Tasaul Lake Historical Data, Reasons for Tasaul Project Objectives *(Laura Alexandrov, Irina Cernisencu, Razvan Mateescu, Dacian Teodorescu, Dan Vasiliu, Emanuela Mihailov)*	"Cercetari Marine" Issue no. 37 Pages 148-163	2007

TASAUL LAKE HISTORICAL DATA, REASONS FOR TASAUL PROJECT OBJECTIVES

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ABSTRACT

An extensive literature study including unpublished results and translated Romanian publications provides general historical information about Tasaul Lake hydrology, chemistry and biology. The lake has turned from a brackish lagoon into a eutrophic freshwater system with high nutrient input. The ecosystem deteriorated, e.g. biodiversity and fish production diminished from the 1970s to 2003. In 2003 the lake featured quality class 2-3, according to the EU WFD classification. The objectives of the ESTROM Project "Tasaul Lake", based on these compiled data, were mainly to provide an actual data basis for recommended restoration measures.

INTRODUCTION

Tasaul Lake is part of the Romanian Black Sea coastal zone. It is rich in biodiversity, and the uniqueness of habitats, natural resources and ecological communities is representative at regional level. However, human activities such as pollution, river embankment, hydro-technical works, natural resource extraction and overfishing have caused a progressive ecosystem degradation and loss of biodiversity (Table 1). Tasaul Lake has been classified as Important Bird Area by Birdlife International.

Table 1. Tasaul Lake biodiversity (1989, 2003)

Group of organisms	Number of species	
	(1989)	(2003)
Phytoplankton	135	55
Zooplankton	90	15
Zoobenthos	12	5 *
Fish	27	5 (dominant species)

* numbers of groups

In the lake catchment we find some urban and rural communities, a petrochemical plant, a factory for chemical fertilizers (presently out of operation), a quarry, crop-fields, some farms (for fish, pigs, ducks and sheep rearing), roads and railways, different private enterprises and new buildings. Until the 1970s the salinity continually decreased from 26 g to < 1g Cl/l, because of hydro-technical works performed in the 1920s that closed the link to the sea, hence, changing Tasaul Lake from a brackish to a freshwater lake. The operation of channels and dikes increased the water depth of Tasaul Lake from about 1.5 to 4 m, reduced the reed belts from about 300 to 55ha, and increased the surface area from 1200 to 2306 ha. Since 1974, the massive anthropogenic impact, mainly pollution and overfishing, induced significant changes in water quality and living resources. Further, complex hydrological regulation is influencing the lake in the southern part close to the Black Sea.

A retrospective analysis of lake data shows that only few investigations of water chemistry, natural resources, and fish populations exist. There is a lack of systematic limnological and long-term lake monitoring showing depth profiles (for both water and sediments) and seasonal dynamics (for chemistry, plankton and fish). Also, primary production data are scarce.

General hydro-geographical status of Tasaul Lake

Appearance: similar to wetlands and other lakes situated on the lower course of the Danube or on some of its tributaries near coastal areas, Tasaul Lake is connected with the recent palaeo-geographical evolution of the Black Sea basin. As tributary coastal water it developed a deepened valley with its bottom below sea level and filled with salt water. The lowered relief of the littoral zone formed a gulf barred by a sandy belt and developed in time to the lagoon Tasaul Lake, an elongated, sinuous water body with maximum depth near the littoral belt. At that time, it was open to the sea, with a long base and, compared to its surface, a very small recipient basin.

By genesis the **morphometric type** of Tasaul Lake is the estuary (in a former valley). The lacustrine basin shows certain peculiar marks shaped by the morphology and the hydrologic regime (Annex 1).

Ground water in the catchment originates from two large hydrological units in the Eastern and Western parts: the transverse (dorsal) Dunareni–Cobadin in the West, placed a bit higher than the Eastern one. The main ground waters are on the Medgidia–Dumbraveni transverse (West side).

The winds are influenced by the sea shore topography and local climate. We notice:

- dominant North-West and South–West winds in winter and South-East (sometimes Northern) winds in summer;
- marine breeze, during day and night appearing differently in summer and winter;
- lowest rainfall: 350 – 400mm per year;
- evaporation: 850-950mm per year.

TASAUL LAKE SHORT HISTORY. DATA FROM STUDIES AND RESEARCH

In 1976

A hydrogeographycal study (Breier 1976) presents the general features of coastal lakes (including Tasaul Lake), the history of coastal Romanian lakes research till 1976, lakes genesis, orographic and morphometric parameters, geographical conditions with impact on the hydrological regime, water balance, water levels and main physical and life conditions. By this information Tasaul Lake

- Had a riverine-marine ***origin***, being a "liman";
- Was largely ***supplied*** by the discharge of tributaries fluctuating according to the intervals of rain and drought periods;
- Showed variable salt concentrations depending on periods with high discharge (freshwater regeneration) and evaporation (salting);
- Had good conditions for fish rearing due to the favourable nutrient input mainly from the tributaries;
- Presented following **morphological main characteristics**: mean level: l; absolute sea level: 24cm; water surface: 2335ha; volume: $57x10^6m^3$; shore-line length: 36.5km; the coastal length development coefficient: 2.06 (k-l/2$\sqrt{\ }$ωπ); total length, on right profile: 9.5km, on median profile: 11.5km; max width.: 4.0km, mean: 2.0km; depth, max.: 3.75m, mean: 2.4m; mean bottom slope tg α: 0.0043;

The following multiannual **mean flow characteristics** (for 1955-1966) of Casimcea river were recorded at Casimcea station: catchment area: 97 km^2, mean altitude: 204 m a.s.l., Inflow Q mean: 079 m^3/s, specific Q med.: 0.81 $l/s{\cdot}km^2$, the drained coastal precipitation: 25.5 mm. For 1967-1970: Q mean: 0.859 $^3/s$, specific Q mean: 0.88 $l/s{\cdot}km^2$.

Water Mass Balance*:* The basic relations such as conservation of mass, momentum and energy are derived from the fundamental laws of classical physics for the Tasaul Lake catchment. It can be stated that the water of the lake partly evaporates (evaporation: 25.70 x $10^{6\cdot}m^3$, $0.8m^3/s$, 65.0%), partly infiltrates (infiltration: 0.63 x $10^{6\cdot}m^3$, $0.02m^3/s$, 1.5%). The mass balance equation is usually described as: P-Win – R – Ev = ΔS, were P= precipitation = $0.32m^3/s$; Win = ground water inflow = $0.28m^3/s$; Q = river outflow; Ev = total evaporation; Wout=ground water outflow; ΔS = net changes in storage; R = $(Q+G_{out})$ = runoff.

The main inflow to Tasaul Lake is mainly originated from sources with reduced flow. Given that, the groundwater contribution is 8.73 x $10^{6\cdot}m^3$, $0.28m^3/s$, 20.0%; water inflow (+) or outflow (-): 2.55 x $10^{6\cdot}m^3$, $0.08m^3/s$, 6.0%). The water consumption in different purposes represent 5.0% (1.89 x$10^{6\cdot}m^3$, $0.06m^3/s$). The remaining water about 0.28 x $10^{6\cdot}m^3$, $0.01m^3/s$ representing 1.0%. The outflow from the Tasaul Lake to the sea, according to the literature (11.04 x $10^{6\cdot}m^3$, $0.35m^3/s$) represent 28.5% and the water volume variability: (3.50 x $10^{6\cdot}m^3$, $0.12m^3/s$) 6.0%. The calculated amount of water input into the system such as the rainfall rate of: 10 x 10^{6}·l/m^3, with a Volumetric flow rate of 0.32m^3/s that represent an intake of 24.0%, and the run-off is 20.97 10^{6}·m^3, 0.66 m^3/s, 49.0%.

Human impact main events: After 1922, when the salty water of Tasaul Lake led to the decrease of fish populations, technical works started: A channel between Siutghiol and Tasaul Lakes, some dams between Gargalac and Corbu Lake and the channel for the outflow from the lake to the sea. At the most far point of Tasaul Lake from the sea, a fish hatchery with 67ha total surface was built. It was supplied by freshwater inflow from Casimcea River (0.4m^3/s); small channels permitted water outflow to the lake. The Gargalac (Corbu) Lake also discharged its water into Tasaul Lake by a common channel, during fishing seasons. The supplementary channel is often active and impacted by agricultural and animal breeding activities. During rainy periods coastal waters intrude and supply ground water.

During 1966 - 1977

Hydrobiological data and quality indicators show the importance of Tasaul Lake for fish production (Cure et al. 1977). After a general introduction to lake genesis, the following morphometric and hydrological characteristics are given:

- Lake surface 2306ha (1976-1977),
- Water inflow: specific Q <11.0 l/s km^2, >50% during winter,
- Ratio lake surface / lake catchment area: 0.026,
- Lake catchment area 755km^2, including Casimcea river basin,
- Evaporation exceeded precipitation,
- Water level increased in 1977 to 174cm (mean value), compared with previous years with 98-180cm (1960-1975); this contributed to an enhanced euthrophication, due to flash flows containing nutrients from diffuse and point sources.

The following sources of pollution have been identified: irrigation systems, industrial impact of Mechanical Factory Navodari City, domestic wastewater from Navodari City, Constanta county Company for Power Plant Network, Navodari Summer Camp for Children, the Agricultural Complex Sibioara for Food/Meat Processing, and other industrial objects.

- *Main water variables*: salinity: 0.5 g Cl/l (compare with 26 g Cl/l in 1929, 6.7g Cl/l in 1938, and 2.8 g Cl/l in 1964), O_2 mg/l: 8.00-13.36, BOD_5 mg/l O_2: 4.11-8.08, $KMnO_4$ mg/l: 23.40-39.62, pH: 8.05-8.45, fixed residue mg/l: 1056.0-1180.8.
- *Main sediments variables*: pH: 8.31-8.80, humus (organical substance amorphous as fertility indicator) %: 0.60-1.20, NO_3mg/l: 2.92-5.44, P_2O_5 mg/l: 5.60-8.00, HCO_3 mg/l: 24.4-29.3, Cl mg/l: 33.3-74.7, SO_4: 8.93-101.3 mg/l, Ca^2: 8.2-39.5 mg/l, Mg^2: 5.2-25.1 mg/l, Na: 12.2-15.00 mg/l, K: 2.00-3.75 mg/l, residues mg/l: 107.0-289.2.
- *Biological variables*:
  - mineralization degrees $_{\text{(calcinacion)}}$ - 1 g/l; very low macrophyte biomass: *Phragmites communis, Typha* sp., *Scirpus* sp., *Myriophillum spicatum, Potamogeton crispus, Vallisneria spiralis, Chara,*
  - phytoplankton density (average) 12637 – 22816 x 10^3cell/l, (May,August); biomass 5086 – 7334mg/m^3; major phytoplankton groups: Cyanophyta (*Microcystis,*

Aphanizomenon), Chlorophycea (*Scenedesmus, Crucigenia, Tetrahedron),* Diatoma, Euglenophyta,
- zooplankton densities: 798 000ex/m^3, mainly rotifers;
- zoobenthos biomass: 30kg/ha, dominated by chironomids larvae,
- fish productivity: 40kg/ha(1947-1964), 80kg/ha(1964-1970), 60kg/ha(1970-1977),

These results indicated mainly a mesotrophic state of Tasaul Lake during 1966-1977. Fish production was 60kg/ha, with relative contribution of 56% by carp and 16% by pike perch. This fish yield is considered too small due to inadequate population structure (low abundance and biased species composition). Recommendations for rehabilitation and increasing fish productivity encompass:

- propagate early repopulation, especially with carp fingerlings and juveniles,
- introduce zooplanktonophagous species (as Chinese Carps family),
- improve water quality and use adequate fishing methods and tools.

The lake was investigated by NIMRD during **1970-1985, 1988-1989 and 2001-2003.**

Various **taxa lists** of phytoplankton, zooplankton, benthos, fish, and macrophytes (small reed belts scattered along the shore) are available, but no temporal trends can be detected due to lack of continuous monitoring. There is also a lack of a systematic evaluation with regard to **biodiversity**. However, the fish production decreased from 199 tons per year in 1992 to 5 tons per year in 2000, while high-valued species like pikeperch, pike and carp almost completely disappeared from the catches. The structure and dynamics of the fish fauna in Tasaul Lake reflected the changes by anthropogenic impacts, over-fishing and eutrophication, which favoured few ubiquitous species and the proliferation of introduced Chinese cyprinids.

Fish populations with commercial value are considered good indicators of environmental alteration. Fisheries independent data were collected to account for the state of the stocks. Basic results (estimates of fish recruitment, biomass, mortality rates, etc.) have been interpreted in the ecosystem context and on the interactions between fish stocks, fishing and environment.

During 1988-1989

The NIMRD own research regarding "*The Establishment of trophic and fishing potential of freshwater pools and basins*" yielded the following results and conclusions.

The natural productivity of Tasaul Lake is influenced by the sunny day regime and radiation intensity, excessively powerful, with more than 15-20% than normal, due to prolonged solar flare phenomena; this had an impact on fish metabolism and consumption, and on the power of cell division during embryogenesis which decreased. This leaded to a general decrease of bioproductivity rates (Table 2).

- This leds to a decrease in replication of phytoplankton in the same proportion; instead of 50-52 generations / year replication was limited to 20-22 generations, causing a decrease of primary biomass at the base of the food chain. This metabolic disorder diminished the photosynthesis. These theoretical considerations were confirmed in the field.

- The environmental impact from terrestrial sources is reflected by the physico-chemical variables: transparency: 47.5 cm, temperature: 13.8 ºC, pH: 8.90, O_2: 7.8 mg/l, BOD_5: 4.45mg O_2/l, COD: 4.52mg O_2/l, Si-SiO_4: 1399µg/l, N-NO_2: 11.05µg/l, N-NO_3: 186.97µg/l, N-NH_4: 133.90µg/l, total N: 331.92µg/l, P-PO_4: 198.35µg/l, N/P ratio: 4, salinity: 1.26 g Cl/l.
- Other parameters assessed: trophogenic volume: 0.57m^3/m^2, *chlorophyll* a: 19.36mg/m^2, organic carbon C: 580.48mg/m^3/day, phytoplankton biomass: 10.36g/m^3, zooplankton biomass: 788.42mg/m^3, NTG/ml la 22 ºC: 52 350.

The main aim of this assessment was the evaluation of the trophogenic potential of Tasaul Lake measured by organic carbon. 2,950 tons C/$48 \cdot 10^6 m^3$ were transformed by mineralization into 17,000 tons conventional biomass. The theoretical conversion of this biomass into fish meat, based on a maximum rate of consumption (60%, 12% mean value), yielded 1.122 tons planktivorous fish. This conversion proved that Tasaul Lake still has a large fish production capacity despite adverse anthropogenic impacts, mainly due to restocking ensuring population structures with a diverse feeding spectrum.

Table 2. Tasaul Lake's main parameters in 1989, comparing to 1988

Tasaul Navodari/ Lake	Surface ha	Average Depth (m)	Total Water Volume (m^3)	Transparency Mean value (cm)	Primary production raw data of phytoplankton biomass t/ha/year
1988	-	-	-	47.0	103.55
1989	2.025	2.4	48.6 10^6	47.5	8.51

Annual volume of the trophogenic layer m^3/ha (mean value)	Bioproductive volume % of total volume	Mean content of chlorophyll a in trophogenic layer (g/ha)	Primary production annual mean value C_{org} kg/ha/yr
5640	23.50	269.64	2950.68
5700	23.75	110.35	1207.54

Main comments and discussion:

- The tropholytic mineralization provided a good recycling of organic matter, according to the continued photosynthetic primary production;
- The thermal regime allowed the sum of 5037 degree-days, considered exceptionally favorable support for primary production;
- Alkalinity and high pH were optimal for fish physiology;
- Comparing with other coastal lakes in Romania where oxygen balance was slightly negative, in Tasaul Lake, due to a mean depth (2.4m), oxygen consumption had higher volume per unit area, reflected in BOD_5 and COD values, (with excepttion in winter season);
- Silica and nitrogen concentrations were consistent with their external sources but phosphorus showed one single exception: during summer a sudden 30-fold increase of

phosphorus concentrations as compared to the spring values could only be explained by unauthorized discharge of large quantities of wastewater from a Chemical Industrial Plant in Navodari, with an estimated phosphorous load of 18.5 tons;

- This accidental spill unbalanced the N/P ratio to a value less than unity (1), which continued until the end of 1989.
- This produced a decrease in chlorophyll a and phytoplankton biomass of 50% and over 60%, respectively, slightly recovering in fall; in this case big and unexpected quantities of P is limiting factor for phytoplankton growth.
- I the same time a microbiological activity shown an increased NTG / ml figures up to 160,000, mainly in summer (NTG increased) due to domestic waste discharge;
- The phytoplankton was dominated by Diatoma and Chlorophyceae ensuring a high trophic value, based on favorable biochemical content; the biomass of 8.5t / ha / year in 1989 provided a primary basis corresponding to the consumption requirements;
- Zooplankton abundance, especially in summer and autumn, was the highest registered in the last 5 years; in 1989 an average biomass of 788.5mg / m^3 and an annual production of 284.4kg / ha were recorded;
- The diversification and the increasing amount of benthos food (Oligochaeta, *Mysis* shrimp, Cumacea, Chironomidae, bivalves), with an estimated average of 18.5g/m^2 and a production factor of 2.8, provided a trophic basis equivalent to 518kg/ha, unprecedented in the last 5 years;
- In accordance with the trophic base, the structure of the fish populations composed of appropriate consumers provided a substantial increase of fish production, with over 70t higher than in previous years.

During 2001-2002

NIMRD evaluated the natural feeding potential of Tasaul Lake for fish population and fish productivity development. The main variables analyzed at 8-12 impacted stations were; hydro-physical (temperature, pH, salinity) hydro-chemical (oxygen concentration and biological consumption, organic substance, PO_4, SiO_4, NO_3, NH_4, NO_2) and hydro-biological (bacteria activity, phytoplankton, zooplankton, benthos, fish population). The sampling stations were (Figure 1):

- *Station* 1- Navodari City coast, could be considered the most polluted lake area during this period, reflected by the salinity (0.87g/l), the phosphorus concentration (117µg/l) and hydrocarbons (64.50µg/l), high values of ammonia (1.25mg/l) and total nitrogen in water (1775.9µg/l) and sediments (1340µg/l). Bacteria activity was most intense, according to the decomposition of organic matter. The phytoplankton community was based on Cyanophyta with maximum density (68 x 10^6cells/l) and Euglenophyta (maximum biomass 5682.52mg/m^3).

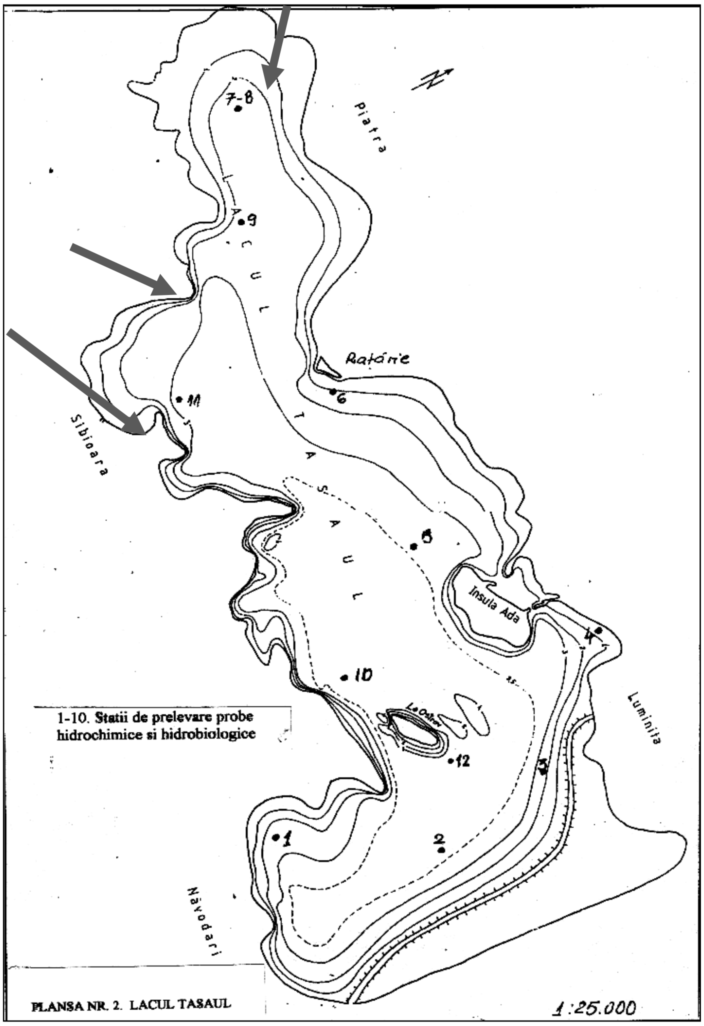


Fig. 1. Tasaul Lake sampling stations (1-12):
Red arrows show main Tasaul Lake tributaries (1:25.000)

- *Station* 2 - Southern sandy area, separated from Navodari-Midia Petrochemical Plant by a concrete channel, railway and roads, is representative for Cyanophyta development and the high density of Chironomidae.
- *Station* 3 - Mining coast is impacted by calcareous mines and railway stones transport. It had minimum phytoplankton development, but an important zooplankton community (4537.4 mg/m^3) mainly nematodes.
- *Station* 4 - *Luminita village*, had a large quantity of total nitrogen (1833µg/l), maximum protein of sediments and a high benthos density (240,000ex/m^2).
- *Station* 5 - central area, is close to the middle of the lake, well aerated (12.20mg/l oxygen), with phosphorus deficit (20µg/l), but high amount of ammonia (1000µg/l),

maximum phytoplankton density (275 x 10^6cells/l) and biomass (55,000mg/m^3), very small zooplankton and benthos biomasses.

- *Station* 6 - Old Ducks Farm area. This former ducks farm still is a zone with a large number of wild birds, rich in organic substances on ground and water areas; the water is characterised by high concentration of lipids.
- *Station* 7 - 8 - the Northern area, in farthest distance from the sea coast, is greatly influenced by Casimcea River, *Piatra village* and also by "*Mihail Kogalniceanu*" Fish Farm's outflow. It has some important particularities:
  - the area has mostly become marshy,
  - sediments keep high concentrations of ammonia (1200μg/l) in their pore water; bacteria are abundant in both water and sediments,
  - phytoplankton is well developed, zooplankton more diversified than in other stations (124mg/l copepods; 88mg/l cladocereans; 1104.80mg/l rotifers)
- *Station* 9 - Pigs farm, most polluted area contaminated by diffuse organic sources
- *Station* 10 - *Sibioara village,* with domestic, agriculture, zootechnical and cemetery impacts
- *Station* 11 - Meadows area with high concentrations of total nitrogen and lipids, mostly originating from Sibioara farms wastewaters.
- *Station* 12 - Navodari City off-shore reflects the horizontal spread of anthropogenic impacts from station 1, in particular in the bottom sediments. The main results:
  - phosphates and lipids in high concentration
  - high concentrations of total nitrogen (1100μg/l), phosphorus (42μg/l), proteins and hydrocarbons in the pore water of sediments
  - phytoplankton dominated by Chlorophycea and Cyanophyta; zooplankton dominated by rotifers and cladocereans; benthos population diminished, based on nematodes.

In 2003

Tasaul Lake's ecological status was assessed during summer by NIMRD and classified according to the recommendations of the EU Water Framework Directive, by respecting surface water standards, water depths, euthrophication index, salinity categories and ecological status. The EU Regulation COM (97)614 recommends to use five categories for chemical and biological evaluations. According the main water qualities (Table 3; Figure 2) the following classification was established:

- The salinity is below 1g Cl/l, relating to the oligohaline type; the oxygen content is high (11.10 mg/l O_2), usual for coastal area;
- The $N\text{-}NO_3$ content of Tasaul Lake water corresponded to the *First quality class*. $N\text{-}NO_2$ was in *Second quality class* (station 11) and in *Third quality class* (stations 9 and 11). Ammonium concentrations were *Quality class 2* (Stations 9 and 11) and *Quality class 3* at all the other stations, similar as the inorganic phosphorus ($P\text{-}PO_4$) content. According to the phytoplankton communities (dominated by Cyanophyta by 95% forming algal blooms of *Oscillatoria planctonica* and *Microcystis pulverea*), the total nitrogen (522.2 - 814.8μg/l) represents eutrophic waters at Stations 9 and 7, and mesotrophic waters at the other stations.
- The organic content of sediments was 3.17% - 7.77% and caused the decrease and extinction of some benthos groups (mysids, amphipods).

Table 3. Tasaul Lake water quality (12.06.2003)

Station	T°C	pH	S g Cl/l	Organic Subst. mgO2/l	O2 mg/l	O2 %
1	24	8.6	1.44	7.26	7.30	125.0
2	24	8.6	0.96	9.88	7.03	120.4
3	24	8.6	1.20	6.04	6.93	118.7
4	24	8.4	0.86	7.35	8.02	137.3
5	24	8.6	1.32	6.53	6.75	115.6
6	24	8.6	0.67	6.86	7.13	121.7
7	24	8.6	0.72	5.96	5.76	98.3
9	26	8.6	0.90	6.04	5.58	99.1
10	26	8.7	1.01	6.53	6.99	124.2
11	26	8.6	0.96	6.53	7.28	129.3
12	26	8.7	0.84	7.84	6.88	121.8

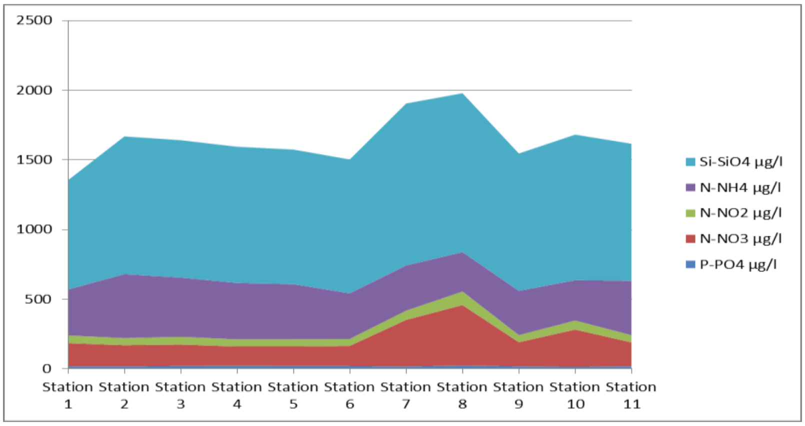


Fig. 2 Tasaul Lake water quality - main nutrients (12.06.2003)

Table 4. Tasaul Lake Sediments quality (12.06.2003)

Station	Water content %	Dry sediment / 105°C g/100g fresh sediment	Organic Substances g /100g dry sediment	Mineral Substance g/100g dry sediment
1	17.79	82.21	3.17	96.83
2	26.45	73.55	4.88	95.12
3	29.66	70.34	5.16	94.84
4	45.45	54.55	6.31	93.69
5	34.37	65.63	6.27	93.73
6	30.56	69.44	5.84	94.16
7	35.52	64.48	7.77	92.23
9	35.91	64.09	7.35	92.65
10	26.78	73.22	4.20	95.80
11	35.37	64.63	6.87	93.13
12	23.42	76.58	4.82	95.18

In 2002-2003

The results of the annual program for assessment (surveillance monitoring) of National Administration "*Apele Romane*" provided significant information. The samples were collected seasonally, i.e. four times a year, at following selected stations: Sibioara Farm, P.H.Nãvodari Sibioara, small tributary channel Dalufac, and the Tasaul Lake's center (only once a year), Table 5:

Table 5. Main parameters of Tasaul Lake water quality 2003, (annual average)

No. crt.	**Indicators**	**Mean Value/2002** (mg/l)	**Mean Value/2003** (mg/l)
1.	Chlorines	232.19	222.610
2.	Rezidues	1333.160	1053.94
3.	COD/CBO_5	6.260	9.060
4.	BOD/CCOMn	16.180	22.750
5.	Total N	2.990	4.100
6.	Total P	0.160	0.165
7.	Phytoplankton Biomass (mg/m^3)	52.390	14.040

- Quality Class 2-3 were evaluated for the organic substance (in water samples) proving high variability compared to previous years.
- The maximum value of total nitrogen (4.87mg/l) was near the Sibioara area.
- Total nitrogen value of 4.1mg/l and phosphorus 0.165mg/l, were eutrophic indicators.
- The primary biological productivity had decreased year by year,
  - Phytoplankton biomass: 14.04mg/l in 2003, 52.39mg/l in 2002,
  - Phytoplankton dominant group: Cyanophyta = 24×10^6 – 141×10^6cells/l.
- Phytoplankton, specially in the Navodari City station (50.008mg/m^3 biomass) was recorded.
- Zooplankton was dominated by Oligochaeta group as stages coming from benthos representatives.
- According to national regulations (Stass 4706/1988) Tasaul Lake was qualified as eutrophic lake.

Since along the Romanian coastal zone a strong Mediterranean influence is evident (the general Romanian climate is temperate continental), evaporation clearly exceeds rainfall by a factor of about two. Hence, droughts play a major role and lead to several intermittent small rivers/ tributaries. These are activated by flash floods during frequent summer storm events (Figure 3).

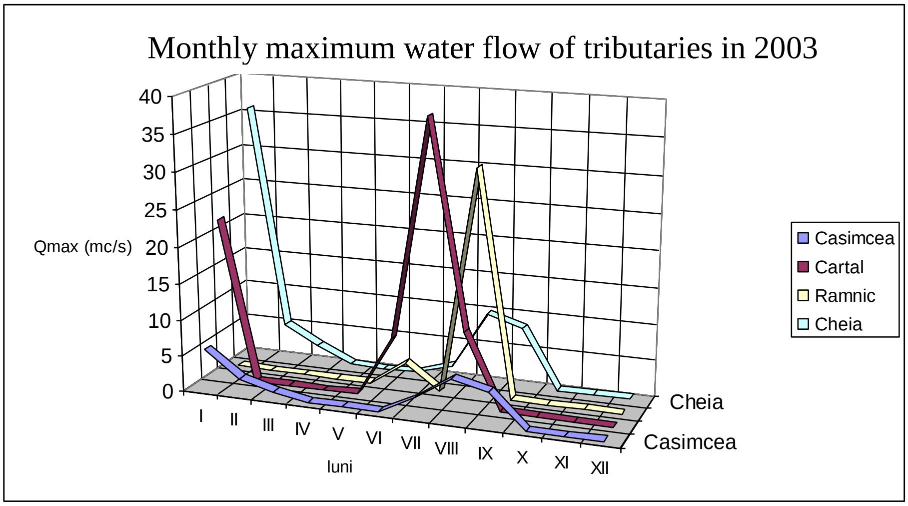
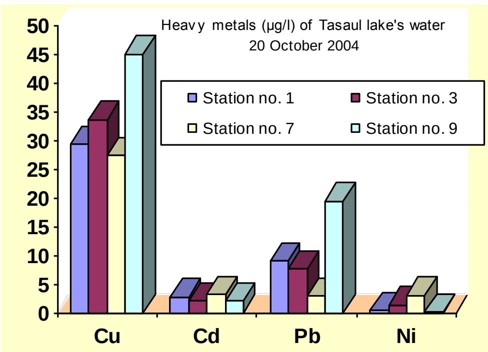


Fig. 3. Monthly maximum flow of Tasaul Lake tributaries in 2003
(DADL information, 2003)

- The catchment area (755 km^2) is relatively large when compared to the lake surface (23km^2). This is crucial for the nutrients and contaminants input to the lake, from diffuse sources in particular.
- While the nutrient load estimates from the upstream part of the main tributary (Casimcea, main river), no specific load from diffuse sources (mainly agriculture) is known.

In the survey of 20 October 2004, before the TASAUL Project started, contaminants were assessed for the first time: copper (Cu) and lead (Pb) were the dominant heavy metals, while lindane and heptachlor were the most abundant pesticides, particularly found near the City of Navodari (Station 1, Figs. 4 and 5).



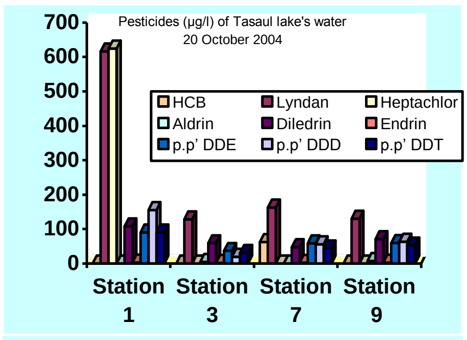


Fig. 4. Heavy metals of Tasaul Lake

Fig. 5. Pesticides of Tasaul Lake

SUMMARY AND CONCLUSIONS

This paper presents research results by discontinuous investigations of different authors and NIMRD "G.Antipa" Constanta. They can contribute to future research, identifying anthropogenic sources and impacts.

A comparative analysis of results over all periods can be summarized as follows:

- In the Casimcea basin and all around Tasaul Lake have urban and rural communities, with domestic wastes, agricultural areas, zootechnical activities regarding livestock (fish, pigs, ducks, sheep, goats, cattle, horses), a petrochemical plant, mining areas, various other industries and companies, transport ways, roads and railways, bridges, new buildings and major hydraulic structures.
- All of these activities influence lake quality and eutrophication processes. The anthropogenic impact, the nitrogen compounds concentration, the variability or scarcity of minerals, organic substances in water and sediments have led to a periodical ecological degradation of Tasaul Lake.
- The influence of climate instability is essential and needs to be further studied: the main characteristics are strong winds, dry periods alternating with periods of flooding or heavy rain, along with other extremes phenomenon (storm/typhoon, ice, etc.)
- The origin of Tasaul Lake, general characterization, specific elements and the main tributaries Casimcea (with low but permanent flow), Sibioara and Dalufac (with torrential character) have been mentioned.
- Anthropogenic factors led to the processes of eutrophication and impacted fish populations, the specific breeding aspects and technological decisions.
- The bacteria as indicator of microbial processes showed intense activity in areas of organic (food industry) and domestic impact;
- Phytoplankton often produced blooming periods by blue-greens;
- Zooplankton developed sometimes high densities, on only some species (very low diversity), most belonging to rotifers, nematodes; primary and secondary consumers of this group are also indicators of waters eutrophication;
- Zoobenthos is not abundant, even declining, and with low diversity and productivity.
- A decrease of valuable species, such as diatoms, cladocerans, mysids and amphipods, important for fish nutrition is reported.
- Fish productivity and biodiversity are reduced, mostly by hydrochemical parameters and riverine silt input affecting the abiotic and biotic components. The dominant species, according to present environmental conditions, is *Carrasius auratus gibelio*.
- Fisheries have to be developed and recovered for carp, silver carp, bighead carp, crucian carp, bream, pike, perch. Tasaul Lake can only operate by populating/stocking and restocking of fish by finding the best forms and suitable structure on species.

Future approaches have to bring together scientists from various fields of research (hydrologists, chemists, biologists, ecologists, etc.), who have experience in interdisciplinary programs. In this context, we have proposed the following topics:

- point sources which influence water quality (industry, municipal wastewater, plants, landfills);
- diffuse sources (agricultural areas, groundwater);

- fate and behaviour of pollutants under extreme hydrological conditions and impact on water quality;
- mobilisation models for different flow conditions (risk management);
- indicator substances (which flow conditions trigger which substances);
- techniques for estimating hydrological regimes at gauged and ungauged locations;
- methods for detecting changes in the frequency of hydrological extreme events;
- evidence for specific causes of change in the frequency of extremes.

Through the ESTROM Program new objectives came into focus:

- to provide input to the harmonisation of methodologies for the monitoring and analyses of priority substances, mandated by the WFD;
- to provide knowledge on critical pathways of chemicals in aquatic ecosystems;
- to develop and apply methods for the analysis of new and emerging chemicals where gaps in harmonized methodologies and environmental concentration occur;
- to apply advanced analytical instrumentation to provide knowledge on environmental aspects and processes controlling environmental chemical behaviour;
- to support the improvement of models describing the transport, fate and bioaccumulation of priority substances and emerging chemicals;
- to provide advanced analytical support to institutional and competitive projects;
- to provide scientific input to chemical issues highlighted in the Environment and Health Strategy and Integrated Coastal Zone Management.

REFERENCES

- Bratescu, C., Lacul Tasaul, 1971; Pisota, I., Trufas, V., Hydrology of Romania vol. II, Lakes of Romania, fasc. I, Univ. Buc., pg 45 (pg. 534): Danescu, Grig. Gh., op., The big geographic dictionary of Romania, vol. II, p. 547 (407)
- Breier, Ariadna, 1970 - Regimul nivelurilor in complexul lacustru Tasaul –colective paper, limnology. Instit. geogr.
- Breier, Ariadna, 1976 – Lacurile de pe litoralul romanesc al Marii Negre. (Studiu hidrogeografic), Ed.Academica., Bucuresti
- Comanescu, Laura Georgiana, 2004 - Bazinul morfohidrografic Casimcea- studiu geomorfologic, Editura Universitatii, Bucuresti
- Cure V., M.Nazaru, Antonescu, C. S. 1970, Hydrobiological data and quality indicators – Biologia apelor – Ed. Didactica si Pedagogica Bucuresti
- Cure V., M.Nazaru, M.Monea, 1977, Hydrobiological data and quality indicators: "*Some problems regarding the water quality of coastal Lakes from Siutghiol-Tasaul complex and their fish production in the present stage (1977)*", The Fisheries Research Bulletin, No.1-2, year I(XXXII), new series, Fisheries Research Station "Nucet", Dambovita, Romania
- Manoleli D., Breier A.,Cure E., Ionita R., 1982 - Formarea, evolutia si functiile lagunelor si limanurilor marine, Pontus Euxinus, Studii si cercetari, Constanta,2, pag 281- 287
- Niculescu Duvaz, Mircea; Parpala L; Rusu C; Caraiman Ghe. 1978, Buletin de cercetari piscicole I – II, Statiunea de cercetari pentru piscicultura
- Orghidan, N. – Bazinul vaii Casimcea, observatii geomorfologice, Lucr. Inst. Speol. " Emil Racovita ", I-II , 1963
- xxx - Annals of Dobrogea, year X, fascicle. 1 – 12, 1929, pg. 323
- xxx - Maritime Hydrographical Direction, C-ta, 1971: Tasaul map, sc. 1:100000
- xxx - S.C. PESTOM S.A. C-ta, Tasaul bathymetric map, 1997, sc. 1: 25000
- xxx –IRCM-INCDM "G.Antipa" unpublished Annual Reports

Annex 1. Tasaul Lake historical data of hydrology - Dacian Teodorescu

Trough a memory signed by first habitant of Sibioara village in 1922, called Nicolae Cergau - and forwarded to the administration forums by C. Bratescu, it was proposed the construction of a channel of 5km length with normal slope flow, between Siutghiol and Tasaul Lakes. Thus it were ensured the water supply of Tasaul and Gargalac (Corbul) Lakes - and the water in excess were flow to the sea through an old brook, which at that time were dry, as well as Gargalac (Corbul) Lake. Later on, in 1929, at the end of all works done – the channel (a pipeline with 5250 m length and 1000 mm section) were realised. (*the verbal-process/account of proceedings from 02.06.1929, in Annals of Dobrogea, year X, fascicle 1-12, 1929, pg. 323*)

Starting with the artificial technical works Siutghiol–Tasaul Lakes and finishing with navigable Channel Poarta Alba–Midia–Navodari (Navodari-Luminita ramification) were induced the decreasing of south island surface due to lake level changing (from 12ha in 1899 to 3ha in 2000) together with transformation of northern peninsular zone in island. From achieves data, it is mentioned that between 1897 and 1899 the lake surface was 1200ha, in 1922 was 2183ha, and in 1971 become 2306ha. (*Danescu, Grig. Gh., cited. op., page. 407, The big geographic dictionary of Romania, vol. II, p. 547; Bratescu, C., Lacul Tasaul, pag. 534; Pisota, I., Trufas, V., Hydrology of Romania vol. II, Lakes of Romania, fasc. I, Univ. Buc., 1971, page 45*)

According to Poarta Alba-Midia-Navodari (with Navodari-Luminita ramification), the channel execution, the water surface and reed was reduced to 55ha in 1967 due to the systematisation of approximatively 300 ha).

According to historical, archived data, the maximum depth were 1.50m in 1922 (meaning 1.90m under Black Sea level), 3.60m in 1971 and 4.00m. in 1997. Sources of this information are *Maritime Hydrographical Direction, Constanta: map of Tasaul Lake, sc. 1: 100000, 1971; S.C. PESTOM S.A. Constanta, bathymetric map of Tasaul Lake, 1997, sc. 1: 25000* (Alexandrov, this volume).

Because of the Siutghiol-Tasaul Channel construction; because of the dam which induced an accumulative regime from 1965; because of the seaward runoff control; and because, at least, to the water surpluses from precipitations and irrigations in 1970 the Tasaul Lake level were increased with around 4,00m comparatively with the existent level in 1921–1923, due to dryness in. (Breier A., 1976, op. cited, pg. 85 - 86)

Comparing with this level rising in Tasaul Lake, in 1970, it were registered a decreasing of the Siutghiol Lake level, fact which imposed the reactivation for several months of the pipeline (which functioned with few gaps, till 1967). The reactivation, in this case, were done by water pumping in reverse sense of normal slope - thus it were added from Tasaul Lake to Siutghiol Lake a significant water volume of 0.200mc/s, alight with the average quantity of 1958-1966 period, when the water from Siutghiol to Tasaul Lake was about 0.150 cubic meters/s. Towards the end, it has to be mentioned an important information which could be escaped at first sight is that the stoned dam permeability, which cut off the Tasaul Lake from the navigable branch Navodari - Luminita.

In present, these two lakes, Tasaul and Corbu, were transformed by their separation in fishing basins. Thus, they are well known under the names of Luminita I and Luminita II, because of Luminita Village, located in the vicinity.

For the eastern part of Dobrogea, *in Corbu locality (Carachioi, Caracoium, Gargalac) - as typological Romanian-Rusian village, with Turkish names, it is done an interesting reference about the natural springs depletion in August 1922, but also to the existence of a freshwater drug-well placed on the sand-belt located between Tasaul Lake and the Black Sea. An increasing of its level, in 28 August 1922 was indicating when the sea level was 1.90 m above the lake surface level.*

More than a half of its volume were gone trough evaporation, due to several years of dryness from that time, the maximum depth of the lake were *1.50 m in front of the Island "without name"*. The well from the sand-belt had a deepness of 0.5 m (water surface = 2.26m / H water = 0.5 m). Counting, it was result that well column to the water surface was 1.57m under the sea level, but also with 0.33 m above the lake surface/level. The bottom of the well were with several centimetres under lake level – the sand-belt was formed from sand dunes with a high of 5-7 m above the sea level and it had a width of 1500 m, which stopped the salt water intrusion.

Also, it was mentioned that the pump-well was charged only from rains (Annals of Dobrogea 1922). Probably, today this well is under the foundations of PETROMIDIA oil installations, which induced the new modifications of hydrostatic level, from its placement and the massive drains. Also here, it could be remembered that, at 28 August 1922 Gargalac (Corbu) Lake was completely empty.

At Cicarci (Sibioara) the dryness affected the Corbu Lake, in July 1921, when water bringing the subsalts crystallization trough evaporation. At that time Casimcea River was used for coastal gardens irrigations. Important to remember is the fact that later on, between 1926-1927 it was built *a connecting channel/passage under a concrete underground hydraulic pipeline, between Mamaia (Siutghiol) Lake and Tasaul Lake, trough it were made additional charge of freshwater volume, normally evaporated from Tasaul Lake (Annals of Dobrogea, 1928).*

Today, the pipeline exists and it is in conservation, and the Tasaul Lake is divided in two compartments, Luminita I and II, respectively Tasaul and Corbu Lakes, linked by pipelines. The lakes compartments are used for fishing/aquaculture. According with the lake/level measurements Mamaia Lake had 1.80m above sea level; Tasaul Lake had 1.90m under sea level.

The length between Mamaia Lake and Gargalac Lake is 6 km.

Several data referring to chemical analysis come from Romanian *Geologic Institute, 1906 - 1907, which mention that Tasaul's salty water had around 23.63 g/l.* In *Sibioara (Cicarci)* locality, long time before that period were discovered many chute feeders and tile-drain which were used to collect and transport the water into a Roman fortification.