STUDY AND ANALYSE OF SPATIAL DISTRIBUTION OF WASTE IN THE SOUTHERN ATLANTIC OF MOROCCO

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Abstract
The ocean remains one of the most mysterious and diverse places on Earth. Unfortunately, nowadays our oceans are much polluted: discarded plastic, industrial waste and unwanted fishing nets. This is still a growing problem for the world's oceans and constitute a threat to both people and oceanic life.
This paper aims to identify and localize the ocean waste pollutant in the Atlantic Ocean of Morocco. To achieve this goal, we participated in a scientific trawling survey made by the National Institute of Fisheries Research (INRH) in the southern Moroccan Atlantic area. Our sampling network consisting of 100 stations distributed in a random method. Several types of waste found in the sea are mainly made of glass, metal, fishing equipment and octopus pots that are used in artisanal fishing for octopus hunting, also a large amount of plastic was found such as bottles, plastic bags, etc. To analyze the collected information, GIS tools and statistical analysis were used. The result shows that 80% of the southern Moroccan Atlantic ocean wastes are plastic followed by metal, textile, rubber and glass. The concentration of these wastes is usually correlated to a set of factors such as the proximity to the artisanal fishes sites, and to the current effect.

Keywords*: ocean, Marine wastes, GIS .*

INTRODUCTION

The accumulation of solid wastes is one of the fastest growing threats affecting the marine ecosystem health (Galgani et al.,2010; Depledge et al., 2013;Pham et al., 2014).

the united nations environment programme (UNEP) defined the Marine wastes as any material or object manufactured and used for the benefit of humanity that is directly or indirectly, intentionally or unintentionally discarded or abandoned into the marine and coastal environment.

Owing to the wind patterns and the dynamic nature of ocean currents, marine debris are present in all marine environments, from the beaches , the middle of the ocean of the deepest points in the oceans, even up to 2,5 km deep (Barnes et al., 2009; Pham et al., 2014; Galgani et al., 2015). Generally, Plastic bags, nets, waste glass, metal, wood, paper, cardboard, clothing, pottery, fishing gear. and all kinds of unidentified materials are the scenery of the oceans funds(OSPAR, 2007). Despite of all these types of litter found in the world's oceans, on a global scale, plastics are the most numerically abundant types of marine debris (UNEP,2005; OSPAR,2007; Thompson et al. 2009). it's by far the most abundant material recorded. Their impact on marine ecosystems is of great concern. 275 million metric tons (MT) of plastic waste were generated in 192 coastal countries, with 4.8 to 12.7 million MT entering the ocean (Marcus Eriksen, 2014; al. Jenna R. Jambeck , and al, 2015).

Literature from 1960 to date has highlighted the problems of debris in the marine environment and discussed their impacts and implications Besides the unquestionable aesthetic issue,debris can be impacting the fauna (Ana Paula Madeira Di Beneditto et al., 2014) , the marine biodiversity and all the ecosystem health (Vegter et al.,2014; S.C. Gall

et al.,2015; GESAMP, MaLiTT, May 2002). It is readily apparent from all this published literature that 80% of the marine litter enters the ocean by land based sources ; 20% is derived from maritime activities (Wilber , 1987; Galgani et al.,2010).

Morocco has a coastline that stretches more than 3,500 km with double maritime frontages, the Atlantic Ocean and the Mediterranean Sea. The maritime area is about 1.2 million km2, an estimated fish potential in close 1.5 million tons "renewable every year "FAO". unfortunately , to date they are no local authoritative interested to protect the ressource against the pollution by wastes and no assessment of waste distribution patterns, because of the high cost of sampling the sea.

The aim of this study was to use scientific prospection Surveys to investigate the occurrence and distribution of ocean wastes collected in the southern Atlantic Ocean of morocco. And the relationship with the socio-economic activities and environmental characteristics.

STUDY AREA

The study was conducted in The Southern Atlantic area, located between Cap Boujdor 26°10'N and Cap Blanc 20°50'N , one of the most exploited fishing areas in the world Eastern Central Atlantic.

The coastline stretches over 600km go trough two great ports: Boujdour, and dakhla where the population rate exceeds 100000 inhabitants (the monograph of laayoune Boujdour Sakia El Hamra, 2010 ; the monograph of Dakhla Oued Eddahab lgouira, 2010) and a many artisanal fishing site with over 1000 small active boats (less than 6 m in length).

The geomorphology of the area shows that the higher part of the continental shelf is less than 100 meters depth, the depths less than 50 meters are predominant in the central part.

In addition, the southern boundary of this area consists of a mixture of two masses of different origin waters, North Atlantic central waters (NACW) and South Atlantic central waters (SACW) (Roy 1991). Moving NACW is observed northward to the critical latitude 23° N (Hagen, 2001), which gives the area between 21°N and 23°N special planctonic wealth (Binet,1991).

the key feature of the this area is the presence of deep, cold waters "upwelling" leading to a coastal water enrichment in nutrients and high biological productivity. This zone is considered like the most productive because it is subject to continuous upwelling (Minas et al., 1982; Binet, 1991; Makaoui et al., 2000) (Figure 1).

The specific hydrological conditions prevailing promote strong organic production. The pelagic fishery and Cephalopods (octopus, cuttlefish and squid) are the main species exploited in the fishery and the high demand in foreign markets, while bream and other ground fish are considered as bycatch species (FAO, 2013; INRH, 2002).

The exploitation of these resources has seen a great evolution since the beginning of seventy years , it reached up 60% of all of the activity of national fishing. This evolution is related in one hand, to the increase of the number of fishing units and on the other hand, to the diversification of fishing techniques (deep sea fishing, coastal fishing and artisanal fishing) (stock status, INRH) .

Two types of structures hosting the landings of fishery products : the fishing Sites (fishing villages and landing sites equipped) and the Landing ports. The operational fleet registered in these ports is composed of 5545 artisanal fishing boats, 351coastal vessels and 15 offshore vessels (INRH, 2014).

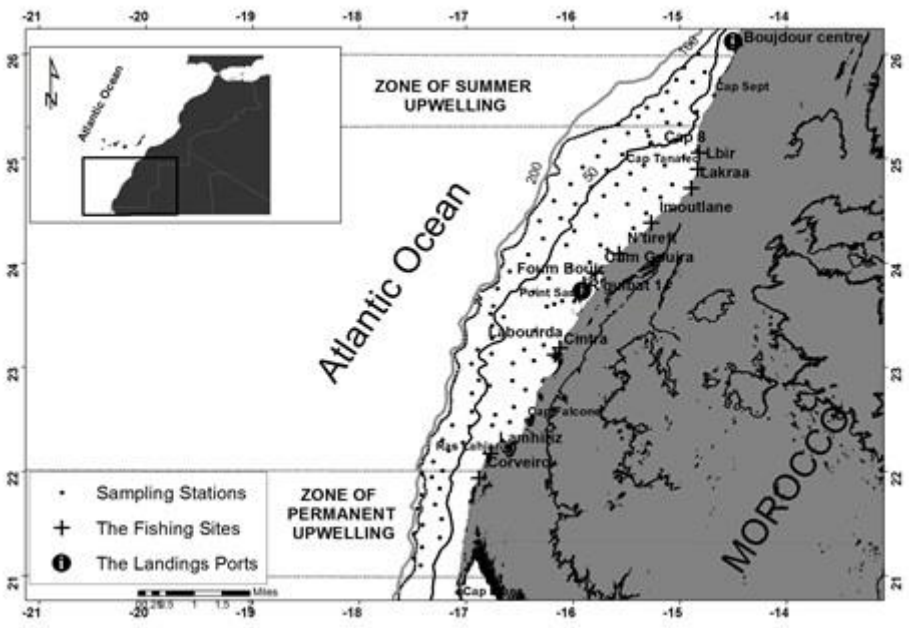

Figure 1. Locations of the study area between cap Boujdor and cap blanc with the sampling network used by the Charif Al Idrissi vessel in October 2014

MATERIALS AND MÉTHODS

Survey sampling method

To identify ressources distribution and to study every phenomenons affecting the Moroccan marine ecosystem, the National Institute of Fisheries Research staff organizes each year scientific surveys and they provide excellent spatial coverage to all Moroccan waters EEZ.

The used database was collected during the scientific trawling surveys conducted by Charif AL IDRISSI research vessel on October 2014 along the continental shelf extending between cap Bojdour (26°10'N) and Cap Blanc (20°50'N).

the Schema of prospecting consists of a grid of trawling stations arranged in a random sampling network. The number of Sampling stations was chosen randomly, according to, the search time available and the distance traveled by the vessel to explore all of the potential geographical coverage.

Data analysis

Using the same sampling network as the prospection survey, we arrived to cover n=100 stations in the southern Atlantic ocean of morocco. Multitude of parameters has been identified in each station: the geographical position of the stations, the time of trawling, the depth, the seabed nature, and the total quantity and nature of each type of waste. Debris was categorized according to material type defined by (Keller et al. (2010) plastic, glass, metal, anthropogenic wood, textiles (fabric or fiber), rubber (Figure 2). The most of the plastic and metal materials founds in the sampling area are fishing gears abandoned, lost or discarded into the ocean.

Figure 2. Examples of marine wastes items collected on the sampling area: (a) trowl bottom "gost fishing" (b) pots of octopus octovulgarus (c) aluminum can, of soda (d) trawl protects (e) lost fishing rope, (f) plastic chip bag (g) plastic shoes (h) glass soda bottle (i) plastic oil bottle.

SPATIAL ANALYSIS

All GIS analysis tools were conducted using Environmental Systems Research Institute, Inc. (ESRI) ArcGIS version 10.2.1. We used the GIS mapping techniques to identify the hotspot points, cartography the distribution of each category of wastes, and show the occurrence of the total Quantity of debris by the kernel density tool.

After this a detailed study of the data matrix by GEODATA software is carried out to study the different relationships between all recorded parameters, in order to know if debris items were distributed randomly or clustered within each site, and to determine the factors that manage this distribution.

RESULTAT

Quantities and the Composition of the solid wastes:

The waste collection in the survey conducted in the Atlantic ocean of morocco shows that a 293 pieces falling into 5 categories were located in our study grid. The total weight of them was 602,676 kg. Plastic materiel formed the majority of all the wastes occupying 34,41% of the total weight followed by the metal 29,16% , textiles 29,15% , rubbers 0,77% and glass 0,16%.

In terms of number, the plastics represent 83,61% of the total number, followed by metal(7,50%), textiles (7,16%), rubbers (12.21%), and glass wastes comprising more than (0,34%) (figure 3).

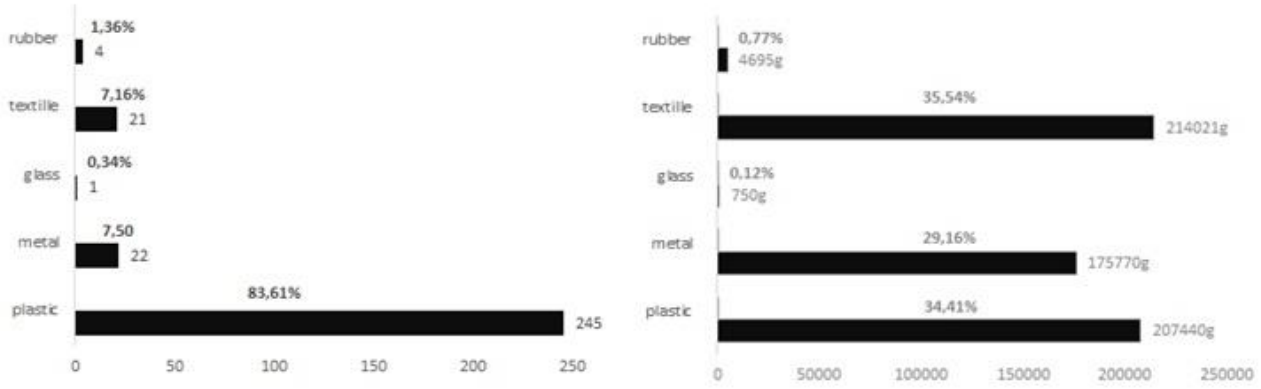

Figure 3. Quantities of marine wastes in terms of number and weights (g) on the survey Area.

The plastic wastes are generally formed by many types of fishing gears specially the pots used to capture the octopus vulgaris with (95,44%), and (4,55%) of bottles and plastic bags . The metal materials found were divided into (99,4%) of trawl buttons and other metal fishing gears, and (0,5%) were some type of cans. Concerning The textile wastes, they are formed by the fiber with (99,7%), and the fabric (0,23%) (Figure 4).

Graphically, The occurrence of the all this Quantity of debris concentrated in the northern part, the highest concentration area was between cap sept (26 N) and cap falcone (22 N) (Figure 5).

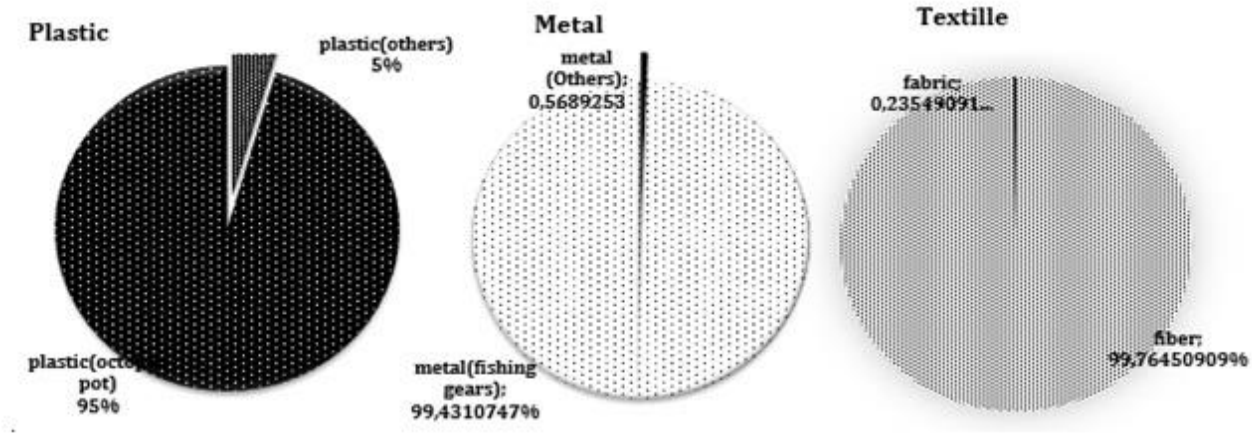

Figure 4. Composition of different categorie of marine debris collected from the survey Area.

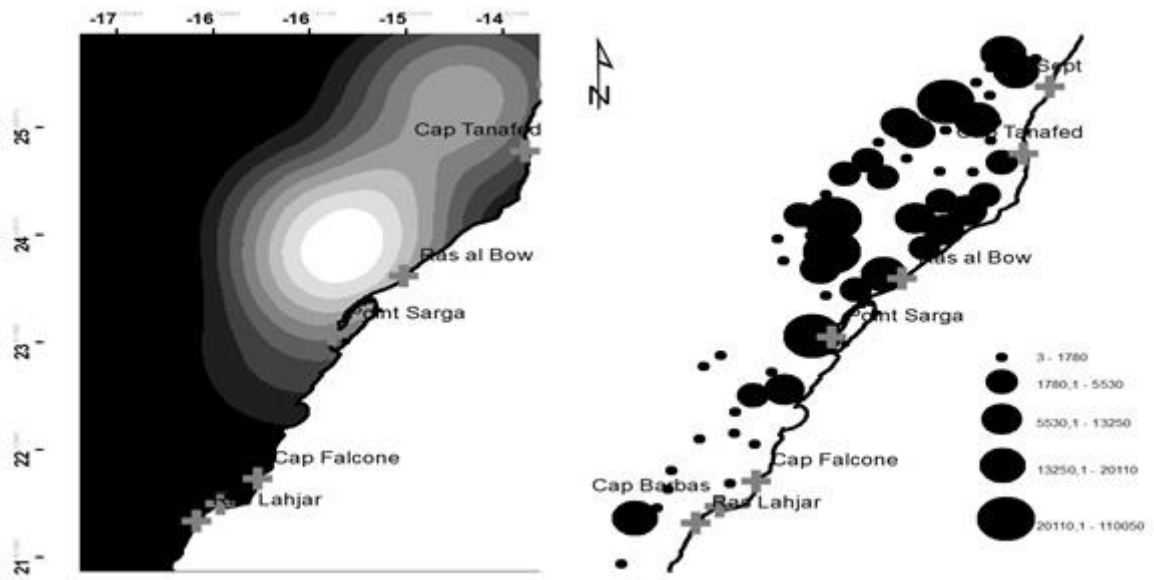

Figure 5. Marine debris kernel density map. Kernel density parameters are presented in equal intervals .the selected cell size was 0.01 (~1 km2) and the search radius was kept at 1 (~100 km) due to the dispersion

The Sapatial autocorrelation analysis:

The analysis of correlation between all parameters collected on the sampling network was a necessary step to study the different factors with an impact on the spatial distribution of wastes. The sampling stations were chosen in different distances to the coastal line and using different levels of depth between 50 to 250 m .We analyzed the overall distribution of wastes relative to the depth levels and the distance to the coastline (Figure 6).

A X^2 analysis of distribution of wastes shows that all major categories were found in all the distance near or far to the coastline, except the plastic which was found more frequently near to the coastline. This pattern of distribution of plastic in the sampling area is closely matched to the pattern of distribution of total quantity of debris because the plastic represents the biggest percentage of the solid wastes in the area.

On the other hand and knowing that all the sampling station were selected in depths between 10 to 100m except two stations with 115m and 263m . The analysis of distribution relative to the depths illustrates that , metal, textiles and rubber were found more frequently in deeper depths (50– 100m), while the opposite was true for Plastic, which was found more frequently with large quantity (between 10 to 50m). We can conclude that the distance to the coastline were not a significant factor determining the distribution for all categories of wastes except for the plastics materieals. however the depth plays a significant role in the distribution of Them .

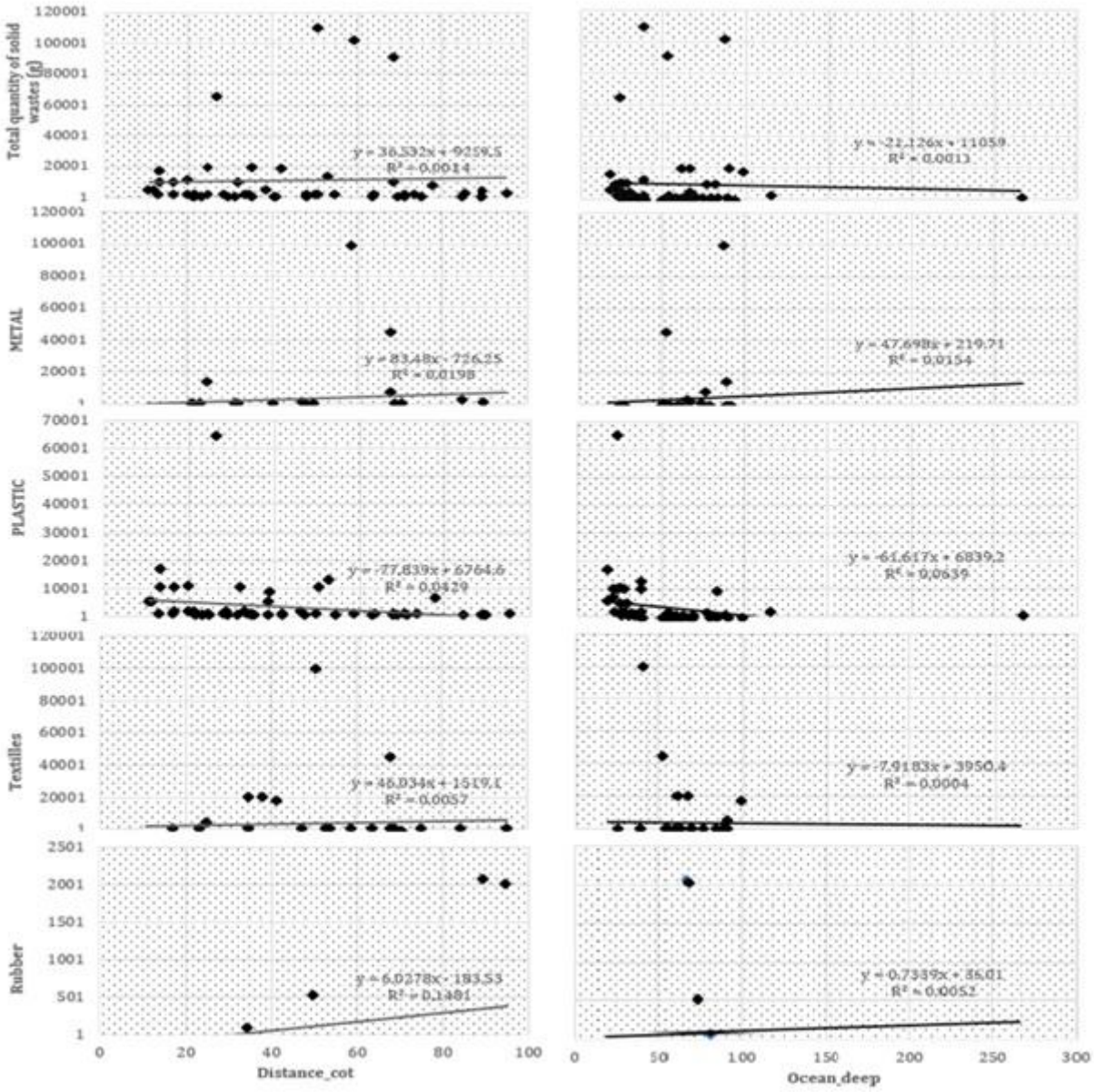

Figure 6 . χ2 analysis of distribution tests for all categorie of wastes in relation to the depth and the distance to the coastline.

DISCUSSION

The majority of waste items collected in the survey area were campared to the Hydrography, land based activities an fishery activities to determine the amount type and origin of debris reaching the ocean waters .

The southern area is characterized by the lack of industrial activities and public landfills near to the coastline, so the main sources of the marine wastes are relied to the fishery activities operated in this zone because the dominant material found were plastic fishing gear used to capture the octopus pots by artisanal fishing of cephalopod .

The development plan of the cephalopod fishery delimits the artisanal fishing zone between 3 and 8 miles and give a limitation of 300 pots allowed per artisanal boat . They are installed in the form of line, each line is composed of 100 pots linked one to another, but Some industrial trawlers often work in coastal areas they damage the lines of pots of artisanal fishermen. Lost pots (detached from their line) are now very common on the entire continental shelf, even away from the coastal area where they were originally installed (Jouffre et al, 2000). In some places (very large sandy areas and sandy mud).

Gis tools with correlation analysis are allowed to compare the distribution of lost pots with the zone autorized to capture the cephalopods. As a result the concentration of this fishing gear was in the part limited by the artisanal fishing with a small amount outside the area and even between Mauritania and Morocco although there is no activity in this zone. (Figure 7).

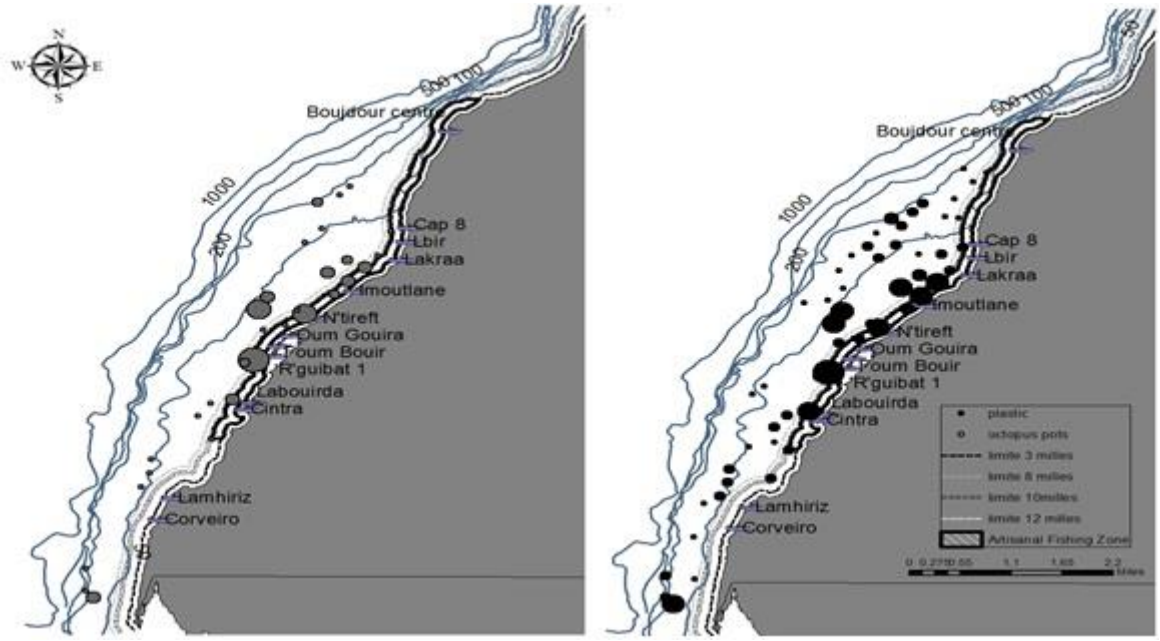

Figure 7. The spatial distribution of octopus pots ans plastics in the southern Atlantic of morocco compared with the area autorised of artisanal fishing.

For the other categories of Abandoned, lost or otherwise discarded fishing gear (ALDFG) found in the study area, The trawl bottoms manufactured by the textile with metal pannier were graphically distributed throughout the sampling network and even outside the authorized fishing area by the three segements of fishing over 12 miles (Figure 8).

The factors behind the abandonment, loss or release of these gears are numerous and include: bad weather; various operational factors concerning fisheries, such as the cost of recovering a vehicle; conflicts of fishing gear; Illegal fishing, unreported and unregulated fishing; vandalism and theft Then they move in the ocean due to the current and the wind .

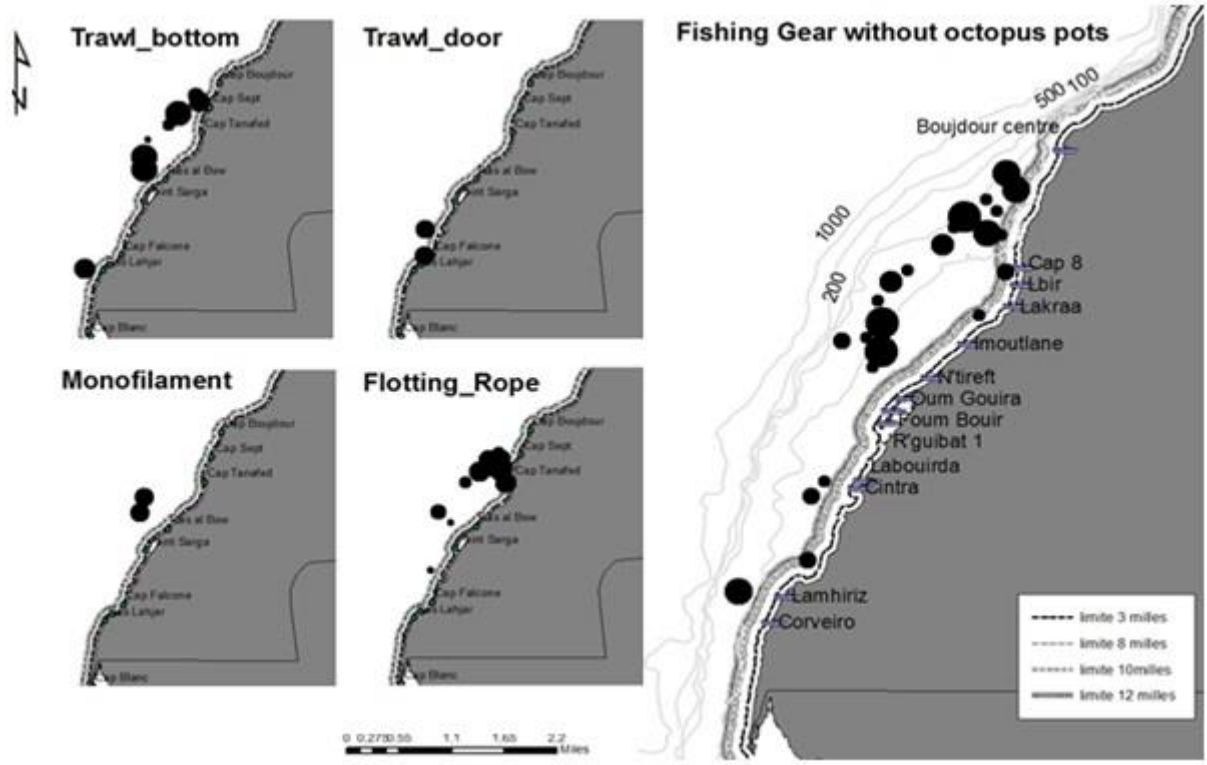

Figure 8. The spatial distribution of fishing geras without octopus pots in the southern Atlantic of morocco.

CONCLUSION

the distribution of solid waste at the southern Moroccan atlantic area is generally a phenomenon that has never been studied due to the exploration costs of maritime Area. the use of the same sampling network of trawling prospecting surveys give us an opportunity to collect more information on the state of the marine environment.

the result shows that the Moroccan Southern Atlantic Ocean like any other part of the ocean was affected by the pollution caused by solid waste. This phenomenon, is typically related to the fishing activity conducted by three segments of fisheries that operated in the Area. Most wastes founded were plastics materiels and specially the fishing gear used to capture the octopus vilgarus , then the wastes were transported to other areas outside the fishing zone due to the current effects.

A future study will dedicate just study the micro wastes and their impact on the marine environement in general.

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