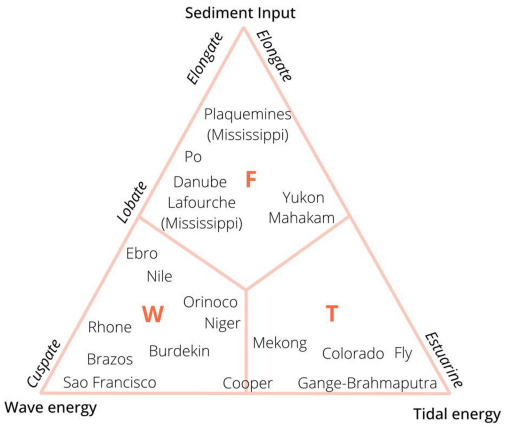
In recent centuries, the surface area of the islands has changed as a result of erosion and accretion along the coast, yet their hierarchy has been preserved. Letea Island accounts for 27.2% of the entire delta, followed by Razelm and Sfântu Gheorghe islands with similar proportions (19.9% and 19.1%). The least extensive is Dranov Island (15%). Owing to repeated confluences and the presence of three secondary deltas with numerous islets, the Chilia Arm makes up 12% of the delta as a whole. The Sulina and Sfântu Gheorghe arms cover smaller shares (2.1% and 1.8%). The continental floodplains of Somova and those downstream of Tulcea represent almost 3% (1.8% and 1.0%), while the smallest extent belongs to the Tulcea Arm, with only 0.2%.

Within the deltaic space three distinct units can be identified: open water (27.1%), marsh (47.4%), and levees (25.5%). The greatest extent of open water is found in the Razelm area (75.5%), whereas Sfântu Gheorghe and Letea islands have lower values (15.8% and 10.9%). If the lagoon system is excluded, the largest lake in the delta is Lake Dranov; however, within the island of the same name, water covers only 6.8% of the area.

Major Deltas of the World



Uncova Channel (Danube Delta)



Amguema
Colville
Mackenzie
Yukon-Kuskokwim
Cooper
North Pacific Ocean
NORTH AMERICA
Sacramento
Colorado
Rio Grande
Mississippi
Gulf of Mexico
Tropic of Cancer
Nayarit
Grijalva-Usumacinta
East Central America
Pacific-Columbia
Orinoco-Amazon
Ecuator
Rio Guayas
Rio Piuro
SOUTH AMERICA
Sao Francisco
Jequintinonha
Doce
Paraibo
Tropic of Capricorn
South Atlantic Ocean
South Pacific Ocean
Parana
Colorado
North Atlantic Ocean
Rhine-Elbe
EURO
Rhone
Ebro
Tagus
Sebou
Senegal
Volta
Niger
Ogooue
Congo

Backround image: Natural Earth v. 4

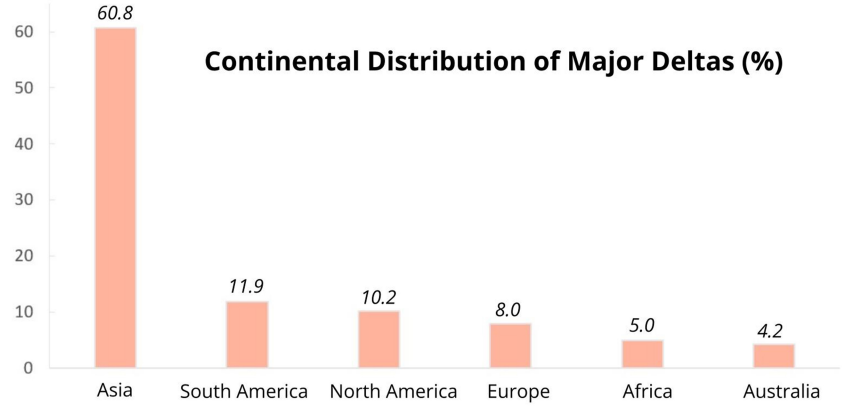
River deltas classification

F: Fluvial dominated

W: Wave dominated

T: Tide dominated

Continental Distribution of Major Deltas (%)



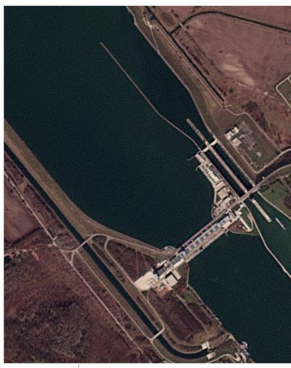


9°E 12°E 15°E 18°E

Hydropower Dams in the Danube Basin

▲ along the river **62**

▪ in the river basin



Vilshofen

the first Danube hydro dam

1927

Iron Gates I



Initiated as a joint venture between Romania and Yugoslavia, construction of Iron Gates I commenced in 1964 and reached completion in 1972. It remains the largest hydroelectric power plant on the Danube, with an installed capacity of 1,266 MW and an annual production of approximately 4,490 GWh.

0 100 km

Projection: Lamb
Datum: ETR

21°E 24°E 27°E 51°N 30°E



Gabcikovo

The Gabčíkovo Dam, part of a Czechoslovakia-Hungary project from a 1977 treaty, began in the 1980s. Hungary halted work in 1989 over environmental concerns and withdrew in 1992. Slovakia continued, diverting the Danube in 1992, and the dam became fully operational in 1996

Data source: Danube Regional Project (undp-drp.org)

48°N

45°N

42°N

Iron Gates I

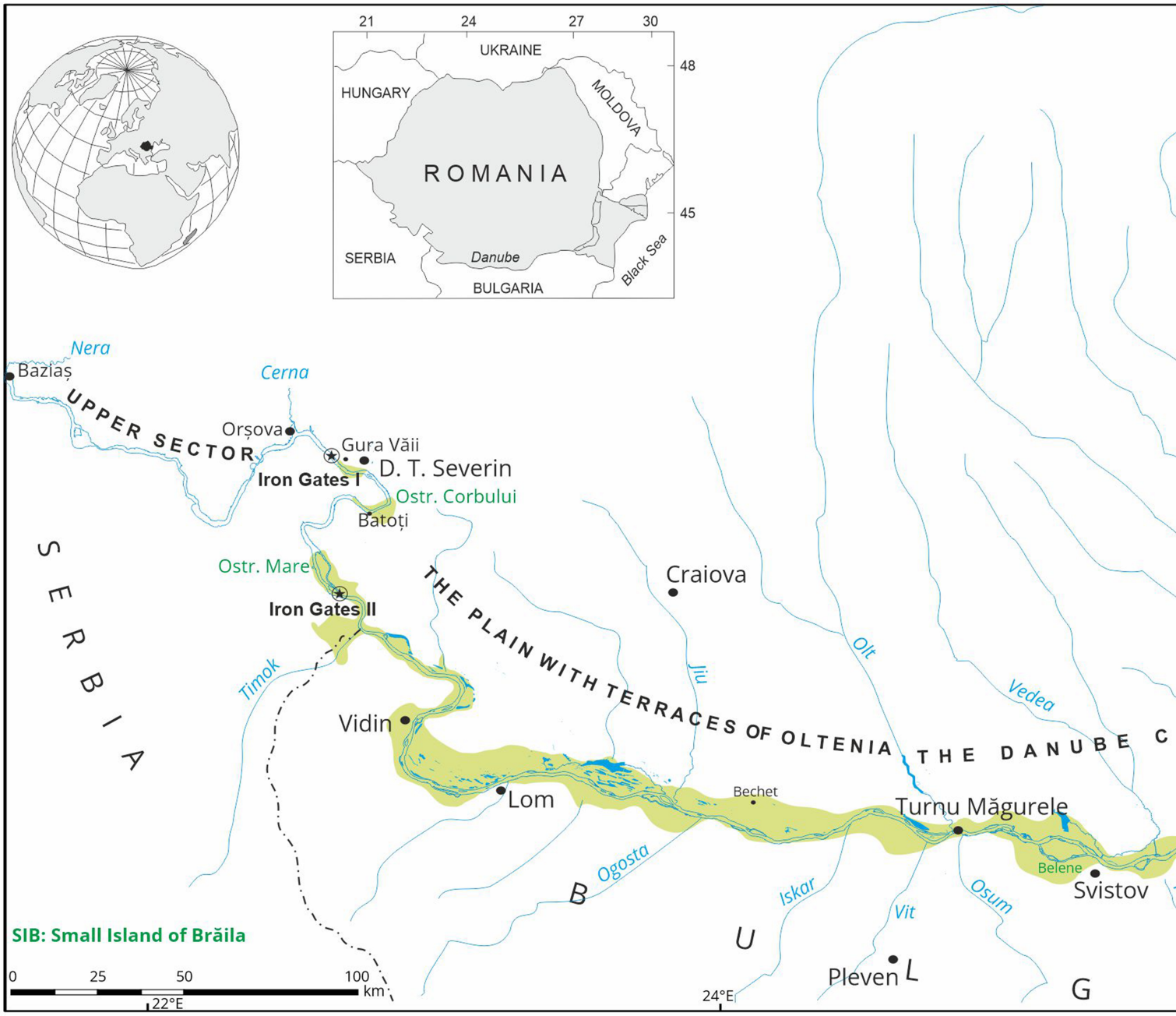
Iron Gates II

Iron Gates II

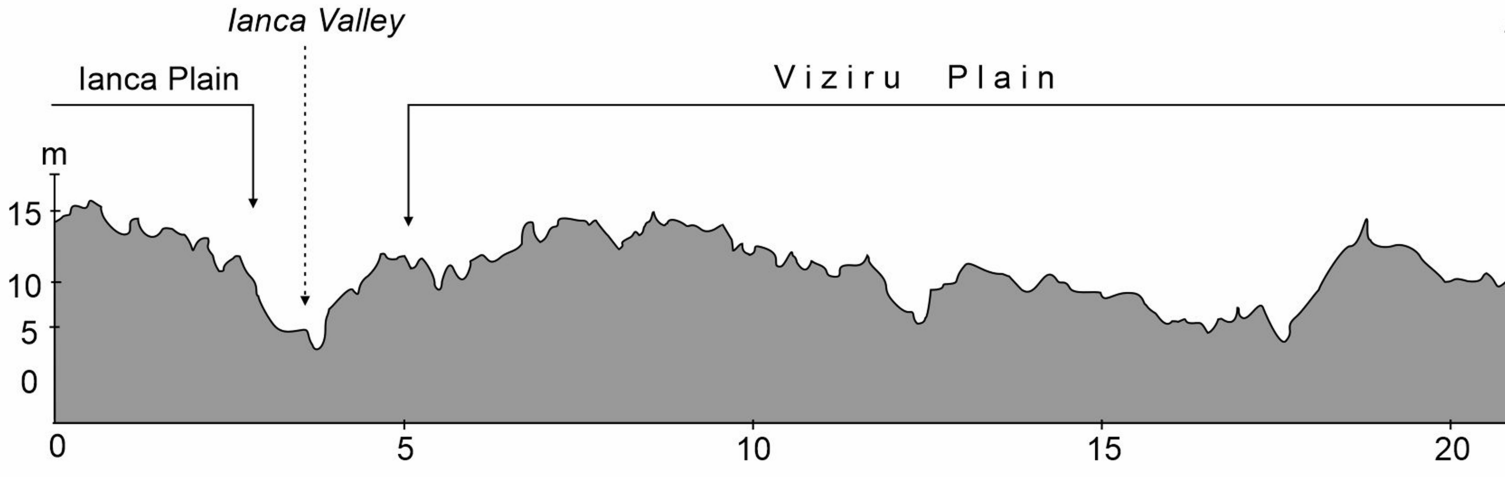


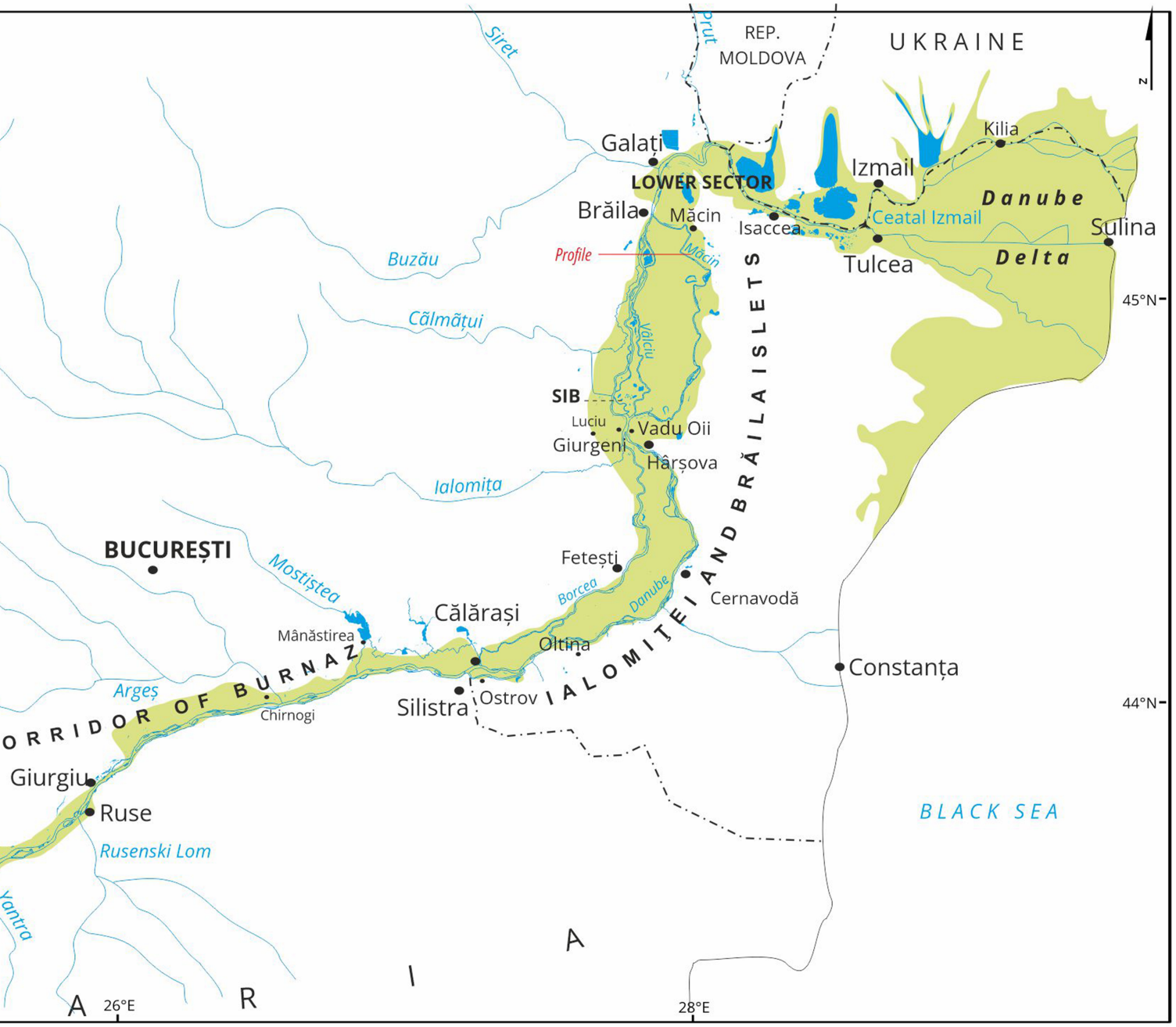
Iron Gates II, conceived as an extension of the Romanian-Yugoslav undertaking, commenced in 1977 and reached completion in 1984. Serving as a secondary hydroelectric power station along the Danube, it boasts an installed capacity of 537 MW and an estimated annual energy output of approximately 2,000 GWh.

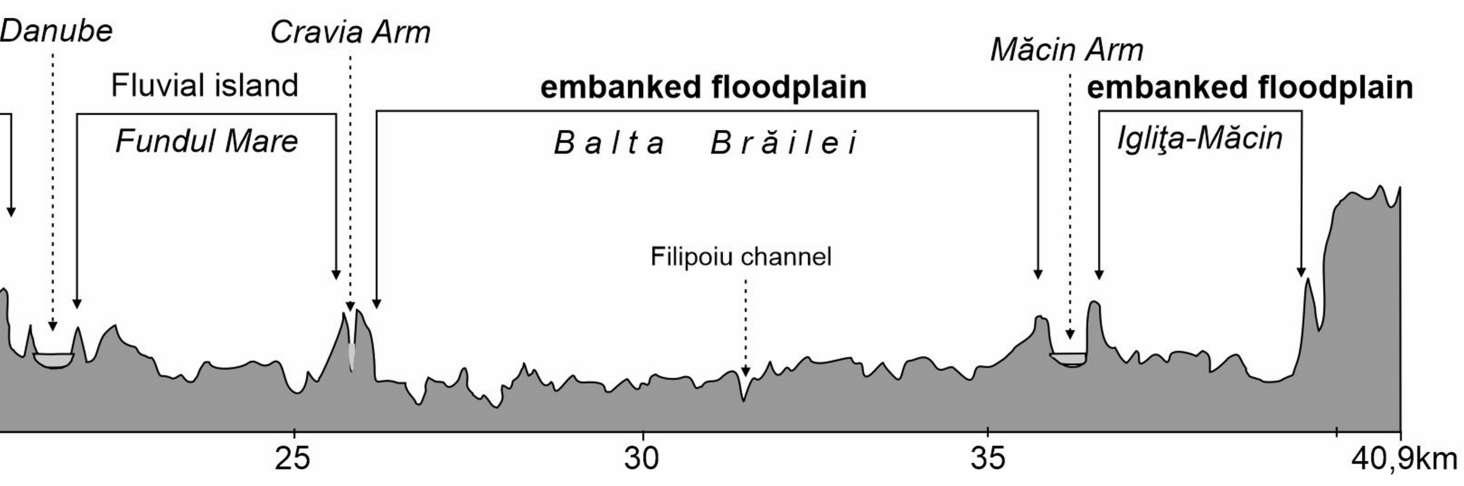
bert Azimuthual Equal-Area
RS 89 EPSG 3035



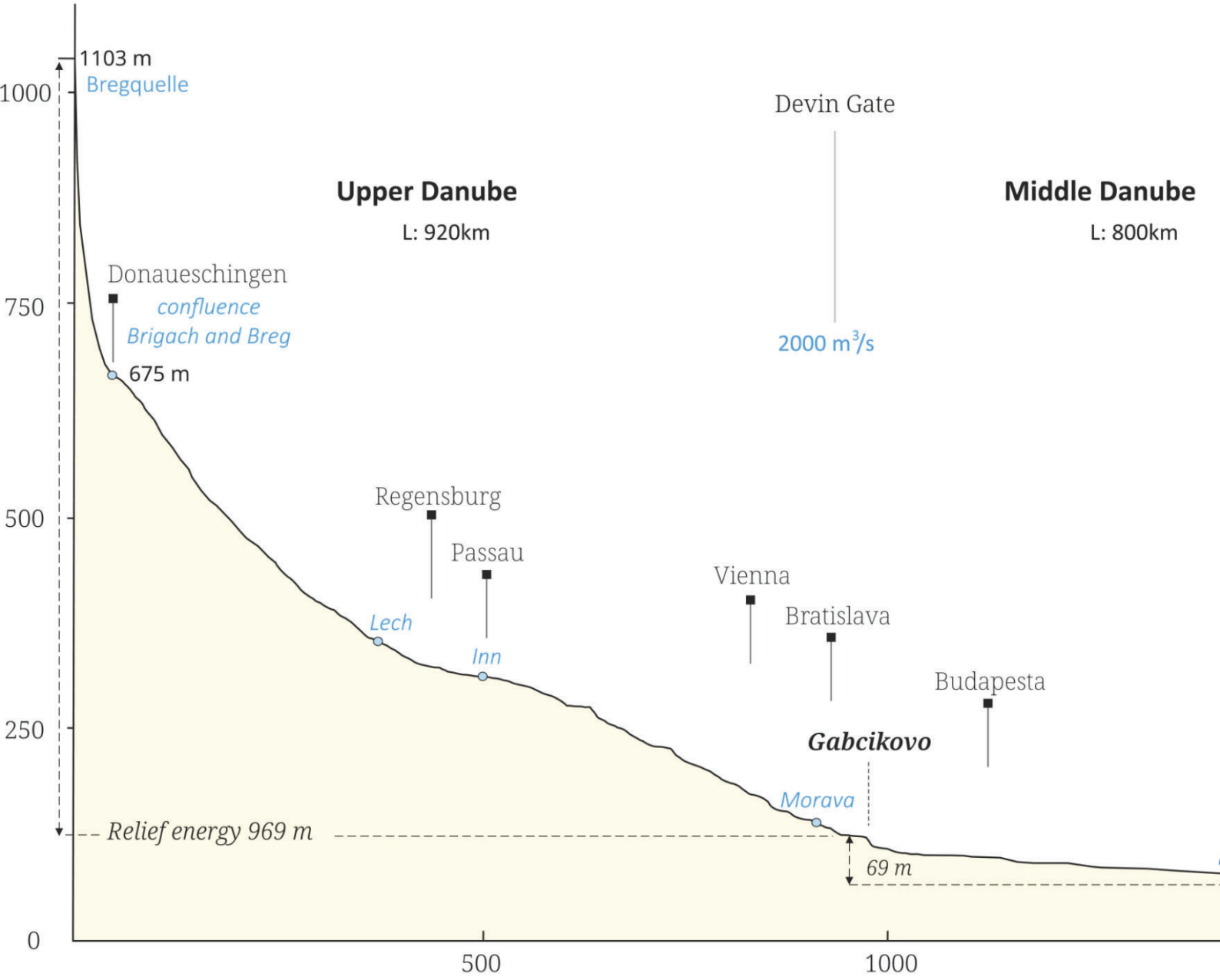
The Danube River floodplain and its morphological sectors



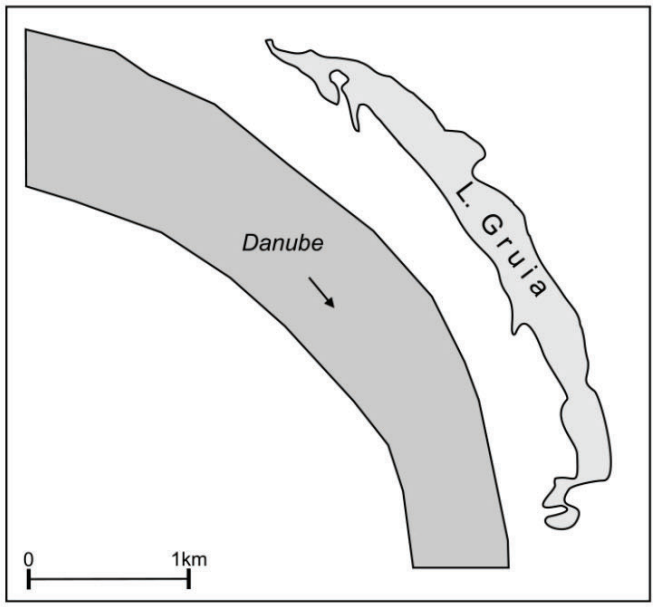

Siret
Prut
REP.
MOLDOVA
UKRAINE
N
Galați
Kilia
Izmail
LOWER SECTOR
Brăila
Măcin
Isaccea
Ceatal Izmail
Danube
Sulina
Delta
Tulcea
Buzău
Profile
Măcin
Călmățui
Văliciu
45°N
SIB
Luciu
Vadu Oii
Giurgeni
Hârșova
Ialomița
BUCUREȘTI
Mostiștea
Fetești
Borcea
Danube
Cernavodă
Călărași
Mânăstirea
Oltina
Constanța
Argeș
Chirnogi
Silistra
Ostrov
44°N
Giurgiu
Ruse
BLACK SEA
Rusenski Lom
Yantra
26°E
28°E


Danube
Cravia Arm
Măcin Arm
Fluvial island
Fundul Mare
embanked floodplain
Balta Brăilei
embanked floodplain
Igliţa-Măcin
Filipoiu channel
25
30
35
40,9km

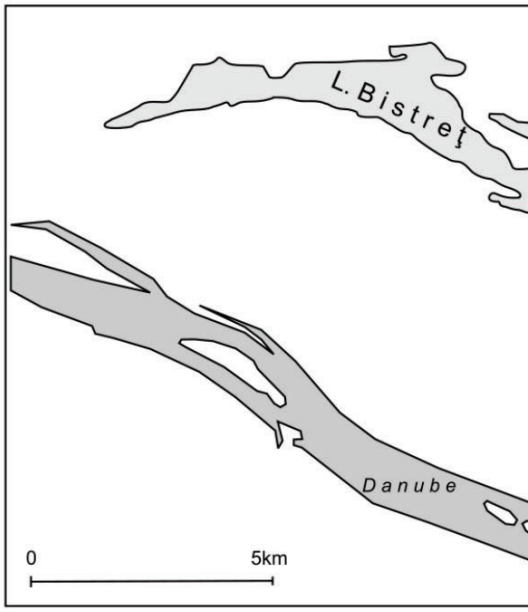
Longitudinal Profile of the Danube Valley



Morphology of Danube Floodplain Lakes.



Oxbow lakes



Isolated lakes, infreque

Baziaș

5551 m³/s

Lower Danube

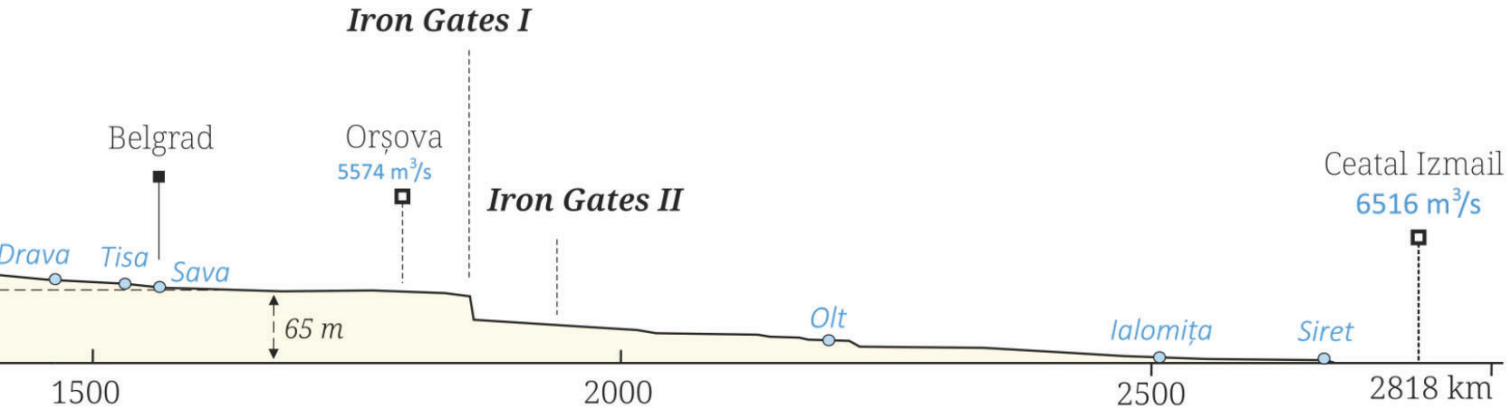
L: 1098km

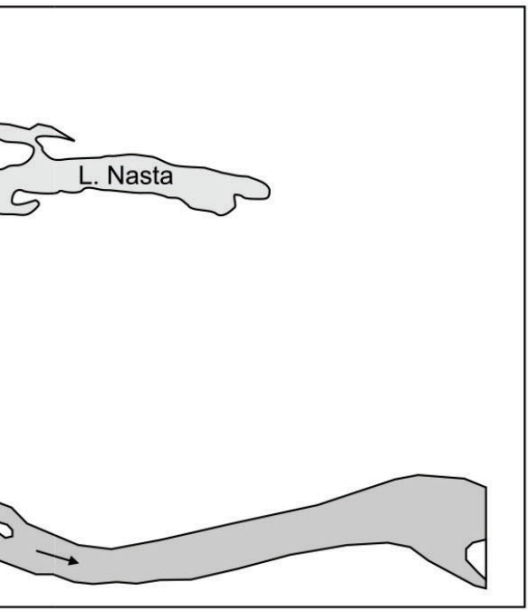
Black Sea

Chilia
61.6 %

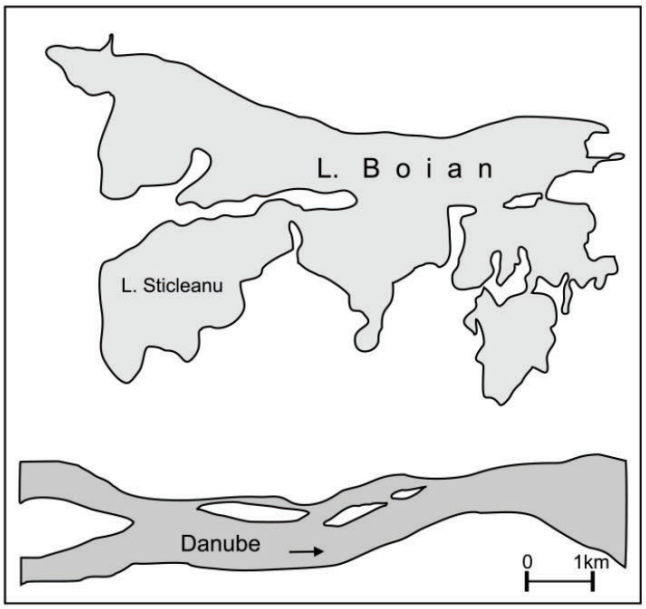
Sulina
13.2 %

Sf. Gheorghe
21.6 %





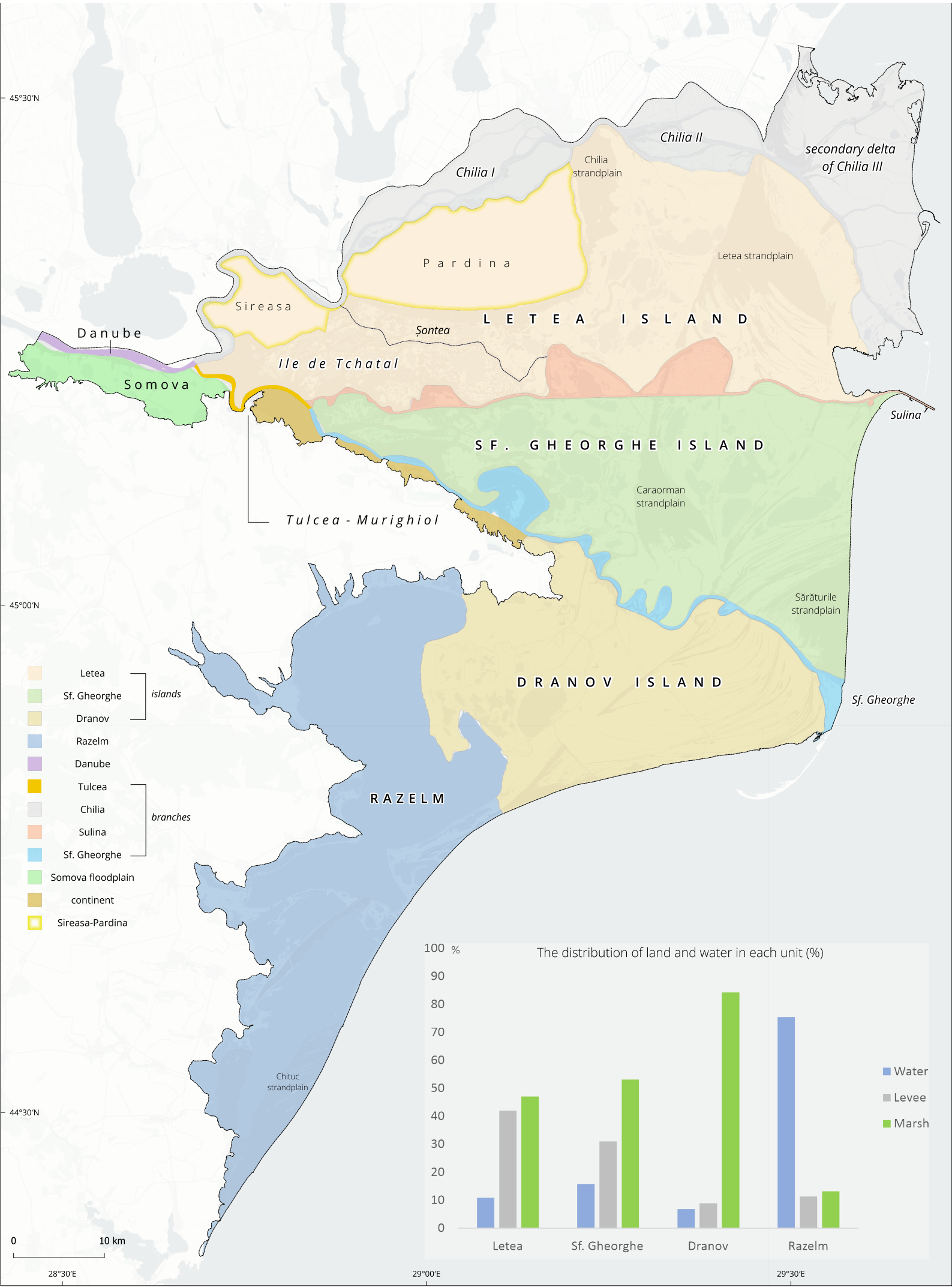
ntly forming complexes



Lake complexes

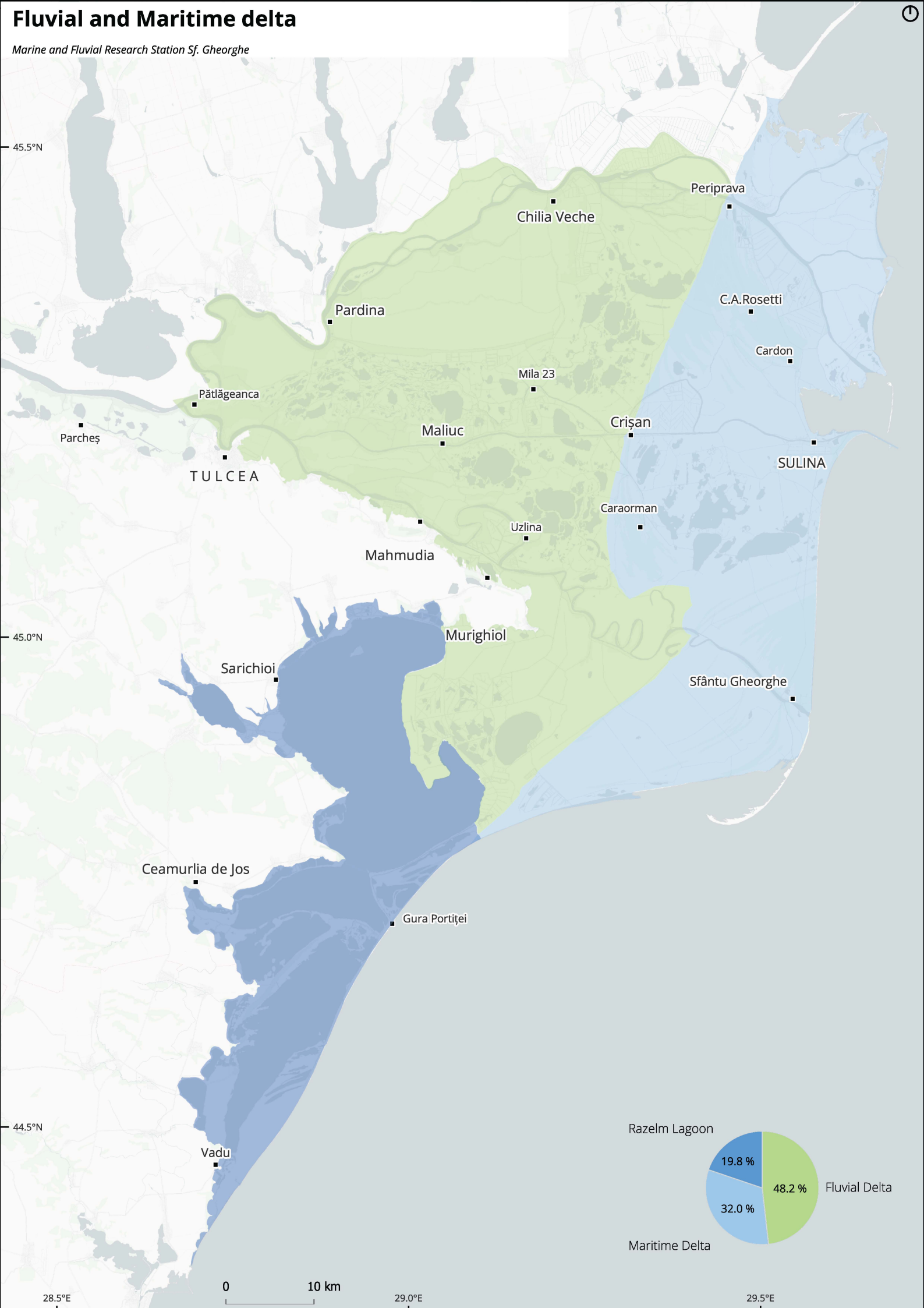
Regional Units the Danube Delta (2024)

Marine and Fluvial Research Station Sf. Gheorghe



Fluvial and Maritime delta

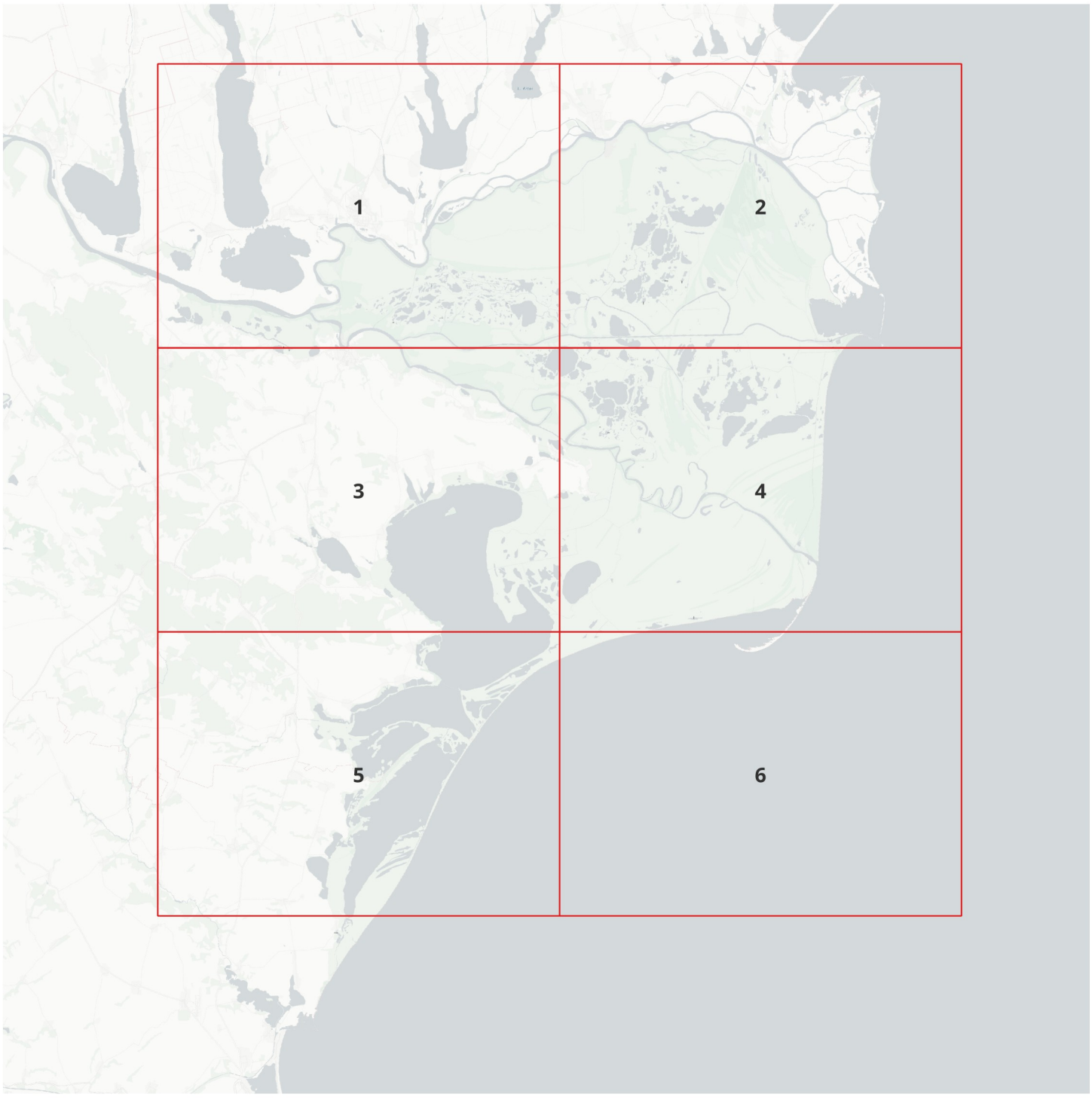
Marine and Fluvial Research Station Sf. Gheorghe



Topographic map of the Danube Delta

Marine and Fluvial Research Station Sf. Gheorghe





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1: 100.000

Limits

- state border
- county border

Points of interest

- tourist complex
- weather station
- archaeological site
- geodetic marker
- fishermen's huts
- fishery
- forest
- lighthouse

Places of worship

- cathedral
- monastery
- church
- old-rite church
- skete
- mosque
- synagogue

Industry

- quarry
- wind turbine
- oil/gas platform
- power network

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- town **ISACCEA**
- commune Sf. Gheorghe
- village Caraorman

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- shoreline (2025)
- isobath
- permanent rivers
- temporary rivers
- ailings pond
- branch
- canal
- floodplain

Relief

- elevation (m)
- hillock / mound
- 37 contour lines
- cliff / escarpment
- sand
- levee

Transport

- ferry crossing
- fuel station
- NAVROM port
- shipwreck
- cale ferată

Road

- national / european
- county
- communal
- logging / forest

Vegetation

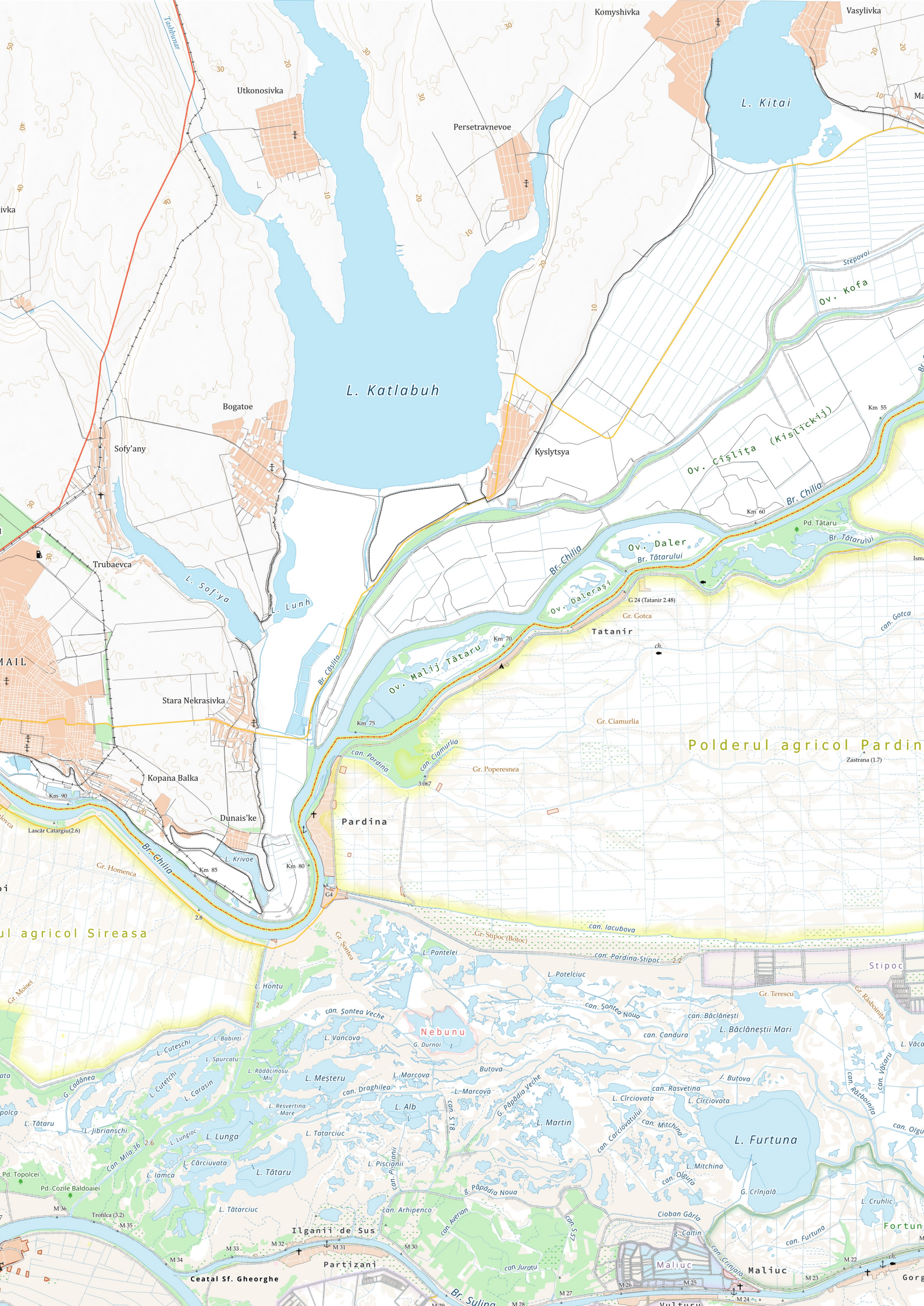
- pasture
- forest
- vineyard
- wine centre (winery)

Regionalisation

- reserve
- strictly protected area
- renatured areas
- fish farm
- agricultural polder

Glosar	Glossary
Balta	Pond
Braţ (Br.)	Arm
Canal (Can.)	Channel
Cap	Cape
Câmp marin	Strandplain
Câmpie	Plain
Cherhana	Fishery
Colinã	Hillock
Deal (D.)	Hill
Depresiune	Depresion
Gârlă (g.)	Stream
Grind	Levee
Golf	Bay
Lac (L.)	Lake (L.)
Mânăstire	Monastery
Mlaştina	Marsh
Movilă (Mov.)	Mound
Munte	Mountain
Ostrov (Ostr.)	Islet
Parc natural	Natural park
Pădure	Forest
Plajă	Beach
Podiş	Plateau
Polder agricol	Ag. polder
Port turistic	Marina
Râu	River
Vale	Valley


Kalanchak
Krynychne
Karasuldk
Kotlovyna
Loshchyn
Kosa
Novoozerne
L. Yalpuh
Plavni
Ozerne
Mizhnarodnyy Aeroport Izmayil
Broska
Larzhanka
Matroasca
Krepost
Nova Nekrasivka
Novosil's'ke
Km 95
Plauru
Lascăr Catargiu Vest (4.6)
Km 100
Km 105
Ceatalchio
Polderu
Sălceni
Dedova (1.1)
Pd. Covaliova
Km 110
Pd. Rosie
L. Cartal
G. Zhapzha
L. Kuhurlui
G. Stupanskya
G.Kyshkuvata
Dunărea
Noviodunum
ISACCEA
can. Skunda
Pyrkuleth
Insula Ivancea
Alunga (3.6)
L. Lui Gisca
Km 115
Ceatal Izmail
L. Martin
Rotund
L. Urechea
L. Telincea
G. Telincea
L. Parcheș
Balta Isaccei
L. Morun
Pătlăgeanca
Br. Tulcea
M 43
M 41
M 42
L. Gorgonel
Gapaclia
Isaccea
Mănăstirea Saon
L. Ciorciovata
L. Listeghea
L. Babele
L. Potica
Parcheș
Delta Nature Resort
Tudor Vladimirescu
M 40
M 39
Glacisul Isacce
Glacisul Somovei
D. Stinca Mare
205
Somova
Gârla Mare
L. Chișca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Komyshivka
Vasylivka
Utkonosivka
Persetravnevoe
Bogatoe
Sofy'any
Kyslytsya
Trubaevca
Stara Nekrasivka
Kopana Balka
Dunais'ke
L. Sof'ya
L. Lunh
L. Krivoe
Ov. Kofa
Ov. Cîşliţa (Kislickij)
Ov. Daler
Ov. Daleraşi
Ov. Malij Tătaru
Br. Chilia
Br. Tătarului
Br. Tătarului
Br. Cîşliţa
Pd. Tătaru
Km 55
Km 60
Km 70
Km 75
Km 80
Km 85
Km 90
G 24 (Tatanir 2.48)
Tatanir
Gr. Gotca
can. Gotca
Gr. Ciamurlia
Gr. Poperesnea
3.067
can. Pardina
can. Ciamurlia
Pardina
Polderul agricol Pardin
Zastrana (1.7)
Lascăr Catargiu(2.6)
Gr. Homenca
G4
2.8
can. Iacubova
Gr. Stipoc (Boţoc)
can. Pardina-Stipoc
2.2
Stipoc
L. Pantelei
L. Potelciuc
Gr. Terescu
Gr. Răsboieniţa
Gr. Sontea
Gr. Moşei
L. Hontu
can. Sontea Veche
can. Sontea Nouă
can. Băclăneşti
L. Băclăneştii Mari
Nebunu
G. Durnoi
can. Candura
L. Vancova
L. Babinţi
L. Cuteschi
L. Spurcatu
L. Rădăcinosu Mic
L. Meşteru
L. Marcova
Butova
L. Butova
can. Draghilea
L. Marcova
can. Rasvetina
L. Circiovata
L. Circiovata
G. Păpădia Veche
L. Alb
L. Martin
can. Carciovaului
can. Mitchina
L. Furtuna
L. Mitchina
can. Olgura
G. Crinjală
L. Cruhlic
Cioban Gârla
G. Caltin
can. Furtuna
can. Crinjala
Fortun
Maliuc
Maliuc
L. Resvertina Mare
L. Tătaru
L. Jibrianschi
L. Lungioc
L. Lunga
L. Tatarciuc
L. Cârciuvata
L. Iamca
L. Tătaru
L. Tătarciuc
Pd. Topolcei
Pd. Cozile Baldoaiei
Trofilca (3.2)
M 36
M 35
M 34
M 33
M 32
M 31
M 30
M 29
M 28
M 27
M 26
M 25
M 24
M 23
M 22
Ilganii de Sus
Partizani
Ceatal Sf. Gheorghe
Br. Sulina
can. Arhipenco
can. Averian
can. Juraţu
can. Pisciganii
can. S 18
can. S 17
G. Cădânea
L. Cuteţchi
L. Carasin
L. Lungioc
Can. Milo 36
2.6
L. Cuteschi
L. Spurcatu
L. Babinţi
L. Vancova
L. Meşteru
L. Marcova
L. Alb
L. Martin
L. Furtuna
L. Tătaru
L. Jibrianschi
L. Lunga
L. Tatarciuc
L. Cârciuvata
L. Iamca
L. Tătaru
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Pd. Topolcei
Pd. Cozile Baldoaiei
Trofilca (3.2)
Ilganii de Sus
Partizani
Ceatal Sf. Gheorghe
Br. Sulina
Gr. Moşei
Gr. Sontea
Gr. Homenca
Gr. Terescu
Gr. Răsboieniţa
Gr. Stipoc (Boţoc)
Gr. Poperesnea
Gr. Ciamurlia
Gr. Gotca
Tatanir
Nebunu
Pardina
Stipoc
Maliuc
Maliuc
Polderul agricol Pardin
ul agricol Sireasa
Br. Chilia
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Br. Chilia
Br. Cîşliţa
Br. Tătarului
Br. Tătarului
Br. Sulina
Ov. Kofa
Ov. Cîşliţa (Kislickij)
Ov. Daler
Ov. Daleraşi
Ov. Malij Tătaru
Stepovoi
Tashlhunar
can. Iacubova
can. Pardina-Stipoc
can. Sontea Veche
can. Sontea Nouă
can. Băclăneşti
can. Candura
can. Draghilea
can. Rasvetina
can. Carciovaului
can. Mitchina
can. Olgura
can. Crinjala
can. Furtuna
can. Arhipenco
can. Averian
can. Juraţu
can. Pisciganii
can. S 18
can. S 17
can. Gotca
can. Ciamurlia
can. Pardina
can. Vâcaru
can. Războieniţa
can. Olgu
Cioban Gârla
G. Păpădia Noua
G. Păpădia Veche
G. Crinjală
G. Caltin
G. Cădânea
Butova
L. Butova
L. Vâca
L. Cruhlic
L. Furtuna
L. Martin
L. Alb
L. Marcova
L. Circiovata
L. Circiovata
L. Mitchina
L. Potelciuc
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L. Vancova
L. Babinţi
L. Cuteschi
L. Spurcatu
L. Rădăcinosu Mic
L. Meşteru
L. Resvertina Mare
L. Tătaru
L. Jibrianschi
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L. Iamca
L. Tătaru
L. Tătarciuc
Pd. Topolcei
Pd. Cozile Baldoaiei
Trofilca (3.2)
Can. Milo 36
2.6
Km 55
Km 60
Km 70
Km 75
Km 80
Km 85
Km 90
G 24 (Tatanir 2.48)
3.067
Zastrana (1.7)
Lascăr Catargiu(2.6)
2.8
G4
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M 36
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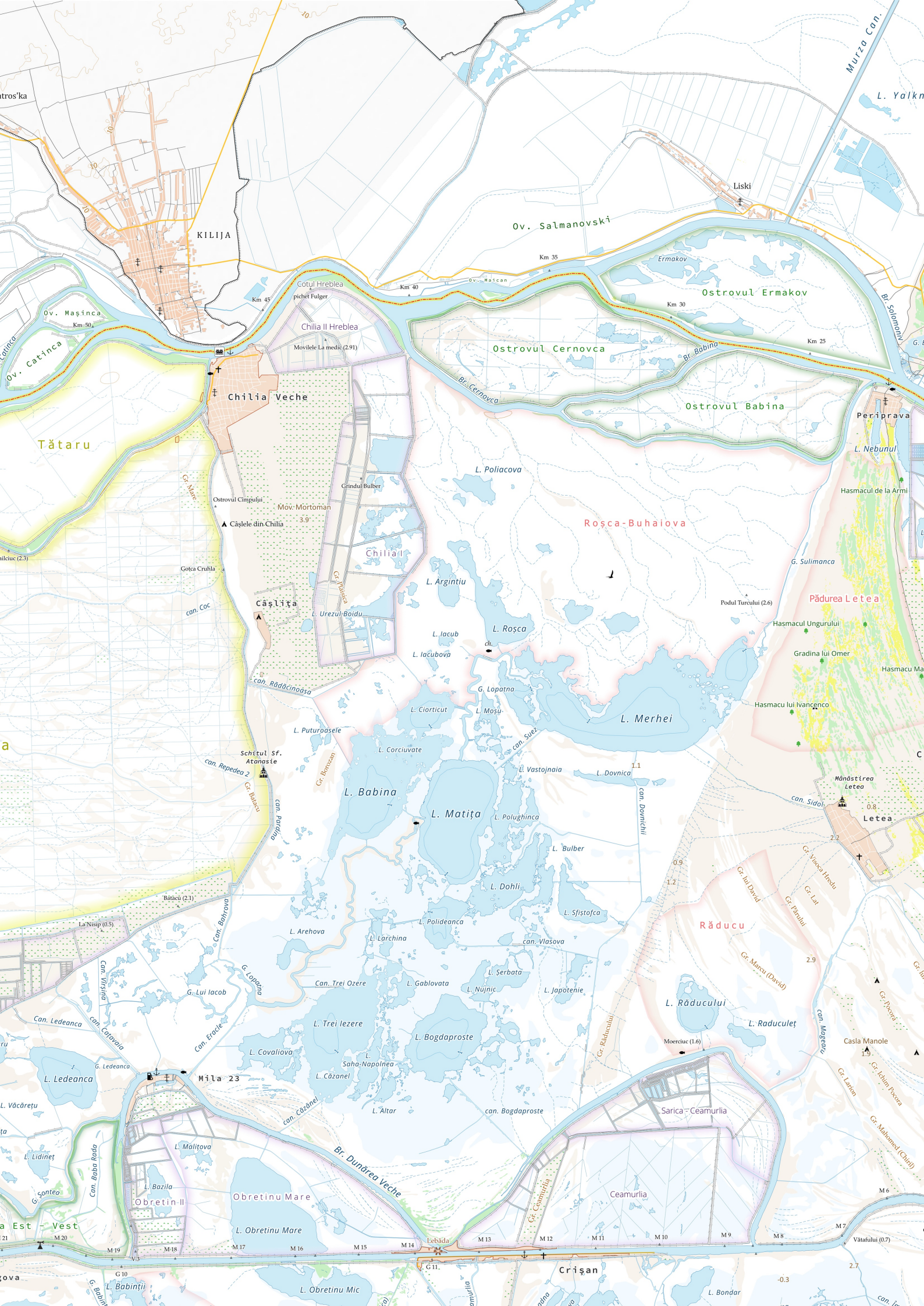
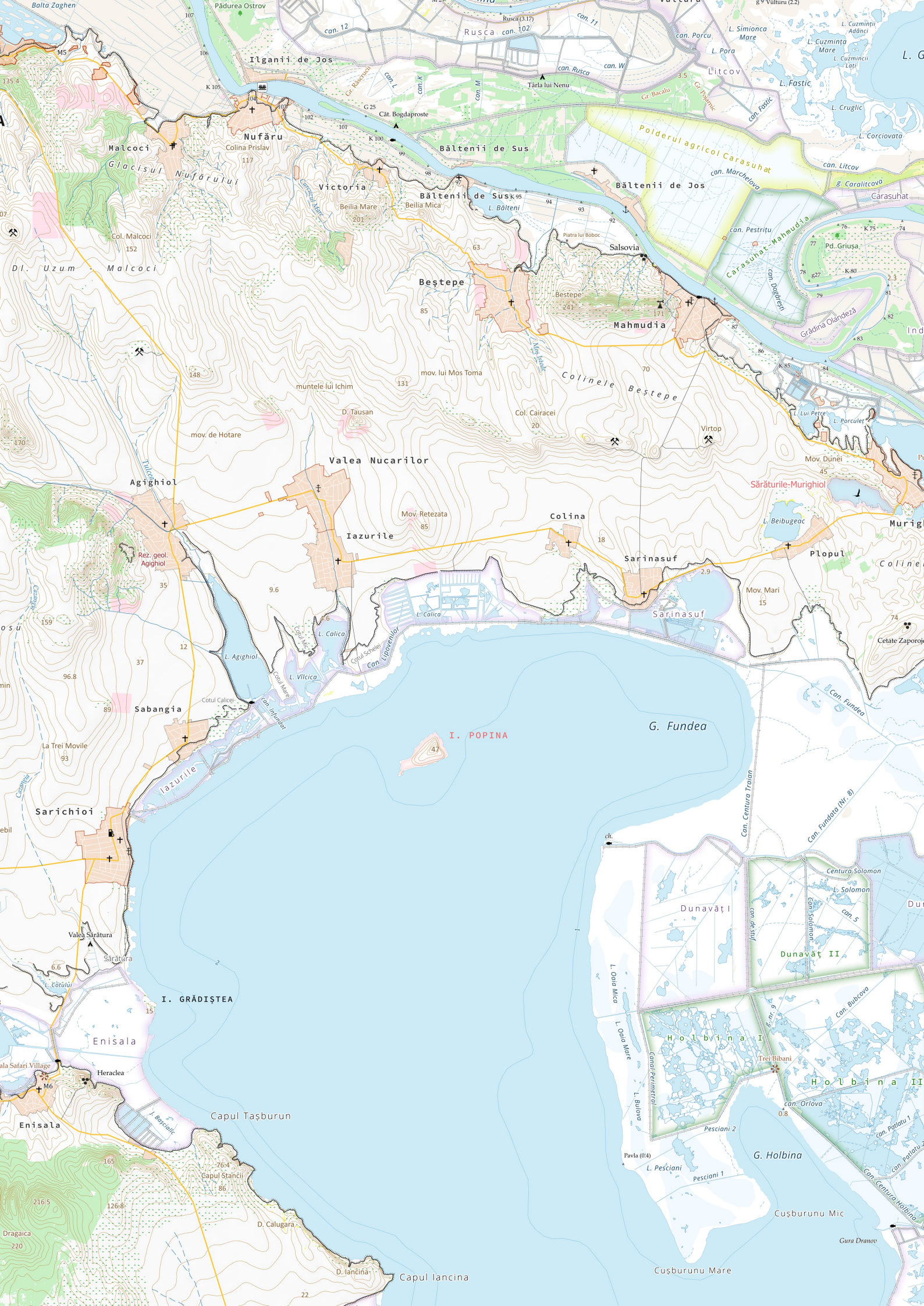

KILIJA
Liski
Ov. Salmanovski
Murza Can.
L. Yalkn
Ermakov
Ostrovul Ermakov
Km 35
Km 40
Km 45
Km 50
Km 30
Km 25
Ov. Maican
Cotul Hreblea
pichet Fulger
Chilia II Hreblea
Movilele La medic (2.91)
Ov. Mașinca
Ov. Catinca
Chilia Veche
Ostrovul Cernovca
Br. Babino
Br. Cernovca
Br. Solomoniv
Ostrovul Babina
Periprava
Tătaru
L. Nebunul
L. Poliacova
Grindul Bulber
Ostrovul Cimpului
Mov. Mortoman
3.9
Câșlele din Chilia
Hasmacul de la Armi
Roșca-Buhaiova
Chilia I
Gr. Nare
Gotca Cruhla
Gr. Fărăsica
L. Urezul-Boidu
Câșlița
can. Coc
L. Argintiu
G. Sulimanca
Podul Turcului (2.6)
Pădurea Letea
Hasmacul Ungurului
L. Iacub
L. Roșca
ch.
L. Iacubova
Gradina lui Omer
Hasmacu Ma
can. Rădăcinoasa
G. Lopatna
L. Ciorticut
L. Mosu
Hasmacu lui Ivancenco
L. Merhei
L. Puturoasele
can. Suez
L. Corciuvate
Schitul Sf. Atanasie
can. Repedea 2
Gr. Batacu
Gr. Bonvzan
L. Vastojnaia
L. Dovnica
1.1
Mănăstirea Letea
can. Sidol
0.8
Letea
L. Babina
L. Matița
can. Dovnichi
L. Polughinca
2.2
L. Bulber
Gr. Visoca Hredu
0.9
1.2
L. Dohli
Gr. lui David
Gr. Lat
Gr. Panului
Bătacu (2.1)
L. Sfistofca
La Nisip (0.5)
L. Polideanca
Răducu
L. Arehova
L. Larchina
can. Vlasova
Can. Bahrova
2.9
Gr. Marcu (David)
Can. Vișina
G. Lopatna
L. Serbata
Can. Trei Ozere
L. Gablovata
L. Nujnic
L. Japotenie
G. Lui Iacob
L. Răducului
Can. Ledeanca
Can. Catavaia
Can. Eracle
L. Trei Iezere
L. Raduculeț
Moerciuc (1.6)
Casla Manole
1.9
L. Bogdaproste
L. Covaliova
L. Saha-Napolnea
G. Ledeanca
L. Ledeanca
Mila 23
L. Cazanel
L. Văcărețu
L. Altar
can. Cazanel
can. Bogdaproste
Sarica - Ceamurlia
L. Malițova
Br. Dunărea Veche
L. Lidineț
Can. Baba Rada
L. Bazila
G. Sontea
Obretin II
Obretinu Mare
Ceamurlia
Gr. Ceamurlia
L. Obretinu Mare
M 20
M 19
M 18
M 17
M 16
M 15
M 14
M 13
M 12
M 11
M 10
M 9
M 8
M 7
M 6
Lebăda
Vătafului (0.7)
G 11
Crișan
G 10
L. Babintii
L. Obretinu Mic
L. Bondar
2.7
-0.3

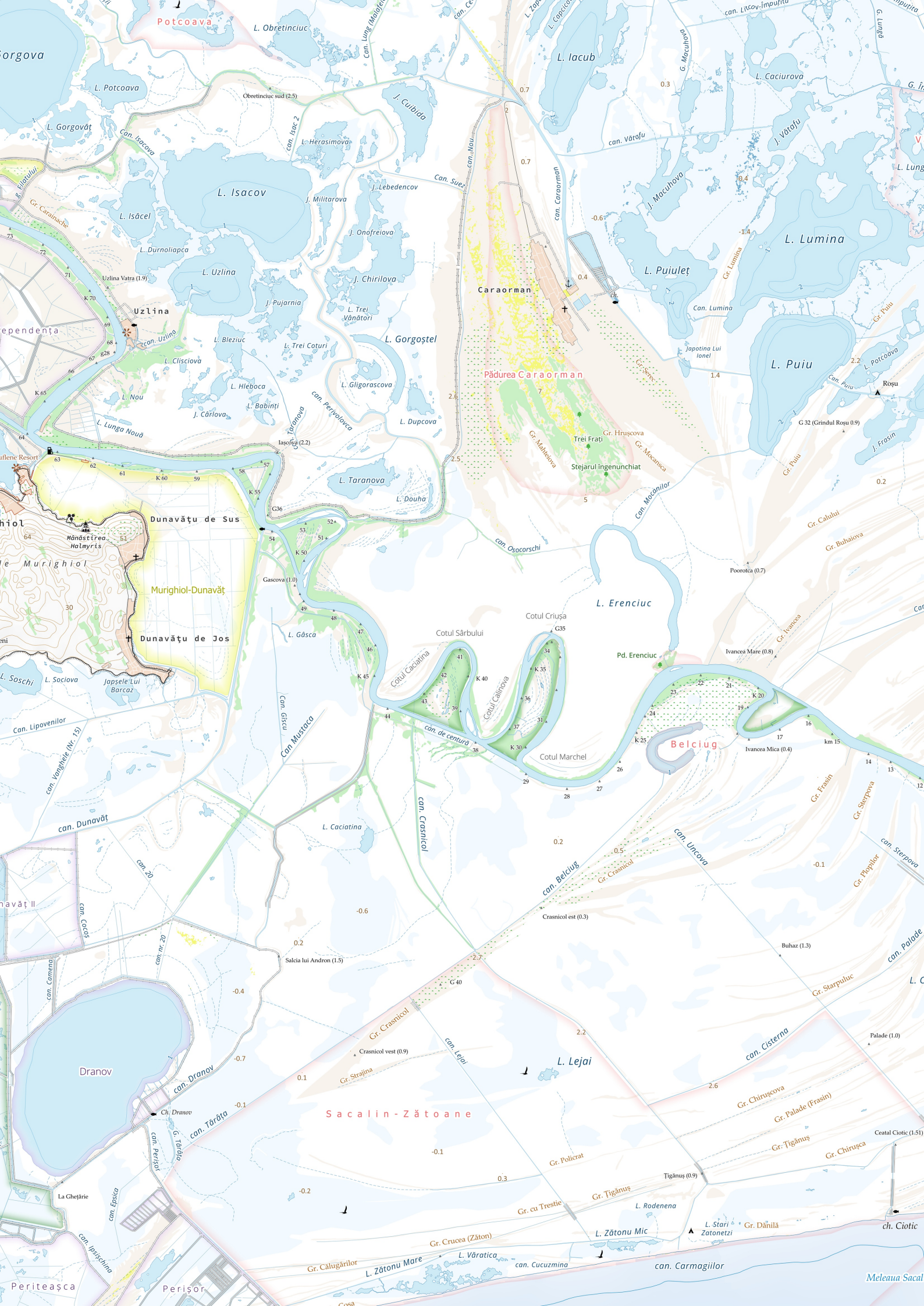

G. Zhebriianska
G. Taraniv Kut
G. Badyk
G. Solonyi Kut
Ov. Polunochnyy
Ov. Shabash
Ov. Prirvy
Ov. Gneushev
G. Zhelannyi Kut
Ov. Bilhorods'kyy
Br. Oceakov
Ov. Poludennyy
G. Poludennoe
L. Lazarkyn Kut
G. Bielgorodskoie
Buzunchuk
VÂLKOV
Ov. Oceakov
G. Otnojnoii
Km 20
G. Ankudinovo
Ov. Ankudinov
Ultima Frontieră
Br. Srednee
Km 15
Ov. Pishchanyy
G. Pesceanoe
Ov. Stambul
Gr. Mare
Popina
Br. Stambulul Nou (Bistroe)
Gr. Mostiștea
ch.
Km 10
Ov. Cuban
KOSA PTICHYA
Gr. Vinișipia
G. Vostocinoe
Sfiștofca
G. Perstinev
Km 5
P o p i n a II
G. Anankin
L. Sărat
Can. Magistral
Br. Stambulului Vechi
G. Zueva
G. Zuev
Buna Vestire
Capul Mosorali
G. Zavodninski
Cardon Nord
Can. Musura
Ov. Limba
Br. Tiganskoe
Gr. Sulina
Cardon
G. Tiganski
Can. Magistral
Gr. Cherhănoiu
can. Măgearului
Ov. Kurilskie
L. Limba
I. MUSURA
Br. Lebedinka
Can. cu ciulini
Gr. Pocora
can. Bărbosu
Golful Musura
Gr. cu Movilă (0.8)
Can. Magistral (Cardon)
Gr. Șimic Hratca
M 5
Grindul Petea (1.0)
G 15 (PARID R II)
M 4
M 3
M 2
M 1
PARID R III
C2
ch.
Turgut S
SULINA



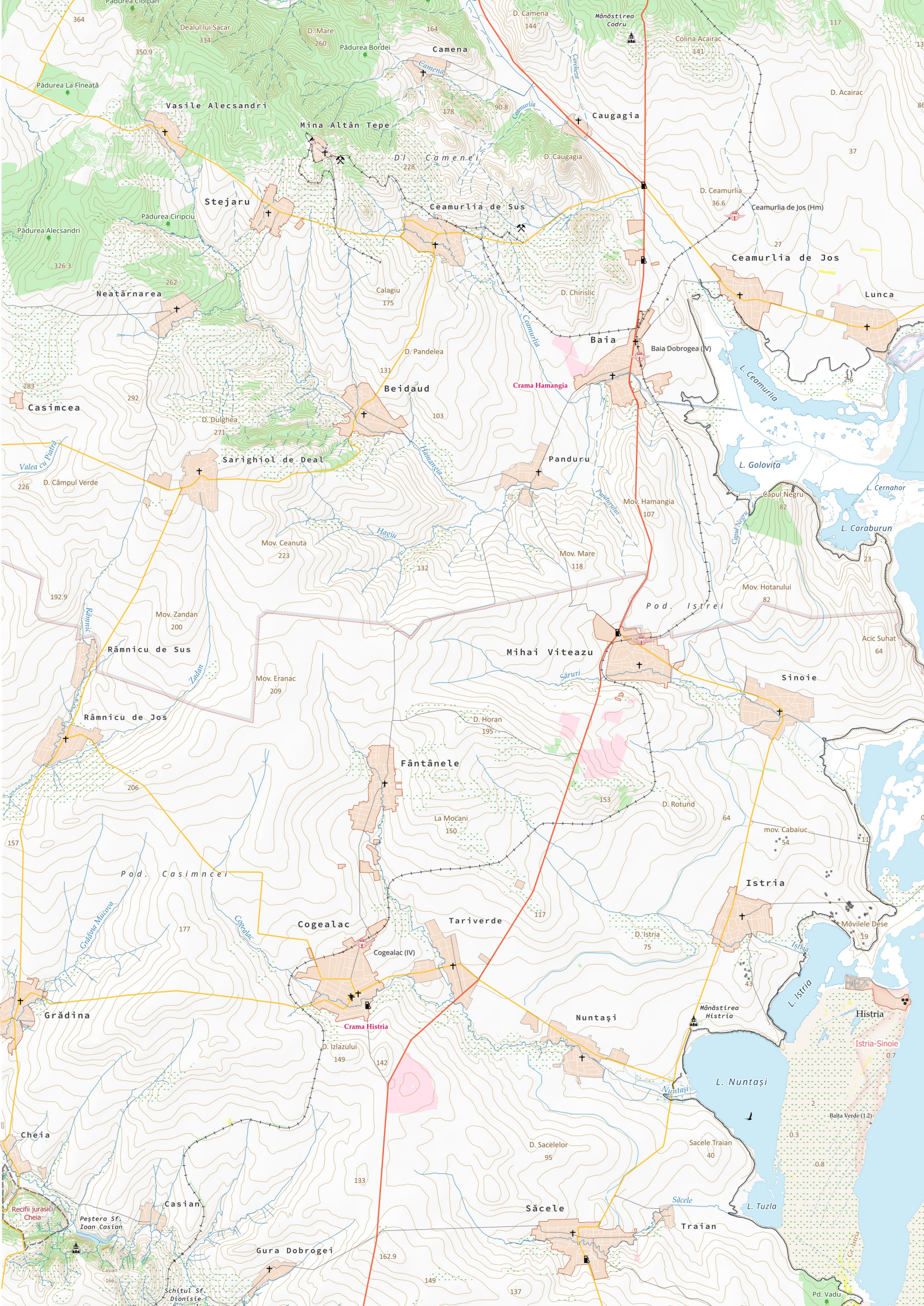
Viticola Sarica Niculițel
Crama La Sapata
Niculițel
D. Sarica
Pod. Isaccei
Teliţa
Mineri
Lac rezidual de bauxită
Tulcea Marfuri (II)
TULCEA
L. Somova
L. Fidan
Memelegiu
Sf. Ioan Botezatorul
D. Humular
D. Dandilu
Colina Cartal
D. Colțului
D. Mare
Mânastirea Celic Dere
D. Celic
Poşta
Frecăţei
D. La Plantaţie
D. Redi
Valea Teilor
Edirlen
Cataloi
Cataloi (Hm)
Dl. Trestenicului
D. Cartal
D. Muchia Verde
Trestenic
Mov. Martazau
D. Cataloi
D. Caratepe Mare
D. Caratepe Mic
D. Uzum
Aerop. Delta Dunarii
D. Caragiorman
Alba
D. Frăsiniş
D. Caracus
Nalbant
Mihail Kogălniceanu
D. Lozva
Izvoarele
D. Bujorului
Lăstuni
Furca Dealurilor
Horia
D. Consul
Iulia
D. Tătarului
Rândunica
Cloşca
Denis Tepe
Nicolae Bălcescu
Mov. Ploschiti
Dl. Carierei
D. Gavana Mare
Turda
Rez. nat. Dealul Bujorului
D. Gavana Mica
Zebil (H)
Satu Nou
D. Lutariei
Rez. de liliac Valea Oilor
Mihai Bravu
Tauc
L. Zebil
Zebil
Pădurea Turzii
Dl. Atmagea
Glacisul Babadagului
Topraichioi
Pădurea Geambaşi
Pădurea Slavelor
Babadag
Pod. Slavelor
Ciucurova
Pădurea Jidina
BABADAG
Slava Cercheză
Crama Verde
Gazi Ali Paşa
D. Molfa
Islic
Pădurea Carado
Rez. botanică Korum Tarla
Dl. Ciucurovei
Dep. Slavelor
Fântâna Mare
Visterna
Mânăstirea Visterna
D. Carul Mare
Slava Rusă
Pod. Visternei
Mânăstirea Uspensia
Pădurea Babadagului
Codru (Hm)
Rez. de liliac Fântâna Mare
Pădurea Mănăstirii



Balta Zaghen
Pădurea Ostrov
Ilganii de Jos
Rusca
Târla lui Nenu
Litcov
Cât. Bogdaproste
Nufăru
Colina Prislav
Malcoci
Glacisul Nufărului
Victoria
Bălteni de Sus
Bălteni de Jos
Polderul agricol Carasuhat
Carasuhat
Beilia Mare
Beilia Mica
Col. Malcoci
Dl. Uzum - Malcoci
Salsovia
Beştepe
Mahmudia
Carasuhat-Mahmudia
Pd. Griuşa
Grădina Olandeză
Colinele Beştepe
mov. lui Mos Toma
muntele lui Ichim
D. Tausan
Col. Cairacei
Virtop
mov. de Hotare
Valea Nucarilor
Agighiol
Sărăturile-Murighiol
Mov. Dunei
Mov. Retezata
Colina
Iazurile
Sarinasuf
Plopul
Rez. geol. Agighiol
Mov. Mari
Cetate Zaporoje
L. Agighiol
L. Calica
L. Vîlcica
Sabangia
Cotul Calicei
La Trei Movile
I. POPINA
G. Fundea
Iazurile
Sarichioi
Valea Sărătura
Sărătura
I. GRĂDIŞTEA
Enisala
Heraclea
Capul Taşburun
Capul Stancii
D. Calugara
Capul Iancina
Dragaica
Dunavăţ I
Dunavăţ II
Holbina I
Holbina II
Trei Bibani
G. Holbina
Cuşburunu Mic
Cuşburunu Mare
Gura Dranov
Pesciani 2
Pesciani 1
L. Pesciani
Pavla (0'4)
Centura Solomon
L. Solomon
Can. Fundea
Can. Centura Traian
Can. Fundata (Nr. 8)
Can. Bubcova
Can. Orlova
Canal Perimetral
L. Oaia Mica
L. Oaia Mare
L. Bulova


Potcoava
L. Obretinciuc
Obretinciuc sud (2.5)
L. Potcoava
L. Gorgovăț
L. Isacov
L. Isăcel
L. Durnoliapca
L. Uzlina
Uzlina Vatra (1.9)
Uzlina
L. Bleziuc
L. Trei Coturi
L. Cliscicova
L. Hleboca
L. Nou
L. Babinți
J. Cârlova
L. Lunga Nouă
Iasicova (2.2)
L. Taranova
L. Douha
L. Gligorascova
L. Dupcova
L. Gorgoștel
J. Pujarnia
L. Trei Vânători
J. Chirilova
J. Onofreiova
J. Militarova
J. Lebedencov
L. Herasimova
J. Culbiga
L. Iacub
L. Caciurova
J. Vătafu
J. Macuhova
L. Lumina
L. Puiuleț
L. Puiu
Caraorman
Pădurea Caraorman
Trei Frați
Stejarul îngenunchiat
Gr. Hrușcova
Gr. Mahteiova
Gr. Mocanașca
Gr. Șerec
Japotina Lui Ionel
Roșu
G 32 (Grindul Roșu 0.9)
Dunavățu de Sus
Dunavățu de Jos
Murighiol-Dunavăț
Mănăstirea Halmyris
Gascova (1.0)
L. Gâsca
L. Soschi
L. Sociova
Japșele Lui Barcaz
L. Erenciuc
Cotul Criușa
Cotul Sârbului
Cotul Caciatina
Cotul Călinova
Cotul Marchel
Pd. Erenciuc
Belciug
Ivancea Mare (0.8)
Ivancea Mica (0.4)
Poorotca (0.7)
L. Caciatina
Crasnicol est (0.3)
Buhaz (1.3)
Salcia lui Andron (1.5)
Crasnicol vest (0.9)
Palade (1.0)
Țigănuș (0.9)
Ceatal Ciotic (1.51)
Dranov
Ch. Dranov
L. Lejai
L. Rodenena
L. Zătonu Mic
L. Zătonu Mare
L. Stari Zatonetzi
L. Văratica
Sacalin-Zătoane
La Ghețărie
Periteașca
Perișor
ch. Ciotic
Meleaua Sacal
can. Isacova
can. Isac 2
can. Suez
can. Caraorman
can. Nou
can. Vătafu
can. Lumina
can. Uzlina
can. Taranova
can. Pervolovca
can. Osocorschi
can. Macanilor
can. de centură
can. Crasnicol
can. Uncova
can. Belciug
can. Sterpova
can. Palade
can. Cisterna
can. Dranov
can. Tărâța
can. Perișor
can. Ipsișchina
can. Carmagiilor
can. Cucuzmina
can. Vonghele (Nr. 15)
can. Lipovenilor
can. Mustaca
can. Gîscu
can. 20
can. nr. 20
can. Camena
can. Cocos
can. Dunavăț
Gr. Crasnicol
Gr. Strajina
Gr. Policrat
Gr. Țigănuș
Gr. cu Trestie
Gr. Crucea (Zăton)
Gr. Călugărilor
Gr. Chirușcova
Gr. Palade (Frasin)
Gr. Chirușca
Gr. Starpuluc
Gr. Plopilor
Gr. Frasin
Gr. Ivancea
Gr. Calului
Gr. Buhaiova
Gr. Puiu
Gr. Lumina
Gr. Dănilă
Gr. Tărâța
Gr. Filatului
Gr. Caraiache
Can. Lung (Malaifa)
Can. Ce
Can. Lung
G. Macuhova
G. Lungă
L. Zaporojeț
L. Capicova
can. Litcov-Împuțita
Împuțita
Can. Lung
L. Lung
L. Frasin
Can. Puiu
L. Potcoava
Can. Lumina
Gr. Puiu
Gr. Sterpova
Gr. Ivancea
Gr. Calului
Gr. Buhaiova
Gr. Frasin
Gr. Plopilor
Gr. Starpuluc
Gr. Chirușca
Gr. Țigănuș
Gr. Crucea (Zăton)
Gr. Crasnicol
Gr. Strajina
Gr. Policrat
Gr. cu Trestie
Gr. Călugărilor
Gr. Dănilă
Gr. Tărâța
Gr. Filatului
Gr. Caraiache
Can. Lung (Malaifa)
Can. Ce
Can. Lung
G. Macuhova
G. Lungă
L. Zaporojeț
L. Capicova
can. Litcov-Împuțita
Împuțita
Can. Lung
L. Lung
L. Frasin
Can. Puiu
L. Potcoava
Can. Lumina
Gr. Puiu
Gr. Sterpova
Gr. Ivancea
Gr. Calului
Gr. Buhaiova
Gr. Frasin
Gr. Plopilor
Gr. Starpuluc
Gr. Chirușca
Gr. Țigănuș
Gr. Crucea (Zăton)
Gr. Crasnicol
Gr. Strajina
Gr. Policrat
Gr. cu Trestie
Gr. Călugărilor
Gr. Dănilă
Gr. Tărâța
Gr. Filatului
Gr. Caraiache


Farul Nou
J. Prostu
G. Busurca
Gr. Sulina
L. Stambulet
Busurca (0.7)
Can. Central
L. Buival
G. Imputita
Porcului
L. Porcului
can. Roșu-Imputita
can. Sonda
L. Roșuleț
deversor
L. Roșu
L. Balanova
L. Kruglicul Mare
Buhaiova (1.8)
Japșa Lui Matei
L. Tătaru
L. Tatarciuc
Gr. Ivancea
can. Tătaru
Gr. Cerbului
Gr. Roșu
Căsla Vădanei
Gr. Cazăcului
Gr. Mocanilor
Gr. Iepurilor (Portocala)
Gr. Lung
Gr. Ivan
Gr. Andrei
Gr. Purcelu
Gr. Sărăturile
Gr. Babelor
Gr. Căsla Vădanei
M 12
Gr. Morilor
M 13
L. Comatiova
M 14
Gr. Osocorska
Gr. Nicova
Can. Central
Amenajare silvică
t. Palade
Gr. Radova
Sfântu Gheorghe
PARID R I
Green Village
G. Olinca
Capul Buival
arini
Gr. Cal Mort
Can. Ciotica - Zaton
Gr. Buhaz
Gr. Caraseyschi
Gr. Holinca
G. Seredne
Gr. Lizanova
G. Turcească
Gr. Sobacea
Gr. Vasile
Farul vechi
t. Flămânda
Gr. Crasovschi
Gr. Mocirla
L. Mihailuțova
Gr. Buhaz
Gr. Flămânda
L. Mocirla
I. S A C A L I N
0.3
0.5
0.5
1.9
2
20



Pădurea Cioipan
Dealul lui Sacar
D. Mare
Pădurea Bordei
Camena
D. Camena
Mănăstirea Codru
Colina Acairac
Pădurea La Fineață
Vasile Alecsandri
Mina Altân Tepe
Caugagia
D. Acairac
Dl. Camenei
D. Caugagia
Stejaru
Ceamurlia de Sus
D. Ceamurlia
Ceamurlia de Jos (Hm)
Pădurea Ciripciu
Pădurea Alecsandri
Ceamurlia de Jos
Neatârnarea
Calagiu
D. Chirislic
Lunca
Baia
Baia Dobrogea (IV)
D. Pandelea
Crama Hamangia
L. Ceamurlia
Beidaud
Casimcea
D. Dulghea
Sarighiol de Deal
Panduru
L. Golovița
Valea cu Piatră
D. Câmpul Verde
Capul Negru
L. Cernahor
Mov. Hamangia
L. Caraburun
Mov. Ceanuta
Mov. Mare
Mov. Hotarului
Pod. Istrei
Mov. Zandan
Râmnicu de Sus
Mihai Viteazu
Acic Suhat
Sinoie
Mov. Eranac
Râmnicu de Jos
D. Horan
Fântânele
D. Rotund
La Mocani
mov. Cabaiuc
Pod. Casimncei
Istria
Cogealac
Tariverde
Mövilele Dese
D. Istria
Cogealac (IV)
L. Istria
Grădina
Crama Histria
Nuntași
Mănăstirea Histria
Histria
Istria-Sinoie
D. Izlazului
L. Nuntași
Balta Verde (1.2)
Cheia
D. Sacelelor
Sacele Traian
Casian
Săcele
L. Tuzla
Recifii jurasici Cheia
Peștera Sf. Ioan Casian
Traian
Gura Dobrogei
Schitul Sf. Dionisie
Pd. Vadu


Dl. Dragaicii
Sălcioara
Sălcioara
Lacul Razelm
G. Petuh
Periteașca de mare
D. Visinei
D. Ceardac
D. Ivan
Jurilovca
Vișina
Argamum
Capul Dolșman
Mov. Inalta
L. Pașacâșla
g. Stoianschi
Lunca
I. BISERICUȚA
L. Periteașca
Gr. Rinec
L. Pahane Rinec
Periteașca-Leahova
Gr. Gosa
L. Coșnei
L. Leahova Mare
Lacul Golovița
Gura Portiței
L. Curt Bei (Vechi)
Farul Portița
Grindul Lupilor
Canalul 5
L. Curt Bei (Nou)
Lacul Zmeica
Insula Ceaplace
Gr. Lupilor (Curtbei)
Can. Nr. 2
Mvl. Sinoie
Lacul Sinoe
Gr. Prisop
Can. Edighiol
Prundul cu pasari
L. Edighiolul Mare
L. Edighiolul Mic
Grindul Chituc
Chituc Sinoie (1.9)
Gr. Chituc
Gr. Chituc
Gr. Carn
ch.


Gr. Perișor
La Indicator
Câșla Perișor (0.3)
Capul Roh
Tuzla
49


10
30
50

Hypsometry

Previous studies have examined the hypsometry of the Danube Delta (Brătescu, 1912, 1921, 1922; Antipa, 1910, 1914; Banu and Rudescu, 1965; Driga, 2004; Vespremeanu, 2004; Gâștescu and Știucă, 2008), using the same spatial extent: from Ceatal Izmail in the west, to the Chilia Arm in the north (excluding the Ukrainian sector), and the eastern shore of Lake Razelm. The main reason for this delineation was the coverage of Romanian topographic maps, which did not include the Ukrainian delta. These studies relied on topographic maps from the 1960s, with a contour interval of 0.5 m.

In 1912, Brătescu described the delta as a large depression, with its floor lying 1–2 m below sea level. For the Romanian geographer, the delta could be analysed from a physiographic perspective, as a mixture of older and newer organs (components).

Our approach is based on a combination of Digital Elevation Models (DEMs) and a Digital Terrain Models (DTMs) created from topographic maps. The average altitude for the entire deltaic and lagoon space is 0.27 m. If the Razelm lagoon system and the Somova floodplain are excluded, the altitude is 0.49 m (similar to the Gâștescu/Driga value of 0.52 m).

The fluvial delta plain has an average altitude of 0.64 m, while the maritime plain averages only 0.26 m. The Somova floodplain, developed on the right arm of the Danube, has an altitude of 2.84 m. More than three quarters of the deltaic space lies below 1 m (77.5%), while levees and dunes above 3 m represent only 1.9%. All these values highlight the fragility of this territory in the current context of climate change, with flooding as the main concern for local communities. At the regional scale, significant differences can be observed: Dranov and Razelm islands have more than 90% of their surface below 1 m altitude (98.1% and 93.6%), Letea Island is the highest area, with 61% below 1 m, while Sf. Gheorghe Island occupies an intermediate position, with 77.9%.

The Chilia loess promontory and the central part of the Stipoc levee are pre-deltaic territories, together representing 2.4% of the entire delta.

Letea Island has the highest average altitude (0.81 m), Sfântu Gheorghe Island averages 0.35 m, and Dranov Island is the lowest sector, at only 0.10 m.

Based on our revised limits for the arm sectors, an interesting conclusion emerges: Chilia, Tulcea and Sulina all have nearly the same average altitude (0.39, 0.38 and 0.35 m). Only the Sfântu Gheorghe

Arm stands out as the highest (0.65 m), reflecting its older age and the intense accumulation processes along its levee.

The Chilia promontory (a pre-deltaic territory) has the highest average altitude at 2.58 m. Caraorman, Letea and Stipoc show similar values (1.53, 1.46 and 1.43 m), while the other strandplains lie below 1 m (Chituc: 0.94 m, Perișor: 0.84 m, and Sărăturile: 0.78 m). Based on a LiDAR model from 2011, Sacalin Island has the same value as Sărăturile (0.78 m). The continental floodplain has 1.48m altitude.

Hypsometric distribution of the Danube Delta on different DEMs (%)

Elevation (m)	**DEM 1960 (20m)**	**Coastal DEM V1**	**CoastalDEM V2**	**COP30**	**FabDEM 30m**	**Diluvium (30m)**
< 0	39.7	50	40.7	28.6	27.2	29.7
0 - 1	37.7	32.6	41.1	34.0	35.5	43.8
1 - 3	20.7	15.9	16.6	31.3	34.3	24.3
> 3	1.9	1.5	1.6	6.1	3.1	1.8

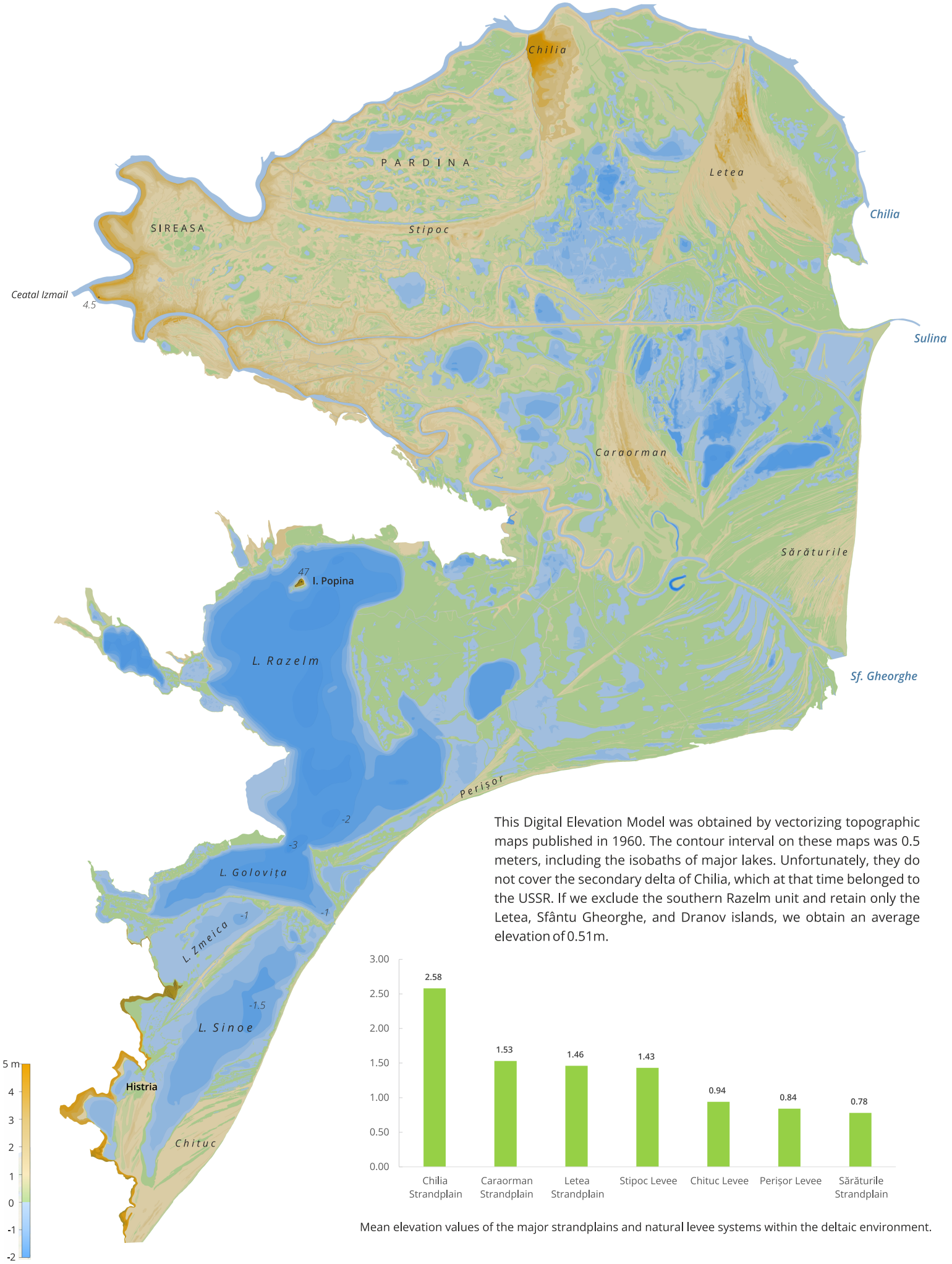
Our Digital Terrain Model, based on 1:25,000 topographic maps from the 1960s, was considered the reference DEM for this study. The MERIT DEM was produced by removing multiple error components (absolute bias, stripe noise, speckle noise, and tree height bias) from existing spaceborne DEMs (SRTM3 v2.1 and AW3D-30m v1). Copernicus being a Digital Surface Model, provide higher elevation values due to the presence of vegetation, which was not filtered out.



RGB composite (432) created from Sentinel-2 data, Copernicus/ESA (2025-08-29)
processed by the author.

Relief of the Danube Delta

The maps were produced by ISP and IPACH, in collaboration with the Photogrammetry Laboratory of the Construction Institute in Bucharest (1960s)



This Digital Elevation Model was obtained by vectorizing topographic maps published in 1960. The contour interval on these maps was 0.5 meters, including the isobaths of major lakes. Unfortunately, they do not cover the secondary delta of Chilia, which at that time belonged to the USSR. If we exclude the southern Razelm unit and retain only the Letea, Sfântu Gheorghe, and Dranov islands, we obtain an average elevation of 0.51m.

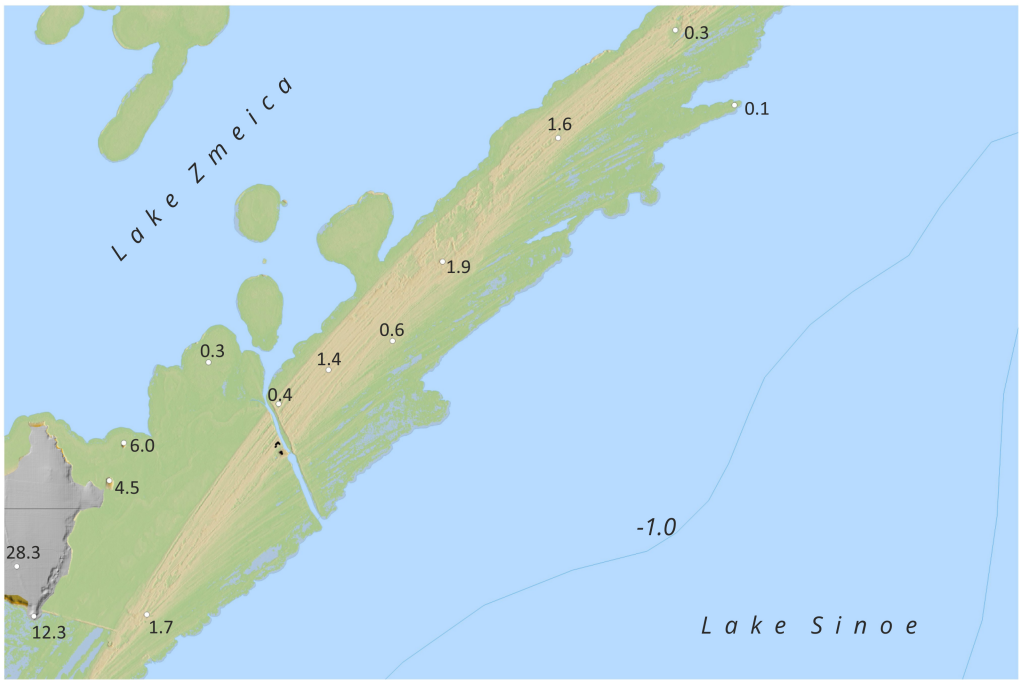
Mean elevation values of the major strandplains and natural levee systems within the deltaic environment.

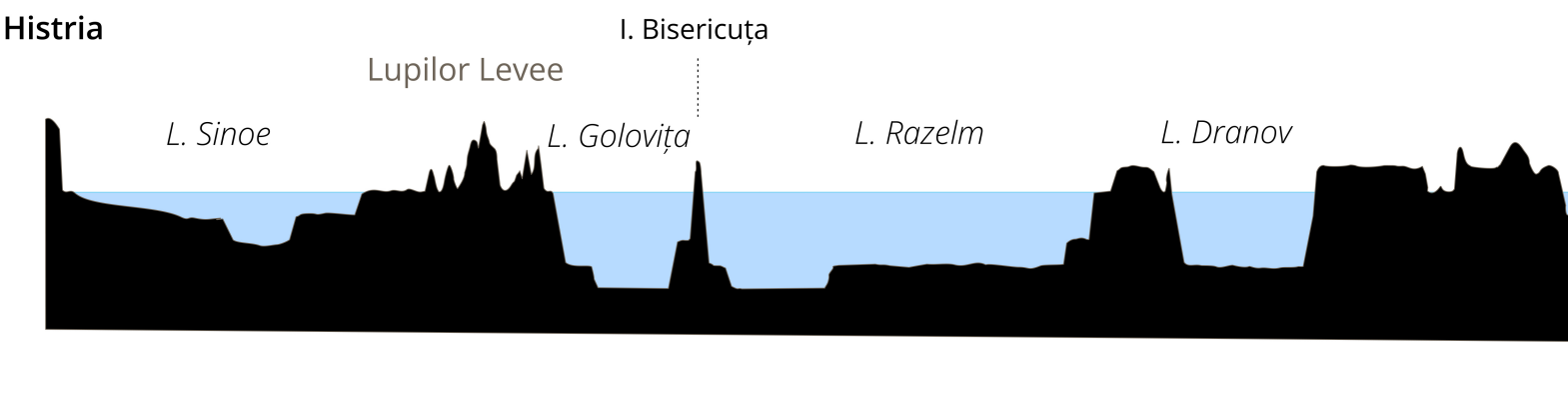
Topographic cross-section of the Danube Delta

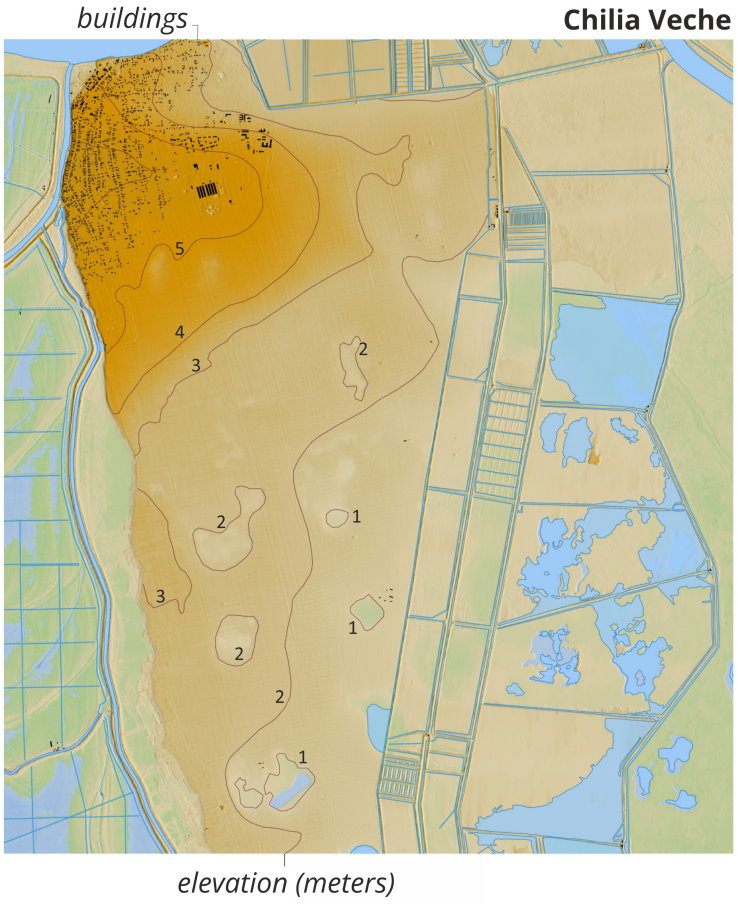
highlighting the relief features of the strandplains

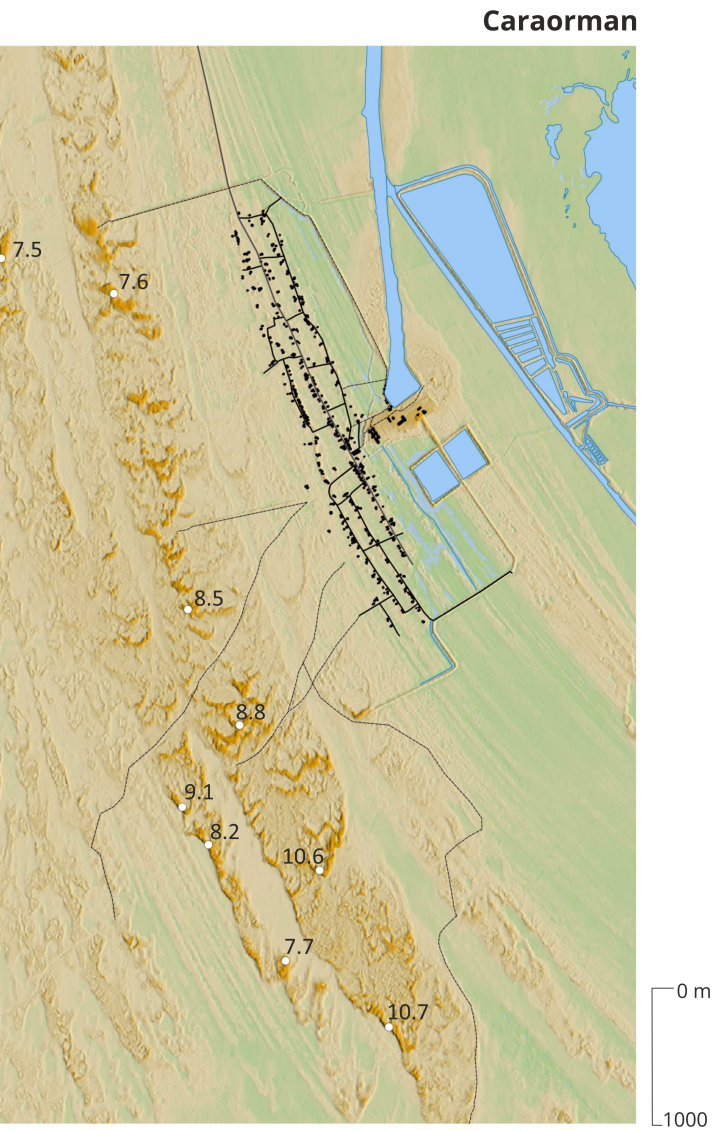


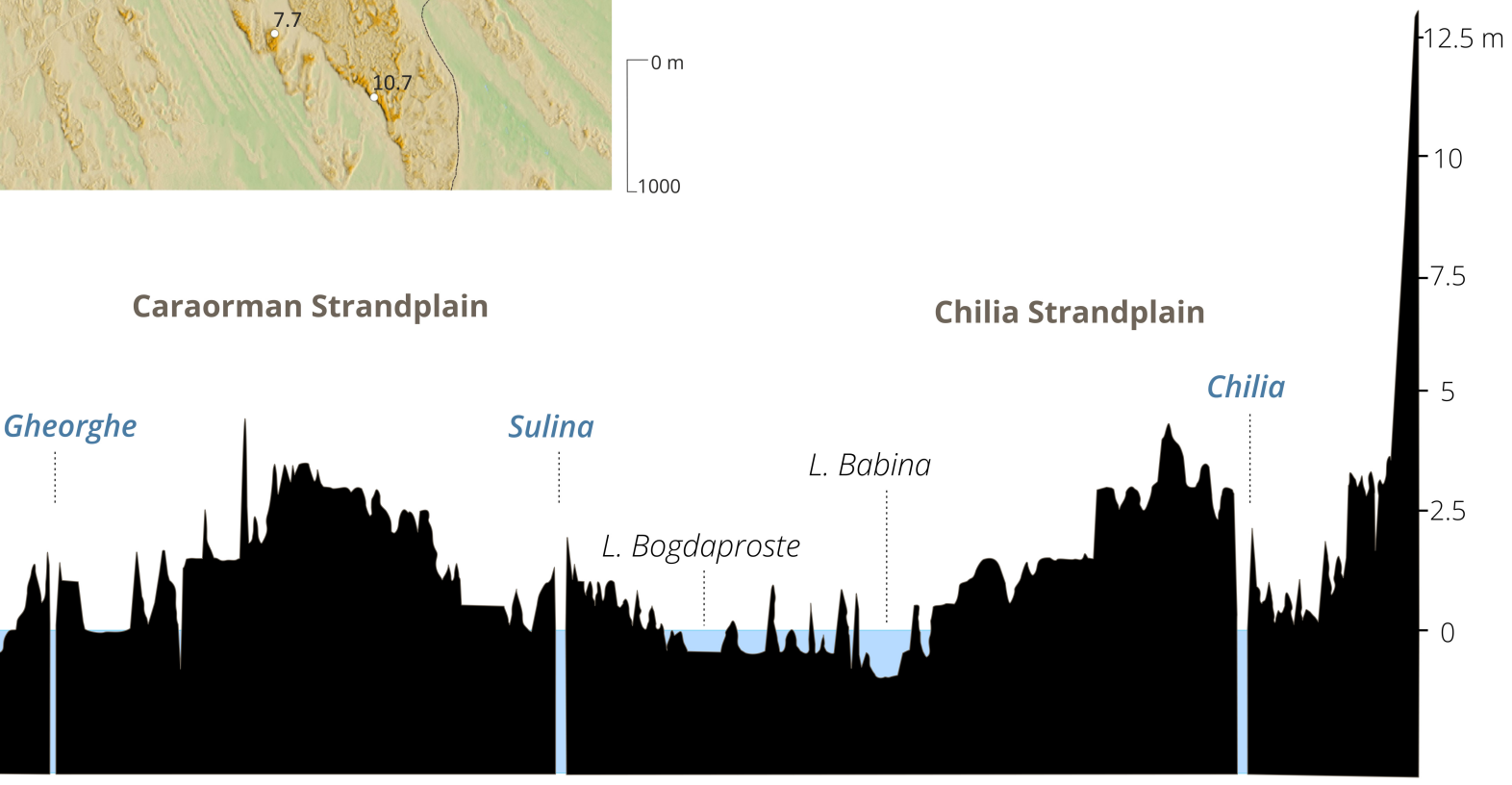




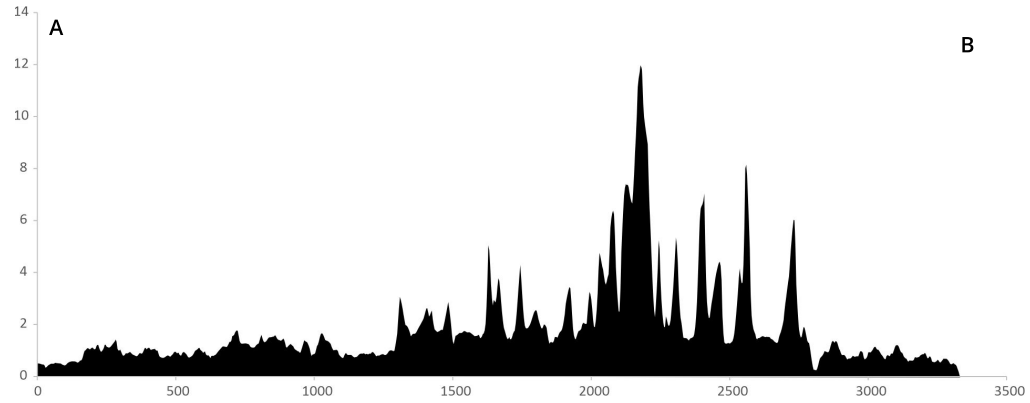


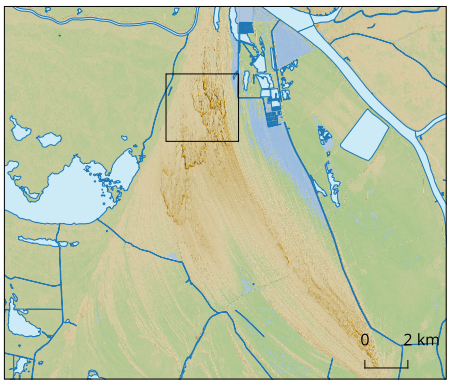

buildings
Chilia Veche
5
4
3
2
2
1
3
1
2
2
1
0 m
1000
elevation (meters)


Caraorman
7.5
7.6
8.5
8.8
9.1
8.2
10.6
7.7
10.7
0 m
1000

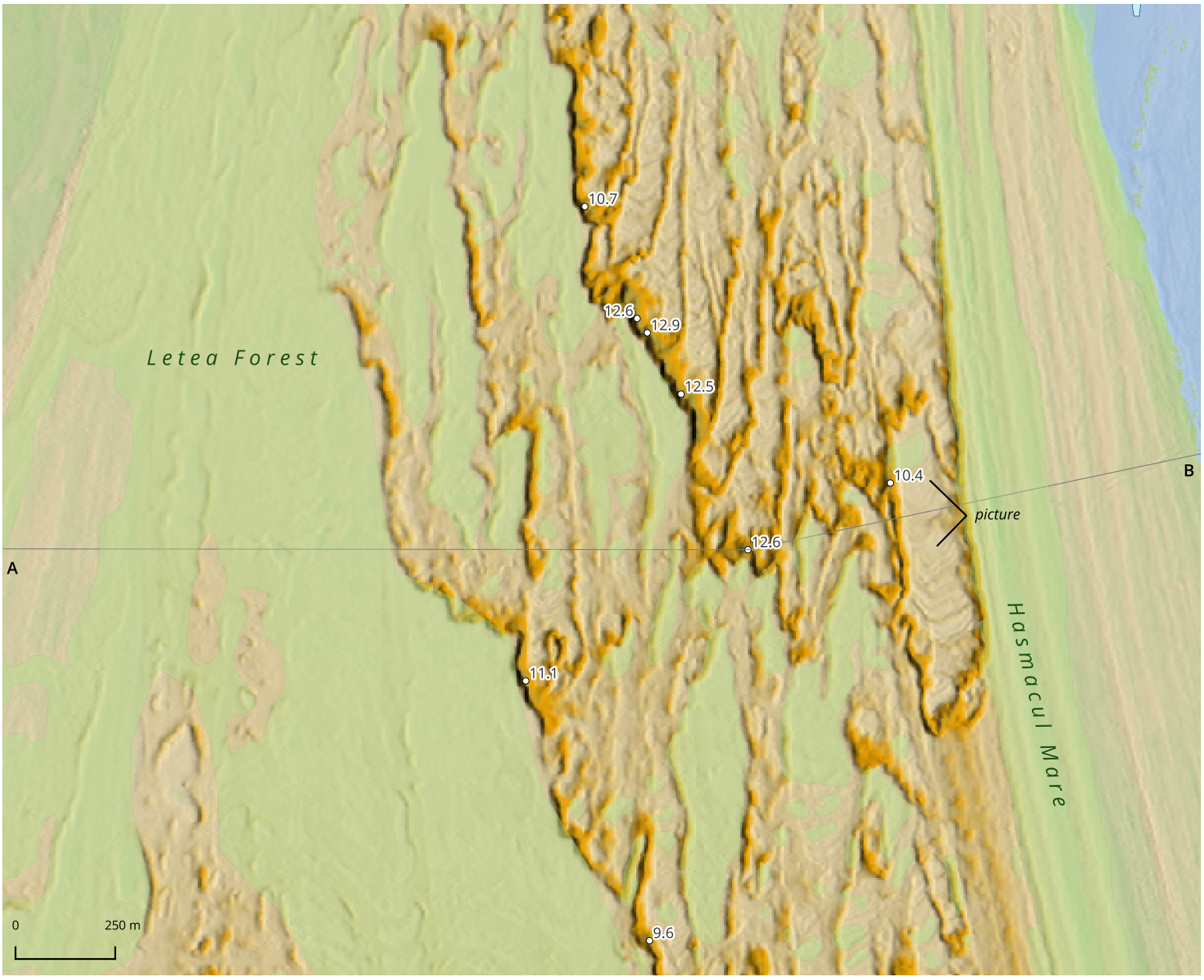

Caraorman Strandplain
Chilia Strandplain
Gheorghe
Sulina
L. Bogdaproste
L. Babina
Chilia
12.5 m
10
7.5
5
2.5
0
SF. GHEORGHE ISLAND
LETEA ISLAND

The relief of the Letea Strandplain with sand dune fields

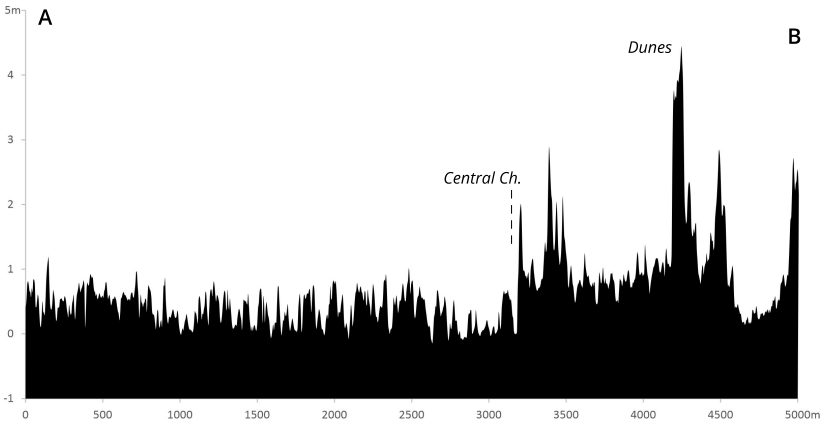


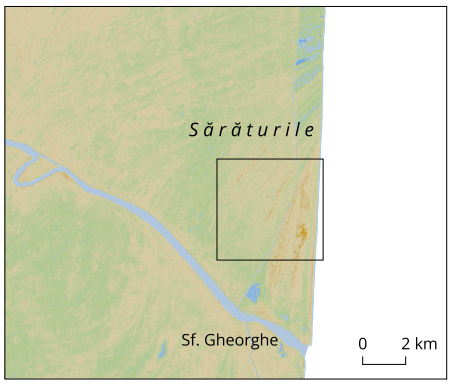






The relief of the Sărăturile Strandplain











Climate

The Danube Delta has a temperate continental climate, with hot summers and cold, windy winters. Mean temperatures increase from west to east, but also from the central area towards both north and south. The 12°C isotherm includes much of the Chilia and the entire Letea Strandplains. Further south it separates Sacalin Island and the southern lagoon system from the central deltaic area.

The maximum temperature recorded was 39.7°C (20/08/1945) at Tulcea, while inside the delta 38.2°C was measured at Gorgova (18/08/1951). The minimum was -27.2°C (18/01/1963) at Tulcea and -26.2°C at Gorgova (18/01/1963). Mean summer temperatures increase from east to west, while in winter the trend is reversed.

The average number of hot days, when maximum daily temperature exceeds 30°C, is 10.6 for the delta as a whole. Values rise from south to north, with maxima in the Pardina-Chilia Veche area, and also from east to west.

The mean number of frost days (1940-2023) is 56.1, with a clear downward trend. In the 1940s values could exceed 90 days, but after 2020 they dropped below 30. Values above 400 mm of annual precipitation occur west of Maliuc, with multiyear maxima in the Somova floodplain (465 mm).

The maximum 24-hour precipitation was recorded on 30/08/1924 at C.A. Rosetti (524 mm). On the same day 243 mm fell at Sarichioi and 219 mm at Sulina.

Relative humidity averages 73%, with a clear increase from west to east, explained by the presence of the Black Sea. Mean annual precipitation (1971-2024) is 367 mm, with a marked decrease from west (Tulcea: 467 mm) to east (Sulina: 281 mm).

Wind is an extremely important climatic factor for the inhabitants of the delta, influencing not only daily activities but sometimes even the fish catch. The maps presented here are based on Copernicus Climate Data (*E-OBS daily gridded meteorological data for Europe*) and cover 1980-2023. These values should be viewed with caution, and a detailed analysis of wind speed requires meteorological station data.

The most important fishing community in the delta has always been Sfântu Gheorghe. Sturgeon fishing at sea always depended on wind conditions. Rough seas restricted boats from going out, creating a very close relationship between the local communities and the wind. Direction was the most important factor, with speed showing its strength. The local population, largely Ukrainian, borrowed names of Slavic origin (Vostok, Zapad), but Turkish influence is visible in

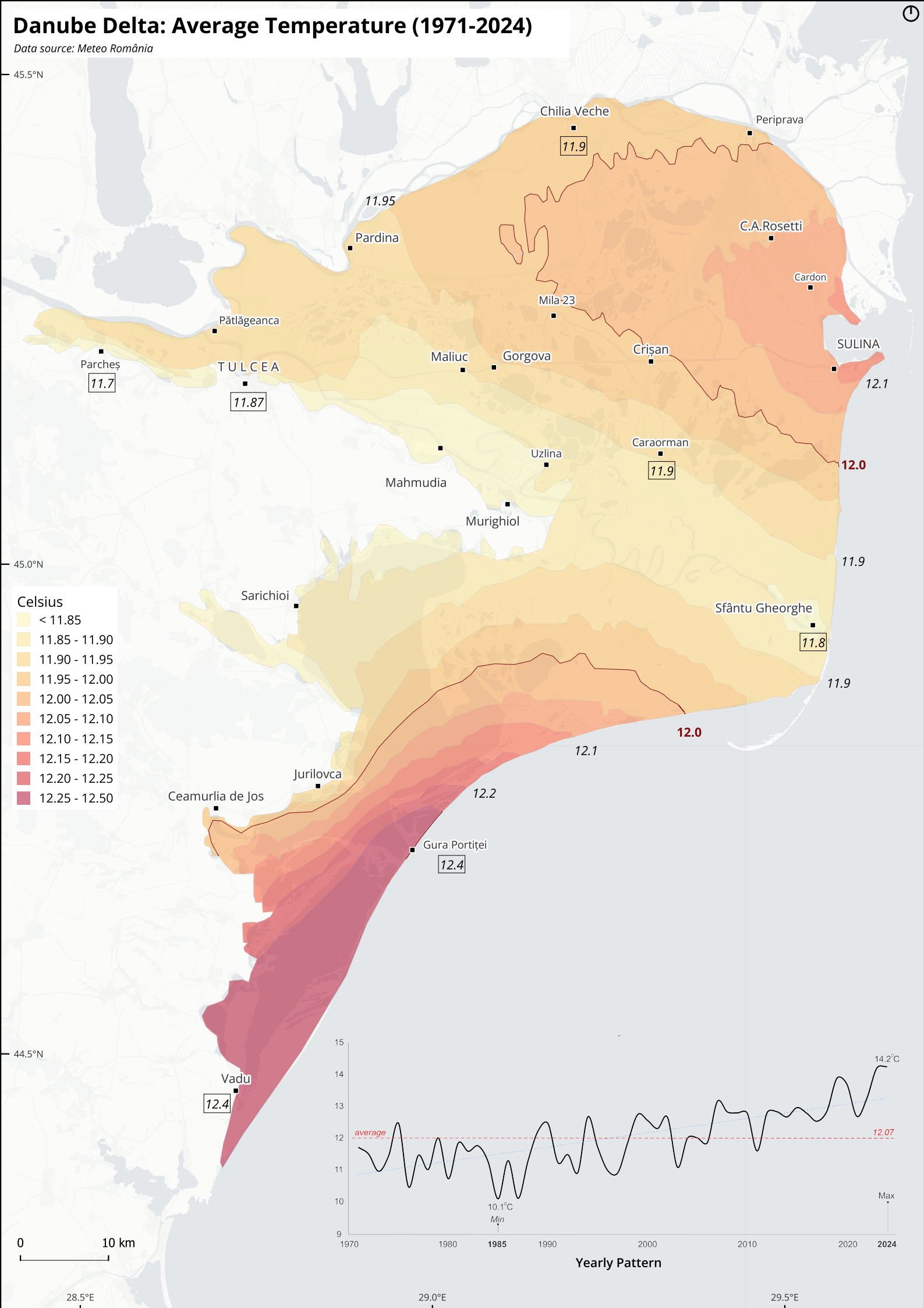
the survival of two major names from that language (Caraeli, Lodus). The southern wind (*Moreana*) cools the sea waters and has a special importance for fishing. We have included a separate figure to explain the etymology of these names.

Maximum wind speed increases naturally from west to east, with a mean of 10.2 m/s for the delta as a whole.

The maps included in this section are based on data published by Meteo Romania. Where these were not available, we used Copernicus Climate Data. Each map clearly indicates its source at the top.

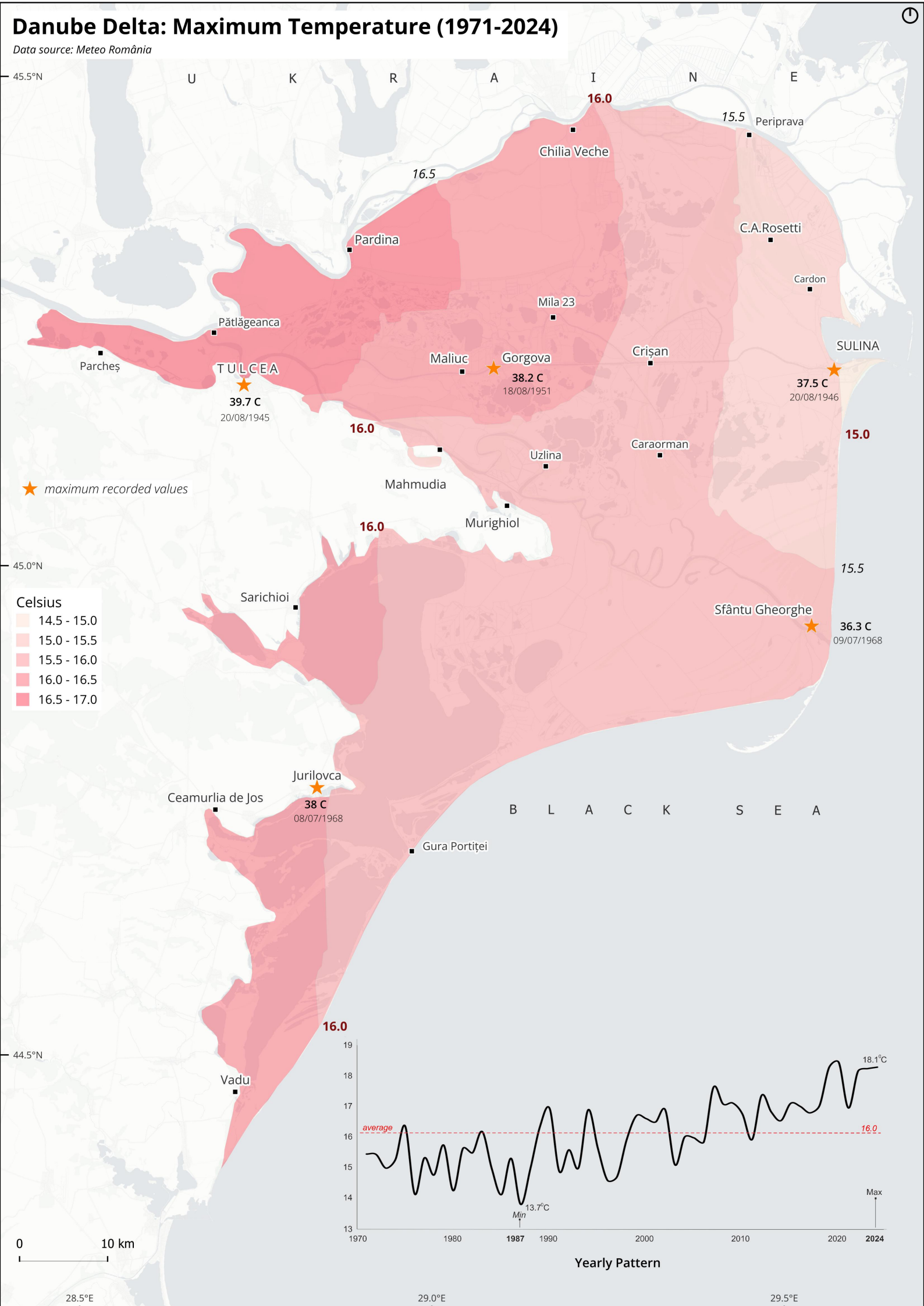
Danube Delta: Average Temperature (1971-2024)

Data source: Meteo România



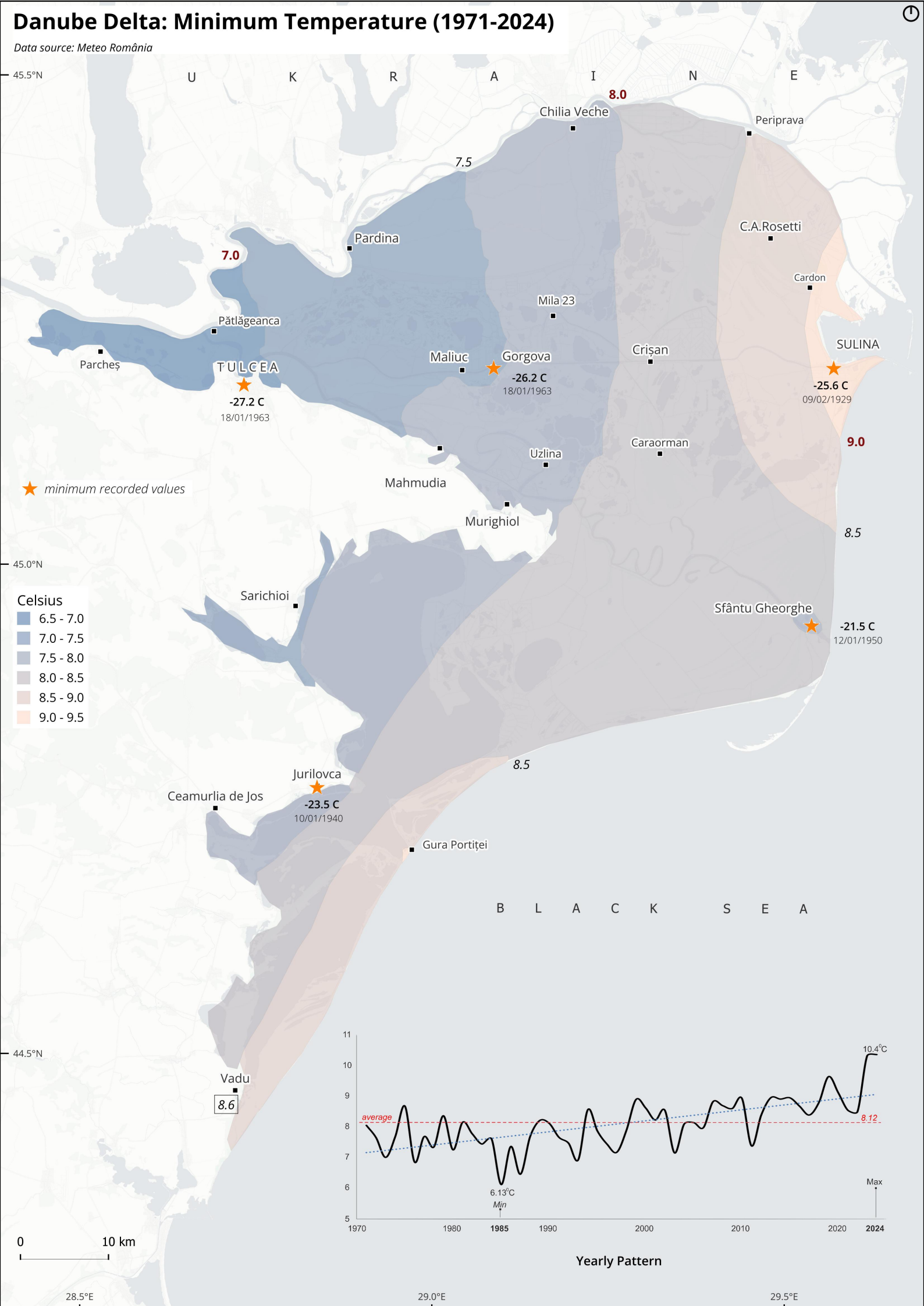
Danube Delta: Maximum Temperature (1971-2024)

Data source: Meteo România



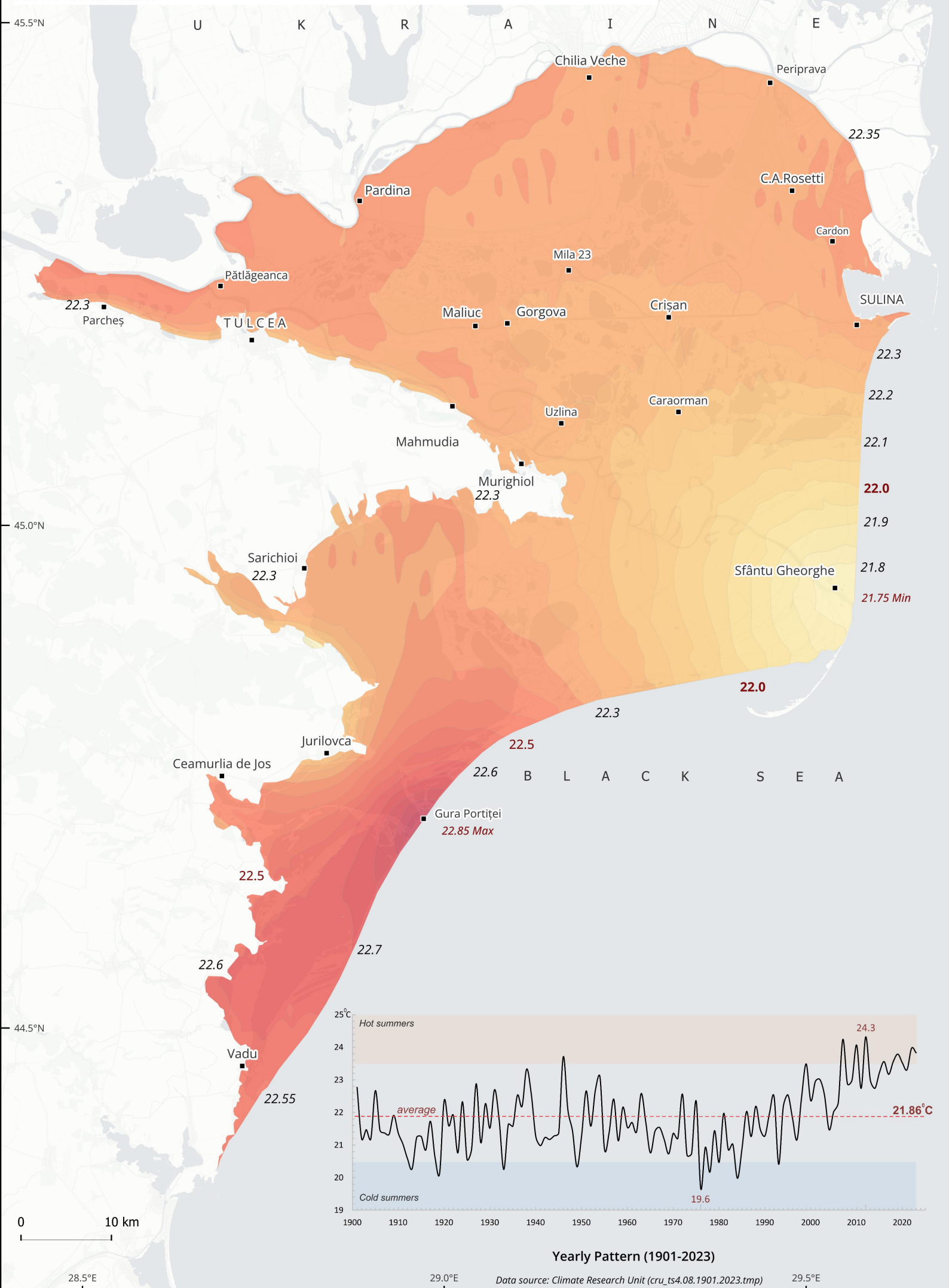
Danube Delta: Minimum Temperature (1971-2024)

Data source: Meteo România



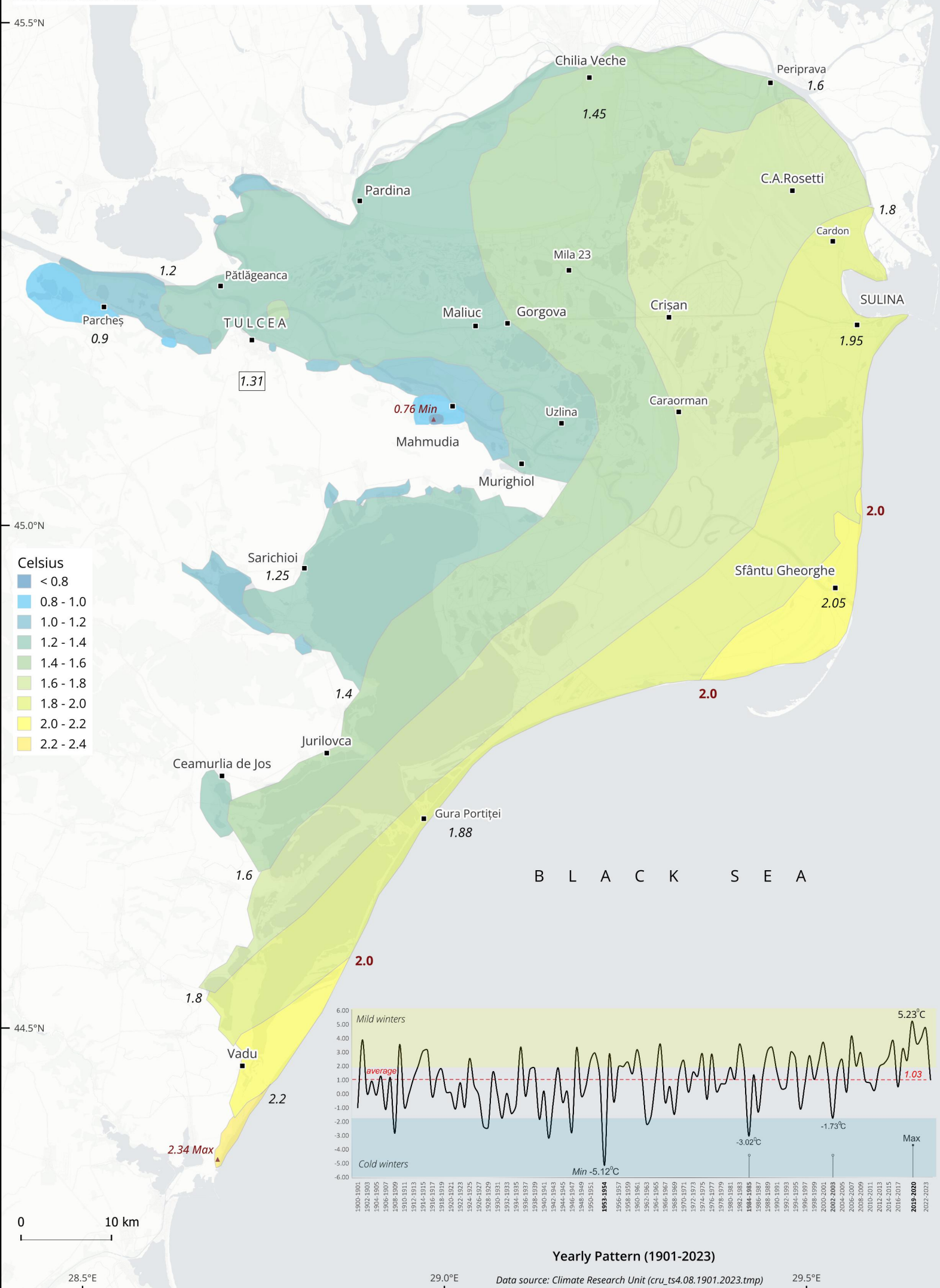
Danube Delta: Mean Summer Temperature (1971-2022)

Data source: Meteo România



Danube Delta: Mean Winter Temperature (1971-2022)

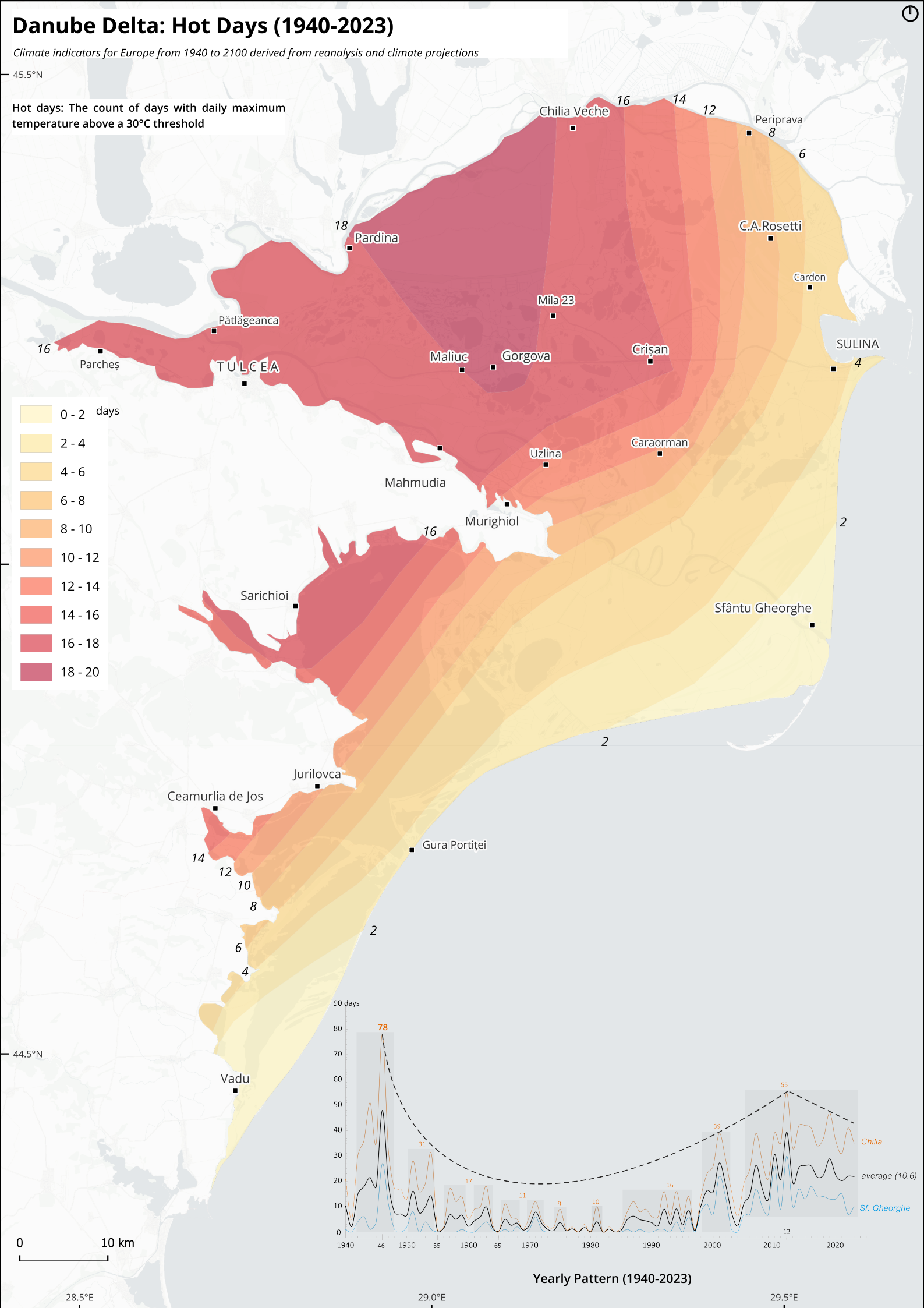
Data source: Meteo România



Danube Delta: Hot Days (1940-2023)

Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections

Hot days: The count of days with daily maximum temperature above a 30°C threshold

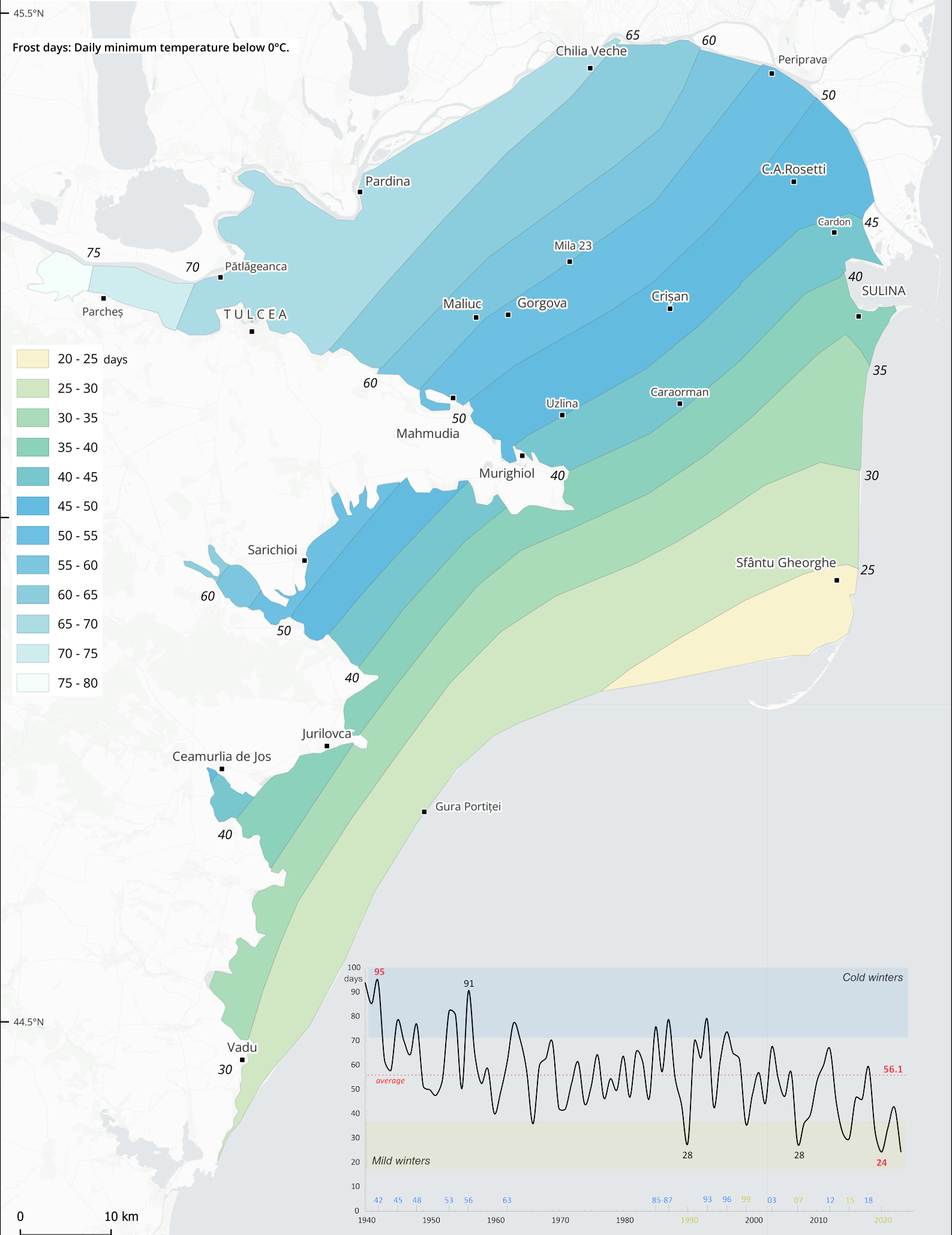


Yearly Pattern (1940-2023)

Danube Delta: Frost Days (1940-2023)

Climate indicators for Europe from 1940 to 2100 derived from reanalysis and climate projections

Frost days: Daily minimum temperature below 0°C.

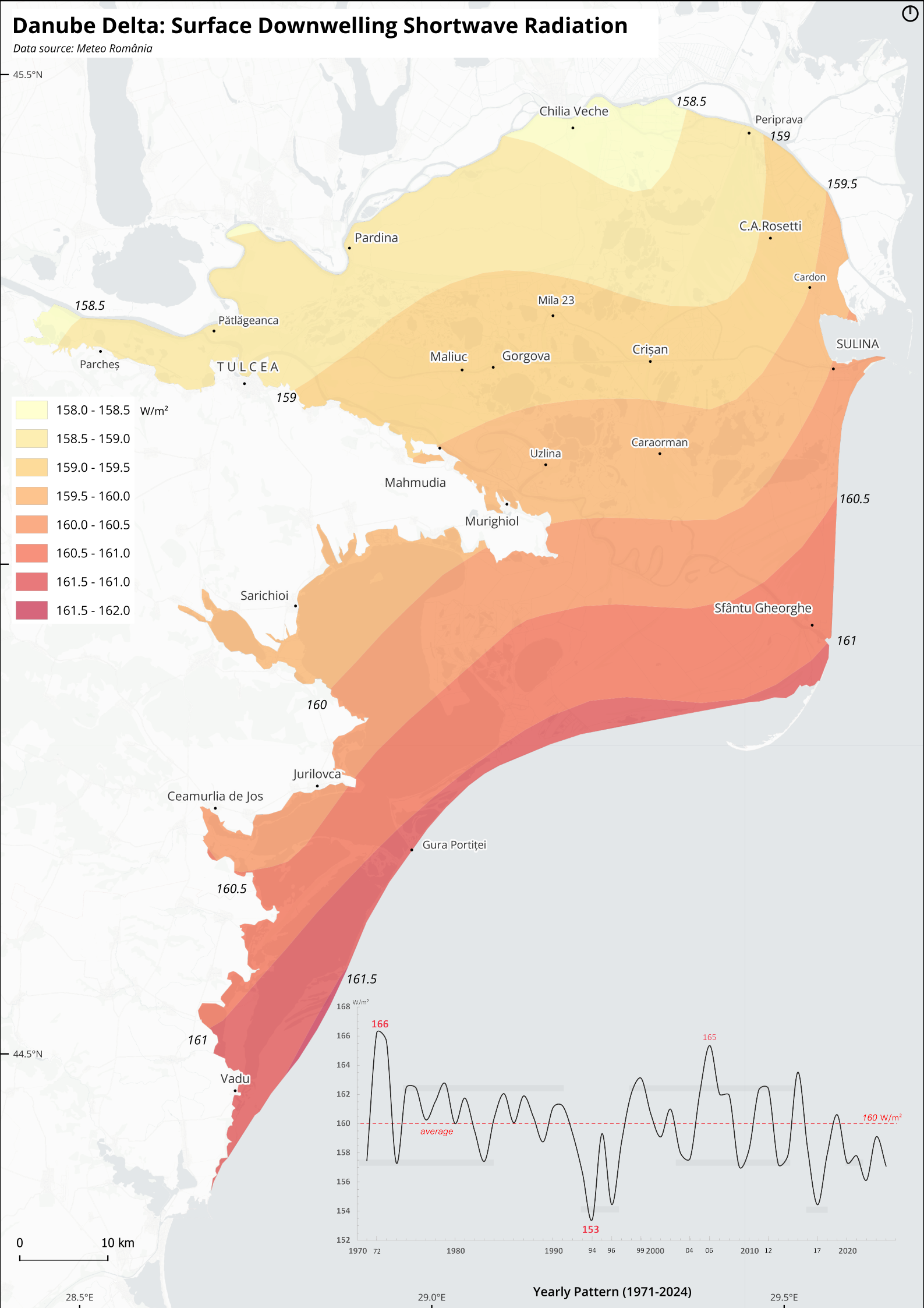


Copernicus Climate Data Store

Yearly Pattern (1940-2023)

Danube Delta: Surface Downwelling Shortwave Radiation

Data source: Meteo România



Danube Delta: Heating Degree Days (1971-2024)

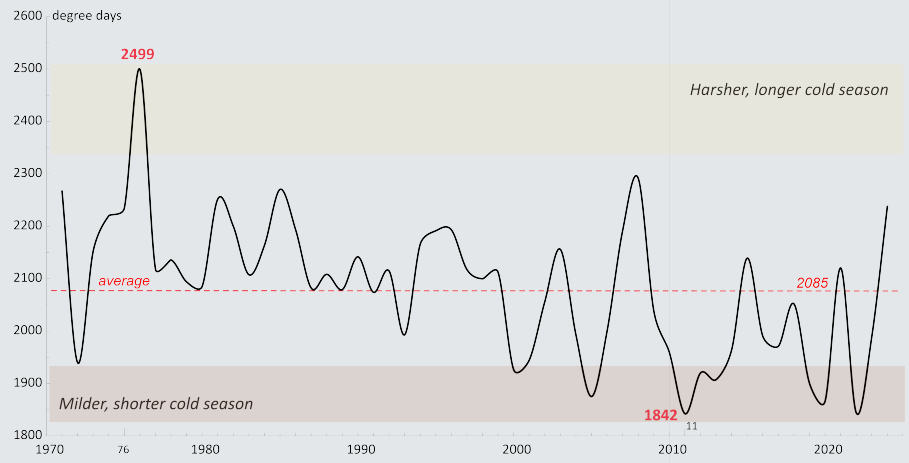
Data source: Meteo România

Heating Degree Days (HDD) represent the annual sum of daily differences between the mean daily temperature (Tmed) and a user-defined base temperature (T), provided that Tmed < T. This indicator measures the energy demand for heating buildings. In the European Union, the standard threshold is 15.5°C

45.5°N

2080
2090
Chilia Veche
2070
Periprava
2090
2130
Pardina
2110
C.A.Rosetti
Cardon
2160
Mila 23
Pătlăgeanca
SULINA
Parcheș
Maliuc
Gorgova
Crișan
TULCEA
2100
2130
Caraorman
Uzlina
2110
Mahmudia
Murighiol
2100
45.0°N
Sarichioi
Sfântu Gheorghe
2090
2090
2080
Jurilovca
Ceamurlia de Jos
2070
Gura Portiței
2100
2240 degree days
2040
2060
2050
44.5°N
2080
Vadu
0
10 km
28.5°E
29.0°E
29.5°E

Higher HDD values indicate colder climates or longer, harsher cold seasons, leading to increased heating energy demand. Lower HDD values suggest milder winters with less need for heating. In regions with HDD above 3000, winters are severe, while values below 1500 indicate relatively warm climates with minimal heating requirements.



Yearly Pattern (1971-2024)

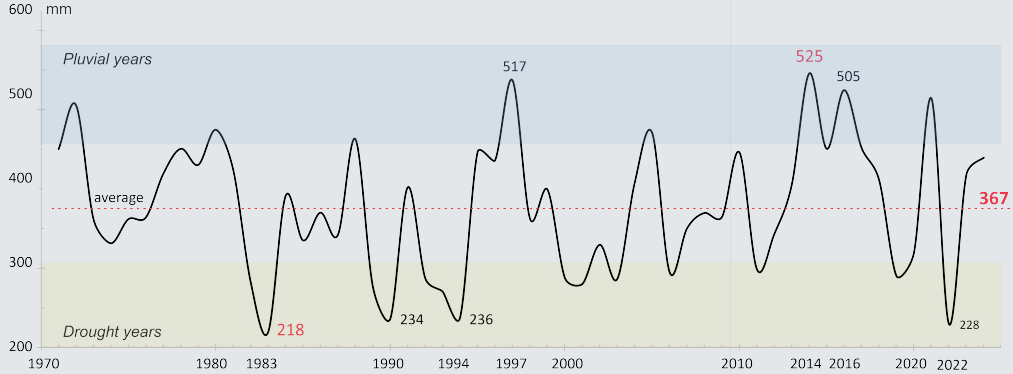
Danube Delta: Average Precipitation Regime (1971-2024)

Data source: Meteo România

45.5°N

Chilia Veche
372
Periprava
325
400
C.A.Rosetti
309
450
Pardina
431
Cardon
292
Mila 23
366
Pătlăgeanca
461
465
Parcheș
TULCEA
467
Maliuc
391
Gorgova
Crișan
339
SULINA
281
411
Caraorman
339
Uzlina
369
Mahmudia
386
300
Murighiol
45.0°N
Sarichioi
401
Sfântu Gheorghe
333
350
Jurilovca
368
Ceamurlia de Jos
376
Gura Portiței
349
44.5°N
Vadu
393

< 300 mm
300-350
350-400
400-450
> 450



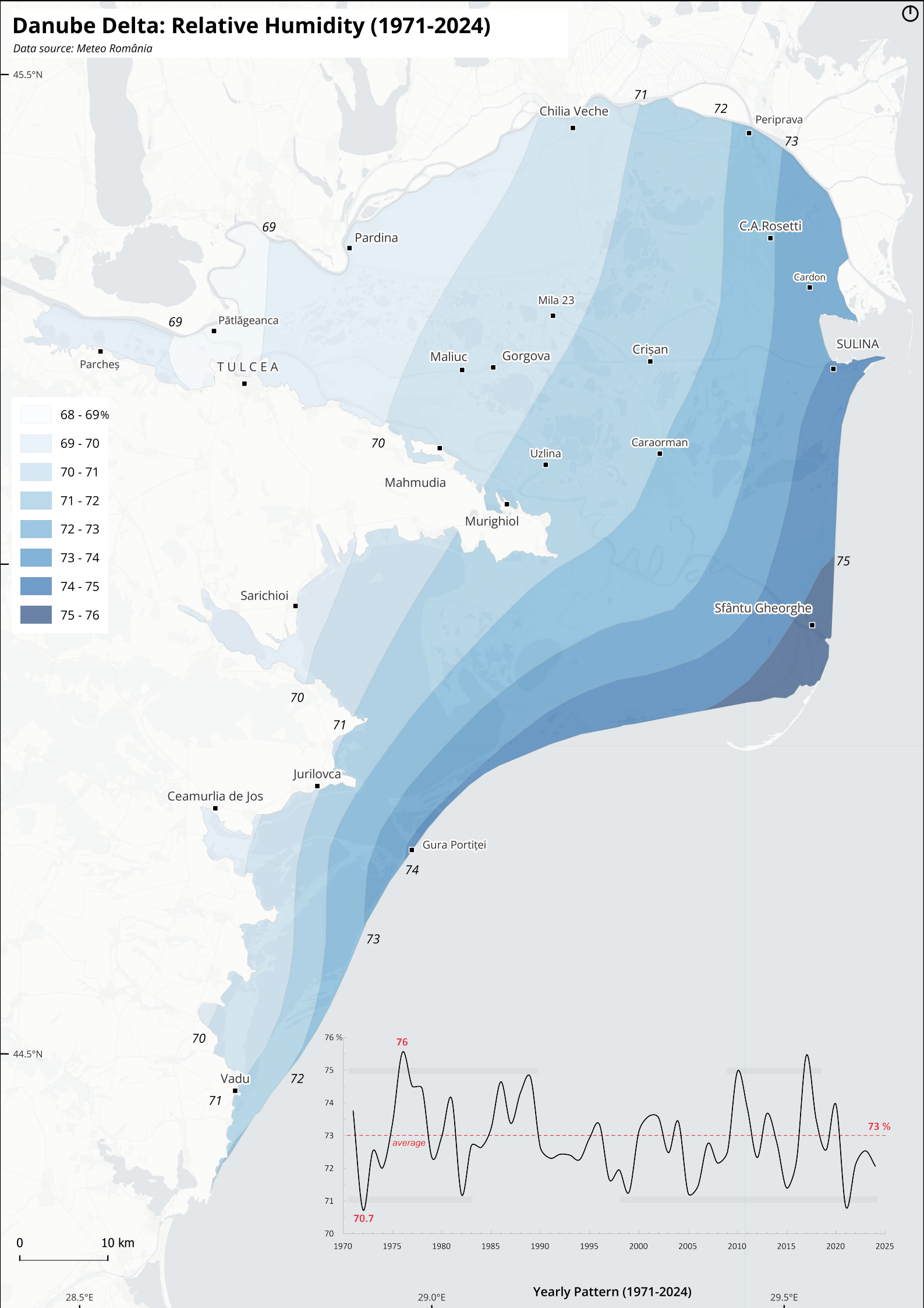
Yearly Pattern

0 10 km

28.5°E 29.0°E 29.5°E

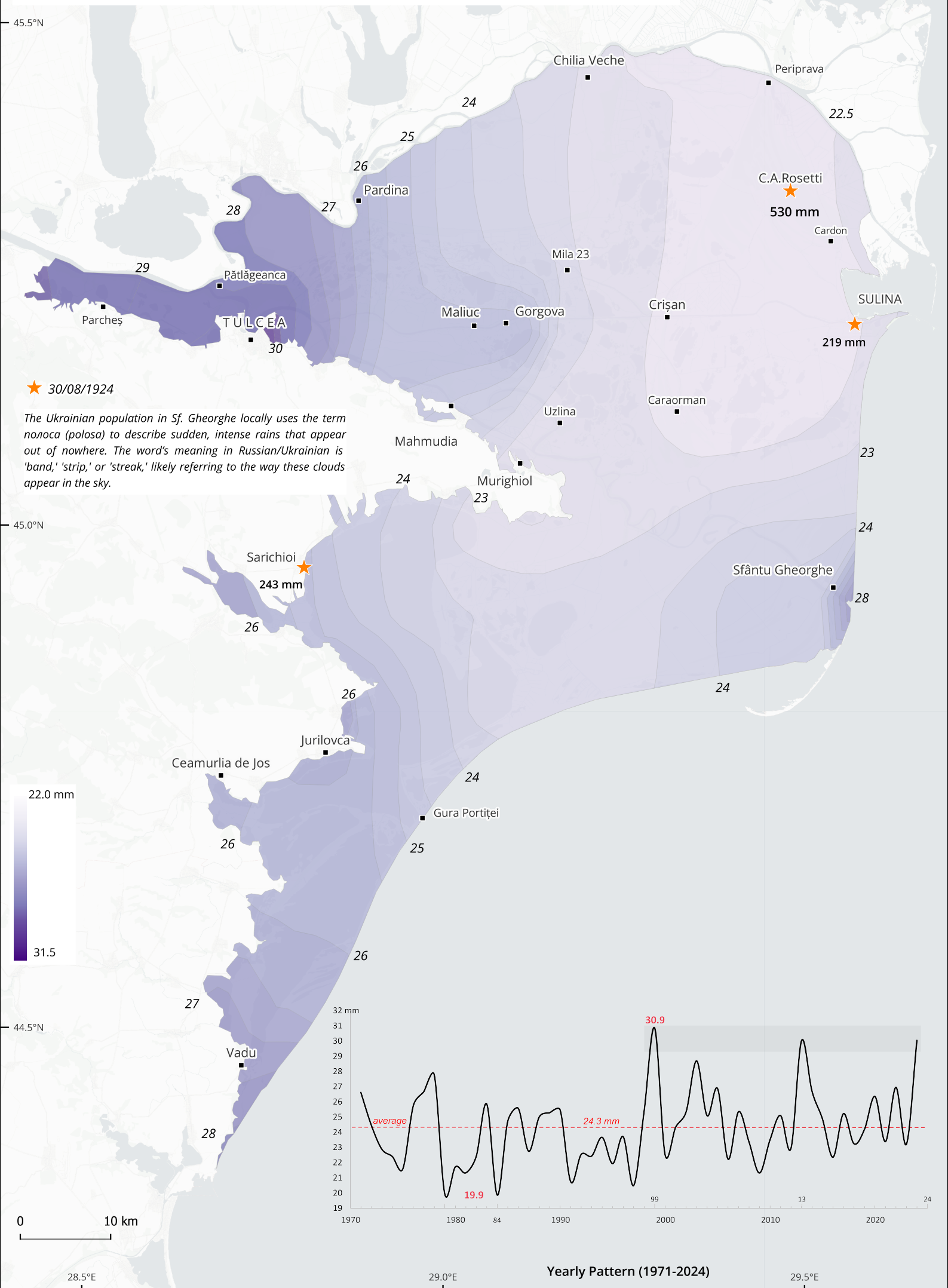
Danube Delta: Relative Humidity (1971-2024)

Data source: Meteo România



Danube Delta: Maximum 24-hour Precipitation (1971-2024)

Data source: Meteo România

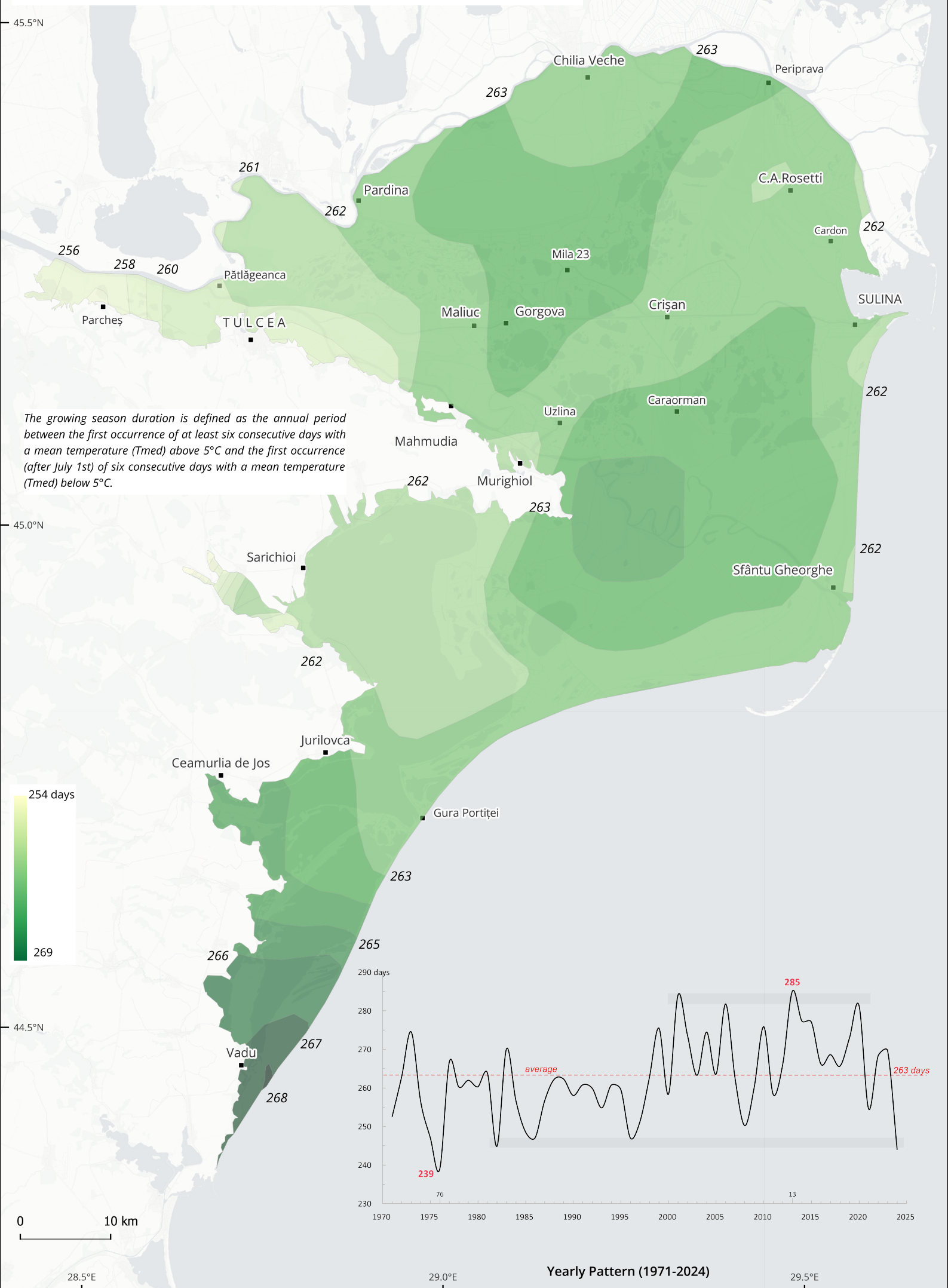


The Ukrainian population in Sf. Gheorghe locally uses the term полоса (polosa) to describe sudden, intense rains that appear out of nowhere. The word's meaning in Russian/Ukrainian is 'band,' 'strip,' or 'streak,' likely referring to the way these clouds appear in the sky.

Yearly Pattern (1971-2024)

Danube Delta: Growing Season Length (1971-2024)

Data source: Meteo România

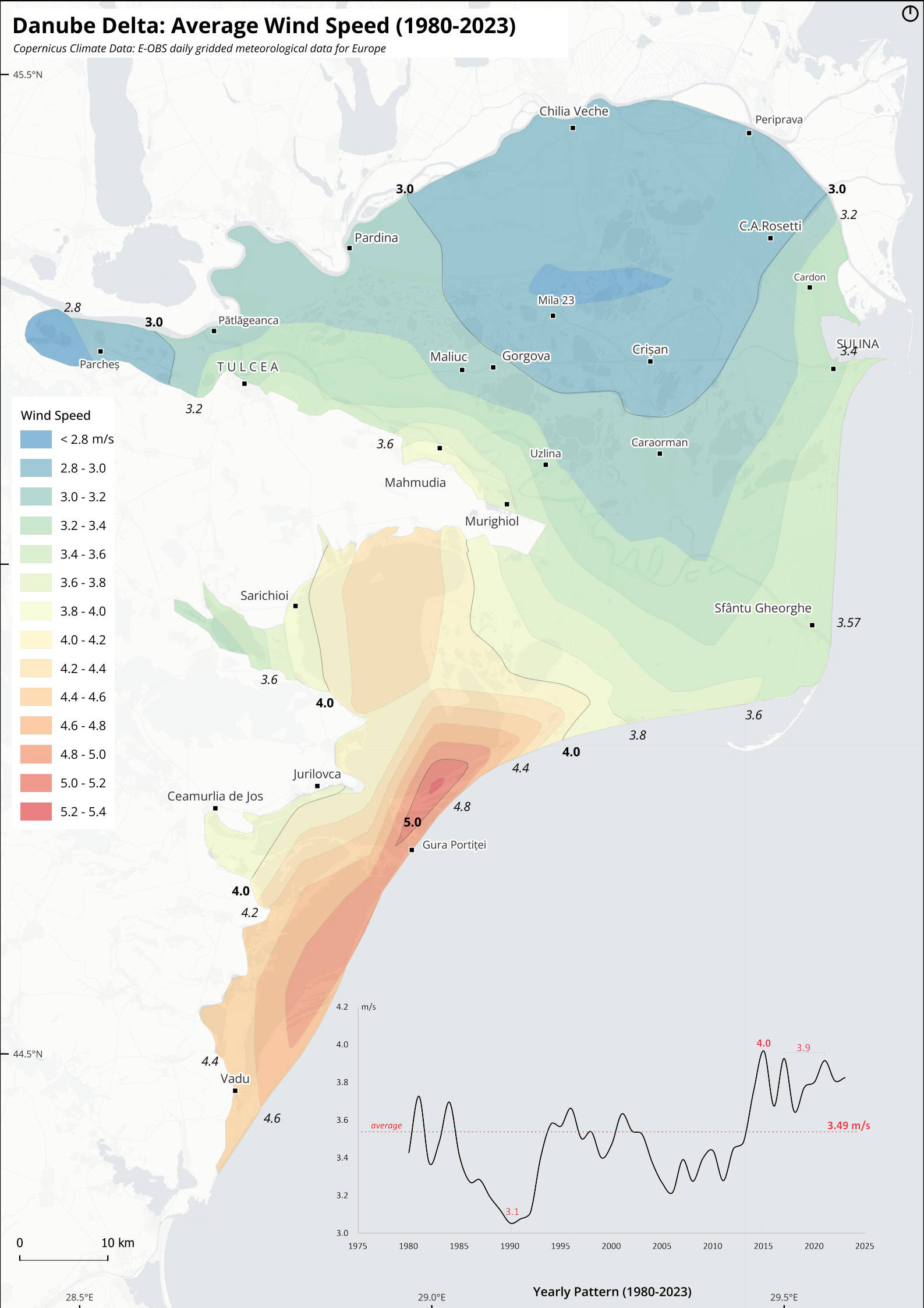


The growing season duration is defined as the annual period between the first occurrence of at least six consecutive days with a mean temperature (Tmed) above 5°C and the first occurrence (after July 1st) of six consecutive days with a mean temperature (Tmed) below 5°C.

Yearly Pattern (1971-2024)

Danube Delta: Average Wind Speed (1980-2023)

Copernicus Climate Data: E-OBS daily gridded meteorological data for Europe



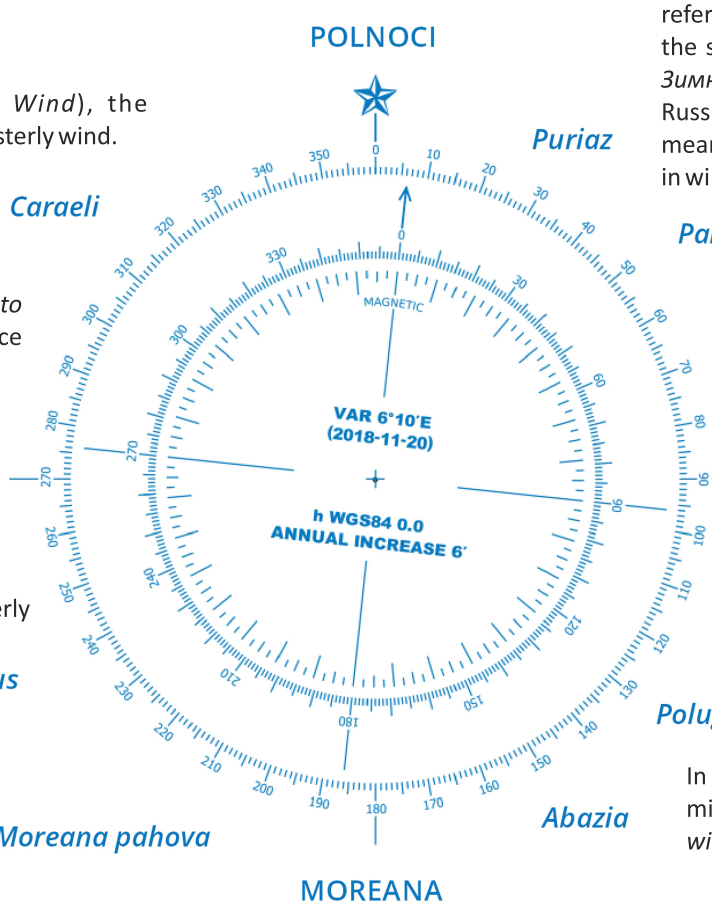
Local wind names used by the fishermen of Sfântu Gheorghe

In Russian: *полночь* (polnoch') = midnight. *Polu* = half / middle, *nochi* / *noć* = night. In Slavic and Romanian folk culture, the north = the direction of darkness, of cold, *where the night is*.

In Greek mythology, *Βορέας* (Boreas) represents the north wind. The term Puriaz may be interpreted as a Slavicised derivative of *Boreas.*

In Russian dialects, *Паховой* (Pahovoi) referred to a strong, penetrating wind, with the sense of a blizzard; *пахать* = to plough. *Зимний* (zimnii) = winter / hibernal. East in Russian is *Восток* (vostok). In this context, the meaning is that of a strong, cold wind blowing in winter.

From Turkish *Karayel* (*Black Wind*), the traditional name for the north-westerly wind.



From Old Slavic *падати* (padati) = *to fall, to set Запад* (Zapad) = the place where the sun sets (the west).

From the Old Slavic verb *восходить* (voskhodit') = to rise, to ascend. *Vostok* = the place where the sun rises.

From Turkish *Lodos*, the south-westerly warm and humid wind.

In Slavic, *полудень* (poluden') = *noon*, the middle of the day. The meaning is *the wind from noon*.

In Russian, *пах* (pakh) = *armpit* / side, hence *Moreana Pahova* refers to the sea wind blowing along the shore.

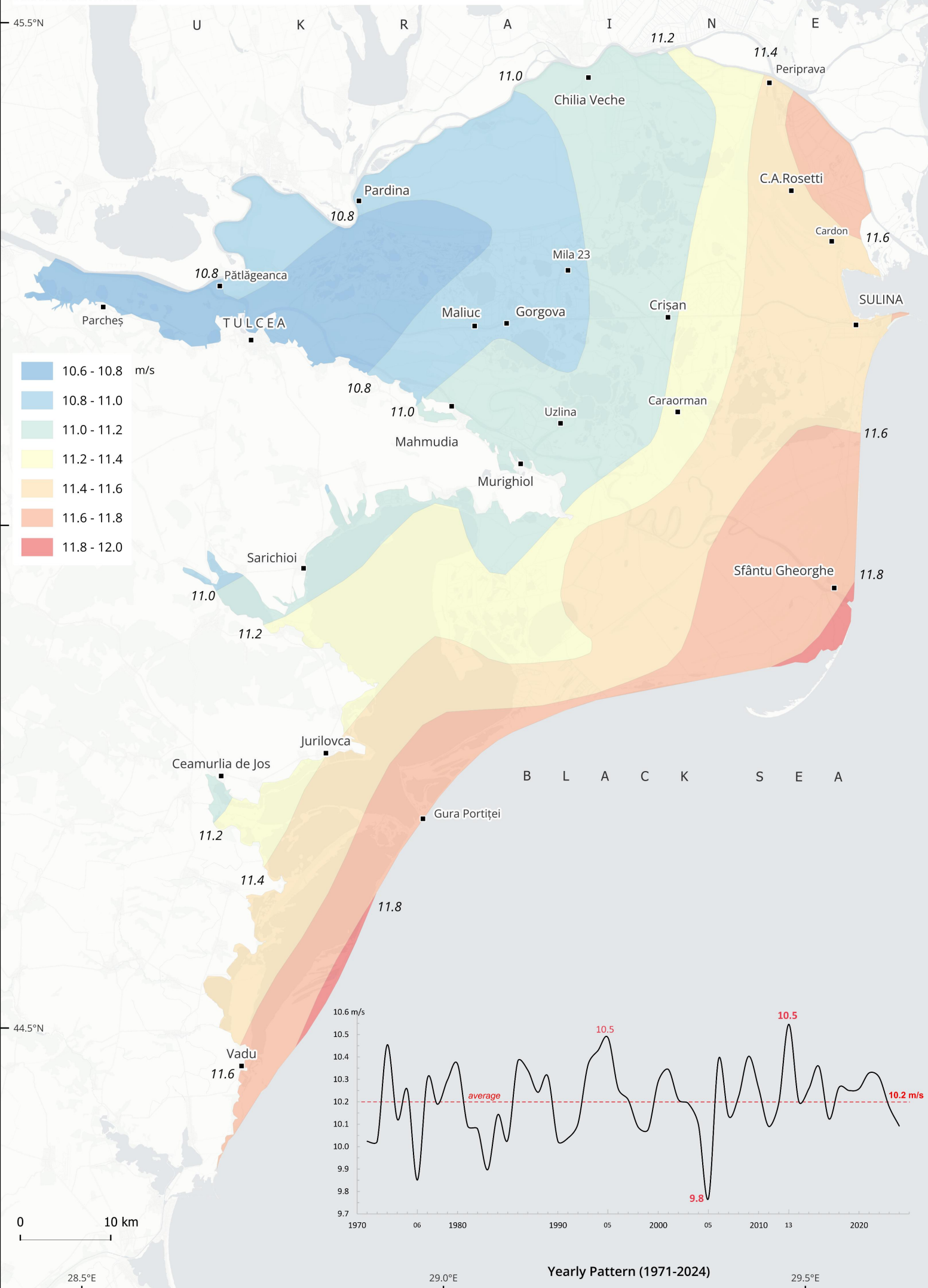
Abazia, possibly derived from Abkhazia (Абхазия), the Caucasian region lying in that direction?

Moreana may derive from the Slavic root *море* (more) = sea.

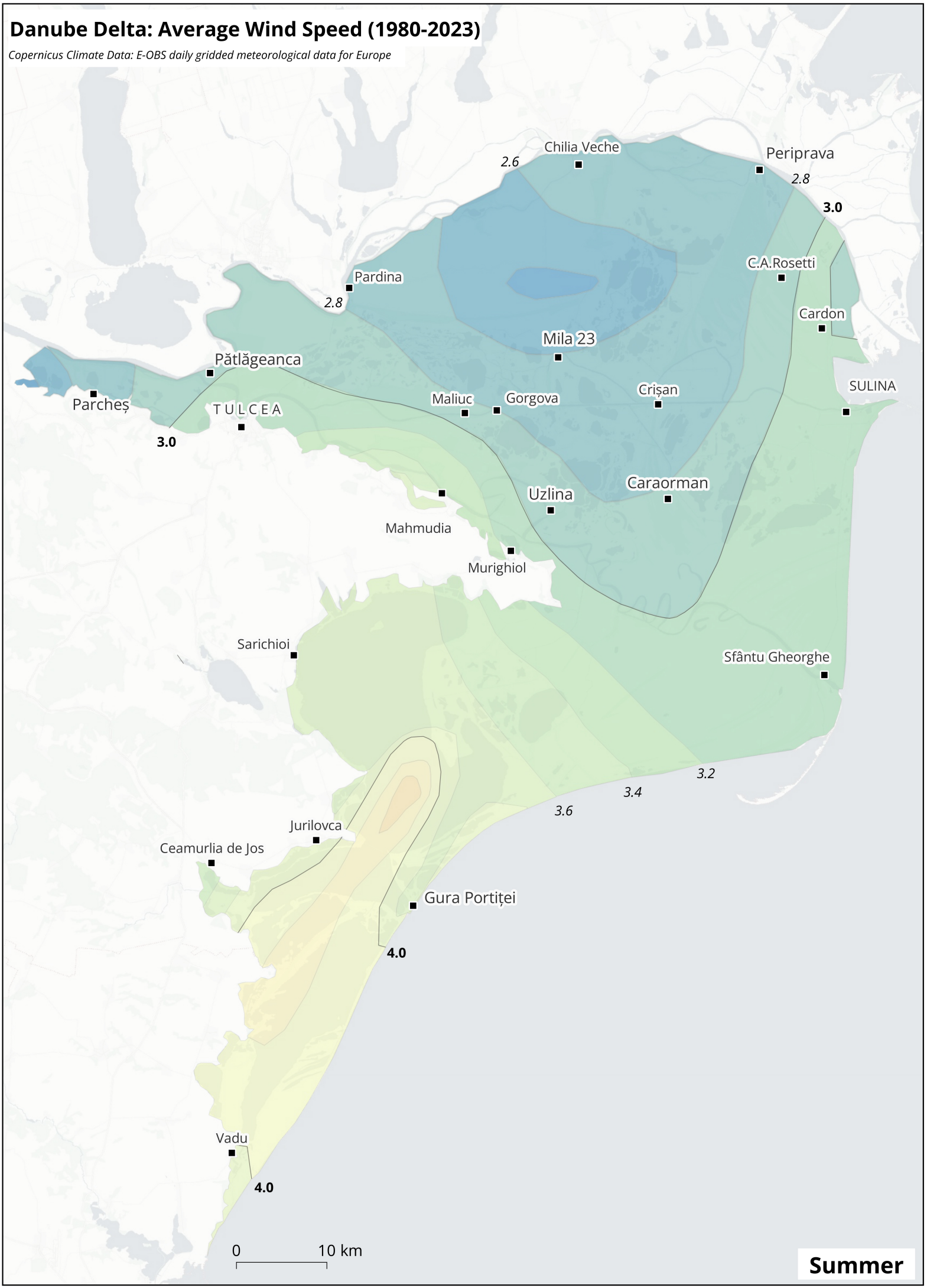
Nevertheless, we never encounter two fishermen in full agreement on the names, let alone on the directions, of the intercardinal winds.

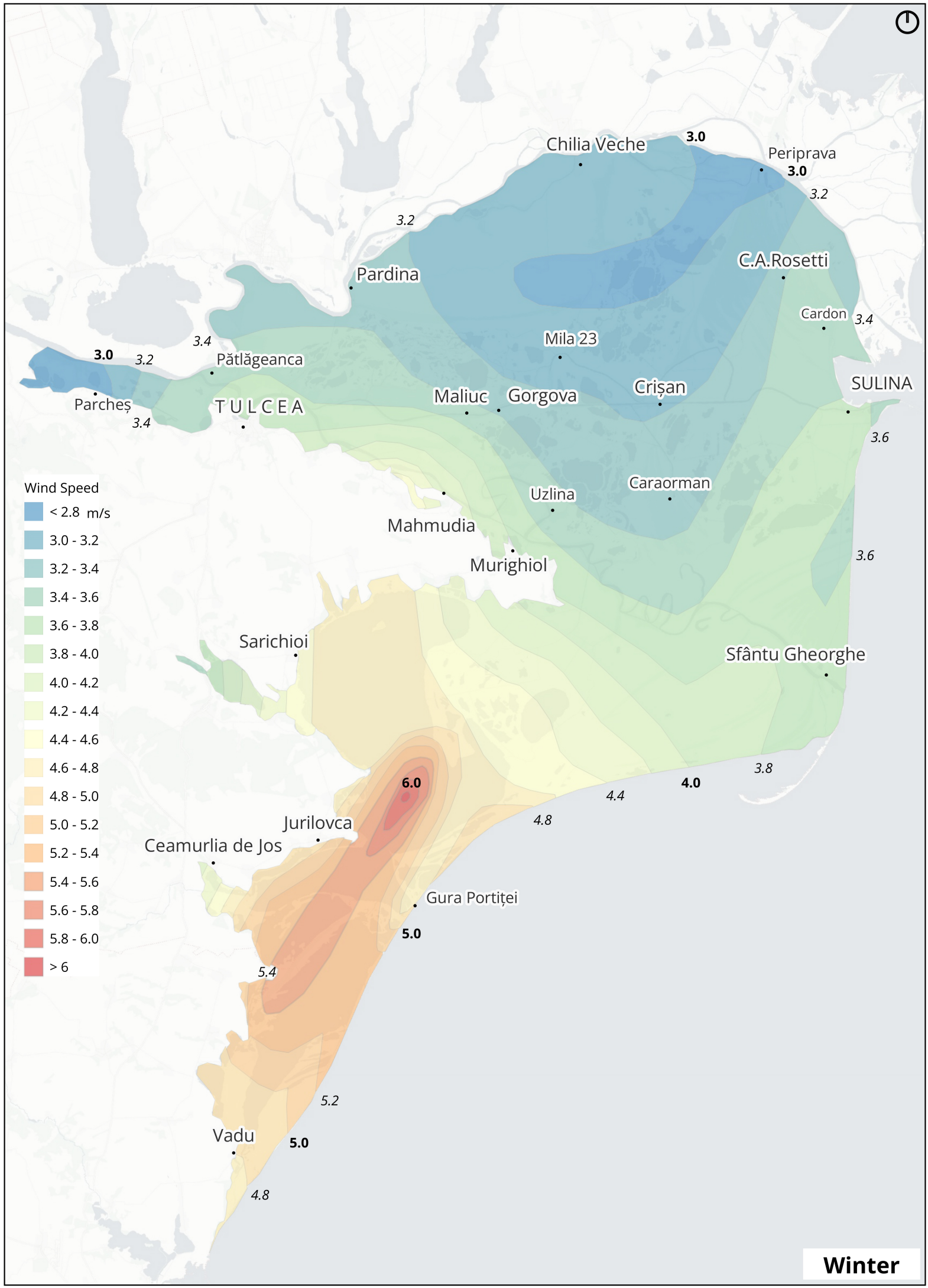
Danube Delta: Maximum Wind Speed (1971-2024)

Data source: Meteo România



Yearly Pattern (1971-2024)


Danube Delta: Average Wind Speed (1980-2023)
Copernicus Climate Data: E-OBS daily gridded meteorological data for Europe
Chilia Veche
Periprava
2.6
2.8
3.0
C.A.Rosetti
Pardina
2.8
Cardon
Mila 23
Pătlăgeanca
Parcheș
TULCEA
3.0
Maliuc
Gorgova
Crișan
SULINA
Caraorman
Uzlina
Mahmudia
Murighiol
Sarichioi
Sfântu Gheorghe
3.2
3.4
3.6
Jurilovca
Ceamurlia de Jos
Gura Portiței
4.0
Vadu
4.0
0
10 km
Summer


Chilia Veche
3.0
Periprava
3.0
3.2
3.2
C.A.Rosetti
Pardina
Cardon
3.4
Mila 23
3.4
3.0
3.2
Pătlăgeanca
Crișan
SULINA
Maliuc
Gorgova
Parcheș
TULCEA
3.4
3.6
Caraorman
Uzlina
Mahmudia
Murighiol
3.6
Sarichioi
Sfântu Gheorghe
3.8
6.0
4.0
4.4
4.8
Jurilovca
Ceamurlia de Jos
Gura Portiței
5.0
5.4
5.2
Vadu
5.0
4.8
Wind Speed
< 2.8 m/s
3.0 - 3.2
3.2 - 3.4
3.4 - 3.6
3.6 - 3.8
3.8 - 4.0
4.0 - 4.2
4.2 - 4.4
4.4 - 4.6
4.6 - 4.8
4.8 - 5.0
5.0 - 5.2
5.2 - 5.4
5.4 - 5.6
5.6 - 5.8
5.8 - 6.0
> 6
Winter

Hydrography

The mean annual water discharge of the Danube, at the entrance to the delta, is 6,470 m^3/s (Bondar, 2011). The highest peak ever recorded was in July 1897 (20,940 m^3/s), while the lowest was in October 1921 (1,350 m^3/s). Since the 1897 value is considered inaccurate, the next maximum, 15,900 m^3/s, recorded in 2006, is usually cited in the literature. Minimum values were recorded in 2003 at Ceatal Izmail (2,030 m^3/s). For the Danube Delta, the influence of the Siret and Prut rivers is important, as they deliver significant amounts of water and suspended sediment. Based on a long interval of water discharge data (1840–1990), Bondar noted a slight upward trend, with an annual rate of 3.9 m^3/s, while the solid discharge shows a decreasing tendency, at about −8.3 kg/s per year.

There are 62 dams along the Danube, with the Iron Gates acting as the main trap for sediments. The Iron Gates I and II dams are usually regarded as the largest sediment retention system on the river. Various authors have estimated the extent of this trapping. Panin (1996) suggested a 35–50% decrease in the Danube's sediment discharge following the construction of the dams. Between 1972 and 1994, Iron Gates I retained 325 × 10^6 t of sediment, equivalent to ~10% of the lake's total capacity (Liska, 2008). Bondar (2008) quantified the retention of Iron Gates I at around 34% of incoming sediments between 1971 and 2005, while another study (Arhip et al., 2010) estimated that 24.58% of the reservoir was already infilled. Iron Gates II has a much lower retention value of 0.17% (Arhip et al., 2010). At the entrance to the delta, sediment load decreased by 53% (from 1,846 kg/s between 1840 and 1970 to 962 kg/s between 1971 and 2000) (Bondar, 2008). Smaller dams on the Danube's tributaries also play an important role in reducing sediment discharge. For example, since the 1970s, 244 reservoirs have been constructed in Romania with a total retention volume of 3,000 m^3, of which around 19.7% is already infilled with sediment. Recent studies (e.g. Rădoane, 2008) indicate reductions in sediment discharge along the Danube after the confluence with major Romanian rivers: by 69% downstream of the Jiu, 67% downstream of the Argeș, and 48% downstream of the Siret and the Prut. Before the 1970s, these tributaries supplied roughly one third of the suspended sediment entering the Danube.

On longer time scales, model results from McCarney et al. (2012) suggest that modern suspended sediment flux is approximately 60% lower than simulated pre-dam values, and 80% lower than during the 'Little Ice Age', when deforestation and climatic variability increased sediment loads (Giosan et al., 2012). In Romania, for example, it has been estimated that 500–1,000 years ago forests occupied an area 70–80% larger than today (Giurescu, 1976). Deforestation continued into the early 19th century, when 50–60% of

Romania's territory was still covered by forest, compared to just 27% today. The most affected regions were the Romanian Plain in the south, the Sub-Carpathian Hills, and the Moldavian Plateau, all major sources of fine sediments derived from loess.

Over the last 150 years, the Danube's sediment discharge has been shaped by both far-field controls, such as climatic variability, river damming, and floodplain engineering, and local factors, such as meander cut-offs and diversions within the delta itself. According to Rîmbu et al. (2002), Danube discharge is inversely correlated with the decadal North Atlantic Oscillation (NAO). Predominantly positive NAO phases explain low-flow intervals such as 1943-1953, 1958-1962, and 1983-2000. Conversely, negative NAO phases also lead to increased storminess in the Black Sea, which may account for the intense erosional processes affecting the Danube Delta coast in the 1960s and the first half of the 1970s (Vespremeanu-Stroe et al., 2007). The first author to mention the role of deforestation in the sediment budget of the Danube was Max Phannenstiel (1952), who argued that the intensification of clogging in the last two centuries resulted from the large volumes of alluvium brought by the river due to deforestation in the Carpathian Basin.

The Branches

The entire drainage network of the delta can be summarised in a hierarchical structure comprising: the branches (Chilia, Tulcea, Sulina, and Sfântu Gheorghe), the anthropic canals (Dunavăţ, Dranov, Mila 35, Crasnicol, etc.), and the natural channels (Şontea, Perivolovca, Lopatna, etc.). The flowing network varies in width from a maximum of 1,100 m in the case of the Chilia Arm to only a few metres along some channels.

The branches of the Danube form the main arteries transporting water to the Black Sea.

Between 1870 and 2019, the surface area of water along the principal arms decreased by -11.2%. The great meander of Sfântu Gheorghe recorded a reduction of -33.6% as a result of route shortening. Along its natural course, this southern arm lost -16.2% of its water surface. The northern Chilia Arm decreased by -12.2%. In the case of the new Sulina maritime canal, the surface area of water remained unchanged, but it generally follows a new route between artificial levees. The large "M" meander, however, reduced its water surface by -31%.

The width. Over the last 150 years, the width of the Danube's arms has decreased by -10.3%, from an average of 272 m in 1870 to 215 m in

2019. The most intense narrowing occurred along the Sfântu Gheorghe Arm (-29.8%, from 307 m to 215 m), followed by Sulina (-18%, from 173 m to 142 m) and Chilia (-4.4%, from 348 m to 332 m). In contrast, the Tulcea Arm recorded a slight increase of +3.6%, from 377 m to 390 m.

A particular situation is found along the Chilia, where numerous secondary arms exist. The general trend here has been a reduction in width of about one quarter. The most intense clogging processes occurred along the Câşliţa Arm (-74%), Tătaru (-32%), Cernovca (-26%), Maşinca (-25%), Catinca (-19%), and Babina (-15%).

The length. Because of its meandering course, the Sfântu Gheorghe Arm was in 1870 the longest, with a length of 114.2 km; today it is shorter by -38 km. The secondary delta of Chilia has expanded, and the length measured along the Old Stambul Arm increased by 11.5 km (from 110.6 km to 122.1 km). From Ceatal Sfântu Gheorghe to the end of the jetty, Sulina measured 86.9 km in 1870. Engineering works carried out by the ECD shortened its length by -14.1 km.
The sinuosity of the arms reflects anthropogenic intervention: Sulina was transformed into a straight channel (from 1.42 to 1.05); Sfântu Gheorghe remains the most sinuous (1.7/1.9); while Tulcea (1.3) and Chilia (1.4) retained the same values.

The depths. One of the most challenging tasks is to evaluate the average depths of the deltaic arms. Old maps produced by the ECD (Constantinescu et al., 2024) show a few sounding points in feet, without bathymetric lines. Sometimes only 3-4 measurements exist along a profile with an average width of 300 m. The political context, with the Chilia Arm forming the border between Romania and Ukraine, further complicates the problem in the absence of a unitary bathymetric survey for the entire arm. The Sulina maritime channel is the most studied, with repeated surveys conducted by AFDJ (Lower Danube River Administration), whereas Sfântu Gheorghe has the lowest navigational importance, with the last survey dating from 2015. For these reasons, present-day assessments rely on different bathymetric maps (Chilia: 1990/2010; Sulina: 2010 multibeam survey; Sfântu Gheorghe: 1988/2015). In 1870, the average depth for all arms was -6.3 m, a value which has since increased by about 2 m.

The Sulina channel today averages -9.5 m, five metres more than in 1870 (-4.5 m). Another significant deepening occurred along the Tulcea Arm (-6.2 m/-10.8 m), resulting in an increase of water flow and a reduction in travel time to the sea. By contrast, the Chilia Arm has become shallower (-8.0 m/-6.8 m), while Sfântu Gheorghe shows non-uniform data (-6.4 m in 1870/-7.1 m in 2015).

The average water volume was also computed for each arm. Chilia currently transports 8.8 million m^3 less than in 1870 (374/365 million m^3), a reduction offset by the Sulina Arm (67/82 million m^3). A major change occurred at Sfântu Gheorghe, which now delivers 22.3 million m^3 less water to the sea (237/214 million m^3). The deepening of the Tulcea Arm has led to a larger volume of transported water (44/79 million m^3). Considering the total volume of water along all Danube arms, there is an overall increase of 19.4 million m^3.

The volume. In 1870, the total volume of the Chilia Arm, excluding the secondary delta, was 374 million m^3. At present, the volume is reduced by 8.8 million m^3, equivalent to an average deposition of 73,953 m^3/yr. The Sulina channel has been deepened through dredging, radically altering its water flow. Its volume increased from 67.1 million m^3 in 1870 to 82.5 million m^3 in 2010, accompanied by a steeper slope and higher velocity. These changes must be correlated with similar processes along the Tulcea Arm, where erosion increased by 258,027 m^3/yr (from 44.0 million m^3 in 1870 to 79.3 million m^3 in 2007). By contrast, intense deposition (22.3 million m^3) occurred along the Sfântu Gheorghe Arm between 1870 and 2015 (237.1/214.7 million m^3). For the entire system of Danube arms, this results in an overall deposition rate of 34,913 m^3/yr.

The Channels

A natural network of channels can connect two arms (Şontea, Rusca, etc.), link an arm with a lake (Gârla Francezului connects the Sfântu Gheorghe Arm with Lake Murighiol), join two lakes (Gârla Matiţa links Lake Merhei with Lake Matiţa), or transfer water across the marshes. This network resembles an arterial system, transporting matter and energy throughout the entire delta. Vidraşcu's maps, from the early 20th century, illustrate this natural (neural) network particularly well.

In order to improve water quality in certain lakes or deltaic depressions, Romanian authorities cut artificial canals during the first quarter of the 20th century. Grigore Antipa followed the natural routes, straightening and deepening their courses. Several important canals were created: Regal Carol (1904-1906, now Dunavăţ), Regele Ferdinand (1912, now Dranov), and Litcov (1930-1940), among others. The effect on fisheries was considerable, with a major increase in production, especially in lakes such as the Razelm-Sinoe complex.

After WWII, in a new political context, the communist authorities cut a dense network of canals in order to increase fish and reed exploitation or to shorten distances across the delta: Can. Lipovenilor (closed after 1984), Can. Mila 35 (1982-1983), Can. Central (after 1988), etc. Even from the 1980s many of these works generated secondary effects, with consequences for the entire deltaic flow. Without a unitary vision, the canals were built only for local purposes. A major impact can be observed in the following engineering projects:

- Can. Crişan - Caraorman altered the flow network in the Roşu-Puiu complex; by transporting more freshwater from Sulina, this canal explains the increase in the surface of Lakes Lumina and Puiu (fig. …); for a detailed discussion see Driga (2004).

- **Can. Central (30 km)** is one of the major engineering projects linking the Sulina and Sfântu Gheorghe arms. With a projected width of 15-20 m and depth of 4-5 m, the canal is protected by an artificial levee on the eastern maritime side. A local road of pebbles and sand was installed on this dyke. Initially, only a single overflow point was constructed at a higher level (+130 cm) for connection with the sea. Now, another lower-level connection exists. All these narrow discharge points are insufficient, causing an increase of water levels to the west.

- **Lakes or depressions**: Can. Uzlina and Can. Filat are the most appropriate examples.

However, some canals have proven to be effective, improving water circulation and increasing fish production: Regele Carol (Dunavăț), Regele Ferdinand (Dranov), Litcov, Eracle, Sireasa, etc. These engineering projects were carried out based on studies made by Grigore Antipa at the beginning of the 20th century.

This network of artificial canals almost tripled the water discharge towards the interior of the delta plain, counteracting sea-level rise by enhancing sedimentation (Giosan et al., 2013). Some canals were cut at the beginning of the 20th century, but the most intense activity took place between the 1960s and 1980s. Over the following 50-60 years, many canals have suffered clogging at their upstream or downstream mouths. Dredging was not carried out uniformly, and many canals have remained shallow, especially at their junctions with the Danube. Before 1990, only boats used for industrial activities (fishing or reed harvesting) had engines, while those belonging to fishermen were rowboats. In the last two decades, however, all boats in the delta have switched to engines, and their numbers increase every year. This has had a direct impact on the morphology of the artificial canals: the central part retains almost the same depth due to currents induced by propeller engines, while sedimentation occurs along the edges, resulting in narrowing. Topographic maps from the 1960s and 1980s show an average width of 12-14 m and an average depth of 2 m. In recent summers, however, the network around Dranov Island has shrunk to only 6-8 m in width (Ciotic-Zăton, Can. Lejai, Can. Carmagiilor, Can. Crasnicol, etc.).

Two small canals connect Dranov Island with the Black Sea: Can. Ciotica and Can. Carmagiilor. For fishing purposes, these canals were sometimes closed at their sea mouths. Can. Ciotica is larger, with an average width of 14-15 m and a general depth of -2.28 m.

The morphology follows the same pattern: the greatest depths occur at the junction with the main canal (more than 3 m), while values drop below 1 m at the sea mouth.

Natural water flow once occurred through several channels and by outflows from the large hydrographic units. Human interventions simplified the entire system, reducing natural inputs and outputs but overestimating the new ones: Can. Crișan-Caraorman, Mila 35, Can. Sonda. Water circulation is now faster, with higher velocities, intensifying clogging processes in certain sectors. The reported length of artificial canals varies in the literature: between 1910 and 1990 their extent doubled, reaching 3,400 km (Nichersu et al., 2016); combined, natural and artificial canals exceed 3,500 km in length (Driga, 2004).

The Lakes

Lakes currently represent 22.2% of the entire delta and lagoon system. If we consider only the delta proper (“Delta mică”), the value is 8.8%. Driga (2004) provides a similar figure of 9.2%..

Average area of lakes larger than 1ha

Average area (ha)	1911/1924	1960	2020
Danube Delta	**72.0**	**34.4**	**33.8**
I. Letea	67.5	28.9	28.8
I. Sfantu Gheorghe	72.6	46.0	50.4
I. Dranov	106.3	43.8	32.9

These values should be treated with caution, especially those from 1911/1924. Some lakes larger than 1 ha were not included on Vidrașcu’s map, and this minor omission is reflected in the average surface. Even with these uncertainties, the average surface of lakes was almost double that of today. Maximum values were initially recorded on Dranov Island, where anthropogenic intervention fragmented the natural lake systems to one third of their original size. New channels cut into Sfântu Gheorghe Island (Crișan-Caraorman, Can. Central, etc.) altered the water balance, increasing the surface of lakes after the 1960s to maximum values for the entire delta (50 ha). The agricultural polders on Letea Island (Sireasa and Pardina) halved the average surface of lakes, from 72 ha to 34 ha.

Razelm is the largest lake in Romania (39,413 ha), followed by Dranov (2,090 ha, on the homonymous island), Lumina (1,674 ha, on Sfântu

Gheorghe Island), and Merhei (1,436 ha, on Letea Island). The deepest lake in the delta is Belciug (Sfântu Gheorghe Island), with a maximum depth of 10.4 m (bathymetric survey from 07/06/2012, at a Danube water level of 160 cm at Tulcea). Previous studies (Driga, 2004; Gâștescu and Știucă, 2008) mention a maximum depth of –7 m. Belciug was once an old meander of the Danube that gradually became isolated from the river, maintaining only a minimal connection through an artificial channel. In this way, sedimentation rates remained low. Another meander-type lake, in contrast, is Erenciuc, where sedimentation rates are high due to its proximity to the river and the presence of an active brook. Here, maximum depths do not exceed –2.5 m.

The lakes of the Sireasa complex had their bottoms above mean sea level before drainage (Gâștescu, 1971).

Lakes in the delta are grouped into lacustrine complexes, overlapping large depressional units: Roșu-Lumina-Puiu; Babina-Matița-Bogdaproste; Isac-Isăcel-Uzlina; Gorgova-Potcoava-Gorgovăț, etc.

Water extension

The amount of water stored in the Delta (1,285.5 km^2) shows only minor variation (±2.2%) over the last century. At the regional scale, however, important differences can be observed:

- **1911/1924 - 1960**: a maximum increase of 33.4% in Sfântu Gheorghe Island and a reduction of almost –40% in the flooded plain between Tulcea and Murighiol; a similar decrease (12–14%) was recorded along the Chilia and Sfântu Gheorghe Arms, while the Sulina Arm increased by 4%; the interfluve areas experienced the same tendency of reduction (–26% in Dranov Island and –10.3% in Letea Island); in the Razelm-Sinoe lagoon system, the water surface dropped by almost 3%.

- **1960 - 2019**: the amount of water returned to levels similar to those at the beginning of the 20th century; maximum increases were recorded in Dranov Island (44%) and in the flooded continental area (42.5%); the arms showed a general increasing tendency (Chilia: 3.3%, Tulcea: 13.2%, and Sulina: 26%), with the exception of Sfântu Gheorghe (–5%); drainage in the new agricultural polders of Sireasa and Pardina reduced the water surface (lakes and natural channels) by –90%; in the remaining parts of Letea Island water increased by 50%, and in Sfântu Gheorghe Island by 15.5%; in the southern lagoon system a decrease of almost –3% was recorded.

- **Maximum water extent based on satellite data (1984-2018)**: shows that almost 40% of the entire deltaic area can be covered by water during flooding periods. In the case of the arms, floods can cover most of the levees and marshes (88% in Tulcea, 53% in Sfântu Gheorghe, 34% in Sulina, and 22% in Chilia); the Razelm-Sinoe complex was largely inundated (85%), while the islands were covered between one quarter and one third (Dranov: 21%, Sfântu Gheorghe: 28%, and Letea: 32.5%).

The Water and Wetness Probability Index in the Danube Delta (2009-2015) was produced using a dataset published by the Copernicus Land Monitoring Service. The index is useful for understanding human impact at the deltaic scale. The embankments and agricultural polders remain, for the most part, unoccupied by water. More than a quarter of the delta (26.35%) is covered permanently by water (occurrence: 90-100%), while almost one third (32.6%) is inundated only during higher floods (occurrence: 10-30%).

Natural and Anthropic Channels in

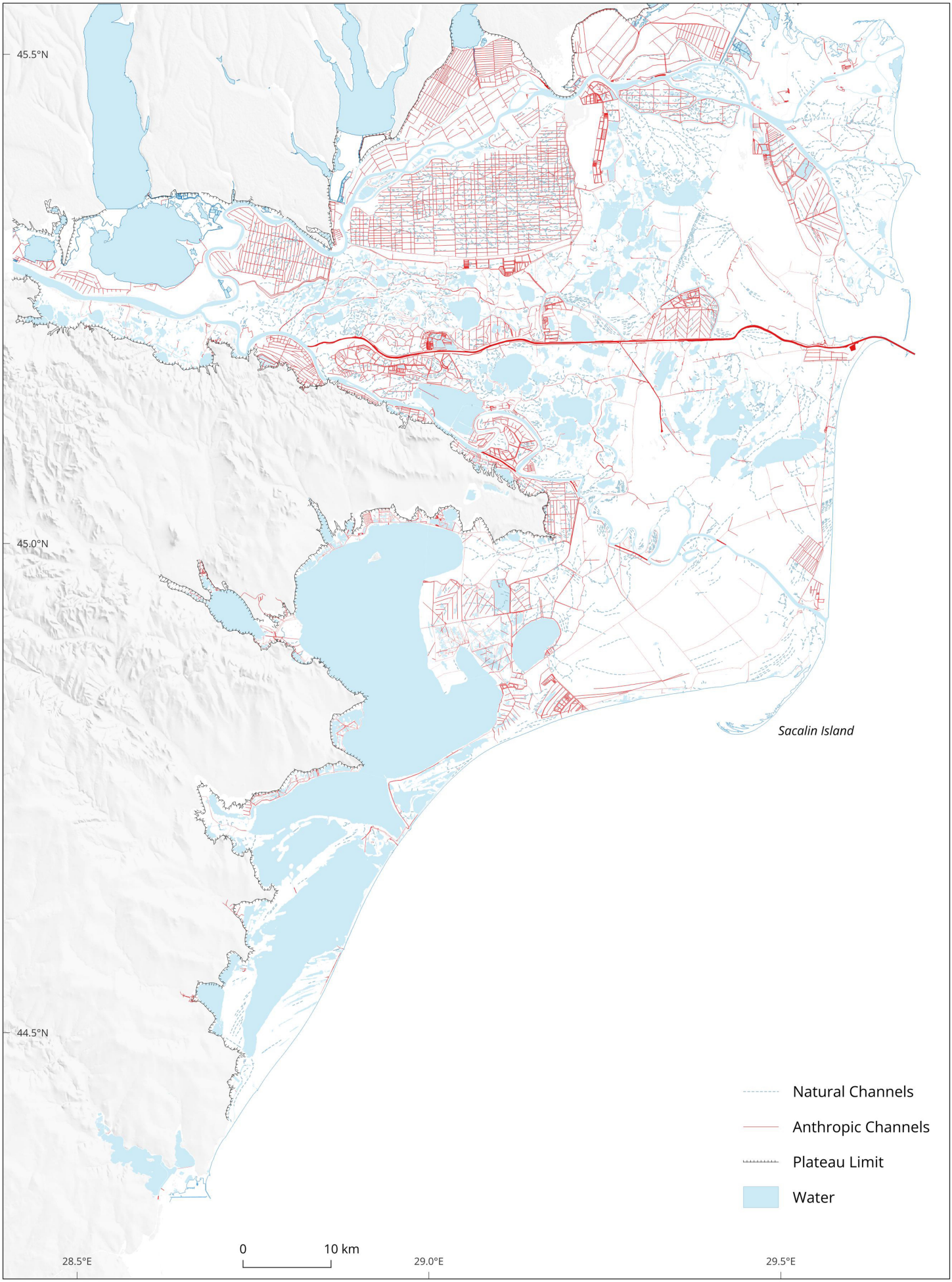
Thomas Abel Brimage Spratt (1856), European Commission of the Danube



Spratt's 1856 map drew upon earlier Russian surveys (1835, 1841, etc.), while also making numerous original contributions. The ECD's primary focus was on mapping the main navigable branches, whereas the territory between them, being insufficiently explored, remained largely unmapped. The lower number of lakes and channels must be understood in this context.

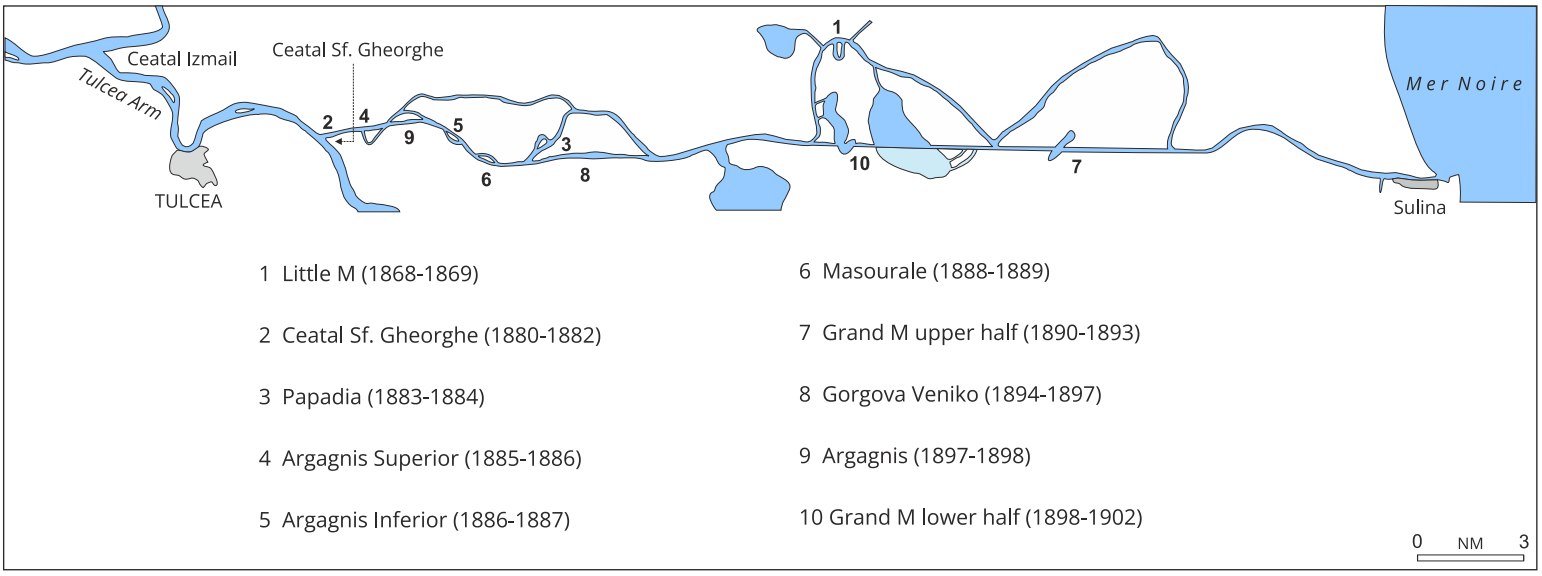
n the Danube Delta (1856 vs. 2024)

Marine and Fluvial Research Station Sf. Gheorghe



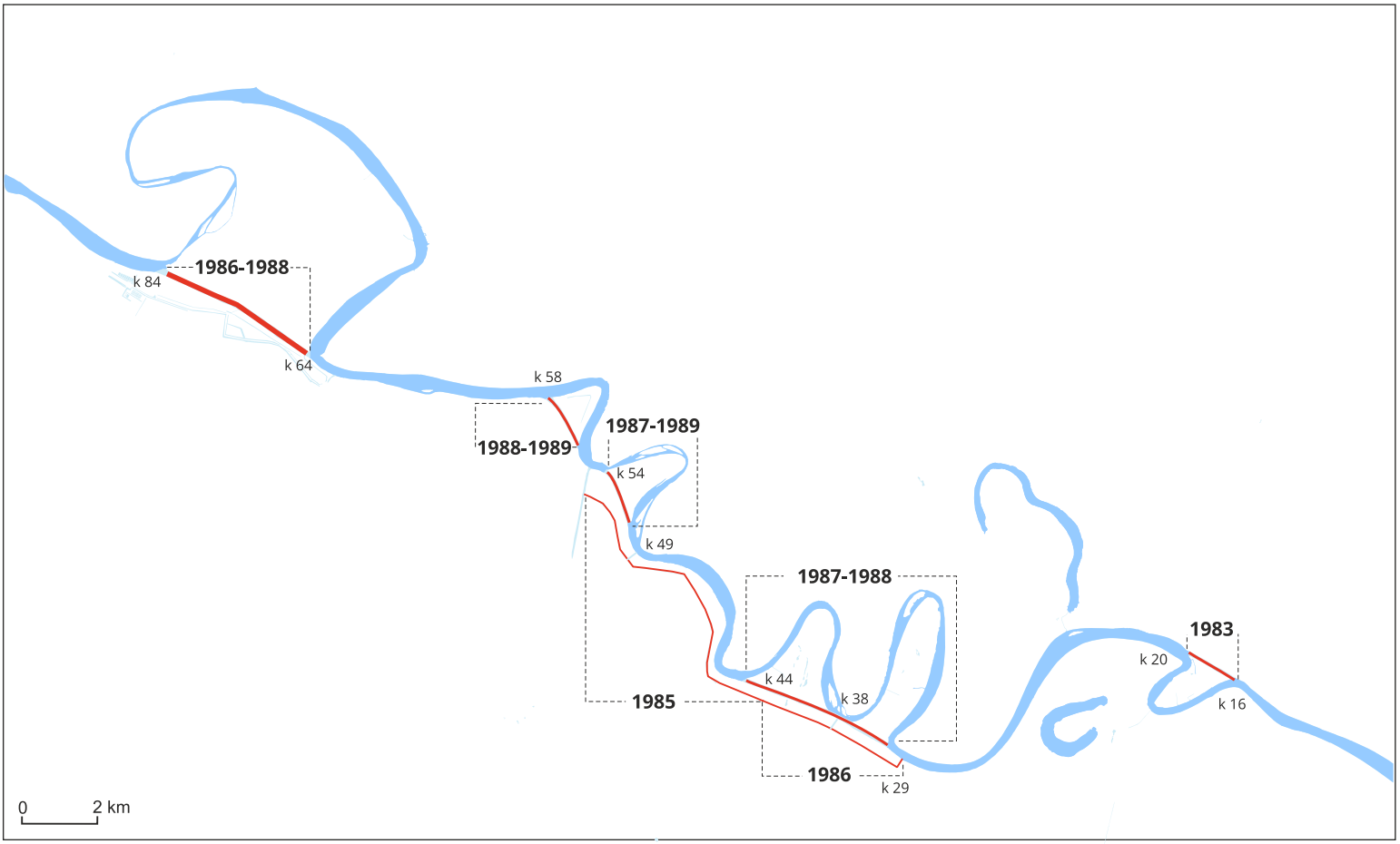
From river arm to maritime channel: The shortening and transformation of Sulina

Data source: Rosetti, Carlo and Rey, Francis. 1931. *La Commission Européenne du Danube et son oeuvre de 1856 a 1931*. Paris: Imprimerie Nationale.



Artificial channels along the Sf. Gheorghe arm documented from Landsat Imagery

Data source: Constantinescu, Ștefan, and Mihnea Tanasescu. 2018. *Simplifying a Deltaic Labyrinth: Anthropogenic Imprint on River Deltas*. Revista de Geomorfologie (20):66–78.

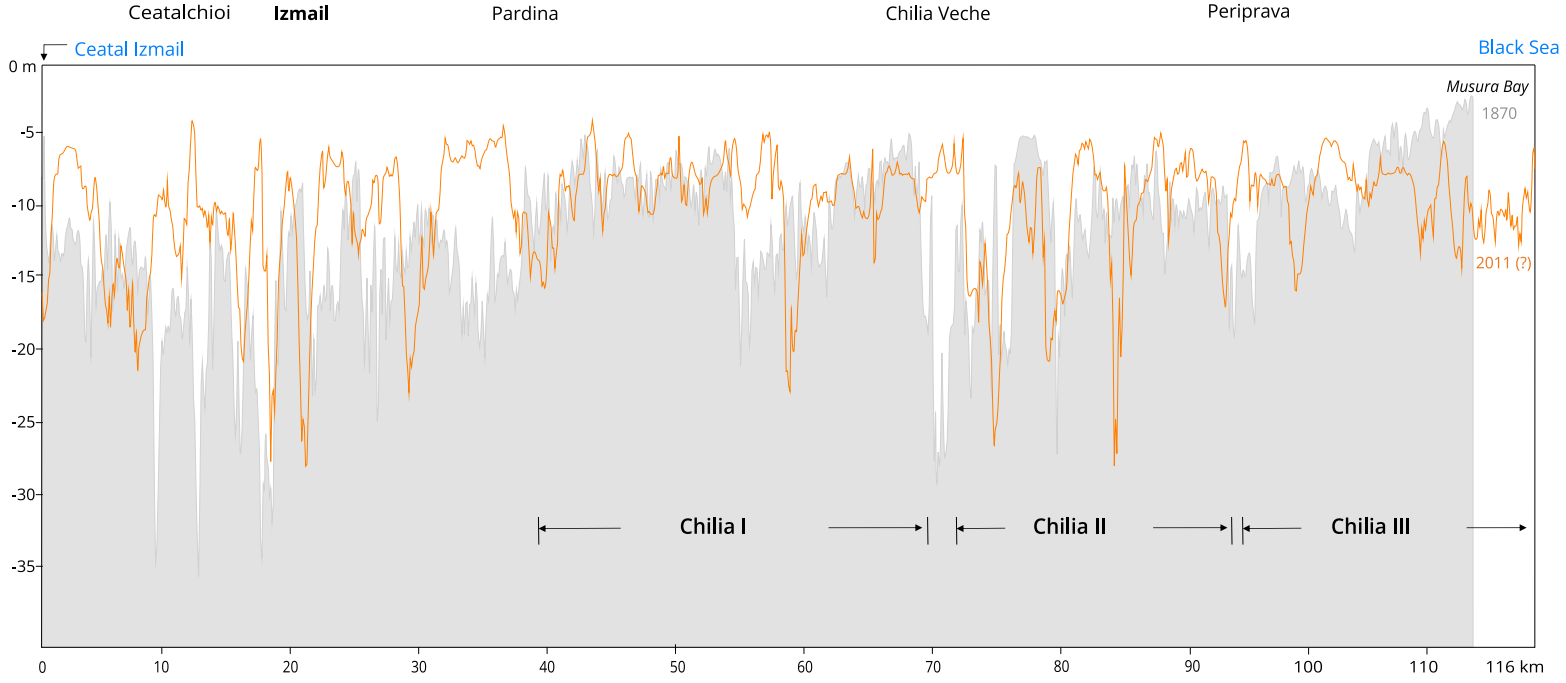


Bathymetric Profiles along the Delta Branches



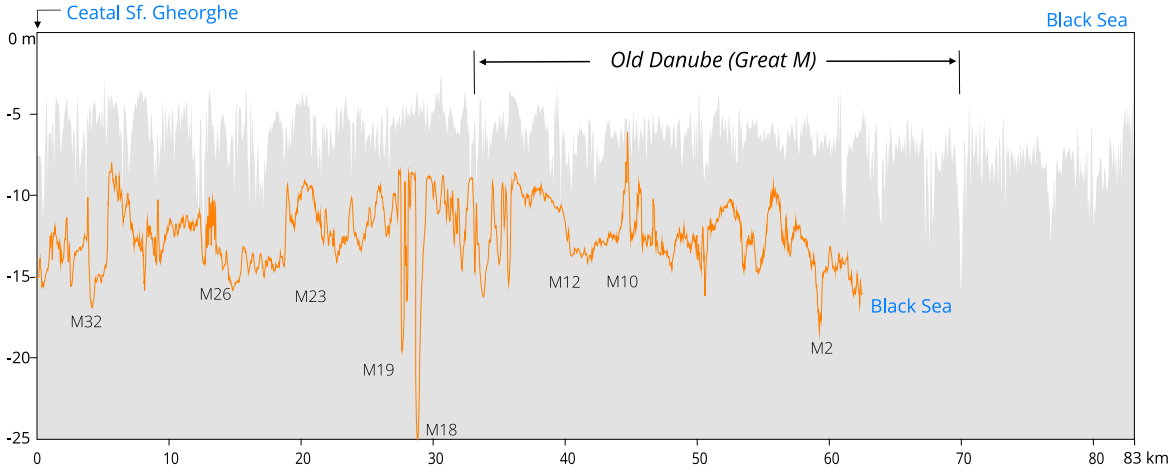
CHILIA BRANCH

Data source: Atlas of the European Commission of the Danube, 1887. Bathymetric data: 1870
Danube River from Port Reni to Mouth (Hydrographic Service of Ukraine, 2011. Year of the bathymetric survey unspecified



SULINA BRANCH

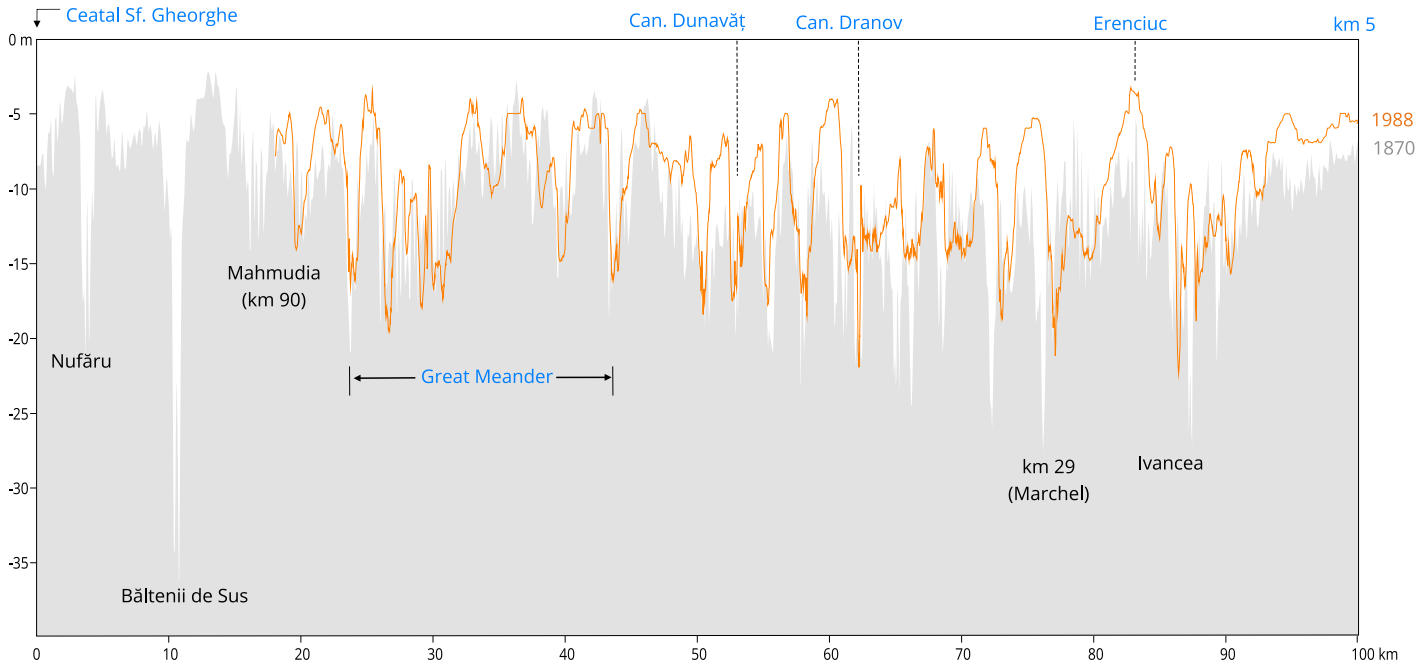
Data source: Atlas of the European Commission of the Danube, 1870
Lower Danube River Administration, 2010



Bathymetric Profiles along the Delta Branches

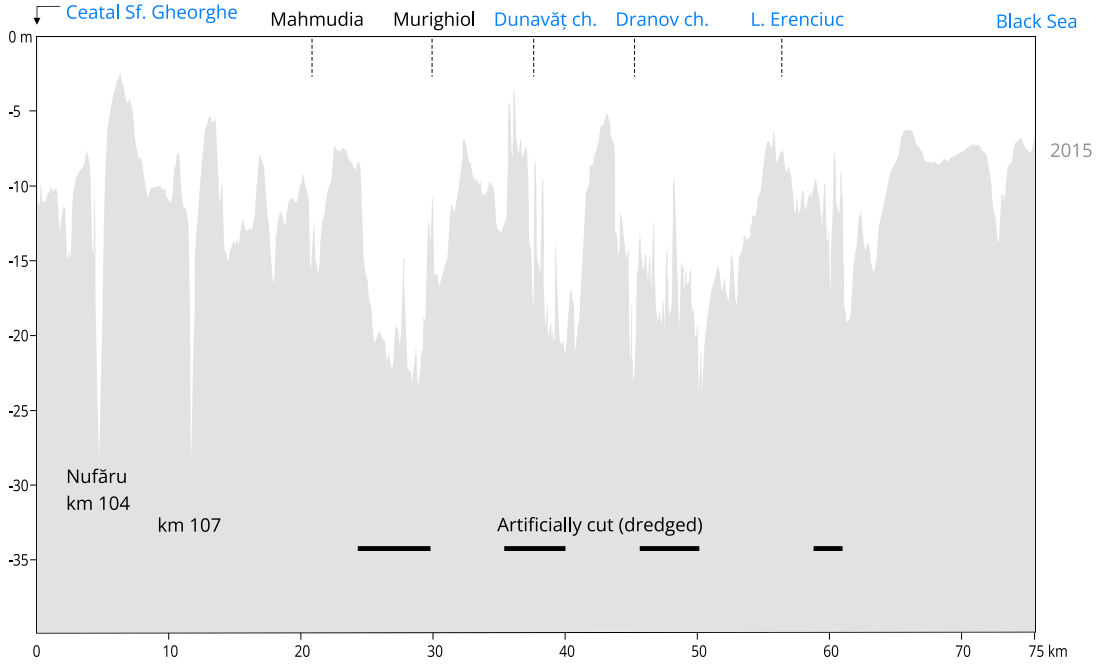
SF. GHEORGHE BRANCH

Data source: Atlas of the European Commission of the Danube, 1870
Bathymetric chart of the Sfântu Gheorghe Branch prepared by the Institute of Meteorology and Hydrology, August 1988



SF. GHEORGHE BRANCH

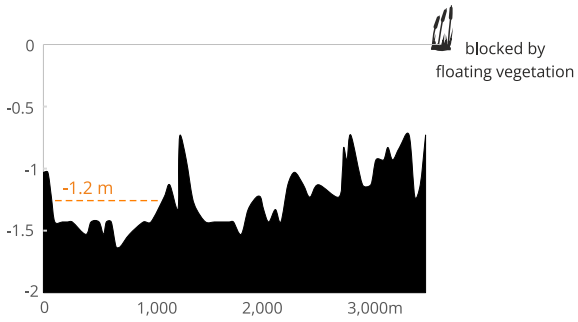
Data source: Danube Delta National Institute for Research and Development.
Data set name: SBES_Sf_Gh_DDNI_2015
SeaDataNet



Bathymetric profiles along major deltaic channels

Marine and Fluvial Research Station Sf. Gheorghe

1. LEJAI



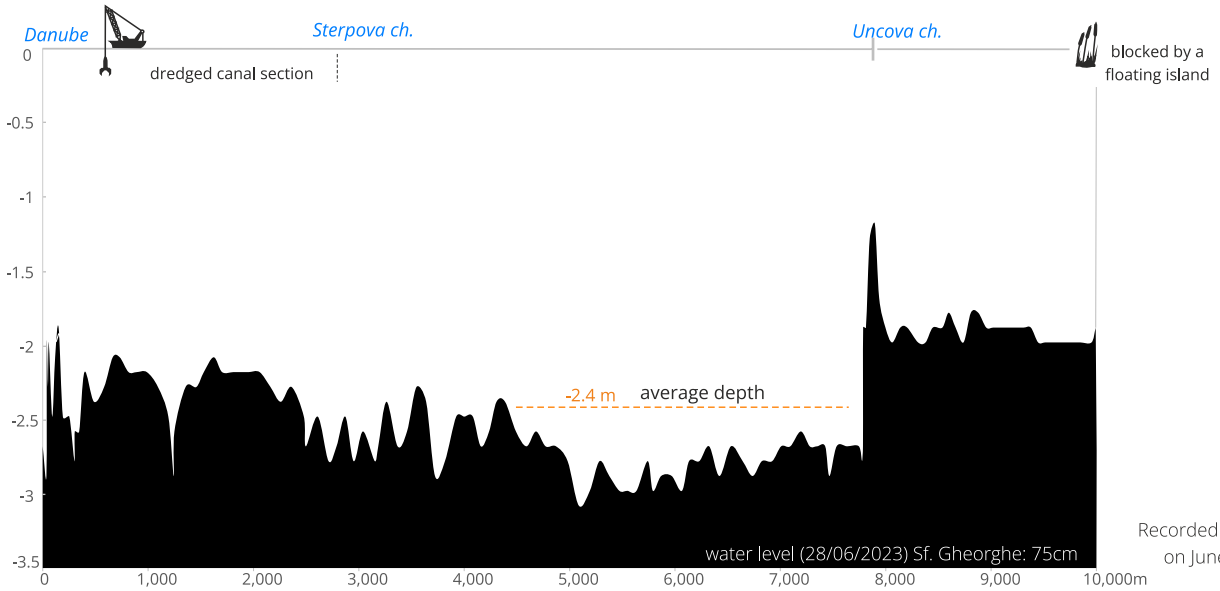
Water level at Sf. Gheorghe on July 6th, 2020: 74 cm



The Ivancea Channel on September 1th, 2022

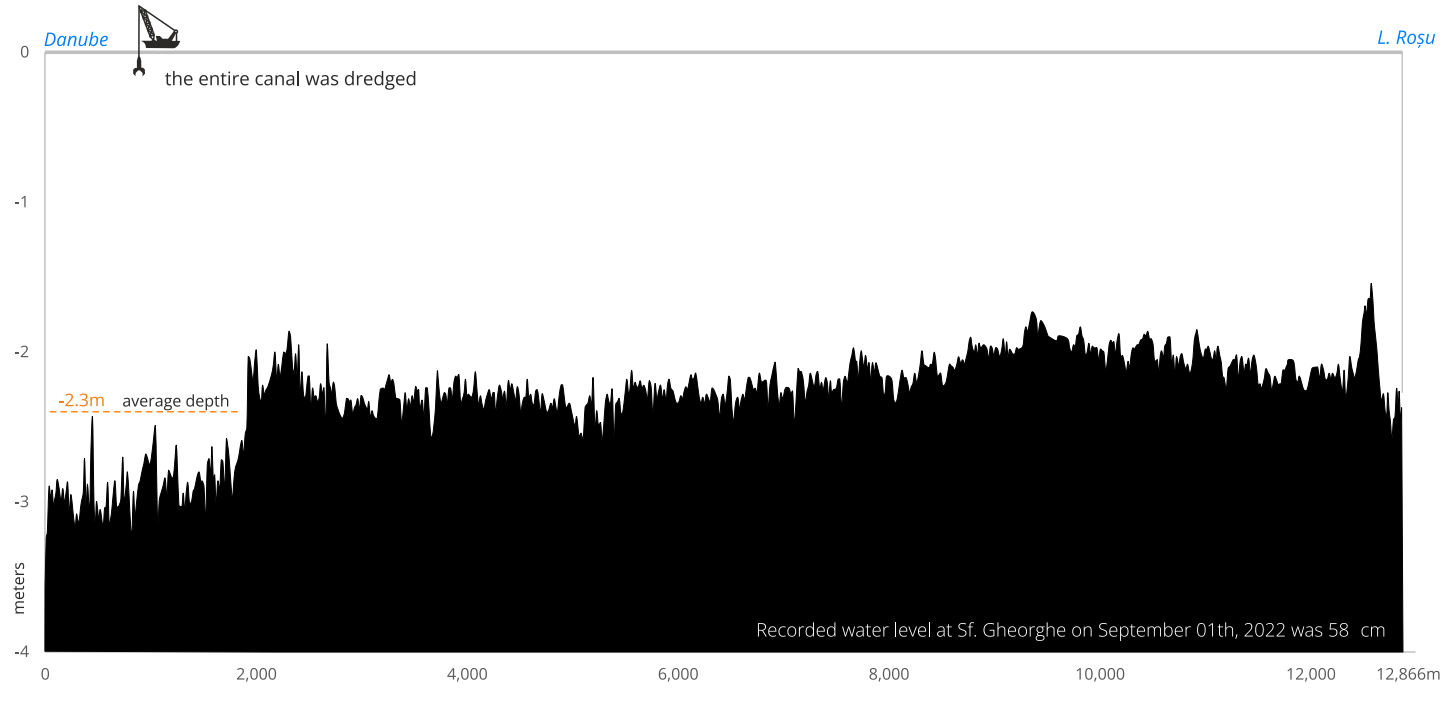


2. PALADE



Recorded water level at Sf. Gheorghe on June 28th, 2023 was 75 cm

3. IVANCEA



Bathymetric profiles along major deltaic channels

Marine and Fluvial Research Station Sf. Gheorghe

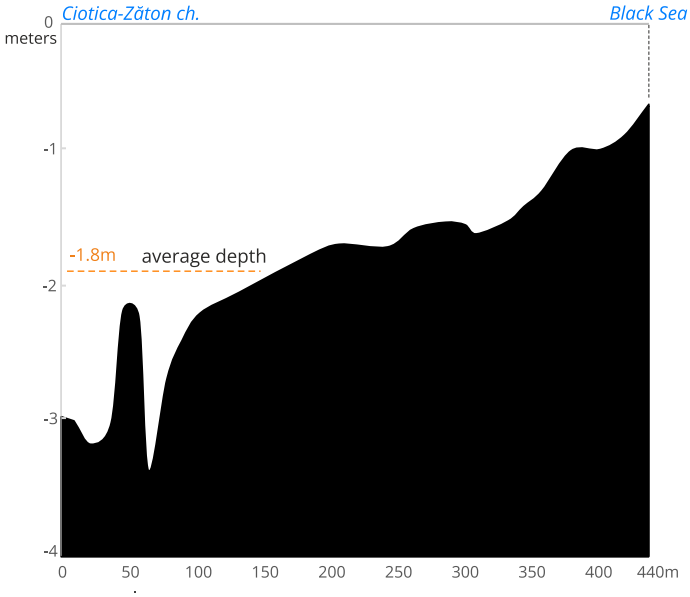


The Ciotica Channel mouth at the Black Sea coast

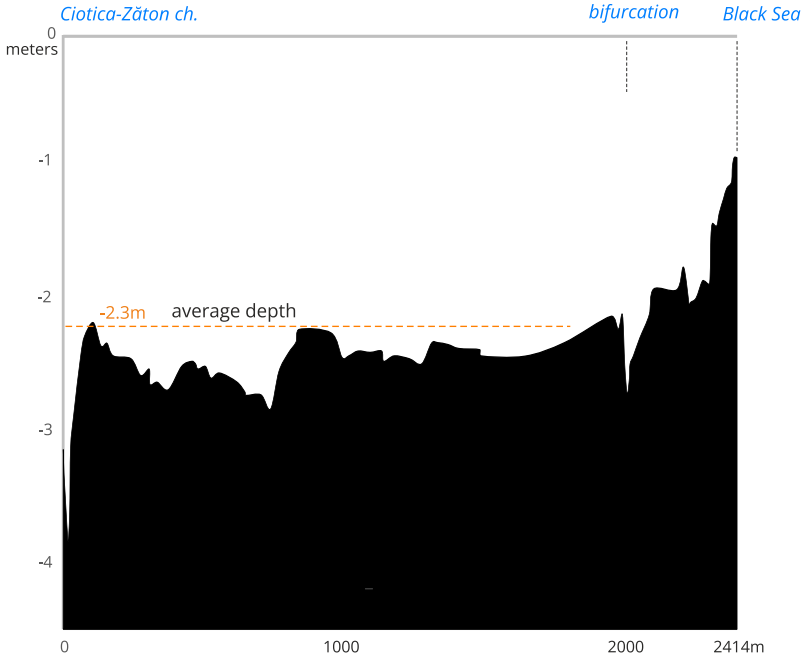
25/07/2025



4. CARMAGIILOR

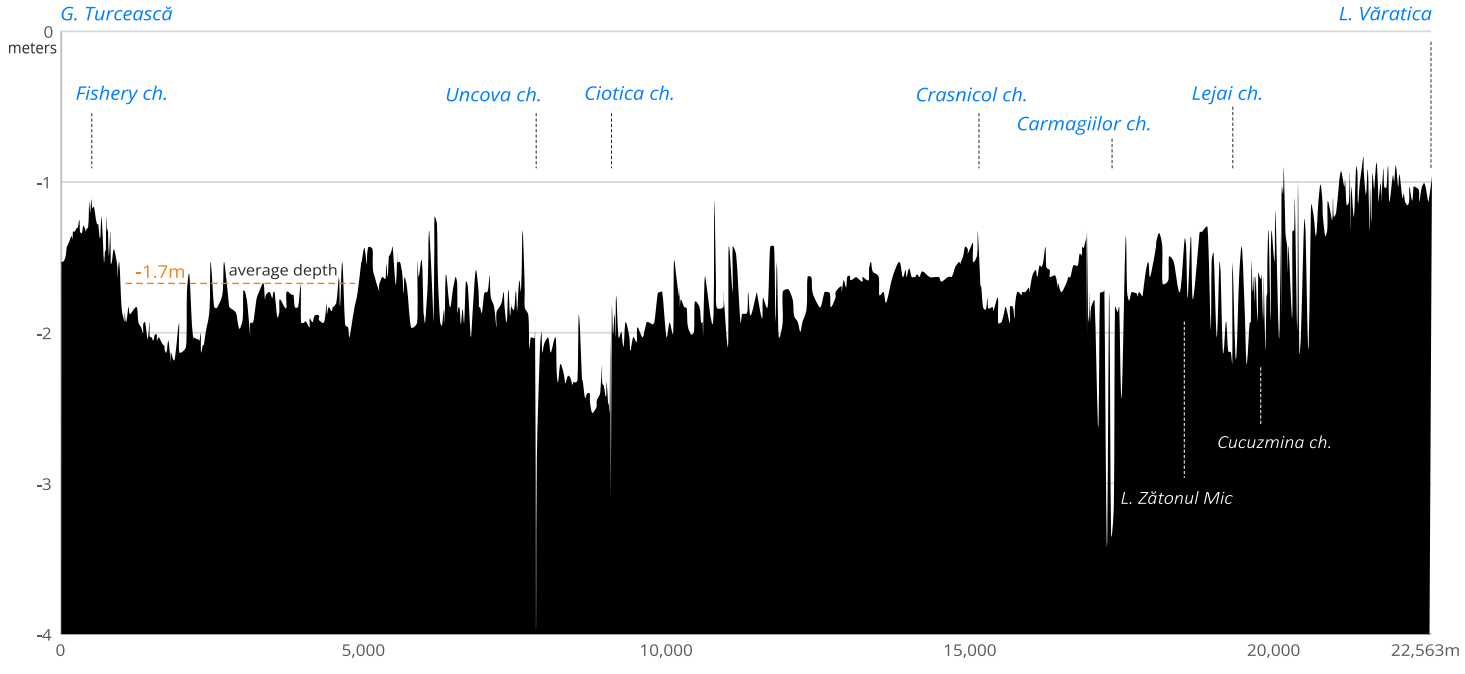


5. CIOTICA-BLACK SEA



Recorded water level at Sf. Gheorghe on July 6th, 2020 was 74 cm

6. CIOTICA - ZĂTON





Ciotica Canal (11/07/2023)

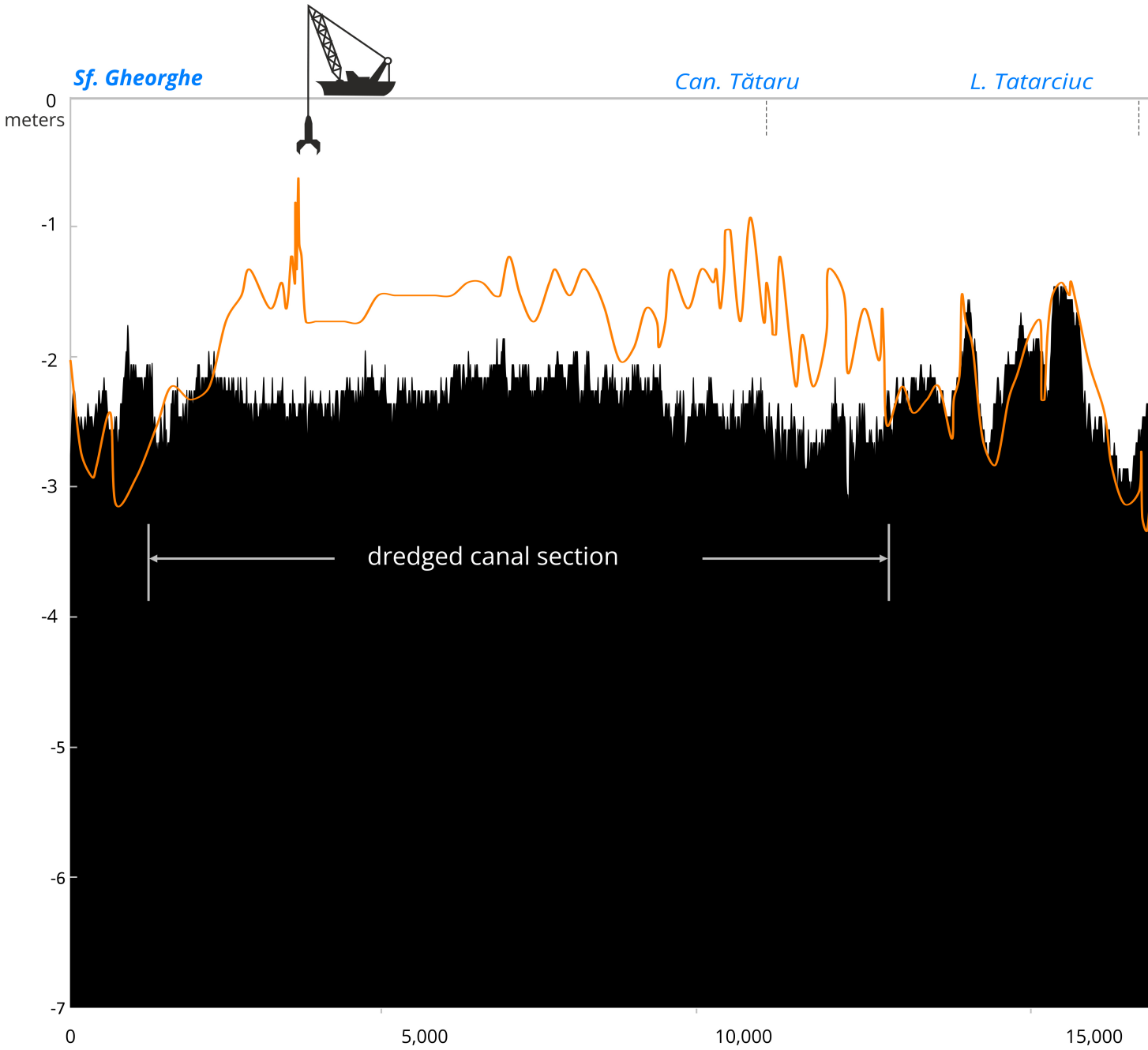
Bathymetric profiles along major deltaic channels

Marine and Fluvial Research Station Sf. Gheorghe



7. THE COASTAL RIDGE CHANNEL

Central Channel

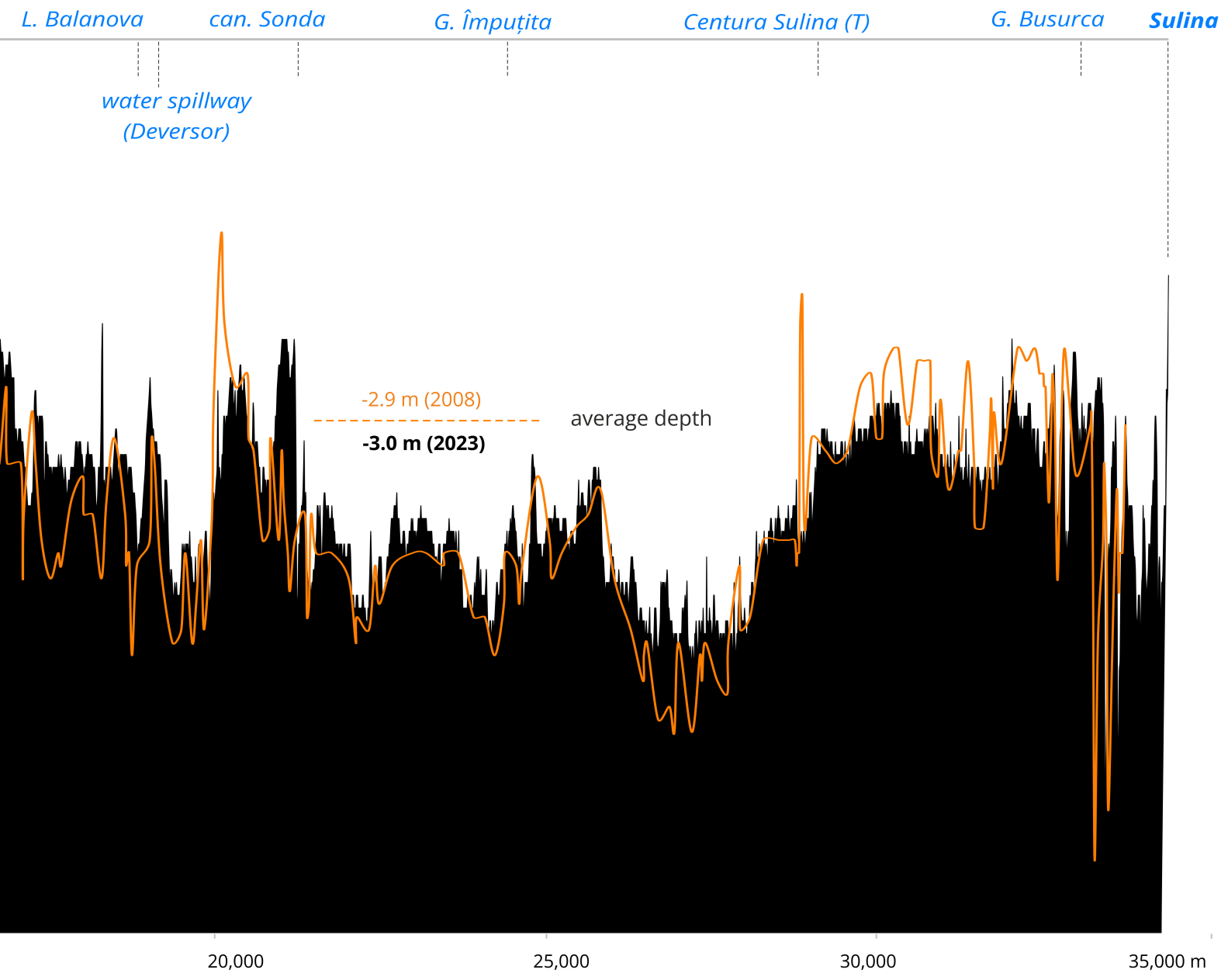


Water levels at Sf. Gheorghe: 64 cm (11 July 2008), 60 cm (25 July 2023)



07/08/2023

A moment along the Central Channel

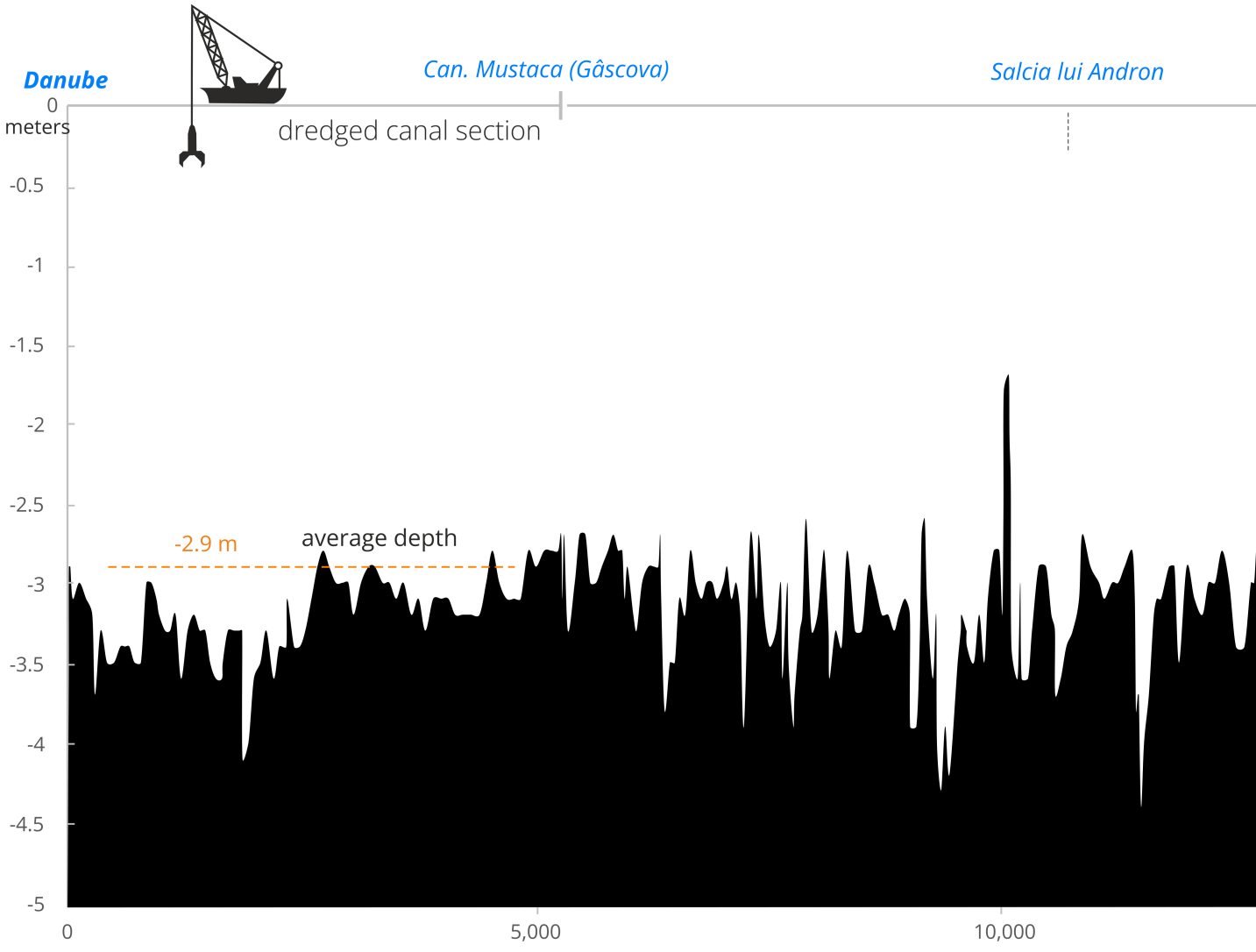


Bathymetric profiles along major deltaic channels

Marine and Fluvial Research Station Sf. Gheorghe

8. DRANOV



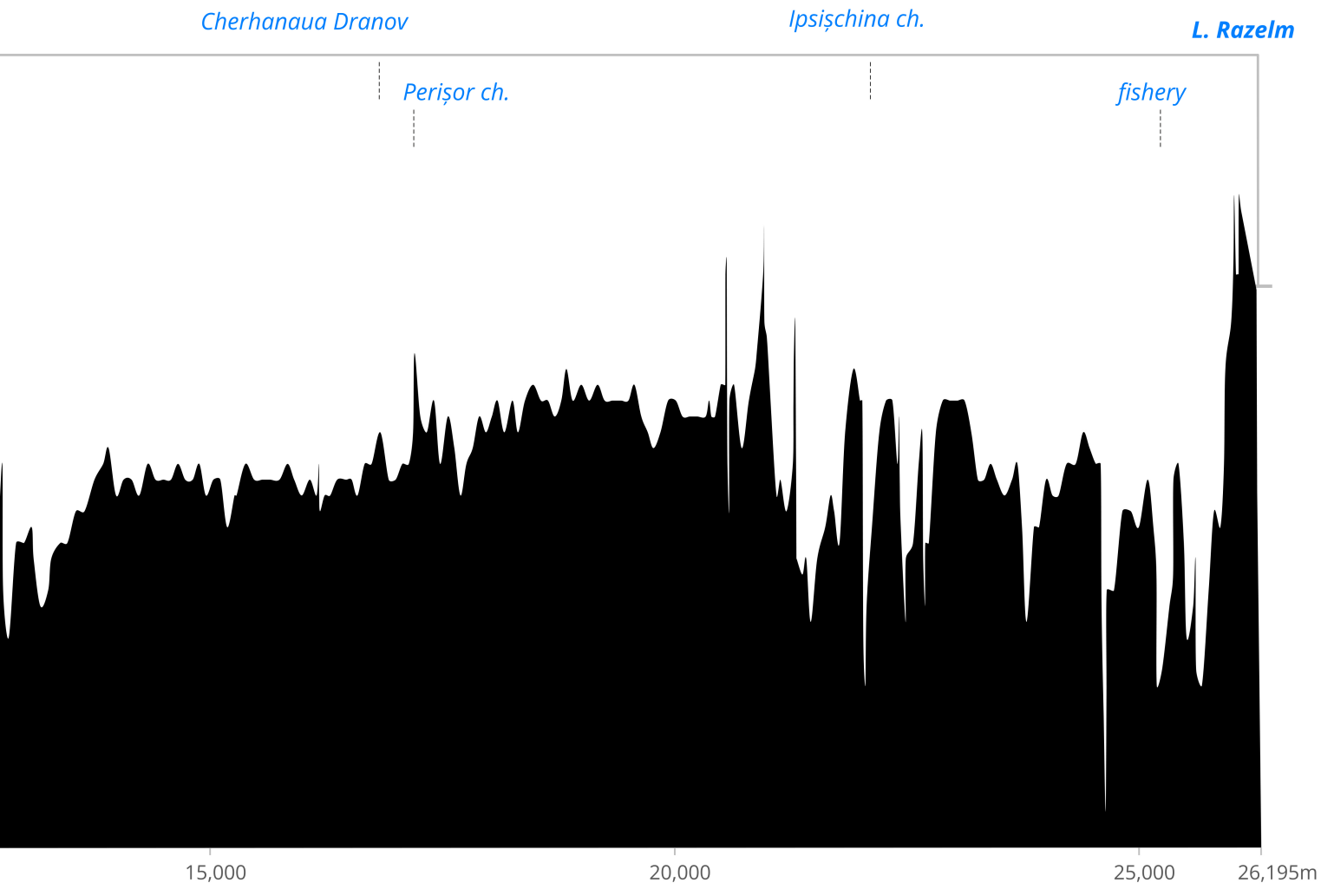


Recorded water level at Sf. Gheorghe on June 28th, 2023 was 75 cm

23/07/2023



Scenic view of the Dranov Channel



Maximum Water Extent in the Danube Delta (1984-2021)

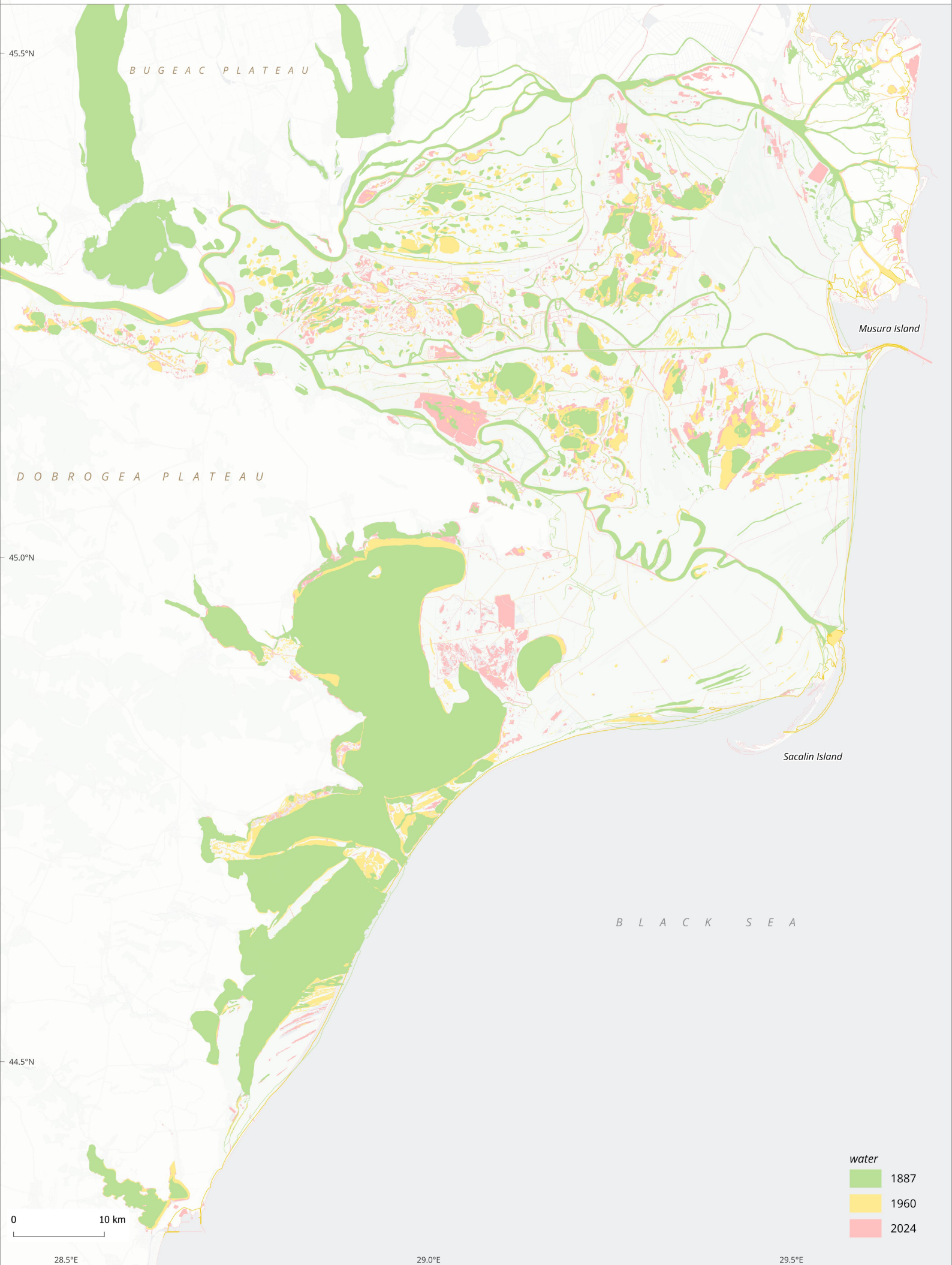
Global Surface Water (EC JRC/Google)

Marine and Fluvial Research Station Sf. Gheorghe



Changes in the Water Surface Area of the Danube Delta

Marine and Fluvial Research Station Sf. Gheorghe



The coastline and shoreface morphodynamics

Sedimentation rates in front of the secondary delta of Chilia decreased from 7.8 cm/yr to only 1.3 cm/yr by the mid-1970s. However, erosive processes became predominant over the next three decades, with the average value turning negative for the first time (-0.1 cm/yr). The evolution in Musura Bay was closely linked to the advance of the Sulina jetties. To their north, the highest accumulation rates on the deltaic shore were recorded (8.7 cm/yr between 1898-1940). The reduction in the Danube's solid discharge was evident even here, with accumulation rates decreasing to only 2.2 cm/yr between 1975-2003. The interdistributary shore between Sulina and Sfântu Gheorghe was characterised by predominantly erosive processes, due to the same jetties blocking sediment input from the north. Maximum erosion on the deltaic shore was recorded south of the Sfântu Gheorghe mouth, in front of Sacalin Island (-9.6 cm/yr between 1975-2003).

The Danube exerts a strong influence on turbidity plume extension, but currents can alter this distribution, especially along the shoreline sector. The highly erosive sector between Sulina and Sfântu Gheorghe corresponds to low turbidity values, indicating a poor particulate matter supply in this area (Constantin et al., 2016).

The recent construction of reservoirs along the Danube and its tributaries has become a major short-circuit in fluvial sediment transport, leading to sediment starvation at the coast and a rapid, fundamental change in morphodynamics at the river mouth.

Sacalin Island

Many previous studies have examined the formation of Sacalin Island and proposed evolutionary models (Bondar et al., 1973; Vespremeanu, 1983, 1987; Panin, 2003; Giosan et al., 1999, 2005, 2007; Stănică, 2003; Dan et al., 2009, 2011; Ovejanu, 2012; Vespremeanu-Stroe, 2004, 2007; Vespremeanu-Stroe and Preoteasa, 2015; Zăinescu, 2019).

Located between Sacalin Island and the delta plain, the Sacalin Lagoon is one of the most important areas for biodiversity in the entire delta. The lagoon hosts the largest deltaic colonies of Sandwich Terns (*Sterna sandvicensis*) and Mute Swans (*Cygnus olor*). The protection offered by the barrier island against waves, together with the salinity gradient from brackish to freshwater, provides an ideal habitat for numerous migratory birds and feeding grounds for limnic species (DDBRA, 2013).

Before the emergence of the Sacalin barrier island in 1897, a shoaling effect (Giosan, 2007) produced by the vast subaqueous delta platform

(the zone less than 2-3 m deep) also helped trap sediment near the mouth. The appearance of a sand bank on the 1886 map already pointed to the future location of the Sacalin barrier island. A map from 1902 (Hartley, 1902) records the expansion of this sand bank into a chain of five emergent islets. By 1909, Grigore Antipa had already discussed the emergence of a barrier island (Antipa, 1941). After Sacalin Island began to extend in length around 1920, its barrier steering effect led to the rapid expansion of the deltaic platform toward the south (Giosan, 2007).

Before the island's emergence, the mouth was characterised by multiple thalwegs carved by the fluvial effluent within the delta platform before reaching the mouth bar, the major depocentre at the platform's edge. Once the barrier island emerged, thalwegs located behind it, feeding the secondary delta, became shallow and narrow low-discharge secondary channels.

After 1935, and continuing to the present, erosional processes have prevailed at the mouth, gradually intensifying with average rates between 30 and 50 cm/year. A brief shift to depositional conditions within this overall erosional regime occurred between 1960 and 1975. However, after 1975, a strongly erosive regime re-established itself, with mean rates of -10 to -30 cm/year at the mouth. The eroded sediment was redistributed downdrift along the Sacalin barrier, leading to the continuous southward extension of the delta platform. During this interval, in 1972, the barrier island attached to the secondary delta near the mouth and became a spit. The overall evolution suggests that allogenic forcing, such as variations in sediment load, plays an important role in controlling the sedimentation pattern at the mouth. From a sediment budget perspective, accretion dominated at the mouth until the second decade of the 20th century, followed by widespread erosion thereafter.

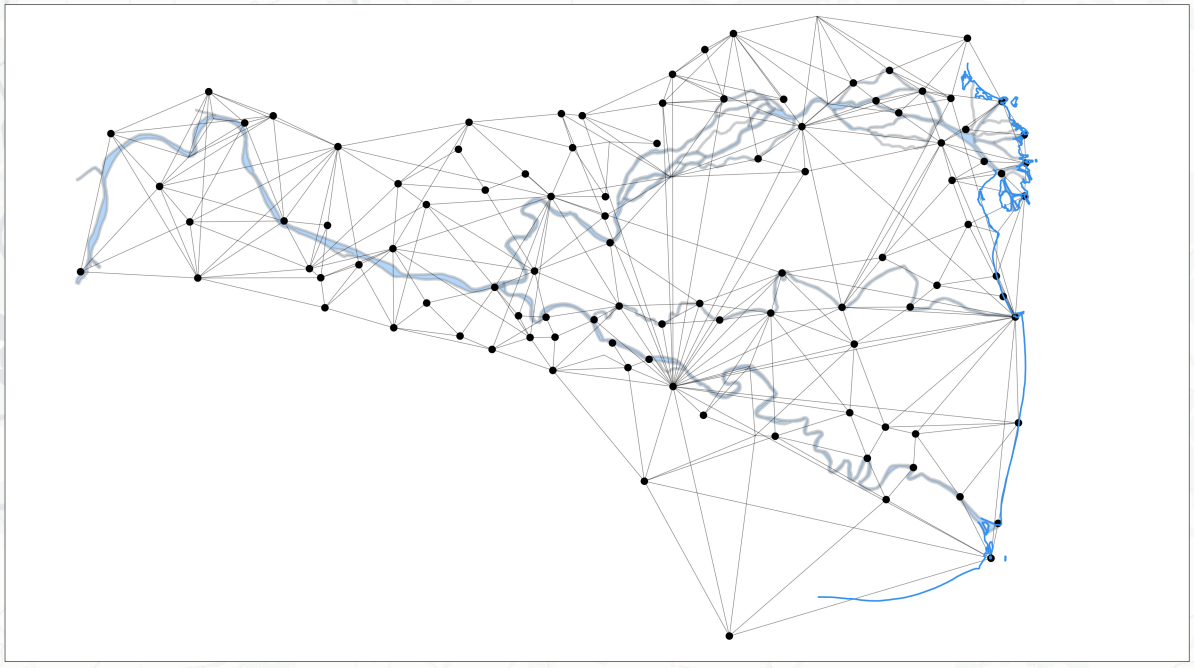
Once the Sacalin barrier island emerged on this platform, morphodynamic feedbacks shifted the depositional regime at the mouth toward erosion and drove the southward extension of the platform, as sediments began to be steered along the shore of the continuously elongating barrier. Extraordinary floods in the 1970s led to a short episode of accretion at the mouth, but after 1975 erosional processes again became dominant in the mouth area and gradually expanded southward along the deltaic platform.

Synthesis of ECD bathymetric surveys on the Danube (1870

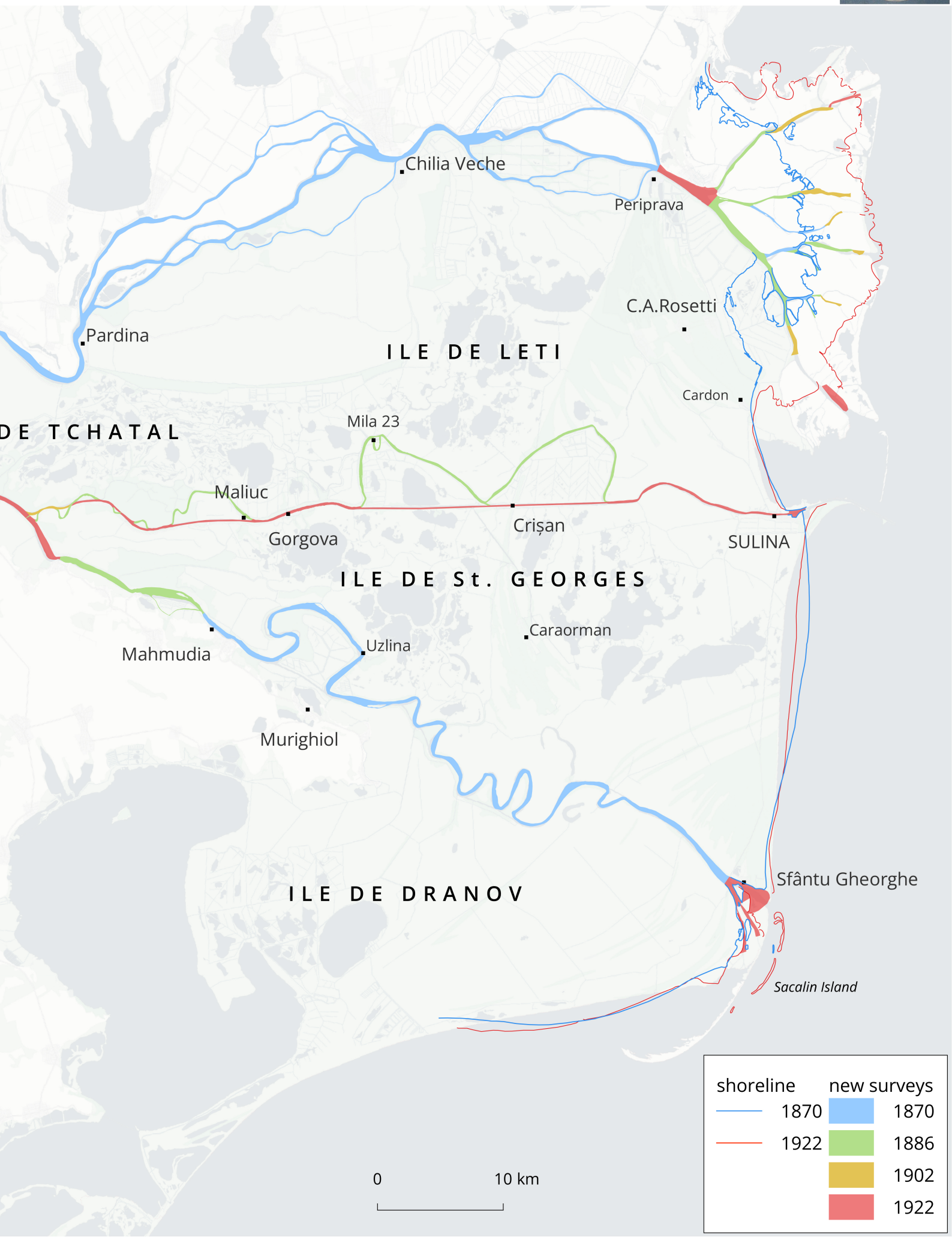
Marine and Fluvial Research Station Sf. Gheorghe

Reni
Galați
Brăila
Isaccea
Pătlăgeanca
Parcheș
TULCEA

First triangulation network established in the Danube Delta (1870)

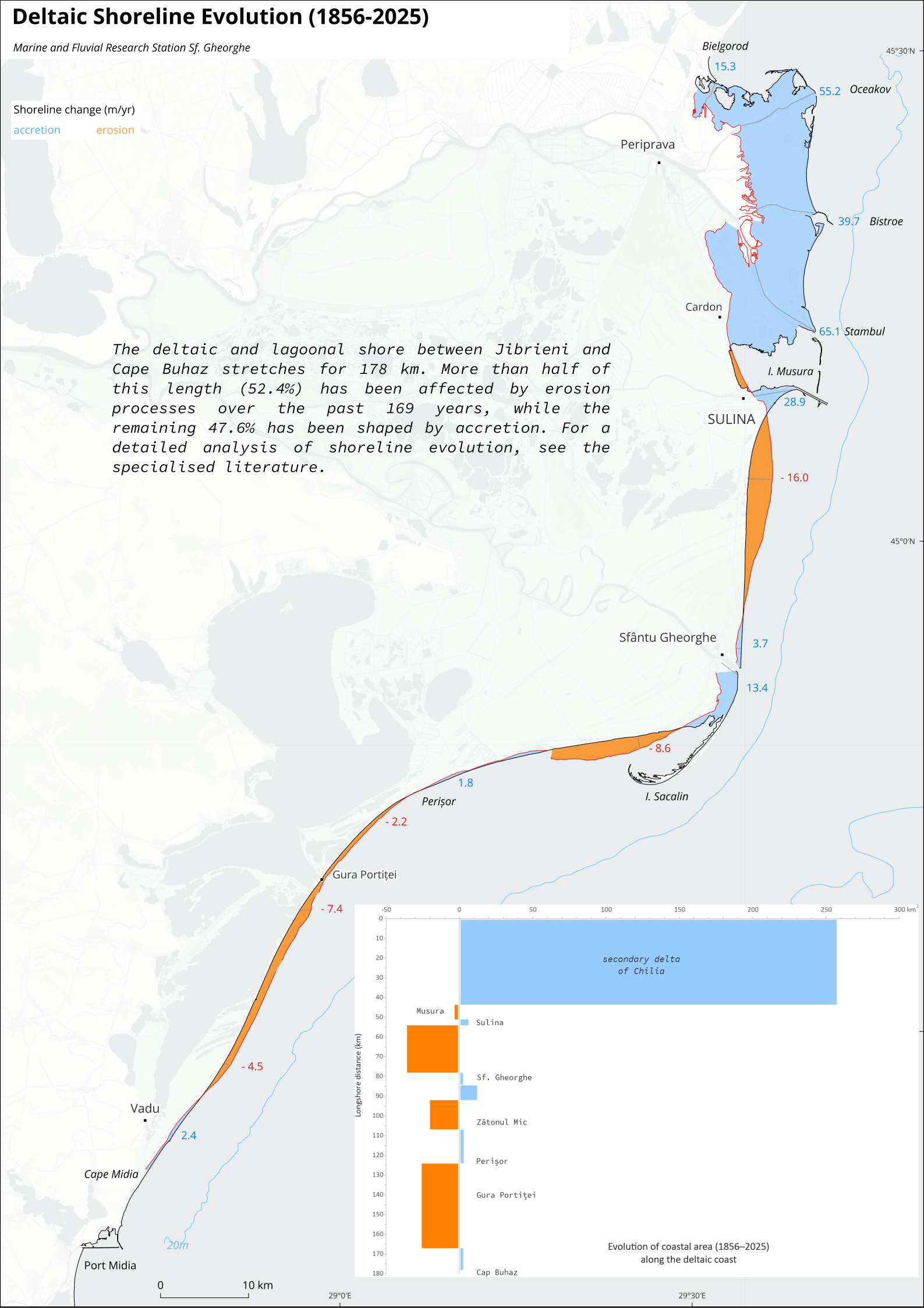


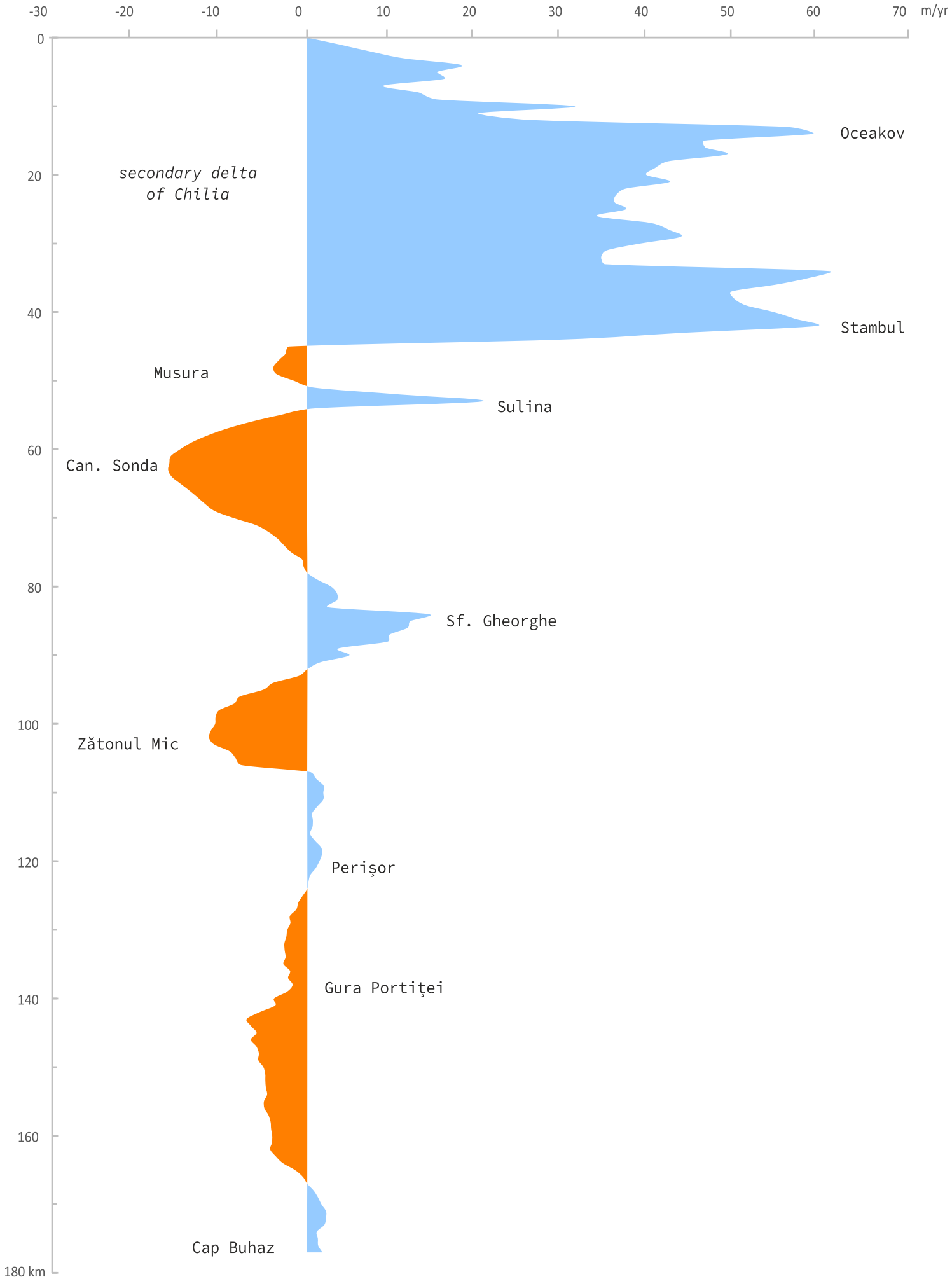
–1922)


Chilia Veche
Periprava
C.A.Rosetti
Pardina
ILE DE LETI
Cardon
DE TCHATAL
Mila 23
Maliuc
Gorgova
Crișan
SULINA
ILE DE St. GEORGES
Caraorman
Uzlina
Mahmudia
Murighiol
Sfântu Gheorghe
ILE DE DRANOV
Sacalin Island
shoreline
1870
1922
new surveys
1870
1886
1902
1922
0
10 km

Deltaic Shoreline Evolution (1856-2025)

Marine and Fluvial Research Station Sf. Gheorghe




-30
-20
-10
0
10
20
30
40
50
60
70
m/yr
0
20
40
60
80
100
120
140
160
180 km
secondary delta
of Chilia
Oceakov
Stambul
Musura
Sulina
Can. Sonda
Sf. Gheorghe
Zătonul Mic
Perișor
Gura Portiței
Cap Buhaz
Erosion
Progradation

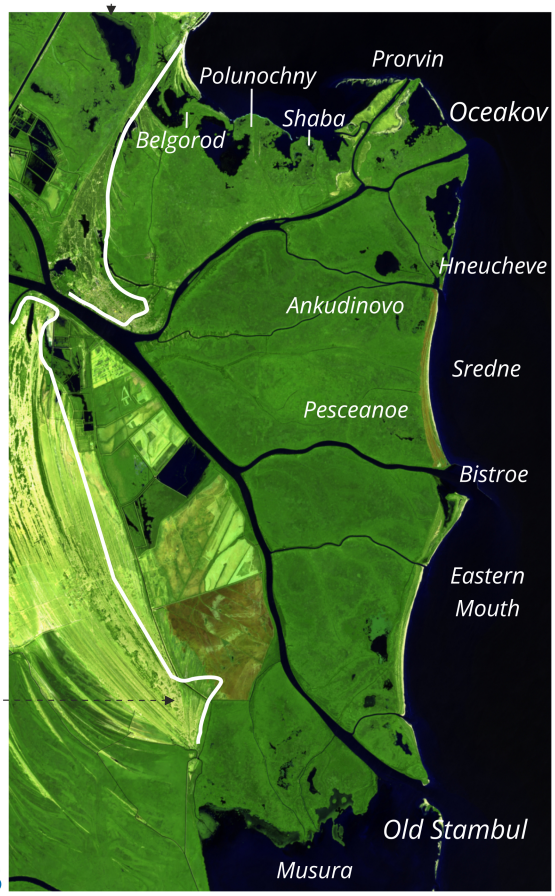
Two



1771

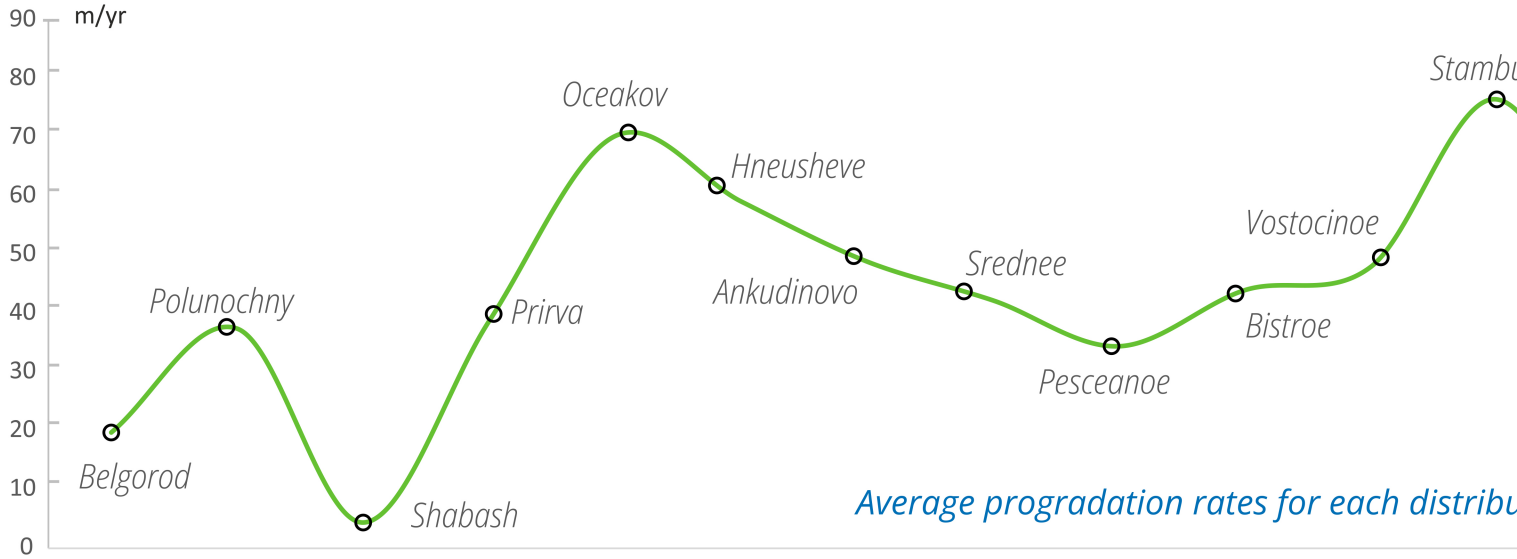
Lake Jibrieni

Cape Musura



2025

300
250
200
150
100
50
0



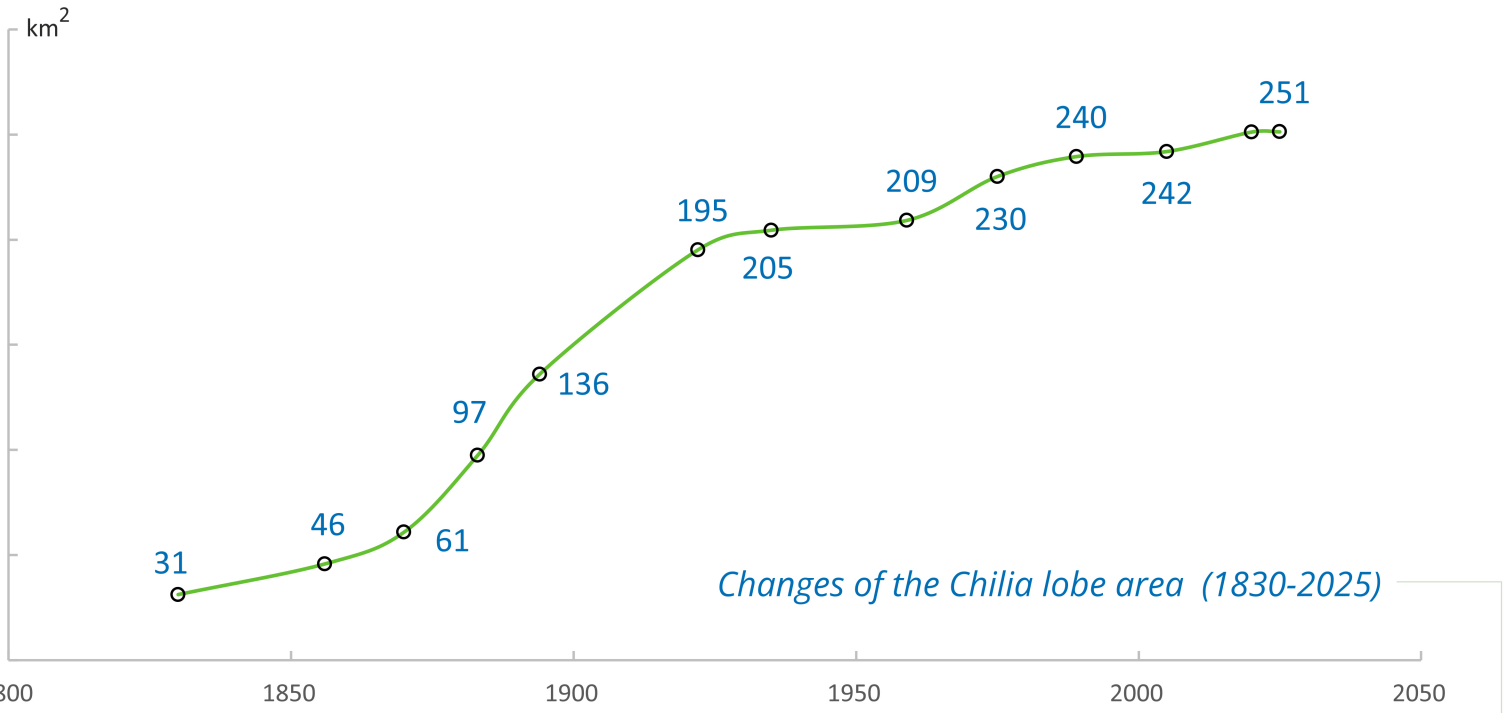
Average progradation rates for each distribu



1830 1856 1870 1883 1894 1922 1935 195

and a Half Centuries of Change: The Chilia Secondary Delta

Marine and Fluvial Research Station Sf. Gheorghe

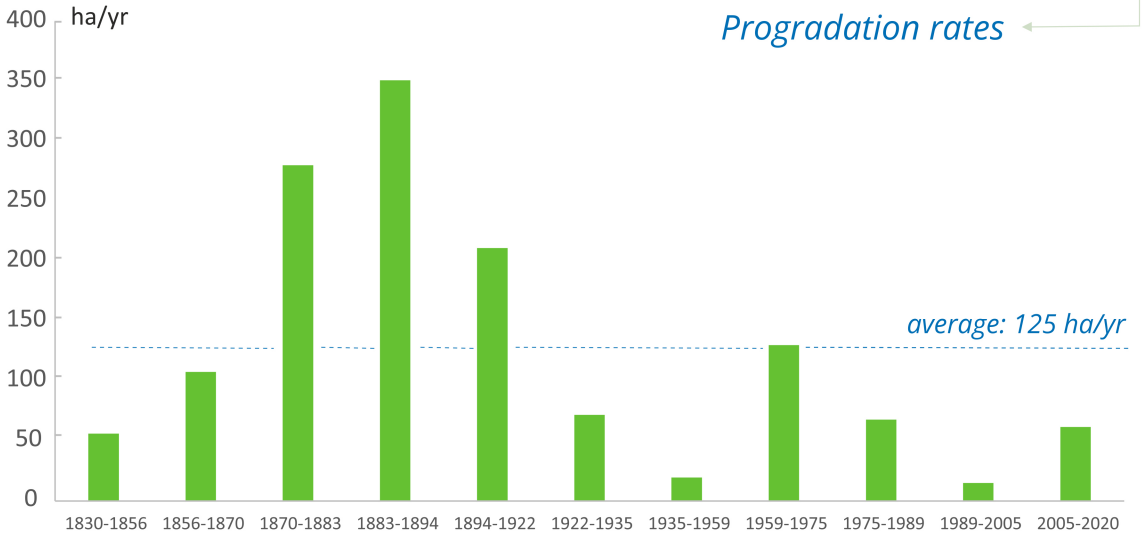


Changes of the Chilia lobe area (1830-2025)



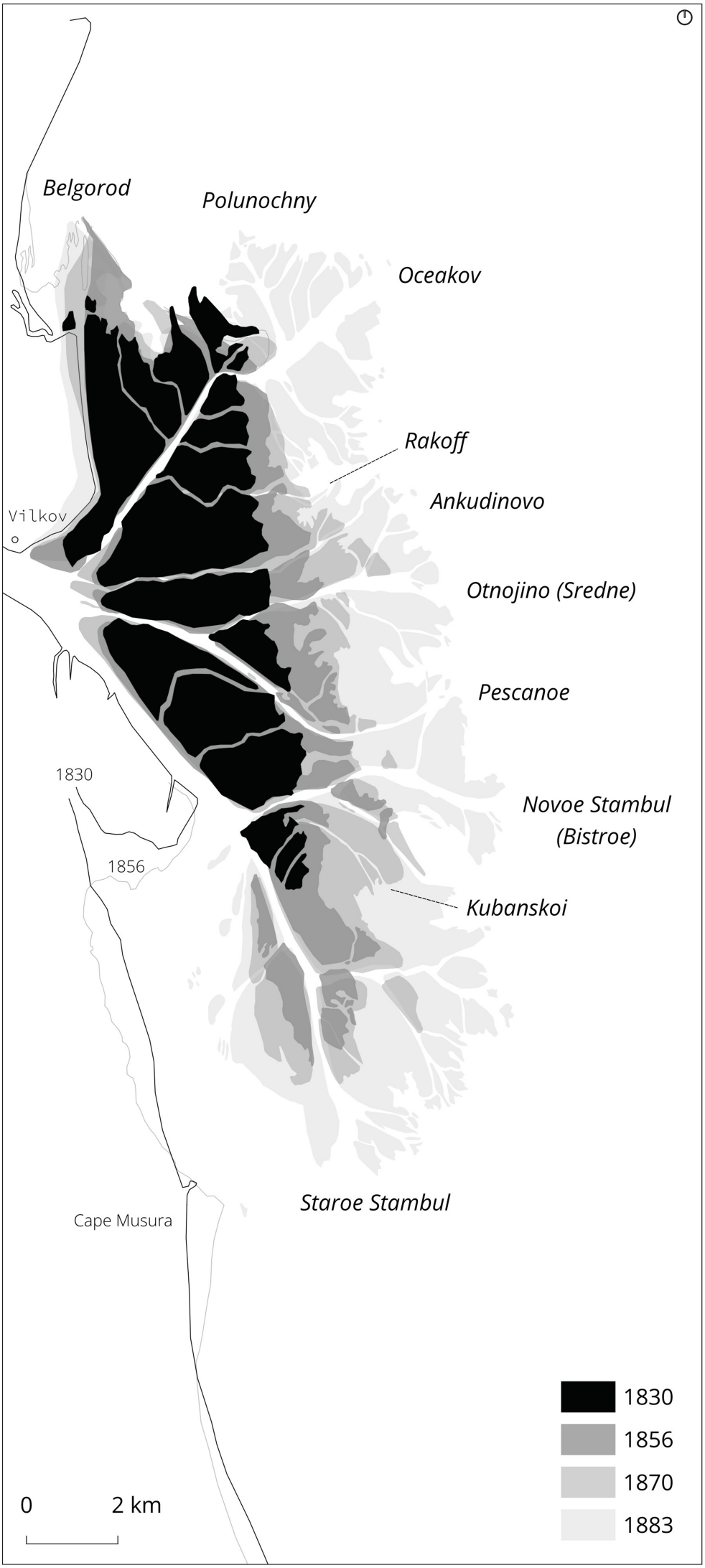
utary mouth

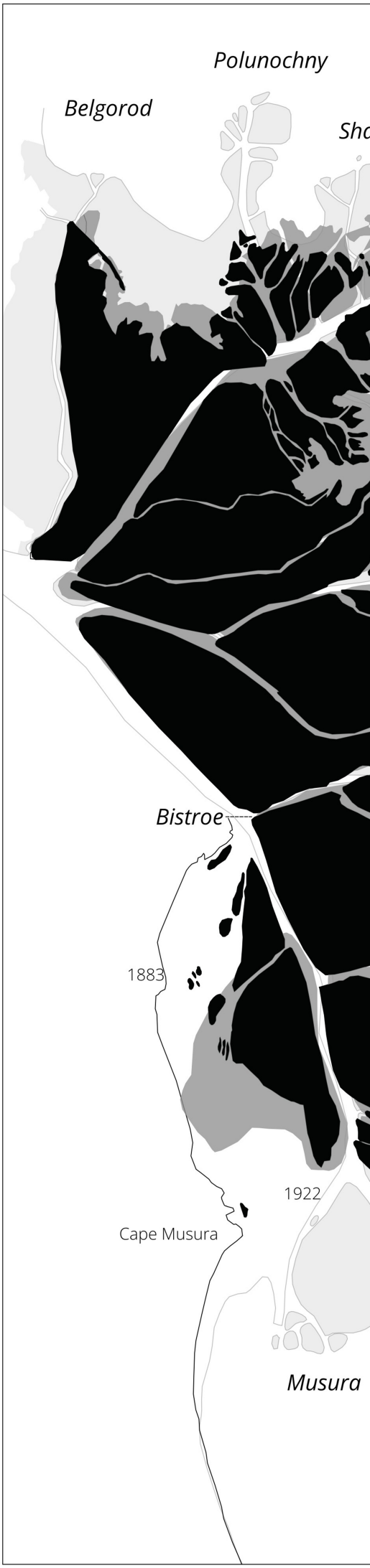
Progradation rates

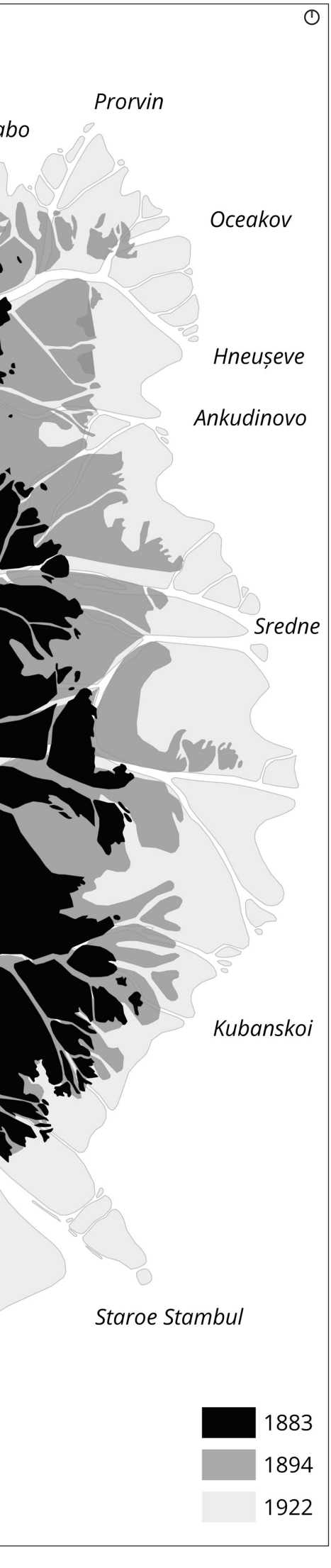


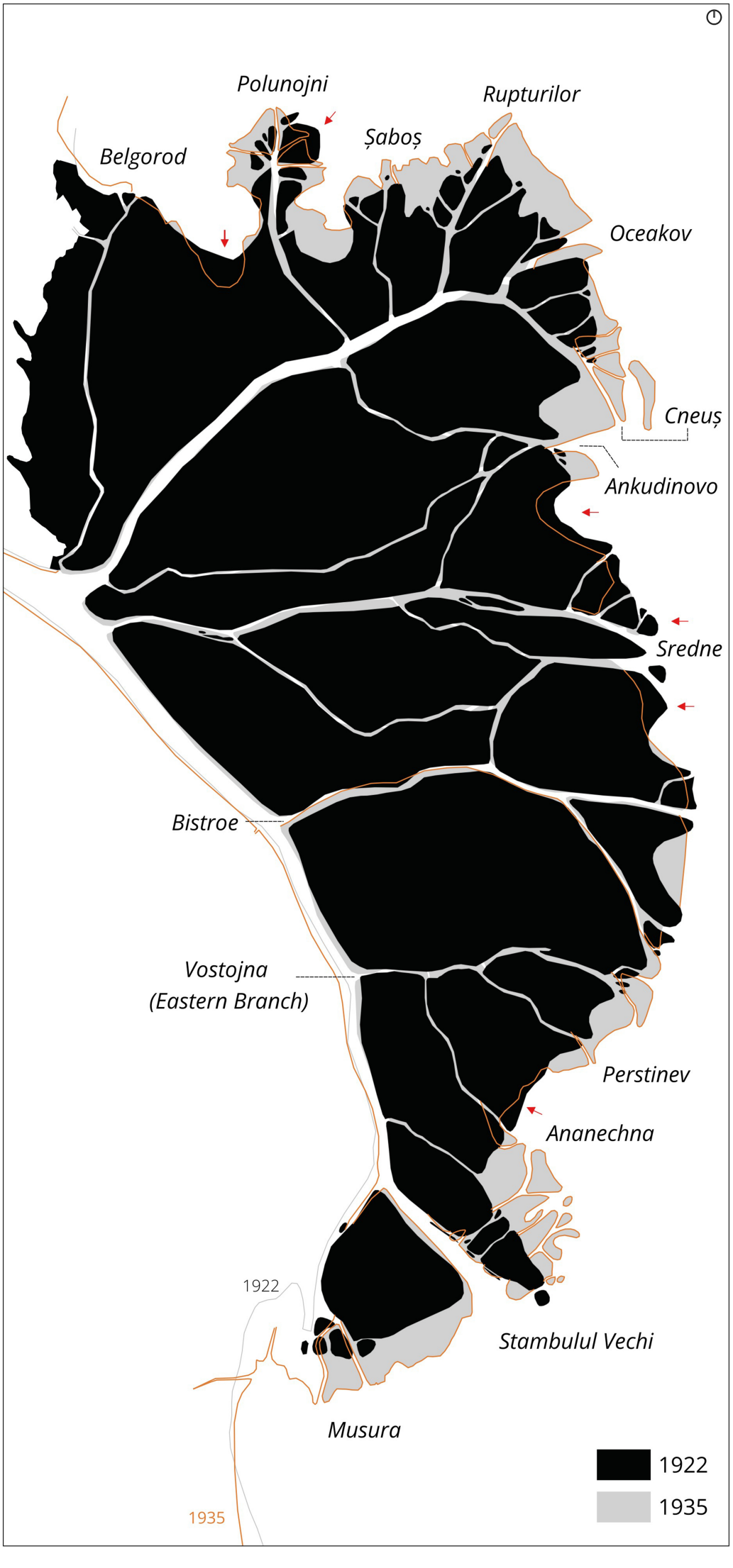


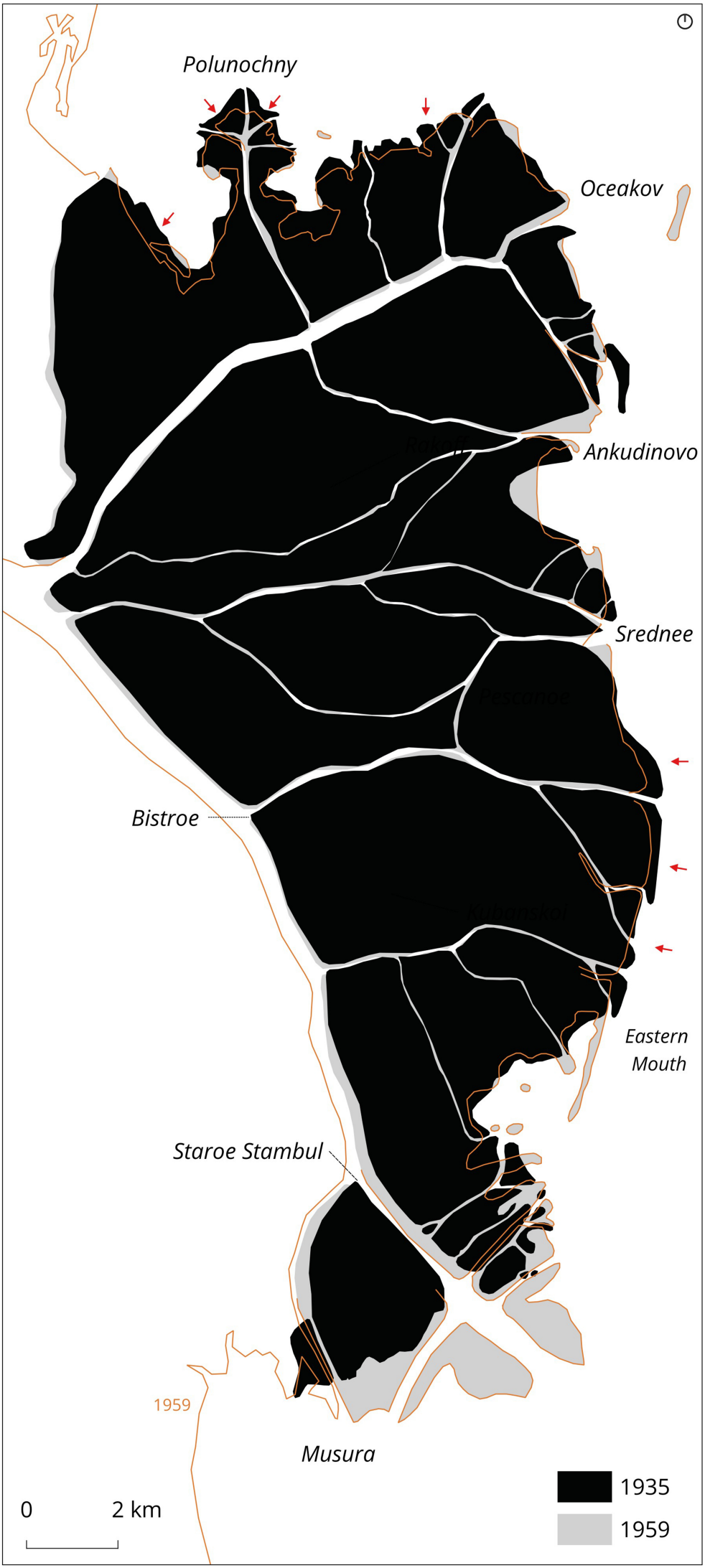
9 1975 1989 2005 2020 2025


Belgorod
Polunochny
Oceakov
Rakoff
Ankudinovo
Vilkov
Otnojino (Sredne)
Pescanoe
1830
Novoe Stambul
(Bistroe)
1856
Kubanskoi
Staroe Stambul
Cape Musura
0
2 km
1830
1856
1870
1883


Polunochny
Belgorod
Bistroe
1883
1922
Cape Musura
Musura


Prorvin
abo
Oceakov
Hneușeve
Ankudinovo
Sredne
Kubanskoi
Staroe Stambul
1883
1894
1922

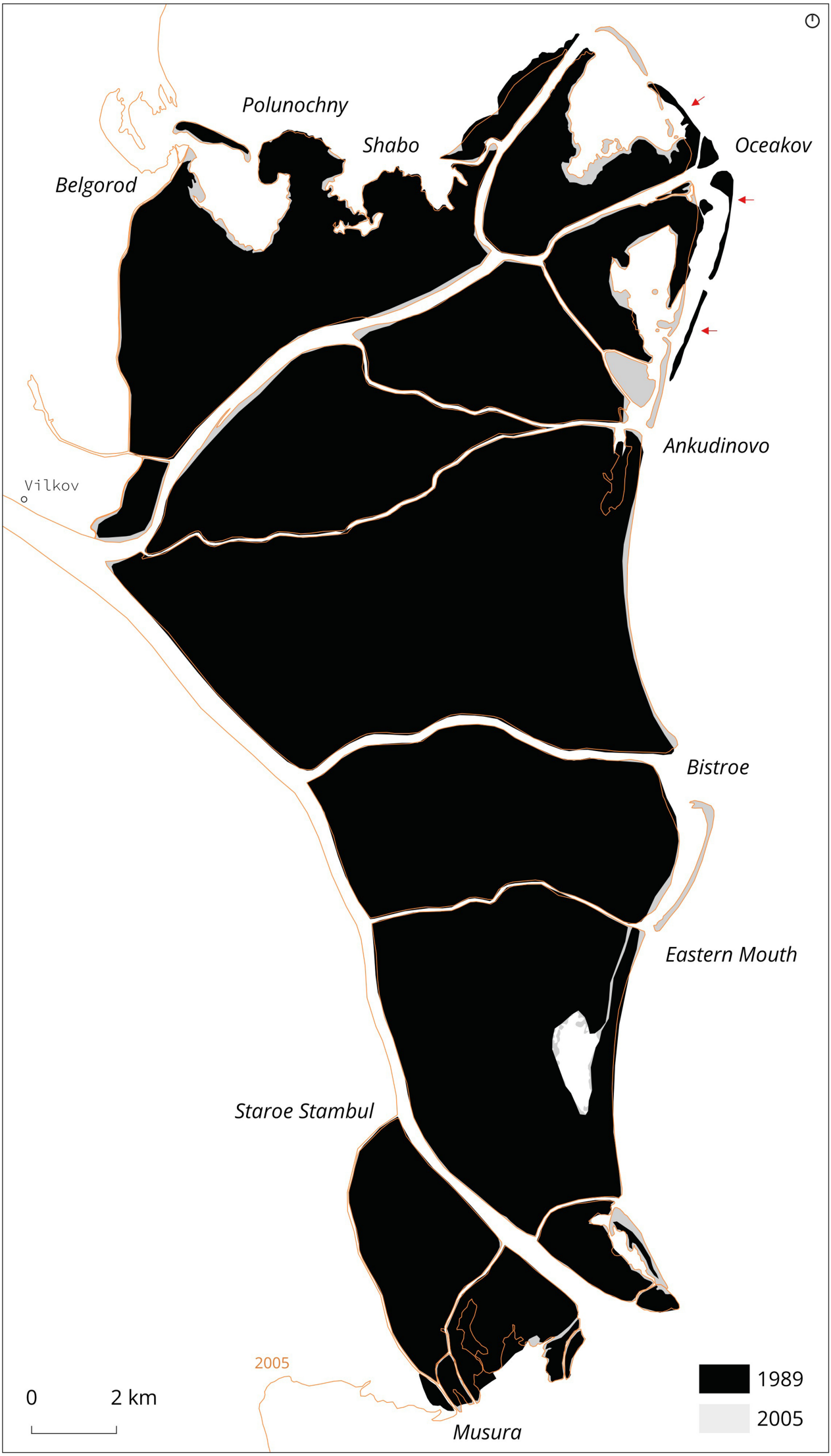

Polunojni
Rupturilor
Belgorod
Șaboș
Oceakov
Cneuș
Ankudinovo
Sredne
Bistroe
Vostojna
(Eastern Branch)
Perstinev
Ananechna
1922
Stambulul Vechi
Musura
1935
1922
1935


Polunochny
Oceakov
Ankudinovo
Srednee
Pescanoe
Bistroe
Kubanskoi
Eastern
Mouth
Staroe Stambul
1959
Musura
0
2 km
1935
1959


1975


1959
1975


1975
1989
1989


Polunochny
Shabo
Oceakov
Belgorod
Ankudinovo
Vilkov
Bistroe
Eastern Mouth
Staroe Stambul
2005
Musura
0
2 km
1989
2005


Vilkov
2020
2005
2020

Historical Evolution of Musura Island

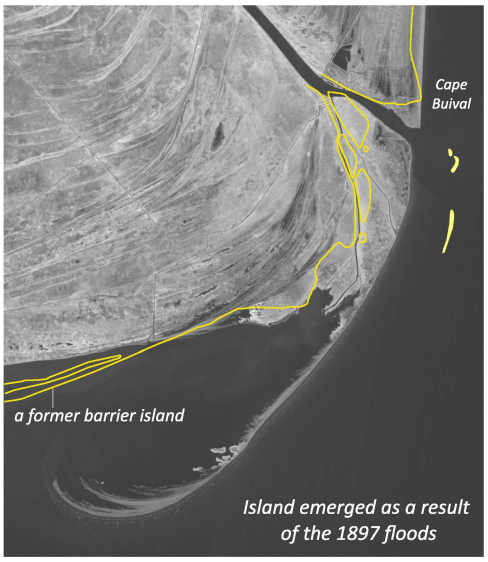
Marine and Fluvial Research Station Sf. Gheorghe

Background image: Planet (June 2025)

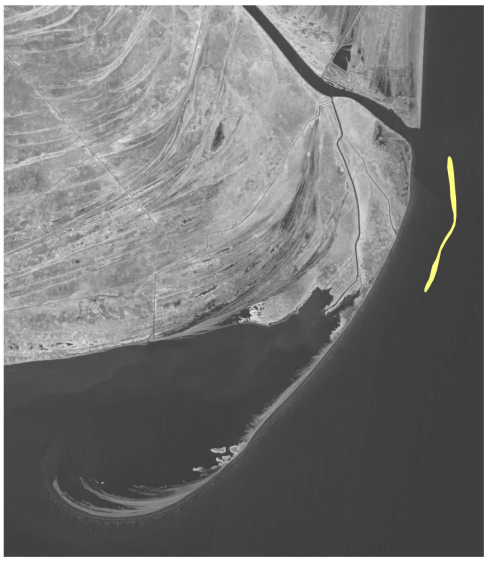


The evolution of Sacalin Island

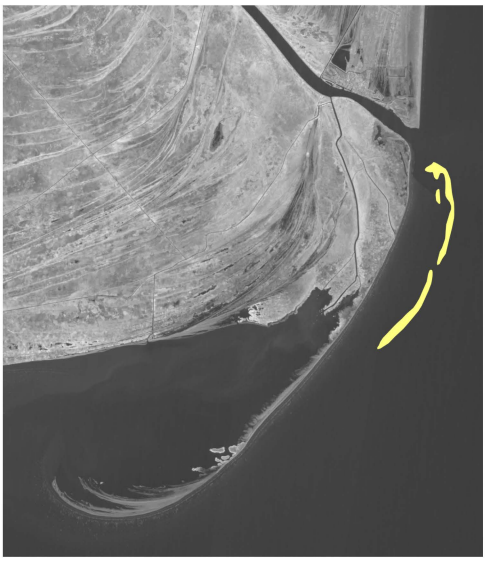
Marine and Fluvial Research Station Sf. Gheorghe



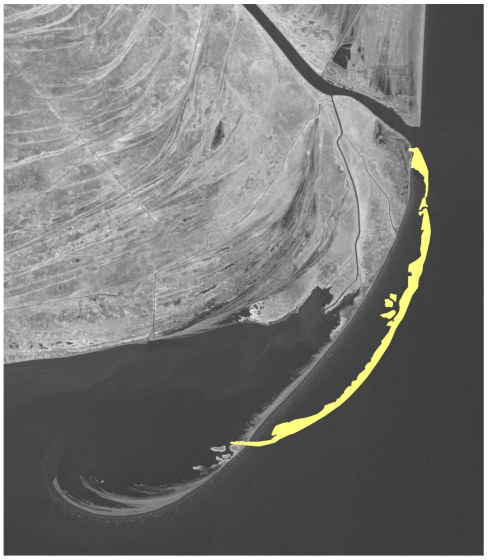
1898



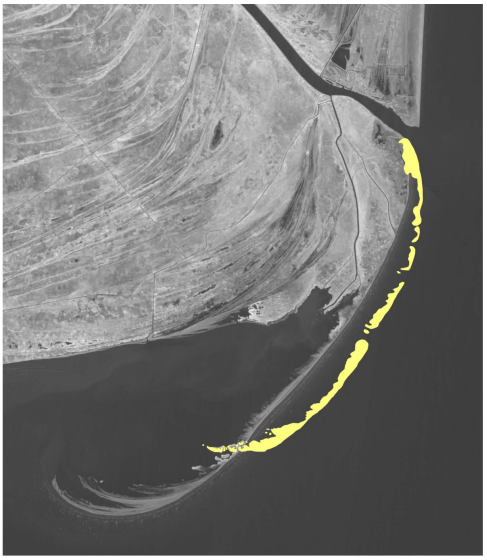
1911



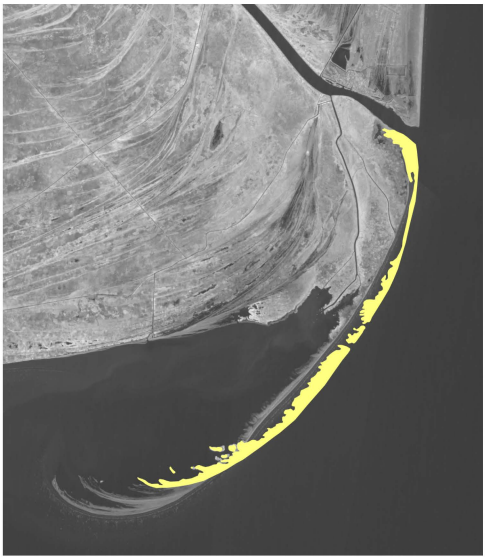
1927



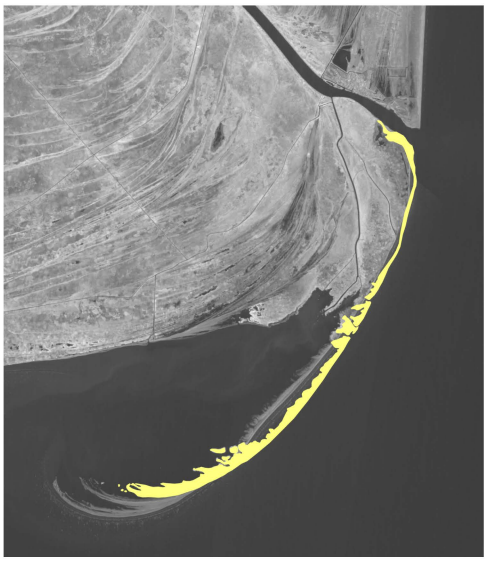
1961



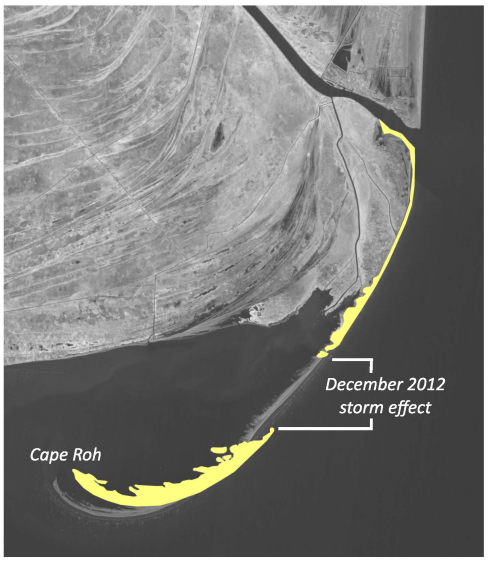
1971



1989



2000



2013

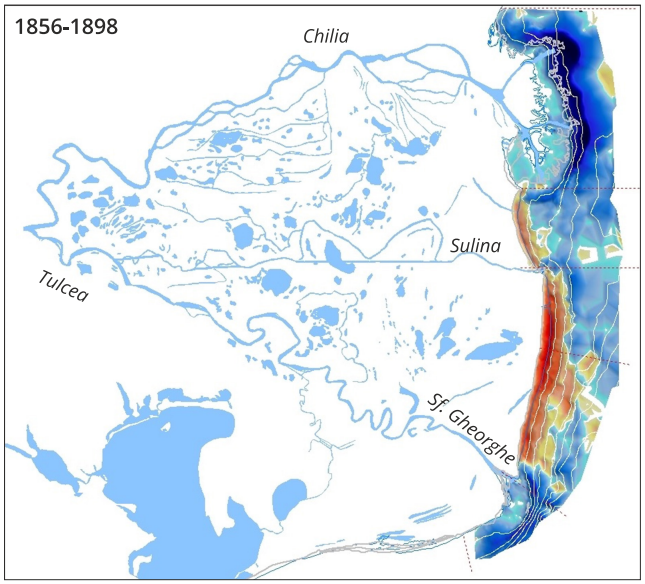


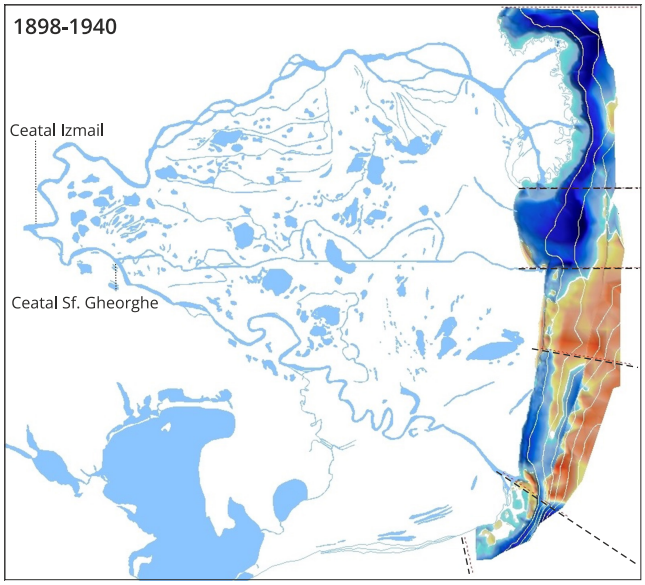
2022

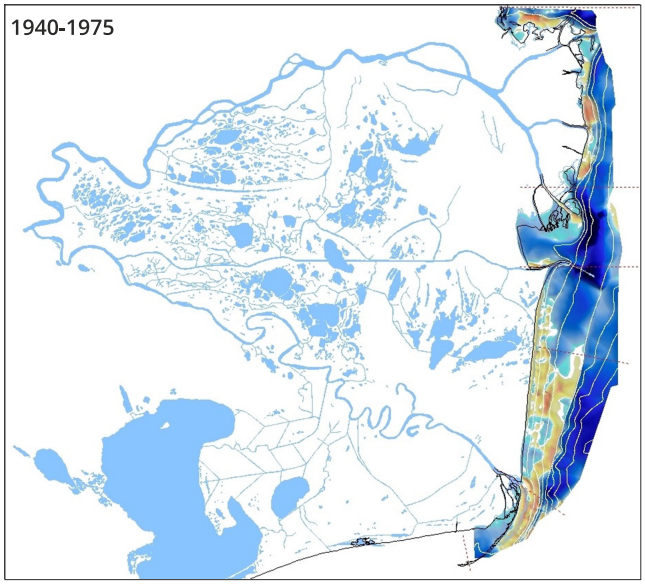
Background image: Planet (2024/05/07)

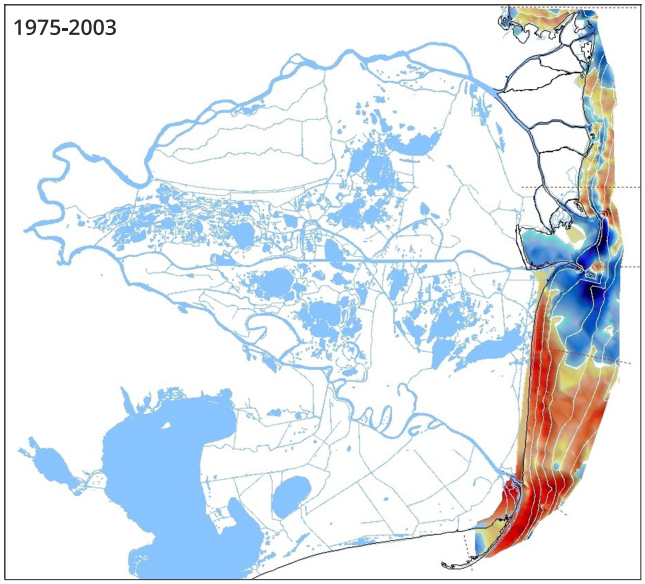
Shoreface morphodynamics along the Danube Delta

Marine and Fluvial Research Station Sf. Gheorghe

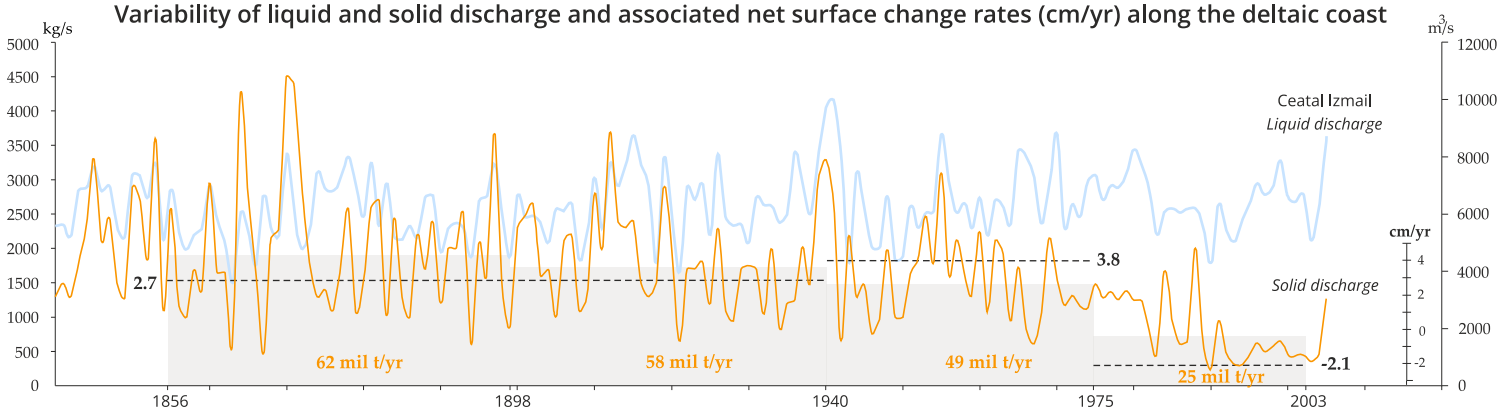




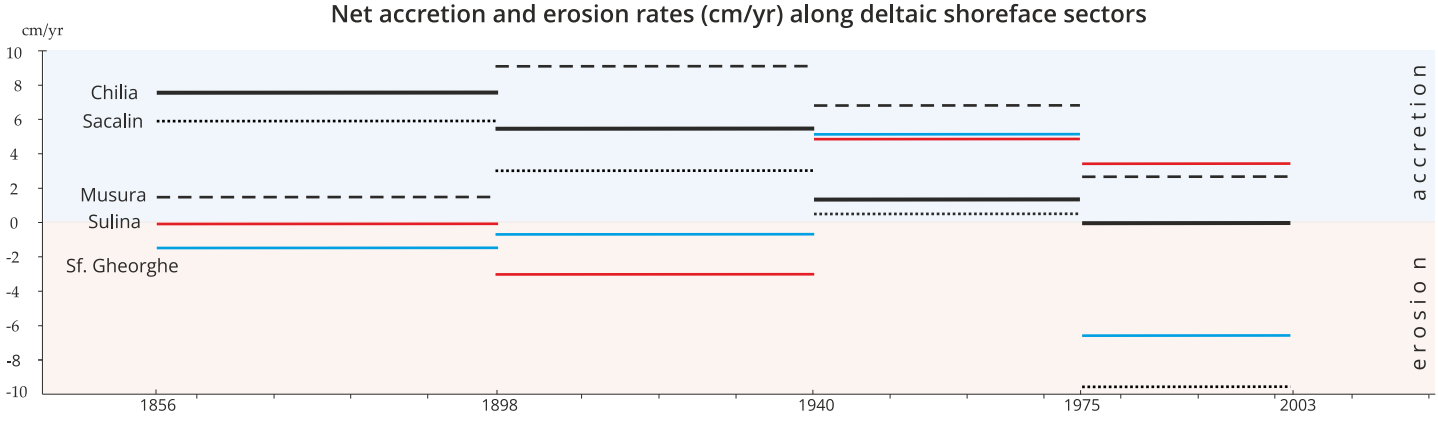




Variability of liquid and solid discharge and associated net surface change rates (cm/yr) along the deltaic coast



Net accretion and erosion rates (cm/yr) along deltaic shoreface sectors



Administrative Organization and Population

Within the delta there are 8 Administrative-Territorial Units (ATUs) located strictly inside it: the town of Sulina, and the communes of Chilia Veche, Sfântu Gheorghe, Murighiol, C.A. Rosetti, Crișan, Maliuc, Pardina, and Ceatalchioi. Several other communes, developed on the continental edge of the Dobrogean Plateau, also extend into the delta: Murighiol, Mahmudia, Beştepe, Nufăru, Somova, and the town of Tulcea.

An interesting statistic highlights the three largest ATUs in Romania by area, all of them located in the delta: Murighiol (the largest), Sfântu Gheorghe, and Chilia Veche.

In Ukraine, the most important town is Izmail, followed by three ATUs: Safianivska, Kiliiskva, and Vylkivska.

Among the delta's settlements, the largest is the town of Izmail (69,932 inhabitants), closely followed by Tulcea (65,624 inhabitants). At a considerable distance comes the Ukrainian town of Kilia (18,745 inhabitants), followed by Vylkovo (7,712 inhabitants). The largest town within the Romanian part of the delta is Sulina (3,118 inhabitants). The last census (2021) indicated that the largest locality without town status is Chilia Veche (1,728 inhabitants). Sfântu Gheorghe follows with only 639 inhabitants, the only one falling into the 500-1000 residents category. Next is a series of settlements grouped in the 200-500 residents category: Pardina (489), Mila 23 (442), Crișan (423), Maliuc (312), Partizani (301), Ceatalchioi (291), Letea (270). The village of C.A. Rosetti (159), although smaller than Letea, serves as the commune's administrative center. Depopulation is a key feature of delta villages: Câșlița and Ostrovu Tătaru currently have no residents, while others are nearing disappearance: Tatanir (3), Uzlina (11), Cardon (12), Sfiștofca (28), Plauru (32), Vulturu (48), Bălteni de Jos (50).

The population of the delta, counting here only settlements strictly within it, is extremely low—under 10,000 inhabitants (9,209). For our maps, however, we chose to also include riparian localities, whose inhabitants carry out economic activities inside the delta. These, however, are connected by roads to the main higher-level administrative centers: Tulcea (65,624) and Babadag (9,213). The same situation occurs in Ukraine, where all localities are located within the Bugeac Plateau, with one exception—Vylkovo, situated on the Jibrieni levee, but also connected by roads to the surrounding settlements.

Relative to the delta's surface area, population density is extremely low—2-3 inhabitants/km^2. These values increase if we also include

continental localities, but remain far below the average population density of the world's deltas (480–680 inhabitants/km^2), as indicated by recent studies (Anthony et al., 2024).

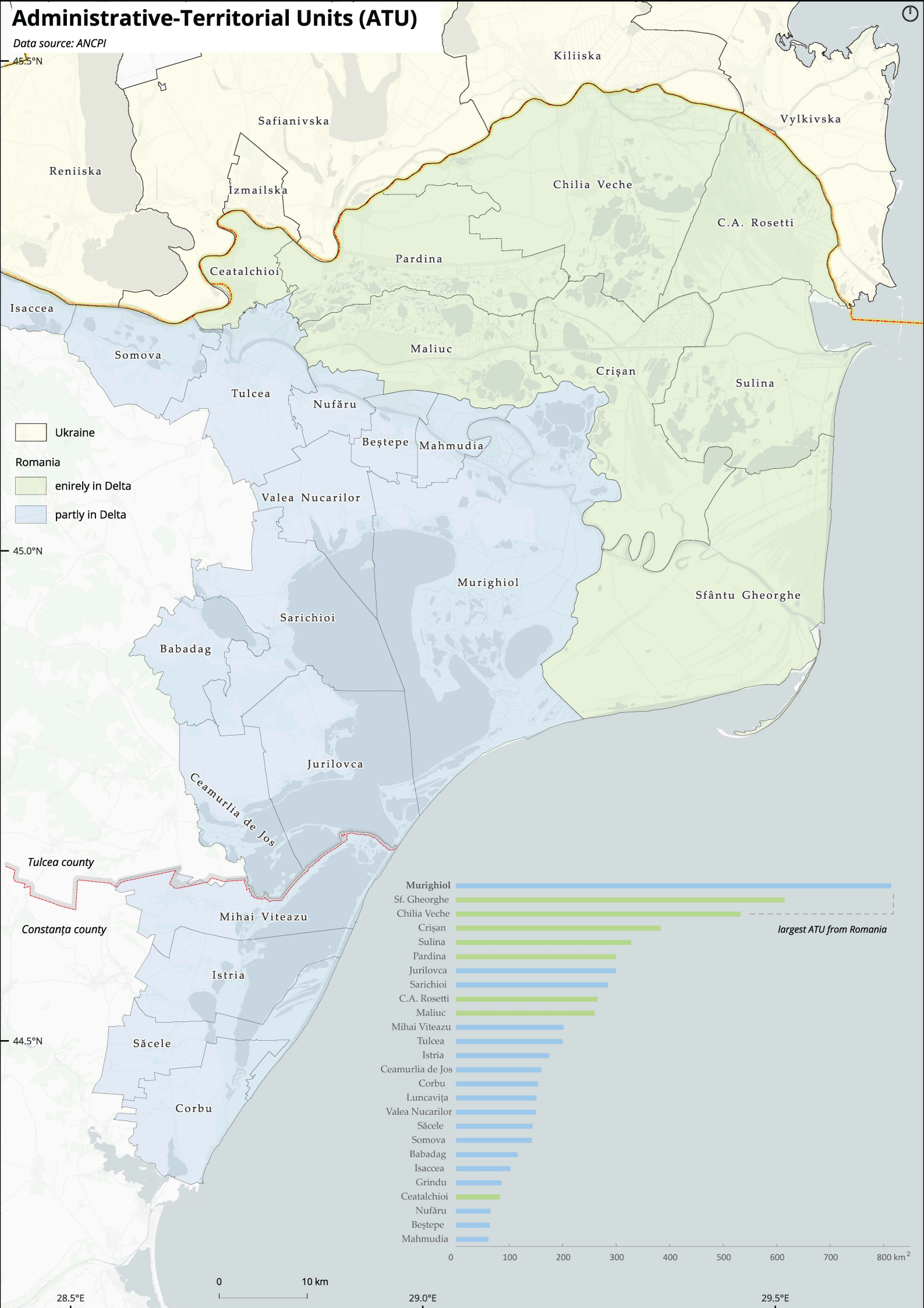
The population structure a century ago was much more diverse. Today, Romanians are the majority (80.7%), followed by Lipovans (5.3%) and Ukrainians (4.5%). Interestingly, at the last census 9.4% of the data was not made public. On our maps we nevertheless chose to represent the surrounding localities as well, to provide the reader with a broader picture. The largest numbers of ethnic Russians (Lipovans) are found in Sarichioi (2,030), followed by Tulcea (1,244) and Jurilovca (1,465). Within the delta proper, only in Sulina did 200 persons declare themselves as Lipovans, followed by C.A. Rosetti (127) and Crișan (106).

Ukrainians, also known as *haholi*, are most numerous in Tulcea (278), followed by Murighiol (155). Within this commune, Dunavăț is the main Ukrainian center. In C.A. Rosetti there are 120 persons, while in Pardina 109 residents declared Ukrainian ethnicity. Crișan and Sfântu Gheorghe show similar figures (64 and 57 persons, respectively).

Regarding religious affiliation, the majority are Orthodox (82.7%), followed by Old-Rite Christians (6.7%). Here too, we encounter a similar percentage (approx. 10%) of the population who chose to keep their religious identity undisclosed.

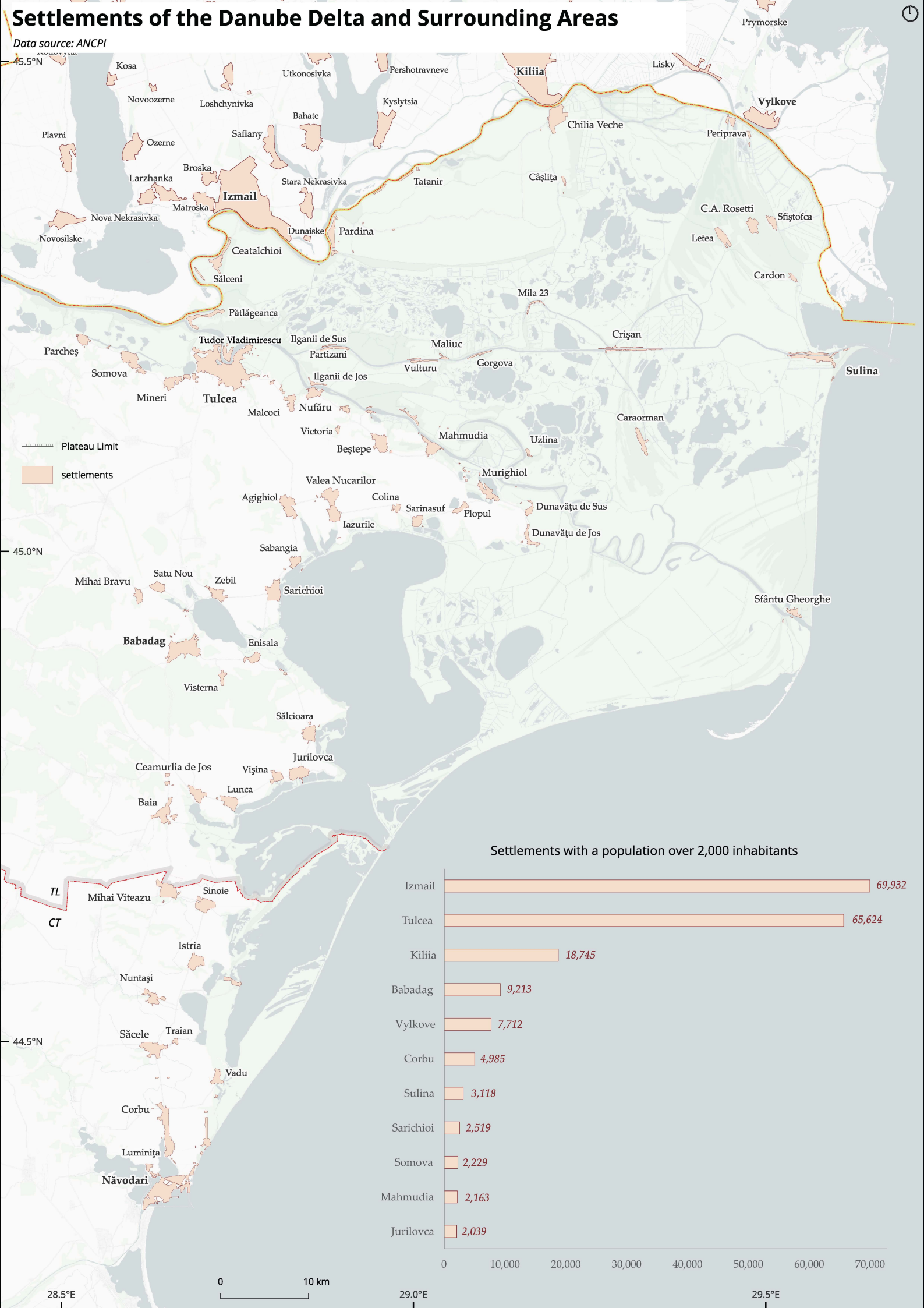
Administrative-Territorial Units (ATU)

Data source: ANCPI



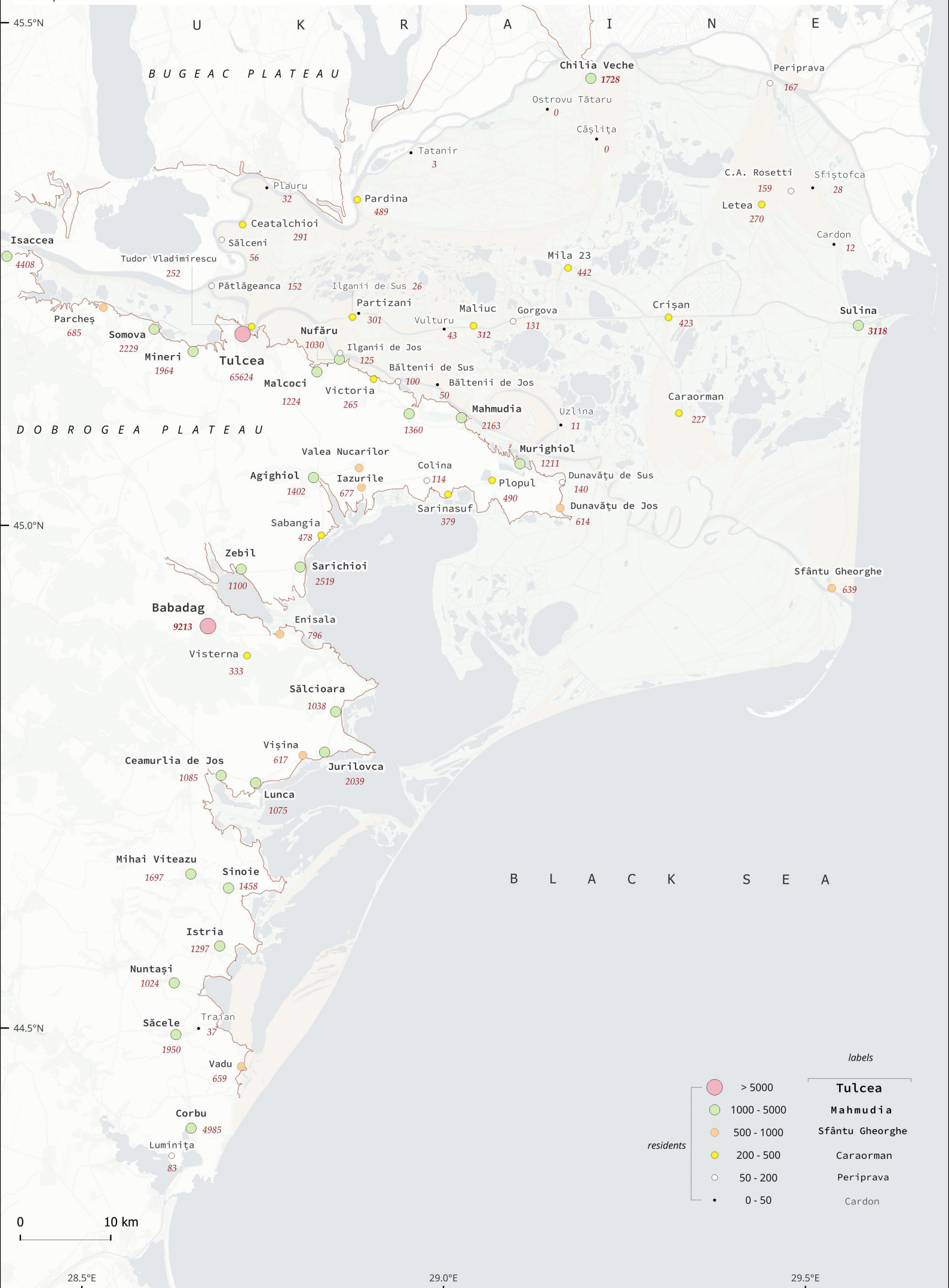
Settlements of the Danube Delta and Surrounding Areas

Data source: ANCPI



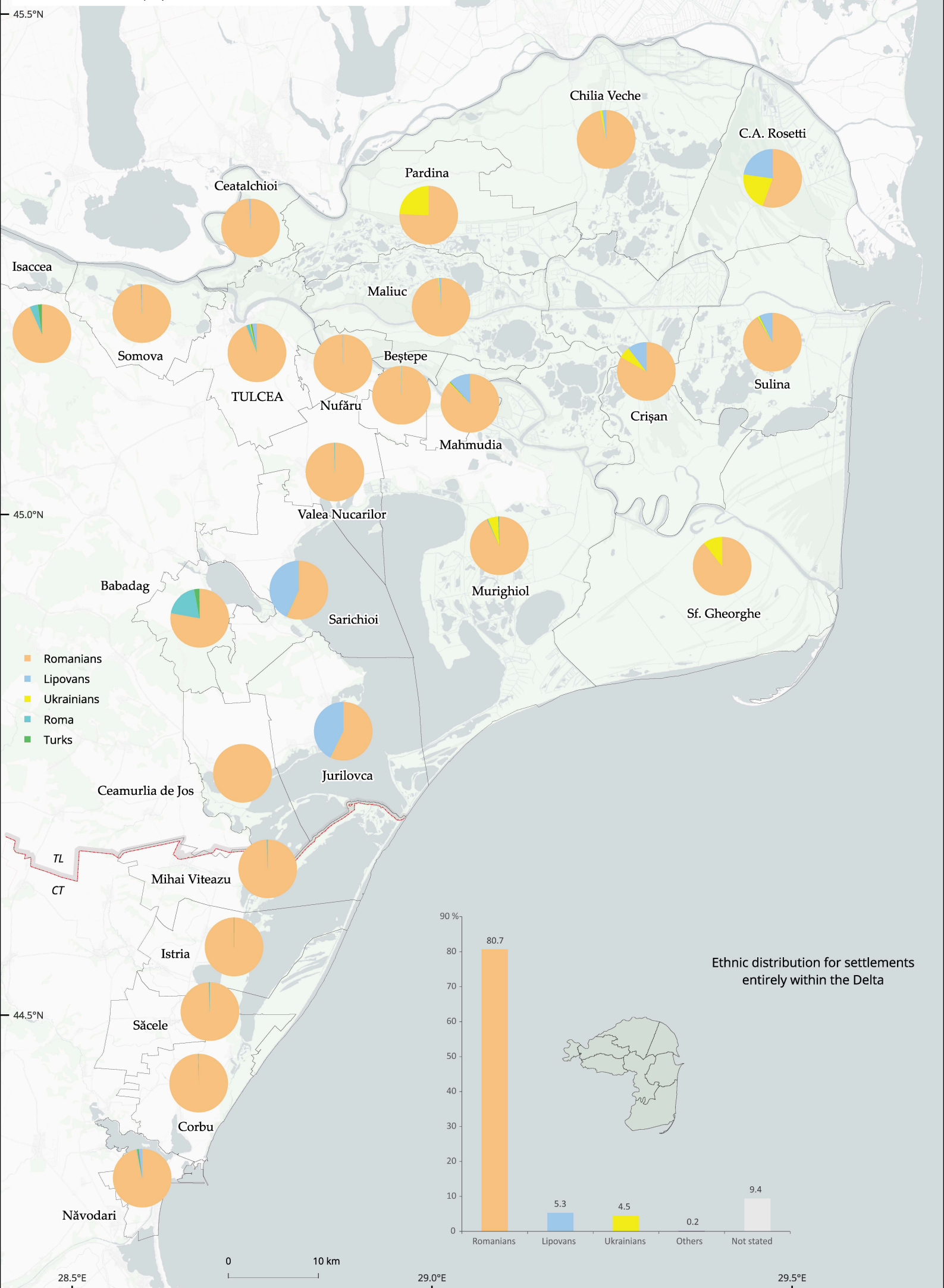
Danube Delta: Settlement classification according to the number of residents

2021 Population Census



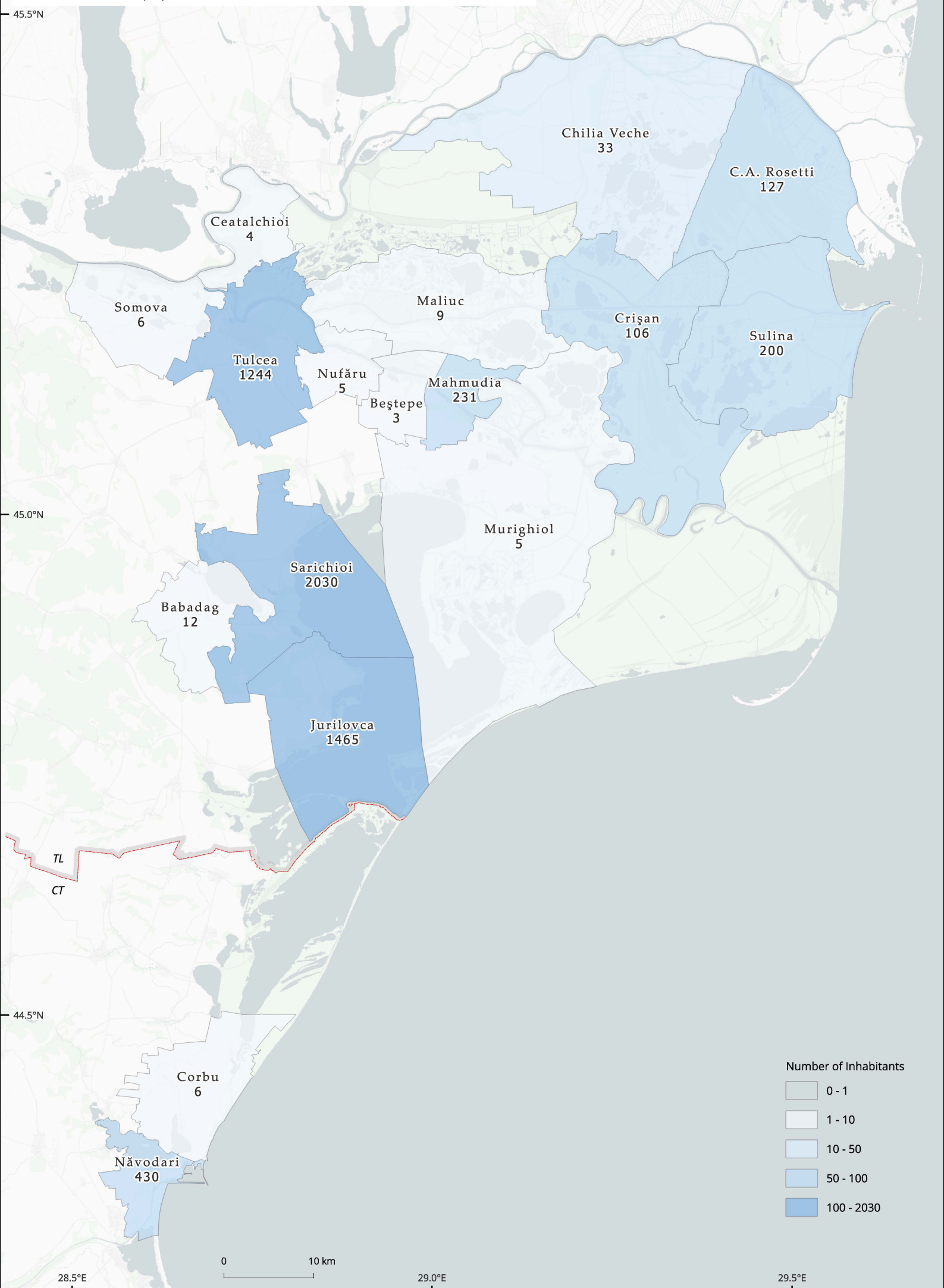
Population by ethnicity (%)

Data source: Census 2021 (INS)



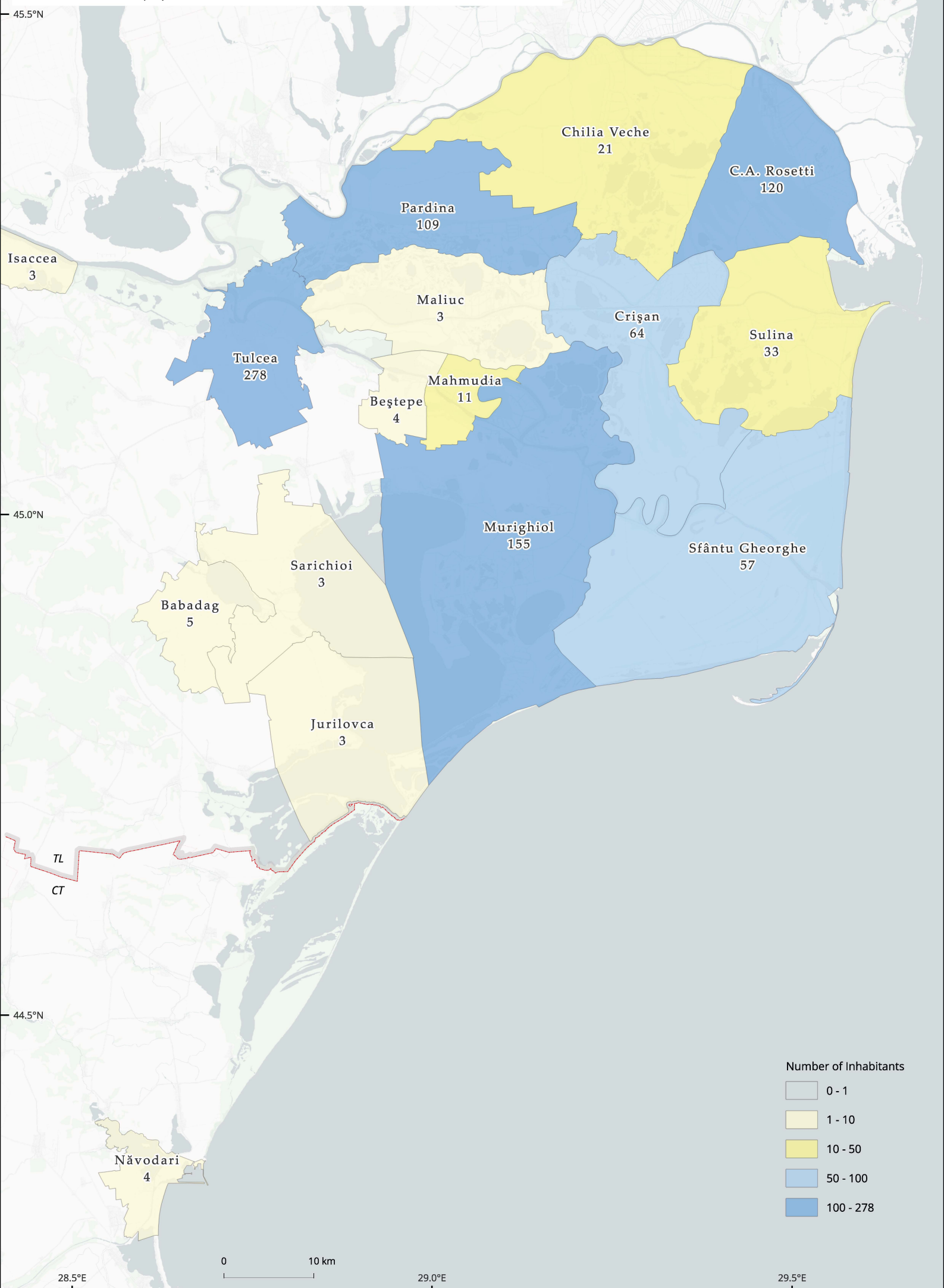
Distribution of the Lipovan Ethnic Population

Data source: Census 2021 (INS)



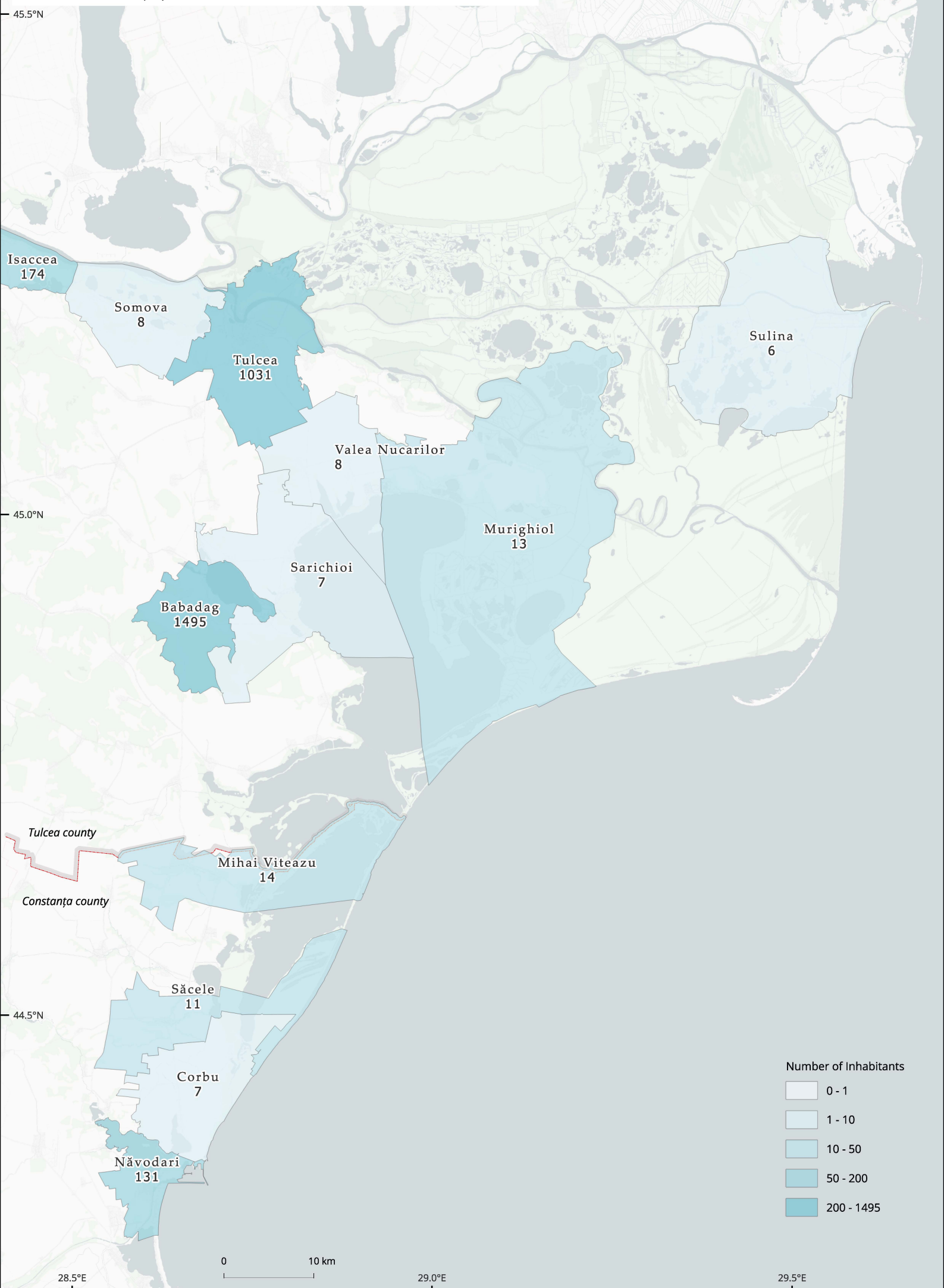
Distribution of the Ukrainian Ethnic Population

Data source: Census 2021 (INS)



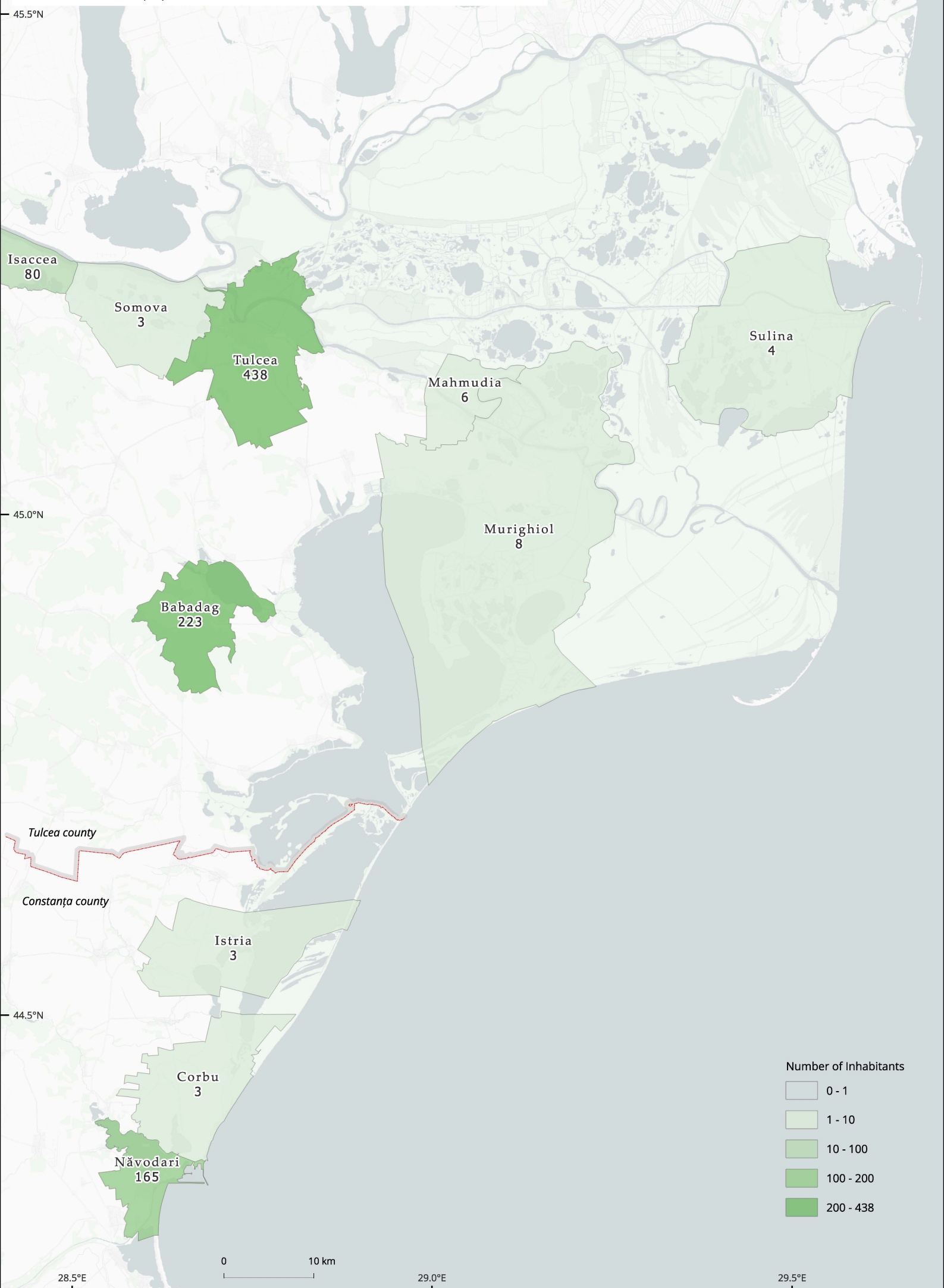
Distribution of the Roma Ethnic Population

Data source: Census 2021 (INS)



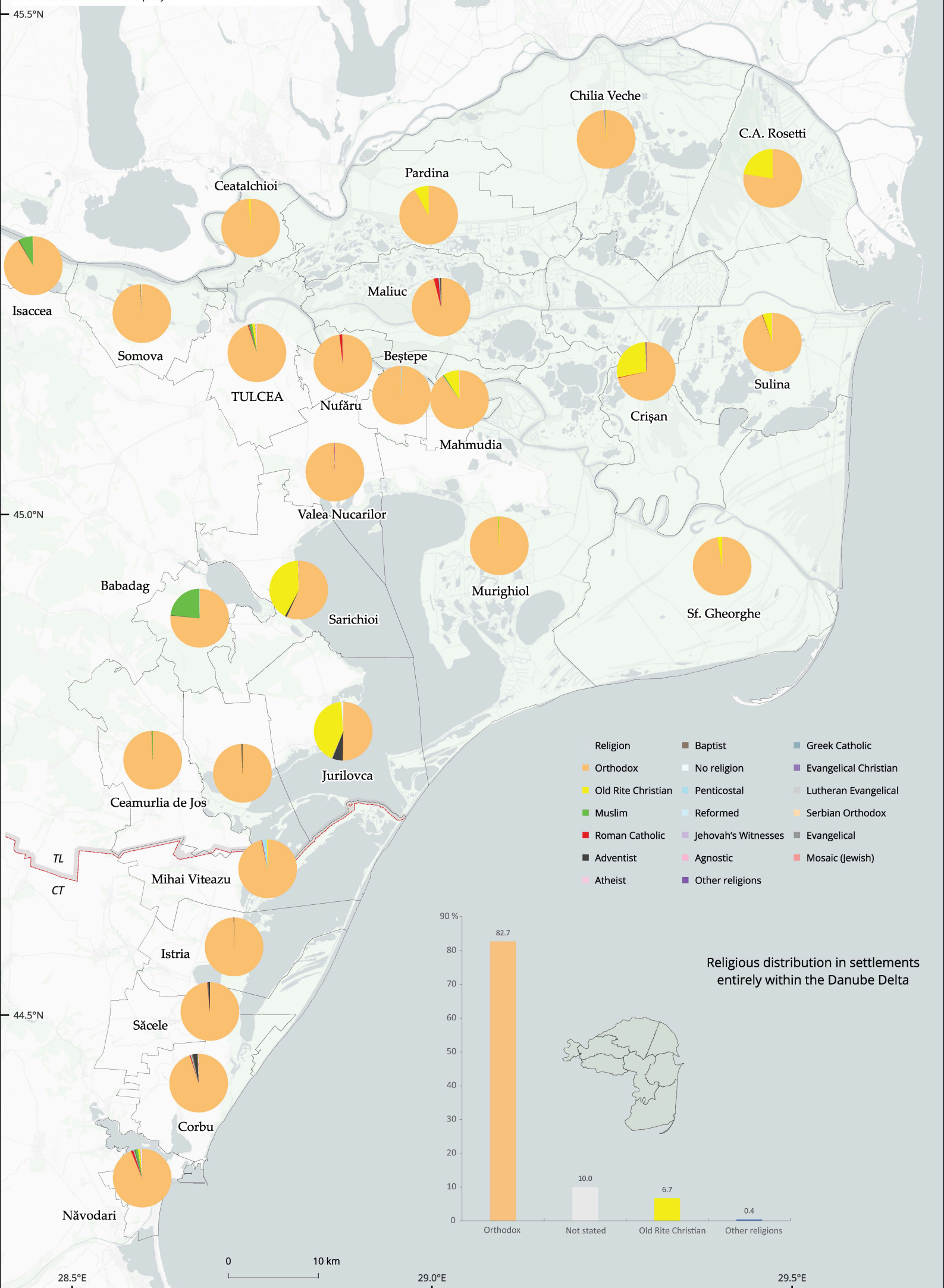
Distribution of the Turkish Ethnic Population

Data source: Census 2021 (INS)



Population by religion (%)

Data source: Census 2021 (INS)



Religious distribution in settlements entirely within the Danube Delta

Carte du Danube et de ses Embranchements (1887)

Commission Europenne du Danube

A Borderland Space

military · roads · animals · windmill
huts · fishing · trade · hunting

45.5°N

Hassanpacha · Dimiansk · KILIA · Balgarod · Otchakof · Solomanof · Bazartchuk · VILKOV · Rakof · Babinof · Vieux Kilia · Tcherniofka · Ankodinovo · Otnojino · Soulimanka · Peripravy · Pechanoi · Novoe Stamboul · Amudia · Sistof · Satanof · Leti · Cardon · Sulina Lighthouse · SOULINA

Bras de Kilia · Parachia · Ivaneshti · Getcova Saha · Repedea · Pardina · Hliboca Saha · Iacob Saha · Bras de Soulina

L. Katlaboug · L. Yalpouc · L. Sofian · L. Kougourlui · L. Kartal · L. Tatanir · L. Babina · L. Matița · L. Bogdaproste · L. Yidianka · L. Fortuna · L. Obretin · L. Gorgova · L. Ciubida · L. Isacov · L. Roșuletu · L. Roșu · L. Razelm · L. Dranov · L. Periteașca

I L E D E L E T I

I L E D E T C H A T A L

I L E D E St. G E O R G E S

I L E D E D R A N O V A

M E R N O I R E

Doloukoui · Kislitza · Babel · Barda · Broska · Larjanka · Sofian · Tatanir · Seredne · Popu · Izmaïl · Vieux Nikrasofka · Satanov · Matrosofka · Moskra · Boujak · Pardine · Kartal · Krasnoi Most · Aleși · St. Theraspont Monastere · ISAKTCHA · Dunare · Pătlăgeanca · Iolganu · Papadia · Partish · Toulcha · Tchatal de St. Georges · Somova · Rusca · Nikolitza · Kishla · TOULTCHA · Prislav · Karasova · Malkotch · Pourlita · Douna · Besh Tepe · Mahmoudie · Yuslin · Karaorman · Litkof · Mouri Ghioul · Sari Gheul · Agi Gheul · Kalika · Dunavățu de sus · Dunavățu de jos · Yerintchuk · Ivancha · Galinova · Bras de St. Georges · Kedrilles · St. George Lighthouse

45.0°N

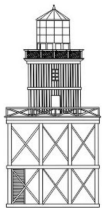
Kunahas · Sabanja · Popin Id. · Satanov · Zabil · Sara keui · Bras de Donaviza · Cerneții Florea · Marshy with High Rushes · Hadabina Inlet · Baba Dagh · Yenisol · Karaman keui · Jurilovca · Ceamurli de jos · Paşacâşla · Hamangi · Canlâ bugeac · Gura Portiții · Casapchioi · Sinoe · Caranasuf · Duingi · Peletlia · Vadul · Gargalâcul Mare · Gargalâcul Mic · C. Midia · Taşaul · Corbu · C. Clisargic

44.5°N

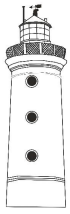
If the quantity of Water discharged by the Danube be divided into 27 parts, it has been estimated that out of the Kilia Branch issue...17 parts, Sulina...2 parts, St. Georges...8 parts.



Windmills of Toulcha



St. George Lighthouse



Sulina Lighthouse

- Wind Mills
- Guard Post
- Cattle and Sheepfold
- 1829 - Adrianople border
- Natural Channels
- Plateau Limit
- Telegraph Line

Roads
- primary
- secondary
- natural

- Water
- Forest
- levee

Entrance to Lake Razelm



0 — 10 km

28.5°E · 29.0°E · 29.5°E

Topographic Map of the Danube Delta (1960s)

DTM: Military Topographic Directorate

Intensive Exploitation

agriculture · industry · new fisheries · reeds · new channels · forestry

45.5°N

L. Kitai · L. Yalkniș · L. Jibrieni · Ov. Shabash · Ov. Prirvy · KILIJA · Ov. Salmanovski · Ov. Bilhorods'kyy · Ov. Polunochnyy · Ov. Gneushev · Ov. Kofa · Ov. Ermakov · Ov. Poludennyy · L. Katlabuh · Vylkovo · L. Yalpuh · Bogatoe · Kyslytya · Ov. Cîșlița (Kislickij) · Chilia Veche · Ov. Oceakov · Periprava · Ov. Ankudinov · Ov. Pishchanyy · Roșca - Buhaiova - Hrecișca · Ov. Stambul · L. Lunh · L. Sof'Ya · Nova Nekrasovka · Matroskaya · IZMAIL · Staraoa Nekrasovka · Ov. Malyj Tătaru · Tatanir · Câșla Chiliei · Pădurea Letea · Ov. Cuban · Novosilskoe · Larzhanka · L. Merhei · C. A. Rosetti · Sfiștovca · Orlovka · Pardina · L. Matița · Letea · Lascăr Catargiu · L. Cartal · L. Kuhurlui · Ceatalchioi · Sălceni · Ov. Limba · Cardon · ISACCEA · Ceatal Izmail · Mila 23 · Ov. Kurilskie · L. Furtuna · Pătlăgeanca · Ov. Ceamurlia · Iganii de Sus · Parcheș · Partizani · Maliuc · Gorgova · Crișan · SULINA · Tudor Vladimirescu · Vulturu · Somova · Ilganii de Jos · TULCEA · Cât. Bogdaproste · Mineri · Carasuhatul de Sus · Carasuhatul de Jos · L.Isacova · Malcoci · Pârlita · Caraorman · L. Lumina · Beștepe · Uzlina · L. Puiu · L. Roșu · Mahmudia · Valea Nucarilor · Murighiol · Mihail Kogălniceanu · Agighiol · Caraibil · Calica · Dunavățu de Sus · Lăstuni · Beibugeac · Sarinasuf · Dunavățu de Jos · Rîndunica · Sabangia · I. Popina · 45.0°N · Satul Nou · Zebil · Sarichioi · L. Belciug · Mihai Bravu · Sf. Gheorghe · BABADAG · L. Razelm · L. Dranov · Enisala · Visterna · Sf. Gheorghe - Zătoane - Perișor · 6 Martie · Camena · Sacalin Island · Jurilovca · Pașacâșla · Peritesca - Leahova - Portita · Ceamurlia de Jos · Lunca · Baia · L. Golovița · M A R E A N E A G R Ă · L. Zmeica · Gura Portiței · Sinoe · L. Sinoe · Istria · Nunatași · 44.5°N · Săcele · Traian · Vadu · Corbu de Sus · Corbu de Jos · 0 · 10 km · Portul Midia



Reed harvesting in the Danube Delta (Flacăra, 26/12/1964)

- Cattle and Sheepfold
- Fisheries
- Natural Channels
- Artificial Levee
- Plateau Limit

Roads
- primary
- secondary
- natural

- Water
- Forest
- levee
- Protected Natural Areas

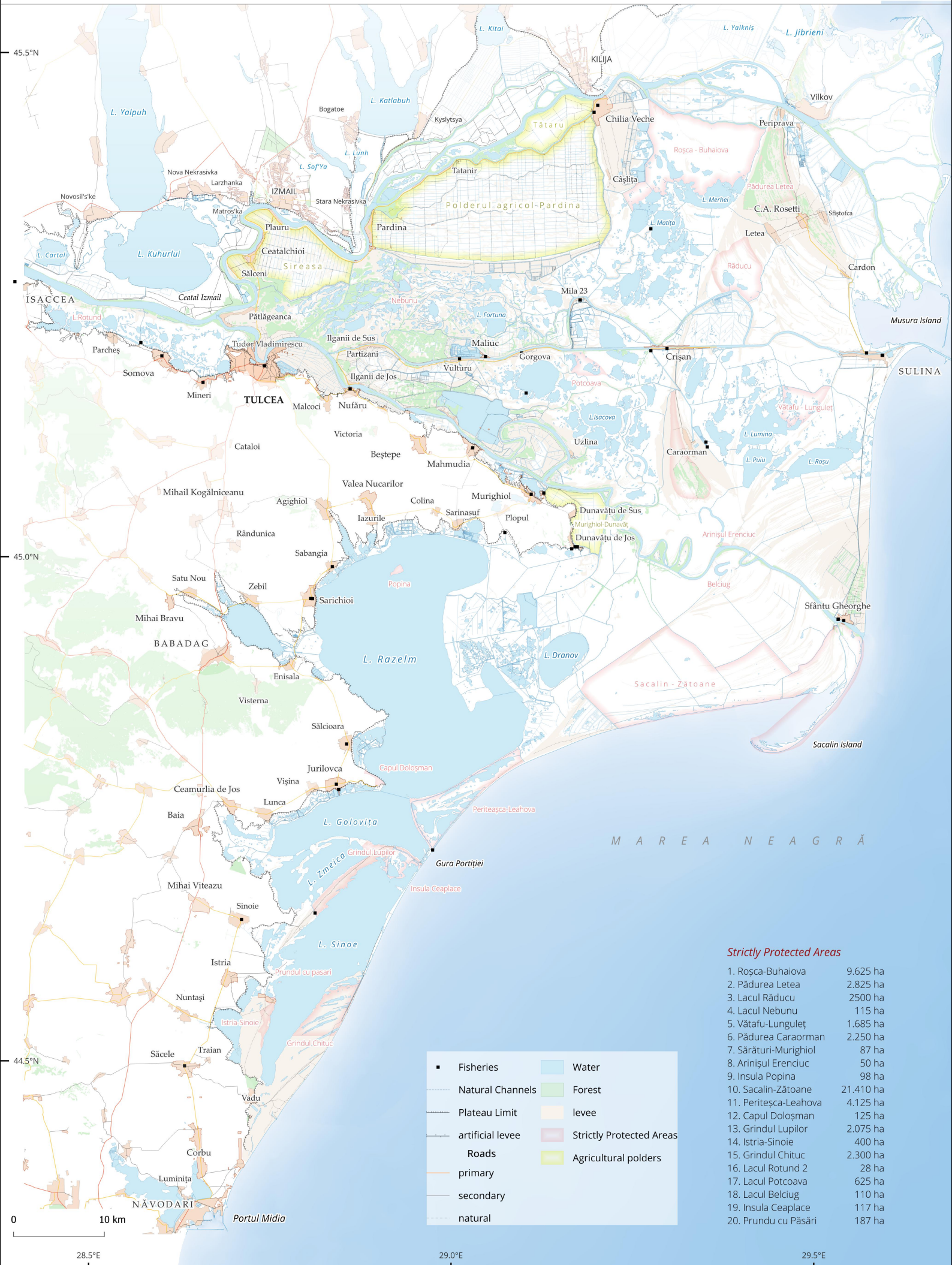
28.5°E · 29.0°E · 29.5°E

Topographic Map of the Danube Delta (2024)

DTM: Military Topographic Directorate

Ecological Age

D.D.B.R.A



- Fisheries
- Natural Channels
- Plateau Limit
- artificial levee
- Roads
  - primary
  - secondary
  - natural
- Water
- Forest
- levee
- Strictly Protected Areas
- Agricultural polders

Strictly Protected Areas

1. Roşca-Buhaiova	9.625 ha
2. Pădurea Letea	2.825 ha
3. Lacul Răducu	2500 ha
4. Lacul Nebunu	115 ha
5. Vătafu-Lunguleţ	1.685 ha
6. Pădurea Caraorman	2.250 ha
7. Sărături-Murighiol	87 ha
8. Arinişul Erenciuc	50 ha
9. Insula Popina	98 ha
10. Sacalin-Zătoane	21.410 ha
11. Periteşca-Leahova	4.125 ha
12. Capul Doloşman	125 ha
13. Grindul Lupilor	2.075 ha
14. Istria-Sinoie	400 ha
15. Grindul Chituc	2.300 ha
16. Lacul Rotund 2	28 ha
17. Lacul Potcoava	625 ha
18. Lacul Belciug	110 ha
19. Insula Ceaplace	117 ha
20. Prundu cu Păsări	187 ha

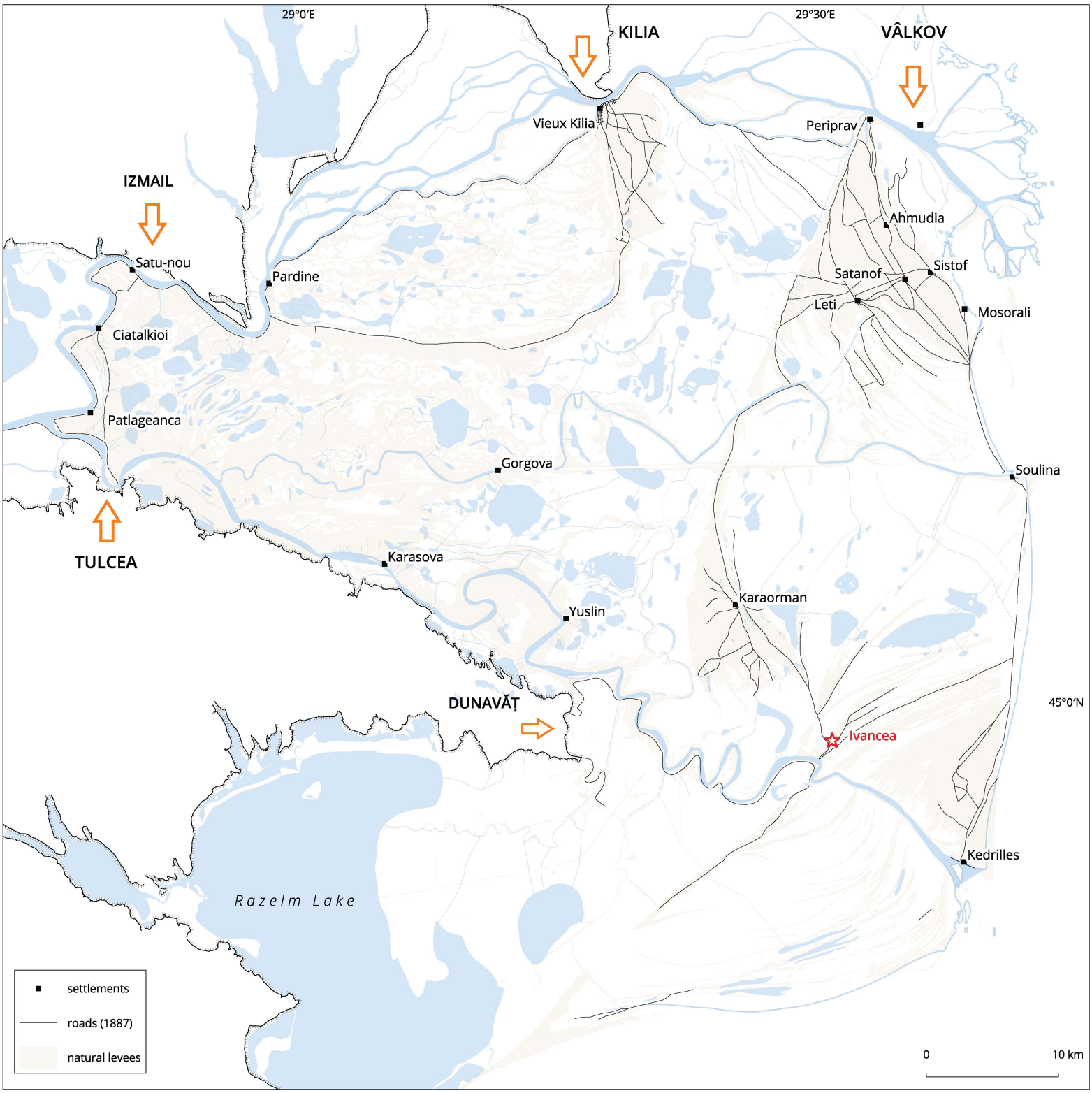
Roads distribution in Danube Delta (1887)

European Commission of the Danube



The main entry points along the Delta roads, used by both people and animals (sheep and cattle). These routes were heavily used during the Russo-Turkish wars (18th–19th centuries). The spot at Ivancea, an important fishing station, was also known as Grindul Trecătorii. It served as the only access point throughout the year, allowing animals to be brought in from the mainland to the interior of the Delta. For a more detailed discussion, see:

Constantinescu, Stefan, and Mihnea Tănăsescu. 2023. 'Moving through Liquid Territories: A Cartographic History of Roads in the Danube Delta'. The Geographical Journal 189(3):441–54. doi:10.1111/geoj.12490.



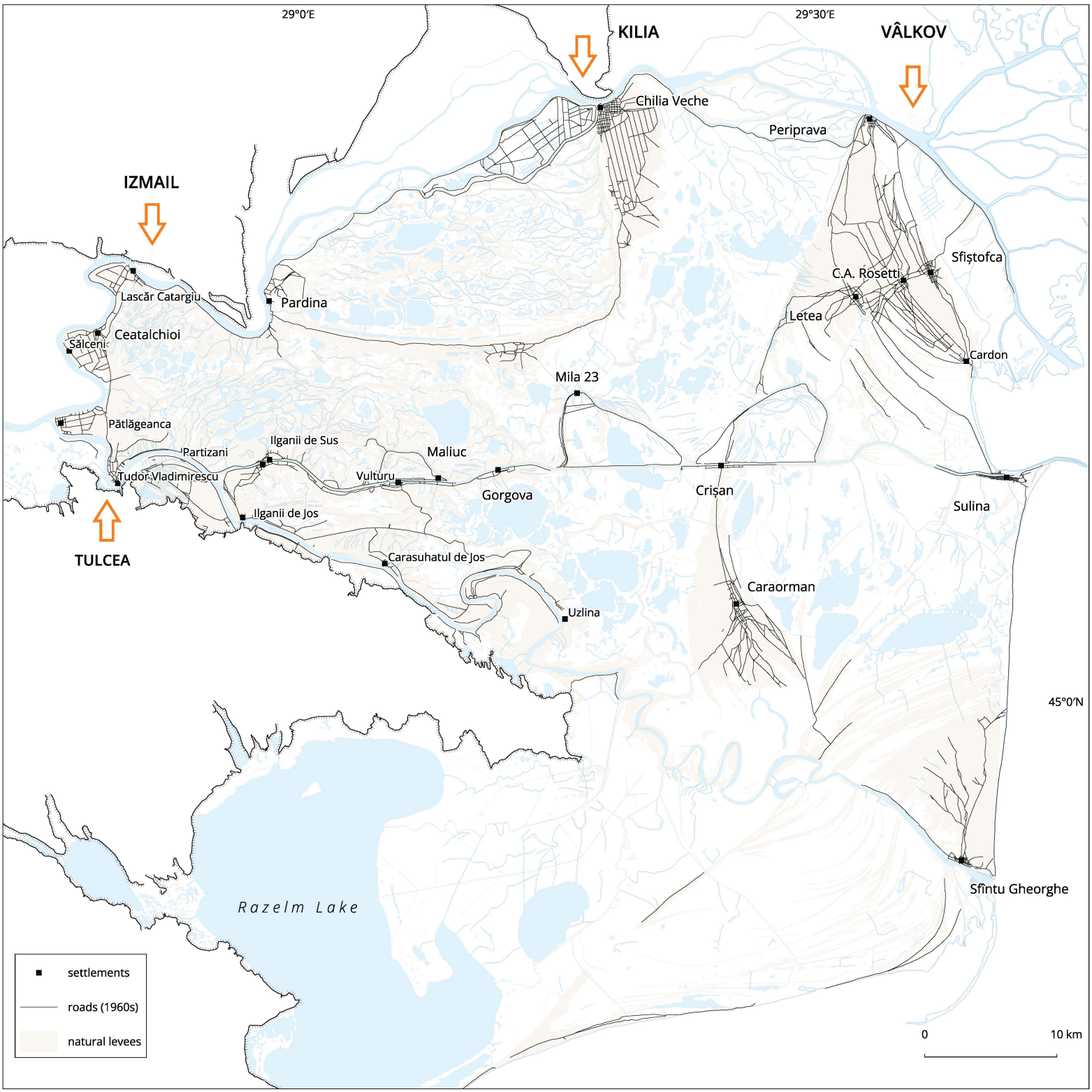
Roads distribution in Danube Delta (1960)

Topographic maps from the 1960s



The cutting of new channels in the Delta, especially during the 1950s and 1960s, disrupted the natural connections between the old roads linking the Delta's settlements. The Ivancea crossing point lost its importance, as the development of water transport and the use of motorized boats further reduced the traditional use of these routes.

Along the old roads of the Delta, with Răzvan Crimschi (July 2022)

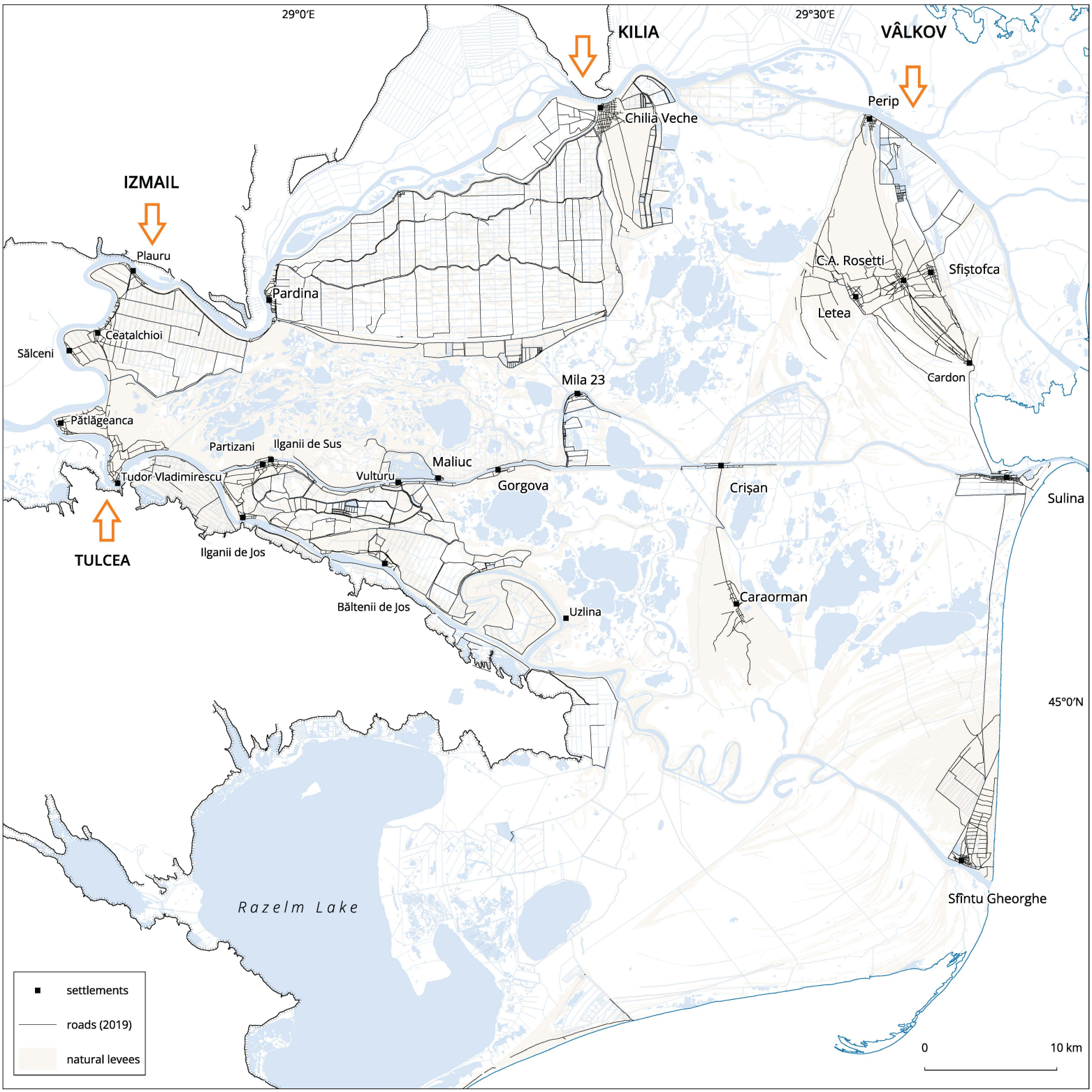


Roads distribution in Danube Delta (2020)

Aerial and satellite images from 2018-2020



Today, the old road network that once connected all the settlements of the Delta has disappeared. In its place, only local networks remain, stretching at most between the villages on the strandplains. The former road that led from Ivancea into the interior of the Delta is now barely traceable, only the alignment of trees hints at the many people and animals that once passed through here.



Environmental issues

The total area of the Danube Delta Biosphere Reserve (DDBR) is about 5,800 km², including the Danube Delta (3,510 km²), the Danube between Cotul Pisicii and Isaccea (13 km²), the continental floodplain between Isaccea and Murighiol, the Razelm-Sinoe lagoon (1,154 km²), and the coastal waters of the Black Sea up to the 20 m isobath (1,030 km²).

According to official statistics published by DDBR, there are 30 fishing farms and 5 agricultural polders, which in practice no longer maintain their initial purpose. Many of them are abandoned, particularly the fishing farms, where agriculture is now practised inside the old basins. From a sedimentological perspective, these areas represent units separated from the rest of the delta by artificial levees or embankments. Most were constructed in the 1950s–1960s and are now experiencing human-enhanced subsidence.

Pardina was the largest area (255.9 km²) in the delta to undergo a radical landscape transformation. Initially organised for reed exploitation in the 1960s, it was completely converted into an agricultural polder after 1983. The few remaining channels inside consistently face water deficits, leading to intense eutrophication processes. The second agricultural polder is Sireasa (67.4 km²), which under natural conditions contained many small lakes with bottoms above sea level. Both areas are candidates for future renaturation, as has already been done in the Chilia islets of Babina and Cernovca.

In 1990, the embankments in the Romanian part of the Danube Delta covered 97,408 ha (27.6%), after which all agricultural projects were halted. By 2008, DDBR reported more than 328 km of canals that had been dredged and unclogged. The renatured areas, originating from agricultural or unproductive fish farms, covered 15,712 ha and included Babina, Cernovca, Furtuna, Dunavăț, Holbina I and II, the islets along the Sfântu Gheorghe Arm, and Popina (Gâștescu and Știucă, 2008). Presented as success stories, these projects should nevertheless be viewed with caution.

The first embankment project in Romania was carried out in 1895 along the Sfântu Gheorghe Arm in the area known as *Grădina Olandeză* (The Dutch Garden), which soon proved inefficient. Later, Ostrovul Tătaru was transformed into an agricultural polder in 1938. A Master Plan elaborated in 1962 by the Communist authorities envisaged that 84% of the delta would remain in natural conditions and 16% would be converted (12% for agriculture and 4% for forestry exploitation). The Complex Plan for the Economic Exploitation of the Danube Delta, adopted in 1975 and implemented four years later, called for the intensification of land use for agriculture by constructing new artificial levees and large-scale drainage systems (Schneider, 2014). After 1983, a new Programme for the Integral Exploitation of Natural Resources proposed extending agricultural surfaces to 144,000 ha.

Fortunately, only 53,000 ha were converted, and just 39,000 ha remained in use. After 1990, all previous agricultural projects in the Romanian delta were abandoned.

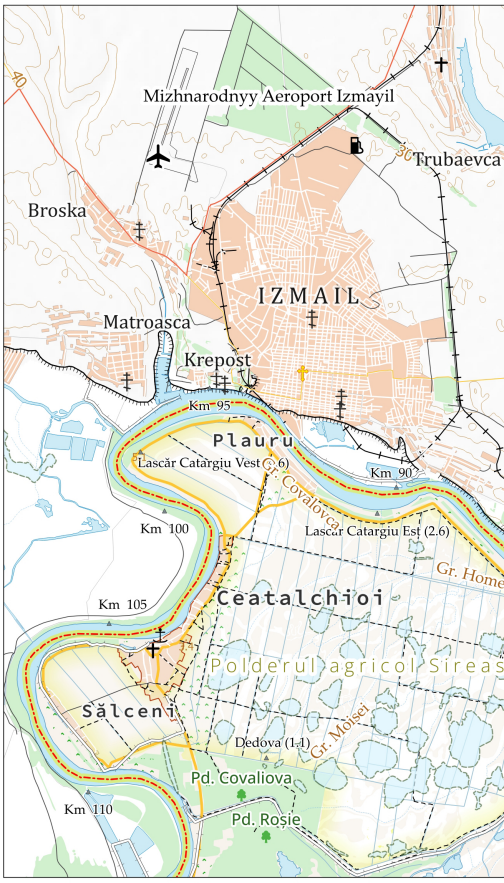
At present, agricultural fields represent 11.6% (61,220 ha) of the deltaic area, the majority being in the fluvial delta (68%). Of this total, more than half (54%) lies within embanked areas that were drained, while the rest is distributed across the Chilia Promontory and along the fluvial or maritime levees (Gâștescu and Știucă, 2008).

Forestry areas in the Danube Delta were calculated using Romanian topographical maps from 1880–1884, which did not cover the Ukrainian sector. The resulting value (121,433 ha) was compared with the present-day forest cover (144,652 ha) obtained from aerial and satellite imagery. Despite inherent uncertainties in the old maps, a key conclusion emerges: forest area has increased over the last century by approximately 16%. During the Communist period, new forest plantations were established in several enclosures: Păpădia (2,265 ha), Rusca (1,225 ha), Carasuhat (620 ha), Pardina (425 ha), Murighiol (400 ha), and Sfântu Gheorghe (1,640 ha). Along the arms and channels, forests were planted for exploitation, including *Salix alba*, *S. fragilis*, *Populus alba*, and *P. canadensis*.

The distribution of vegetation in the Danube Delta has been classified into nine categories (Hanganu et al., 2014): marsh vegetation (48%), aquatic vegetation (27%), beach/dune vegetation (6%), floodplain forest (5%), river levee grassland (2%), salt-tolerant vegetation (1%), grassland on sandy steppes (1%), dune forests (1%), and other types (9%).

Since 1994, DDBR has implemented three types of ecological restoration projects: wetlands altered by human activity (dammed and drained), the restoration of degraded areas, and projects aimed at improving water circulation (ddni.ro). These activities were carried out by the Danube Delta National Institute for Research and Development (DDNI) and DDBR in collaboration with various NGOs and foundations: WWF Auen Institute, Rastatt (Germany), for Babina (2,100 ha) and Cernovca (1,580 ha) agricultural areas, the Furtuna Forest East–West (2,115 ha), and the Popina II fish-farming area (3,600 ha); the Directorate General for Public Works and Water Management, Flevoland (The Netherlands), for the fishing polders Popina II and Holbina I/II (4,370 ha) and Dunavăț II (1,260 ha).

Sireasa and Pardina in natural regime



In ’83, the General Secretary of the Party, Nicolae Ceaușescu, issued the brilliant directive of revalorizing and superior reusing of the Delta’s resources, discovering, with the eyes of an enlightened mind, that there another Bărăgan could be born.

Flacăra, 17-01-1986



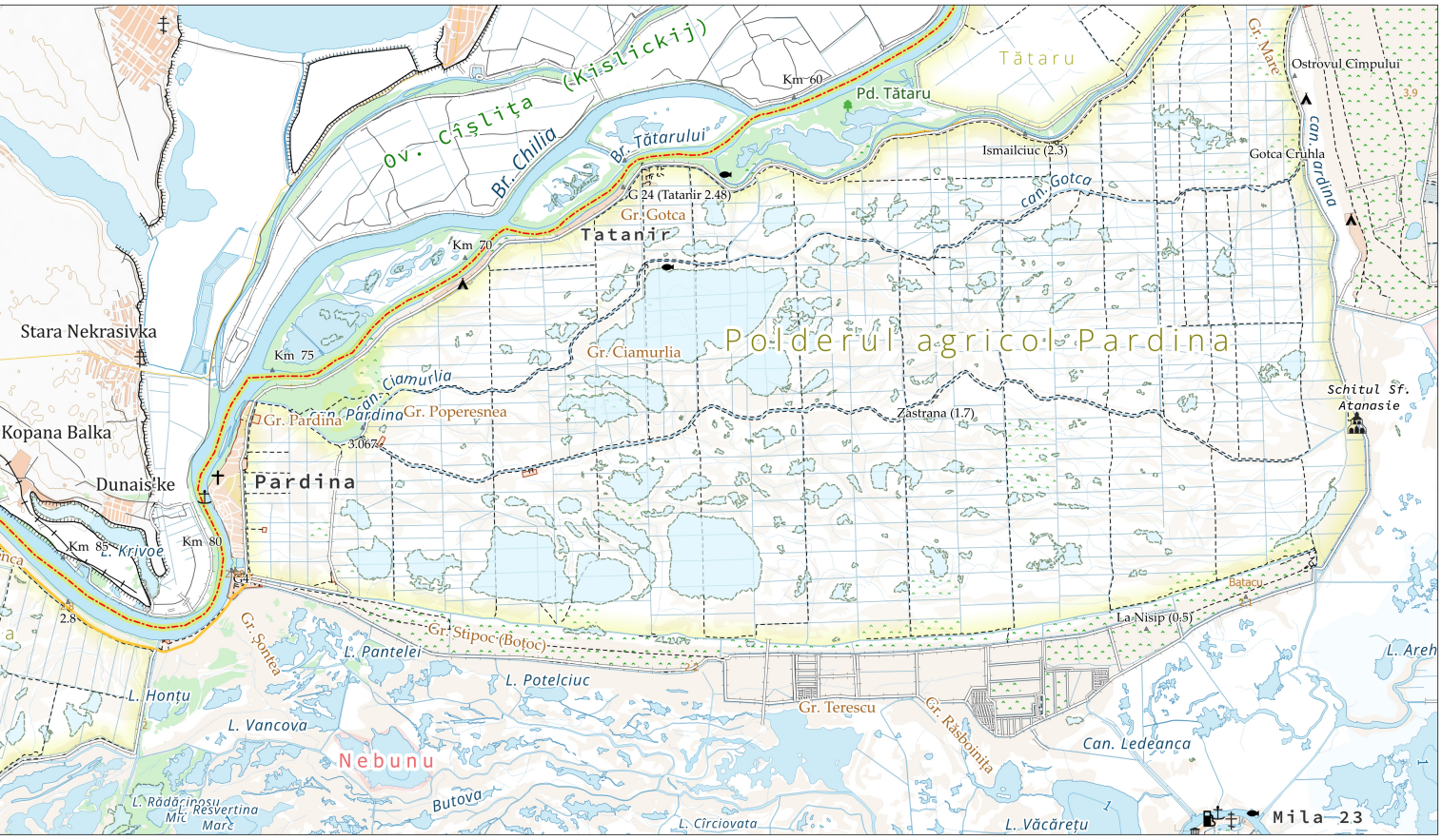
Sireasa and Pardina agricultural polders today




Ogoarele deltei

Flacăra, 07-11- 1986

The development of

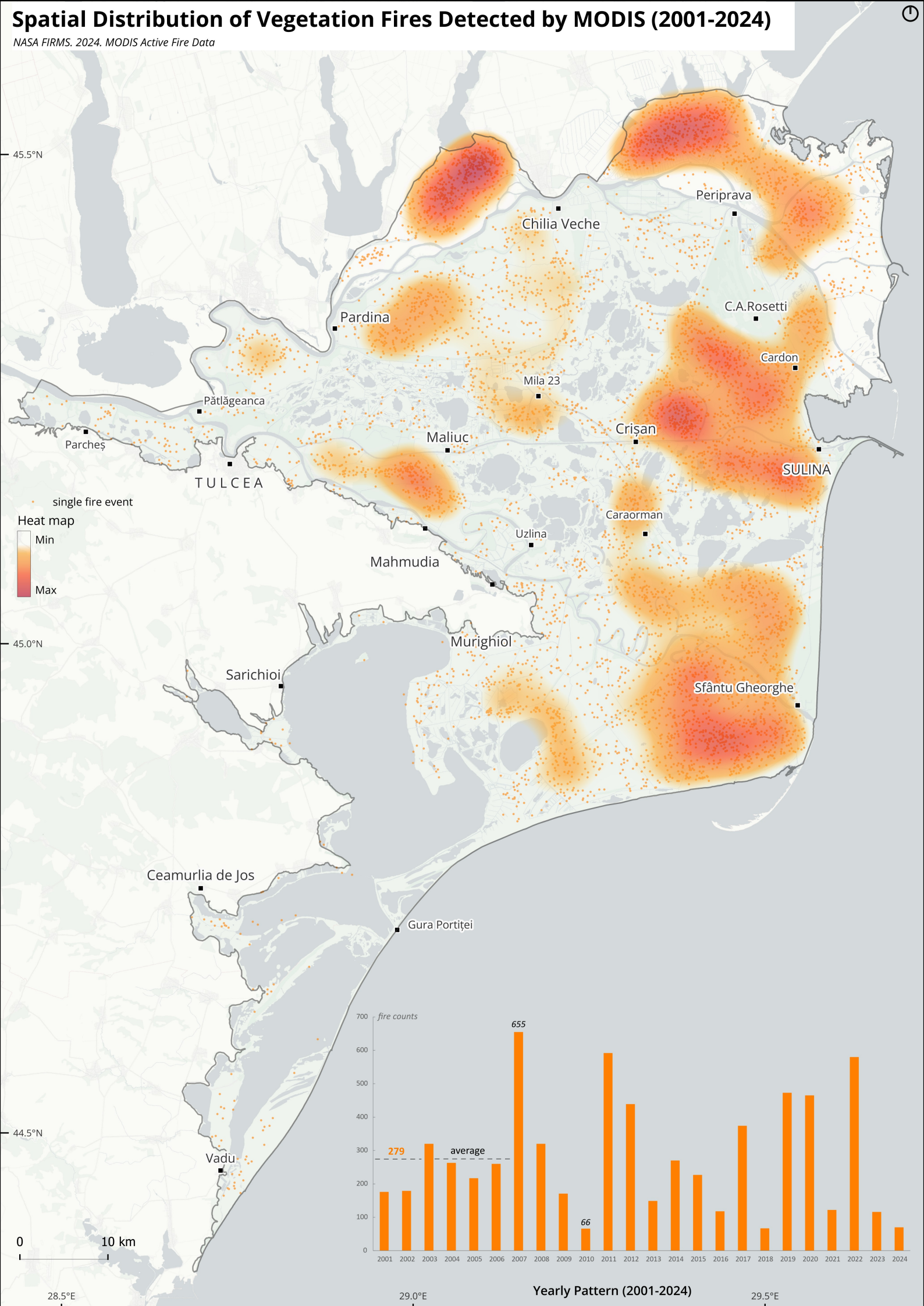




agricultural polders led to a 90% reduction of the aquatic surface area (lakes and natural channels)

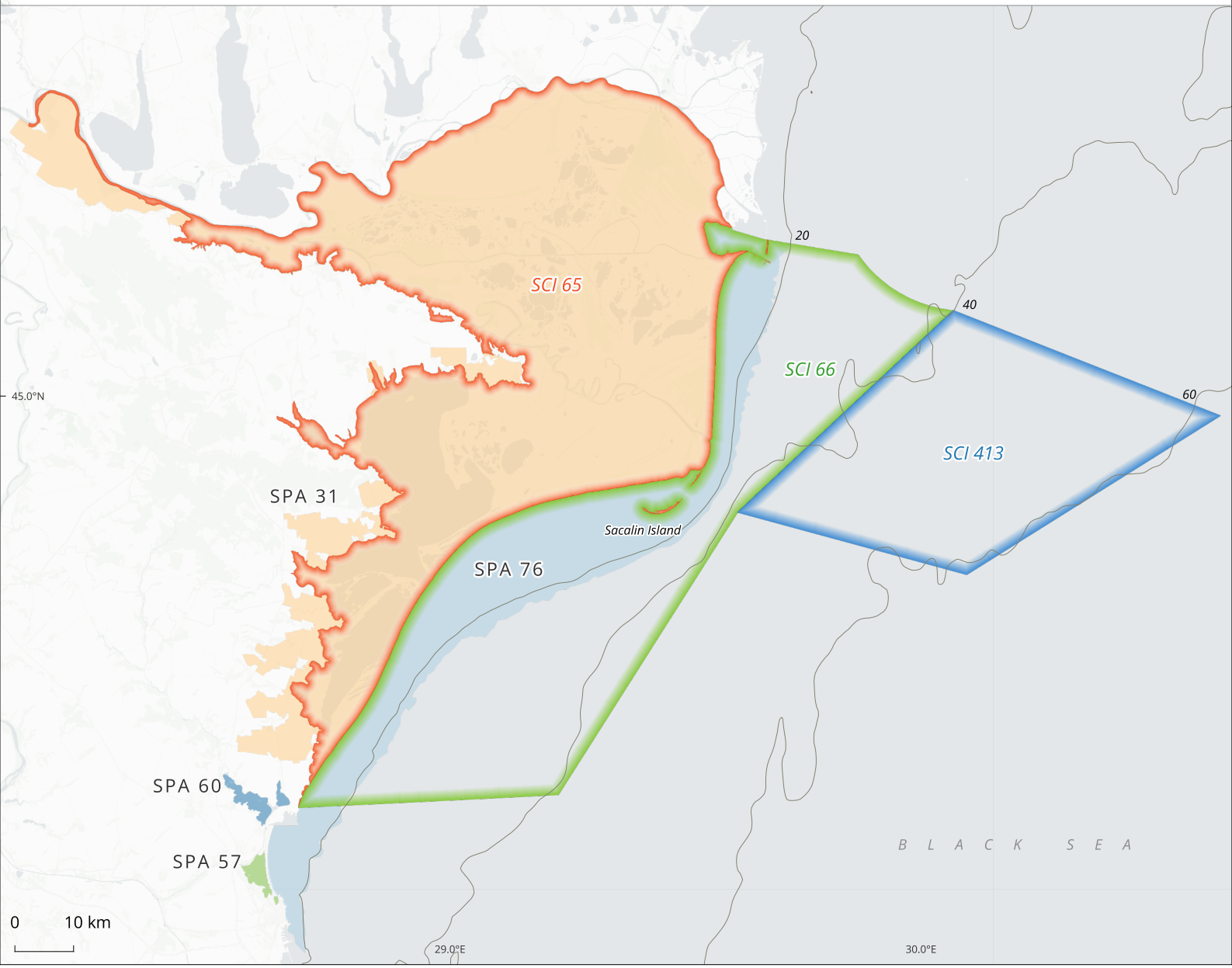
Spatial Distribution of Vegetation Fires Detected by MODIS (2001-2024)

NASA FIRMS. 2024. MODIS Active Fire Data



Sites of Community Importance (SCI) and Special Protection Areas (SPA)

Ministry of the Environment (mmediu.ro)



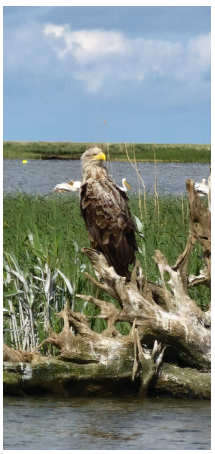
isobaths (m)

SCi (Site of Community Importance)

- SCI 65: Danube Delta
- SCI 66: Maritime Zone
- SCI 413: The southern lobe of Zernov's Phyllophora Field

SPA (Special Protection Area)

- SPA 31: Danube Delta and Razelm-Sinoe Complex
- SPA 57: Lake Siutghiol
- SPA 60: Lakes Tașaul-Corbu
- SPA 76: Black Sea







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Finanţat de Uniunea Europeană NextGenerationEU

Planul Naţional de Redresare şi Reziliență

Acest demers este parte a proiectului “Blue Justice ad Just Transformation far-fetched concepts for Romania’s marine protected sites?” (JUST4MPA)

Codul proiectului: PNRR/2022/C9/MCID/I8 CF210/29/11/2022

JUST4MPA explorează impactul conservării costiere şi marine asupra conceptului de justiţie albastră şi examinează modurile în care iniţiativele de conservare pot stimula o transformare justă. Proiectul porneşte de la premisa că adevărata transformare necesită o schimbare fundamentală a felului în care sunt obţinute rezultatele, adesea ca răspuns la schimbările globale. Astfel, pentru ca această transformare să fie justă, ea nu trebuie să adâncească inegalităţile existente.

ISBN 978-973-0-43541-2