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RESEARCH ARTICLE

Mass exchange mechanisms in the Taranto Sea

Umgiesser[1*]G., Scroccaro[1]I., Alabiso[2] G.

[1] ISMAR-CNR - S. Polo, 1364 - 30125 Venezia
[2] IAMC-CNR - Via Roma, 3 - 74100 Taranto

[*]corresponding author: tel.: +39-041-5216875, fax: +39-041-2602340, e-mail: georg.umgiesser@ismar.cnr.it,

Abstract

1 - A two-dimensional finite element model (SHYFEM) was used to study the hydrodynamics of the Taranto Sea. The Taranto Sea is a coastal ecosystem located in the southern part of Italy, that is composed of two parts, the Mar Grande, directly connected with the open sea, and the Mar Piccolo, an inner basin. The exchange mechanisms in the Taranto Sea were investigated over the years 2000 and 2001.

2 - Simulations over two years were carried out with different model parameters and forcing factors in order to investigate the effect they have on the internal dynamics of the basin. A reference simulation was performed with the standard forcing factors (tide, wind and inflow data), and the correlation of the other simulations was computed with respect to it.

3 - The role of tide and wind on the circulation in the Mar Grande and in the Mar Piccolo was analyzed in some detail with the SHYFEM model. The results show that the wind has a strong influence on the exchanges between the Mar Grande and the open sea but that tidal exchanges are more important as far as exchanges between the Mar Grande and Mar Piccolo are concerned.

Keywords: finite element model, hydrodynamic simulations, coastal ecosystems, Taranto Sea, exchange mechanisms

Introduction

The Taranto Sea is a coastal ecosystem situated in the Ionian Sea in the southern Italy, inside the Gulf of Taranto. It is composed of two parts: the Mar Grande, directly connected to the Gulf of Taranto, and the Mar Piccolo, an inner sea in which the intense activity of mussel culture makes it one of the most important mussel farming area in Italy (see Figure 1 for reference).

The Mar Grande covers an area of 35 km^2 with a maximum depth of about 35 m and an average depth of about 15 m. It communicates with the Ionian Sea through two openings. The first one is about 1.8 km wide and is situated in the southern part of the basin, between S. Paolo island and Capo S. Vito. The second one is about one hundred meters wide, located in the north-western part of the Mar Grande near Punta Rondinella. The Mar Piccolo of Taranto with a total surface area of 20.72 km^2, is structured in two shelves, called `First Seno' and `Second Seno'. The maximum depth is about 15 m for the First Seno and about 10 m for the Second Seno. The average depth of the two subsystems is about 5 m (Pastore, 1993). The Mar Piccolo is connected to the Mar Grande through the two channels along the island of the old town of Taranto: the Navigabile channel and the Porta di Napoli channel. The Mar Piccolo is characterized by the presence of some submarine fresh water springs, locally called citro. The two most important ones (taken into account in this study) are the citro Galeso (see Figure 1), in the First Seno near the Galeso river, and the citro Le Kopre, in the north-eastern part of the Second Seno. Vatova (1972) analyzed the climate of the region, distinguishing two periods: a rainy winter period and a dry summer period, which sometimes extends into autumn. He found that the mean annual air temperature is 16.9 °C, with minima of 9 °C in January and maxima of 25.7 °C in July. An important factor, that influences the discharge of the submarine fresh water

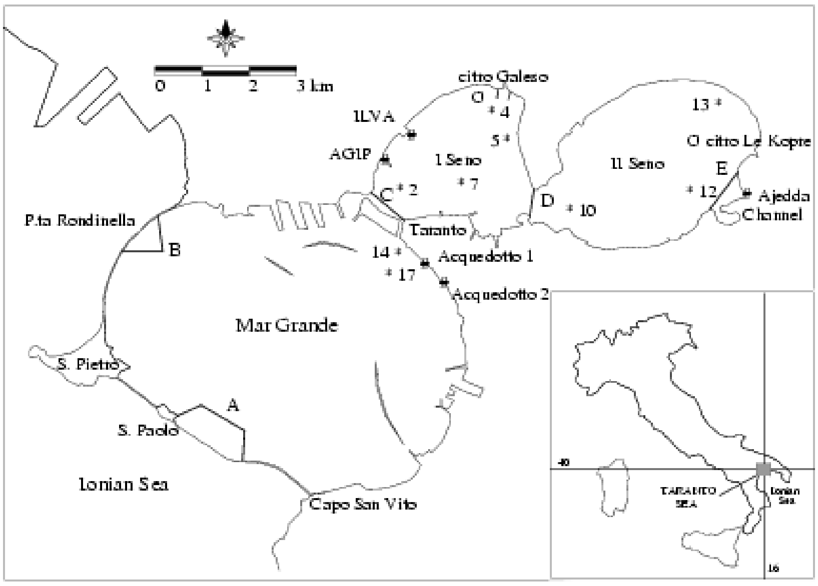


Figure 1. Map of the Taranto basin with the positions of the sampling stations (*), of the submarine fresh water springs (O), of the inflow points () and the sections (A - E) where water fluxes are computed by the model.

springs and hence the salinity of the Mar Piccolo, is the pattern of the rainfall, which amounts to an average of 489.8 mm per year, though interannual variability is quite pronounced (Vatova, 1972).

Under the abiotic aspect, the two basins of the Mar Piccolo have been considered as two different ecosystems influencing each other (Vatova, 1972). In particular the Mar Piccolo of Taranto was assimilated to an estuary by many authors (Cerruti, 1948, Vatova, 1972, Strusi and Pastore, 1975) and according to Pritchard (1955, 1967).

Important human activities of the zone are fishing and aquaculture, in particular mussel culture, which covers wide areas of the Mar Piccolo. These activities are causing an increased diffused pollution and are reducing the environmental quality of the Taranto Sea. In fact the Taranto Sea is exposed to industrial discharges and receives a considerable amount of sewage from the northern part of Taranto and from the nearby towns.

For example the Ajedda Channel discharges the waste waters of 8 municipalities into the Second Seno of the Mar Piccolo (Scroccaro *et al.*, 2004). These wastes amount to about 18272 m^3/day (of which 85 % occurs at the Second Seno), with organic matter equal to 6.7 t/day of BOD5 (Cardellicchio *et al.*, 1991). The daily input of nitrogen and phosphorus in the basin has been calculated as being about 17.2 t/day of nitrogen and 0.3 t/day of phosphorus (Caroppo and Cardellicchio, 1995). Chl-a, dry weight of suspended matter and its content in organic matter data point out a condition of progressive eutrophication moving from the Mar Grande to the Secondo Seno (Alabiso el al., 2005).

Furthermore, in the last twenty years a water pump, belonging to the plant of ILVA (one of the most important iron and steel industry in Europe), withdraws about 35 m^3/s from the First Seno of the Mar Piccolo, for cooling down blast furnace circuits. Such water usage has modified the circulation in the First Seno of Mar Piccolo, causing a higher salinity level, due to the input of water from the Mar Grande.

As reported in Alabiso *et al.* (2005) in a 8 year study carried out in the stations in Figure 1, the three basins are characterised by different levels of confinement; seawater temperature, as an expression of meteorological conditions, plays an important role in determining salinity in the Mar Piccolo, mainly in the Second Seno; in particular a correlation study between the temperature and the salinity data in every station shows that temperature is highly correlated to salinity in the Secondo Seno (>0.7), normally in the Primo Seno (>0.65) (with the exception of station 4 characterised by an important freshwater spring, the citro Galeso) and not correlated in the Mar Grande.

Previous studies have been carried out to characterize the physical-chemical properties in the Taranto Sea (Strusi and Pastore, 1975; Vatova, 1972; Alabiso *et al*., 1997) without making use of numerical modeling. Scroccaro *et al*. (2002a, 2002b, 2004) were first attempts to study the Taranto Sea with modeling techniques that covered the year 2000. In Scroccaro *et al*. (2004) a finite element model (SHYFEM, Shallow water Hydrodynamic Finite Element Model) developed at ISMAR-CNR (Institute of MARine Science) in Venice has been applied to the Taranto Sea. The model was calibrated through salinity and temperature data of the year 2000 and the simulations showed good agreement of these parameters with the data. However, no attempt had been made to explore the dominant processes that drive these exhanges.

This article builds on the work of the aforementioned modeling studies. On one side the simulations have been extended to cover now two years (2000-2001) in order to gain a higher confidence of the model functioning. On the other side the study has been focused on the exchange mechanisms between the Taranto Sea and the Ionian Sea and between the internal basins.

A series of sensitivity studies have been carried out to better understand what regulates the exchange mechanisms between the various basins and the open sea.

Methods

Available Data

Experimental data for the Taranto Sea were derived from the SPICAMAR project (Studio PIlota per la Caratterizzazione ambientale di Aree Marine A Rischio), promoted by CoNISMa. Data were available for the years 2000 and 2001, and were obtained from several sources. Temperature and salinity data were provided by IAMC-CNR Talassografico A. Cerruti of Taranto; the coastline and the discharges data by the University of Bari - Dept. of Physics and Biology; the tidal data by the Servizi Tecnici Nazionali; the meteo data by the Istituto Meteorologico L. Ferrajolo of Taranto. Topographic data and the bathymetric data used to build the grid were obtained from the Carta Nautica del Porto di Taranto e Mar Grande 1:20000, provided by the Biology Dept. of the University of Bari. Unfortunetely, during 2000 and 2001 no measured water level data nor current data was available. Therefore the model could not be calibrated in the usual sense. However, in applying the model the standard values for bottom friction and wind drag coefficient have been used, values that have been thorougly tested in other applications. In fact, the results in Scroccaro *et al*. (2004) show that the available temperature and salinity data could be nicely reproduced, a fact that without a working model would clearly not be possible.

Tidal data

The tidal data have been measured by a tide gauge situated on the Porta di Napoli Channel along the old Taranto island and are provided by the Servizi Tecnici Nazionali for both year 2000 and 2001.

Spring tides have a range of about ± 0.15 m and neap tides of about ± 0.08 m, therefore tidal variations are not very strong in the Taranto Sea. Unfortunately, current measurements and water level measurements at the inlets and inside the basin were not available at the moment.

Discharge data

Important information about the Taranto Sea regards the urban and industrial discharges, the river runoff and the inflow of the citri.

Discharge values (shown in Table 1) come from the Biology Dept. of Bari University, referring to the year 1999. Furthermore the Istituto Talassografico of CNR of Taranto made an in situ estimate of the fresh water springs discharge, whose values are also indicated in Table 1 which shows the high uncertainty of the discharge values.

Table 1. Discharge values for the Taranto Sea, with estimated values of salinity and temperature.

Inflow	*Discharge*	*Salinity*	*Temperature*
	[m^3/sec]	*[psu]*	*[°C]*
Ajedda Channel	1.03	1.5 - 5	20
ILVA	-35.0	-	-
AGIP	0.2	1.5 - 5	20
Acquedotto 1	0.3	1.5 - 5	20
Acquedotto 2	0.3	1.5 - 5	20
Citro Galeso	0.6	1.5 - 5	18
Citro Le Kopre	0.1 - 1.2	1.5 - 5	18

It has to be stressed that there are considerable seasonal fluctuations that may change these values intermittently, but no experimental data are available.

In fact, the only measurements of discharges of the fresh water springs refer to studies and estimations in the 1960-70's (Stefanon and Cotecchia, 1969), whereas the submarine springs are a phenomenon in continuous evolution that may strongly change during the years. Unluckily the bibliography on this subject is rather poor and not recent.

There are only estimates also for the salinity values of the citri, in agreement with the bibliographic references that cite values ranging between 1.5 psu and 3 psu (Cerruti, 1948, Stefanon and Cotecchia, 1969, Pastore, 1993). What concerns the river runoff, monthly average data of the Galeso river were available for the year 2000 provided by the Biology Dept. of Bari University. Maximum discharges occur in spring (April-May) and minimum in the summer period (July-August). Other rivers were not taken into account because of the very low values of their discharges.

It should be noted that the most important discharge in the Taranto Sea is not a source, but a sink. It is the water pump of ILVA, picking up about 35 m^3/s from the First Seno of the Mar Piccolo. This sink is about 10 times higher than all the other sources together.

Meteorological data

The Istituto Meteorologico L. Ferrajolo of Taranto provided the meteorological data, in particular wind speed and direction. The station is located along the coast of the Ionian Sea, at about 6 km from the city of Taranto. The same station also measured heliophany, air temperature, relative humidity, cloud cover, rain and evaporation.

Maximum values for temperature are in June and August (about 32 ^oC) and minima between January and February (about 3 ^oC). On the contrary, relative humidity presents minimum values in the period June-August.

Rain values may reach about 27 mm/day in May for the year 2000. A maximum of about 18 mm/day is found in January and in April for the year 2001. The evaporation, as expected, presents maximum values between May and August and minimum values in the winter period.

The wind pattern of the years 2000-2001 presents mainly the winds from NW and SE, prevailing during the whole year, and secondly the wind from S. The typical wind speed is about 3-4 m/s, with maximum values up to about 9-10 m/s (see Figure 2).

The finite element model

The two-dimensional finite element model SHYFEM, developed at the ISMAR-CNR in Venice, consists of a hydrodynamic module, especially suited for shallow water, which uses the finite element method for the spatial resolution and a semi-implicit scheme for the time integration.

The finite element method (FE) was developed in the 1950's and has been used for hydrodynamic applications since the 1970's.

This method is well suited to describe in high details areas with complicated geometry. The FE method uses a combination of linear and constant form functions to solve the unknowns of the differential equations, such as the total water depth, the water level, the velocities and other model parameters.

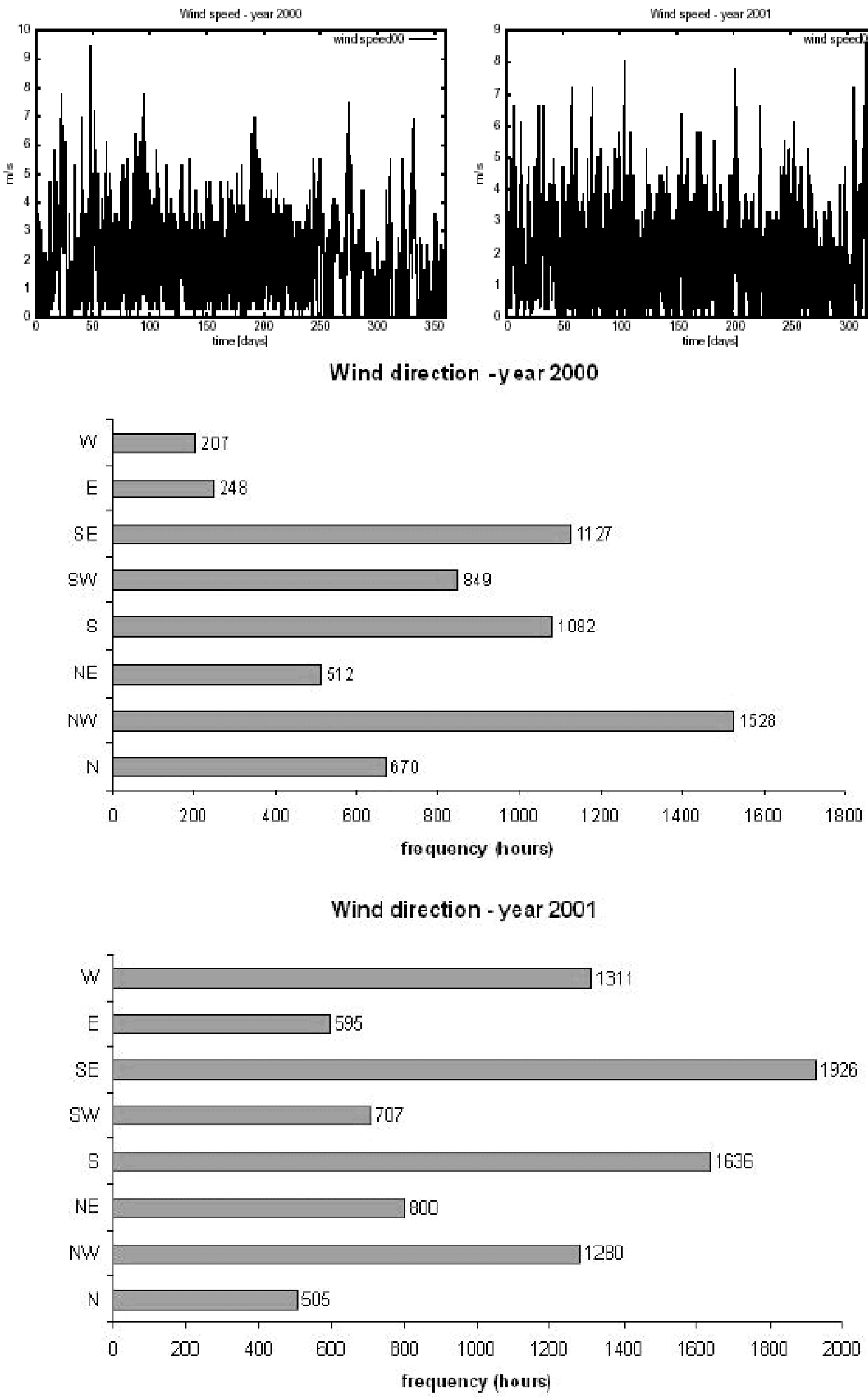


Figure 2. Time series of wind speed (top panel) and wind direction (lower panels) for the year 2000 and 2001.

Details are provided in Umgiesser and Bergamasco (1995). A water quality model also exists that is coupled to the hydrodynamic model (Umgiesser at al., 2003).

In the past the model SHYFEM has been applied to other Italian lagoons, in particular the Venice lagoon (Umgiesser, 1997 and 2000, Umgiesser *et al.*, 2004), the Cabras lagoon, Sardinia (Ferrarin and Umgiesser, 2005) and the Orbetello lagoon (Scroccaro *et al.*, 1999, 2001).

The finite element model solves the vertically integrated shallow water equations of momentum and mass in a semi-implicit manner. The terms treated semi-implicitly are the pressure gradient and the Coriolis term in the momentum equation and the divergence terms in the continuity equation. The bottom friction term has been discretized fully implicitly and all other terms are treated explicitly. For the friction the Strickler formula has been used/ Details are given in Umgiesser and Bergamasco (1993 and 1995) and Umgiesser *et al.* (2004).

The grid for the Taranto Sea was constructed with an automatic mesh generator. It contains 4452 nodes and 8059 triangular elements, with sides of the elements varying from about 10 m to about 200 m. The resulting grid and its bathymetry is shown in Figure 3.

Results and discussion

In this section the results of the simulations are presented. A simulation covering the two years 2000 and 2001 (Sim 1) was performed with the standard forcings (tide, wind and inflow data) and standard parameters (friction and drag coefficient). This simulation has been used as reference for all the other sensitivity simulations and correlations were computed with respect to it.

The water masses from the Mar Grande enter the Mar Piccolo through the two connection channels along the island of the old Taranto. This flux splits up into a percentage of 35 % flow through the Porta di Napoli Channel (western channel) and 65 % through the Navigabile Channel (Scroccaro *et al.*, 2002a, 2002b, 2004). In general currents are low (about 5-10 cm/s) and the maximum velocity can be observed in the two connection channels between the Mar Grande and the Mar Piccolo (up to 30-40 cm/s) and near the two outer openings (about 20-25 cm/s).

Figure 4 shows the daily averaged water fluxes through the sections A-B (top panel) and C-D (bottom panel) during the year 2001. Results for the year 2000 are basically the same and can be found in Scroccaro *et al.* (2004). Positive and negative values indicate in-going and out-going flow respectively. As they are daily averaged values, in order to satisfy mass balance, the water either enters the Mar Grande from the southern inlet (section A) and exits from Punta Rondinella (section B) or enters from Punta Rondinella and exits from the southern inlet in a symmetrical pattern. Furthermore the mean values of section B are negative, whereas the mean values of section A are positive during both years 2000 and 2001. These sections are placed in front of the two inlets of Mar Grande and this might indicate that the exchange with the Ionian Sea is in average ingoing from section A, driven by both wind and tide, and in average outgoing from section B, completely governed by the wind, that is dominant from NW and SE. It has been suggested in Scroccaro *et al.* (2004) that the flux through the two outer inlets depends mainly on the wind action and not so much on the tidal forcing. However, it was yet not clear up to what extent the various physical parameters and forcings would govern the exchanges in the Taranto Sea. Therefore, in order to better understand the influence of the parameters and forcings on the exchange in the Taranto Sea some sensitivity simulations have been carried out. A test was performed on the drag coefficient (Sim 2) with a value of cd = $5 \bullet 10^{-3}$, twice with respect to the reference simulation. Tests were conducted with the bottom friction parameter ks equal to 30 and equal to 25 (Sim 3 and Sim 4).

The influence of the different discharges into the Taranto Sea has been tested in Sim 5.

The action of tide only is considered in Sim 6 and Sim 7, while the importance of the wind is investigated in Sim 8 and Sim 9. In Table 2 a summary of the numerical simulations is given.

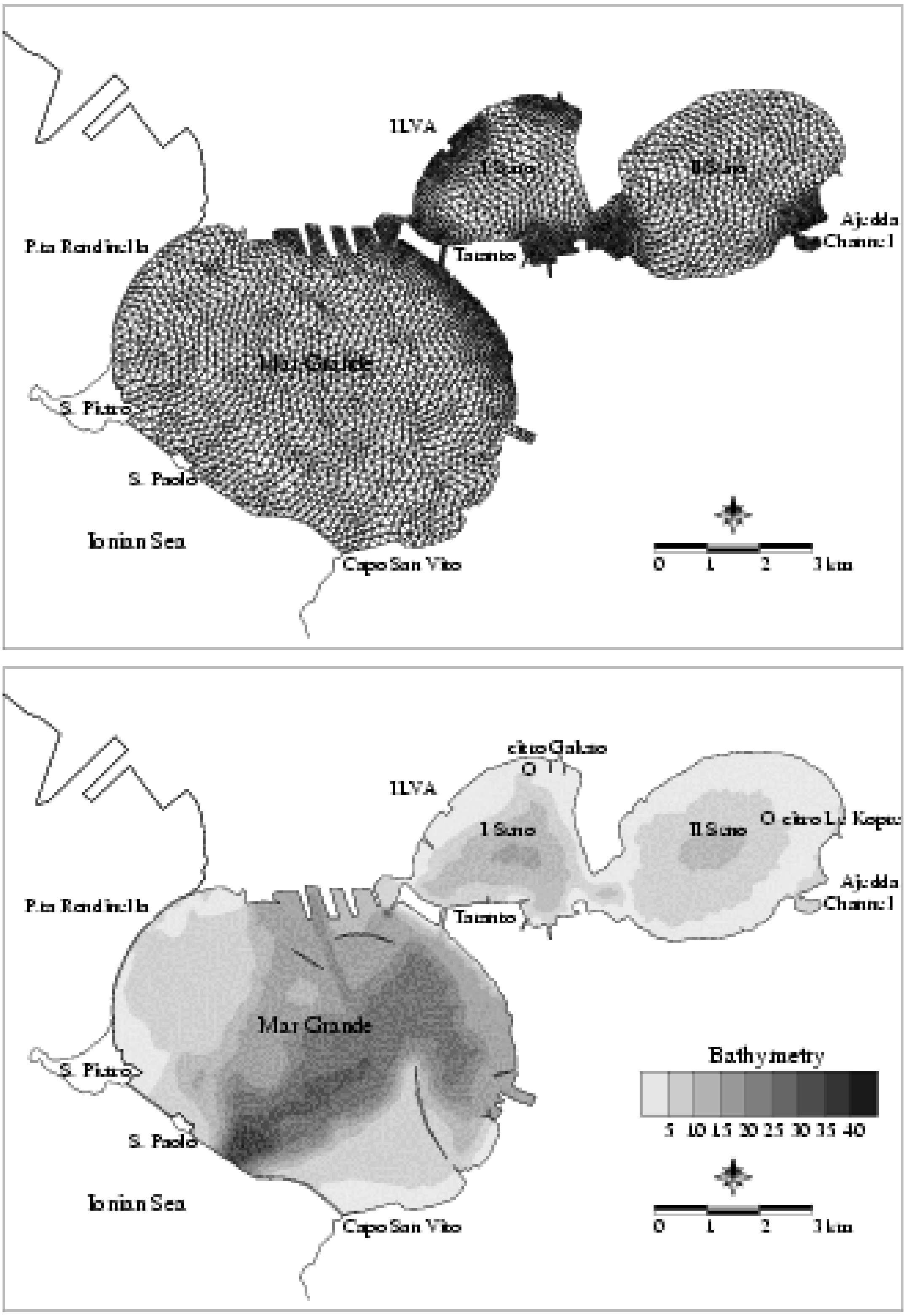
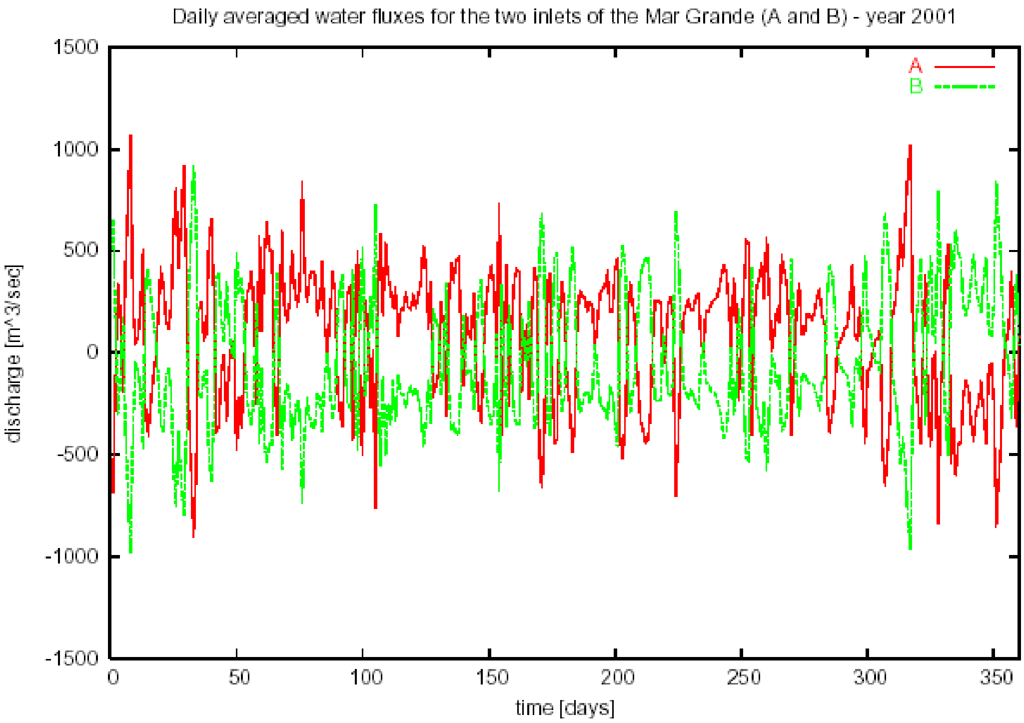


Figure 3. Top: Grid of the finite element model SHYFEM. Bottom: Bathymetry of the investigated area, as represented by the finite element model, with the positions of the submarine fresh water springs.



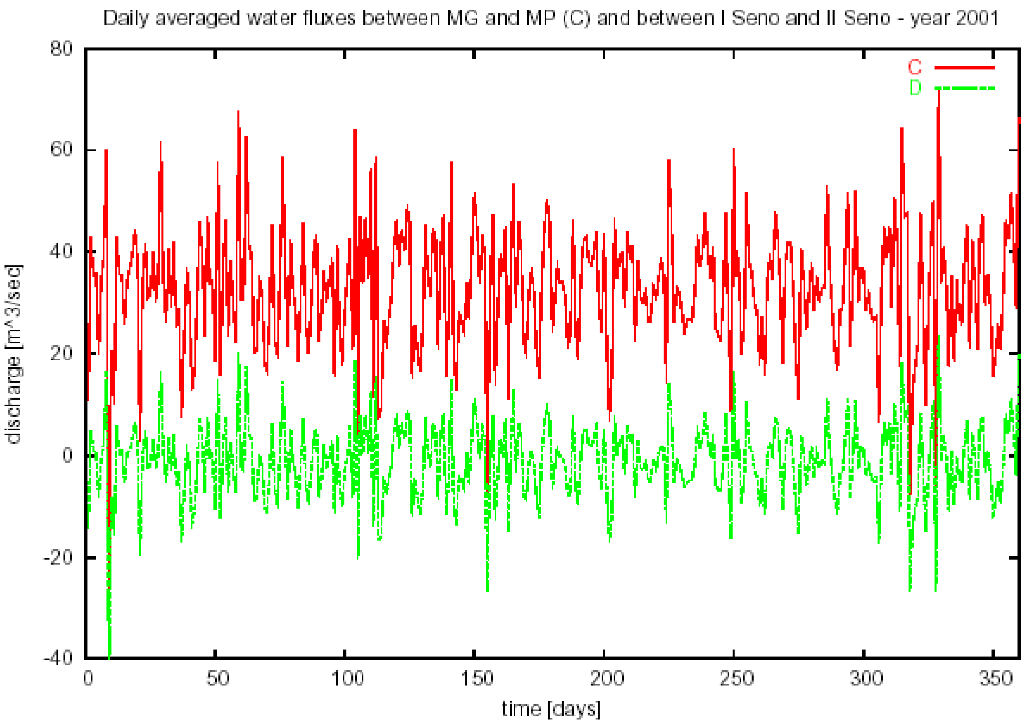


Figure 4 Daily averaged water fluxes through selected sections during the year 2001. Sections A and B (top panel) and sections C and D (bottom panel).

A statistical analysis has been carried out comparing the fluxes through sections A-D. Its results are shown in Figure 5 and Table 3 for the year 2001 only. For every section the mean value, standard deviation and correlation coefficient R are given in the table.

Results for both years and other statistical parameters can be found in Scroccaro (2004).

Increasing the drag coefficient (Sim 2) does enhance the average fluxes through section A and B, but leaves basically unchanged the fluxes through all the other sections, even if C1 seems a little less and C2 a little enhanced (C1 is the eastern channel of section C, and C2 the western part). Please note, however, that section C (C1+C2) and A+B do not show any change at all.

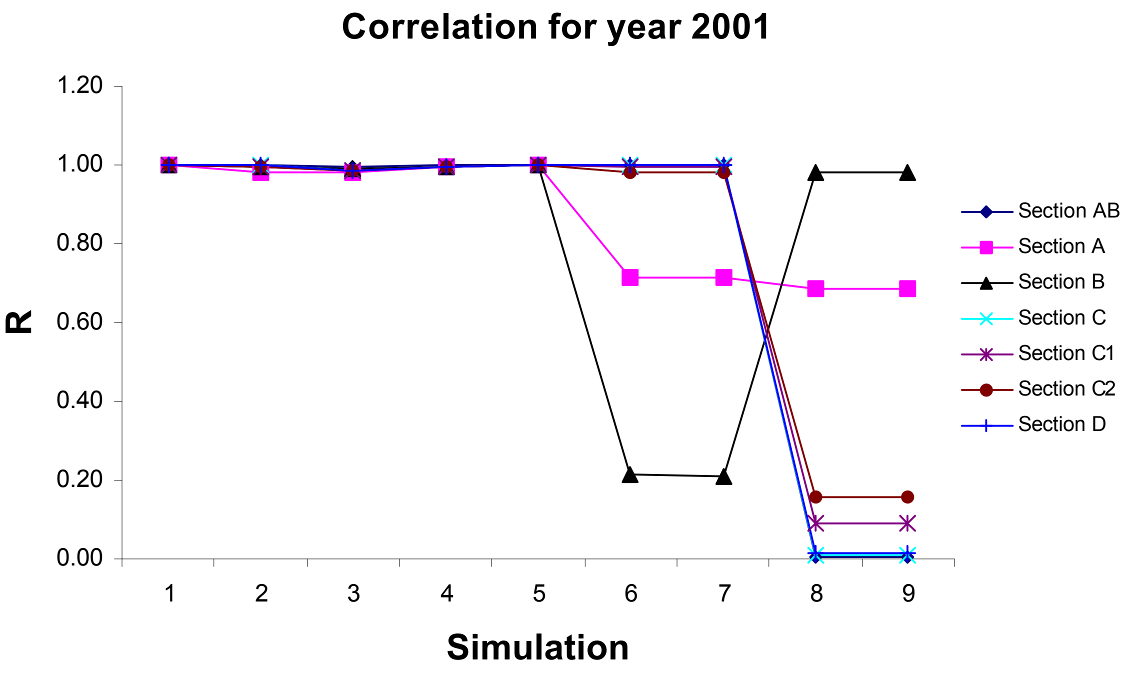


Figure 5. Correlation coefficient of the sensitivity simulations for discharges through various section of the Taranto Sea. The meaning of the simulations is given in Table 2, and the sections can be found in Fig. 1.

The standard deviation is not very different through sections C1, C2 and D, but is much enhanced through sections A and B. Therefore, stronger winds create a more vigorous circulation in the Mar Grande and enhance the fluxes through both outer inlets, but basically do not change the exchange mechanism through the inner section C and D. This finding is in accordance with what has been said in Scroccaro *et al*. (2004).

An increase in the bottom friction (Sim 3 and 4) again shows the strongest decrease in sections A and B, leaving all other average discharges basically unchanged. The effect is stronger in the shallower sections (B and C2).

Switching off the internal sources and sinks does not change at all the circulation and exchanges from the hydrodynamic point of view. Standard deviation and correlation coefficient are the same as the reference simulation. However, the average value through sections A, B and C drops from 31 m^3/s to zero, because of the missing sources and sinks in the inner basin (mostly the ILVA water pump). Therefore, in the remainder we will not distinguish further between the simulations with and without discharges, because the only visible effect is the change in the average discharge of the basins (Mar Grande and Mar Piccolo).

It is interesting to note, however, that, without inner sources, there is a small net import through section C2 and consequently a net export through section C1. Moreover, section B does not seem to be influenced by the absence of the inner sources and sinks (-55.28 m^3/s compared to -54.96 m^3/s for the reference simulation), whereas section A suffers a drop from 86.53 m^3/s in the reference simulation to 54.72 m^3/s in the one without the inner discharges. Therefore it seems that the difference in water flux is all absorbed by inlet A, whereas inlet B is not sensitive at all to the changes in discharge.

Table 2: Summary of hydrodynamic sensitivity simulations.

Sim	**Test**
1	reference simulation
2	$c_d = 5 \times 10^{-3}$
3	$k_s = 30$
4	$k_s = 25$
5	without discharges
6	only tide
7	only tide without discharges
8	only wind
9	only wind without discharges

In simulations 6 and 7 the wind has been switched off as forcing, and therefore only the tide remains as the main driving force. The difference between simulation 6 and 7 is only in the missing inner sources and all what has been said about Sim 5 is true again. Therefore, only Sim 6 is discussed here. Section A suffers a drop of the average value (from 86.53 m^3/s to 33.75 m^3/s) and the standard deviation (541.54 m3/s to 385.17 m^3/s). Its correlation coefficient is 0.716. More dramatic are the changes in section B which passes from an average value of –54.96 m^3/s to –2.18 m^3/s and from a standard deviation of 386.28 m^3/s to 79.71 m^3/s with a correlation coefficient of 0.213. Therefore, the wind is one of the main driving forces that governs the discharges of section B, whereas section A, while still influenced by the wind, is not so sensitive to changes as section B. Another situation can be found for the inner sections C and D. Very little change can be found when the wind action is switched off. Standard deviation is nearly untouched and the correlation coefficient is always higher than 0.98. There is a slight shift between the sections C1 and C2 of the average flux of no more than 1.5 m^3/s. In section D no changes are visible. These results lead to the conclusion that the wind is not influential for the exchanges in the inner part of the Taranto Sea (Mar Piccolo and exchanges with the Mar Grande), but has a strong influence on the circulation in the Mar Grande and its exchanges with the Ionian Sea. Inlets B exhibits a higher reduction than inlet A, probably due to its much shallower depth. The tidal water level gradient is not enough for section B to sustain the fluxes with respect to section A, but when the wind is pushing water in or out through section A, then section B reacts and imports or exports an equivalent quantity of water. One might say that inlet B only reacts to the changes in inlet A and therefore only plays a secondary role in the Taranto Sea. An indication of this behavior has already been found in Sim 5, where the influence of the inner sources and sinks have been discussed. In that case the flux through section B does not change noticeably when the discharges are switched off, while section A shows a reduction equal to the sources that have been eliminated. This might again indicate that the preferential exchange of fresh water fluxes is through section A, while section B is insensitive to an increase or decrease of these quantities. Since the only physical mechanism is the water level difference between the Mar Grande and the Ionian Sea, it seems that the water level drives section A and influences much less section B. Finally, the influence of the tide has been investigated with Sim 8 and 9, where the tide has been switched off as a main forcing. Sectiona A and B do not really show changes in their average values (around 10 %). The standard deviation from section A drops from 541.54 m^3/s to 347.44 m^3/s, and in section B from 386.28 m^3/s to 349.97 m^3/s. This tendency (higher changes in section A) is confirmed by the correlation coefficient for A (0.688) and B (0.981). Again this underpins what has been said before: section B is not so much governed by differences in water level, but only by the wind action. The inner sections C and D show strong attenuation of their fluxes.

Table 3: Results of sensitivity simulations. Given are the following values for the various simulations and sections: Average and standard deviation of fluxes in m^3/s (top and center) and correlation coefficient (bottom). The meaning of the simulations is given in Table 2, and the sections can be found in Figure 1.

Section	AB	A	B	C	C1	C2	D
Sim 1	31.750	86.530	-54.960	32.520	24.200	8.314	-1.255
Sim 2	31.750	107.500	-75.950	32.520	23.410	9.110	-1.253
Sim 3	31.740	63.500	-31.940	32.520	24.080	8.433	-1.255
Sim 4	31.740	73.710	-42.150	32.520	24.190	8.325	-1.255
Sim 5	-0.370	54.720	-55.280	-0.202	-1.980	1.775	-0.123
Sim 6	31.740	33.750	-2.184	32.520	25.700	6.819	-1.257
Sim 7	-0.380	2.290	-2.857	-0.204	0.272	-0.478	-0.125
Sim 8	32.130	80.460	-48.340	32.720	26.520	6.204	-1.130
Sim 9	0.003	48.590	-48.580	0.003	-0.718	0.721	0.002

Section	AB	A	B	C	C1	C2	D
Sim 1	322.78	541.54	386.28	199.33	135.27	71.75	130.04
Sim 2	322.51	597.15	459.65	198.98	135.53	72.28	129.79
Sim 3	315.50	498.27	323.51	189.71	131.54	65.11	122.59
Sim 4	319.28	518.70	353.89	194.69	133.64	68.45	126.45
Sim 5	322.80	541.55	386.28	199.36	135.32	71.82	130.07
Sim 6	323.05	385.17	79.71	199.66	134.73	70.63	130.28
Sim 7	323.07	385.12	79.39	199.69	134.75	70.62	130.30
Sim 8	4.86	347.44	349.97	4.64	15.39	14.46	3.64
Sim 9	4.89	347.44	349.96	4.67	15.73	14.79	3.65

Section	AB	A	B	C	C1	C2	D
Sim 1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sim 2	0.9996	0.9810	0.9930	0.9992	0.9972	0.9929	0.9990
Sim 3	0.9933	0.9790	0.9900	0.9859	0.9856	0.9856	0.9838
Sim 4	0.9983	0.9940	0.9970	0.9965	0.9962	0.9966	0.9961
Sim 5	0.9999	0.9990	0.9990	0.9999	0.9999	0.9998	0.9999
Sim 6	0.9995	0.7160	0.2130	0.9991	0.9940	0.9819	0.9989
Sim 7	0.9995	0.7160	0.2110	0.9990	0.9938	0.9812	0.9988
Sim 8	0.0068	0.6880	0.9810	0.0113	0.0885	0.1566	0.0145
Sim 9	0.0068	0.6880	0.9810	0.0114	0.0881	0.1554	0.0145

Their correlation is around 0.08 (C1) and 0.15 (C2) for section C and 0.01 for section D. Again, this is a confirmation of the fact that the inner basin of the Taranto Sea is completely tidal driven and that the wind only has a marginal role in the exchange mechanisms of the Mar Piccolo.

Conclusions

A finite element model has been applied to the Taranto Sea. With this model the detailed description of the whole area was possible, as well as the high resolution description of the connection channels, thanks to the flexibility of the finite element method. In this work the dynamics of the Taranto Sea has been investigated with the 2D version of the SHYFEM model. Results for the hydrodynamic circulation and the exchange mechanisms between the various water bodies have been studied. Tide, wind, and inflows have been prescribed as forcings for the hydrodynamic circulation.

Water fluxes derived from the model show that the circulation in the Mar Grande and the exchanges with the Ionian Sea are governed by the action of both tide and wind through the southern inlet, and are completely driven by the wind through the opening near Punta Rondinella. Maybe this is due to the particular geometry of the basin and to the position of the two inlets respect to the direction of the dominant winds. In the Mar Piccolo the most important factor driving the circulation and the water exchange is the tide, whereas the wind seems to have a marginal role.

It is clear that the hydrodynamics is the basics information that is needed when one wants to implement an ecological model. Especially exchanges with the open sea and between sub-basins define the availability of nutrients or the removal of organic loads in the basin and are, therefore, of primary importance for water quality modeling. Once available, geochemical data will be used in order to reproduce the main ecodynamic characteristics of the Taranto Sea.

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