



Observations on the sources of deposition of plastic marine debris on the east coast of Atauro, Timor-Leste

Background

Atauro is an island and municipality of Timor-Leste. Atauro is a small oceanic island situated approximately 30 kms north of Dili, on the extinct Wetar segment of the volcanic Inner Banda Arc, between the Indonesian islands of Alor and Wetar. It is 22 km long, 5–10 km wide, and has an area of 150 km². It has a population of 10302, living in 2177 households (Timor-Leste Census 2022).

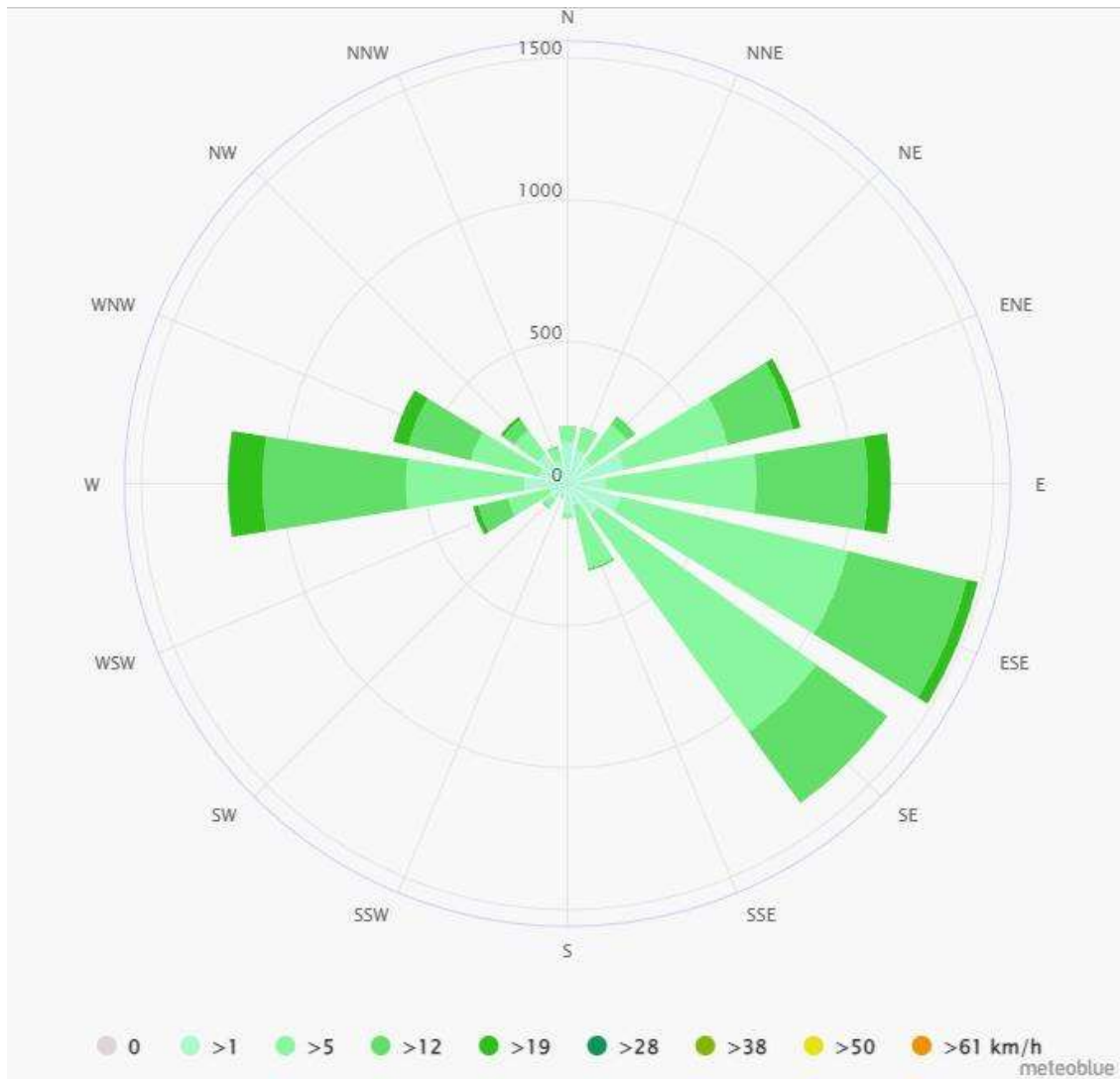


During the months of June-September there are prevailing easterly winds that heavily contribute to the deposition of vast amounts of plastic marine debris on the east coast of Atauro. There are also other possible contributors either directly or indirectly including ocean currents, land-based discharges, marine shipping, artisanal fishing vessels and local passenger and supply vessels.

Prevailing Winds

During the months of June-September the wind on the east coast of Atauro is consistently from the east and brings a large amount of plastic marine debris onshore. A windrose for Atauro is shown below in Figure 1 (Ref 6).

Figure 1



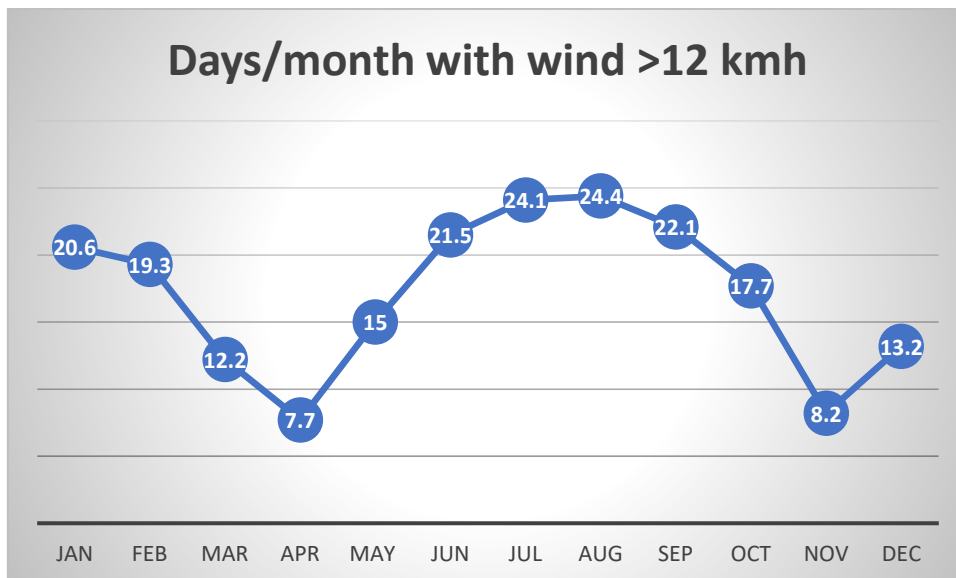
A summary of the hours of duration of these easterly winds is shown in the following Table 1 (Ref 6).

Table 1

Wind Direction (from)	Hours per year
NNE	192
NE	294
ENE	844
E	1138
ESE	1485
SE	1392
SSE	316
Total	5661

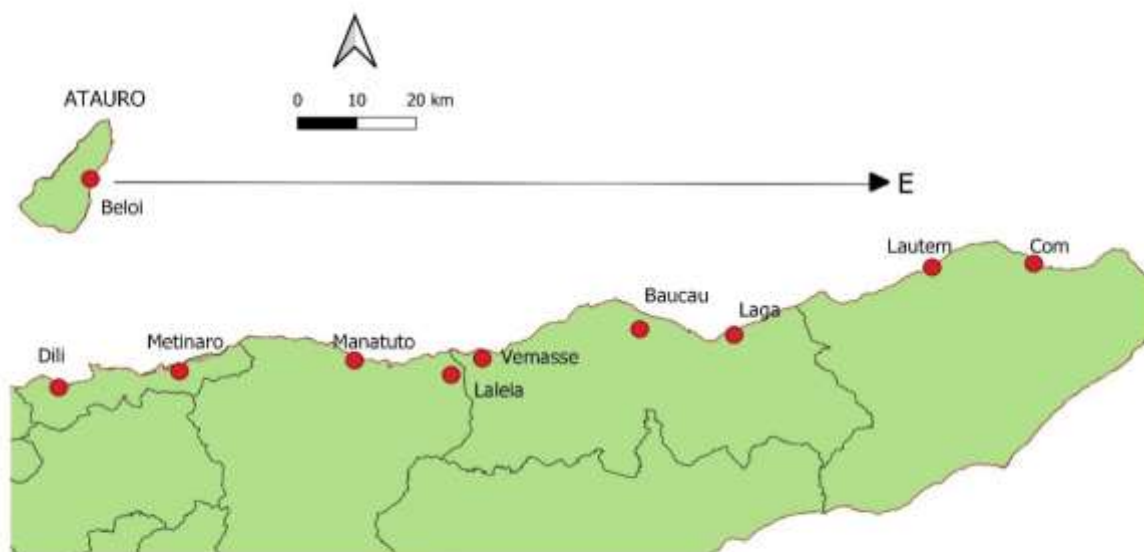
Figure 2 below shows the monthly average of days with wind speed > 12 kmh (Ref 6). The January peak indicates the westerly monsoonal flow.

Figure 2



The following map, Figure 3, shows the relationship of Atauro to the northeast coast of Timor-Leste and possible sources of plastic marine debris along that coast

Figure 3.



Further east there is a large number of Indonesia islands that could also be sources of plastic marine debris.

Figure 4



And this includes the Tanimbar, Kai and Aru Islands.

Figure 5



These islands have populations shown in Table 2 below.

Table 2

Locality	Population (Indonesian National Census 2020)
Wetar	8625
Baber Islands	29078
Damer Islands	5718
Romang Islands	4146
Kisar	18425
Leti Islands	26870
Sermata Islands	5116
Aru Islands	102237
Kai Islands	121511
Tanimbar Islands	123572

Land-based Discharge

Another contributor to plastic marine debris accumulation in the Wetar Strait is the outflow of a number of rivers along the coast between Dili and Com; these include the North Laclo, Seiçal, Lequinamo, Vemasse, Laleia, Roumaco and Dasidora rivers as well as others and minor waterways. These waterways drain vast areas of the hinterlands. Land-based discharge of plastic waste is a major contributor to plastic marine debris (Ref 10, 12).

For example, the North Laclo river is the longest river in Timor-Leste with a drainage area of 1386 km². It discharges into the Wetar Strait at Sau, near Manatuto. The discharge rate ranges from 8.1 m³/second in September to 69.8 m³/second in March. The total mass of discarded plastic waste from the suco and aldeia (village and hamlet) within the catchment is unknown. The extent of the catchment is shown in Figure 6 below (Ref 9).

Figure 6



The data from the Timor-Leste Population and Housing Census 2015, shows the population of Manatuto, Lacleo and Laclubar Sub-districts (Sub-districts now renamed Postu Administrativo) was 34198.

Using the same data source the populations of the 8 Postu Administrativo from eastern Dili municipality to Com is shown in Table 3 below.

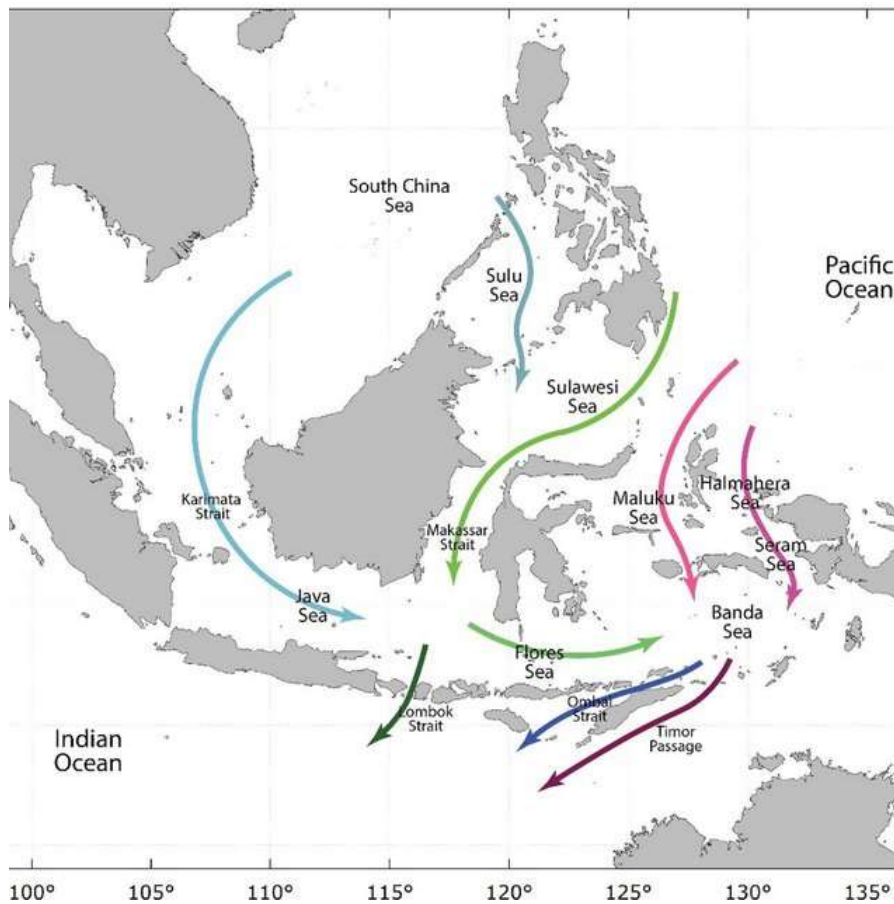
Table 3

Postu Administrativo	Population
Metinaro	5654
Lacleo	7756
Manatuto	14392
Laleia	3689
Vemasse	9643
Baucau	47294
Laga	18359
Lautem	15989
TOTAL	122776

Ocean Currents

Ocean currents may also contribute to the deposition of plastic marine debris on Atauro as the prevailing current is a westward flow through the Wetar Strait along the north coast of Timor island as shown in Figure 7.

Figure 7

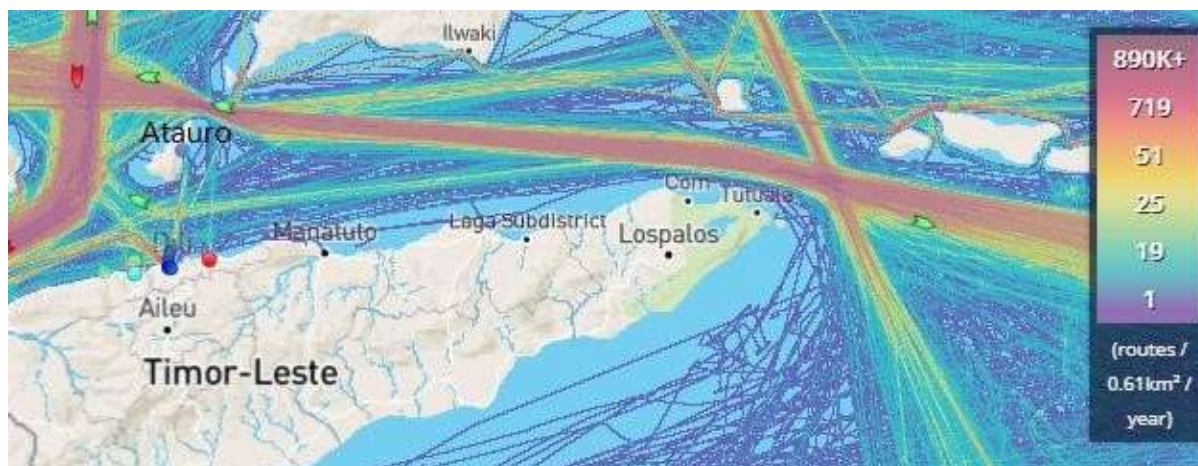


The 'Indonesian Throughflow' is an ocean current with importance for global climate as is the low-latitude movement of warm, relative freshwater from the north Pacific to the Indian Ocean. It thus serves as a main upper branch of the global heat/salt conveyor belt. An important feature of the Indonesian Throughflow is that because the water in the western equatorial Pacific Ocean has a higher temperature and lower salinity than the water in the Indian Ocean, the Throughflow transports large amounts of relatively warm and fresh water to the Indian Ocean. The average flows through the Wetar and Ombai Straits are in the order of 0.11 metres/second. (Ref 1, 2, 3)

Marine Shipping and Artisanal Fishing

International marine shipping has been recognized as a source of plastic marine debris (Refs 4, 5). There is a major marine shipping route through the Wetar Strait passing north of Atauro and is shown in Figure 8 below (Ref 7) The density of traffic in this corridor is greater than 700 route:transits/0.61 km²/year.

Figure 8



Within the Wetar Strait there are also many artisanal fishing boats working these waters plus local passenger and supply routes. It has been reported that in 2019 in Timor-Leste there are 2237 artisanal fishing boats (under 10 metres in length). (Ref 8) An estimate for the coastline from Dili to the eastern tip of Timor Island would give approximately 738 small artisanal fishing boats of Timor-Leste origin operating in the Wetar Strait. The number of these type of boats originating from Indonesian islands such as Liran, Wetar or Kisar is unknown.

There is information on larger vessels in Indonesian waters. In 2019, there was 1599 registered vessels in the Indonesian Fisheries Management Area 718 which runs from Timor-Leste across to Papua (Ref 11). Registered vessels are large vessels of >30 gross tonnes.

Figure 9



Summary

This is a brief summary of some of the contributors to the buildup of plastic marine debris on the east coast of Atauro. Much more work needs to be done to expand on these issues to enable a better understanding of the problem and hopefully guide some efforts in remediation.

References

1. Edwards Taufiqurrahman, A'an J. Wahyudi and Yukio Masumoto. (2020) The Indonesian Throughflow and its Impact on Biogeochemistry in the Indonesian Seas. *ASEAN Journal on Science & Technology for Development* Vol 37, No 1, 2020, 29–35
2. Ming Feng, Ningning Zhang , Qinyan Liu and Susan Wijffels. (2018) The Indonesian throughflow, its variability and centennial change *Geoscience Letters* 5:3
<https://doi.org/10.1186/s40562-018-0102-2>
3. Janet Sprintall, Susan E. Wijffels, Robert Molcard and Indra Jaya. (2009) Direct estimates of the Indonesian Throughflow entering the Indian Ocean: 2004–2006 *Journal of Geophysical Research*, Vol. 114, C07001, doi:10.1029/2008JC005257
4. Mayya Saliba , Sofia Frantzi and Pieter van Beukering (2022) Shipping spills and plastic pollution: A review of maritime governance in the North Sea. *Marine Pollution Bulletin* 181 : 113939
5. Jelena Čulin and Toni Bielić (2016) Plastic Pollution from Ships. *Journal of Maritime & Transportation Science* 51, 57-66 DOI: 10.18048/2016.51.04
6. https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/atauro-island-timor-leste_1651095
7. <https://www.marinetraffic.com/en/ais/home/centerx:125.5/centery:-8.3/zoom:8>
8. López-Angarita J, Hunnam KJ, Pereira M, Mills DJ, Pant J, Teoh SJ, Eriksson H, Amaral L and Tilley A. (2019). Fisheries and aquaculture of Timor-Leste in 2019: Current knowledge and opportunities. Penang, Malaysia: WorldFish. Program Report: 2019-15.
9. Anon (2010) Community-based Integrated Watershed Management in Lacleo and Comoro River Basins in the Democratic Republic of Timor-Leste. Final Report, Volume I: Main Report, March 2010, Japan International Cooperation Agency/Nippon Koei Co., Ltd.
10. Chris Slavin, Anna Grage and Marnie L. Campbell (2012) Linking social drivers of marine debris with actual marine debris on beaches *Marine Pollution Bulletin* 64 : 1580–1588
11. Napitupulu, L., S. Tanaya, I. Ayostina, I. Andesta, R. Fitriana, D. Ayunda, A. Tussadiah, K. Ervita, K. Makhas, R. Firmansyah, and R. Haryanto. (2022). 'Trends in Marine Resources and Fisheries Management in Indonesia.' Report. Jakarta: World Resources Institute Indonesia. Available online at doi. org/10.46830/wriipt.20.00064
12. Jenna R. Jambeck, Roland Geyer, Chris Wilcox, Theodore R. Siegler, Miriam Perryman, Anthony Andrady, Ramani Narayan and Kara Lavender Law (2015) Plastic waste inputs from land into the ocean. *Science* Vol. 347 Issue 6223, 768-771

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