

Research Article

Towards solving coastal debris problems in Catbalogan, Samar and Maqueda Bay, Philippines

Ronald L. Orale*

College of Engineering, Samar State University, Catbalogan City, Philippines.

*Author to whom correspondence should be addressed, email: ronald_catb@yahoo.com

This paper was originally presented at the International Conference on the Role of Universities in Hands-On Education, Chiang Mai, Thailand, August 2009.

Abstract

More than half of Catbalogan baranggays (villages) are situated along the Maqueda Bay, the primary source of food for Samariños. Sixty percent of these coastal baranggays have no direct access to waste disposal facilities such as garbage trucks and landfill. Almost 50% of domestic waste from these baranggays is thrown directly into the sea, while 22% partly dispose their waste into Maqueda Bay or a total of 7201 kg of waste daily. The waste disposal practices of coastal communities have been worsening and impacts of these have started to be felt. Acknowledging the role of the University, SSU students and personnel have implemented programs and projects intended to educate not only the coastal communities but as well as the local government unit of Catbalogan. Intervention includes research and extension work which includes EIC materials development and distribution, dialogue, lectures and consultancy services. The said intervention is very hopeful that it will result into holistic strategies in finally solving the worsening coastal debris problem in Catbalogan Samar and Maqueda Bay.

Keywords: solid wastes, garbage disposal, coastal degradation, coastal debris, Catbalogan, Maqueda Bay

Introduction

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



Figure 1: Samar Island, Philippines

Population, economic growth and waste

The economic activity in the town as well as its population continuously increases. The town population in the 2007 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 baranggays 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% of all beach closures and advisories in 2004, over 19,950 days were results of excessive counts of bacteria in the beach waters (www.physorg.com: 2006). Since waste generation is a function of population, coastal waters of Catbalogan and other coastal communities are expected to become more contaminated.

Coastal debris

Dumping wastes in waterways directly pollutes the water down to the seas and finally to the ocean. Bacteria eat away biodegradable components of the waste using the oxygen in water. Because of this, oxygen in water is depleted which consequently chokes living organisms like fish, and sea grasses. Water turns dirty that it becomes unfit for human use including recreational activities.

Water occupies almost 2/3 of the earth's surface. This size has become a misconception of many people. Because of its vastness, many people have believed that throwing anything into it will not matter. Uninformed individual believes that the seas and the ocean can carry the waste human have been generating ever since.

During the September 2008 International Coastal Cleanup, a total of 6.8 million pounds of trash was collected on selected shores around the world. They removed more than 400 pounds (181 kg) of debris for every mile of beach cleaned.

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.

Role of academic institutions in educating the community

Academic institutions are home of one of the well respected professionals in the Philippines countryside. Teachers, instructors, and professors serves as the mentors of the youth especially during their formative years. The culture in general and its character in particular is significantly influenced by what they have been exposed specifically during their formative years. Exposing them to issues like coastal zone protection and waste management will create a community who are aware of their roles in maintaining livable place. Aside from this, the academic institutions like Samar State University (SSU) is equipped with the necessary skills to undertake research and extension work that will provide relevant, up-to-date information necessary in developing new policies to solve pressing problems of the community.

SSU, the only university in this part of the country is committed to help develop Samar, one of the poorest provinces of the Philippines. With this situation, SSU is trying its best to be of use to the local government units in its serviced area.

Municipal Solid Waste

Waste generated in the Philippines is estimated at 17,871.53 MT per day. Projections show that waste generation will increase 47% by 2010 or about 26,194.95 MT/day (USA Dept. of Commerce: 2007). Typically, wastes in urban city/municipality range 40-50 tons/day. According to the International Panel on Climate Change (IPCC), 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.

Coastal Debris in Maqueda Bay

Coastal debris collected on the Philippine shore is a bit different from the worldwide total. Comprising 55% are plastic bags, followed by paper bags (20%), and food wrappers (8%). According to Cabatbat (2003), waste generated in the Philippines is composed of 5% special wastes, 15% residual, 30% factory returnable, and 50% compostable wastes (25% of the compostable wastes are used as organic fertilizers).

Shown in figure 2 are the top 10 debris collected in the six coastal areas of Catbalogan which constitute about 91% of the total waste. Similar to Philippine Marine Debris Index, topping the list are plastics.

Residents in many 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 has 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 will be insignificant. Some even eat seabed dwelling molluscs in areas near disposal zones. This is an alarming attitude that requires intervention from institutions like SSU and Catbalogan LGU.

Catbalogan population in 2007 national census is about 92,454. According to 2006 IPCC Guidelines, the Philippines per capita generation rate in the year 2000 is about 0.19 tonnes/capita/year or about 0.52kg per day per person. This values mean that Catbalogan

produces around 48 tonnes of wastes daily, 10% (Rapanan: 2003) of these wastes or 4.8 tonnes are uncollected which are dumped in waterways like canals, esteros and rivers. 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 baranggays with no access to dump-trucks and other waste disposal facilities throw their waste directly to the sea that further increase the volume of waste dumped into the sea.

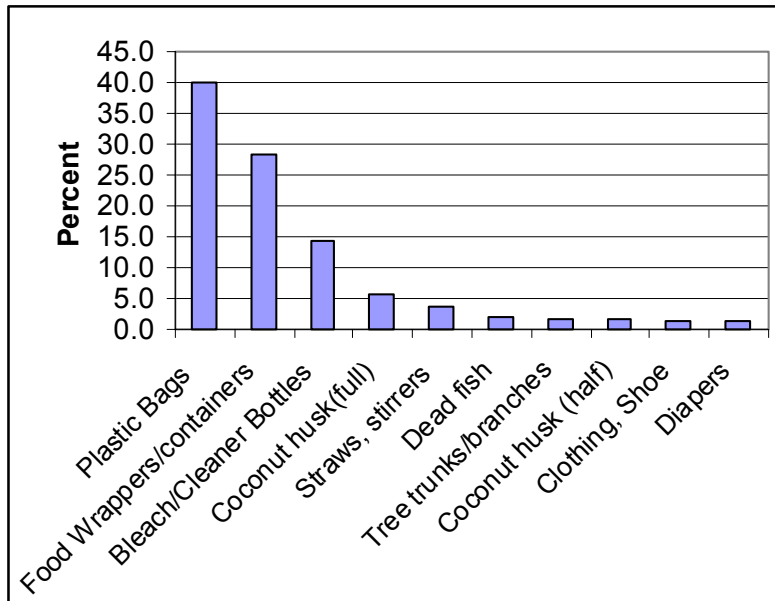


Figure 2. Catbalogan Samar Marine Debris Index.
(Top Ten coastal wastes)

Profile of coastal communities

Approximately, Catbalogan 82.6 km coastline, around 11.06 % or 9.14 km of which is fully inhabited. Around 1.93% or 79.5 hectares of coastal area has been fully inhabited by about 44,155 people and is increasing. Including reclaimed coastal zones in Poblacion Catbalogan, the population would reach to about 57,623.

Table 1. Top 5 reasons for dumping waste in the Sea/Coast.

Reasons	%
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

Around 40% of coastal baranggays close to downtown Catbalogan have access to solid waste disposal facility such as garbage trucks. The rest of the baranggays (60%) throw their wastes somewhere else. Many coastal communities allow throwing waste directly into the shores and some have dumping sites on coastal cliff. Like many towns and cities in the Philippines, domestic waste water runs through canals and into the sea.

Waste disposal practices in the coastal communities

Research about the factors influencing coastal communities' disposal to the sea reveals that inaccessibility to Municipal Solid Waste Disposal Facility (MSWDF) is the major factor. Almost all island and other far-flung baranggays have no ideal disposal site, these situation encourages the residents to dispose their wastes just anywhere. Coastal zones are favorite disposal sites because most of these areas are government owned. Many argue that the wastes they have disposed into the sea are carried by the sea current. According to most of them, the wastes they have thrown disappear after high tide. About 10% of those with access to MSWDF still throw their waste directly into the sea influenced by the irregular waste collection of LGU in Catbalogan.

Table 2. Coastal Communities Waste Disposal into the Sea

Coastal Barangays	No. of Household	Households disposing			Estimated amount of waste disposed into the sea (kg/day)
		all waste into the sea (100%)	their waste partly into the sea	their waste properly	
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 Baranggays	1650	1023 (62%)	363 (20%)	264 (18%)	2614
Total	10153	2263 (49%)	2053 (22%)	5837 (29%)	7201

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.

Table 2 shows the number of household in the coastal baranggays 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% (Cabatbat: 2003) or 3.6 tons will decompose while at sea. The rest of the wastes partly sinks and later floats 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.

Organic silt deposits in selected coastal areas in Catbalogan Samar

All coastal zones directly facing a community have considerable amount of silt deposits of organic origin. The silt deposits are the organic wastes dumped into these areas. These wastes

degrade and are transformed into silt-size sediments, making the beach front dark in colour with foul odor. Shown in Figure 3 is a typical coastal zone in Catbalogan facing a community.



Figure 3. Barangay Estaka Buri organic silt lined shores with debris.

Some Impact of Coastal Waste on Catbalogan and Nearby Towns

Some impacts are visible and some are not. The current state of coastal beds in Catbalogan Samar is a product of long term activities of its people. Impacts that are enumerated in this study are based on the coastal community appraisal and records of SSU-College of Fishery and Marine Sciences R&D office.

Coastal debris

Based on interviews, the community have unanimously agreed that coastal resources as well as shoreline status have worsened and pollution is the major identified culprit. Table 3 summarizes the community appraisal of coastal zones facing their communities.

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 (Estewart:2009). 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 red tide poisoning. The same report however did not identify the main cause of red tide occurrences. In 2008, the green mussel “tahong” industry of Jiabong and Catbalogan suffered heavy losses (90% of production: PhP 38M) due to 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 (ABS-CBN:2009).

Losing marine habitat

More than an eyesore, marine debris also poses threats not only to humans but to marine wildlife as well. According to NOAA (2007), 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 (www.eoearth.org).

Table 3. 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
<p>Legend: (B) Better (S) Same (SW) Slightly worse (W) Worse</p> <p>(C) Clean, no evidence of dirt/litter</p> <p>(MC) Most of the time clean. Litter is carried from other areas.</p> <p>(D) Dirty. Litter is very evident most of the time</p> <p>(VD) Very dirty. All the time, litter is present all the time; sea bed is full of organic silt and is black</p>			

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

Tourism

A 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 are also gifted with long coastlines 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 destinations 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 throws 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 (probably formed due to oxygen demanding waste) is observed which is believed to come from the nearby community. Guinsorongan beach fronting the town cemetery has improved physically but the quality of its water has deteriorated. Beachgoers often complains of skin itch, some even catch skin related disorders which they attribute to the poor quality of beach water.

SSU Intervention Towards Solving Coastal Debris Problems

SSU as a state owned institution has four fold functions such as instruction, research, extension and production. As part of its extension and community involvement program, different Colleges of SSU undertake several projects all intended to have a cleaner Catbalogan.

Coastal clean-up activities

Coastal debris, especially those that are not naturally occurring are an eyesore. Alarmed with the very dirty coastal zone in one of the adapted community of SSU-College of Engineering, the university undertook its first coastal clean-up activity in 2003. Many coastal zones have also been visited and cleaned. Other colleges in the University followed and have conducted coastal clean-up in other coastal baranggays. In one of the consultative meetings with different colleges of the University, personnel and student alike unanimously agreed that the coastal clean-up is not an effective way of solving the problem. The impact of such activity was very low therefore different strategy must be implemented. One of the identified solutions is to develop IEC materials, dialogue with the LGU officials and baranggay folks about the problem. According to NOAA, the problem is more than just removing existing debris. Changing the behavior that cause's marine debris to enter the environment-is the only way to truly manage the marine debris pollution issue.



Figure 4. Coastal Clean-up led by SSU.

R&D activities on waste disposal in Catbalogan

SSU have been conducting waste disposal and waste management researches in the past 10 years. Its faculty and students are encouraged to undertake researches to help solve the pressing problems in the immediate community. Many of its researches have been utilized by the University and by the LGU as inputs in policy making. The project entitled “Solid Waste Management Program: Catbalogan Samar Based Project” conducted in 1997 was the basis of the landfill project of the said town. Other researches about Catbalogan waste include Waste Disposal Practices in Selected Residential Areas in Catbalogan (2003), and Evaluation of the Solid Waste Management of Samar State University (2005) by students in Civil Engineering as a requirement in their environmental engineering subject. Other recent studies include Solid Waste Management of Catbalogan: Basis for Social Intervention (2005) and Coastal Waste Transport in Catbalogan Samar and Nearby Towns (2009) to name a few. The said researches have been very useful in formulating strategies on how to solve the increasing problem on waste especially along coastal zones in Catbalogan.

One of the most recent studies conducted was about the transport of coastal waste in Catbalogan. The study is anchored on a 3D physical model and actual observation. The said study was conducted to support claims of the University that the waste found in the coastal zones of Catbalogan is from many sources. It will also be important information expected to be useful to Catbalogan LGU as it formulates the ten-year Ecological Solid Waste Management Program.

Table 4: 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

Table 4 summarizes the results of the study about where floating waste goes after disposal in selected coastal zones. The said study revealed that wastes are transported beyond municipal and even provincial boundaries. Factors that control the waste transport is primarily due to the wind. Other factors such as seawater temperature, density, salinity and the rotation of the earth has minimal impact on the coastal waste transport.

Table 5. Catbalogan Wastewater Movement.

Wind Direction	Waste Destination	% 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

Wastewater which usually is denser sinks and its movement is indirectly affected by the blowing wind. It also reveals that much of the wastewater stays near the source and some is transported. Table 4 and Figure 3 illustrates possible destination of wastewater dumped in downtown Catbalogan.

Information dissemination activities

The R&D Office of the College of Engineering has developed EIC materials to inform the local communities about waste and the problems associated with it. About five different guides have been developed in waray-waray, the native dialect of Samareños. Aside from this, short waste-related multi-media presentation and product from recycled wastes have been presented for better appreciation of coastal communities. Interview with local communities reveals that the inaccessible MSWDF, low enforcement of environmental laws are the identified culprit of the coastal debris problems.

In the recent study of SSU about waste transport, it clearly cited that waste from one coastal community will be transported to other coastal zones. This means that proper waste disposal must be implemented by everybody. This is also the reason why SSU personnel regularly

participates R&D fora to encourage all to do their part in solving waste problems in the coastal zones.

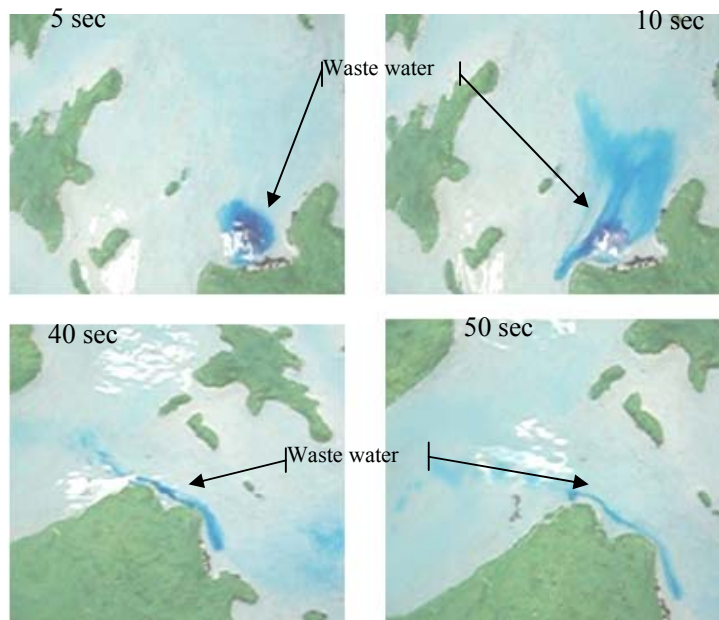


Figure 5. Catbalogan wastewater movement in the 3D Physical Model (NE wind).

The EIC materials were patterned to the tips presented by Marine debris 101 of NOAA, Plastic Debris from Rivers to Sea by Algalita Marine Research Foundation, and clean up the world organization to name a few.



Figure 6. EIC materials distribution and lectures.

SSU level proper solid waste management program

In late 2008, SSU Board of Regents passed a resolution to institutionalize Proper Solid Waste Management activities inside the Campus. It has just recently started implementing the

program after thorough information campaign. Its impact is still to be seen in the near future. SSU believes that by practicing it in the campus will develop a culture that can actually influence more than the coastal clean-up conducted by the University. Expected to be successful, SSU proper solid waste disposal program may become a showcase to other community/organization that waste disposal management is possible.

Consultancy services

In answer to the Philippines Ecological Solid Waste Management Act of 2000, also known as RA 9003, the LGU of Catbalogan formulated a team known as the Catbalogan Solid Waste Management Council to tackle waste related problems. One of the members of the council is the University's VP for Planning R&E.

At the moment, the LGU of Catbalogan is set to approve the 10-year Ecological Waste Management Program. In this program, SSU will be tapped by the LGU in performing some of the provisions in that program, specifically in educating the community.

Recommendations

SSU, the LGU and other stakeholders have a lot more to do to effectively solve the coastal problems specifically those related to wastes. The following recommendations may help a lot in solving the problems of dirty coastal zones in this part of the world.

1. LGU must increase the access of people to waste disposal facilities (WDF). WDF in the island and far-flung barangays must be established.
2. 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.
3. Establishing municipal/city wastewater treatment facility may not be feasible for most towns/cities, therefore other strategies to reduce wastewater impact must be implemented.
4. Waste transport goes beyond baranggay 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.
5. Nationwide implementation of Republic Act 9003 must be enforced. Entities such as SSU and other agencies/organization must take the lead in educating people about the proper waste disposal. Practicing the 4 R's (refuse, reduce, recycle, and reuse) in solid waste management will help a lot in solving the growing problem of waste.
6. 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).

Acknowledgements

The researcher wishes to express his heartfelt acknowledgement to those who have contributed in one way or the other for the successful completion of this study. To my supportive wife Margie; to the fifth year CE students namely; C. Albeza, D. Baylon, G. Cabahog and R. Sagadal for gathering field data; The R&E Office and the College of Engineering for the material support and use of facilities of the College respectively. To Tomas Bañez for the motor boat used in the conduct of the field assessment. SSU-COFMAS for data shared; Engr. Rico Macabare of Catbalogan LGU in sharing their plans and programs to make Catbalogan cleaner; to Engr. Felisa Gomba for the expert advice, Redentor Palencia for editing this paper and to SSU Management for the support extended.

References

1. Algalita Marine Research Foundation, Plastic Debris from Rivers to Sea. www.algalita.org
2. American Metreological Society, 2008, Data Stream Ocean, Ocean in Motion: Ekman Transport Background.
3. Cabatbat A.B., 2003, Separation, Recovery and Recycling, of Municipal Organic Wastes, (<http://www.env.go.jp>)
4. Congress of the Philippines, Solid Waste Management Act of 2000 (RA 9003), (www.emb.gov.ph)
5. Docdocan R., 2009, White tide' killing 'tahong' in Samar town, ABS-CBN, www.abs-cbnnews.com
6. Environmental Protection Agency and National Oceanic and Atmospheric Administration (Content Sources); Jean-Pierre Gattuso (Topic Editor). 2007. "Marine debris." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth August 25, 2006; Last revised February 3, 2007, (http://www.eoearth.org/article/Marine_debris)
7. Furio EF. et.al, Widespread Outbreak of Toxic Red Tide in the Philippines, <http://fol.fs.a.u-tokyo.ac.jp>
8. Global Energy Network Institute (GENI), Surface Current Map, <http://www.geni.org>
9. IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories (NGGI), Prepared by the NGGI Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan
10. National Oceanic and Atmospheric Administration (NOAA) 8/23/07, Marine Debris 101: Land-Based Sources of Marine Debris, Fishing Facts, Boating Facts, Ocean Conservancy 2009 Report, A Rising Tide of Ocean Debris and what can we do about it.
11. Physorg.com, 2009, Coastal Water Contamination Increases with Population, (<http://www.physorg.com>)
12. Rapanan NN, et.al., 2003, Waste disposal practices of selected residential areas in Catbalogan. The SSU-Engineering Peeble, Vol 3 2003-2004, SSU-CoEng'g, Catbalogan Philippines.
13. Reinhart D., 2004, University of Central Florida, College of Engineering & Computer Science. Determining the Chemical Composition of Solid Waste, www.cccs.ucf.edu
14. Sara Lata, 2008, Modeling the currents of the New York Bight & Just when you thought it was safe to go back in the water. (www.ncsa.uiuc.edu)
15. Stewart R. 2009, Harmful Algal Bloom, Our Ocean Planet, Oceanography in the 21st Century-An online textbook, <http://oceanworld.tamu.edu/>

16. Tandoc Jr. EC., 2009, LGU execs face raps for ignoring the law, Philippine Daily Inquirer, www.inquirer.net
17. US Department of Commerce, 2008, (www.buyusa.gov)
18. University of South Florida, 1998, What Causes Ocean Currents and How Do We Measure Them?, 1998 Project Oceanography Spring Series, www.marine.usf.edu
19. Van Veldhuizen, H.D. and N. Aragonés, 1992, Ecological Impacts of Waste Disposal in the Coastal and Marine Environment, pp 91-98 In T.-E. Chua and L.R. Garces (eds) Waste Management in the Coastal Areas of the ASEAN Region, roles of governments, banking institutions, donor agencies, private sector and communities, ICLARM Conference Proceedings 33, 218 p. Ministry of Environment and Canada ASEAN Centre, Singapore; Asian Development Bank, and International Center for Living Aquatic Resources Management, Philippines.