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Floating Debris in the Low Segura River Basin (Spain): Avoiding Litter through the Irrigation Network

Carmen Rocamora [1,*], Herminia Puerto [1], Ricardo Abadía [1], Margarita Brugarolas [1], Laura Martínez-Carrasco [1] and José Cordero [2]

[1] Centro de Investigación e Innovación Agroalimentaria y Agroambiental (CIAGRO-UMH), Miguel Hernandez University, Carretera de Beniel km 3.2, 03312 Orihuela, Alicante, Spain; hpuerto@umh.es (H.P.); abadia@umh.es (R.A.); mbrugaro@umh.es (M.B.); lmartinez@umh.es (L.M.-C.)

[2] Department of Agro-Environmental Economics, Cartography Engineering and Graphic Expression in Engineering, Miguel Hernández University, Carretera de Beniel km 3.2, 03312 Orihuela, Alicante, Spain; jcordero@umh.es

* Correspondence: rocamora@umh.es

Abstract: The Vega Baja region lays on the lower course of the Segura River (southeastern Spain). It is one of the six traditional "*huerta*" European landscapes and has an ancient, extensive, and complex network of irrigation and drainage channels. The accumulation of floating waste causes numerous economic, environmental, and landscape problems in its irrigation infrastructures, hindering farmers' water management practices. This work classifies and estimates the total volume of floating waste at various points along the Segura River and its irrigation channels as a first systematic approach to define and quantify the problem of floating waste accumulation. Aerial images taken by a drone were analyzed over time and a manual count of residues was performed on selected points. The results obtained show that reeds and residues of riparian vegetation represent more than 95% of the floating debris volume measured on the riverbed. Anthropogenic waste, which represents less than 5% of debris volume, was characterized, finding that plastics of domestic sources are the most abundant by count (14.9%) and only a reduced part of the floating waste can be attributed to agricultural activities (3.8%). Assessing the type and origin of the floating waste is essential to inform the actions required in order to avoid the floating waste reaching the Mediterranean Sea.

Keywords: debris; irrigation channels; river; floating residues; plastic waste

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Citation: Rocamora, C.; Puerto, H.; Abadía, R.; Brugarolas, M.; Martínez-Carrasco, L.; Cordero, J. Floating Debris in the Low Segura River Basin (Spain): Avoiding Litter through the Irrigation Network. *Water* **2021**, *13*, 1074. https://doi.org/10.3390/w13081074

Academic Editor: Jenn Kai Tsai

Received: 15 March 2021
Accepted: 10 April 2021
Published: 13 April 2021

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1. Introduction

The image of piles of garbage and waste in water bodies and coastal areas is unfortunately common in many parts of the planet. These garbage accumulations usually contain plant debris, but also anthropogenic residues, among which plastics are an important fraction.

There is abundant literature regarding the presence of plastics and other waste in the seas and oceans, both in the open sea and in estuaries and coasts [1–9], and in lakes [10–12]. It is broadly accepted that 80% of marine litter has land-based sources, such as urban and storm runoff, sewer overflows, littering of beaches, and inadequate waste disposal and management. In investigations where the composition of the waste has been reported, plastic is the most frequent form of litter [2,4,6–9,13,14].

The presence of waste in water bodies is a problem in itself. Aquatic animals are damaged by plastics through entanglement or ingestion [15–20]. Marine litter provokes economic impact on fisheries and aquaculture, shipping, and ports [21,22]. The presence of plastic debris causes loss of touristic value of beaches, lakes, and other landscapes [4,23–26]. Besides this, marine litter is a vector for the transport of chemicals and biota [22], and plastics present in the sea or on beaches degrade, resulting into microplastics that cause damage to marine fauna [27].

Most of the plastic waste found in the seas and oceans originates from the mainland [27,28] and is transported to the sea by rivers [3,29].

Recently, there is an increasing number of papers that have focused on the evaluation of plastic debris in rivers. Gasperi et al. [30] drew attention to the importance of taking into account the floating debris globally to address environmental issues related to plastics. Some evaluations of the quantity and quality of floating plastics in rivers and estuaries have been carried out such as those reported on the Seine (France), on the Thames and on the Tamar Estuary (United Kingdom), in the Ombrone river (Italy), and on the Danube [3,29–32]. The situation of rivers beyond the European continent has also been reported [33–37]. Jang et al. [38] identified main points of accumulation of floating debris in the Nakdong River Basin (South Korea), concluding that accumulations closest to the mouth are at significant risk of reaching the ocean if not properly collected.

Suaria et al. [5] reported that natural debris were more abundant than artificial litter in most surveyed locations on the Black Sea, probably due to the proximity of the Danube delta. Plastic items were the most abundant type of litter; 89.1% of all artificial items. Ali and Shams [4] reported that plastic waste represented 50.5% in number of litter items, but only 19.9% in weight on Clifton Beach (Karachi). In marine debris reported worldwide, plastics are the most abundant waste per number of items [19].

The transport of plant debris such as reeds and branches along the rivers to the sea is a natural phenomenon and does not represent a pollution risk, in contrast to anthropogenic waste. However, large vegetable debris can pose a hazard to river navigation and electricity generation [37], and the design of diversion devices to remove large debris in order to protect inlets and other structures such as turbines, hydropower plants, or bridge piers has received significant attention [39–41].

The problem of plastic waste and vegetal debris accumulation has been described in natural environments such as rivers, lakes, seas, and oceans, but little information is available regarding the effect of this floating litter on artificial surface irrigation infrastructures.

Case Study Description

The Vega Baja region is located on the lower course and floodplain of the Segura River in southeastern Spain—it encloses one of the six traditional "*huerta*" artificial landscapes in Europe [42]. The Vega Baja *huerta* is the largest and most complex of the three *huertas* in Spain, with the widest irrigation and drainage network [43]. The irrigation infrastructure of this centuries old *huerta* ecosystem is formed by an extensive network of irrigation channels and drainage ditches characterized by scarce slopes and a reutilization system of drainage water, "dead waters", which allow for irrigation of land at lower altitudes towards the river mouth, with drainage waters from upper areas.

The Segura River shows a heavy infestation of the invasive giant reed (*Arundo donax*, L.) along its middle and lower course [44]. There are ongoing efforts to eliminate this invasive species, for instance, the river authority performs selective cuttings of giant reed stands periodically. The cuttings are usually deposited on the banks and are transported by the river when its flow increases.

Debris from reed cuttings accumulate at certain points of the riverbed, forming a characteristic reed and mud build-up that hinders the natural river discharge. At these points, plant residues favor the accumulation of other garbage, mainly plastics, expanding their negative effects.

Floating items of a certain size in the river cause trouble in irrigation infrastructures such as obstruction of the irrigation channel intakes. If these floating debris accumulations make it through the irrigation channels, they hinder the farmers' water management and impede ordinary irrigation operations.

At present, there are no studies about the importance and the economic costs of debris removal.

At the irrigation channel level, the irrigators' communities that own the irrigation channels are responsible for their maintenance and they have the duty to keep the channels clean and clear. Since drainage channels discharge drainage waters into the river, the river authority can compel the irrigators' communities to install retention elements and can impose sanctions if waste reaches the river through these drainage channels.

There are numerous references in the local press to the situation of the river and the irrigation and drainage network. Public opinion is sensitized to the subject and sometimes holds the irrigators' communities socially accountable for the incidence of floating debris. Thus, floating debris that invade the entire water transport system on the Segura River are causing environmental, social, and economic problems whose solution requires a multidisciplinary approach. Although the presence of waste in the river and channels is a years-long problem, it is only recently that it has been subject to public debate.

The objective of this paper is to quantify and characterize the floating residues found in the final section of the Segura River and assess their effect on the traditional *huerta* irrigation system. A methodology is proposed as a first approach to quantify and characterize the floating debris by means of aerial photography and manual recording and classification of debris extracted in the irrigation and drainage channels. This information will help assess the proper actions that need to be taken in order to eliminate floating litter build-up in the irrigation and drainage channels and the population that should be addressed by these actions.

2. Materials and Methods

2.1. Description of the Studied Area and Location of Litter Accumulation Areas/Points/Stretches

The region of Vega Baja del Segura is located in southeastern Spain, in Alicante province, along the lower course of the Segura River (Figure 1). The area comprises 27 municipalities from Orihuela, at the province limit, to Guardamar del Segura at the river mouth. The whole region is a great alluvial plain of 42,739 hectares, of which 38,085 are cultivated in irrigated land and 4654 ha in dry land. The surface under traditional irrigation reaches 23,391 hectares, which is 55% of the agricultural area of the entire region [45].

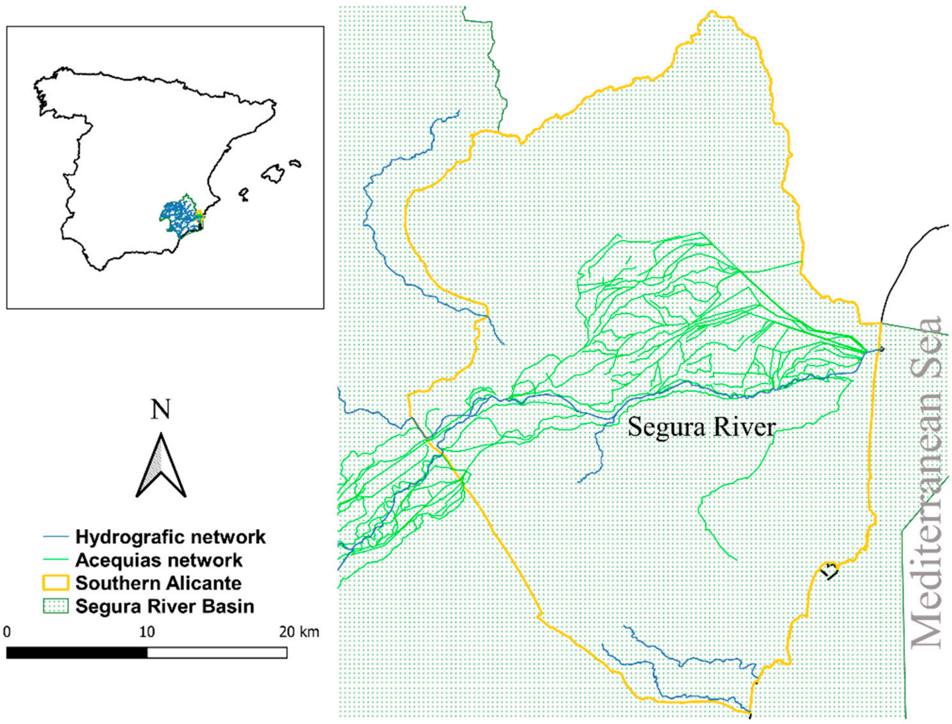

Figure 1. Location of the study area and delineation of the irrigation infrastructure of the Low Segura River Basin at the southern Alicante province.

The traditional irrigation system that has been developed in this area since Roman times consists of a complex system of irrigation and drainage channels that take water directly from the river Segura through small dams located on the river bed, called *Azudes*, which divert water to irrigation channels called *Acequias*, which are responsible for distributing water to the fields. The excess irrigation water is collected in drainage ditches, called *Azarbes*, which in turn are used as irrigation channels when they reach a sufficient height over the fields. The low slope of the plain, less than 1 per 10,000, hinders greatly the land's natural drainage.

In the decade of 1990, channeling works were carried out in several stretches of the river throughout the area. Near the mouth, the Segura River was channeled to the south of the original stretch, but the last section of the old river was maintained to facilitate the drainage of the lands on the north margin of the river.

For the purpose of this work, we selected 8 litter accumulation points along the river where floating retentions occur, either because of the presence of dams, or because of the installation of retention elements (Figure 2). Two accumulation points were selected on the irrigation infrastructure, one located on an irrigation channel and the other one located in a drainage ditch. In both cases, there was a syphon in the intersection with other channel where waste accumulates. Finally, the floating screen at the mouth of the river was chosen as the last accumulation point.

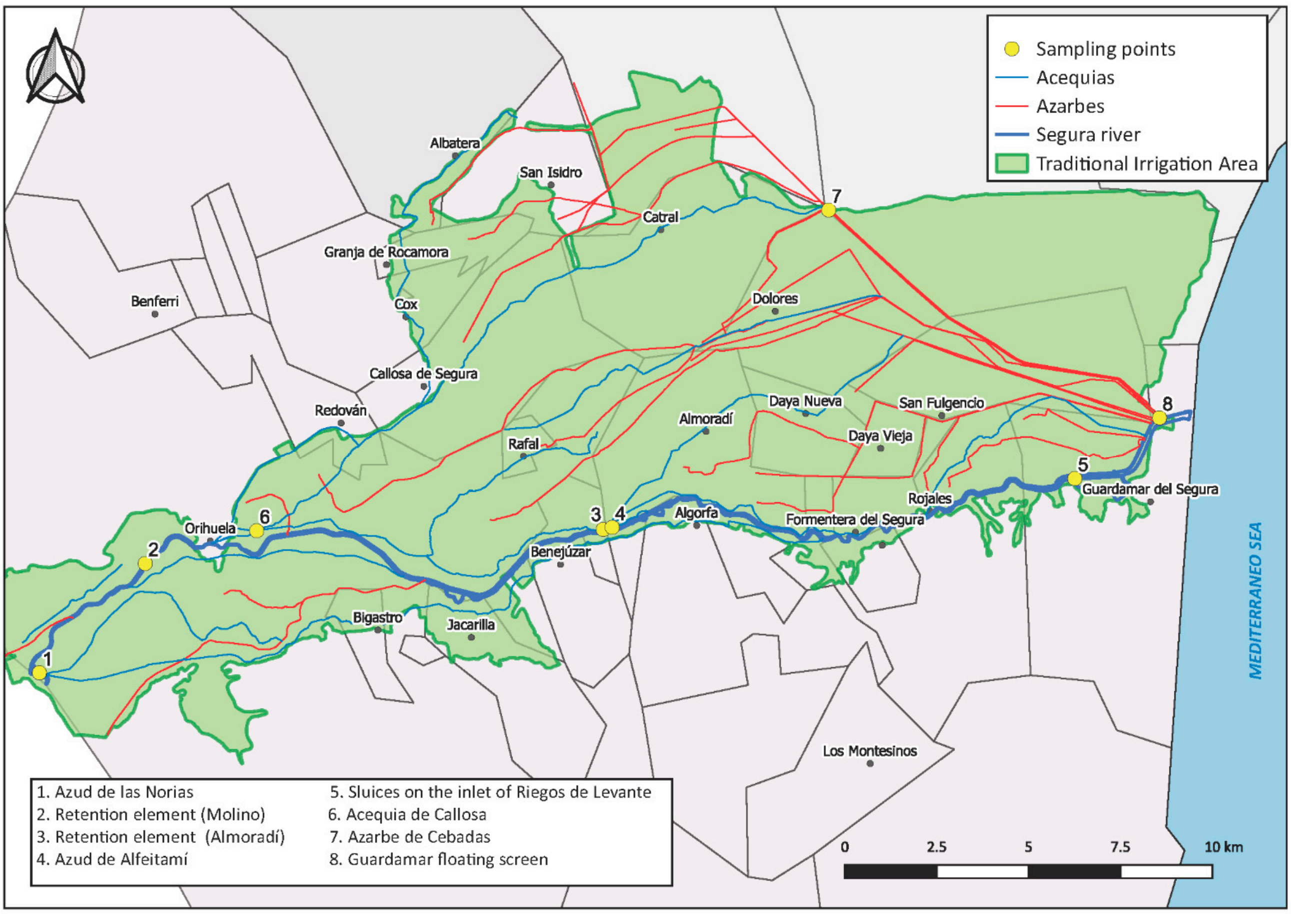

Figure 2. Traditional irrigation area along the lower course of the Segura River. The names correspond to the municipalities in the area. Yellow dots correspond to the sampling points locations as described in the text. *Acequias* correspond to irrigation channels while *Azarbes* correspond to drainage ditches.

The sampling points are shown in Figure 3 and described in Table 1.

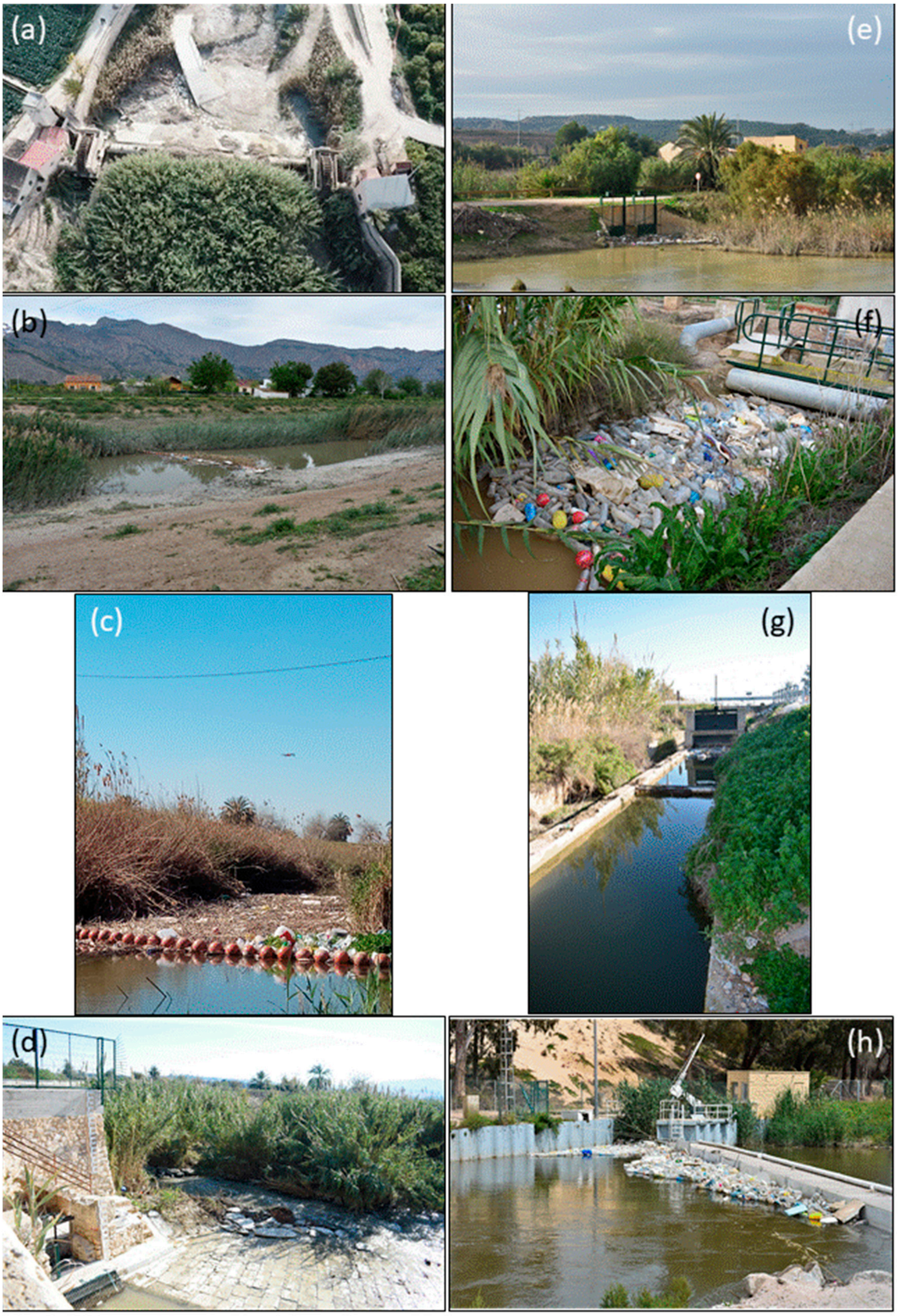

Figure 3. Sampling points. ID1, *Azud de las Norias* (**a**); ID2, boom at the *Molino de la Ciudad* (**b**); ID3, boom at Almoradí (**c**); ID4, *Azud de Alfeitamí* (**d**); ID5, inlet of Riegos de Levante (**e**); ID6, *Acequia de Callosa* (**f**); ID7, *Azarbe de Cebadas* (**g**); and ID8, Guardamar floating screen (**h**).

Table 1. Identification and description of the sampling points depicted in Figure 2.

ID1	*Azud de las Norias*. At that point there is a dam to derive water. It is the first singular point of the river in the Vega Baja district and thus in the province of Alicante.
ID2	Boom at the *Molino de la Ciudad*. Retention element installed by the Segura River Authority.
ID3	Boom at *Almoradí*. Retention element installed by the Segura River Authority.
ID4	*Azud de Alfeitamí*. It is a dam to derive water to the ditch of Almoradí.
ID5	Sluices on the inlet of *Riegos de Levante* irrigators community.
ID6	*Acequia de Callosa*, syphon at the crossing with *Acequia Vieja de Almoradí*.
ID7	*Azarbe de Cebadas*, syphon at the crossing with *Azarbe del Convenio*.
ID8	Guardamar floating screen. It is a retention system installed at the mouth of the old river to avoid the arrival at sea of floating debris that comes from the drainage ditches that discharge on the left bank into the last section of the river.

2.2. Sampling Methodology and Measurements by Image Analysis

The surface area of the river or the channels occupied by floating debris at the 8 selected points described above was assessed by means of aerial overhead photography.

The photographs were taken from a sufficient height for the spot of floating debris to be captured in a single image. In each image, a ranging rod was photographed along the debris for scale determination. Other images were captured from lower heights to obtain better images for the waste characterization (Figure 4).

Figure 4. Zenith images captured from the drone: general (**a**) and details (**b**,**c**).

Measurements were taken on 22 January, 25 February, 8 April, 6 May, and 1 July 2019. The dates were influenced by the authorities issuing flight permits.

Zenith images were taken using a drone. Drone type was a DJI MAVIC PRO with a weight of 743 g, three-axis stabilization, inclination of −90° to +30°, and rotation of 0° or 90° (horizontal and vertical). The camera had a 1/2.3″ CMOS sensor; 12.35 effective Mpixels (total: 12.71 Mpixels), and a 26 mm lens (35 mm format equivalent) f/2.2 FOV 78.8°.

ImageJ software, based in the software NIH Image, developed by National Institutes of Health of the United States (https://imagej.net (accessed on 4 February 2019)), was used for image analysis.

The scale factor for each photograph was determined with the help of the measure of the ranging rod. The photo scale was entered using the Analyze > Set scale option. The contour of the floating debris was determined by a freehand selection and the surface occupied by the Analyze > Measure option.

For the characterization of floating waste, we defined 11 categories and subdivided them into groups. The number of floating residues of each group was manually counted. We used "multipoint" function of ImageJ software to count the elements that are thus marked with correlative numbers. A different counter was used for each category detailed in Table 2.

Table 2. Waste categories and classes.

	Category	Classes
1	Vegetal material	Reeds, branches, algae, fruits, and vegetables
2	Dead animals	Wild animals, domestic animals, livestock
3	Beverage containers	Water bottles, soft drinks bottles, water cans, soda cans
4	Plastic household containers	Oil bottles, plastic cups and plates, food containers, empty bags, plastic sheeting, full garbage bags, personal hygiene products containers, cleaning products containers
5	Other household containers	Tetrabricks, canned cans, aerosols
6	Industrial waste	Packaging of motor oil and automobile products, rubber, manufactured wood
7	Other materials	Textiles, footwear, balls, toys, paper, and cardboard
8	Others	Medication boxes and blisters, lamps, gas bottles, etc.
9	Glass containers	Glass bottles of beer, wine, liquor or soft drinks, food jars, cosmetic jars
10	Agricultural containers	Cans and bottles of phytosanitary products, fertilizer bags and boxes
11	Other agricultural waste	Transplant trays, drip irrigation pipes

2.3. Manual Counting of Litter

Aerial photography makes it possible to measure the surface occupied by residues at each selected accumulation point and to count the objects of each type that can be distinguished in the surface layer. It is necessary to contrast these results and relate them to the volume of floats and their mass, as well as to make a count of all the retained objects, not only those visible in the aerial photography.

A mechanical extraction of waste was performed in each channel. The extraction for calibration was performed by means of construction machinery in ID6 and with manual means such as nets and hooks in ID7. The waste was spread on the floor, counted, and sorted. Objects less than 3 cm were not considered as they are not retained by extraction means. Manual counting was compared to image analysis counting, performed as described above.

Volume of reeds and non-vegetal waste were estimated from the measured area occupied by reeds and other waste, respectively. Data obtained in the extraction in ID6 was used for these estimations, except for the sampling point ID7, located at a drainage ditch, where only non-vegetal waste was found, and data obtained in the extraction at the same point were used for the estimations of volume. A similar procedure is described in [46] for estimating the litter-covered area over a beach.

Although reeds are very abundant on the riverbank, they are not frequently found in channels. However, after episodes of heavy rain, the reeds can go through the intake of the irrigation channels. In April 2019, a heavy rainfall occurred in Orihuela and, as a result, a large number of reeds accumulated at point ID6 in the following weeks. This circumstance allowed us to compare the area of reeds measured by image analysis with the volume and weight of reeds measured in the extraction made in May.

2.4. Classification of Litter

Waste categories were defined on the basis of the most likely material, use, and origin. For this purpose, the type of waste observed in the previous visits to the accumulation points was taken into account, as well as classifications referenced in scientific publications. The list published in Guidance on Monitoring of Marine Litter in European Seas [47] helped in defining the waste classes. However, many items in this list correspond to articles found at the seashore that do not come from river channels, such as fishing gear and beach items. The document Floating Macro Litter in European Rivers—Top Items [48] presents lists of the most frequently found items in European rivers, particularly in the rivers of the Mediterranean basin.

A χ^2 test was performed to assess if there were differences in the proportions of the waste classes found in ID6 and ID7, both on a volume and weight bases. This kind of test was also applied for the results of the repeated measures of waste classes in all the sampling points located in the river and channels.

3. Results

3.1. Debris Volume

Volume of reeds and non-vegetal waste are displayed in Figure 5. The total debris volume shown in Figure 5a presents different trends along time depending on the sampling points. In general, the prevalence of reeds debris (Figure 5b) heavily influenced the trend of the total debris volume. On the riverbank (ID1, ID2, ID3, ID4, and ID5), reeds represent the most abundant type of debris. Area occupied by reeds was higher than 85%. Volume could be even higher since the plastic waste was often on a layer of reeds. Estimated weight of plant debris on these sampling points was over 98% of total debris weight.

Point ID6 is located in an irrigation channel, where the quantity of reeds is usually low. However, after heavy rains in April 2019, a large number of reeds dragged by the river entered the irrigation channel and accumulated at this point.

Point ID7 is in a drainage ditch, where it is rare to find reeds and almost all of the waste is of non-vegetable origin.

Point ID8 is located at the mouth of the old riverbed, at the end of a short section with riverbank vegetation where a large number of drainage ditches run down the left bank. Most of the floating debris were non-vegetable waste, but there is also a considerable number of reeds (Figure 6).

In mid-March, the river authority carried out a floating debris cleaning in ID2, ID3, and ID8; this cleaning is shown in Figure 5a,b as there is a big drop in the volumes observed.

The trend in ID1 is quite different from the rest of measuring points. ID1 is a shallow weir that is able to retain the floating waste when the river water levels are low but not when water levels rise. The sharp increase of debris volume between 30 March and 15 April was mostly due to the transportation of reeds along the river caused by a 17 mm precipitation on 31 March. The reduction of the observed debris volume was attributed to a more abundant precipitation of 51 and 55 mm in 19 and 20 April 2019, respectively, that increased the river water levels and transported the reeds downstream.

Figure 5. Estimated volume of debris at sampling points on the riverbank (**continuous lines**), channels (**dashed lines**) and floating screen (**dotted line**): total debris volume (**a**), volume of reeds at sampling points on the riverbank (**b**), non-vegetal residues on the riverbank and channels (**c**).

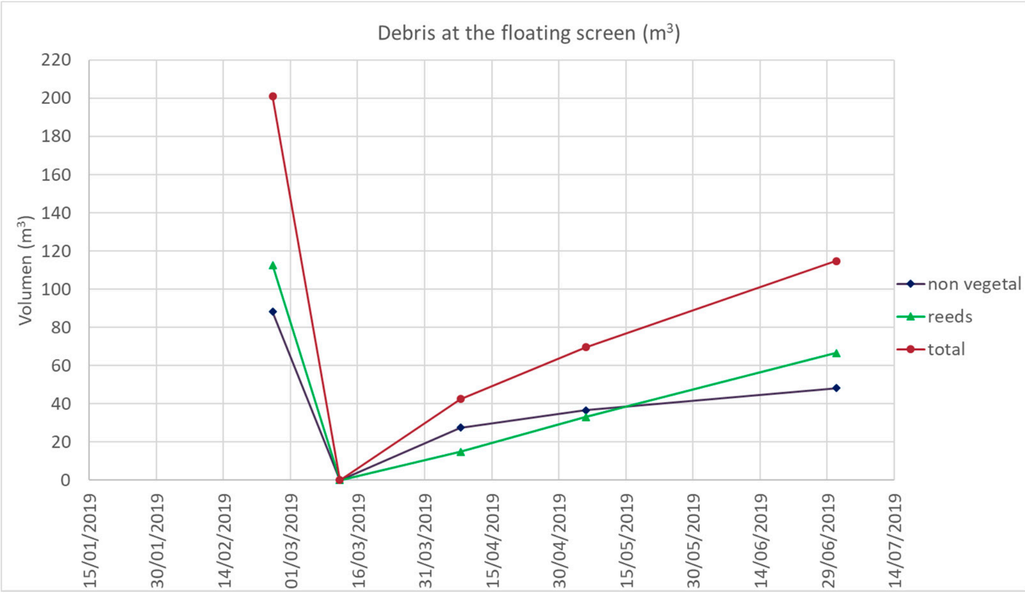

Figure 6. Estimated volume of debris at the floating screen, ID8.

This downstream transport can also be at the origin of the sharp decrease of non-vegetal residues volume shown in ID2 and ID4 of Figure 5c.

ID3 values in Figure 5 span from the beginning of measurements until 8 April when the boom across the river was removed and no more measurements were possible.

Figure 6 shows a more detailed trend of floating debris accumulation at ID8, the floating boom located at the mouth of the Segura river. The cleaning of the boom by the river authority caused the well-defined decrease observed at the end of March. From that date onwards, the accumulation of floating debris increased continuously along time, without noticing the effect of the April precipitations.

3.2. *Waste Characterization*

Table 3 shows the weights and volumes of different categories measured after classifying the waste extracted in points ID6 and ID7.

Table 3. Weights and volumes of waste extracted for calibration at sampling points ID6 (syphon at *Acequia de Callosa*) and ID7 (syphon at *Azarbe de Cebadas*).

		ID6		ID7	
	Category	**Volume (m^3)**	**Weight (kg)**	**Volume (m^3)**	**Weight (kg)**
1	Vegetal material	7.5	3000 [a]	0.02	0.05
2	Dead animals	0.2 [b]	50 [b]	-	-
3	Beverage containers	2.3	41.41	0.23	7.41
4–8	Plastic household containers, other household containers, industrial waste, other materials, others	1	79.76	0.06	7.2
9	Glass containers	0.6	89.8	0.04	15.5
10	Agricultural containers	0.5	17.21	0.05	4.54
11	Other agricultural waste	1	14.52	0.1	10.28

[a]: approximate weight [b]: estimated values.

Four dead animals (category 2) were found at ID6. Three of them were wild animals whose habitat is the river (a duck and a carp) or that could accidentally fall into the channel (a hedgehog). However, a lamb was also found, which can be considered a residue of livestock activity. These animals were not visible on the zenith images at ID6. On the contrary, several dead animals were seen on images captured at the Guardamar floating screen (ID8). Waste extraction at this point was not viable. However, these animals were apparently goats, that is, waste originating from livestock farming.

A large number of bottles and water drums (category 3) were counted, which occupied between 41% and 48% of the total volume of non-vegetable waste, and a weight close to 15%. This waste was separated from other household waste because the use of this type of packaging is universal, cannot be identified with any segment of the population, and cannot be associated with an economic activity.

The weights and volumes of objects in categories 4 to 8 were measured together. It is in all cases domestic waste. Even products classified as industrial waste were cans of motor products commonly used by the population and they do not necessarily come from a workshop. This set of categories represented between 13 and 15% of the total volume of non-vegetal waste.

Agricultural waste corresponds to categories 10 and 11, basically consisting of containers of phytosanitary products and transplant trays. They represented approximately 30% of total non-vegetal waste volume.

Glass containers, mainly 1 L beer bottles, represented approximately 10% of the total volume of non-agricultural waste.

Items of category 7 were found at ID6. Among them there was a significant number of balls.

Other residues were found, such as medication boxes and blisters, syringes, lamps, lighters, and a 1.8 kg camping butane bottle.

The results of the χ^2 test applied to the distribution of floats extracted in ID6 and ID7, on a weight basis (Table 3), showed that there were very significant differences ($p < 0.01$) in the proportions of the extracted items between the samples obtained in both places. The same analysis performed on a volume basis showed no statistically significant differences.

Table 4 shows the results of the characterization of residues through image analysis and manual count after the extraction at points ID6 and ID7.

Table 4. Results of count of items of different categories in accumulation points ID6 (syphon at *Acequia de Callosa*) and ID7 (syphon at *Azarbe de Cebadas*) by image analysis and after extraction of waste.

		ID6		ID7	
	Category	**Image Analysis**	**Extraction**	**Image Analysis**	**Extraction**
1	Vegetal material	[a]	[a]	[a]	[a]
2	Dead animals	0	4	0	0
3	Beverage containers	238	646	67	112
4	Plastic household containers	53	326	18	31
5	Other household containers	6	37	5	15
6	Industrial waste	0	15	0	4
7	Other materials	8	107	0	4
8	Others	0	47	0	3
9	Glass containers	11	184	11	31
10	Agricultural containers	17	50	7	11
11	Other agricultural waste	27	[b]	25	[b]

[a] The quantity and characteristics of the vegetal material found, made up entirely of reeds, made it impossible to count. [b] In the extraction, the transplant trays were broken into innumerable fragments; their weight and volume were recorded.

The same χ^2 analysis was applied to the proportion of objects in each category counted in ID6 and ID7 (Table 4). Again, in this case, the differences between the proportions of the different classes showed statistically very significant differences ($p < 0.01$).

Images obtained at the selected sampling points throughout the study were analyzed. Table 5 shows the results of the counts by image analysis of elements in each category at different points and dates.

Table 5. Result of counting by image analysis of elements at different points and dates.

	Date	Water Plastic Bottles (1.5 to 2 L)	Water Plastic Drums (5 to 8 L)	Personal Care and Cleaning Product Containers	Cans, Tetrabricks, and Other Household Containers	Full Garbage Bags	Other Materials (Balls, Shoes, Toys)	Glass Bottles	Cans and Bottles of Phytosanitary Poducts	Transplant Trays and Fragments
ID1	25/02/19	14	2	8	3	0	5	2	0	0
ID1	06/05/19	8	1	3	0	0	1	0	0	4
ID1	01/07/19	7	1	2	0	0	1	1	1	0
ID2	25/02/19	42	4	4	7	0	1	4	6	2
ID2	06/05/19	51	4	2	0	2	0	0	1	5
ID3	08/04/19	109	0	18	0	0	1	6	2	5
ID4	08/04/19	35	2	9	15	4	2	6	5	10
ID4	06/05/19	10	6	3	0	0	1	7	3	0
ID5	06/05/19	63	7	4	3	0	1	1	6	9
ID6	25/02/19	56	0	9	2	0	2	0	2	4
ID6	06/05/19	214	7	10	3	1	8	12	8	22
ID6	24/05/19	112	11	13	10	0	3	10	3	25
ID6	01/07/19	36	0	3	10	0	6	3	0	0
ID7	25/02/19	191	12	6	13	0	1	0	5	18
ID7	08/04/19	39	2	9	15	4	2	6	6	17
ID7	06/05/19	2	0	0	1	0	0	0	1	1
ID7	01/07/19	65	7	10	9	2	0	10	6	16
ID7	08/07/19	58	8	9	11	1	0	11	5	20
Sum counted objects		1112	74	122	102	14	35	79	60	158

According to the number of elements of each class, the most numerous class of waste is made up of 1.5 to 2 L bottles and 5 to 8 L drums of bottled water and soft drink cans (category 3), which represent on average 74.2% of the total number of elements counted. These items belong to the same category stated in Table 2, but they are separated in two columns since they differ significantly in size and also in the number of objects counted. The vast majority of items in this category were 1.5 to 2 L bottles. The number of containers, plastic or not, of purely domestic origin (food, personal care, and cleaning products containers) represented 14.9%. The number of agricultural waste items, that is, bottles and cans of phytosanitary products, represented only 3.8% of elements counted at the sampling points.

Transplant trays appeared broken into a large number of fragments. In the counts, both whole trays and pieces of sufficient size to be identified were added. The number of tray pieces counted cannot be considered since the surface was not measured and the equivalent number of whole trays present cannot be known. For these reasons, the percentages of items reported above were calculated over a total of 1598 items.

For the analysis of the proportions of items of each category counted at different sampling sites (Table 5), we applied a Shapiro–Wilk test that showed that the data were not normally distributed. Therefore, we applied χ^2, a non-parametric test. We pooled together the river locations, ID1 to ID5, and the irrigation infrastructure locations, ID6 and ID7, obtaining the average of all sampling sites and dates. The χ^2 test result showed us that there were no differences (p = 0.94) in the proportion of residues classes found in the river and in the irrigation channels. However, the number of counts was not enough to draw conclusions in this regard.

Throughout the study, large accumulations of reeds were observed on the shore at various points in the river. Occasionally the river authority cuts reeds, which are left aside on the shore. When heavy rain occurs and the water level rises, these reeds are carried away by the river flow. Part of them reach a retention boom located downstream, but others are held in meanders or other points in the river. In the final section of the river, downstream from Rojales, which was widened in the 1990s, the riverbed is very wide, 60 to 70 m, and a large part is overgrown with reeds and tamarisks. In this stretch, large accumulations of reeds have also been observed, on which other residues are piled up, especially plastics. It is therefore difficult to estimate the total volume of debris that is transported to the sea through the river.

Unfortunately, we also verified the presence of large appliances in the riverbed, such as a TV set and a refrigerator, as well as pieces of furniture, which shows that for some people the river is nothing but a landfill.

3.3. Economic Appraisal of Yearly Waste Removal

In order to determine the economic cost of waste removal to the irrigators' communities, we estimated the volume of floating waste that would accumulate yearly in the *Acequia de Callosa* syphon (ID6) and at the river screen that collects the discharge of all the drainage ditches at Guardamar (ID8).

The yearly volume estimated at the *Acequia de Callosa* was 54 m^3. The irrigators' community that is in charge of that channel needs to clean it up several times a year. For instance, during the period of study, two cleanings took place, on 26 January and on 24 May 2019.

The cleaning of these channels requires the use of construction machinery for extraction and evacuation of the waste to landfill. The presence of phytosanitary produce containers makes it compulsory to dispose of the extracted materials as hazardous waste, which increases the costs of disposal. Prices for delivery to an authorized manager of hazardous waste of a 1.0 m^3 container with glass, plastic, and wood that contain or are contaminated by hazardous substances were collected form a specialized web in Spain [49]. The price of dumping fees, not including the container or transport, was found to be EUR 153. The transportation of a 1.0 m^3 hazardous piece of waste to a specific landfill or waste recovery or disposal center, including delivery, rental, and on-site collection service of the container, was found to be EUR 132.60. The yearly economic cost of cleaning was assessed between EUR 8308 and 15,454 for the *Acequia de Callosa* syphon (ID6) and between EUR 87,975 and 164,220 for the screen at Guardamar (ID8), considering that the transportation to the waste disposal center was made by own means or has to be hired, respectively. In the case of the *Acequia de Callosa*, this cost represents between 4.1 and 7.6% of the budget of the irrigators' community.

The river authority requires the irrigator communities to install floating retention grids to prevent floating debris from going back to the river through the drainage ditches, warning that otherwise the works will be carried out by the administration in a subsidiary way and the costs will be passed on to the irrigator's communities. The river authority also has the power to impose penalties to the irrigators' communities, but thus far have not come to that.

Both the cleaning costs and the cost of installation of retention grids are expenses that the irrigation communities have to pass on to their partners, the farmers, who are the ones who ultimately have to bear the costs.

The massive flow of floating debris through the river is also a source of conflict between the authority and the irrigation communities. The cleaning of the river is the responsibility of the river authority since it is the public hydraulic domain. However, if the river is not kept clean, the floating debris passes into the irrigation channels and in some cases prevents the water from passing. This is detrimental to irrigators who, however, cannot access the riverbed to unclog the intakes of the irrigation channels under penalty of being fined.

On the one hand, the river's authority does not keep it clean and the floating waste passes from the river to the irrigation channels. On the other hand, the irrigator communities are forced to keep their channels clean and not to let pass floating waste into the river.

Irrigation water management in this context is difficult since the agents involved have very different perceptions of the origin of the problem and the responsibilities. The problems caused by floating debris require a solution that must be agreed between the stakeholders.

4. Discussion

The results show that the volume of reeds is the main component of floating debris on the riverbed. Estimated weight of plant debris on these sampling points was over 98% of total debris weight. These numbers are similar to the results reported [30] for the Seine River, where plant debris represented between 92.0% and 99.1% of total debris by weight.

Floating debris found in drainage ditches are almost exclusively anthropogenic waste. This is favored by the drainage ditches running parallel to roads and pathways and their lower altitude, this makes it easy for any waste thrown on the road to be windblown to the ditch.

The two locations of the irrigation infrastructure, the ID6 and ID7, that were particularly prone to floating waste accumulation are syphons, that is, a U section where irrigation water flows downwards, filling the whole section of the syphon, and then upwards to the following reach of the channel. The floating waste is retained at the upstream side of the syphon as long as the water keeps flowing. When the irrigation shift changes, the water level in the channel reduces gradually and the floating waste is carried into the lower part of the U section. When the new irrigation shift resumes, the waste flows downstream to the following accumulation point. This irrigation dynamics, characteristic of surface irrigation districts, makes it difficult to assess the effects of waste accumulation on the irrigation infrastructure. Another reason is that, as soon as the person in charge of the irrigation channel realizes that the accumulation of waste reduces the channel discharge, they proceed to the extraction, and thus it is not easy to make an estimate of the reduction in flow caused by the floats and even less a correlation between the volume of floats and the flow of the ditch.

The dynamics of the reed accumulation in the river depends on the type of barrier. Floating booms across the riverbed generate increasing accumulations over time that need to be periodically cleaned. This is the case for ID2, ID3, and ID8. On the other hand, accumulations of waste in weirs and dams are sensitive to river flooding, in which the water drags much of the waste downstream, such as in ID1 and ID4.

The Guardamar floating screen, ID8, is a safe defense to prevent the arrival of plastics into the sea because the retention of floating solids increases through time and is not reduced by heavy rainfall episodes.

The fact that reeds are the biggest part of the floating debris causes no problems to the environment. However, the presence of plastics has important consequences in hindering the irrigation water management at the drainage ditches and the accumulation of plastics at the river mouth poses a hazard to maritime life if they are not periodically removed.

Between 41% and 48% of the total volume of non-vegetable waste was made up by bottles and water drums. This waste can come from household garbage, farmers, walkers, sportspeople, workers, or anyone who discards a bottle of water. Therefore, it cannot be associated with a certain type of human activity, and in particular it cannot be associated with agricultural activities.

Though the layperson's perception is that most of the litter comes from agricultural activity [50,51], the results obtained in our area closely resemble those found in South Korea by Jang et al. [38]. They found that 70% of the floating debris consisted of plant debris, 23.4% were household waste, and only 4.5% had an agricultural origin, while a proportion of 90% of natural debris and only 5% of plastic debris in the Three Gorges Reservoir Area (China) was reported [37].

Since the Vega Baja is largely an agricultural area, it could be expected that the waste from agricultural activity would be predominant. On the contrary, the number of agricultural waste items, that is, bottles and cans of phytosanitary products, represented only 3.8% of elements counted at the sampling points.

It is striking that the number of containers of domestic origin of food, personal care, and cleaning products containers represented 17% of the number of items counted in the extractions. This fact, along with the presence in the riverbed of large appliances, such as a TV set and a refrigerator, as well as pieces of furniture, showed that some inhabitants take the river as a sewer.

The irrigator communities, as managers of the irrigation water [52] and infrastructure, have to bear high cleaning costs when the volume of debris prevents the passage of water through the irrigation channels. The payment of penalties to the river authority for the presence of waste in the drainage ditches aggravates the economic problem of the irrigators' communities. Although the economic cost of the cleaning of channels and ditches does not seem to be very high, it adds up to the increasing cost of inputs and labor, reducing the already low returns of the agricultural activity. In addition, the discussion about the responsibility of the farmers in the dumping of waste and the fact that the river water carries debris that passes into the ditches generates conflict between the irrigation communities and the river authority, which is detrimental to proper water management in traditional irrigation.

The problem of the floating waste accumulation in the Segura River requires a multi-sectoral approach. In April 2019, a focus group discussion was carried out on local premises with the participation of Vega Baja stakeholders in order to debate about the presence of floating waste that reaches the watercourses, the problems they generate, as well as the possible solutions [53]. The most prominent problems stated by stakeholders were economic (costs generated, loss of value, etc.) and environmental and landscape (pollution, effect on fauna and flora), but also public health, social (conflicts over responsibility for the waste spill and its management), and legal (obstacles, sanctions, and lack of identification of competencies) problems were referred.

The results obtained in this stakeholder focus group showed that they have a well-suited perception of the causes of the floating waste accumulation problem. This experimental work was able to assess and quantify the magnitude of the problem.

5. Conclusions

The estimate of the volume of floating debris in certain sections of the river or channels by using aerial photography is reliable, fast, and economical. It allows for making decisions about the need for cleaning or taking the appropriate measures to reduce them. The method also allows for the characterization of floats, although it would be convenient to develop algorithms that eliminate the subjective component in the object counting process.

The results show that the floating waste found along the Segura River and the irrigation channels has diverse origins, predominantly vegetal waste from the banks of the river itself, such as reeds, as well as various types of waste among which plastic predominates.

Most of the anthropogenic waste found in the river and channels is of domestic origin. The agricultural activity is responsible for a small part of the waste present in the river and in the channels.

The costs generated by the floating waste represent high expenses for the budget of the irrigation communities, considerably increasing the cultivation costs associated with irrigation and thus compromising the profitability of farms.

In addition, the responsibility for keeping the river and channels clear generates conflicts between administrations and irrigators' communities, which are detrimental to good water management.

The problems caused by floating waste have important consequences for the region's economy, from an agronomic, environmental, and touristic point of view. It is necessary to take measures to alleviate these problems.

6. Recommendations

The large presence of reeds, which represent more than 95% of the volume of waste at the river retention points, highlights the need to improve the maintenance of the riverbank by the competent authority.

The presence of waste affects both the river and the channels network. On the one hand, it is urgent to adopt measures aimed at preventing the dumping of waste into the watercourses through environmental education programs. It is also necessary to take measures to eliminate waste from channels and ditches, since there will always be elements that reach the channel accidentally dragged by the wind. This requires the installation of retention grids and the implementation of a periodic cleaning process for these elements. An effective system of sanctions and the improvement of regulations might also help to prevent the waste dumping. It is also worth considering the payment to the farmers for ecosystem services considering that they are the ones that take care for floating litter clean up.

The coordination between the different agents and institutions involved is fundamental for a sustainable management of the basin so that it is kept free of floating waste and in good environmental conditions.

Author Contributions: Conceptualization, C.R. and H.P.; methodology, R.A.; software, H.P.; validation, M.B. and L.M.-C.; resources and visualization, J.C.; data curation and formal analysis, H.P.; writing—original draft preparation, C.R.; writing—review and editing, H.P., R.A. and C.R. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by the General Directorate of Water of the Regional Ministry of Agriculture, Rural Development, Climate Emergency and Ecological Transition of the Valencian Regional Government (*Conselleria d'Agricultura, Desenvolupament Rural, Emergència Climàtica i Transició Ecològica de la Generalitat Valenciana*).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study is available on request from the corresponding author.

Acknowledgments: The authors wish to thank the support of the technician Ivan Vaz-Romero in the acquisition of images with the drone.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Caulton, E.; Mocogni, M. Preliminary Studies of Man-Made Litter in the Firth of Forth, Scotland. *Mar. Pollut. Bull.* **1987**, *18*, 446–450. [CrossRef]
2. Martinez-Ribes, L.; Basterretxea, G.; Palmer, M.; Tintoré, J. Origin and Abundance of Beach Debris in the Balearic Islands. *Sci. Mar.* **2007**, *71*, 305–314. [CrossRef]
3. Sadri, S.S.; Thompson, R.C. On the Quantity and Composition of Floating Plastic Debris Entering and Leaving the Tamar Estuary, Southwest England. *Mar. Pollut. Bull.* **2014**, *81*, 55–60. [CrossRef]
4. Ali, R.; Shams, Z.I. Quantities and Composition of Shore Debris along Clifton Beach, Karachi, Pakistan. *J. Coast. Conserv.* **2015**, *19*, 527–535. [CrossRef]
5. Suaria, G.; Melinte-Dobrinescu, M.C.; Ion, G.; Aliani, S. First Observations on the Abundance and Composition of Floating Debris in the North-Western Black Sea. *Mar. Environ. Res.* **2015**, *107*, 45–49. [CrossRef] [PubMed]
6. Munari, C.; Corbau, C.; Simeoni, U.; Mistri, M. Marine Litter on Mediterranean Shores: Analysis of Composition, Spatial Distribution and Sources in North-Western Adriatic Beaches. *Waste Manag.* **2016**, *49*, 483–490. [CrossRef] [PubMed]

7. Giovacchini, A.; Merlino, S.; Locritani, M.; Stroobant, M. Spatial Distribution of Marine Litter along Italian Coastal Areas in the Pelagos Sanctuary (Ligurian Sea—NW Mediterranean Sea): A Focus on Natural and Urban Beaches. *Mar. Pollut. Bull.* **2018**, *130*, 140–152. [CrossRef] [PubMed]
8. Ourmieres, Y.; Mansui, J.; Molcard, A.; Galgani, F.; Poitou, I. The Boundary Current Role on the Transport and Stranding of Floating Marine Litter: The French Riviera Case. *Cont. Shelf Res.* **2018**, *155*, 11–20. [CrossRef]
9. Zeri, C.; Adamopoulou, A.; Bojanić Varezić, D.; Fortibuoni, T.; Kovač Viršek, M.; Kržan, A.; Mandic, M.; Mazziotti, C.; Palatinus, A.; Peterlin, M.; et al. Floating Plastics in Adriatic Waters (Mediterranean Sea): From the Macro- to the Micro-Scale. *Mar. Pollut. Bull.* **2018**, *136*, 341–350. [CrossRef] [PubMed]
10. Faure, F.; Corbaz, M.; Baecher, H.; Felippe, L. Pollution Due to Plastics and Microplastics in Lake Geneva and in the Mediterranean Sea. *Arch. Des. Sci.* **2012**, *7*, 157–163.
11. Baldwin, A.K.; Corsi, S.R.; Mason, S.A. Plastic Debris in 29 Great Lakes Tributaries: Relations to Watershed Attributes and Hydrology. *Environ. Sci. Technol.* **2016**, *50*, 10377–10385. [CrossRef]
12. Šebo, J.; Gróf, M.; Šebová, M. A Contingent Valuation Study of a Polluted Urban Lake in Košice, Slovakia: The Case of the Positive Distance Effect. *J. Environ. Manag.* **2019**, *243*, 331–339. [CrossRef] [PubMed]
13. Vlachogianni, T.; Fortibuoni, T.; Ronchi, F.; Zeri, C.; Mazziotti, C.; Tutman, P.; Varezić, D.B.; Palatinus, A.; Trdan, Š.; Peterlin, M.; et al. Marine Litter on the Beaches of the Adriatic and Ionian Seas: An Assessment of Their Abundance, Composition and Sources. *Mar. Pollut. Bull.* **2018**, *131*, 745–756. [CrossRef] [PubMed]
14. Schwarz, A.E.; Ligthart, T.N.; Boukris, E.; van Harmelen, T. Sources, Transport, and Accumulation of Different Types of Plastic Litter in Aquatic Environments: A Review Study. *Mar. Pollut. Bull.* **2019**, *143*, 92–100. [CrossRef]
15. Laist, D.W. Impacts of marine debris: Entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In *Marine Debris, Sources, Impacts, and Solutions*; Coe, J.M., Rogers, D.B., Eds.; Springer: New York, NY, USA, 1997; pp. 99–139.
16. Gall, S.C.; Thompson, R.C. The Impact of Debris on Marine Life. *Mar. Pollut. Bull.* **2015**, *92*, 170–179. [CrossRef]
17. Kühn, S.; Rebolledo, E.L.B.; Franeker, J.A. van Deleterious Effects of Litter on Marine Life. *Mar. Anthropog. Litter* **2015**, 75–116. [CrossRef]
18. Law, K.L. Plastics in the Marine Environment. *Annu. Rev. Mar. Sci.* **2017**, *9*, 205–229. [CrossRef]
19. Isangedighi, I.; David, G.; Obot, O. Plastic Waste in the Aquatic Environment: Impacts and Management. *Environment* **2018**, *2*, 1–31.
20. Domènech, F.; Aznar, F.J.; Raga, J.A.; Tomás, J. Two Decades of Monitoring in Marine Debris Ingestion in Loggerhead Sea Turtle, Caretta Caretta, from the Western Mediterranean. *Environ. Pollut.* **2019**, *244*, 367–378. [CrossRef]
21. McIlgorm, A.; Campbell, H.F.; Rule, M.J. The Economic Cost and Control of Marine Debris Damage in the Asia-Pacific Region. *Ocean Coast. Manag.* **2011**, *54*, 643–651. [CrossRef]
22. Werner, S.; Budziak, A.; van Franeker, J.A.; Galgani, F.; Hanke, G.; Maes, T.; Matiddi, M.; Nilsson, P.; Oosterbaan, L.; Priestland, E.; et al. *Harm Caused by Marine Litter*; European Union: Brussels, Belgium, 2016; ISBN 978-92-79-64534-1.
23. Williams, A.T.; Randerson, P.; Di Giacomo, C.; Anfuso, G.; Macias, A.; Perales, J.A. Distribution of Beach Litter along the Coastline of Cádiz, Spain. *Mar. Pollut. Bull.* **2016**, *107*, 77–87. [CrossRef] [PubMed]
24. Jang, Y.C.; Lee, J.; Hong, S.; Lee, J.S.; Shim, W.J.; Song, Y.K. Sources of Plastic Marine Debris on Beaches of Korea: More from the Ocean than the Land. *Ocean Sci. J.* **2014**, *49*, 151–162. [CrossRef]
25. Krelling, A.P.; Williams, A.T.; Turra, A. Differences in Perception and Reaction of Tourist Groups to Beach Marine Debris That Can Influence a Loss of Tourism Revenue in Coastal Areas. *Mar. Policy* **2017**, *85*, 87–99. [CrossRef]
26. Qiang, M.; Shen, M.; Xie, H. Loss of Tourism Revenue Induced by Coastal Environmental Pollution: A Length-of-Stay Perspective. *J. Sustain. Tour.* **2020**, *28*, 550–567. [CrossRef]
27. Andrady, A.L. Microplastics in the Marine Environment. *Mar. Pollut. Bull.* **2011**, *62*, 1596–1605. [CrossRef] [PubMed]
28. Dris, R.; Gasperi, J.; Rocher, V.; Saad, M.; Renault, N.; Tassin, B. Microplastic Contamination in an Urban Area: A Case Study in Greater Paris. *Environ. Chem.* **2015**, *12*, 592–599. [CrossRef]
29. Lechner, A.; Keckeis, H.; Lumesberger-Loisl, F.; Zens, B.; Krusch, R.; Tritthart, M.; Glas, M.; Schludermann, E. The Danube so Colourful: A Potpourri of Plastic Litter Outnumbers Fish Larvae in Europe's Second Largest River. *Environ. Pollut.* **2014**, *188*, 177–181. [CrossRef]
30. Gasperi, J.; Dris, R.; Bonin, T.; Rocher, V.; Tassin, B. Assessment of Floating Plastic Debris in Surface Water along the Seine River. *Environ. Pollut.* **2014**, *195*, 163–166. [CrossRef]
31. Morritt, D.; Stefanoudis, P.V.; Pearce, D.; Crimmen, O.A.; Clark, P.F. Plastic in the Thames: A River Runs through It. *Mar. Pollut. Bull.* **2014**, *78*, 196–200. [CrossRef]
32. Guerranti, C.; Cannas, S.; Scopetani, C.; Fastelli, P.; Cincinelli, A.; Renzi, M. Plastic Litter in Aquatic Environments of Maremma Regional Park (Tyrrhenian Sea, Italy): Contribution by the Ombrone River and Levels in Marine Sediments. *Mar. Pollut. Bull.* **2017**, *117*, 366–370. [CrossRef]
33. Rech, S.; Macaya-Caquilpán, V.; Pantoja, J.F.; Rivadeneira, M.M.; Jofre Madariaga, D.; Thiel, M. Rivers as a Source of Marine Litter—A Study from the SE Pacific. *Mar. Pollut. Bull.* **2014**, *82*, 66–75. [CrossRef]
34. Rech, S.; Macaya-Caquilpán, V.; Pantoja, J.F.; Rivadeneira, M.M.; Campodónico, C.K.; Thiel, M. Sampling of Riverine Litter with Citizen Scientists—Findings and Recommendations. *Environ. Monit. Assess.* **2015**, *187*, 335. [CrossRef]

35. Moore, C.J.; Lattin, G.L.; Zellers, A.F. Quantity and Type of Plastic Debris Flowing from Two Urban Rivers to Coastal Waters and Beaches of Southern California. *RGCI* **2011**, *11*, 65–73. [CrossRef]
36. Pinto, U.; Maheshwari, B.L. Community Perspectives on Managing Health of Peri-Urban River System: Evidence from the Hawkesbury-Nepean River Catchment, Australia. *J. Environ. Plan. Manag.* **2016**, *59*, 1257–1276. [CrossRef]
37. Wan, J.; Wang, Y.; Cheng, M.; Engel, B.A.; Zhang, W.; Peng, H. Assessment of Debris Inputs from Land into the River in the Three Gorges Reservoir Area, China. *Environ. Sci. Pollut. Res.* **2018**, *25*, 5539–5549. [CrossRef]
38. Jang, S.-W.; Kim, D.-H.; Chung, Y.-H.; Yoon, H.-J. A Study on Exploring Accumulation Zone and Composition Investigation of Floating Debris in Nakdong River Basin. *J. Korean Assoc. Geogr. Inf. Stud.* **2015**, 18. [CrossRef]
39. Hosseini, S.M.; Coonrod, J. Coupling Numerical and Physical Modeling for Analysis of Flow in a Diversion Structure with Coanda-Effect Screens. *Water* **2011**, *3*, 764–786. [CrossRef]
40. Toniolo, H. The Effects of Surface Debris Diversion Devices on River Hydrodynamic Conditions and Implications for In-Stream Hydrokinetic Development. *Water* **2014**, *6*, 2164–2174. [CrossRef]
41. Meister, J.; Fuchs, H.; Beck, C.; Albayrak, I.; Boes, R.M. Head Losses of Horizontal Bar Racks as Fish Guidance Structures. *Water* **2020**, *12*, 475. [CrossRef]
42. European Environment Agency. *Europe's Environment—The Dobris Assessment*; European Environment Agency: Copenhague, Denmark, 1995.
43. Martí, P.; García-Mayor, C. The Huerta Agricultural Landscape in the Spanish Mediterranean Arc: One Landscape, Two Perspectives, Three Specific Huertas. *Land* **2020**, *9*, 460. [CrossRef]
44. Aguiar, F.C.F.; Ferreira, M.T. Plant Invasions in the Rivers of the Iberian Peninsula, South-Western Europe: A Review. *Plant Biosyst. Int. J. Deal. Asp. Plant Biol.* **2013**, *147*, 1107–1119. [CrossRef]
45. Sánchez, R.A.; Molina, H.P.; Osorio, M.C.R.; García, F.H.; Navarro, A.M.; Zapata, J.A.S.; Robles, F.B.; Casalduero, A.G.; de Revenga Martínez, E.D.; Blaya, E.P.; et al. Modernización de los regadíos tradicionales la Vega Baja del Segura. In *Agroalimentación, Agua y Sostenibilidad*; Joaquín, M.M., Ricardo, A.S., Eds.; Ayuntamiento de Orihuela, Universidad de Alicante: Alicante, Spain, 2018; pp. 141–168. ISBN 978-84-13-02014-3.
46. Nakashima, E.; Isobe, A.; Magome, S.; Kako, S.; Deki, N. Using Aerial Photography and in Situ Measurements to Estimate the Quantity of Macro-Litter on Beaches. *Mar. Pollut. Bull.* **2011**, *62*, 762–769. [CrossRef] [PubMed]
47. European Commission; Joint Research Centre; Institute for Environment and Sustainability; MSFD Technical Subgroup on Marine Litter. *Guidance on Monitoring of Marine Litter in European Seas*; Publications Office: Luxembourg, 2013; ISBN 978-92-79-32709-4.
48. González-Fernández, D.; Hanke, G.; the RiLON Network. *Floating Macro Litter in European Rivers—Top. Items*; Publications Office of the European Union: Luxembourg, 2018.
49. CYPE Ingenieros, S.A. CYPE. Available online: www.cype.es (accessed on 3 February 2021).
50. La Verdad La Basura Flotante Reaparece En El Río Segura Horas Después de Limpiarlo | La Verdad. La Verdad. 2019. Available online: https://www.laverdad.es/murcia/basura-flotante-reaparece-20190315012226-ntvo.html (accessed on 14 July 2020).
51. Pamies, D. La Confederación Vuelve a Culpar al Riego Tradicional de La Contaminación Del Segura—Informacion.Es. 2019. Available online: https://www.informacion.es/vega-baja/2019/03/14/confederacion-vuelve-culpar-riego-tradicional-5469160.html (accessed on 14 July 2020).
52. Puerto Molina, H.M.; Melián Navarro, A.; Rocamora Osorio, M.C.; Ruiz Canales, A.; Cámara Zapata, J.M.; Abadía Sánchez, R. Social and Irrigation Water Management Issues in Some Water User's Associations of the Low Segura River Valley (Alicante, Spain). *Sustain. Irrig. Manag. Technol. Policies* **2006**, *1*, 205–214.
53. Abadía, R.; Brugarolas, M.; Rocamora, C.; Martínez-Carrasco, L.; Puerto, H.; Cordero, J. Causes, Consequences and Solutions to the Problem of Floating Solid Waste in the Segura River and Its Irrigation Channels, in the District of Vega Baja (Alicante, Spain). In Proceedings of the 5th International Congress Water, Waste, and Energy Management (WWEM-19), Paris, France, 22–24 July 2019; p. 178.