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Coastal Waste Transport in Catbalogan City, Philippines and Nearby Towns

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Abstract: More than half of Catbalogan barangays (villages) are situated along the Maqueda Bay, the primary source of food for Samariños (people of Samar). Sixty percent of these coastal barangays have no direct access to waste disposal facilities such as garbage trucks and landfill. Almost 50% of domestic waste from these barangays is thrown directly to the sea, while 22% partly dispose their waste into Maqueda bay or a total of 7201 kg of waste daily. An improvised 3-dimensional micro-model shows how wastes are transported from one barangay to the other. The waste transport goes beyond barangay boundaries for many of waste travel to the coast of other municipalities and probably to other provinces. Approximately about 33% of fresh wastes float and are transported to other places, most of the remaining waste rot onsite making the site dark, dirty and has foul smell. Waste disposal practices of coastal towns/cities affects each other, therefore proper waste disposal practices must be widely practiced.

Key words: Coastal degradation · Coastal debris · Coastal waste transport · Catbalogan · Maqueda bay

INTRODUCTION

Samar is an agriculture-fishery based economy. It produces about 46,000 metric tons of fish and fish related products (BFAR8: 2007), 66% of which are produced for local consumption. The province of Samar had a relatively long coastline in the western side extending over 300 kilometers from Calbayog City to the southernmost municipality of Marabut, of which fishing became its major activity (Samar Provincial Local Government: 2006). Catbalogan is composed of 57 barangays, 33 of which are found along coast with a total length of more or less 82km. Although the sea is the main source of food and income of many Samariños (people of Samar), care for its resources seems not given much importance by its people. This is very evident on the conditions of the beach fronting the coastal communities.

Population, Economic Growth and Waste: The economic activity in the town as well as its population continuously increases. The town population in the 2007 Philippine National Census Office (NSO) survey is already 92,454 with an average yearly increase of 1.35 % from 2000 to 2007. On the other hand the average annual population growth rate in the coastal communities of Catbalogan is about 1.60%, with some barangays having 2 to 4% growth rate. According to the study conducted by Michael A. Mallin of the University of North Carolina, the increase in coastal area population is directly correlated to an increase in contaminated waters and shellfish bed closings. In the United States, over 85 percent of all beach closures and advisories in 2004, over 19,950 days were results of excessive counts of bacteria in the beach waters [1]. Since waste generation is a function of population, coastal waters of Catbalogan and other coastal communities are expected to become more contaminated.

In the study of Gorean, *et al*. [2] about the water quality and coral reef health in Boracay, El Nido, Isla Verde and Balicasag Philippines revealed that 78.3% of observed sites showed moderate to high levels of algae growth indicating that they are currently exposed to elevated levels of nutrients. Nutrients like phosphorus trigger the growth of algae usually come from sewage and detergents.

Coastal Debris: Solid wastes dumped in waterways pollute the water which flows to the sea and finally to the ocean. Biodegradable component of the solid waste is eaten by bacteria that consume the oxygen in the water.

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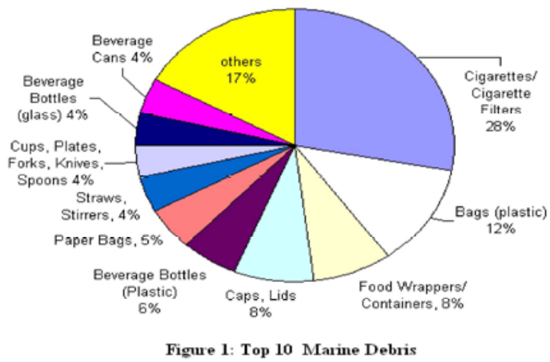

Fig. 1: Top 10 Marine Debris Item in the World
Source: Conservancy International 2009 Report

The excessive growth of these aerobic bacteria can deplete dissolved oxygen which leads to eutrophication and the eventual death of oxygen-consuming aquatic life [3].

Humans once viewed the ocean and its resources as limitless and believed that disposal of waste from vessels and along rivers and coasts into the ocean would do little harm [4].

During the September 2008 International Coastal Cleanup, a total of 6.8 million pounds of trash was collected on selected shores around the world most of which are non-biodegradable with cigarette based waste tops the list as shown on Figure 1. More than 400 pounds (181 kg) of debris for every mile of beach was collected.

Top 10 most common wastes found in many coasts around the world accounts to about 83% of all wastes collected. Obviously the debris collected is mostly non-biodegradable or has slow degradation rate. In the Philippine coasts, around 1,355,236 debris items were collected or about 11.85% of the total coastal wastes collected around the world. This makes the Philippines second to the US for having dirtiest coast in the world, a major ocean polluter [5].

The National Oceanic and Atmospheric Administration (NOAA) of US stated that marine debris became one of the most pervasive pollution problems facing the world's ocean and waterways. NOAA reported that waste generally come from people. People mishandling of waste materials and a host of other items while on land constitute the bulk of the marine debris problems. Debris is also blown into the water or carried by creeks, rivers, storm drains and sewers into the ocean. Some people also generate debris while at sea. Like land based debris, the majority of ocean/waterway based debris reaches the ocean through people's failure to properly dispose or stow their trash while onboard their boat and vessels. It also said that removing existing debris in the shores is a temporary solution to the larger debris problem. Marine debris pollution can only be truly managed through prevention and changing the behaviors of people towards proper waste disposal [6].

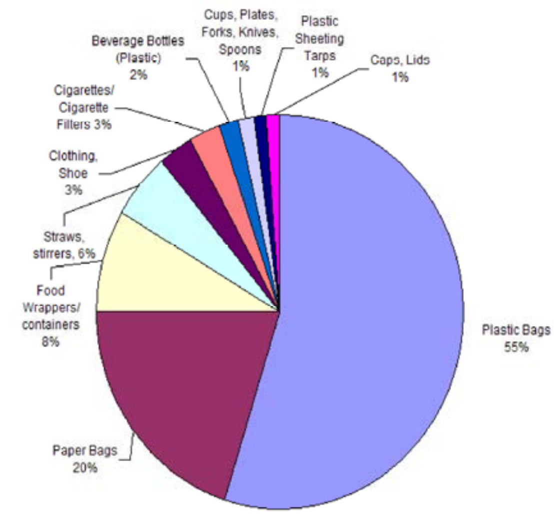

Fig. 2: Top 10 Marine Debris Item in the Philippines
Source: Conservancy International 2009 Report

Municipal Solidwaste: Waste generated in the Philippines is estimated at 17,871.53 MT per day. Projection show that waste generation will increase 47% by 2010 or about 26,194.95 MT/day [7]. Typically, wastes in urban city/municipality range 40-50 tons/day. According to the International Panel on Climate Change, the composition of municipal solid waste (MSW) includes food waste, garden and park waste, paper and cardboard, wood, textiles, nappies, rubber and leather, plastics, metal, glass/pottery/china and other wastes. The first six types contain most of degradable organic carbon in MSW. Ash, dust, rubber and leather also contain certain amounts of non-fossil carbon, but this is hardly degradable. Some textiles, plastics (including plastics in disposable nappies), rubber and electronic waste contain the bulk part of fossil carbon in MSW. Paper with coatings and synthetic leather can also include small amounts of fossil carbon [8]. Many of these wastes end-up in the sea due to improper waste disposal practices [6].

Coastal Debris in Maqueday Bay: Coastal debris collected in the Philippine shore is a bit different from the worldwide total. Comprising 55% are plastic bags, followed by paper bags (20%) and 8% are food wrappers [9]. According to Cabatbat [10], waste generated

Table 1: Catbalogan Samar Marine Debris Index

Debris Type	Count	Percentage
Plastic Bags	8010	36.34
Food Wrappers/containers	5707	25.90
Bleach/Cleaner Bottles	2855	12.95
Coconut husk(full)	1142	5.18
Straws, stirrers	733	3.33
Dead fish	424	1.92
Tree trunks/branches	315	1.43
Coconut husk (half)	302	1.37
Clothing, Shoe	287	1.30
Diapers	286	1.30
Cups, Plates, Forks, Knives, Spoons	277	1.26
Personal Hygene wrapers	265	1.20
Sack	248	1.13
Can	242	1.10
Beverage Bottles (Plastic)	204	0.93
Beverage Bottles (Glass)	163	0.74
Caps, Lids	123	0.56
Leaves	120	0.54
Fishing Nets	71	0.32
Tires	52	0.24
Building Materials	43	0.20
Nipa	38	0.17
Beverage Cans	32	0.15
Toys	24	0.11
Rope	20	0.09
Cigarettes/Cigarette Filters	20	0.09
Crates	14	0.06
Crab/Lobster/Fish Traps	10	0.05
Fishing Line	5	0.02
Medicine wrapers/bottles	4	0.02
Tampons/Tampon Applicators	2	0.01
Cigarette Lighters	1	0
Total Marine Debris Items	22039	100

in the Philippines is composed of 5% special wastes, 15% residual, 30% factory returnable and 50% compostible wastes (25% of the compostible wastes are used as organic fertilizers).

Shown on Table 1 are wastes found on six coastal communities namely Brgy. Ubanon, Sulangan and Estaka as well as beaches of Guinsorongan, Cal-Apog and in Estaka Buri. The survey was made simultaneously during a low tide in March 2009. The area covered during the survey is approximately 6500 sq.m.

The top 10 debris collected in the six coastal areas of Catbalogan as shown on Table 1 constitute about 91% of the total waste. Similar to Philippine Marine Debris Index, topping the list are plastic bags comprising about 36.34%. Plastic wastes in the coastal areas and other water ways of Catbalogan are very evident. Residents in these coastal communities are not worried for they have already adapted to the coastal waste problem. Some even do not bother knowing that they just have thrown all sort of waste into the shores in the morning during low tide and swim during high tide. They argue that the waste have already been carried by the sea. Majority believes that because of the vastness of the ocean compared to the waste they just have thrown, its impact is insignificant. Some even eat seabed dwelling molluscs in areas near disposal zones [11].

Table 2: Top 5 reason of dumping waste in the Sea/Coast

Reasons	Percentage
No access to MSW disposal facilities	93
No designated disposal area	82
Limited access to MSW disposal facilities	44
Convenience	10
No reason given	4

Catbalogan population in 2007 national census was about 92,454. Philippines per capita generation rate in the year 2000 is about 0.19 tonnes/capita/year or about 0.52kg per day per person [8]. This value means that Catbalogan produces around 48 tonnes of wastes daily, 10% [12] of these wastes or 4.8 tonnes are uncollected which are dumped in waterways like canals, esteros and river. These wastes eventually find their way to the sea for all waterways including canals in Catbalogan end up in the sea without filtration. Also, coastal barangays with no access to dump-trucks and other waste disposal facilities throw their waste directly to the sea [11] that further increase the volume of waste dumped into the sea.

Profile of Coastal Communities: Approximately, Catbalogan has 82.6 km coastline wherein around 11.06 % or 9.14 km is fully inhabited. Population density in coastal zones (excluding downtown Catbalogan) reaches to about 555 person/hectares [11].

Around 40% of coastal barangays close to downtown Catbalogan have access to solid waste disposal facility such as garbage trucks. The rest of the barangays (60%) throw there wastes somewhere else. Many coastal communities allow throwing waste directly into the shores and some have dumping sites on coastal cliff [11].

Waste Disposal Practices in the Coastal Communities: It was revealed in the study of Orale [11] that coastal communities throw their wastes on the coast because of the inaccessible municipal solid waste disposal facility (MSWDF). Table 2 shows that about 82% of Island and other far-flung barangays have no ideal disposal site which forces people of these communities to dispose their wastes just anywhere. Coastal zones are favourite disposal sites because it's the most accessible and owned

Table 3: Coastal Communities Waste Disposal into the Sea

Coastal Barangays	No. of Household	Households disposing All waste into the sea (100%)	Their waste partly into the sea	Their waste properly	Estimated amount of waste disposed into the sea (kg/day)
Mainland w/ access to MSWF	5824	35 (0.6%)	752 (13%)	5037 (86%)	904
Mainland w/out access to MSWF	2679	1205 (45%)	938 (35%)	536 (20%)	3683
Island Barangays	1650	1023 (62%)	363 (20%)	264 (18%)	2614
Total	10153	2263 (49%)	2053 (22%)	5837 (29%)	7201

Table 4: Average Thickness of Organic Silt in selected coastal communities of Catbalogan

Coastal Location	Silt➔ Average thickness (mm)	Foul Odor?	Color
Ubanon	130	Yes	Black
Guinsorongan Beach	50	No	Gray
Bunuanan	15	Yes	Gray
Ibol	30	Yes	G-B
Pangdan	35	Yes	G-B
Darahuway Dako	23	Yes	Gray
Basiao*	0	No	Gray
Cal-apog beach	15	No	Gray
Estaka	25	Yes	Black
Baras Beach Buri	25	No	Gray
Maulong	95	Yes	G-B
Silanga	56	Yes	G-B

(G) Gray (B) Black * not inhabited

by the government. According to majority of these coastal communities, the government has been very lacks in protecting the shores from waste disposal activities. Also, around 10% of those with access to MSWDF still throw their waste directly into the sea because waste collection in some of the areas is not regular.

Many people along the coasts find it hard to observe and practice solid waste management and sadly many of them do not feel the need. For example, it is easier for them to throw their garbage into the sea or burn it than practice burying. Many of them however try to re-use plastic bags but once it gets filthy or wet, more likely it will be dumped. Many even pointed out that while some of them practice better waste disposal, a lot of them do not mind. They further stressed that they have not known anyone that has been penalized due to mishandling of waste [11].

Table 3 shows the number of household in the coastal barangays throwing their waste in Maqueda bay. Approximately, about 7.2 tons of wastes in addition to the 4.8 tons thrown into waterways find their way into the sea. Only accounting the 7.2 tons, about 50% [10] or 3.6 tons will decompose while at sea. The rest of the wastes partly sinks and later float when it starts decomposing. Sediments derived which are heavier than seawater sink and stay on shores until they are buried naturally or are carried deeper into the sea by strong waves.

Table 1 data do not include fast deteriorating wastes like food and other kitchen wastes. On a simple experiment, one day fresh waste from a household was placed in a drum with saltwater. The wastes that have floated comprised about 1/3 of the total weight. The rest of the wastes have settled and a small fraction floated in the succeeding days [11]. Organic wastes thrown into the sea decomposes, increasing the carbon and nitrogen in the water. Organic wastes have about 48% carbon and 2.6% nitrogen in terns of solid waste weight [13] which can be added to the seawater. Too much nitrogen in the sea causes harmful algal bloom which directly affects the main source of food and income of many Samareños.

Organic Silt Deposits in Selected Coastal Areas in Catbalogan Samar: There were about 12 coastal areas inspected to determine approximate quantity of organic silt in the coastal bed. Also examined by sensory evaluation is the odor and color of the sea bed. The smell is foul if it smells like deteriorating waste or organic waste smell. Color is rated from light gray, gray, dark gray and black using a chart.

As shown on Table 4, all coastal zones directly facing a community have considerable amount of silt deposits of organic origin. The silt deposits are maybe the organic wastes dumped into these areas. These wastes degrade and are transformed into silt-size sediments, making the beach front dark in color with foul odor. A coast at the back of Basiao Island (not inhabited) is clean and has an insignificant amount of silt deposits with abundant marine life like fishes and shellfish. On the other hand shores in front of Brgy. Ubanon, Estaka (Figure 3) and several others are very dark with unpleasant odor. Also, some coastlines in Maqueda Bay are lined with mud and silt-like sediments. Characteristics of the mud deposited from rivers are totally different from the sediments derived from decaying wastes.

Fig. 3: Barangay Estaka Buri organic silt lined shores with debris

Solid Waste Disposal Control Initiatives of Catbalogan: The General Services Office (GSO) of Catbalogan Local Government Unit (LGU) collects the town wastes daily. It serves 35% of its barangays or about 60% of its total population. Ordinances on the municipal and barangay levels have been promulgated and some of these have been implemented. However, just like many barangays, municipalities, cities, or provinces in the Philippines, law implementation in accordance to proper solid waste management is still very much wanting. According to the Presidential Adviser on Global Warming and Climate Change Heherson Alvarez, only 8% nationwide has complied to the Ecological Solid Waste Management Act of 2000 also known as RA 9003. He further stressed that they might be forced to sue LGUs who still have to comply with the law [14].

Environmental Management Bureau (EMB) Regional Office No. 8, OIC-Regional Director Letecia R. Maceda reported that Catbalogan Samar was already issued with a strike two warning for generating 15 to 75 tons of waste per day and being delayed in its ESWM implementation for eight years now. Failure to this issuance and address the problem would give the city another strike (strike three), which would mean the filing of an administrative case before the Department of Interior and Local Government (DILG) or criminal action as stated under Section 49 of RA [15, 16].

In answer to RA [15], the Municipality of Catbalogan underwent a workshop last March 2009 to come-up a 10 year ecological waste management program for the town. Major programs include the transfer of waste disposal site into a proposed landfill in Brgy. Lagundi; waste segregation program which includes penalties and rewards to barangay and people who participate in it; and hiring of people who will focus on waste management

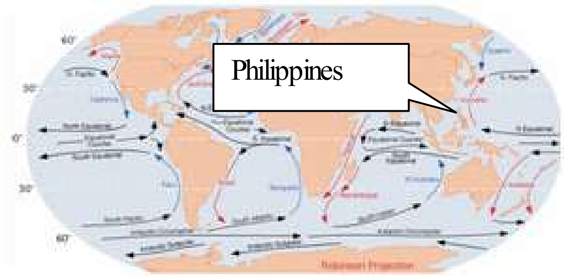

Fig. 4: Surface Currents (www.geni.org)

under the General Services Office (GSO). Information dissemination about solid waste management focusing on waste segregation, recycling, reuse and refuse strategies is also part of the 10-year plan. They are also planning to tap services of academic institutions for this purpose. Areas wherein municipal garbage trucks are inaccessible like island barangays or far-flung coastal communities will be dealt with on case-to-case basis according to the GSO head.

Non-Governmental Organizations (NGOs), private and public organizations/groups in Catbalogan and academic institutions like Samar State University conduct regular coastal clean-up in selected coastal communities of Catbalogan. However these practices are but temporary and cannot solve the main problem. Other initiative such as proper solid waste management information dissemination has been conducted by SSU-College of Engineering as part of their regular community involvement activities.

Understanding Ocean Current: According to Water Encyclopaedia, currents exist at all depths in the ocean; in some regions, two or more currents flow in different directions at different depths. Although the current system is complex, ocean currents are driven by two forces: the Sun and the rotation of the Earth.

Wind-driven Currents: The winds in the atmosphere are generally caused by the sun. The blowing winds drag the surface of the sea through friction, which creates waves. Although the wind strongly affects the surface layer, its influence does not extend much below about 100 meters in depth [17]. The wind blows across the ocean and moves its waters as a result of its frictional drag on the surface. Ripples or waves cause the surface roughness necessary for the wind or couple with surface waters. A wind blowing steadily over deep water for 12 hrs at an average speed of 100 cm/sec (2.2 mi/hr) would produce a 2 cm/sec current (about 2% of the wind speed) [18].

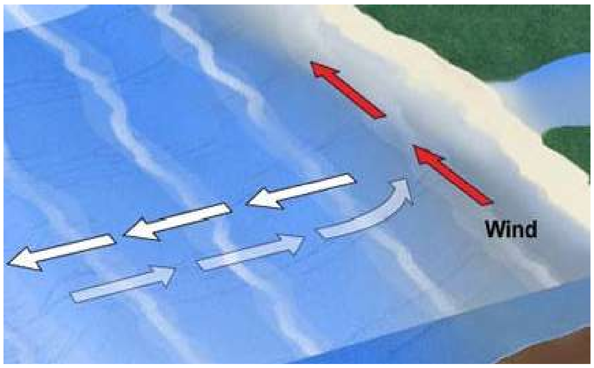

Fig. 5: Upwelling currents

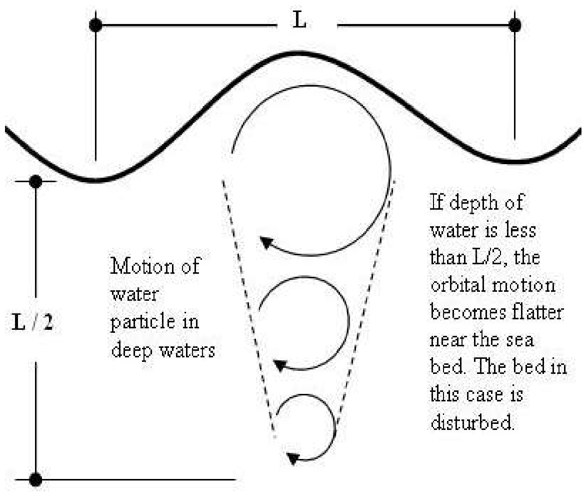

Fig. 6: Orbital Motion of water particle

Most of the time sea waves are always rushing towards the shorelines except when there are upwelling currents. Upwelling occurs when winds blowing across the ocean surface often push water away from an area. When this occurs, water rises up from beneath the surface to replace the diverging surface water. The upwelling current is most likely the reason why wastes from the shores are carried towards the middle of the sea. This movement may also cause to bring up the dirtier water that is usually in the lower strata of the coastal waters due to its higher density.

Dirt on the shores can also be carried by receding high tide waters. The changing tide is caused by moon and sun's gravity as well as the rotation of the earth while upwelling current is due to the wind [19].

The waves rushing on the coastal zones carry the wastes on the shoreline and bring it into the middle of the sea. It is at this point that the floating waste movement becomes more dependent on the water surface current.

Waves are generated primarily due to blowing winds. The upper water layer receives much of the friction and which causes an orbital motion. This orbital motion reduces in size according to depth. In areas where depth of water is less than half of the wavelength (L) the orbital motion of water particle becomes flatter near the sea bed which disturbs the sea bed [20].

Temperature-driven/Salinity-driven and Density currents: Density currents are currents that are kept in motion by the force of gravity acting on a relatively small density difference caused by variations in salinity, temperature, or sediment concentration. Salinity and temperature variations produce stratification in oceans. Below the surface layer, which is disturbed by waves and is lighter than the deeper waters because it is warmer or less saline, the oceans are composed of layers of water that have distinctive chemical and physical characteristics, which move more or less independently of each other and which do not lose their individuality by mixing even after they have flowed for hundreds of kilometers from their point of origin [21].

Coriolis Effect (Rotation of the Earth): The rotation of the Earth also affects the currents through the Coriolis force. This force causes water to move to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. It exists because moving ocean water is affected by friction with the Earth only at the seafloor and because the eastward linear velocity of the earth decreases from a maximum at the equator to zero at the poles (the rotational velocity, however, does not change). A parcel of water at the equator is moving at the same speed as the Earth. If it starts to move north, with no friction, it is then going faster than the Earth beneath it. To conserve momentum (the product of mass and velocity), it consequently moves more to the east as it gets farther from the equator. The Coriolis force therefore increases away from the equator [17].

Water Current Visualization Through the Micro-Model: Studying actual movement of waste at sea or the sea water current is complicated, costly and a tiring work. It will require close observation of how waste moves in relation to the other parameters such as wind velocity and direction which cannot be controlled in the real situation. Furthermore waste water movement will also be very difficult to observe without the use of sophisticated instrument/equipment.

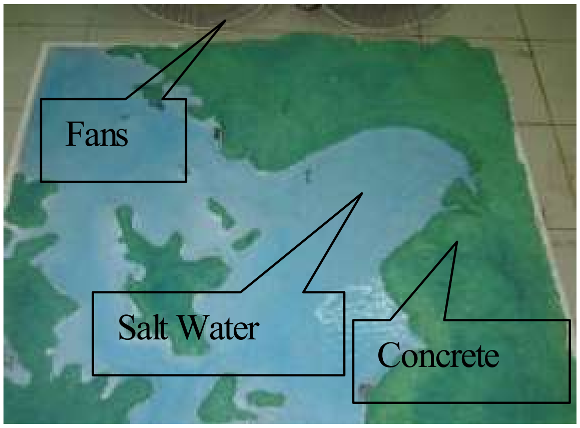

Fig. 7: The micro-model of Maqueda Bay

The 3D Micro Model: A 3D topography representing the land between 11°52’45” N - 124°44’36”E and down to 11°31’55”N -125°6’32”E is made of concrete and coated with paint. The scale of the model is approximately 1:30,000. Two fans were positioned to blow wind horizontally.

The model was filled with sea water collected from Maqueda bay. Four sets of colored floaters made from Styrofoam measuring 1mm x 1mm approximately represent floating waste in the sea. The said floaters were placed in four pre-selected location in the model, three from Catbalogan and another area near Villareal, Samar.

Three wind direction based on Department of Science and Technology (DOST) – Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA) records in Catbalogan from 1991-2005 were considered. January winds are usually north-east, March winds are south-east and July winds are south-west. Three trials were made every wind direction making nine trials all-in-all. Nine trials for waste water movement were also conducted. To record waste movement, an observation check sheet and camera were used.

Waste Movement via Micro-model Apparatus: Styrofoam slices having different color were placed in the four selected sites namely Poblacion, Brgy. Pangdan, Brgy. Estaka Buri and a Barangay inVillareal, Samar. Two fans were placed in the north-east corner of the model and movements of styrofoam were noted until it stopped moving. Fans were also positioned to blow winds in the northwest and southwest directions.

Waste water movement on the other hand was observed using a paint-colored water having specific gravity of about 1.8. Waste movement in the first one minute was observed and was rated according to color.

Fig. 7: Water surface current in Maqueda Bay

Fig. 8: Transported styrofoam slices

Limitations of the Model: The movement of water including the waste is all based on the micro-model. It has a fan acting as the wind blowing in one direction and with constant speed on all trials. Based on PAGASA records on prevailing winds, it appears that the wind direction and speed is very dynamic. Every now and then the direction and speed change which vary in real situation. Speed of waste movement is not relative to the actual movement on field that has not been accounted for in the experimentation. Variation in salinity due to fresh water runoff from the land and river were not considered.

Sea Water Current and Waste Transport in Maqueda Bay: Theoretical movement of ocean waters due to earth movement and the sun is already established. The same current is said to be the medium why coastal waste is transported around the world. Movement of water in semi-enclosed water body especially Maqueda bay is still unknown.

Floating Waste Movement: The wind is the most probable cause of seawater movement in the Maqueda Bay area.

Table 5: Floating Waste Movement in Maqueda Bay

(A) January Wind Direction: North-East

Waste Origin	Waste Destination	P
Poblacion coastal area	Poblacion	30
	Maulong	22
	Mercedes	20
Brgy. Pangdan	Jiabong	30
	Motiong	16
	Wright Paranas	12
Brgy. Estaka	Cabugawan	24
	San Roque	16
	Silanga	10
Pinabacdao, Samar	Pinabacdao	28
	Guintarcan	10
	San Sebastian	7

(B) March Wind Direction: South-East

Waste Origin	Waste Destination	P
Poblacion coastal area	Zumarraga	26
	Villareal	16
	Pinabacdao	8
Brgy. Pangdan	Zumarraga	20
	Guintarcan	20
	Jiabong	10
Brgy. Estaka	Zumarraga	30
	Villareal	16
	Pinabacdao	16
Pinabacdao, Samar	Zumarraga	36
	Pinabacdao	20
	Villareal	10

(C) July Wind Direction: South-West

Waste Origin	Waste Destination	P
Poblacion coastal area	Poblacion	22
	Mercedes	20
	Villareal Samar	20
Brgy. Pangdan	Bunuanan	30
	Ubanon	16
	Guintarcan	16
Brgy. Estaka	Daram, Samar	12
	Buri Beach	8
	Cabugawan	2
Pinabacdao, Samar	Pinabacdao, Samar	34
	Villareal, Samar	20
	Zumaraga, Samar	10

To visualize movement, the fans were positioned to blow air according to the directions based on the records of PAGASA Catbalogan. Top three floating waste destinations according to the computed probabilistic (P) values are presented in Table 5. The probability values shown in Table 5 were computed based on the number of styrofoam chips that stopped moving and settled in a particular area in the model (Figure 8). The number of chips was divided by the total number of original chips positioned in specified area prior to the blowing of the fan. Wind direction and speed were the same all trough-out every experiment.

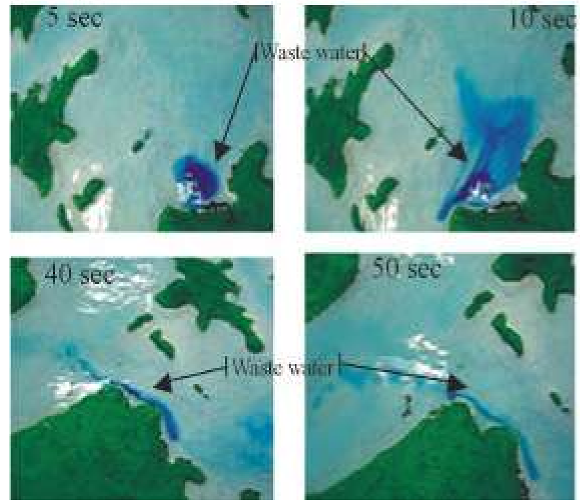

Fig. 8: Catbalogan waste water movement (NE wind)

Results of experiments (Table 5) showed that wastes are transported from one coastal area to the other. Waste destination depends on the wind direction and topographical characteristics of the land. Wastes are transported beyond municipal and even provincial boundaries.

The values shown in Table 5 is an approximation of how much of the floating waste is transported to other areas and how much will stay. The sites mentioned as potential waste destination were visited and wastes believed to be coming from other areas are found. The activity, however, did not validate whether the proportion of waste shown on Table 5 are statistically the same.

Catbalogan Waste Water Movement: Waste water is generally heavier compared to the sea water. The heavier waste water will settle at the lower portion of the water column which reduces the impact of the wind to its movement (Figure 5). Wastewater movement is generally governed by complex interrelation between the wind velocity and direction, slope of coastal zones, density of wastewater and seawater. Shown on Table 6 is the movement of waste water from downtown Catbalogan based on the model used. Paint colored water (sp.gr. 1.8) was ejected in the model in Brgy. Ubanon area and its movements were recorded. The percent amount of waste transported was quantified based on the color of the water compared to a solution placed in bottles at the end of 1 minute from initiation. Three trials were made each wind direction.

Table 6 revealed that about 35% of wastewater from downtown Catbalogan stay in Catbalogan shores for a while and more than half find their ways to other areas

Table 6: Catbalogan Waste Water Movement

Wind Direction	Waste Destination	Percent waste
North-East	Poblacion	35
	Jiabong	20
	Maulong-Silanga	15
South-East	Poblacion	10
	Pinabacdao	5
	San Sebastian	5
South-West	Poblacion	10
	Maulong-Silanga	8
	Daram	5

Table 7: Community Appraisal of Coastal Areas

Selected Coastal Community	Present Coastal Resource Status (baseline: 1980)	Shoreline Status	Impact probably caused by?
Darahuway (D)	SW	D	pollution
Estaka	W	VD	pollution
Guinsorongan	W	VD	pollution
Silanga	W	VD	pollution
Ubanon	W	VD	pollution
Maulong	W	VD	pollution
Basiao*	S	C	-
Baras Beach	SW	MC	pollution
Cal-apog Beach	SW	MC	pollution
Guinsorongan Beach	SW	D	pollution

Legend: (B) Better (S) Same (SW) Slightly worse (W) Worse
(C) Clean, no evidence of dirt/liter
(MC) Most of the time clean. Liter is carried from other areas.
(D) Dirty. Liter is very evident most of the time
(VD) Very dirty. All the time, liter is present all the time; sea bed is full of organic silt and is black

fronting Maqueda Bay. About 20% travel to coast of Jiabong, 15% to Maulong-Silanga of Catbalogan, 10% to Motiong, Samar and the rest of coastal town. In any wind direction, waste water from Catbalogan really travels and affects other nearby towns. Without wind, the waste water runs slow towards the lower elevation.

The distribution of wastewater is a bit different compared to floating waste. Solid waste stays intact until it disintegrates due to decomposition. The wastewater easily mixes with the seawater and since sea/ocean has high assimilative capacity to carry the wastewater thrown into it, its impact is only felt after a while. The kinds of wastewater flowing to the sea are waters from the canals of Catbalogan and domestic/commercial wastes directly thrown to Antiao River and other waterways.

Some Impact of Coastal Waste to Catbalogan and Nearby Towns: Some impacts are immediately visible and some are not. The waste floating in Catbalogan and nearby towns' shores as well as dark colored seabed and smelly water is an example of an immediate visible impact. The dirty shores and seabed slowly kills marine life and impact is felt years ahead. Impacts that are enumerated in this paper are based on the coastal community appraisal and records of SSU-College of Fishery and Marine Sciences R and D office.

Coastal Debris: The 60 respondents from three coastal communities' surveyed aging 40 and up were asked about the state of their coastal resources since 1980 and what caused the changes. Table 7 summarizes the responses in the survey conducted. Most agreed that the major cause of coastal degradation in most areas identified is due to pollution. The beaches considered in the evaluation are moderately dirty but the coastal zones directly facing the coastal communities are very dirty. Respondents have unanimously agreed that coastal resources as well as shoreline status have worsened and pollution is the major identified culprit

Harmful Algal Bloom (HAB): HAB occurs due to the increase in nutrients, rapid increase of population in coastal zones and the increase use of fertilizes on farms and lawns leading to more nutrients in runoff to the ocean maybe a contributing factor to increase blooms [22]. HAB also occurs due to other factors, but majority the bloom is caused directly or indirectly by waste.

In the report of Furio, around 637 cases and 29 casualties from 1983 to 2002, were attributed to redtide poisoning. The same report however did not identify the main cause of redtide occurrences. In 2008, the green mussel "tahong" industry of Jiabong and Catbalogan suffered heavy losses (90% of production: PhP 38M) due to harmful algal bloom (HAB). Algal blooms can be triggered by the large concentration of nutrients like phosphorus and nitrogen, which can come from human waste or polluted water runoffs, causing algae to reproduce quickly, resulting in algal blooms [23].

Loosing Marine Habitat: More than an eyesore, marine debris also poses threats not only to humans but to marine wildlife as well. According to NOAA [5], abandoned nets, plastic tarps, fishing gear and other debris can smoothen and crush sensitive coral reef and sea grass bed ecosystems and their benthic (bottom-dwelling) species.

The Marine Mammal Commission reports that 267 marine species have been reported entangled in or having ingested marine debris. The plastic constricts the animals' movements, or kills the marine animals through starvation, exhaustion, or infection from deep wounds caused by tightening material. These animals may starve to death, because the plastic clogs their intestines preventing them from obtaining vital nutrients. Toxic substances present in plastics can cause death or reproductive failure in the fish, shellfish and wildlife that use the habitat [24].

SSU-COFMAS R and D records shows that a number of species are now extinct and some are endangered of losing specifically along Maqueda Bay. Fishes like saddle grunt (agoot), spotted catfish (tabangongo), silver grunt (bakoko), gizzard cod (kabasi) have been considred extinct while night eyed flounder (palad) and hump head (agdawon) is near extinction. Shell fishers like nerite snail (lagokay), triton, snail (tambali), are already extinct while helmet shell (budyung), cowrie (baboy-baboy), were near extinction. Sea cow, a turtle were continuously declining in number. The reason of the extinction or nearing extinction is primarily attributed to pollution, climate change and over/illegal fishing that destroys marine habitat.

Tourism: National survey reveals that the beaches are the number one tourist attractions in the Philippines. Like most of the Philippines, Catbalogan and Samar in general is also gifted with long coastline and other marine resources such as coral reefs. Many potential beaches abound in the area; however because of population increase these areas are now occupied. Catbalogan LGU web site listed beaches as its primary tourist attraction. It identified beaches and coral reefs as tourist destination namely; Cal-apog/Mendoza Beach Resort in Brgy. Bunuanan, Basiao Island Beach, Baras Beach in Buri Island, Darahuway Daku and Guti Island, Igot Cove, Malatugawi Island Beach, Payao Beach, Sunshine Beach and Brgy. Guinsorongan and the Waray Banwa Coral Reef.

Cal-apog/Mendoza Beach is very close to Bunuanan that throw its waste in Cugao point making the beach a very good waste destination especially when wind is blowing in SE direction. Baras Beach is also very close to Brgy Estaka that throws its waste directly into the coast fronting them. Mostly during early morning when the water is rising, water foaming is observed which is believed to come from oxygen demanding waste beneath the shores of the nearby community. Guinsorongan beach fronting the town cemetery has improved physically but the quality of its water has deteriorated, beachgoers feel skin itch after swimming, some catch skin disorder illnesses, attributed to dirty seawater [10].

Of all the beaches visited only the uninhabited Basiao Beach was waste free, its distance however makes it unlikely to become a tourist destination. Mainland beaches seem clean during high tide because most of the debris is below water. Large quantities of waste are expected to be seen lined on shores every after strong wind or typhoon.

The major tourist destinations in Catbalogan are beaches and the reefs. Keeping them clean must be the primary concern of everyone.

CONCLUSION AND RECOMMENDATION

Based on the model used, most of the waste thrown directly into the Maqueda bay stays in the bay. The impact has become more than just an eyesore for it now affects the people. All coastal zones with habitation are dirty. Many coastal communities have become used to the dirty coastal zones and have considered it as a normal phenomenon. If no bold steps will be implemented, the problem will continue to escalate.

The following recommendations may help a lot in solving the problems of dirty coastal zones.

- LGU must increase the access of people to waste disposal facilities (WDF). WDF in the island and far-flung barangays must be established.
- Majority of the wastes collected in the coastlines are of plastic origin. The “tingi” or “sachet” culture of Filipinos must be slowly stopped for the said practice produces more waste. LGU’s must take bold steps in controlling the plastic waste. Banning the use of plastic packaging must be explored. A number of communities here and abroad have been successful in controlling the use of plastic [25, 26].
- Establishing municipal/city waste water treatment facility may not be feasible for most towns/cities in Samar due to financial constraints; therefore other strategies to reduce waste water impact must be implemented.
- Waste transport goes beyond barangay boundaries, it is therefore important that control/mitigating activities must be everybody’s concern. Improper waste disposal practices of one community will eventually affect the rest.
- Nationwide implementation of Republic Act 9003 must be enforced. Entities such us SSU and other agencies/organization must take the lead in educating people about the proper waste disposal. Practicing the 3 r’s (reduce, recycle and reuse) in solid waste management will help a lot in solving the growing problem of waste.

- Land use zoning must be developed in such a way that waste disposal in coastal zone will be avoided (i.e coastal highways/roads or buffer roads to separate coastal zones and community, parks fronting the coast).

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