ISSN 0554-6397
UDK: 628.14(497.5)(210.7)
629.546.6(497.5)(210.7)
Review article
Received: 05.11.2019.

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Water Carrying Ships in the Adriatic Region - Zadar Region Analysis

Abstract

In this paper the main objective was to analyse water distribution market on Adriatic islands, mainly those without any water piping infrastructure. Those islands are mostly supplied by water carrying ships. The used methodology consisted of analysing, in last four years, the number of water deliveries and amount of precipitation in the research area. The analysis showed that the most critical situation occurs from June to September, when the number of residents grows and the amount of precipitation lowers. In order to avoid critical situations, like water reductions and draughts, important factors are pointed out which could lead to such situations and with proper precautions action can be avoided.

Keywords: Water distribution, water carrying ships, Adriatic islands

1. Introduction

The western coast of the Adriatic Sea is characterized by a great number of islands, which are permanently or temporarily inhabited. Regardless of that fact, the number of residents throughout the year varies. For example, according to the population census of 2011 [1], the island "Dugi otok" has 1698 residents, while according to tourist record of 2017 [2] there were 27389 visitors there. This means an increment in the population by approximately ten times.

On the Croatian side of the Adriatic coast, where water piping infrastructure is not available, islands are supplied by water either from the rain water that is collected and stored in special tanks or by water carrying ships which are then filling those special

water tanks. Collecting rain water mainly depends on the amount of precipitations, which means that autumn, winter and spring are characterized by more rainy days and summer by droughts. Contrary to the number of population.

That is why there is the need for water carrying ships. Those ships have a hull divided by transverse and longitudinal bulkheads that form tanks in which water can be loaded, similarly to tanker ships. That kind of water transport has been present since ages, yet however, constant changes in the population number have led to a change in the market as well as in ships size.

2. Historical development of water cappying ship and trading area

Water carrying ships can be divided by many categories, however in analysed region they are divided by the registry. The first type consists of registered commercial water caring ships and the second one of military registered water carrying ships.

Throughout the history there were several commercial companies that owned water carrying ships like “Mediteranska plovidba”, “Jadranska Slobodna Plovidba – Rijeka” and “Obalna plovidba – Split”.

Table 1 - Historic overview of the water carrying ship fleet [4]

COMMERCIALLY REGISTERED SHIPS		MILITARY REGISTERED SHIPS	
NAME	**OUT OF SERVICE SINCE:**	**NAME**	**OUT OF SERVICE SINCE:**
BRISTVA	Renamed “Zrmanja“	LOVČEN	1986
BOK	1985	BOKANJAC	1986
BRNA	1987	MEDUZA	in use
BANJA	2006	PN 20	Renamed “Kapetan Mrs“
BISAČE	1980	KORALJ	1986
VARAŽDIN	1985	ALGA	1998
JEZERO	in use		
SLAP	1982		
VRELO	1994		
UŠĆE	1974		
POTOK	1955		

There were 11 water carrying ships owned by those and other companies, in addition to 6 military registered water carrying ships (Table 1). Nowadays, there are only 3 commercially registered and one military registered water carrying ships left.

These types of vessels do not sail as liner ships on fixed routes. However, the trading area in the Adriatic is divided into four areas: the Kvarner area, Zadar area, Sibenik area and Split area.

The Kvarner area covers bigger islands like Cres, Losinj, Krk and Rab and a dozen of smaller islands like Unije, Srakane, Susak, Ilovik, Plavnik, Prvić, Grgur, Goli, Dolin etc. Islands Cres and Losinj have their own water supply from Lake Vrana. Their piping infrastructure satisfies the need of 90% of population. Island Krk also has its own water piping infrastructure mostly fed from wells across the island. Island Rab is connected to the shore water supply. Other smaller islands like Unije, Susak and Ilovik have their water tanks supplied by m/s Bocac, which is adequate for those islands due to their small population.

Zadar area covers bigger populated islands like Silba, Premuda, Olib, Pag, Vir, Molat, Ist, Ugljan, Pasman, Iz, Rava, Zverinac and Dugi otok. Only island Ugljan, Pasman, Vir and Pag have their water piping infrastructure connected to the shore supply and all the other islands depend on the water carrying vessel. Those islands are supplied by ship Zrmanja. The biggest consumer is island Silba with over 1000 tons of delivered water, followed by Veli Iz at island Iz, and Bozava and Sali at island Dugi otok.

At the Sibenik area, islands requiring water supply by ship are Kaprije, Zirje, Obonjan and national park Kornati, while islands Zlarin and Prvic are connected to the land water supply. This area is supplied by ship Bocac.

Most of the islands in the Split area like Hvar, Brac, Solta, Lastovo, Vis are connected to the land water supply and only islands Drvenik Veli and Drvenik Mali depend on water deliveries. That area is covered by ship Kapetan Mrs.

If we compare these four areas, it is noticeable that Zadar area has the largest number of islands which require water supply by ship. Also, according to the population census of 2011 [1] the supplied islands in the Zadar area have a population of 3295, the Sibenik area a population of 400, the Kvarner area population of 324, and the Split area population of 237. As it can be seen, the greatest need for water deliveries concerns the Zadar area, so this area will be analysed.

3. Technical characteristics of water carrying ships

The most important technical characteristic of this type of ships is protection of water hygiene. Water carried by a ship is directly transferred to household tanks to be used as drinking water. Decks, piping arrangements, hull and tanks have to be in good shape and condition. In order to achieve that, their tanks have a special coating. Apart from the coating, all cargo arrangements have to be regularly cleaned and inspected. Hygienic standards are to be fulfilled not only by the ship but also by the crew that is required to respect hygienic regulations.

In order to fulfil hygienic standards, cargo tanks protection can be divided in three types:

- Installation of plastic tanks inside the ship hull. While this is the best technique to maintain the required hygienic level, it is also the most expensive one.
- Tanks silicone coating is also one of the best ways to protect the cargo; however, it requires great care because it can be easily damaged during cargo tanks cleaning.
- Tanks epoxy coating. One of the most economic techniques to protect the tanks, but hardest to maintain. Coating has to be constantly checked for damages.
- Special care has to be dedicated to tank hatches that have to be air and water tight, thus to provide protection from air pollution and sea water contamination during bad weather.

Ship capacity depends on the ship operating area. As it can be seen, not all areas require the same amount of water and at this moment there are four water carrying ships of 200 to 1000 tons deadweight (Table 2).

Table 2 - Technical characteristics of currently operating water carrying ships [4]

SHIP NAME	ZRMANJA	BOČAC	KAPETAN MRS	MEDUZA
BUILT YEAR	1967	1955	1953	1956
SHIPYARD	BREMENHAVEN	KRALJEVICA	SPLIT	TROGIR
IMO no.	6729933	6405771	8846448	PT-71
CALL SIGN	9A2267	9A6196	9A2219	PT-71
HOME PORT	ZADAR	SPLIT	SPLIT	SPLIT
FLAG	CROATIAN	CROATIAN	CROATIAN	CROATIAN
LENGTH (m)	55,69	34	43,75	43,75
BREADTH (m)	9,4	7	7,9	8,2
DRAFT (m)	4,2	2,7	4,12	3,5
DEADWEIGHT (t)	942	255	400	350
ENGINE POWER (kW)	405	330	684	684
SPEED (kn)	10	5,5	10	10

Comparing ships' characteristics from table 2, mainly ships' deadweight, it can be seen that ships are adequately allocated to the most appropriate area of operation respectively. For example, m/s "Zrmanja" of the largest deadweight operates within the Zadar area where the water supply requirement is the largest one, while m/s "Bocac" with the smallest deadweight operates within the Kvarner area where the water supply requirement is the least.

4. Precipitation and water consumption analysis

According to all the data, the Zadar area requires the largest amount of water on its islands. In order to properly analyse water consumption, the analysis is divided in two parts. The first one concerns the precipitation analysis in the summer period from 1st June to 31st August and the second one refers to the number of water deliveries by ship.

The rainfall analysis at the Zadar area extends to the past four years (Table 3). In that period the following data were analysed: the amount of precipitations from 1st June till 31st August, the longest period between two significant precipitations (over 5 mm/m^2) and the total number of days without precipitations from 01st June till 31st August.

Table 3 - Precipitation data for the period from 1st June to 31st August from 2015 to 2018 [3]

Year	Precipitations from 01.06-31.08 (mm/m^2)	The longest period without precipitation (days)	Total number of days without precipitation from 01.06.-31.08
2015	103,1	31	91
2016	107,9	34	93
2017	33,5	17	89
2018	108,9	32	90

Data in Table 3 show that the analysed period from 1st June till 31st August records a small amount of precipitations, especially in the year 2017. However, the same year 2017 has the smallest period between two significant precipitations (over 5 mm/m^2). Usually, rain is collected on surfaces of around 100 square meters on the average (rooftops), which means that in selected periods the total amount of collected water is around 10 m^3.

Precipitation data show that the water collected from rainfall in the analysed period is not adequate and there is a great necessity for water deliveries by ship. Table 4 shows the data on water deliveries for the past four years in the Zadar area.

Table 4 - Number of water deliveries to the Zadar area islands from 2015 to 2018 [5]

	SILBA	PREMUDA	MOLAT	IST	IŽ	RAVA	ŽVERINAC	DUGI OTOK	Total
2015	9	2	4	2	8	2	1	7	35
2016	10	3	5	3	9	2	2	8	42
2017	8	2	4	2	6	1	1	6	30
2018	9	2	4	2	8	2	1	7	35

It can be seen that the number of deliveries in the analysed period averages around 35; when multiplied by ship capacity, it results in the amount of 32970 m3 of delivered water. To perceive the total problem, it is necessary to make a comparison between the data on precipitations and deliveries.

It is symptomatic and visible that the year with the largest amount of rain records the largest number of water deliveries, and the year with the smallest amount of rain records the smallest number of deliveries. This brings us to the conclusion that the total amount of rain is not of any crucial importance because the first day of summer can bring 100 mm/m2 of rain and the same amount of rainfall on the last day of summer. In total, these data result in an average of 200 mm/m^2 delivered to household water tanks; however, these tanks are limited in size and the period until next rainfall may be long. This brings us to the second vital information which concerns the number of days between two significant rainfalls. If the number of water deliveries is compared with draught periods, we can notice the link (Figure 1). Regardless of a small amount of rain, that rain was properly distributed throughout the analysed period which allows for regular topping up of household water tanks.

Also, the total amount of deliveries can be deceiving. If we compare the year 2016 with all other analysed years, it can be seen that all the islands had only one or maximally two water deliveries more than in all other years. In total, one delivery more per island results in the total amount increased by 8.

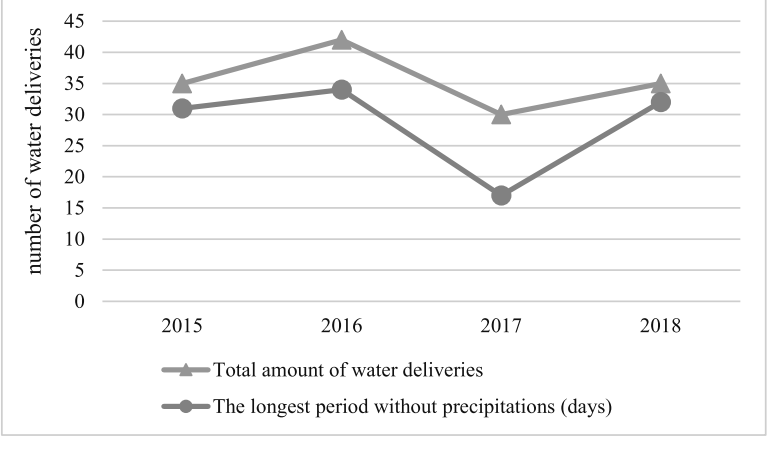

Figure 1 - Comparison of the total number of water deliveries and the number of days between two rainfalls

In order to avoid water shortages on the before mentioned island during summer periods, the following conclusions and recommendations can be made:

- It is of vital importance to follow the growth in the tourist/resident ratio on islands and to identify the highest one

- to record the island with the largest water reservoir and household tank reserves in the beginning of the summer as well as the largest capacity,
- to consult hydro-meteorological services for precipitation forecasts,
- to follow the number of days without precipitations,
- As soon as the number of days without precipitations exceeds 28, to record the list of water residues and plan water deliveries to avoid draughts,
- If the number of days without precipitations exceeds 32, all islands will require at least one extra water delivery.

5. Conclusion

The provided data and the analysis showed that the Zadar region islands, notwithstanding the largest population in comparison with other islands within the Adriatic region, lack in the water piping infrastructure. Having this information in mind, it can be concluded that water carrying ships will be needed yet for a long period. Also, the current water carrying ship is almost 50 years old and in a short period it will most probably lack in capacity and speed of deliveries. With a newer ship hygienic requirements would be easily fulfilled, the ship would have greater sailing speed and pumps with greater capacity. That would enable a larger number of deliveries per total period, even more deliveries per one day. In case the number of days without precipitations should increase, the current vessel performance might not be adequate to fulfil all water supply requirements and the consequences could reflect upon the tourist season which is basically the main source of income on islands.

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